Document 2314440
Facility 441234
Surety ID: 20140095

Pit No. 1 Facility ID: 439235

Form 28 Rev 6/09

State of Colorado
Oil and Gas Conservation Commission

1120 Lincoln Street, Suite 801, Denver, Colorado 80203 (303) 894-2100 Fax: (303) 894-2109

CENTRALIZED E&P WASTE MANAGEMENT FACILITY PERMIT

Submit this Form and accompanying documents for each facility per Rule 908. Financial Assurance in the amount of $50,000 is required to operate each facility.

RECEIVED
FOR OGCC USE ONLY
MAR 23 2015
COGCC
Surety ID: 20140095

OGCC Operator Number: 10150
Name of Operator: Black Hills Exploration & Production
Address: 1515 Wynkoop St., Suite 500
City: Denver **State:** CO **Zip:** 80202

Contact Name and Telephone:
Jessica Donahue
No: 720-210-1333
Fax: 303-566-3344

Surface Owner (if different than above):
Address:
City: **State:** **Zip:** **Phone:**

Facility Name: De Beque Water Station
Address:
City: **State:** **Zip:**
Phone: **Fax:**

Location (QtrQtr, Sec, Twp, Rng, Mer): SESW Sec 29, T8S, R97W
Latitude: 39.32377 N
Longitude: 108.24253 W

Complete the Attachment Checklist

	Oper	OGCC
Site description (topo, geol, hydro)	✓	
Adjacent land use description	✓	
Topographic map	✓	
Site drainage map with structures	✓	
Scaled drawing and survey map	✓	
Facility design & engineering	✓	
Operating plan	✓	
Water analysis report	✓	
Financial assurance	✓	
Closure plan	✓	
Local gov't zoning compliance	✓	
Local gov't permits and notice	✓	

1. Is the site in a sensitive area? ☑ Y ☐ N

2. What are the average annual precipitation and evaporation rates for the site? Precipitation: 12.82 inches/year Evaporation: 78.24 inches/year

3. Has a description of the site's general topography, geology and hydrology been attached? ☑ Y ☐ N

4. Has a description of the adjacent land use been attached? ☑ Y ☐ N

5. Has a 1:24,000 topographic map showing the site location been attached? ☑ Y ☐ N

6. Has a site plan showing drainage patterns, diversion or containment structures, roads, fencing, tanks, pits, buildings and any other pertinent construction details been attached? ☑ Y ☐ N

7. If site is not owned by the operator, is written authorization of the surface owner attached? ☑ Y ☐ N

8. Has a scaled drawing and survey showing the entire section(s) containing the proposed facility been attached? ☑ Y ☐ N

9. What measures have been implemented to limit access to the facility by wildlife, domestic animals or by members of the public? Briefly explain.
The site entire site will be fenced to limit access for people and animals. The ponds will have a floating cover to limit access for birds.

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12. Have surface water diversion structures been constructed to accommodate a 100-year, 24-hour event? ☑ Y ☐ N

13. Has a waste profile been calculated according to Rule 908.b.6? ☑ Y ☐ N

14. Has facility design and engineering been provided as required by Rule 908.b.7? ☑ Y ☐ N

15. Has an operating plan been completed as required by Rule 908.b.8? ☑ Y ☐ N

16. Has ground water monitoring for the site been provided? ☑ Y ☐ N ***Attach Water Analysis Report, Form 25, for each monitoring well installed.***

17. Has financial assurance been provided as required by Rule 704? ☑ Y ☐ N

18. Has a closure plan been provided? ☑ Y ☐ N

19. Have local government requirements for zoning and construction been complied with? ☑ Y ☐ N

20. Have permits and notifications required by local governments and other agencies been provided? ☑ Y ☐ N

Print Name: Jessica Donahue

Signed: [signature] **Title:** Regulatory Technician **Date:** 3/18/15

OGCC Approved: **Title:** **Date:**

CONDITIONS OF APPROVAL, IF ANY:

Facility Number: 441234

WWC ENGINEERING
1275 Maple Street, Suite F - Helena, MT 59601 - (406) 443-3962
Fax (406) 449-0056 - Email: infohln@wwcengineering.com

March 19, 2015

State of Colorado
Oil & Gas Conservation Commission
1120 Lincoln Street, Suite 801
Denver, CO 80203

RE: De Beque Water Station Form 28 Permit Application

Dear COGC Commission:

On behalf of Black Hills Plateau Production, WWC Engineering is submitting a Form 28 permit application for the De Beque Water Station project for review. The De Beque Water Station project is a proposed production water reuse and raw water facility that will conserve water by recycling flow-back and produced water for reuse in well stimulations or drilling. The project is located in the SE ¼ of the SW ¼ of Section 29, Township 8 South, Range 97 West, 6th P.M. as can be seen on Exhibit 1 – Topo Map. The overall proposed De Beque Water Station project will consist of the construction of a pump house, site grading, storm water drainage measures, access roads, an office building and parking lot, fencing, and three produced water storage ponds. This project will be phased with the first phase consisting of one produced water pond (Pond 1), access roads, and storm water drainage measures. Phase 2 will consist of constructing an office building, pump station building and piping infrastructure for Pond 1 operation. Phase 3 will consist of constructing Ponds 2 and 3 separately. A Form 2A Permit Application was submitted to the Colorado Oil and Gas Conservation Commission (COGCC) on February 27, 2014 and approved on September 19, 2014. A Form 15 Permit Application for Pond 1 was submitted to the COGCC on July 7, 2014 and conditionally approved on October 7, 2014. Form 15 Permit Applications for Pond 2 and Pond 3 are submitted concurrently with this application.

A design report and the required Form 28 attachments are included with this submittal to provide the detailed site plan, design cross-sections, and calculations. It is our sincere hope that the requirements have been adequately addressed and that the **Form 28 Permit Application** be approved as soon as possible. Please do not hesitate to contact us should you have any further questions or require additional clarification.

Sincerely,

Shawn Higley, P.E.,
Helena Branch Manager

SH/kg
Enc.: As Noted
cc: Black Hills Plateau Production & File

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FORM 28 Rev 6/09

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Print Name: Jessica Donahue

Signed: _____ Title: Regulatory Technician Date: 3/18/15

OGCC Approved: _____ Title: _____ Date: _____

CONDITIONS OF APPROVAL, IF ANY:

Facility Number:

DE BEQUE WATER STATION FORM 28 PERMIT REPORT

PREPARED FOR:

Black Hills Exploration & Production
A Black Hills Corporation Enterprise

BLACK HILLS PLATEAU PRODUCTION
1515 WYNKOOP STREET, SUITE 500
DENVER CO 80202

PREPARED BY:

WWC ENGINEERING

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HELENA, MT 59601
(406) 443-3962
www.WWCengineering.com

Innovation
Quality
Value

MARCH 2015

De Beque Water Station Form 28 Permit Report

Prepared for: Black Hills Plateau Production
ATTN: Brett Hurlbut
1515 Wynkoop Street, Suite 500
Denver, CO 80202
(303) 566-3356

Prepared by: WWC Engineering
1275 Maple Street Suite F
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(406) 443-3962
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Principal Authors: Kevin Grabinski, P.E., Project Manager

Reviewed by: Shawn Higley, P.E., Helena Branch Manager
Drew Pearson, P.E., Project Engineer

Date: March 2015

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INTRODUCTION

The De Beque Water Station project is a proposed production water reuse and raw water facility for Black Hills Plateau Production (Black Hills) that will conserve water by recycling flow-back and produced water for re-use in well stimulations or drilling. The De Beque Water Station will generally consist of a site enclosed by security fence that contains three lined storage ponds, a pump station, an office building, a laydown yard, and storm water facilities (see Exhibit 1). The project is located in the SE ¼ of the SW ¼ of Section 29, Township 8 South, Range 97 West, 6th P.M. A Form 2A Permit Application was submitted to the Colorado Oil and Gas Conservation Commission (COGCC) on February 27, 2014 and approved on September 19, 2014. A Form 15 Permit Application for Pond 1 was submitted to the COGCC on July 7, 2014 and conditionally approved on October 7, 2014.

The relatively remote nature of Black Hills' operations necessitates the construction of this facility so that water produced during the drilling, completion and production of natural gas wells in the area may be collected and stored in a central location for reuse in operations or disposal. This facility is designed to provide a consolidated system of water storage impoundments (or ponds) that Black Hills will use to efficiently and safely transport water around their field(s). The construction of the water impoundments facility and associated pipeline infrastructure at this location will enhance Black Hills's ability to reuse produced water in its operations and will minimize the need for trucking water thereby increasing the safety of both the company's operations and reducing their impact on neighboring properties and the environment. The proposed storage capacity will enable Black Hills to store water during low demand days and reduce or eliminate trucking water to a commercial disposal site.

Per the COGCC 100 Series rules, the De Beque Water Station will be a non-commercial centralized E&P waste management facility. According to the COGCC, a Centralized E&P Waste Management Facility shall mean a facility, other than a commercial disposal facility regulated by the Colorado Department of Public Health and Environment, that (1) is either used exclusively by one owner or operator or used by more than one operator under an operating agreement; and (2) is operated for a period greater than three (3) years; and (3) receives for collection, treatment, temporary storage, and/or disposal of produced water, drilling fluids, completion fluids, and any other exempt E&P wastes that are generated from two or more production units or areas or from a set of commonly owned or operated leases. Black Hills intends to operate this facility for more than three years and therefore is required to submit a Form 28 Application to the COGCC. This report provides additional information required by

COGCC Rule 704 and the 900 Series Rules and is submitted as a supplement to the Form 28 Application.

Black Hills has worked with Mesa County to secure local permitting approval for a Conditional Use Permit, Building Permit, and a Wastewater Permit for an on-site septic tank and drainfield that services the office building. Copies of these permits have been provided as required by the COGCC rules. A well will not be drilled for potable water due to the significant depth required to reach an aquifer. Potable water will be hauled to the site as needed and stored in underground cisterns adjacent to the office building.

This facility will contain three lined storage ponds that also fall under the jurisdiction of the Colorado Division of Water Resources (CODWR). Pond 1 is classified by the CODWR as a non-jurisdictional size dam. Ponds 2 and 3 are classified as minor jurisdictional size dams. Black Hills is currently working with the CODWR to permit the minor jurisdictional dams for Ponds 2 and 3.

FORM 28 APPLICATION ATTACHMENTS

The Form 28 application has required Attachments that must be provided with the application. The required attachments are provided with this report in the locations noted in Table 1 below:

Table 1. Form 28 Required Attachment Locations

Item	Location
Site Description (topo, geol, hydro)	Report Body
Adjacent Land Use Description	Report Body
Scaled Drawing and Survey Map	Exhibit 2
Topographic Map	Exhibit 3
Site Drainage Map with Structures	Appendix B
Financial Assurance	Appendix C
Closure Plan	Appendix C
Water Analysis Report	Appendix I
Facility Design & Engineering	Appendix G
Operating Plan	Appendix J
Local Government Zoning Compliance	Appendix L

SITE DESCRIPTION

The project site is located on the south side of County Road V 2/10 within Mesa County parcel # 2445-293-00-225. This parcel contains approximately 23.32 acres that is owned by Black Hills. The remaining 15.96 acres of this quarter-quarter is utilized by Red Rock Gathering Company for their compressor station.

The existing ground cover and vegetation is mostly bare ground with low density native grass and scrub brush. Soil data has been obtained from the National Resources Conservation Service (NRCS) Web Soil Survey to provide an overview of the soil types located at the project site. From the NRCS Web Soil Survey, the predominate soils on the site are comprised of Bunkwater very fine sandy loam, 1 to 8 percent slopes and Dominguez clay loam, 3 to 8 percent slopes. The topography of the site is fairly consistent with a general slope from the northwest corner to the southeast corner of the parcel. The site has approximately 47 feet of elevation difference across the site with an average slope of 2.7%. A copy of the NRCS Web Soil Survey Map and description is provided in Appendix A with a Geological Hazard report.

United States Geologic Survey (USGS) geological maps created by Donnell et al in 1992 of the De Beque Quadrangle suggest that the site is underlain by the Molina member of the Wasatch Formation. This formation consists of mudstone and claystone with fine-to-coarse grained sandstone beds. The thickness of the sandstone beds varies by location, but the beds are generally less than 20 feet thick (Donnell et al, 1992). In locations where the Molina member of the Wasatch Formation has been eroded by the Colorado River and its tributaries, the soil is expected to consist of alluvium material typical of stream-bed, low alluvial terraces, and floodplain deposits. A Geological Hazard Report is provided in Appendix A.

The site contains two small ephemeral drainages that traverse through the property generally towards the southeast. The site does not contain any existing drainage structures or detention areas. The proposed development will require the redirection of the northern ephemeral drainage along the boundary the site. The southern ephemeral drainage passes through only the southwest corner of the property and will remain in its natural state. The proposed development will not alter the flow path for the southern ephemeral drainage. A Hydrology and Stormwater Report is provided in Appendix B and the figures within this report show these existing drainages. An approval letter from Mesa County is also included in Appendix B.

Adjacent Land Use Description

The northwest corner of this quarter-quarter is owned by Red Rock Gathering Company, LLC and utilized for their compressor station with the remainder of the quarter-quarter owned by Black Hills. The area to the west of the site is privately owned and undeveloped (County parcel # 2445-293-00-216). The area to the north of the site is privately owned and undeveloped (County parcel # 2445-293-00-270). The area east of the site is mostly undeveloped with a small industrial facility and is owned by Chevron (County parcel # 2445-294-00-140). The area south of the site is undeveloped and is

owned by the Bureau of Land Management (County parcel # 2445-194-00-914). As such, there exists a very low risk of impact or influence from the facility to offsite sources.

COGCC RULES

700 Series Rules

704. Centralized E&P Waste Management Facilities

An operator which makes application for an offsite, centralized E&P waste management facility shall, upon approval and prior to commencing construction, provide to the Commission financial assurance in an amount equal to the estimated cost necessary to ensure the proper reclamation, closure, and abandonment of such facility as set forth in Rule 908.g, or in an amount voluntarily agreed to with the Director, or in an amount to be determined by order of the Commission. Operators of centralized E&P waste management facilities permitted prior to May 1, 2009 on federal land and April 1, 2009 for all other land shall, by July 1, 2009, comply with Rule 908.g and this Rule 704.

A reclamation cost estimate has been provided for the facility that is itemized by phase of construction and a copy is provided in Appendix C with the closure reclamation plan. The financial assurance for the facility shall be provided upon approval of the cost estimate and Form 28 application by COGCC.

708. General Liability Insurance

All operators shall maintain general liability insurance coverage for property damage and bodily injury to third parties in the minimum amount of one million dollars ($1,000,000) per occurrence. Such policies shall include the Commission as a "certificate holder" so that the Commission may receive advance notice of cancellation.

A copy of Black Hills general liability insurance coverage is provided in Appendix D. The policy lists the Commission as a "certificate holder" as required by Rule 708.

900 Series Rules

902. Pits – General and Special Rules

Rule 902.a *requires that any pits used for exploration and production of oil and gas shall be constructed and operated to protect public health, safety, and welfare and the environment, including soil, waters of the state, and wildlife, from significant adverse environmental, public health, or welfare impacts from E&P waste, except as permitted by applicable laws and regulations.*

The ponds for this facility have been designed with a liner system that will prevent contamination of the existing ground water and soils. This liner system will be described in detail under Rule 904.

Black Hills has been working with the Colorado Parks and Wildlife office to ensure that proper wildlife deterrents will be incorporated into the De Beque Station facilities. The proposed wildlife BMP plan is located in Appendix E. A brief overview of the best management practices that are included in this plan are:

- A 7-foot high chain-link fence capable of preventing elk, deer and other wildlife from entering the pit; concurrently with a small mesh type of fencing along the bottom of the fence (buried one-foot below grade level and extending two-feet above grade) capable of preventing small animals from entering between the gaps. This fence will have three strands of barb wire running across the top which will deter unauthorized personnel from entering the site.
- Hexprotect floating tiles cover to prevent waterfowl and other birds from coming in contact with water in the pits for Pond 1. Upon approval from the COGCC, Hexprotect floating tiles will be used to cover Ponds 2 and 3 as well.
- Bear proof trash containers will be provided
- Night lighting will be full-cutoff type and/or timed or otherwise minimized to reduce disruption to wildlife.

Rule 902.b *requires pits shall be constructed, monitored, and operated to provide for a minimum of two (2) feet of freeboard at all times between the top of the pit wall at its point of lowest elevation and the fluid level of the pit. A method of monitoring and maintaining freeboard shall be employed. Any unauthorized release of fluids from a pit shall be subject to the reporting requirements of Rule 906.*

Ponds 1, 2, and 3 have been designed with a total freeboard of 3 feet with a freeboard of 2 feet below the crest elevation of the spillway that is required by the Colorado Division of Water Resources (CODWR). The COGCC and CODWR jointly developed a Draft Policy Memorandum No. 01-14 regarding spillway requirements for “Produced Water Pond Dams”. A copy of the draft policy is provided in Appendix F. The water level in the pond will fluctuate as water is pumped to and from off-site locations. The water level will be monitored in the proposed pump house via a pressure transducer that will be installed in the bottom of the ponds. Operation controls and warnings will be enforced to ensure that 2 feet of freeboard below the spillway is maintained at all times. While not anticipated, if fluids are released from the pit all reporting requirements of Rule 906 will be followed.

Rule 902.c *requires that any accumulation of oil or condensate in a pit be removed within twenty-four (24) hours of discovery. Operators shall use skimming, steam cleaning of exposed liners, or other safe and legal methods as necessary to maintain pits in clean condition and to control hydrocarbon odors. Only de minimis amounts of hydrocarbons may be present unless the pit is specifically permitted for oil or condensate recovery or disposal use. A Form 15 pit permit may be revoked by the Director and the Director may require that the pit be closed if an operator repeatedly allows more than de minimis amounts of oil or condensate to accumulate in a pit. This requirement is not applicable to properly permitted and properly fenced, lined, and netted skim pits that are designed, constructed, and operated to prevent impacts to wildlife, including migratory birds.*

Produced water will undergo primary separation from oil and condensate on the well pads before produced water is piped to the DeBeque Station. When produced water is returned to the facility it will run through a secondary oil skimming chamber located within the proposed pump station before it will be stored in the lined Ponds. Any oil or condensate collected from the skimming chamber will be stored in a buried tank outside the building. Oil and condensate collected at the facility will be transported off-site by trucks from the facility on an as-needed basis. The pump station building contains a vapor wall separating the skimming chamber from the main portion of the building and all components within this section of the building are explosion rated. Engineering plans are attached showing the building location on the site. If any oil or condensate is discovered within the pond, action will be taken within 24 hours to ensure that it is removed safely and legally.

Rule 902.d *requires that where necessary to protect public health, safety and welfare or to prevent significant adverse environmental impacts resulting from access to a pit by wildlife, migratory birds, domestic animals, or members of the general public, operators shall install appropriate netting or fencing.*

As described in detail under Rule 902.a, appropriate fencing will prevent access to the facility from wildlife, domestic animals, or members of the general public. In the unlikely event that animals do enter the facility, wildlife escape ramps are provided along the perimeter fencing to allow the animals to escape. Floating hextiles will be installed at this facility to prevent migratory birds from landing in the ponds. These measures will prevent adverse impacts to wildlife and the general public.

Rule 902.e *requires that pits used for a period of no more than three (3) years, or more than three (3) years if the Director has issued a variance, for storage, recycling, reuse, treatment, or disposal of E&P waste or fresh water, as applicable, may be permitted in accordance with Rule 903 to service multiple wells, subject to Director approval.*

Ponds 1, 2 and 3 will be used for a period of time exceeding three years and will be used for the storage, recycling, and reuse of raw and produced water. A Form 15 has

already been submitted for Pond 1 and approved with conditions by the COGCC. Form 15s will be submitted concurrently with this Form 28 Application for Ponds 2 and 3 along with design reports and engineering plans in accordance with Rule 903.

Rule 902.h *requires that produced water shall be treated in accordance with Rule 907 before being placed in a production pit.*

The produced water stored in Ponds 1, 2 and 3 will be treated in accordance with Rule 907 before being placed in the production pit. The treatment is explained in further detail for Rule 907.

Rule 902.i *requires that operators shall utilize appropriate biocide treatments to control bacterial growth and related odors as needed.*

Ponds 1, 2 and 3 will have an aeration system installed in order to prevent the water from becoming stagnant and thus reducing the possibility of odors. The floating hextiles on the surface will also reduce evaporation and help reduce the possibility of odors. If needed, biocide treatments shall be used to control bacterial growth and odors.

903 Pit Permitting/Reporting Requirements

Rule 903.a.(4) *requires that An Earthen Pit Report/Permit, Form 15, shall be submitted to the Director for prior approval for the following pits:*

Multi-well pits containing produced water, drilling fluids, or completion fluids that will be recycled or reused, except where reuse consists only of moving drilling fluids from one (1) oil and gas location to another such location for reuse there.

A Form 15 permit was previously submitted for Pond 1 and approved with conditions by the COGCC. Form 15s for Ponds 2 and 3 are submitted as required by Rule 903 simultaneously with this Form 28 Application.

904 Pit Lining Requirements and Specifications

Rule 904.a *requires that pits that were constructed before May 1, 2009 on federal land, or before April 1, 2009 on other land shall comply with the rules in effect at the time or their construction. The following pits shall be lined if they are constructed on or after May 1, 2009 on federal land, or on or after April 1, 2009 on other land:*

All of the proposed ponds will be constructed after the April 1, 2009 date and will contain produced water from hydraulic fracturing. Ponds 1, 2 and 3 will be lined in accordance with Rules 904.b and 904.d.

Rule 904.b *requires the following specifications shall apply to all pits that are required to be lined:*

(1) *Materials used in lining pits shall be of a synthetic material that is impervious, has high puncture and tear strength, has adequate elongation, and is resistant to*

deterioration by ultraviolet light, weathering, hydrocarbons, aqueous acids, alkali, fungi or other substances in the produced water.

(2) *All pit lining systems shall be designed, constructed, installed, and maintained in accordance with the manufacturer's specifications and good engineering practices.*

(3) *Field seams must be installed and tested in accordance with the manufacturer specifications and good engineering practices. Testing results must be maintained by the operator and provided to the Director upon request.*

The liner used in Ponds 1, 2 and 3 will be a 60-mil HDPE liner and will meet all the requirements of this rule. A copy of the material specifications for the 60-mil HDPE liner is included in Appendix G. The HDPE pit lining systems will be designed, constructed, installed and maintained in accordance to the manufacturer's specifications. A representative from the lining company will be on-site during the field installation to ensure that the liner is installed properly. The manufacturer will have a representative on-site during the field seeming process and during testing to ensure that they are seamed to the manufacturer's specifications. The operator will maintain all test results that are performed on the liner.

Rule 904.d *requires the following specifications shall also apply to pits used at centralized E&P waste management facilities, unless an oil and gas operator demonstrates to the satisfaction of the Director that a liner system offering equivalent protection to public health, safety, and welfare, including the environment and wildlife resources, will be used:*

(1) *Liners shall have a minimum thickness of sixty (60) mils. The synthetic or fabricated liner shall cover the bottom and interior sides of the pit with the edges secured with at least twelve (12) inch deep anchor trench around the pit perimeter. The anchor trench shall be designed to secure, and prevent slippage or destruction of, the liner materials.*

Pond 1 has been lined with several layers to prevent the produced water from leaking into the adjacent soils. The primary liner on the surface is a 60-mil HDPE liner. The next layer beneath the primary liner is a 200-mil geocomposite drainage material. Should a puncture occur in the primary liner layer this geocomposite layer will facilitate the flow of the water to the leak detection system to allow for a timely response to any unlikely punctures of the primary liner. The next layer beneath the geocomposite layer is a secondary 60-mil HDPE liner. This layer is a backup liner that will prevent produced water from leaking into the soil shall a puncture occur in the primary liner. This secondary liner in conjunction with the geocomposite drainage material will convey any leaking water to leak detection system located at the low corner of the pond. A geosynthetic clay liner fabric is placed beneath the secondary liner to provide

separation between the soil and liner and act as a liner foundation. The liner is anchored with an 18” down, 18” over, and 12” up key trench configuration as recommended by the manufacturer that can be seen on the attached engineering plans. Ponds 2 and 3 will be constructed using the same liner configuration as Pond 1.

(2) *The foundation for the liner shall be constructed with soil having a minimum thickness of twenty-four (24) inches after compaction covering the entire bottom and interior sides of the pit, and shall be constructed so that the hydraulic conductivity shall not exceed 1.0 X 10^{-7} cm/sec after testing and compaction. Compaction and permeability test results measured in the laboratory and field must be maintained by the operator and provided to the Director upon request.*

A geosynthetic clay liner will installed in place of the 24-inch compacted liner foundation as allowed by the COGCC.

(3) *As an alternative to the soil foundation described in Rule 904.d.(2), a secondary liner consisting of a geosynthetic clay liner, which is a manufactured hydraulic barrier typically consisting of bentonite clay or other very low permeability material, supported by geotextiles or geomembranes, which are held together by needling stitching, or chemical adhesives, may be used.*

A geosynthetic clay liner (GCL) will be installed in place of the 24-inch compacted liner foundation. The GCL will have geotextile built into the fabric. The GCL will be placed on compacted clay soil which will reduce the probability of a puncture. This GCL is shown on the attached Engineering Plans.

Rule 904.e *requires that in Sensitive Areas, the Director may require a leak detection system for the pit or other equivalent protective measures, including but not limited to, increased record-keeping requirements, monitoring systems, and underlying gravel fill sumps and lateral systems.*

The proposed facility is located within a sensitive area due to a down-gradient water surface feature (canal) that is located approximately 366 feet from the property boundary. Per consultation with Jim Komatinsky of the Colorado Parks and Wildlife department, the proposed Oil and Gas Location is also within a sensitive wildlife habitat. These habitats are the mule deer critical winter range, black bear habitat, and the white-tailed prairie dog colonies. The site is not within a restricted surface occupancy area. A leak detection system will be constructed in the low corner of each Pond. The low corner is the corner of each pond that the pond bottom is sloped toward. The system will consist of a gravel sump with a six inch diameter PVC pipe placed between the 200-mil geocomposite layer and the secondary 60-mil HDPE liner layer. If a leak occurs in the primary liner the produced water will flow to the low corner of the pond where it can be detected via the PVC pipe. A detail of the leak detection system is located in the attached Engineering Plans.

905 Closure of Pits

Rule 905.b *requires that pits not used exclusively for drilling operations, buried or partially buried produced water vessels, and emergency pits shall be closed in accordance with an approved, Form 27. The workplan shall be submitted for prior Director approval and shall include a description of the proposed investigation and remediation activities in accordance with Rule 909.*

A Form 27 Site Investigation and Remediation Workplan will be completed in accordance with Rule 909 and submitted prior to closure of any of the pits used for this facility. Black Hills will ensure that soils and ground water meet the concentration levels of Table 910-1; the E&P waste shall be treated or disposed in accordance with Rule 907; the synthetic liner material shall be removed and disposed in accordance with applicable legal requirements for solid waste disposal; and the soil beneath the low point of the pit shall be sampled to verify no leakage of the produced water.

906 Spills and Releases

Rule 906.a *requires that spills/releases of E&P waste, including produced fluids, shall be controlled and contained immediately upon discovery to protect the environment, public health, safety, and welfare, and wildlife resources. Impacts resulting from spills/releases shall be investigated and cleaned up as soon as practicable. The Director may require additional activities to prevent or mitigate threatened or actual significant adverse environmental impacts on any air, water, soil or biological resource, or to the extent necessary to ensure compliance with the concentration levels in Table 910-1, with consideration to WQCC ground water standards and classifications.*

In the event that any produced water is spilled at this facility, Black Hills will control and contain the spill upon discovery, investigate the spill, and clean up the spill as soon as practicable as required within Rule 906.a..

Rule 906.b *requires that spills/releases of E&P waste shall be reported on COGCC Spill/Release Report, Form 19. An 8 1/2 x 11 inch topographic map showing the governmental section and location of the spill shall be included. Such report shall also include information relating to initial mitigation, site investigation, and remediation. Spills/releases which exceed twenty (20) barrels of an E&P waste, or which impact or threaten to impact any waters of the state, residence or occupied structure, livestock, or public byway shall also be verbally reported to the Director as soon as practicable, but not more than twenty-four (24) hours after discovery. Spills/releases of any size which impact or threaten to impact any surface water supply area shall be reported to the Director and to the Environmental Release/Incident Report Hotline (1-877-518-5608). Spills and releases that impact or threaten a surface water intake shall be verbally reported to the emergency contact for that facility immediately after discovery. Chemical spills and releases shall be reported in accordance with applicable state and federal*

laws, including the Emergency Planning and Community Right-to-Know Act, the Comprehensive Environmental Response, Compensation, and Liability Act, the Oil Pollution Act, and the Clean Water Act, as applicable.

In the event that any produced water is spilled at this facility, Black Hills will control and contain the spill upon discovery; investigate the spill and clean up the spill as soon as practicable; and report the spill and submit a Form 19 as required within Rule 906.b.

907 Management of E&P Waste

Rule 907.c *requires that produced water shall be treated prior to placement in a production pit to prevent crude oil and condensate from entering the pit. This rule also allows for produced water to be reused for enhanced recovery, drilling, and other approved uses in a manner consistent with existing water rights and in consideration of water quality standards and classifications established by the WQCC for waters of the state, or any point of compliance established by the Director pursuant to Rule 324D.*

The produced water will receive primary separation at the well head from crude oil and condensate as previously described for Rule 902.c. When produced water is returned to the facility it will run through an oil skimming chamber located within the proposed pump station for secondary treatment before it will return to the Ponds. The produced water will be stored within the lined ponds and subsequently reused for enhanced recovery, drilling, and other approved uses.

Rule 907.e *requires that oily waste includes those materials containing crude oil, condensate or other E&P waste be treated or disposed of at a commercial solid waste disposal facility; Land treatment onsite; or Land treatment at a centralized E&P waste management facility permitted in accordance with Rule 908.*

Any oil or condensate collected by the oil skimming chamber will be stored in an underground tank on-site and transported periodically from the site by truck and sold with oil collected from the well sites. Any waste material generated on-site will be properly disposed of as required by this rule.

908. Centralized E&P Waste Management Facilities

Rule 908.a *states that operators may establish non-commercial, centralized E&P waste management facilities for the treatment, disposal, recycling or beneficial reuse of E&P waste. This rule applies only to non-commercial facilities, which means the operator does not represent itself as providing E&P waste management services to third parties, except as part of a unitized area or joint operating agreement or in response to an emergency. Centralized facilities may include components such as land treatment or land application sites, pits, and recycling equipment.*

Black Hills intends to operate this facility as a non-commercial, centralized E&P waste management facility for the storage and recycling of E&P waste to frac and develop subsequent wells as a beneficial reuse of the produced water. Black Hills will not operate this as a commercial facility and will not accept E&P wastes from third parties.

Rule 908.b.(1) *requires that the application shall contain the name, address, phone and fax number of the operator, and a designated contact person.*

The required information is provided below:

Operator Name:	Black Hills Plateau Production
Address:	1515 Wynkoop St., Suite 500
	Denver, CO 80202
Phone:	(303) 566-3356
Fax:	(720) 210-1363
Contact Person:	Brett Hurlbut

Rule 908.b.(2) *requires that the application shall contain the name, address, and phone number of the surface owner of the site, if not the operator, and the written authorization of such surface owner.*

Black Hills is the surface owner for this facility and can be contacted at the address or phone number provided for Rule 908.b.(1).

Rule 908.b.(3) *requires that the application shall provide the legal description of the site.*

The site is located within a parcel of land situated in the SESW, Section 29, Township 8 South, Range 97 West of the 6th Principal Meridian, Mesa County, Colorado. The address for the parcel is currently unassigned by Mesa County. A survey map required by Rule 908.b.(5).B. is also shown on Exhibit 2.

Rule 908.b.(4) *requires that the application shall provide a general topographic, geologic, and hydrologic description of the site, including immediately adjacent land uses, a topographic map of a scale no less than 1:24,000 showing the location, and the average annual precipitation and evaporation rates at the site.*

The general topographic, geologic, hydrologic description of the site, and the adjacent land uses was described previously in the report. The topographic map is provided on Exhibit 3. The average annual precipitation in the area of the facility is approximately 12.82 inches as shown in Table 2 (average of the Palisade (056266) and Parachute (056311) Climate Stations as reported from the Western Regional Climate Center). The average annual pan evaporation rate in the area of the facility is approximately 78.24 inches (average of the Grand Junction 6 ESE and Grand Junction Walker Climate

Stations as reported from the Western Regional Climate Center). Backup data for the average evaporation rate is provided in Appendix H.

Table 2. Average Annual Precipitation

Station	Annual Average Precipitation (in)
PALISADE, COLORADO (056266)	9.88
PARACHUTE, COLORADO (056311)	15.76
Average	**12.82**

Rule 908.b.(5).A. *requires that the application shall provide a site plan showing drainage patterns and any diversion or containment structures, and facilities such as roads, fencing, tanks, pits, buildings, and other construction details.*

A site plan showing the drainage patterns, diversions and containment structures as well as the facilities, including ponds, roadways, fencing, and buildings is shown on Exhibit 4. Detailed drawings are provided with the attached engineering plans. A run-on interception ditch is constructed along the west property boundary to intercept run-on from upstream drainage areas and convey the water around the site to the existing natural drainage on the south side of the facility. Run-off control ditches are constructed along the south, north, and east property boundaries to intercept run-off from the site and convey the water to a detention pond located in the southeast corner of the property.

Rule 908.b.(5).B. *requires that the application shall provide scaled drawings of entire sections containing the proposed facility. The field measured distances from the nearer north or south and nearer east or west section lines shall be measured at ninety (90) degrees from said section lines to facility boundaries and referenced on the drawing. A survey shall be provided including a complete description of established monuments or collateral evidence found and all aliquot corners.*

A scaled drawing show the facility location within the section is shown on Exhibit 2. The distances from the section lines have been measured and dimensioned on the drawing at ninety degree angles from said section lines as required.

Rule 908.b.(5).C. *requires that the facility shall be designed to control public access, prevent unauthorized vehicular traffic, provide for site security both during and after operating hours, and prevent illegal dumping of wastes. Appropriate measures shall also be implemented to prevent access to the centralized facility by wildlife or domestic animals.*

The entire facility will be fenced and gates will be provided to control access to the facility. These will prevent unauthorized vehicular traffic, prevent illegal dumping of

wastes, and provide for site security. The layout for the fence and gate is shown on the attached Engineering Plans.

Rule 908.b.(5).D. *requires that the facility shall have a fire lane of at least ten (10) feet in width around the active treatment areas and within the perimeter fence. In addition, a buffer zone of at least ten (10) feet shall be maintained within the perimeter fire lane.*

The facility provides fire lanes that are at least ten (10) feet in width around the site that also include the required ten (10) feet wide buffer zones. This is provided for the facility by using the top of the berm around the ponds and uses the access road to the laydown yard around the pump station. The fire lanes are shown on the attached Engineering Plans.

Rule 908.b.(5).E. *requires surface water diversion structures, including, but not limited to, berms and ditches, shall be constructed to accommodate a one hundred (100) year, twenty four (24) hour event. The facility shall be designed and constructed with a run-on control system to prevent flow onto the facility during peak discharge and a run-off control system to contain the water volume from a twenty-five (25) year, twenty-four (24) hour storm.*

The facility has a storm water conveyance system that will convey water from the 100-year, 24-hour event, and will detain storm water from the 25-year, 24-hour event. A run-on control ditch is provided along the west property line that will intercept upstream surface water and convey it to the natural drainage basin located south of the facility. The storm water design report has been submitted to and approved by Mesa County. A copy of the Mesa County approved storm water report is included in Appendix B-2 with the site drainage map. A HydroCAD™ Report for the 100-year, 24-hour event (not required by Mesa County) is also included in Appendix B-3. The HydroCAD™ models also use precipitation depths from older NOAA Atlas 2 as model inputs, which are higher than the more recently issued NOAA Atlas 14 for Colorado, resulting in a conservative grading and drainage design.

Rule 908.b.(6) Waste Profile *requires that for each type of waste, the amounts to be received and managed by the facility shall be estimated on a monthly average basis. For each waste type to be treated, a characteristic waste profile shall be completed.*

This facility will receive produced water for storage and reuse from wells in the general vicinity. A typical water chemistry profile is provided in Appendix I that is representative of wells that have been previously developed in the region. A map is also provided in Appendix I showing the location of the De Beque Station in relation to the three fields that this facility will be serving (Homer Deep Unit, Horse Shoe Canyon Unit, and the Winter Flats Unit). The volume of water received by the facility will be variable based on the frequency at which Black Hills develops new wells. Black Hills anticipates using approximately 500,000 barrels of water per well frac and anticipates recovering 20% to

30% of this volume as produced water that will be stored at the facility for the next subsequent well development.

Rule 908.b.(7) Facility Design and Engineering *requires the facility design and engineering data, including plans and elevations, design basis, calculations, and process description.*

The Engineering Plans for the facility are bound separately and attached. A geotechnical report with the site bore logs, analyses results, and slope stability modeling results is provided in Appendix G. The slope stability models use conservative values while still providing slope stability factors of safety that exceed 1.5. The hydrology and hydraulics design for the storm water facilities is provided in Appendix B.

Rule 908.b.(7)A. *requires Geologic data, including, but not limited to:*

i. Type and thickness of unconsolidated soils;

ii. Type and thickness of consolidated bedrock, if applicable;

iii. Local and regional geologic structures; and

iv. Any geologic hazards that may affect the design and operation of the facility.

A geological hazard report that describes the site and the hazards is provided in Appendix A. A geotechnical investigation was also completed for the site and data on the borehole drill logs and sample analyses results are included in Appendix G with the geotechnical report.

Rule 908.b.(7)B. *requires hydrological data, including, but not limited to:*

i. Surface water features within two (2) miles;

ii. Depth to shallow ground water and major aquifers;

iii. Water wells within one (1) mile of the site boundary and well depth, depth to water, screened intervals, yields, and aquifer name;

iv. Hydrologic properties of shallow ground water and major aquifers including flow direction, flow rate, and potentiometric surface;

v. Site location in relation to the floodplain of nearby surface water features;

vi. Existing quality of shallow ground water; and

vii. An evaluation of the potential for impacts to nearby surface water and ground water.

There are numerous surface water features within a 2 mile radius of the site. These include but are not limited to: the Colorado River, Roan Creek and numerous Reservoir or Irrigation Ditches. A Hydrologic Feature Map is provided on Exhibit 5 and a Wetland Feature Map is provided on Exhibit 6.

Boreholes drilled for the geological geotechnical report to depths ranging from 30 to 100 feet, and wells within a one mile radius of the site suggest that shallow groundwater is not present around the site. Well logs in the vicinity of this site are listed as being completed into an unnamed confined aquifer. However, this site area is located in the Piceance Aquifer which is part of the Colorado River Basin. Table 3 provides information about the water wells within a one mile radius of the site (see Exhibit 7). A copy of the water well logs is provided in Appendix B-4 and the data from these wells was used to develop a potentiometric surface map (see Exhibit 8). The wells have depths ranging from 304 feet to 540 feet with screened intervals ranging from 220 to 482 feet below ground surface. As there is no shallow groundwater near the facility location, no data is available about the existing quality of the shallow groundwater. Black Hills is currently working with adjacent landowners to get access to obtain water samples from each of the required wells that are completed in the deeper aquifers. This data will be provided to COGCC when it is available.

The facility site is not located within the floodplain. A floodplain map showing the site location in relation to nearby surface water features is provided with the Storm Water Report in Appendix B-2. As shown in the Storm Water Report, the proposed BMPs for this facility will mitigate the potential impacts to nearby surface water and ground water.

Table 3. Water Well Data- One Mile Radius Around De Beque Water Station

WELL PERMIT NUMBER	WELL DEPTH (FEET)	DEPTH TO WATER (FFET)	SCREENED INTERVALS	YIELDS (GPM)	AQUIFER NAME
278939	482	90	410-482	10	UNNAMED AQUIFERS
249795	540	325	NA	10	UNNAMED AQUIFERS
279019	344	106	244-344	1.5	UNNAMED AQUIFERS
292780	430	36	370-410	4-5	UNNAMED AQUIFERS
45237	304	27	220-270	15	UNNAMED AQUIFERS

i. .

Data Retrieved from the Colorado Department of Natural Resources, Water Resources Division, Colorado's Well Permit Search.

Rule 908.b.(7)C. *requires engineering data, including, but not limited to:*

i. Type and quantity of material required for use as a liner, including design components;

ii. Location and depth of cut for liners;

iii. Location, dimensions, and grades of all surface water diversion structures;

iv. Location and dimensions of all surface water containment structures; and

v. Location of all proposed facility structures and access roads.

The required engineering data is provided with the attached Engineer Plans.

Rule 908.b.(8). *requires an operating plan, including, but not limited to:*

A. A detailed description of the method of treatment, loading rates, and application of nutrients and soil amendments;

B. Dust and moisture control;

C. Sampling;

D. Inspection and maintenance;

E. Emergency response;

F. Record-keeping;

G. Site security;

H. Hours of operation;

I. Noise and odor mitigation; and

J. Final disposition of waste. Where treated waste will be beneficially reused, a description of reuse and method of product quality assurance shall be included.

The Operating Plan for this facility is provided in Appendix J.

Rule 908.b.(9).A. *requires that water samples shall be collected from water wells known to the operator or registered with the Colorado State Engineer within a one (1) mile radius of the proposed facility and shall be analyzed to establish baseline water quality. Analytical parameters shall be selected based upon the proposed waste stream and shall include, at a minimum, all major cations and anions, total dissolved solids, iron and manganese, nutrients (nitrates, nitrites, selenium), benzene, toluene, ethylbenzene, xylenes, pH, and specific conductance. Copies of all test results described above shall be provided to the Director and the water well owner within three (3) months of collecting the samples. Laboratory results shall also be submitted to the Director in an electronic data deliverable format.*

Black Hills is currently working with landowners that have wells within the required one-mile radius to obtain permission to collect water samples to establish the baseline water quality. After Black Hills receives the water quality results from an independent laboratory, this data will be provided to the COGCC.

Rule 908.b.(9).B. *states that where applicable, the Director shall require ground water monitoring to ensure compliance with the concentration levels in Table 910-1 and*

WQCC standards and classifications by establishing points of compliance, unless an oil and gas operator demonstrates to the satisfaction of the Director that an alternative method offering equivalent protection of public health, safety, and welfare, including the environment and wildlife resources, can be employed and provided the operator employs a dual liner with a leak detection system that provides for immediate leak detection from the uppermost liner. All monitoring well construction must be completed in accordance with the State Engineer's regulations on well construction, "Water Well Construction Rules" (2 C.C.R. 402-2).

Black Hills has installed three monitoring wells to a depth of 100 feet (one up-gradient and two down-gradient) but has not encountered ground water to a depth of 100 feet below ground surface. Black Hills is constructing all of the storage ponds with a dual 60-mil HDPE liner that contains a leak detection system. The leak detection system will have a sensor that alerts Black Hills to the presence of water should a leak in the primary liner occur. Black Hills requests to be exempted from the ground water monitoring requirement due to the significant depth to ground water at this site and the construction of all ponds with dual liners and leak detection systems.

Rule 908.b.(10). *states that where applicable, the Director shall require baseline and periodic surface water monitoring to ensure compliance with WQCC surface water standards and classifications. Operators shall use reasonable good faith efforts to obtain access to such surface water for the purpose of collecting water samples.*

Black Hills intends to collect baseline and periodic surface water samples to comply with Rule 908.b.(10). Baseline samples will be collected this year as feasible during precipitation events if they are significant enough to produce run-off from the upstream drainages. Water quality results from these events will be provided to the COGCC when they are available.

Rule 908.b.(11). *Requires a contingency plan that describes the emergency response operations for the facility, 24-hour contact information for the person who has authority to initiate emergency response actions, and an outline of responsibilities under the joint operating agreement regarding maintenance, closure, and monitoring of the facility.*

An Emergency Response Plan is provided in Appendix K that addresses the requirements of this rule.

Rule 908.d. *Requires the operator of a centralized E&P waste management facility shall submit for the Director's approval such financial assurance as required by Rule 704. prior to issuance of the operating permit.*

A reclamation cost estimate has been provided for the facility and itemized by phase of construction and a copy is provided in Appendix C. The financial assurance shall be provided upon approval of the cost estimate and Form 28 application by COGCC.

Rule 908.e. *Requires that throughout the life of the facility the operator shall submit proposed modifications to the facility design, operating plan, permit data, or permit conditions to the Director for prior approval.*

Black Hills shall submit proposed modifications for this facility to the Director as required.

Rule 908.f. *States that the facility permit shall be subject to an annual review by the Director. To facilitate this review, the operator shall submit an annual report summarizing operations, including the types and volumes of waste actually handled at the facility. The Director may require additional information.*

Black Hills will submit an annual report summarizing the operations at the De Beque Station including information on volumes of raw & produced water used for well development, volume of produced water returned to the station, and water quality information of produced water from wells sampled by Black Hills.

Rule 908.g(1). *Requires a general preliminary plan for closure shall be submitted with the centralized E&P waste management facility permit, Form 28. The preliminary closure plan shall include, but not be limited to:*

A. A general plan for closure and reclamation of the entire facility, including a description of the activities required to decommission and remove all equipment, close and reclaim pits, dispose of or treat residual waste, collect samples as needed to verify compliance with soil and ground water standards, implement post-closure monitoring, and complete other remediation, as required.

B. An estimate of the cost to close and reclaim the entire facility and to conduct post-closure monitoring. Cost estimates shall be subject to review by the Director.

A general closure and reclamation plan and a cost estimate is provided in Appendix C that details the anticipated activities required to decommission the equipment and reclaim the site for this facility.

Rule 908.g(2). *requires a detailed Site Investigation and Remediation Workplan, Form 27, shall be submitted at least sixty (60) days prior to closure for approval by the Director. The workplan shall include, but not be limited to, a description of the activities required to decommission and remove all equipment, close and reclaim pits, dispose of or treat residual waste, collect samples as needed to verify compliance with soil and ground water standards, implement post-closure monitoring, and complete other remediation, as required.*

Black Hills will submit a Form 27 to the COGCC with a detailed site investigation and remediation workplan at least sixty days prior to closure of this facility.

Rule 908.h. *states that operators may be subject to local requirements for zoning and construction of facilities and shall provide copies of any approval notices, permits, or*

other similar types of notifications for the facility from local governments or other agencies to the Director for review prior to issuance of the operating permit.

Black Hills has been working with Mesa County to obtain all of the required permits for this facility. Copies of the conditional use permit, and additional permits and notices from Mesa County are provided in Appendix L.

EXHIBITS

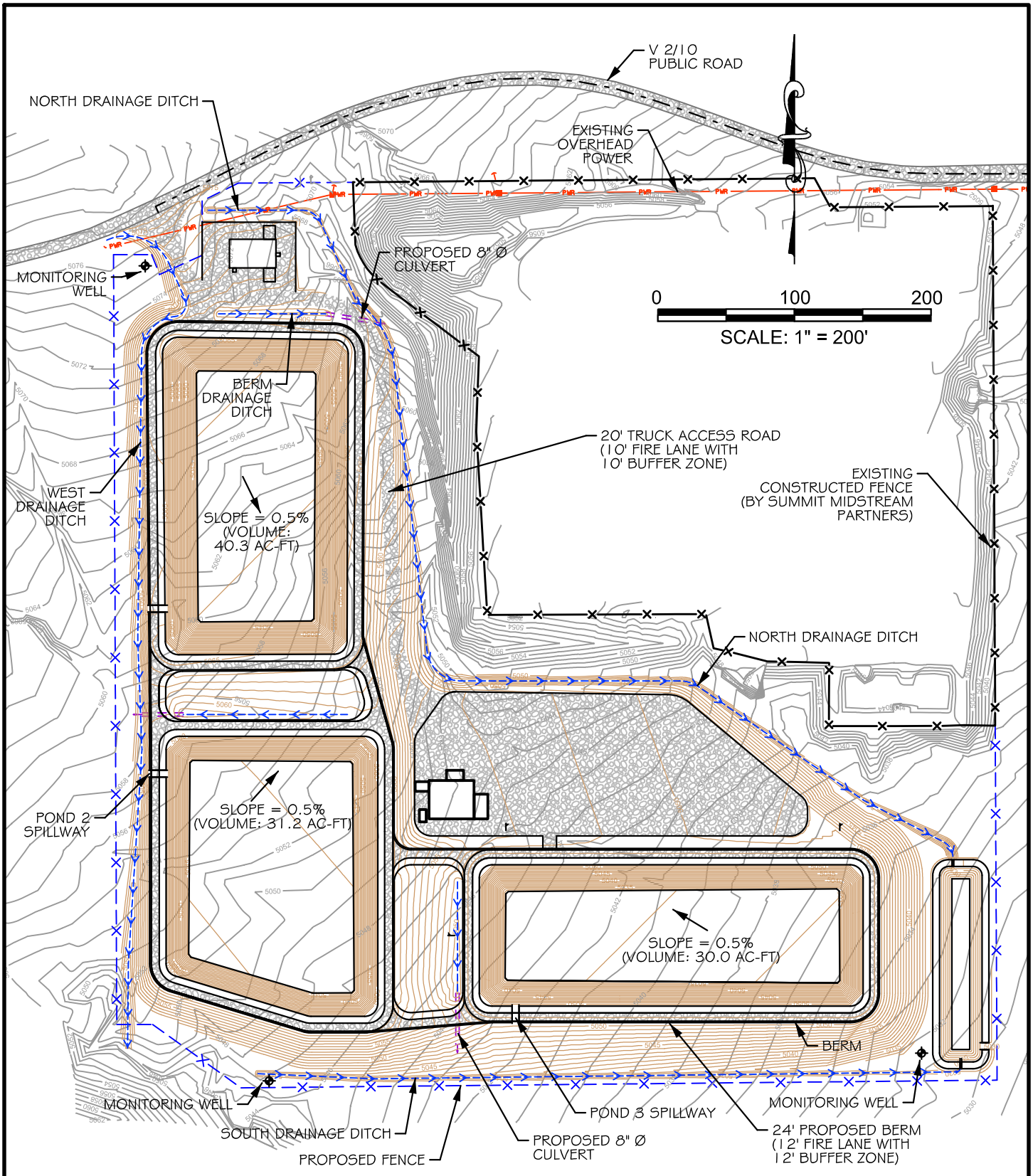

EXHIBIT
1

DE BEQUE WATER STATION
SECTION 29, T8S, R97W 6TH P.M.

FACILITY LAYOUT

DSGN	DATE	CKD
MMZ	10/20/14	STH
REV	DATE	CKD
TAS	2/20/15	STH

JOB # 2013-134

APPLICANT:
Black Hills Exploration & Production
A Black Hills Corporation Enterprise
1515 WYNKOOP ST., SUITE 500
DENVER, CO 80202
(303) 566-3356

WWC ENGINEERING
1275 MAPLE STREET, SUITE F
HELENA, MT 59601
(406) 443-3962

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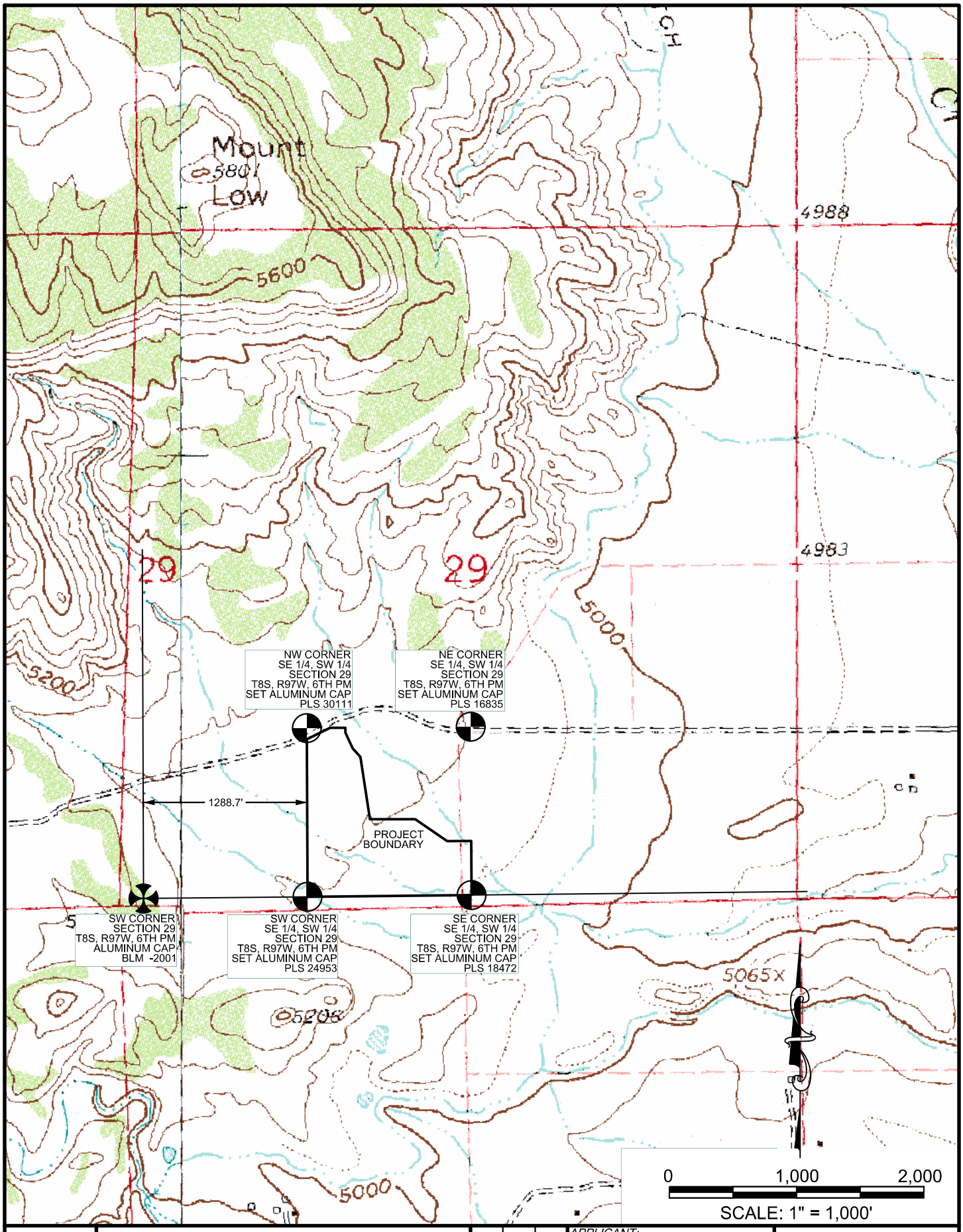

EXHIBIT
2

DE BEQUE WATER STATION
SECTION 29, T8S, R97W 6TH P.M.

SURVEY MAP

DSGN	DATE	CKD
TAS	02/20/15	STH
REV	DATE	CKD

JOB # 2013-134

APPLICANT:

Black Hills Exploration & Production
A Black Hills Corporation Enterprise
1515 WYNKOOP ST., SUITE 500
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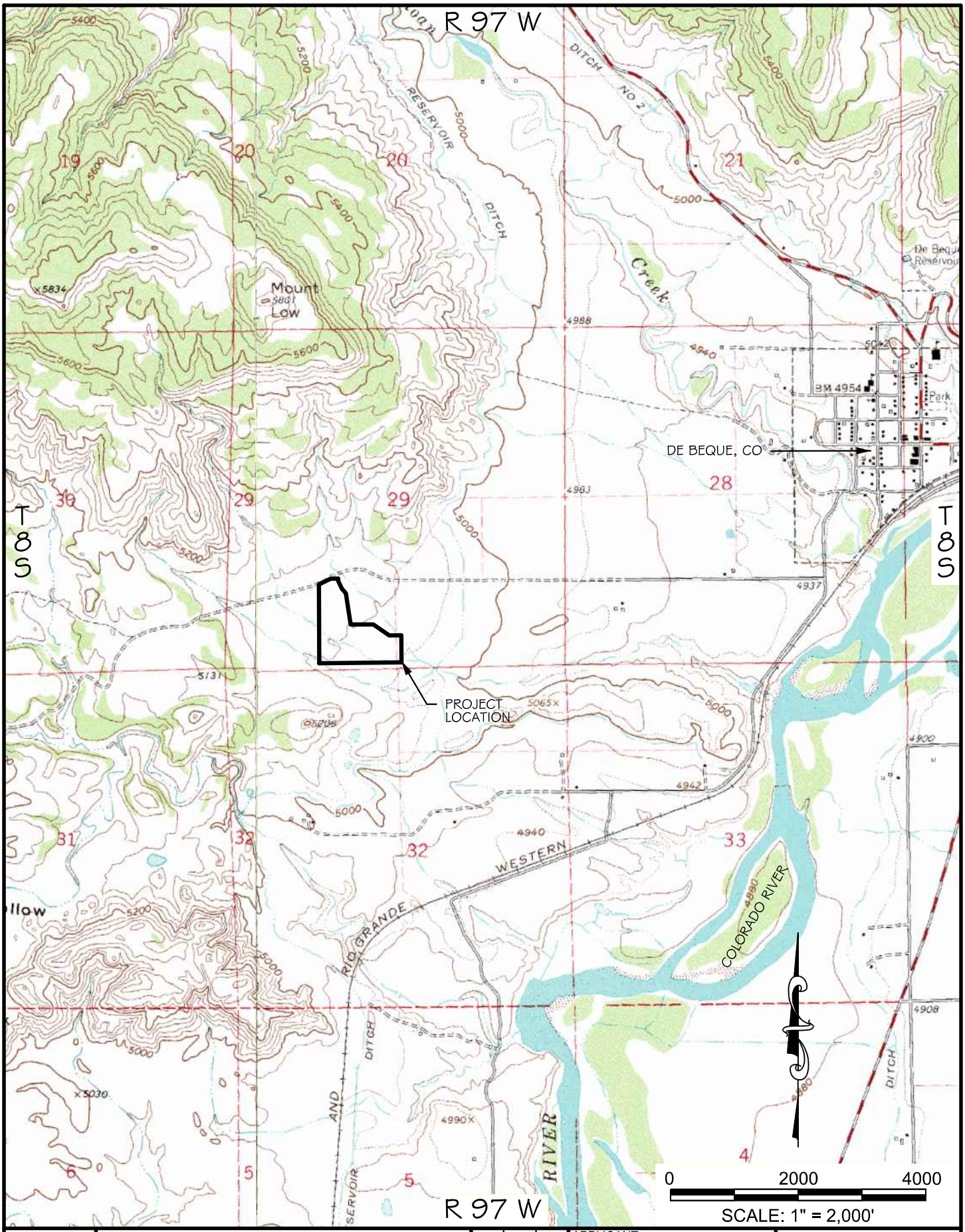

EXHIBIT 3

DE BEQUE WATER STATION
SECTION 29, T8S, R97W 6TH P.M.

TOPOGRAPHIC MAP

DSGN	DATE	CKD
MMZ	10/20/14	STH
REV	DATE	CKD
TAS	2/20/15	STH

JOB # 2013-134

APPLICANT:

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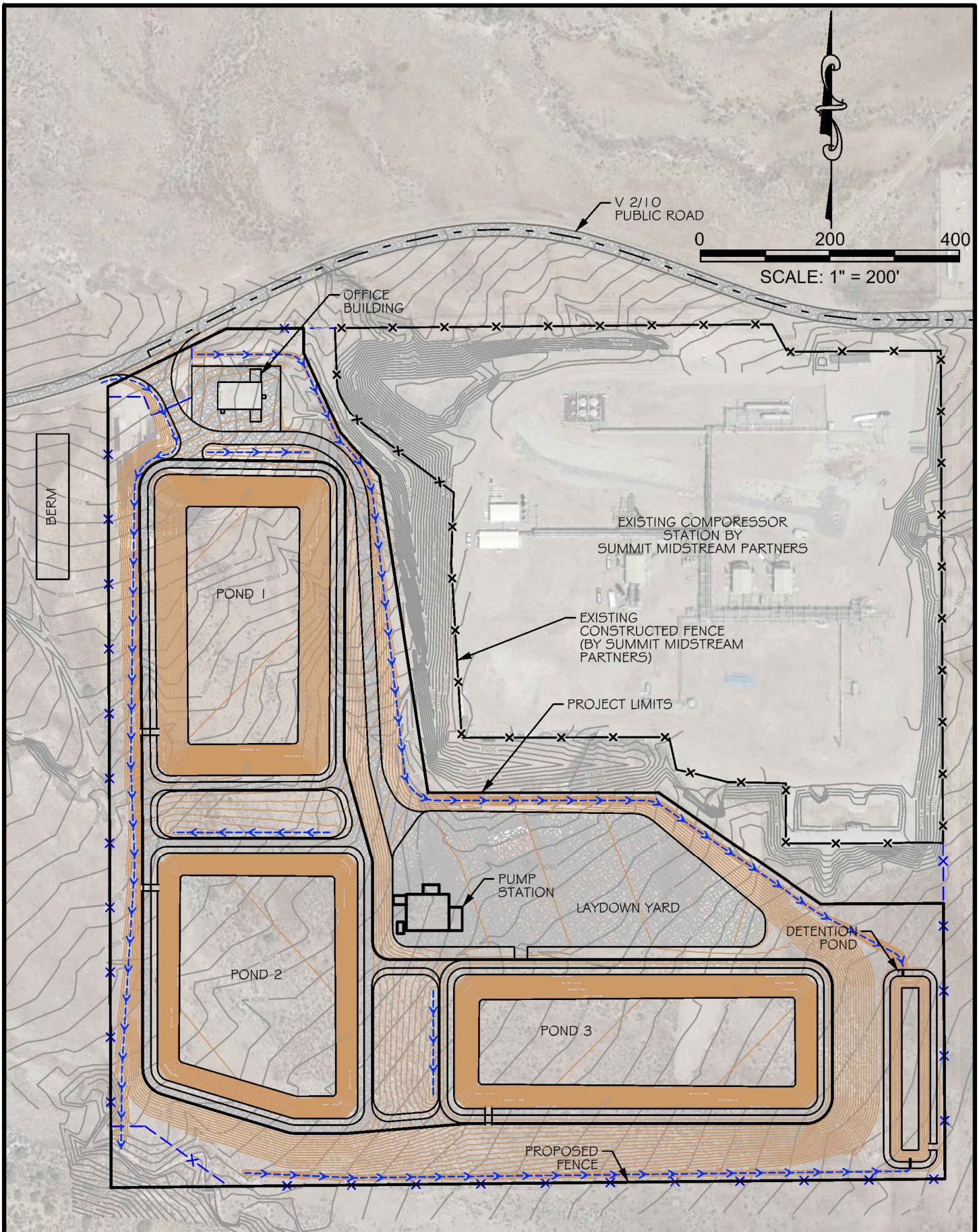

EXHIBIT
2

DE BEQUE WATER STATION
SECTION 29, T8S, R97W 6TH P.M.

SITE PLAN

DSGN	DATE	CKD
MMZ	10/20/14	STH
REV	DATE	CKD
TAS	2/20/15	STH

JOB # 2013-134

APPLICANT:

Black Hills Exploration & Production
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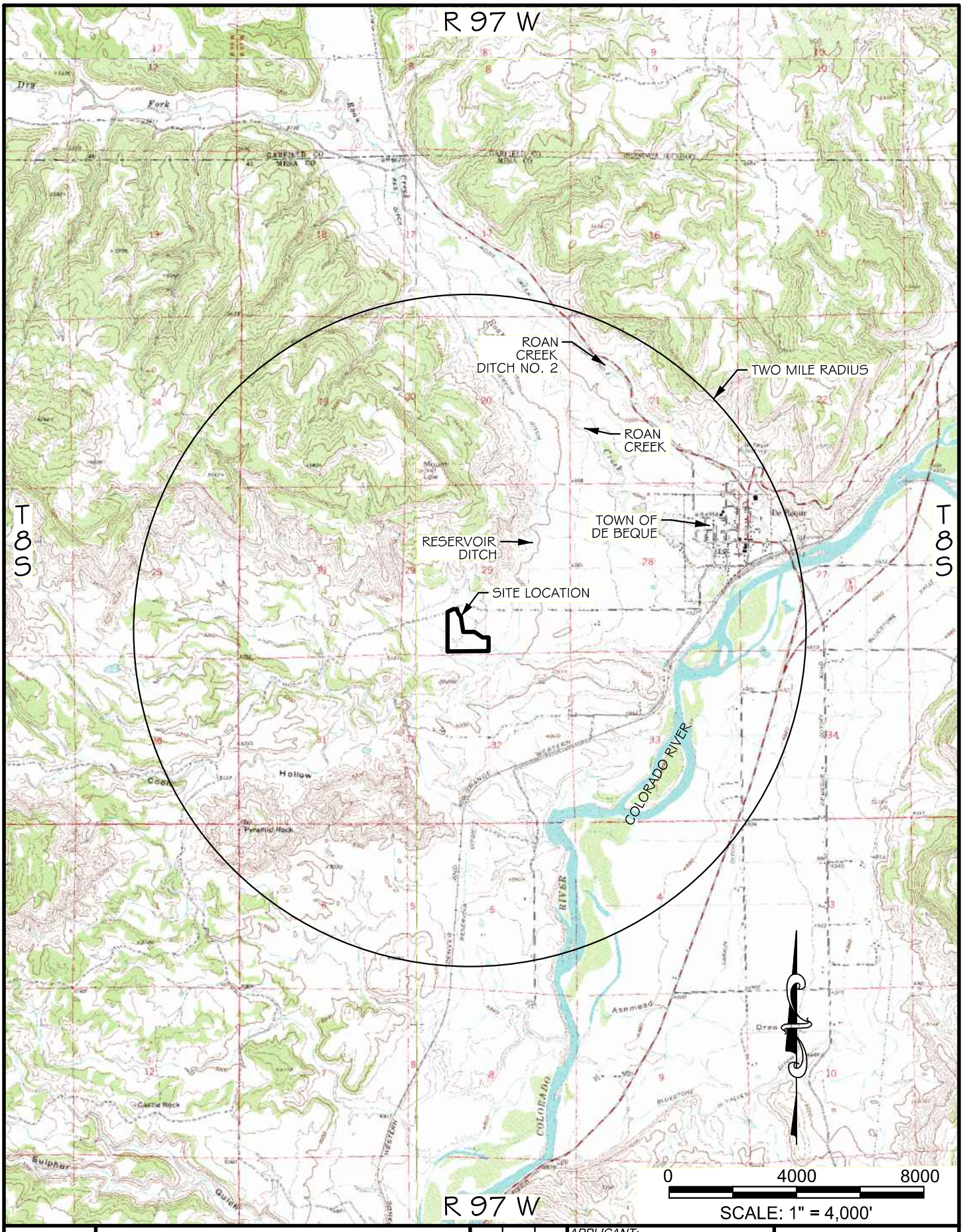

EXHIBIT 5

DE BEQUE WATER STATION
SECTION 29, T8S, R97W 6TH P.M.

HYDROLOGIC FEATURES

DSGN	DATE	CKD
MMZ	10/20/14	STH
REV	DATE	CKD
TAS	2/20/15	STH

JOB # 2013-134

APPLICANT:

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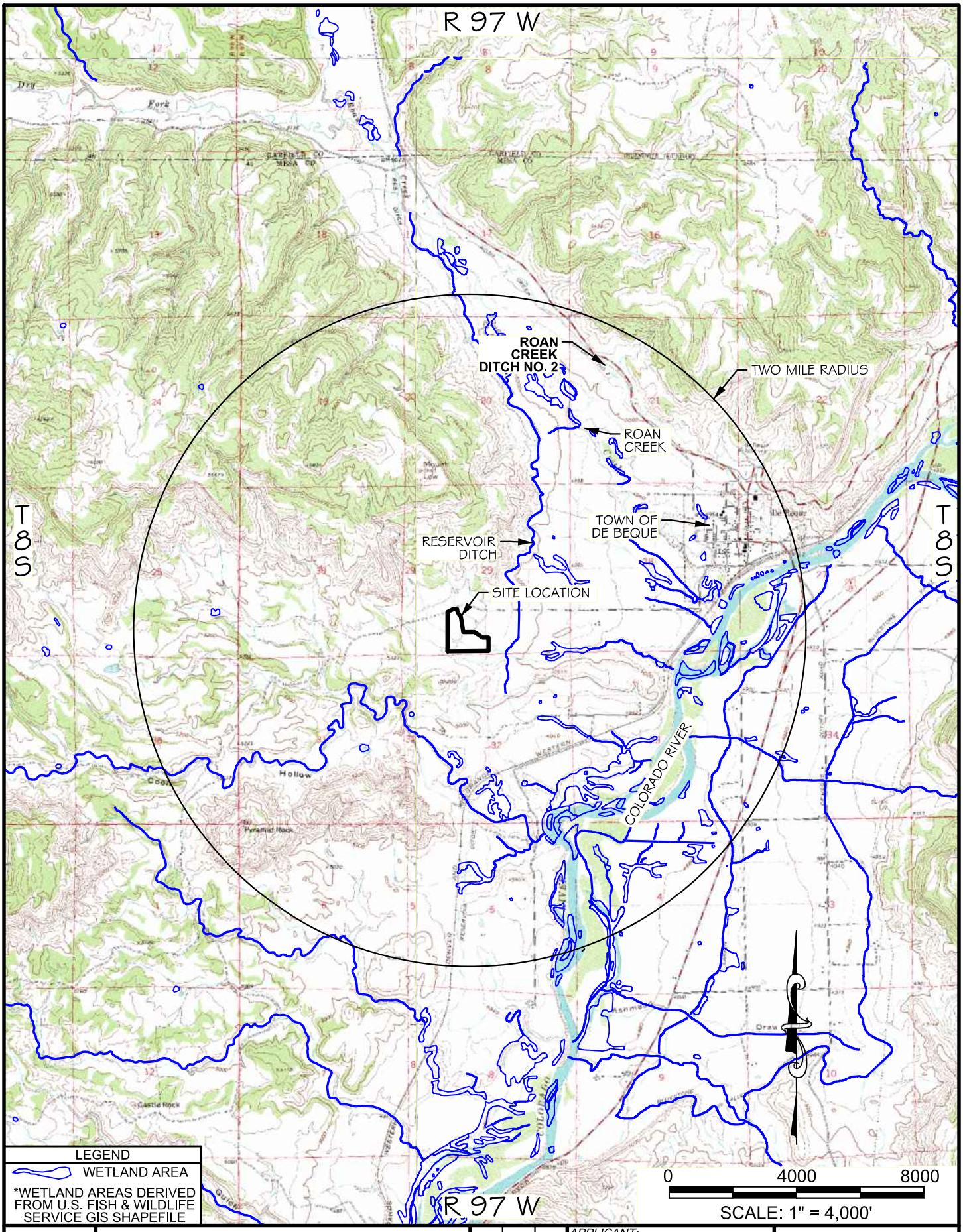

EXHIBIT 6

DE BEQUE WATER STATION
SECTION 29, T8S, R97W 6TH P.M.

WETLAND FEATURES

DSGN	DATE	CKD
TAS	2/20/15	STH
REV	DATE	CKD

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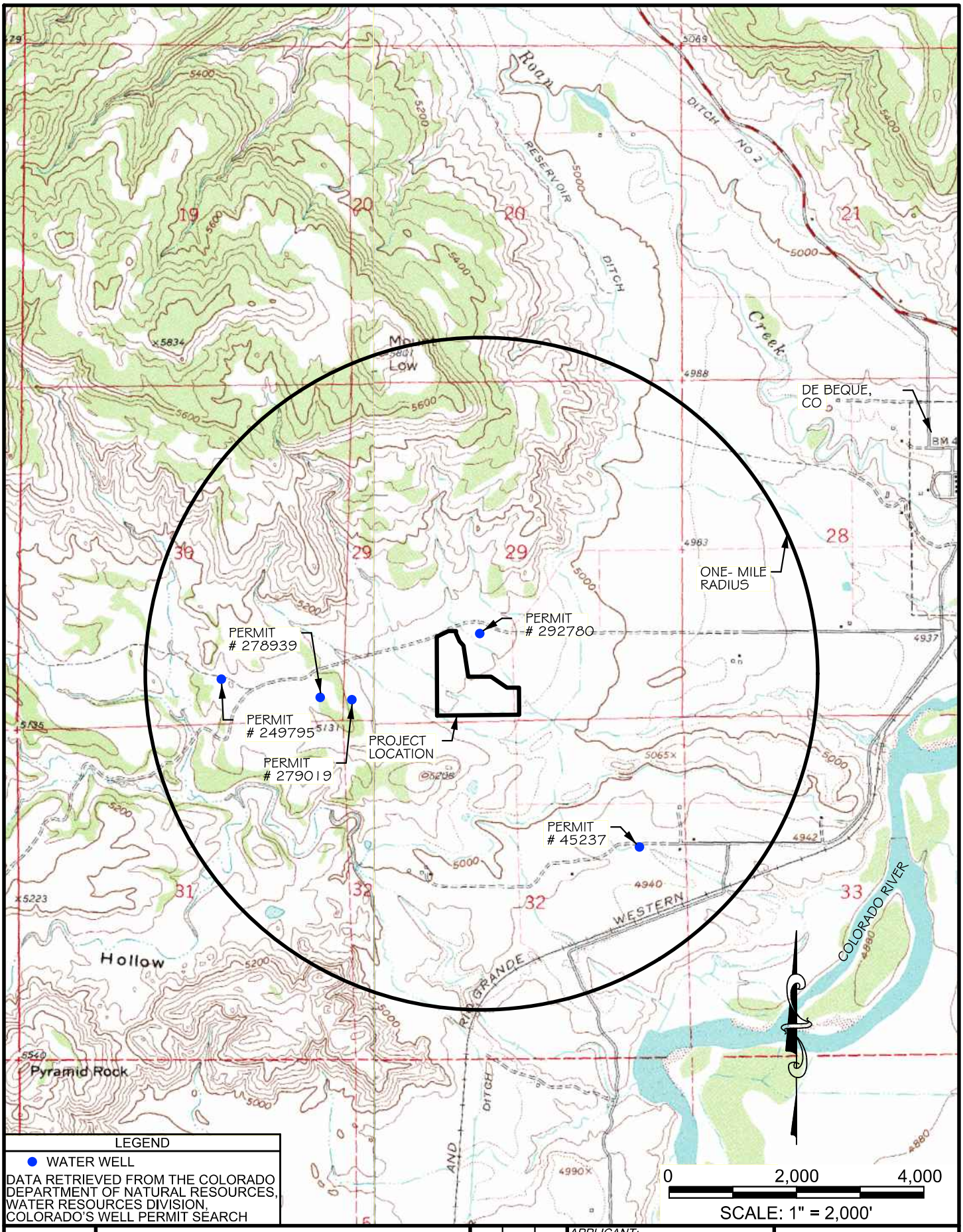

EXHIBIT 7

DE BEQUE WATER STATION
SECTION 29, T8S, R97W 6TH P.M.

ONE MILE WATER WELL MAP

DSGN	DATE	CKD
MMZ	10/20/14	STH
REV	DATE	CKD
TAS	2/20/15	STH

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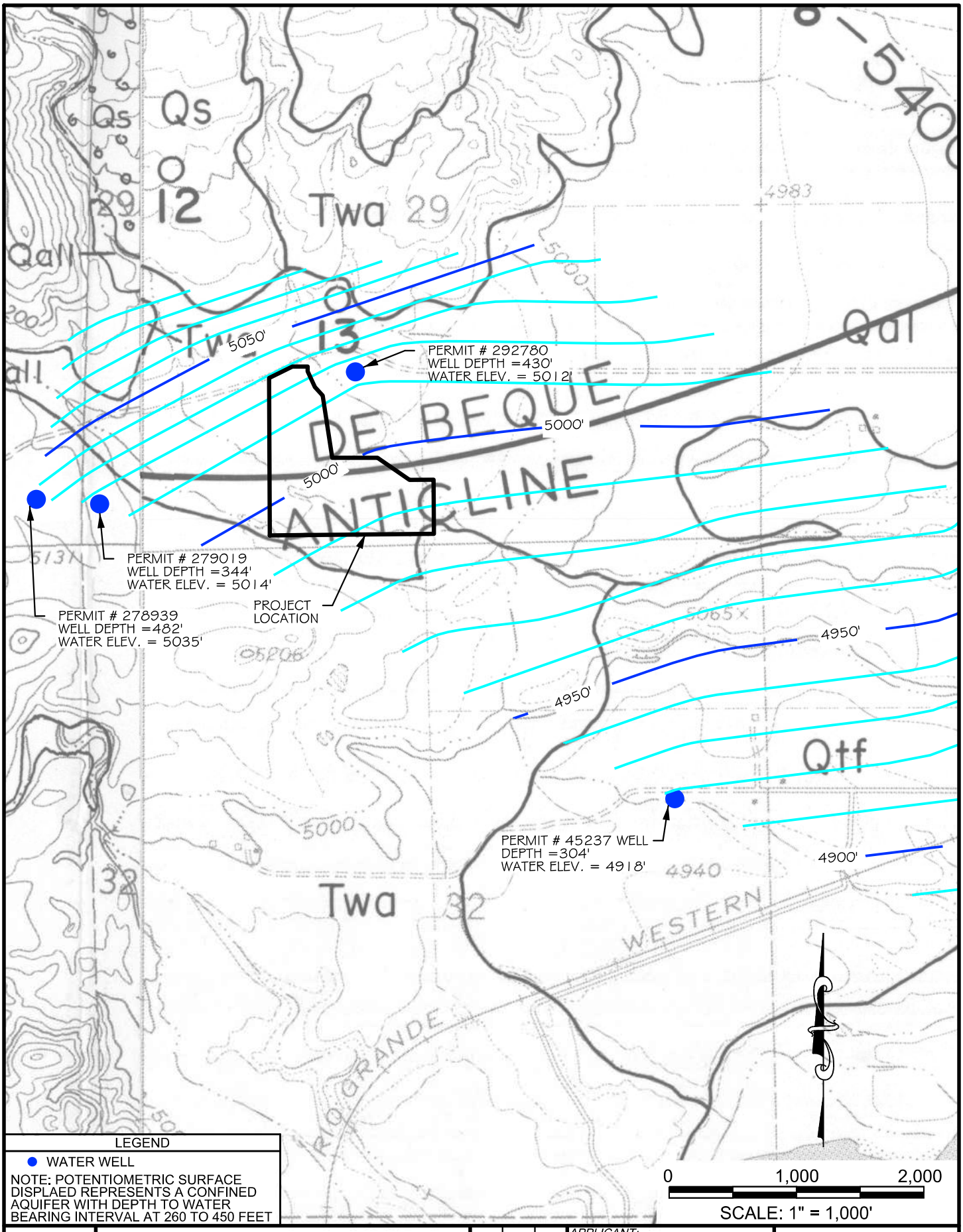

LEGEND

- WATER WELL

NOTE: POTENTIOMETRIC SURFACE DISPLAED REPRESENTS A CONFINED AQUIFER WITH DEPTH TO WATER BEARING INTERVAL AT 260 TO 450 FEET

EXHIBIT 8

DE BEQUE WATER STATION
SECTION 29, T8S, R97W 6TH P.M.

POTENTIOMETRIC SURFACE MAP

DSGN	DATE	CKD
TAS	2/20/15	STH
REV	DATE	CKD

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APPENDIX A

GEOLOGICAL HAZARD REPORT

DE BEQUE WATER STATION GEOLOGICAL HAZARD REPORT

PREPARED FOR:

Black Hills Exploration & Production
A Black Hills Corporation Enterprise

BLACK HILLS PLATEAU PRODUCTION
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PREPARED BY:

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Innovation
Quality
Value

MARCH 2015

DE BEQUE WATER STATION GEOLOGICAL HAZARD REPORT

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Principal Authors:
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Reviewed by:
Shawn Higley, P.E., Helena Branch Manager
Kevin Grabinski, P.E., Project Manager

Date:
March 2015

Table of Contents

APPENDICES

GEOLOGICAL HAZARD REPORT FOR THE BLACK HILLS CORPORATION DE BEQUE WATER STATION

The De Beque Water Station will be designed for the collection of produced water from surrounding oil and gas operations along with raw water from the Colorado River in a series of three storage ponds. The proposed facility is located approximately 2.2 miles southwest of De Beque, Colorado in the SE ¼ of the SW ¼ of Section 29, Township 8 South, Range 97 West, 6th P.M. Potential geologic hazards in the area of the proposed De Beque Water Station include erosion, unstable soils, and earthquakes. However, using the results of a detailed geotechnical field investigation on the suitability of on-site soils for the construction and stability of the proposed ponds it was determined that along with proper design and construction techniques the majority of potential geologic hazards on the site can mitigated.

SURFICIAL GEOLOGY AND SOILS

United States Geologic Survey (USGS) geological maps created by Donnell et al in 1992 of the De Beque Quadrangle suggest that the site is underlain by the Molina member of the Wasatch Formation. This formation consists of mudstone and claystone with fine-to-coarse grained sandstone beds. The thickness of the sandstone beds varies by location, but the beds are generally less than 20 feet thick (Donnell et al, 1992). In locations where the Molina member of the Wasatch Formation has been eroded by the Colorado River and its tributaries, the soil is expected to consist of alluvium material typical of stream-bed, low alluvial terraces, and floodplain deposits. According the Natural Resources Conservation Service (NRCS) the site is underlain by Dominguez clay loams, with 3 to 8 percent slopes (NRCS 2015). This soil is described as well drained, clay loam at depths of 0 to 3 inches, and well drained clay from 3 to 60 inches. The soil has a typical erosion factor Kw of 0.28, generally indicating a low to moderate potential for water erosion (NRCS 2015). USGS Geological maps and NRCS soil data is included in Appendix A-1.

Data collected through a detailed field investigation at the proposed site location support the USGS Geological Maps and NRCS data. The subsurface strata encountered in each borehole was relatively consistent across the site and generally contained clayey sand (SC) and/or lean clay (CL) layers extending from immediately below the topsoil to depths ranging from 18 to 30 feet (maximum depth of boreholes) below the ground surface. The soils that were encountered ranged from stiff to hard. In addition, these layers were relatively homogenous throughout the site and generally penetrated to a depth greater than the proposed excavation depth of 21 feet.

Two boreholes encountered an underlying sandstone layer at depths of 13 and 10 feet below the ground surface, respectively. Both boreholes terminated in this sandstone layer at depths of 30 feet and 100 feet (maximum depth of the borehole). It is assumed that this sandstone layer would have been encountered in the remaining boreholes if they had been drilled to greater depths as a result of the underlying Wasatch Formation.

Limitations of Soils for Intended Use

Information provided by the NRCS in relation to the suitability of soils for proposed uses (shallow excavations and embankments, dikes, and levees) shows that the Dominguez clay loam is somewhat limited in both applications. However, as demonstrated in the geotechnical report, the in-situ soils encountered throughout the site will provide suitable material for the construction of the pond berm foundations. The sandy lean clay that exists throughout the site as well as the absence of groundwater will significantly reduce the risk of berm failure caused by differential settlement, internal piping, base sliding, and seismic induced liquefaction. Multiple slope stability analyses were performed for varying berm geometries as designed for Ponds 1, 2, and 3. These analyses concluded that the minimum factor of safety against slope failure of at least 1.5 was achieved for the worst case conservative scenarios involving strength parameters and berm geometries. The slope stability analyses are located in the Geotechnical Report which has been included in Appendix G of the Form 28 Application.

Seismicity and Earthquakes

More than 700 earthquake tremors of magnitude 2½ or higher have been recorded in Colorado since 1867 (CGS 2015). The majorities of earthquakes that have occurred in Colorado have been below magnitude 3.0 and have not caused significant damage. In addition, some of the most significant earthquakes in Colorado's history were associated with the injection of waste liquids at the rocky Mountain Arsenal during the 1960s (CGS 2015). While the proposed site is underlain by the De Beque Anticline Fault (Donnell et al, 1992), this fault does not appear on the Colorado Earthquake and Fault Map and is thus considered to be at a low risk of causing an earthquake. This is supported by the fact that there have only been 2 earthquakes above magnitude 4.0 or greater over the past 50 years within a 25 mile radius of the site, the closest one occurring approximately 17 miles away (CEHMC 2015). Given the lack of potentially active faults within a large radius around the site, the potential of a damaging earthquake to occur near the facility is considered very low.

Summary and Conclusions

The potential geologic hazards of the site location of the De Beque Water Station include erosion, soil stability issues, and earthquakes. Further investigation and testing of the on-site soils, as seen in the Geotechnical Report located in Appendix G of the Form 28 Application, demonstrate that the proper design can mitigate the potential geologic hazards including erosion and stability. In addition the lack of a nearby active fault suggests that the potential for a damaging earthquake to strike the facility is extremely low. Based on the geologic information available, very little or no impact to the proposed facility from the potential geologic hazards is expected if proper design and construction techniques are utilized.

REFERENCES

Colorado Geological Survey, Earthquakes. Retrieved February 19, 2015, from http://coloradogeologicalsurvey.org/geologic-hazards/earthquakes-2/

Colorado Earthquake Hazards Mitigation Council, Colorado's Earthquake and Fault Map, 2008. Retrieved February 19, 2015, from http://coloradogeologicalsurvey.org/wp-content/uploads/2013/08/Earthquake_Map_20081.pdf

Donnell, J.R., Yeend, W.E., Schmitt, L.J., Smith, M.C., 1992, Geologic Map of the De Beque Quadrangle, Grant and Mesa Counties, Colorado: U.S. Geological Survey, Miscellaneous Field Studies Map MF-2201, Scale 1:24,000.

Ellis, M.S. and Gabaldo, V., 1989, Geologic Map and Cross Sections of Parts of the Grand Junction and Delta 30' x 60' Quadrangles, West-Central Colorado, U.S. Geological Survey, Coal Investigation Map C-124, Scale 1:100,000.

U.S. Department of Agriculture, Natural Resources Conservation Service, 2015, Custom Soil Resource Report, Douglas-Plateau Area, Colorado, Parts of Garfield and Mesa Counties, Web Soil Survey; generated February 19, 2015.

APPENDIX A-1

GEOLOGIC MAPS AND NRCS SOILS DATA

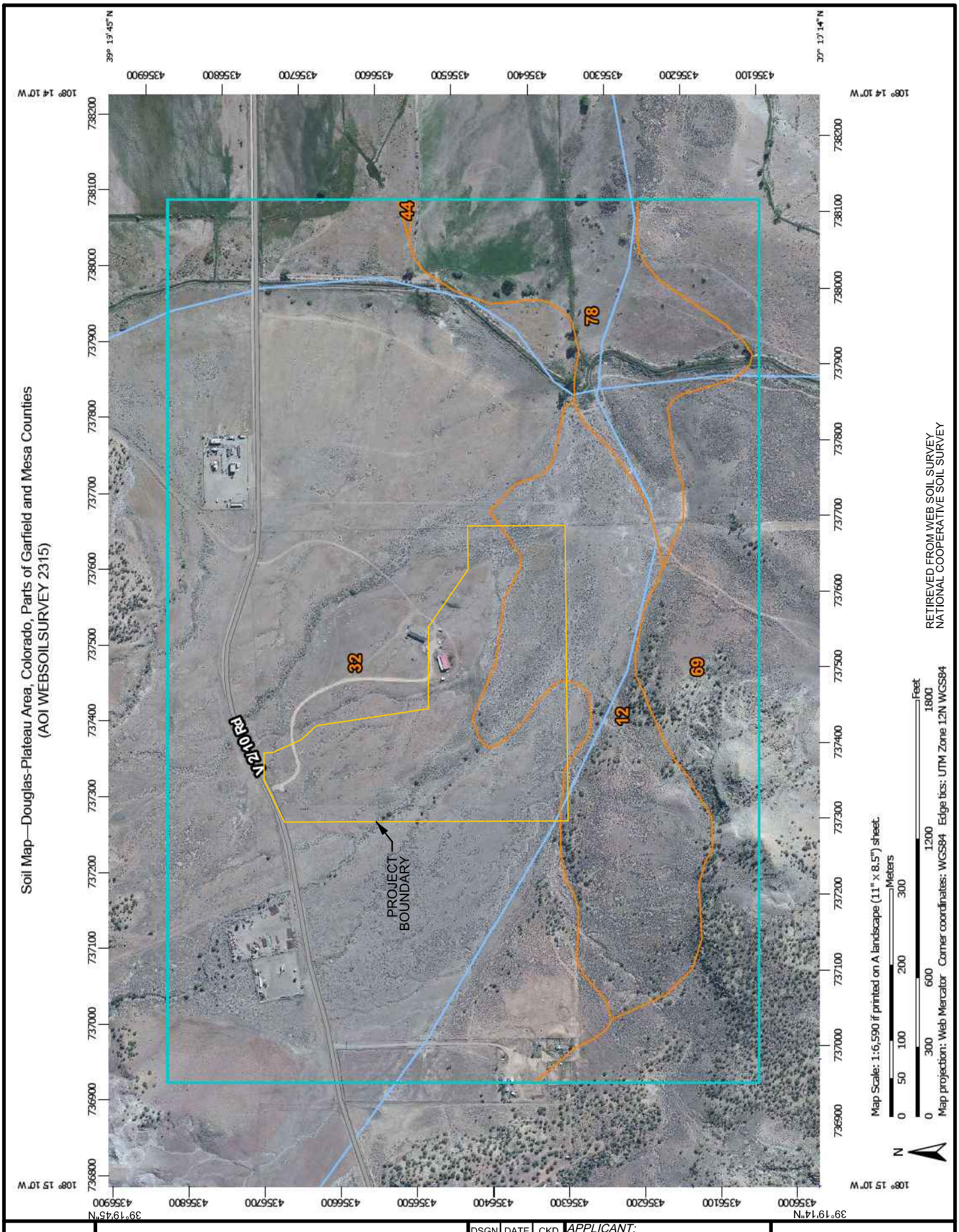

EXHIBIT
A1

DE BEQUE WATER STATION
SECTION 29, T8S, R97W 6TH P.M.

SOILS MAP

DSGN	DATE	CKD
TAS	2/3/15	STH
REV	DATE	CKD

JOB # 2013-134

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Map Unit Legend

Douglas-Plateau Area, Colorado, Parts of Garfield and Mesa Counties (CO682)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
12	Bunkwater very fine sandy loam, 1 to 8 percent slopes	30.8	13.7%
32	Dominguez clay loam, 3 to 8 percent slopes	139.8	62.3%
44	Happle very channery sandy loam, 3 to 12 percent slopes	0.1	0.1%
69	Travessilla-Rock outcrop complex, 10 to 35 percent slopes	33.9	15.1%
78	Youngston loam, 1 to 6 percent slopes	19.8	8.8%
Totals for Area of Interest		**224.5**	**100.0%**

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Political Features
- PLSS Township and Range
- PLSS Section

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.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
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: Douglas-Plateau Area, Colorado, Parts of Garfield and Mesa Counties
Survey Area Data: Version 7, Sep 22, 2014

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

Date(s) aerial images were photographed: Jun 22, 2010—Sep 2, 2010

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.

EXHIBIT
A2

DE BEQUE WATER STATION
SECTION 29, T8S, R97W 6TH P.M.
SOILS MAP LEGENDS AND INFORMATION

DSGN	DATE	CKD
TAS	2/3/15	STH
REV	DATE	CKD

JOB # 2013-134

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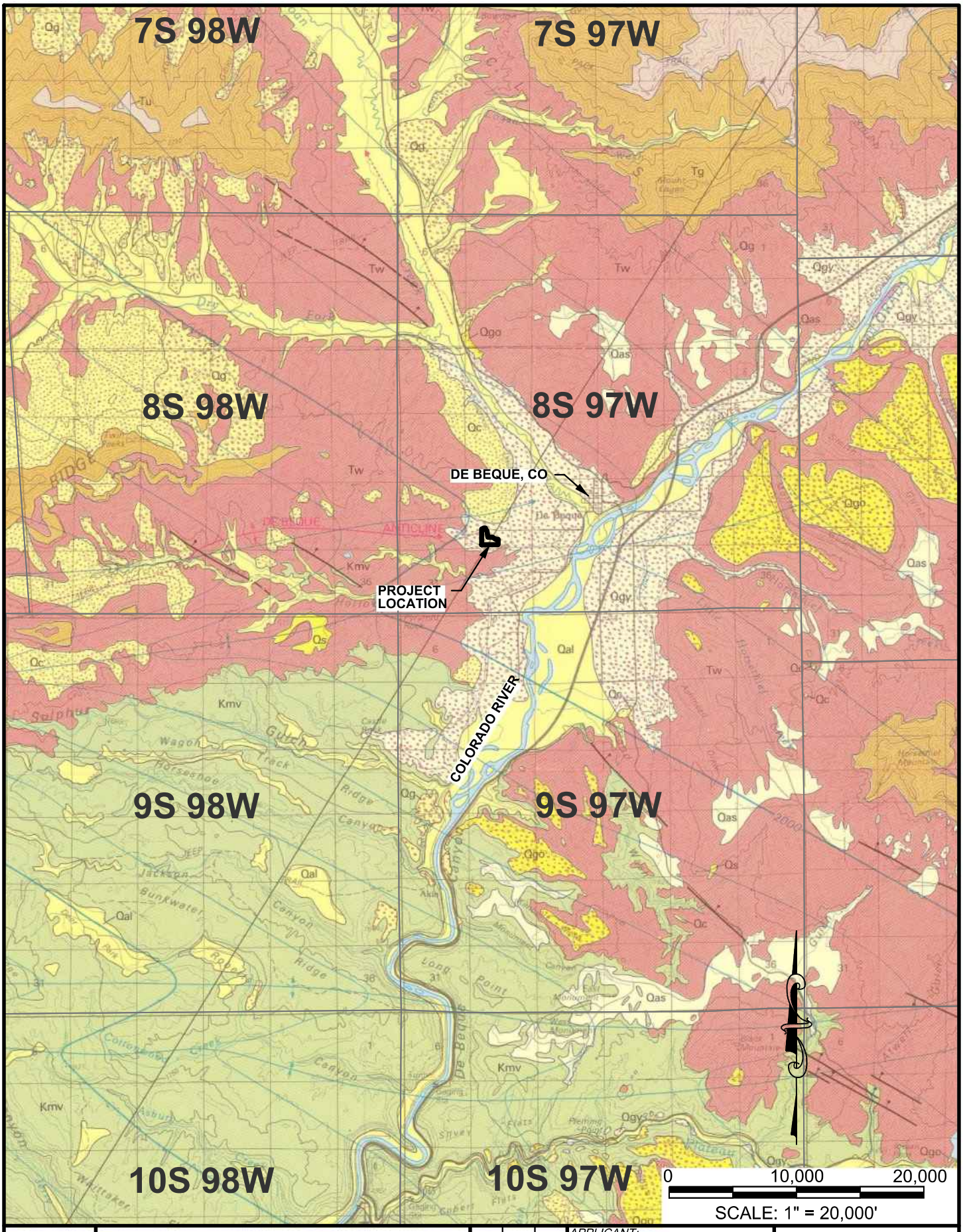

EXHIBIT
A3

DE BEQUE WATER STATION
SECTION 29, T8S, R97W 6TH P.M.

COLORADO GEOLOGY MAP

DSGN	DATE	CKD
TAS	2/4/15	STH
REV	DATE	CKD

JOB # 2013-134

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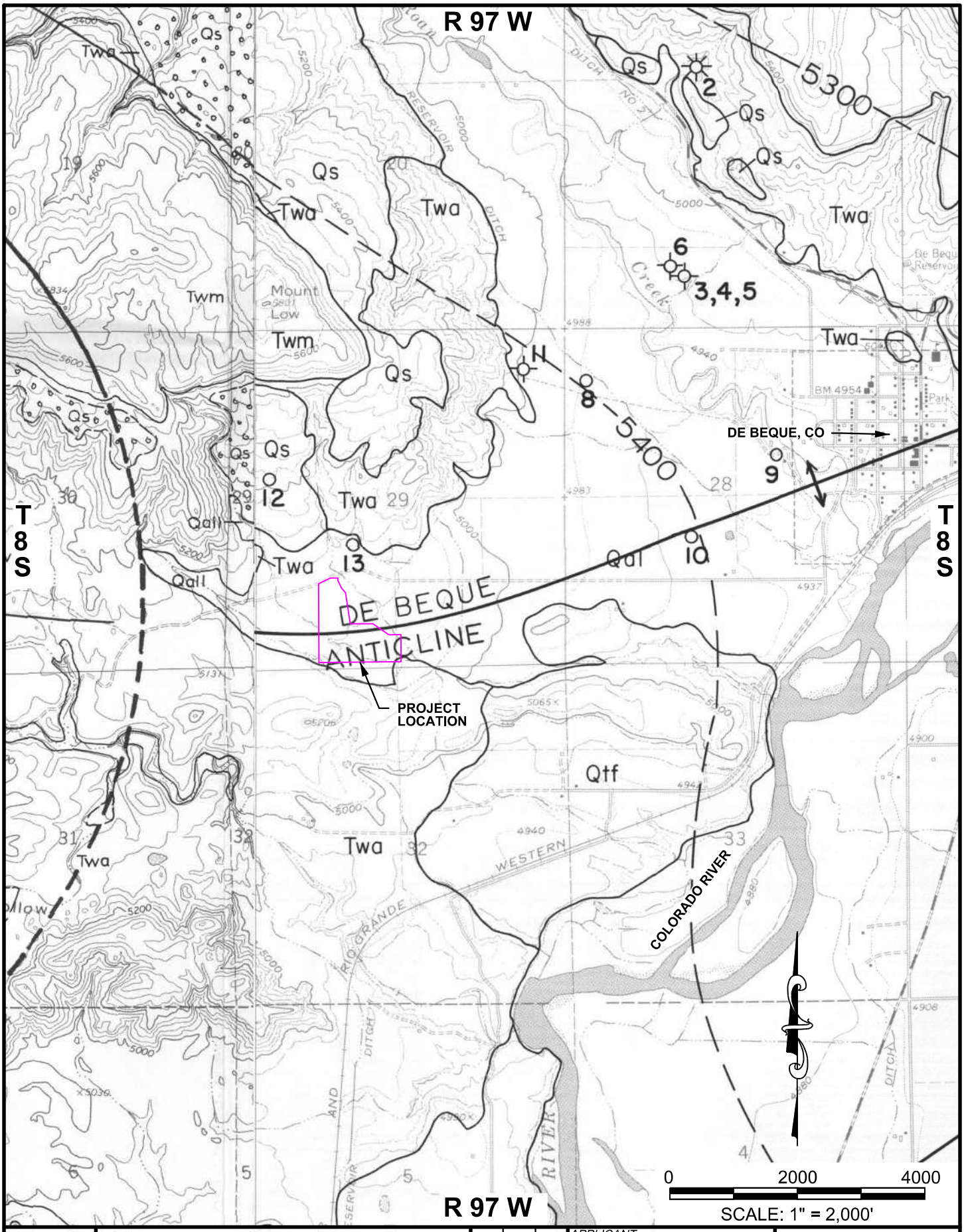

EXHIBIT	DE BEQUE WATER STATION SECTION 29, T8S, R97W 6TH P.M.	DSGN	DATE	CKD
A4		TAS	2/3/15	STH
		REV	DATE	CKD
	AREA GEOLOGY MAP			
		JOB # 2013-134		

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DESCRIPTION OF MAP UNITS

[Note: The Mount Garfield Formation and the Mancos Shale were interpreted to be present in well logs by R.C. Johnson and are shown only in cross section. The unit descriptions were taken from Johnson (1989), Cashion (1973), and interpretations of gamma-ray laterologs]

Qal — **Alluvium (Holocene and Pleistocene?)**—Stream-bed, low alluvial-terrace, and floodplain deposits. Unconsolidated clay, silt, sand, gravel, cobbles, and boulders deposited along Colorado River and its tributaries. Well-rounded and well-sorted clasts of crystalline rock are common in alluvium along Colorado River

Qass — **Alluvial and eolian sand and silt (Holocene)**—Yellowish-brown silt and sand; reddish-brown silt; generally well sorted. Derived mostly from nearby sedimentary rocks; commonly fills depressions and valleys. Mapped only where areally extensive. Maximum thickness about 30 ft (9 m)

Qs — **Slump, earthflow, and landslide deposits (Holocene)**—Relatively small, recent deposits developed mainly in mudstone beds of Wasatch Formation. Most slides still active

Qtf — **Terrace and fan deposits (Pleistocene)**—Pebbles, cobbles, and boulders in a sandy matrix; poorly sorted to well sorted. Clasts angular to well rounded; clasts are commonly basalt but also include sedimentary rock fragments. Cobbles of igneous and metamorphic rocks are abundant near Colorado River. Maximum thickness about 150 ft (46 m)

Qp — **Pediment deposits (Pleistocene)**—Subangular to subrounded pebbles, cobbles, and boulders in a sandy matrix covering gently sloping erosional surfaces on Wasatch Formation. Cobbles, pebbles, and matrix are composed mostly of sandstone, siltstone, claystone, and marlstone of Green River and Wasatch Formations; some basalt boulders are present. Generally less than 50 ft (15 m) thick

Qc — **Colluvium (Pleistocene)**—Angular to subangular, poorly sorted pebbles, cobbles, and boulders in a matrix of greenish-gray sandy silt. Basalt boulders as much as 5 ft (1.5 m) in diameter, and sandstone, marlstone, and claystone slabs as much as 1 ft (0.3 m) in length are common. Caps isolated hills. Thickness about 50–80 ft (15–24 m)

Green River Formation (Eocene)—Sediments deposited in a variety of mostly lacustrine environments

Tgg — **Garden Gulch Member**—Light- to medium-gray marlstone, siltstone, and silty claystone; some thin limestone and fine- to medium-grained thin sandstone beds; minor amounts of papery to flaky shale. Algal stromatolites, oolites, oncolites, and ostracodes present locally. Exposed only in southeastern part of quadrangle on Horsethief Mountain. Thickness about 850–1,000 ft (259–305 m)

Tga — **Anvil Points Member**—Brown and yellowish-brown, ledge-forming, fine- to coarse-grained, massive sandstone interbedded with lesser amounts of light-gray siltstone and marlstone. Exposed only in southeastern part of quadrangle on Horsethief Mountain. Thickness about 160–280 ft (49–85 m)

Wasatch Formation (Eocene and Paleocene)—Rocks mostly of fluvial origin

Tws — **Shire Member (Eocene)**—Mostly variegated red, brown, lavender, purple, and gray mudstone or claystone including a few lenticular, gray or yellowish-gray, calcareous, fine- to coarse-grained sandstone beds; locally forms badland topography. Sandstone beds are generally less than 20 ft (6 m) thick. Measured reference section is located in southeastern part of quadrangle in SE1/4 sec. 13, T. 9 S., R. 97 W. and S1/2 sec. 18, T. 9 S., R. 96 W. (Donnell, 1969, p. M17–M18). Thickness of reference section about 950 ft (290 m)

Twm — **Molina Member (Eocene and Paleocene)**—Gray and brown, fine- to coarse-grained, massive sandstone interbedded with lenticular gray, greenish-gray, or lavender mudstone or siltstone. Ledge-forming sandstone beds are conspicuous, and basal sandstone of the Molina is generally persistent. Sandstone contains small subangular to subrounded chert and quartzite pebbles. A measured reference section of Molina Member is located in southern part of quadrangle in N1/2 sec. 24, T. 9 S., R. 97 W. (Donnell, 1969, p. M14–M15). Thickness of reference section is 390 ft (119 m)

Twa — **Atwell Gulch Member (Paleocene)**—Upper part is composed predominantly of yellowish-gray, yellowish-brown, and black mudstone or claystone and commonly contains carbonaceous shale or mudstone and some coal locally. Middle part is composed of mostly banded purple, lavender, red-brown, maroon, and gray mudstone or claystone, including some interbedded lenticular yellow-brown sandstone; weathers to badlands locally and is similar in appearance to Shire Member. Lower part is composed predominantly of brown sandstone, locally conglomeratic at base. Basal brown conglomerate as much as 10 ft (3 m) thick and composed of chert and quartz pebbles unconformably overlies gray to white Upper Cretaceous Hunter Canyon Formation. This conglomerate is particularly well exposed in southern part of quadrangle along Sand Wash in sec. 22, T. 9 S., R. 97 W. Measured reference section of Atwell Gulch Member is in southern part of quadrangle in N1/2 sec. 26 and S1/2 sec. 23, T. 9 S., R. 97 W. (Donnell, 1969, p. M13-M14). The brown sandstone and conglomerate that were assigned to Ohio Creek Formation by Donnell (1969) are here considered to be basal part of Atwell Gulch Member of Wasatch Formation. Thickness of Atwell Gulch reference section as modified here is about 565 ft (172 m)

Khc — **Hunter Canyon Formation (Upper Cretaceous)**—Massive to thick-bedded, pale-yellowish-gray to white sandstone in upper part, and pale-yellow to brownish-yellow sandstone in lower part, interbedded with lesser amounts of gray mudstone and gray carbonaceous claystone. Nonmarine origin. Sandstone is fine to coarse grained, forms prominent cliffs, and is locally cross bedded, wavy bedded, or horizontally laminated. Sandstone in upper part of unit locally contains a few lenses of chert-pebble conglomerate. White sandstone in upper 160–490 ft (49–149 m) of unit is conspicuous, and color is caused by kaolinite derived from alteration of feldspar (Johnson and May, 1980). The white, sparsely conglomeratic strata have been included in the Ohio Creek Conglomerate by other workers and considered to be Tertiary, but the Ohio Creek Conglomerate was reassigned as the upper member of the Hunter Canyon Formation by Johnson and May (1980). Thickness of partial section exposed in southwestern part of quadrangle is about 350 ft (107 m). Base of unit is not exposed in quadrangle

Mount Garfield Formation (Upper Cretaceous)—Brownish-yellow and gray, fine- to medium-grained sandstone interbedded with gray shale; lower part contains coal beds of economic significance. Thickness about 1,660–1,920 ft (506 m–585 m). Shown only in cross section

Kgu — **Mount Garfield Formation, upper part**—That part of the Mount Garfield Formation which is above the Rollins Sandstone Member

Kgr — **Rollins Sandstone Member**—Prominent regressive marine sandstone overlain by Cameo-Fairfield coal zone and underlain by unnamed tongue of Mancos Shale. Thickness about 70–90 ft (21–27 m)

Kgcz — **Cozzette Sandstone Member**—Interbedded marginal marine sandstone, gray shale, carbonaceous shale, and coal; overlain and underlain by unnamed tongues of Mancos Shale. Thickness about 130 ft (40 m)

Kgcr — **Corcoran Sandstone Member**—Interbedded marginal marine sandstone, gray shale, carbonaceous shale, and coal; overlain by unnamed tongue of Mancos Shale and underlain by main body of Mancos Shale. Thickness about 80–100 ft (24–30 m)

Km — **Mancos Shale (Upper Cretaceous)**—Dark-gray to black marine shale containing some thin sandstone beds. Thickness about 3,000 ft (914 m). Shown only in cross section

Contact—Approximately located; dotted where concealed

U / D — **Fault**—*U*, upthrown side; *D*, downthrown side. Dashed where approximately located; dotted where concealed

—5300— **Structure contour**—Drawn to show base of Molina Member of Wasatch Formation. Dashed where datum was removed by erosion. Contour interval 100 ft (30.5 m). Contours not drawn below 5,100 ft because of insufficient information

2 **Gas well**—Number keyed to table 1

3 **Dry hole**—Oil and gas test hole. Number keyed to table 1

4 **Test well**—Oil and gas test hole of unknown production status. Number keyed to table 1

Anticline

Syncline

Donnell, J.R., Yeend, W.E., Schmitt, L.J., Smith, M.C., 1992, Geologic Map of the De Beque Quadrangle, Grant and Mesa Counties, Colorado: U.S. Geological Survey, Miscellaneous Field Studies Map MF-2201

EXHIBIT
A5

DE BEQUE WATER STATION
SECTION 29, T8S, R97W 6TH P.M.

ARE GEOLOGY MAP KEY

DSGN	DATE	CKD
TAS	2/4/15	STH
REV	DATE	CKD

JOB # 2013-134

APPLICANT:
Black Hills Exploration & Production
A Black Hills Corporation Enterprise
1515 WYNKOOP ST., SUITE 500
DENVER, CO 80202
(303) 566-3356

WWC ENGINEERING
1275 MAPLE STREET, SUITE F
HELENA, MT 59601
(406) 443-3962

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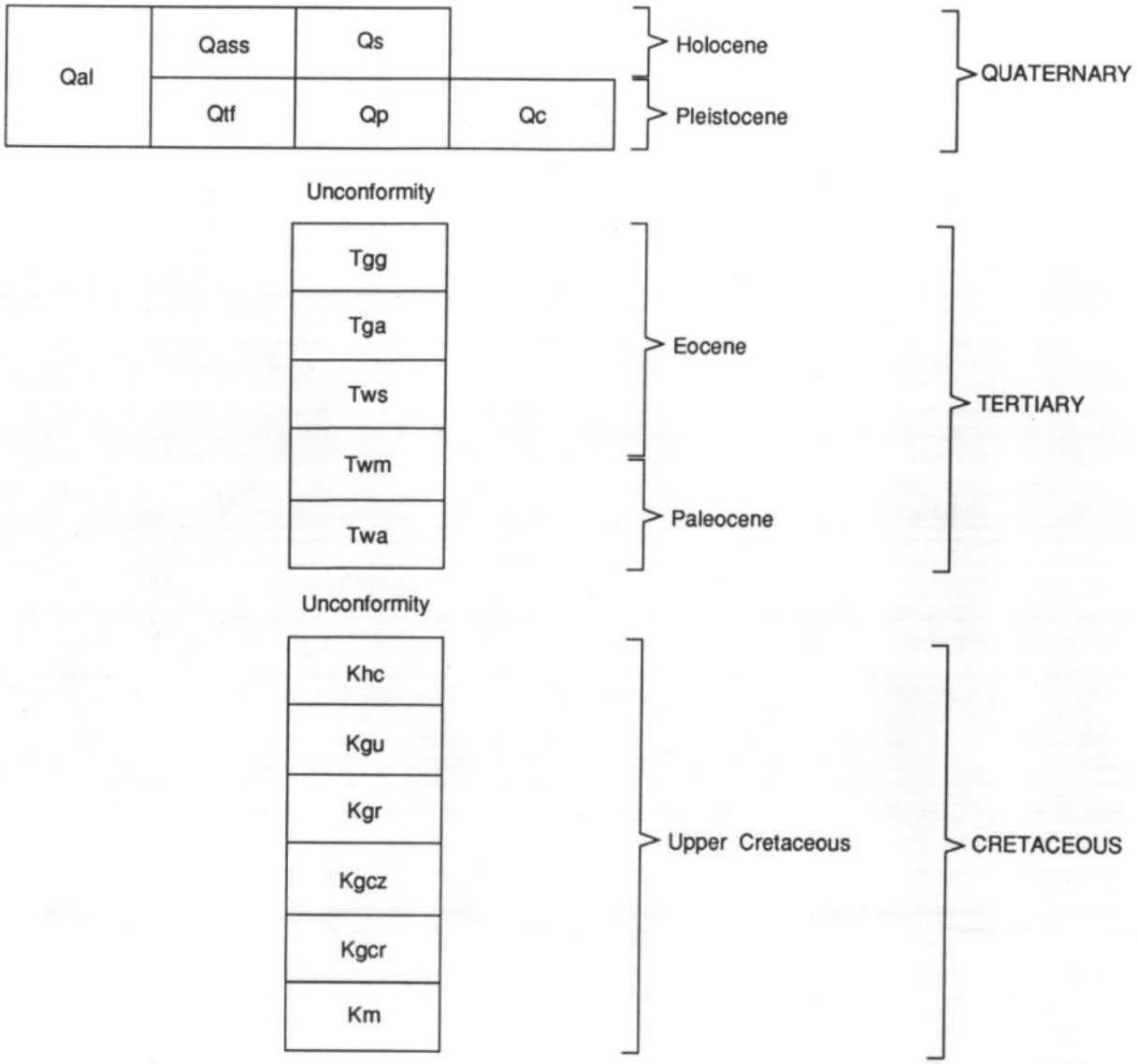
CORRELATION OF MAP UNITS



Donnell, J.R., Yeend, W.E., Schmitt, L.J., Smith, M.C., 1992, Geologic Map of the De Beque Quadrangle, Grant and Mesa Counties, Colorado: U.S. Geological Survey, Miscellaneous Field Studies Map MF-2201

EXHIBIT
A6

DE BEQUE WATER STATION
SECTION 29, T8S, R97W 6TH P.M.

ARE GEOLOGY MAP KEY

DSGN	DATE	CKD
TAS	2/4/15	STH
REV	DATE	CKD

JOB # 2013-134

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APPENDIX B

HYDROLOGY & STORM WATER REPORT

APPENDIX B-1

STORM WATER REPORT APPROVAL LETTER FROM MESA COUNTY

MESA COUNTY DEPARTMENT OF PUBLIC WORKS

Building Inspection – Code Compliance - Engineering - Road and Bridge – Fleet
Regional Transportation Planning - Traffic - Planning - Solid Waste Management

200 S. Spruce Street, Dept. 5022 • P.O. Box 20,000 • Grand Junction, Colorado 81502-5001
Ph (970) 244-1636 Fax (970) 244-1769

November 21, 2014

Mr. Kevin Grabinski, P.E.
WWC Engineering
1275 Maple Street, Suite F
Helena, MT 59601

RE: 2014-0032 Debeque Station Stormwater Report

Dear Mr. Grabinski:

Mesa County Development Engineering has reviewed the Debeque Station Hydrology & Stormwater Report prepared by your office for Black Hills Plateau Production, and received via e-mail on November 7, 2014. All previous comments made by Mesa County Development Engineering have been addressed, and the report complies with the Mesa County Stormwater Management Manual.

If you have any questions, please feel free to call me at (970) 255-7170.

Sincerely,
Mesa County Development Engineering

Daniel J. Larkin
Staff Engineer

cc: Randy Price, MC Planning

file: 2014-0032

APPENDIX B-2

STORM WATER REPORT

DEBEQUE STATION HYDROLOGY & STORMWATER REPORT

PREPARED FOR:

Black Hills Exploration & Production
A Black Hills Corporation Enterprise

BLACK HILLS PLATEAU PRODUCTION

1515 WYNKOOP STREET, SUITE 500
DENVER CO 80202

PREPARED BY:

WWC ENGINEERING

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(406) 443-3962
www.WWCengineering.com

Innovation
Quality
Value

OCTOBER 2014

DeBeque Station Hydrology & Stormwater Report

Prepared for: Black Hills Plateau Production
ATTN: Brett Hurlbut
1515 Wynkoop Street, Suite 500
Denver, CO 80202
(303) 566-3356

Prepared by: WWC Engineering
1275 Maple Street Suite F
Helena, MT 59601
(406) 443-3962
Fax: (406) 449-0056

Principal Authors: Kevin Grabinski, P.E.

Reviewed by: Shawn Higley, P.E., Helena Branch Manager

Date: October 2014

I hereby certify that this *Final Drainage Report* for the design of the DeBeque Water Station was prepared by me (or under my direct supervision) in accordance with the provisions of the Mesa County *Stormwater Management Manual* and Colorado Division of Water Resources requirements for the owners thereof. I understand that Mesa County does not and will not assume liability for drainage facilities designed by others.

Registered Professional Engineer
State of Colorado No. 47398
(Affix Seal)

I, Black Hills Plateau Production hereby certifies that the drainage facilities for the DeBeque Water Station shall be constructed according to the design presented in this report. I understand that Mesa County does not and will not assume liability for the drainage facilities designed and/or certified by my engineer. I understand that Mesa County reviews drainage plans but cannot, on behalf of the DeBeque Water Station, guarantee that final drainage design review will absolve Black Hills Plateau Production and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the Final Plat and/or Final Development Plan does not imply approval of my engineer's drainage design.

Black Hills Plateau Production
Name of Developer

Authorized Signature Date

TABLE OF CONTENTS

LIST OF APPENDICES

I. INTRODUCTION

A. BACKGROUND

1. The De Beque Water Station facility will consist of three lined reservoirs for the storage of produced water and raw water, a pump station, a lay down yard and an office building. Pond 1 is classified as a non-jurisdictional minor dam under the Colorado Division of Water Resources (CDWR) while Ponds 2 and 3 are classified as minor jurisdictional dams and require the review of the CDWR.

   The purpose of this report is to identify the existing drainage conditions, existing and potential drainage issues associated with the development, and present solutions to the existing and potential drainage issues with the design and details for the required drainage facilities. This Final Drainage Report has been prepared by WWC Engineering (Shawn Higley, Colorado Professional Engineer) on behalf of Black Hills Plateau Production. This report and analysis meets the requirements of Mesa County and the Colorado Division of Water Resources.

2. Date of previous comment letter: N/A (1st submittal)

B. PROJECT LOCATION

1. The street address for the DeBeque Water Station is 4325 V 2/10 Road, DeBeque CO 81630. The project site is located approximately 2.2 miles southwest of DeBeque, CO in the SE ¼ of the SW ¼ of Section 29, Township 8 South, Range 97 West of the 6th P.M. The site is located within Mesa County parcel # 2445-293-00-225.

2. The project site is located on the south side of County Road V 2/10. The site is not part of a previous subdivision. The area to the west of the site is privately owned and undeveloped (County parcel # 2445-293-00-216). The area to the north of the site is privately owned and undeveloped (County parcel # 2445-293-00-270). The area east of the site is mostly undeveloped with a small industrial facility and is owned by Chevron (County parcel # 2445-294-00-140). The area south of the site is undeveloped and is owned by the Bureau of Land Management (County parcel # 2445-194-00-914).

3. A general location map is provided as Figure A.

C. PROPERTY DESCRIPTION

1. County parcel # 2445-293-00-225 contains approximately 39.28 acres that is owned by Red Rock Gathering Company, LLC. The project site for the

DeBeque Water Station encompasses approximately 23.32 acres of the site, with the remainder of the site utilized by Red Rock Gathering Company.

2. The existing ground cover and vegetation is mostly bare ground with low density native grass and scrub brush. Soil data has been obtained from the National Resources Conservation Service (NRCS) Web Soil Survey to provide an overview of the soil types located at the project site. From the NRCS Web Soil Survey, the predominate soils on the site are comprised of *Bunkwater very fine sandy loam, 1 to 8 percent slopes [12]* and *Dominguez clay loam, 3 to 8 percent slopes [32]*. The topography of the site is fairly consistent with a general slope from the northwest corner to the southeast corner of the parcel. The site has approximately 47 feet of elevation difference with an average slope of 2.7%.
3. The site contains two small ephemeral drainages that traverse through the property generally towards the southeast. The site does not contain any existing drainage structures or detention areas.
4. The site does not contain any existing irrigation facilities.
5. The proposed land use for this site is Industrial as the site will be developed as a water reuse facility. The site will require regrading to construct lined storage ponds, a laydown yard, an office building, a pump station building, and storm water controls facilities. Conveyance of the runoff from the site and upstream drainage area is an encumbrance that will be addressed for this development.

D. PREVIOUS INVESTIGATIONS

1. The site has not been part of previous drainage master plans or floodplain studies.
2. A previous drainage report has been prepared by Crestone Consultants, LLC for the portion of this site developed by Red Rock Gathering Company, LLC for a compressor station. The stormwater controls installed by Red Rock Gathering Company, LLC are isolated from the proposed Black Hills development and will operate independently of the controls described in this report.

II. DRAINAGE SYSTEM DESCRIPTION

A. EXISTING DRAINAGE CONDITIONS

1. The topography of the site is fairly consistent with a general slope from the northwest corner to the southeast corner of the parcel. The site has

approximately 47 feet of elevation difference with an average slope of 2.7%. A map with existing site contours is provided as Figure D.

2. The site contains two small ephemeral drainages that traverse through the property generally towards the southeast. The site does not contain any existing drainage structures or detention areas. The proposed development will require the redirection of the northern ephemeral drainage on the site. The southern ephemeral drainage passes through only the southwest corner of the property and will remain in its natural state. The proposed development will not alter the flow path for the southern ephemeral drainage. A map showing the proposed development is included as Figure E.

3. Runoff from the site generally flows as overland sheet flow until reaching an ephemeral drainage. Runoff leaving the site is a combination of unconcentrated sheet flow and semi-concentrated flow in ephemeral drainages. Hydrologic calculations for the predeveloped flow entering and leaving the site are provided in Appendix B.

B. MASTER DRAINAGE PLAN

1. The project site has not been a part of any previous Master Drainage Plans. A drainage plan was prepared for the portion of this site used by Red Rock Gathering Company, LLC. The site grading for Red Rock Gathering Companies' facility includes a separation berm between their portion of the site and the portion of the site proposed for this facility. The separation berm isolates the two developments and prevents run-on from entering their facility from the DeBeque Water Station or run-off from leaving their facility and flowing to the DeBeque Water Station.

C. OFFSITE TRIBUTARY AREA

1. The northern ephemeral drainage that enters the project site has an estimated upstream drainage area of 258.9 acres as delineated from USGS quad maps. The southern ephemeral drainage passes through just the southwest corner of the parcel and has an estimated drainage area of 183.5 acres as delineated from USGS 7.5-minute quad maps. The southern ephemeral drainage that passes through the south-west corner of the site will not be altered and has not been evaluated within this drainage report.

2. The existing land use for the majority of the offsite tributary area is undeveloped public lands with a small portion of agricultural lands. The future land use for the public lands is unlikely to change and therefore the future peak flows should be relatively unchanged from the current peak flows. Future offsite detention on public lands is unlikely to occur as this land will not be developed and should not affect the on-site detention requirements.

D. PROPOSED DRAINAGE SYSTEM

1. The northern and southern ephemeral drainages that pass through the site join together just downstream from the site on the southeast. After the confluence of the two ephemeral drainages, the merged ephemeral drainage continues approximately 1.1 miles downstream until reaching the Colorado River. The southern ephemeral drainage through the project site will be unchanged and pass through the southwest corner of the site. The northern ephemeral drainage will be intercepted with a drainage ditch along the west side of the site that conveys the stormwater south to the southern ephemeral drainage. The ultimate receiving water, the Colorado River, and location remains unchanged.
2. The upstream drainage area from the northern ephemeral drainage (SWS 1) approaches the site from the northwest and is intercepted by a drainage ditch that conveys the stormwater to the southern ephemeral drainage. SWS 2 is located along the northern side of the three lined storage ponds and includes the vegetated pond embankments, the laydown yard, the office building, pump station building, and access roads. Runoff from SWS 2 flows to the north drainage ditch that conveys the stormwater to the detention pond located in the southeast corner of the site. SWS 3 is located between the southern property boundary and the lined storage ponds. Runoff from SWS 3 is collected by the south drainage ditch that conveys the stormwater to the detention pond. SWS 4 is located between the lined storage ponds and the detention pond. Runoff from SWS 4 sheet flows directly to the detention pond. The detention pond has sufficient capacity for all of the runoff from the design 100-year, 6-hour event and will settle out any transported sediment into the bottom of the pond while the water infiltrates into the ground. SWS 5 is the northwest lined storage pond (Pond 1) and precipitation falls directly onto the water surface or pond liner and is retained within the freeboard of the pond. SWS 6 is the southwest lined storage pond (Pond 2) and precipitation falls directly onto the water surface or pond liner and is retained within the freeboard of the pond. SWS 7 is the southeast lined storage pond (Pond 3) and precipitation falls directly onto the water surface or pond liner and is retained within the freeboard of the pond. Precipitation that falls onto the lined storage ponds will not be discharged from the site as runoff, but will be utilized for industrial applications.
3. Mesa County requires at a minimum that detention is provided for the 2-year storm event based on pre-development conditions. In addition, detention of the 100-year event is required if the capacity of the downstream drainage

system will be exceeded. The lined storage ponds on the site will reduce the post-development run-off flow rates to below the pre-development run-off flow rates. The downstream drainage has sufficient capacity for the pre-development and post-development flow rates. The detention pond will be 26’ wide x 250’ long and 6’ deep. The pond bottom elevation is at 5,026.0 ft and the pond has a 12” diameter outlet pipe at elevation 5,030.0 ft and a 10’ wide spillway at elevation 5,031.0 ft. The pond provides 0.92 acre-feet of storage at the outlet pipe elevation and 1.26 acre-feet of storage at the spillway elevation. Due to the presence of an irrigation canal downstream from the site that crosses the existing drainage, this development will provide a detention pond that will retain all of the post-development stormwater from the 100-year, 6-hour storm event when the pond is initially dry. During the 100-year, 6-hour storm event the pond has a peak inflow rate of 3.88 cfs and zero outflow at a peak elevation of 5,028.79 ft with all of the water retained in the pond. This provides 1.21 feet of freeboard which exceeds the Mesa County requirement of one-foot. The soils in the pond have a high clay content and infiltration of this water will likely take longer than 48 hours. The outlet pipe is a 12” diameter pipe with an invert elevation of 5,030.0 ft and a slope of 0.92%. This pipe will allow stormwater to flow out of the detention pond at a rate less than the pre-development flow rate if the detention pond is still storing water prior to the 100-year, 6-hour storm event. The flow rate out of the detention basin must be less than 2.77 cfs during the 100-year, 6-hour storm. If the pond is storing water up to the elevation of 5030.0 prior to the storm event, the maximum flow rate from the outlet pipe during the design storm event is 1.65 cfs and below the maximum allowed discharge rate. This design exceeds the Mesa County requirements to provide detention for the 2-year storm event. The analysis and design calculations have been performed using HydroCAD™ Stormwater Modeling software. HydroCAD™ calculation results are provided in Appendix C.

4. Three monitoring wells have been installed on the site to a depth of 100 feet that have not encountered the groundwater table. The depth to groundwater is unknown, but exceeds 100 feet.

5. Direct precipitation on the lined storage pond will be contained within the freeboard of the ponds and will not run-off from the site. Run-on to the site is intercepted by the west ditch that conveys this concentrated flow to the southwest corner of the property where it will flow into the existing ephemeral drainage. Run-off from the site will be intercepted by ditches along the north, east, and south sides of the property and conveyed to the detention pond located in the southeast corner of the property. The detention pond will detain the stormwater from the design event of to the 100-year, 6-hour storm with

over one foot of freeboard in the pond. A spillway is provided for larger storm events that would discharge concentrated flow that leaves the property on the east side.

6. The detention pond in the southeast corner of the pond will be the stormwater quality facility. The pond will allow sediment to settle out of the stormwater into the pond. Additional BMPs will be provided during construction and for final site stabilization.
7. A 10’ wide berm/ maintenance path is provided around the perimeter of the detention basin to allow access for removing captured sediments from the pond. Any sediments removed from the pond will be hauled off-site to an appropriate location.
8. The proposed drainage facilities will be privately owned and easements are not currently proposed. Maintenance will be performed by the property owner.

E. DRAINAGE FACILITY MAINTENANCE

1. All of the proposed stormwater facilities will be located on private property; therefore the owner will be responsible for the maintenance of drainage facilities.
2. The proposed drainage channels, culverts, and detention basin are all located on private property and will be used for the conveyance of run-on to the site and the conveyance and detention of run-off from the site. The property owner will be responsible for the inspection and maintenance of the drainage facilities. The drainage channels and detention basin will require low to moderate amounts of maintenance on a routine basis, but may require more significant maintenance on a periodic basis (10 to 20 years).

   Inspection

   The property owner shall inspect the drainage channels, culverts, and detention basin at least twice annually to observe the amount of sediment and debris that may have accumulated. The owner shall remove debris and litter from the drainage facilities to maintain the design capacity of the facilities.

   Sediment Removal

   Sediment removal from the detention basin is required when the pond depth has been reduced by 6 inches. A vacuum truck may be used to remove the sediment from the pond. Sediment removed from the detention basin should be disposed of properly off-site to ensure that the sediments are not washed back into the detention basin.

   Structure and Erosion Repair

Repair culverts, drainage ditches, pond outlet structures, and all other structural components as needed to maintain the drainage facilities function. Repair and revegetate eroded areas, if needed.

III. DRAINAGE ANALYSIS AND DESIGN CRITERIA

A. REGULATIONS

1. The analysis and design for this drainage report has been prepared in accordance with the provisions of the Mesa County Stormwater Management Manual (SWMM).
2. Ponds 2 and 3 are classified as minor jurisdictional dams and require the review of the CDWR. Table 5.1 in the State of Colorado's *Rules and Regulations for Dam Safety and Dam Construction* was used to determine the Inflow Design Flood (IDF) based on the hazard classification. The CDWR approved Hazard Classification Report classifies Ponds 1, 2 and 3 as Minor Low-Hazard dams. This correlates to using the 50-year, 24-hour rainstorm event per Table 5.1.

B. DEVELOPMENT CRITERIA

1. Drainage constraints have not been placed on this project by major drainage studies or floodplain studies. A separate drainage report for the portion of the property being retained by Red Rock Gathering Company, LLC (compressor station) has been prepared for the northeast corner of this parcel, but a separation berm has been installed to prevent run-on/run-off between the two facilities.
2. The drainage constraints for this project include 1) the interception and conveyance of off-site run-on to the property and returning these flows to the natural ephemeral drainage, and 2) the interception, conveyance, and detention of run-off from the project site. Drainage ditches, culverts, and a detention pond have been designed for these constraints.

C. HYDROLOGIC CRITERIA

1. The Mesa County SWMM and Colorado Division of Water Resources (CDWR) requirements have been followed in the preparation of this hydrologic analysis. A form of the Natural Resources Conservation Service (formerly SCS) Triangular Hydrograph Method was used to estimate the runoff volumes for this development. This method is appropriate for small watersheds similar to the project area. The SCS Curve Number Method is applicable for drainage areas less than 800 hectares (approximately 2,000 acres). Peak flows and volumes were calculated using HydroCAD™ software

that incorporates both hydrologic and hydraulic calculations in one comprehensive analysis.

The major input parameters used in the SCS method are summarized below:

Drainage Area (A): The drainage areas were determined based on the existing and proposed site topography. The upstream drainage area from the northern ephemeral drainage contains 258.86 acres that is intercepted and routed around the development. The lined storage ponds encompass 8.22 acres and precipitation onto these ponds and liners flows directly into the ponds. The remainder of the site contains 14.47 acres with drainage ditches that convey runoff to the detention basin. Detailed breakdowns of the SWS areas are provided in Appendices B and C.

Watercourse Length (L): The watercourse length is the longest drainage path contained within each watershed from the watershed divide to the point of interest. Values were determined based on existing and proposed site topography. These watercourse lengths are provided with the HydroCAD™ model results in Appendix C.

Elevation difference (H): The elevation difference is the total change in elevation along the longest watercourse length. Values were determined based on existing and proposed site topography. These elevation differences are provided with the HydroCAD™ model results in Appendix C.

Curve Number (CN): The curve number is a numeric, dimensionless index developed to represent the combined hydrologic effect of soil, land use, agricultural land treatment class, hydrologic condition, and antecedent soil moisture. Soils within a typical drainage are given a hydrologic classification, ranging from A (most permeable) to D (least permeable), and are further divided into land use and vegetative cover. The hydrologic soil groups within the drainage area were determined from the information provided by the NRCS web soil survey. Soils in this area were determined to belong to Hydrologic Soil Groups C and D as shown on Figure A: General Location Map. Weighted curve numbers were calculated for each SWS and are provided in Appendix B and summarized in Table 1.

Table 1. SWS Weighted Curve Number Summary

	Curve Numbers	
SWS Name	Pre-Development	Post-Development
SWS 1	78.6	78.7
SWS 2	75.7	82.3
SWS 3	74.0	78.3
SWS 4	74.0	75.5
SWS 5	74.0	100.0
SWS 6	74.0	100.0
SWS 7	74.0	100.0

2. The following precipitation values have been calculated for the site in accordance with NOAA Atlas 2 (see Appendix A for calculations):

   Minor flood analysis: 2-year, 6-hour precipitation = 0.80 inches

   Major flood analysis: 100-year, 6-hour precipitation = 1.80 inches

   In addition to the Mesa County SWMM requirements, the facility has been evaluated for the 50-year, 24-hour precipitation event of 2.30 inches (NOAA Atlas 2) to ensure that the spillways for the lined storage ponds are adequately sized for the Colorado Division of Water Resources (CDWR) Inflow Design Flood (IDF) requirements. The lined storage ponds provide two feet of freeboard above the maximum operating level before the spillway elevations. The freeboard provided has adequate capacity to contain the entire IDF without any water flowing through the spillways. While precipitation from the IDF will not result in water flowing through the pond spillways, the spillways have been sized to ensure they provide sufficient capacity to handle the peak flow rate of water entering the ponds from the IDF.

3. Deviations from the Mesa Co. SWMM have not occurred. Additional evaluations have been conducted to meet CDWR requirements for Pond 2 and 3.

D. HYDRAULIC CRITERIA

1. The Mesa Co. SWMM has been followed in the preparation of this hydraulic analysis. The site is adjacent to the graveled V 2/10 County Road and will continue to utilize roadside ditches for stormwater conveyance. Roadways within the site shall be graveled and slope to drain to adjacent ditches for stormwater conveyance.

2. Storm inlets are not utilized in the design for this facility as stormwater is conveyed in open ditches.

3. Storm sewers are not utilized in the design for this facility as stormwater is conveyed in open ditches.
4. The stormwater runoff and detention volumes were calculated using the Natural Resources Conservation Service (formerly SCS) hydrograph method modeled with HydroCAD™. Allowable release rates have been set below the pre-development peak flow rates. The results for these calculations are provided with the model results in Appendix C.
5. Channel capacity has been calculated using Manning's equation within HydroCAD™.
6. Special analysis or design requirements have not been required for the design of this development. Analysis of the south ephemeral drainage that flows through the southwest corner of the property was not performed due to the fact that it has a small contributing drainage area (183.5 acres) and will not impact the proposed development even during large runoff events. Construction of facilities for the DeBeque Water Station have been setback from and will not occur within this drainage channel with the exception of the west drainage ditch that will tie into the south ephemeral drainage.
7. Other deviations from the Mesa County SWMM have not occurred.

E. VARIANCE FROM CRITERIA

1. Variances from the SWMM criteria are not being requested.
2. Pre-existing conditions have not caused a variance request.

IV. POST CONSTRUCTION STORMWATER MANAGEMENT

A. STORMWATER QUALITY CONTROL MEASURES

1. The proposed site includes two drainage channels that convey stormwater runoff to one detention basin that provides sufficient detention to prevent sediments from being transported off-site for most precipitation events. Additional stormwater quality control measures include surfacing with gravel, liners or native seeds. All disturbed areas shall be surfaced to minimize the potential for erosion and transport of sediments off-site.
2. Compensating detention is not required for this project. However, precipitation that falls directly on the lined ponds will be stored in the ponds within the two-feet of freeboard provided. This water will be utilized for industrial applications.
3. Underground detention is not proposed for this project.

4. Proprietary BMPS are not proposed for this project.

B. CALCULATIONS

1. The Water Quality Capture Volume (WQCV) has been calculated according to the Mesa Co SWMM and the calculations are provided in Appendix D. The calculation uses an upstream area of 14.47 acres that actually drains to the detention pond (The remaining area drains into one of the water storage ponds). The required WQCV is 0.31 acre-feet of storage which includes an additional 20% for sediment. The proposed detention pond provides 0.92 acre-feet of storage which exceeds the required WQCV.
2. Calculations for the spillway capacities of the lined storage ponds and the detention pond outlet pipe and overflow spillway have been completed within the HydroCAD™ modeling software and are provided with the results in Appendix C. The spillways are modeled as a broad-crested rectangular weir with a 10 feet crest length. Modeling these as a rectangular weir and ignoring the weir side slopes is a conservative analysis. The spillways provide a capacity of 26.3 cfs that far exceeds the potential flow rate these spillways could receive from a 50-year, 24-hour storm event per CDWR requirements.
3. The stormwater facilities for this project have been designed to ensure that the post-development flow rates are below the pre-development flow rates leaving the site. Table 2. below summarizes the pre- and post-development flow rates and volumes for each SWS for the 100-year, 6-hour design event. The runoff from SWS 2, 3, and 4 is detained within the on-site detention pond. Results for all storm events are provided in Appendix C.

Table 2. Peak Discharge and Runoff Volume Comparison (100-year, 6-hour)

SWS Name	Peak Flow Rates (cfs)		Runoff Volumes (acre-feet)	
	Pre-Development	Post-Development	Pre-Development	Post-Development
SWS 1[(1)]	68.59	68.59	8.84	8.84
SWS 2[(2)]	1.90	3.51	0.27	0.44
SWS 3[(2)]	1.20	1.95	0.07	0.10
SWS 4[(2)]	0.78	0.99	0.03	0.03
SWS 5[(3)]	0.60	0.00	0.06	0.00
SWS 6[(3)]	0.57	0.00	0.06	0.00
SWS 7[(3)]	0.53	0.00	0.06	0.00

Notes: 1) SWS 1 is unchanged by this development and routed around the site.

2) SWS, 2, 3, and 4 are routed to the on-site detention pond which detains all stormwater for the 100-year, 6-hour event.

3) SWS 5, 6, and 7 are lined storage ponds that retain all stormwater for the 100-year, 6-hour event.

V. CONCLUSIONS

A. COMPLIANCE WITH MANUAL

1. This Final Drainage Report has been prepared in compliance with the criteria outlined in the Mesa Co. SWMM.

B. DESIGN EFFECTIVENESS

1. The main components of this drainage design are the proposed drainage channels and detention basin. The drainage channels have been designed to convey stormwater flows for the 100-year storm. The detention basin has been designed to detain the stormwater the design event and allow sediment to settle out of the water into the pond. The lined storage ponds will retain the design storm event within the freeboard of the ponds. These facilities will ensure that the peak flow rates for stormwater leaving the site are less than the historic flow rates for the site and will ensure that adjacent parcels and drainages are not adversely affected by the development of this project site.

C. AREAS IN FLOOD HAZARD ZONE

1. This project is not located within a flood hazard zone as shown on Figure B.

D. VARIANCES FROM MANUAL

1. No variances from the manual are requested.

VI. REFERENCES

1. Mesa County/City of Grand Junction Stormwater Management Manual (SWMM), Effective December 2007.
2. Town of DeBeque Comprehensive Plan Update, Adopted August 3, 2009.
3. Denver Urban Drainage and Flood Control District (UDFCD), Drainage Criteria Manual, Volume 3, Revised November 2010.
4. Flood Insurance Rate Map Mesa County, Colorado and Incorporated Areas. Map Number 08077C0180F, Effective Date July 6, 2010.

5. Natural Resources Conservation Service (NRCS), Web Soil Survey Area: Douglas-Plateau Area, Colorado, Parts of Garfield and Mesa Counties; Survey Area Data: Version 5, February 1, 2008.
6. State of Colorado's Rules and Regulations for Dam Safety and Dam Construction, Effective Date January 1, 2007.

A. TABLES

1. SWS Weighted Curve Number Summary
2. Peak Discharge and Runoff Volume Comparison (100-year, 6-hour)

B. FIGURES

A. General Location Map
B. Floodplain Information
C. Drainage Plan
D. Existing Conditions
E. Proposed Facility Layout
F. Detention Pond
G. Detention Pond Spillway Detail
H. West Ditch
I. South Ditch
J. North Ditch
K. North Ditch
L. Typical Sections
M. Erosion Control Plan

Table 302
Stormwater Management Manual
Drainage Report Checklist

Instructions:
1. Applicant to identify with a "check-mark" if information is provided with report. If applicant believes information is not required, indicate with "n/a" and attach separate sheet with explanation
2. The reviewer will determine if information labeled "n/a" is required and whether information must be submitted.
3. Those items noted with an "asterisk" are not required for conceptual report.
4. Submit three (3) copies of report and include copy of check list bound with report.

TITLE PAGE

A. Type of report (Conceptual/Preliminary or Final Drainage Report).
B. Project Name.
C. Preparer name, firm, address, number, and date.
D. Professional Engineer's seal of preparer.
E. Certifications (see SWMM Section 303.1)

I. INTRODUCTION

A. Background
- ✓ 1. Identify report preparer and purpose.
- ✓ 2. Identify date of letter with previous County comments.

B. Project Location
- ✓ 1. Identify Township, Range, and Section.
- ✓ 2. Identify adjacent street and subdivision names.
- ✓ 3. Reference to General Location Map.

C. Property Description
- ✓ 1. Identify area in acres of entire contiguous ownership.
- ✓ 2. Describe existing ground cover, vegetation, soils, topography and slopes.
- ✓ 3. Describe existing drainage facilities, such as channels, detention areas, or structures.
- ✓ 4. Describe existing irrigation facilities, such as ditches, head-gates, or diversions.
- ✓ 5. Identify proposed types of land use and encumbrances.

D. Previous Investigations
- ✓ 1. Identify drainage master plans that include the project area, including floodplain studies.
- ✓ 2. Identify drainage reports for adjacent development.

II. DRAINAGE SYSTEM DESCRIPTION

A. Existing Drainage Conditions
- ✓ 1. Describe existing topography and provide map with contours extending a minimum of 100 feet beyond property limits.
- ✓ 2. Identify major drainageway or outfall drainageway and describe map showing location of proposed development within the drainageways.
- ✓ 3. Identify pre-developed drainage patterns and describe map showing pre-developed sub-basins and concentrated discharge locations. Provide calculations of pre-developed peak flows entering and leaving the site.

B. Master Drainage Plan
- ✓ 1. Describe location of the project relative to a previously prepared master drainage plan, including drainage plans prepared for adjacent development.

C. Offsite Tributary Area
- ✓ 1. Identify all offsite drainage basins that are tributary to the project.

2. Identify assumptions regarding existing and future land use and effects of offsite detention on peak flows. ✓

D. Proposed Drainage System Description

1. Identify how offisite stormwater is collected and conveyed through the site and ultimately to the receiving water(s). ✓
2. Identify sub-basins and describe, in general terms, how onsite stormwater is collected and conveyed through the site for each location where stormwater is discharged from the site. ✓
3. Describe detention volumes, release rates and pool elevations. ✓ *
4. Identify the difference in elevation between pond invert and the groundwater table. ✓ *
5. Describe how stormwater is discharged from the site, including both concentrated and dispersed discharges. ✓
6. Describe stormwater quality facilities. ✓
7. Describe maintenance access aspects of design. ✓ *
8. Describe easements and tracts for drainage purposes, including limitation on use. ✓ *

E. Drainage Facility Maintenance

1. Identify responsible parties for maintenance of each drainage and water quality facility. ✓ *
2. Identify general maintenance activities and schedules. ✓ *

III. DRAINAGE ANALYSIS AND DESIGN CRITERIA

A. Regulations

1. Identify that analysis and design was prepared in accordance with the provisions of the Manual. ✓
2. Identify other regulations or criteria which have been used to prepare analysis and design. ✓

B. Development Criteria

1. Identify drainage constraints placed on the project, such as by a major drainage study, floodplain study or other drainage reports relevant to the project. ✓
2. Identify drainage constraints placed on the project, such as from major street alignments, utilities, existing structures, and other developments. ✓

C. Hydrologic Criteria

(If Manual was followed without deviation, then a statement to that effect is all that is required. Otherwise provide the following information where the criteria used deviates from the Manual.)

1. Identify how storm runoff peak flows and volumes were determined, including rainfall intensity or design storm. ✓
2. Identify which storm events were used for minor and major flood analysis and design. ✓
3. Identify how and why any other deviations from the Manual occurred. ✓

D. Hydraulic Criteria

(If Manual was followed without deviation, then a statement to that effect is all that is required. Otherwise provide the following information where the criteria used deviates from the Manual.)

1. Identify type(s) of streets within and adjacent to development and source for allowable street capacity. ✓ *
2. Identify which type(s) of storm inlets were analyzed or designed and source for allowable capacity. N/A *
3. Identify which type of storm sewers which were analyzed or designed and Manning's n-values used. N/A *

✓ * 4. Identify which method was used to determine detention volume requirements and how allowable release rates were determined.

✓ * 5. Identify how the capacity of open channels and culverts were determined.

✓ * 6. Identify any special analysis or design requirements not contained with the Manual.

✓ 7. Identify how and why any other deviations from the Manual occurred.

E. Variance from Criteria

✓ 1. Identify any provisions of the Manual for which a variance is requested.

✓ 2. Identify pre-existing conditions which cause the variance request.

***IV. POST CONSTRUCTION STORMWATER MANAGEMENT. See Manual Section 1600 for requirements.**

Note: This section of the Final Drainage Report identifies additional information required by Mesa County's, City of Grand Junction's, and Town of Palisade's, Permit for Stormwater Discharges Associated with Municipal Separate Storm Sewer Systems (MS4s), permit No. COR-090000. The Final Drainage Plan and the Construction SWMP (see SWMM Section 1500) meets the requirements of the MS4s Permit. In general, this section identifies permanent BMP practices to control the discharge of pollutants after construction is complete.

*A. Stormwater Quality Control Measures

✓ * 1. Describe the post-construction BMPs to control discharge of pollutants from the project site.

N/A * 2. If compensating detention is provided, discuss practices to address water quality from area not tributary to detention area.

N/A * 3. If underground detention is proposed, discuss how water quality facilities will be provided on the surface.

N/A 4. If proprietary BMPs are proposed, provide the justification and sizing requirements (see SWMM Section 1603.3).

*B. Calculations

✓ 1. Provide methods and calculations for WQCV, sediment storage, and water quality outlet structure.

V. CONCLUSIONS

A. Compliance with Manual

✓ Compliance with Manual and other approved documents, such as drainage plans and floodplain studies.

B. Design Effectiveness

✓ Effectiveness of drainage design to control impacts of storm runoff.

C. Areas in Flood Hazard Zone

✓ Meet requirements of Floodplain Regulations: Mesa County Land Development Code, Section 7.13; City of Grand Junction Zoning and Development Code, Section 7.1.

D. Variances from Manual

✓ Applicant shall identify any requested variances and provide basis for approving variance. If no variances are requested, applicant shall state that none are requested.

VII. REFERENCES

✓ Provide a reference list of all criteria, master plans, drainage reports, and technical information used.

TABLES

✓ Include copy of all tables prepared for report.

FIGURES

✓ A. General Location Map (See Section 303.2a)

✓ B. Flood Plain Information

✓ C. Drainage Plan (See Section 303.2b)
✓ D. Other pertinent figures.

APPENDICIES

A. DESIGN CHARTS

✓ 1. Provide copy of all design charts (i.e.: tables, figures, charts from other criteria) used for the report.

B. HYDROLOGIC CALCULATIONS (see Manual Sections 600 and 700)

✓ 1. Land use assumptions for off-site runoff calculations.
✓ 2. Time of concentration and runoff coefficients for pre-existing and post development conditions.
✓ 3. Pre-developed hydrologic computations.
✓ 4. Developed conditions hydrologic computations.

C. HYDRAULIC CALCULATIONS

N/A 1. Capacity of existing channels, streets, storm sewers, inlets, culverts and other facilities.
N/A 2. Calculations for existing storm sewer and open channel.
N/A 3. Irrigation ditch flows and ditch system capacity.
✓ * 4. Detention pond design (see Manual, Section 1400 for requirements).
✓ * a. Storage volume, release rates, and pool elevations for 2-year and 100-year storm.
✓ * b. Outlet structure dimensions, orifice diameter, weir lengths, pipe headwater and other data.
✓ * c. Outlet velocity and energy dissipation requirements.
✓ * d. Routing of outlet flows and emergency spillway flows.
N/A * 5. Street capacity calculations, if data in Manual not used (see Section 1100).
N/A * 6. Storm inlet capacity calculations, if data in Manual not used (see Section 1100).
N/A * 7. Storm sewer capacity calculations, if data in Manual not used (see Section 1000).
✓ * 8. Channel capacity calculations, if data in Manual not used (see Section 800).
✓ * 9. Culvert capacity calculations (see Manual, Section 1200).
✓ * 10. Other hydraulic structure calculations (see Manual, Section 900).

D. STORMWATER QUALITY CALCULATIONS

✓ 1. Water Quality Capture Volume (WQCV).
✓ * 2. Storage volume for sediment volume and pool elevations for WQCV.
N/A * 3. Outlet calculations for required area per row, diameter of individual holes, number of holes per row, and number of holes per column.

✓ **CERTIFICATION – PROFESSIONAL ENGINEER'S SEAL AND SIGNATURE**

ACKNOWLEDGEMENTS

Drainage Report checklist was prepared by: _____

COLORADO LICENSED
SHAWN T. HIGLEY
47398
PROFESSIONAL ENGINEER

Table 303
Stormwater Management Manual

Drainage Plan Checklist

Instructions:
1. Applicant to identify with a "check-mark" if information is provided. If applicant believes information is not required, indicate with "n/a".
2. County will determine if information labeled "n/a" is required and whether information must be submitted.

I. EXISTING FACILITIES

✓ A. Contours at two foot intervals, based on USGS datum. Contours to extend at least 50 feet past property line.
✓ B. Location and elevation of USGS benchmarks or benchmarks referenced to USGS.
✓ C. Property lines.
N/A D. Drainage easements.
✓ E. Street names.
✓ F. Major and minor channels and floodplains.

II. PROPOSED FACILITIES

✓ A. Contours at two-foot intervals, based on USGS datum.
✓ B. Property lines.
N/A C. Drainage easements.
✓ D. Street names and grades.
N/A E. Right of way and easement.
✓ F. Finished floor elevations for protection from major storm run-off.
✓ G. Detention pond information:
   ✓ 1. Location of each detention pond with site at 1"=50' scale or larger with 2-foot contour intervals.
   ✓ 2. Inlet and outlet structure, and trickle channel design details.
   ✓ 3. Details of emergency spillway and channel.
   ✓ 4. Landscape information, including side slopes, vegetation and planting requirements.
   ✓ 5. Details of water quality outlet structure.
✓ H. Channel Information:
   ✓ 1. Profiles with existing and proposed grades.
   ✓ 2. Cross sections on 100-foot stations showing existing and proposed topography and required rights of way.
   ✓ 3. Locations and size of all existing and proposed structures.
   ✓ 4. Locations and profiles of adjacent utilities.
   ✓ 5. Typical channel section and lining details.
N/A I. Storm sewer information:
   N/A 1. Alignment and location of manholes, inlets, and outlet structures.
   N/A 2. Profile of invert and pipe crown.
   N/A 3. Invert elevations at manholes and inlets.
   N/A 4. Lengths and grades between manholes and inlets.
   N/A 5. Locations and elevations of utilities adjacent to and crossing storm sewer.
   N/A 6. Easement and other O&M access geometry.
   N/A 7. Outlet details, such as end sections, headwall and wingwalls, erosion control, and vegetation.
✓ J. Street cross sections with design 100-year flood depth.
✓ K. Other drainage related structures and facilities, including underdrains and sump pump discharge lines.
✓ L. Other permanent BMP measures to control pollutant discharges to the County's MS4 system.

III. HYDRAULIC AND HYDROLOGIC INFORMATION

✓ A. Routing and accumulative runoff peaks at upstream and downstream ends of the site and at various critical points onsite for initial and major storms. Inflow and outflow from each subbasin shall be shown for both initial and major storms.

✓ B. Street cross sections showing 100-year flood levels.

✓ C. Major and minor channels and floodplains.

✓ D. Detention pond data:

✓ 1. Release rates for 2- and 100-year storm events.

✓ 2. Required and provided volumes for 2- and 100-year storm events.

✓ 3. Design depths for 2- and 100-year storm events.

✓ 4. Water quality capture volume and pool elevation.

✓ E. Channel data:

✓ 1. Water surface profiles.

✓ 2. Representative 100-year flow velocity and Froude number.

N/A F. Storm sewer data:

N/A 1. Profile of water surface for design flow rate.

N/A 2. Peak flows for design flow, 2-year and 100-year storm events.

IV. STANDARD NOTES

✓ A. No building, structure, or fill will be placed in the detention areas and no changes or alterations affecting the hydraulic characteristics of the detention areas will be made without the approval of the County.

✓ B. Maintenance and operation of the detention and water quality areas is the responsibility of property owner. If owner fails in this responsibility, the County has the right to enter the property, maintain the detention areas, and be reimbursed for costs incurred.

✓ C. Detention pond volumes, all drainage appurtenances, and basin boundaries shall be verified. As-built drawings shall be prepared by a registered professional engineer prior to issuance of certificate of occupancy for any structure within the development.

D. Permission to reproduce these plans is hereby given to Mesa County for County purposes associated with plan review, approval, permitting, inspection and construction of work.

✓ **V. PROFESSIONAL ENGINEER'S SEAL AND SIGNATURE**

VI. OTHER

✓ A. Horizontal and vertical control information and ties to existing and proposed features.

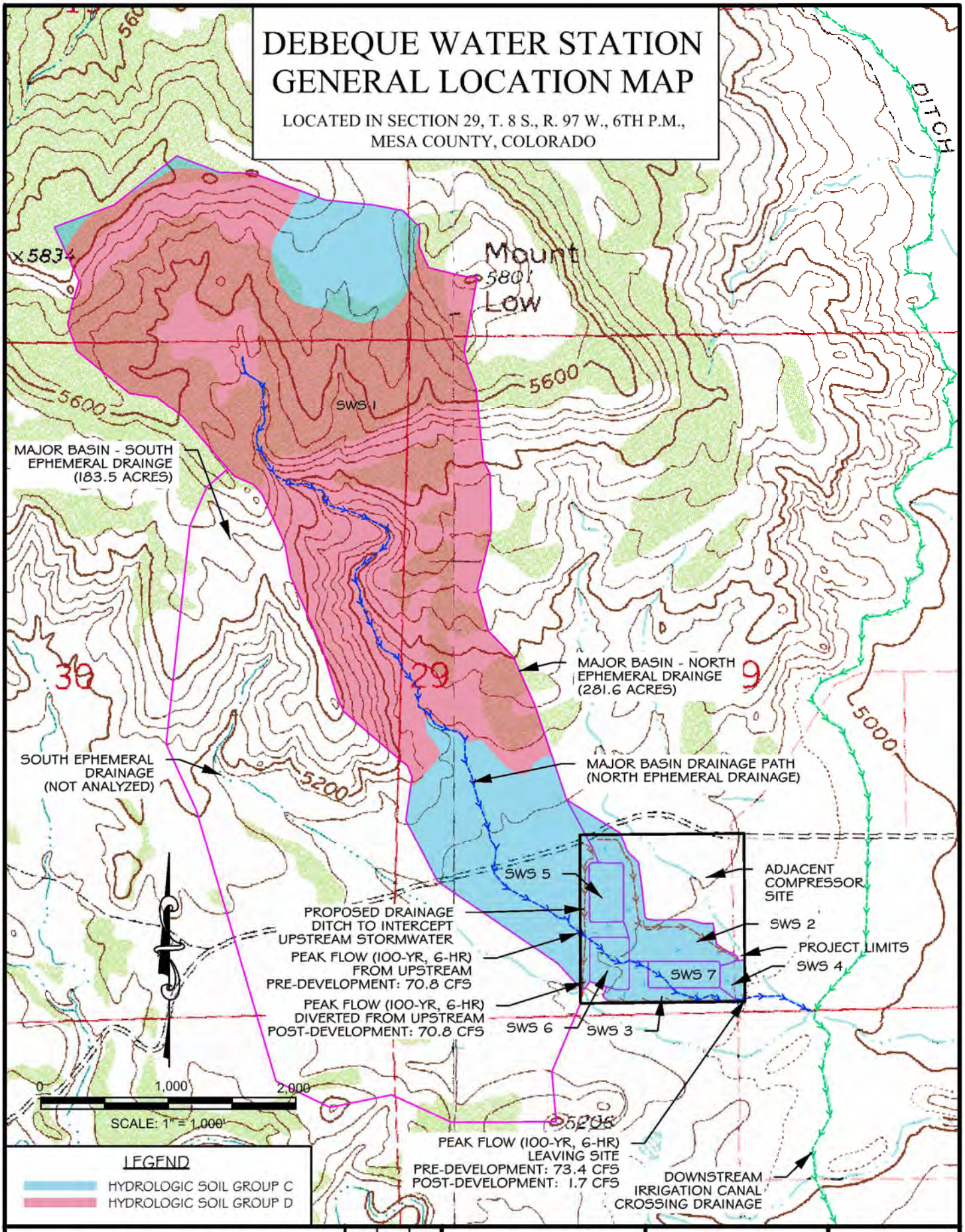
ACKNOWLEDGEMENTS

Drainage Plan checklist was prepared by: _____

FIGURES

DEBEQUE WATER STATION
GENERAL LOCATION MAP

LOCATED IN SECTION 29, T. 8 S., R. 97 W., 6TH P.M.,
MESA COUNTY, COLORADO



DEBEQUE WATER STATION

GENERAL LOCATION MAP

DSGN	DATE	CKD
KJG	09/24/14	STH
REV	DATE	CKD
KJG	10/30/14	STH

JOB # 2013-134

Black Hills Exploration & Production
A Black Hills Corporation Enterprise
2350 G Road, Suite 101
Grand Junction, CO 81505

WWC ENGINEERING
1275 MAPLE STREET, SUITE F
HELENA, MT 59601
(406) 443-3962

FIGURE
A.

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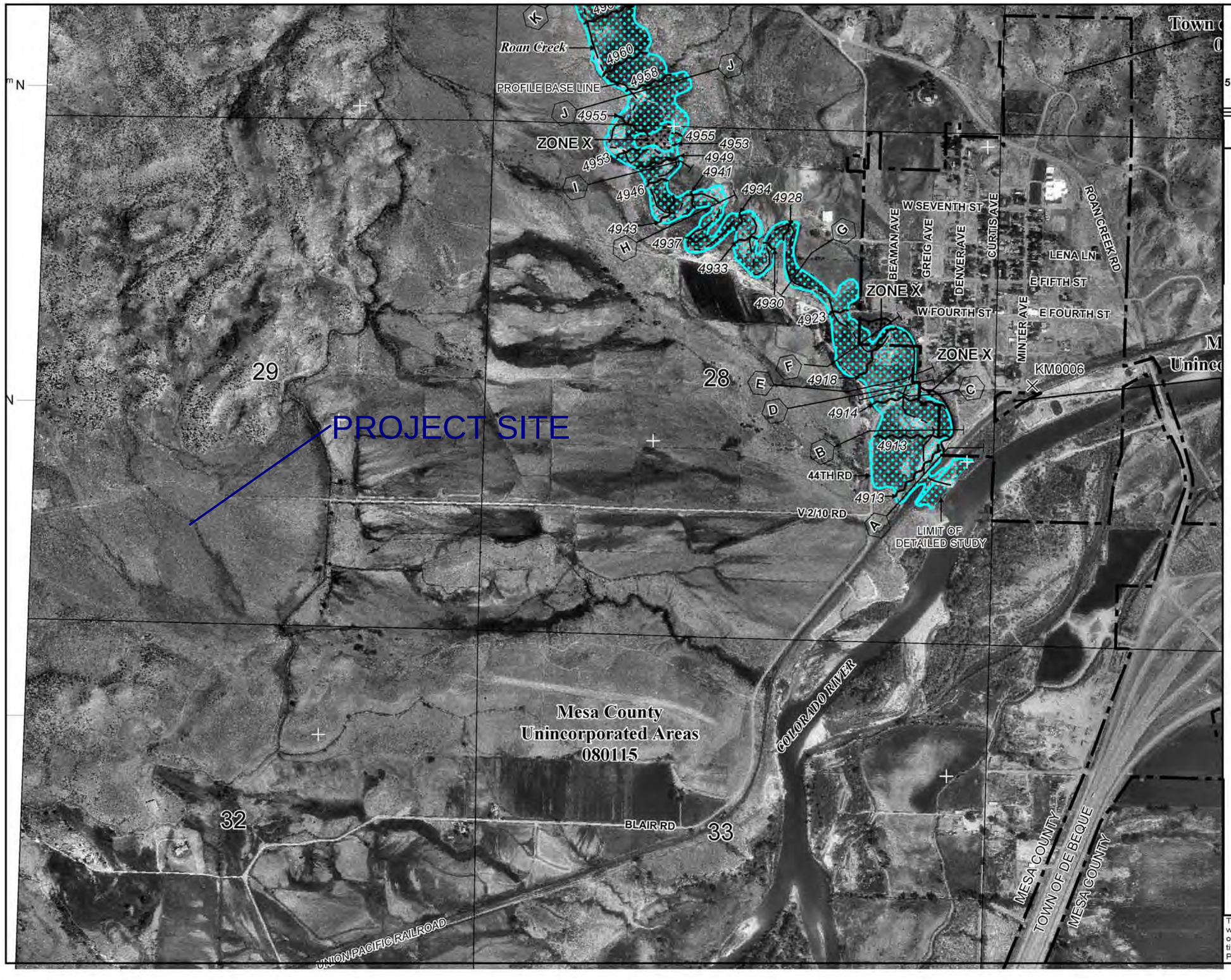
10/30/2014 FILE PATH: K:\Helena\BLACK HILLS\13134 - DE BEQUE STATION\DGN\13134 - Debeque Pond Hydrology.dgn



MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

METE

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0180F

FIRM

FLOOD INSURANCE RATE MAP
MESA COUNTY,
COLORADO
AND INCORPORATED AREAS

PANEL 180 OF 1725

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

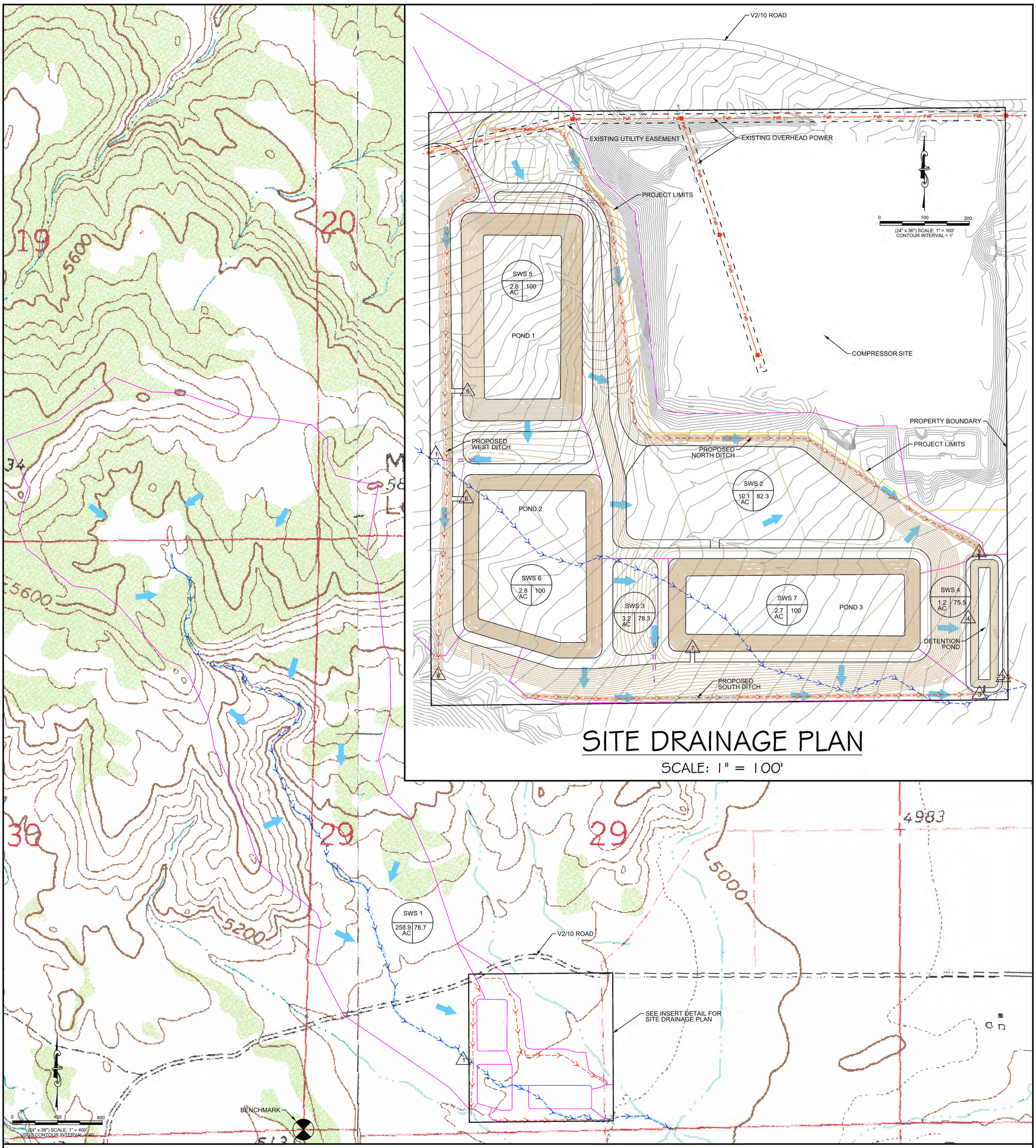
COMMUNITY	NUMBER	PANEL	SUFFIX
DE BEQUE, TOWN OF	080307	0180	F
MESA COUNTY	080115	0180	F

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
08077C0180F

EFFECTIVE DATE
JULY 6, 2010

Federal Emergency Management Agency



SITE DRAINAGE PLAN

SCALE: 1" = 100'

DRAINAGE PLAN OVERVIEW

SCALE: 1" = 400'

STANDARD NOTES

A. NO BUILDING, STRUCTURE, OR FILL WILL BE PLACED IN THE DETENTION AREAS AND NO CHANGES OR ALTERATIONS AFFECTING THE HYDRALIC CHARACTERISTICS OF THE DETENTION AREAS WILL BE MADE WITHOUT THE APPROVAL OF THE COUNTY.

B. MAINTENANCE AND OPERATION OF THE DETENTION AND WATER QUALITY AREAS IS THE RESPONSIBILITY OF THE PROPERTY OWERN. IF OWNER FAILS IN THIS RESPONSIBILITY, THE COUNTY HAS THE RIGHT TO ENTER THE PROPERT, MAINTAIN THE DETENTION AREAS, AND BE REIMBURSED FOR COSTS INCURRED.

C. DETENTION POND VOLUMES, ALL DRAINAGE APPERTUNANCES, AND BASIN BOUNDARIES SHALL BE VERIFIED. AS-BUILT DRAWINGS SHALL BE PREPARED BY A REGISTERED PROFESIONAL ENGINEER PRIOR TO ISSUANCE OF CERTIFICATE OF OCCUPANCY FOR ANY STRUCTURE WITHIN THE DEVELOPMENT.

D. PERMISSION TO REPRODUCE THESE PLANS IS HEREBY GIVEN TO MESA COUNTY FOR COUNTY PURPOSES ASSOCIATED WITH PLAN REVIEW, APPROVAL, PERMITTING, INSPECTION AND CONSTRUCTION OF WORK.

LEGEND

SWS 1 — BASIN DESIGNATION
BASIN AREA: 258.9 AC — SCS CURVE NUMBER: 78.7

1 — DESIGN POINT

POST-DEVELOPMENT FLOW ARROW

DRAINAGE BASIN BOUNDARY

EXISTING GROUND CONTOUR (1' INTERVAL)

PROPOSED GROUND CONTOUR (1' INTERVAL)

EXISTING DRAINAGE FLOW PATH

PROPOSED DRAINAGE FLOW PATH

SUB-WATERSHED PRE- AND POST-DEVELOPMENT FLOW DATA

BASIN	AREA (AC)	PRE-DEVELOPMENT Q2 (CFS)	PRE-DEVELOPMENT Q100 (CFS)	POST-DEVELOPMENT Q2 (CFS)	POST-DEVELOPMENT Q100 (CFS)
SWS 1	258.86	2.29	68.59	2.29	68.59
SWS 2	10.11	0.03	1.90	0.22	3.51
SWS 3	3.16	0.01	1.20	0.02	1.95
SWS 4	1.20	< 0.01	0.78	< 0.01	0.99
SWS 5	2.84	< 0.01	0.60	5.18	11.64
SWS 6	2.75	< 0.01	0.57	5.01	11.27
SWS 7	2.66	< 0.01	0.53	4.85	10.91

DESIGN POINT PRE- AND POST-DEVELOPMENT FLOW DATA

DESIGN POINT	PRE-DEVELOPMENT BASINS	PRE-DEVELOPMENT Q2 (CFS)	PRE-DEVELOPMENT Q100 (CFS)	POST-DEVELOPMENT BASINS	POST-DEVELOPMENT Q2 (CFS)	POST-DEVELOPMENT Q100 (CFS)
1	SWS 1	2.29	68.59	SWS 1	2.29	68.59
2	SWS 2	0.03	1.90	SWS 2	0.22	3.51
3	SWS 3	0.01	1.20	SWS 3	0.02	1.95
4	SWS 4	< 0.01	0.78	SWS 4	< 0.01	0.99
5	SWS 5	< 0.01	0.60	SWS 5	0.00	0.00
6	SWS 6	< 0.01	0.57	SWS 6	0.00	0.00
7	SWS 7	< 0.01	0.57	SWS 7	0.00	0.00
8	N/A	N/A	N/A	SWS 1	2.29	68.59
9	SWS 1 - SWS 7	2.31	71.36	SWS 2 - SWS 4	0.05	1.65

NOTES

1. THIS PROJECT SITE IS NOT WITHIN A MAPPED FLOODPLAIN.

2. THIS PROJECT DOES NOT CONTAIN EXISTING DRAINAGE EASEMENTS

3. THIS PROJECT INTERCEPTS OFFSITE FLOWS AND CONVEYS THEM AROUND THE SITE WITH A DRAINAGE DITCH ALONG THE WEST SIDE OF THE PROPERTY.

4. THE RETENTION BASIN PROVIDES 0.92 ACRE-FEET OF STORAGE BELOW THE SPILLWAY. THIS EXCEEDS THE REQUIRED WQCV OF 0.31 ACRE-FEET.

BENCHMARK:
BLM ALUMINUM CAP AT THE SW CORNER OF SECTION 29, T8S, R97W, 6TH P.M, ELEVATION 5110.50. NAVD '88. BASED UPON GPS OBSERVATIONS USING MESA COUNTY SURVEY INFORMATION MANAGEMENT SYSTEM (SIMS) DATA.

DEBEQUE WATER STATION

DRAINAGE PLAN

DSGN	DATE	CKD
KG	10/1/14	STH
REV	DATE	CKD
KG	10/30/14	STH

JOB # 2013-134

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WWC ENGINEERING
1275 MAPLE STREET, SUITE F
HELENA, MT 59601
(406) 443-3962

FIGURE C

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V 2/10 ROAD

EXISTING 20' UTILITY EASEMENT

EXISTING GAS MAIN (TO BE CONVERTED TO PRODUCED WATER MAIN)

EXISTING MONITORING WELL (DO NOT DISTURB)

EXISTING OVERHEAD POWER

EXISTING COMPRESSOR STATION BY SUMMIT MIDSTREAM PARTNERS

EXISTING FENCE (CONSTRUCTED BY SUMMIT, TO REMAIN IN PLACE)

EXISTING DRAINAGE

EXISTING MONITORING WELL (DO NOT DISTURB)

PROPERTY LINE

EXISTING MONITORING WELL (DO NOT DISTURB)

0 200 400

(11" x 17") SCALE: 1" = 200'
CONTOUR INVTERVAL = 1'

WWC ENGINEERING
1275 MAPLE STREET, SUITE F
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(406) 443-3962

Black Hills Exploration & Production
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2350 G Road, Suite 101
Grand Junction, CO 81505

DSGN	CKD	STH	CKD
DDP	DATE	10/03/14	DATE
REV			

JOB # 2013-134

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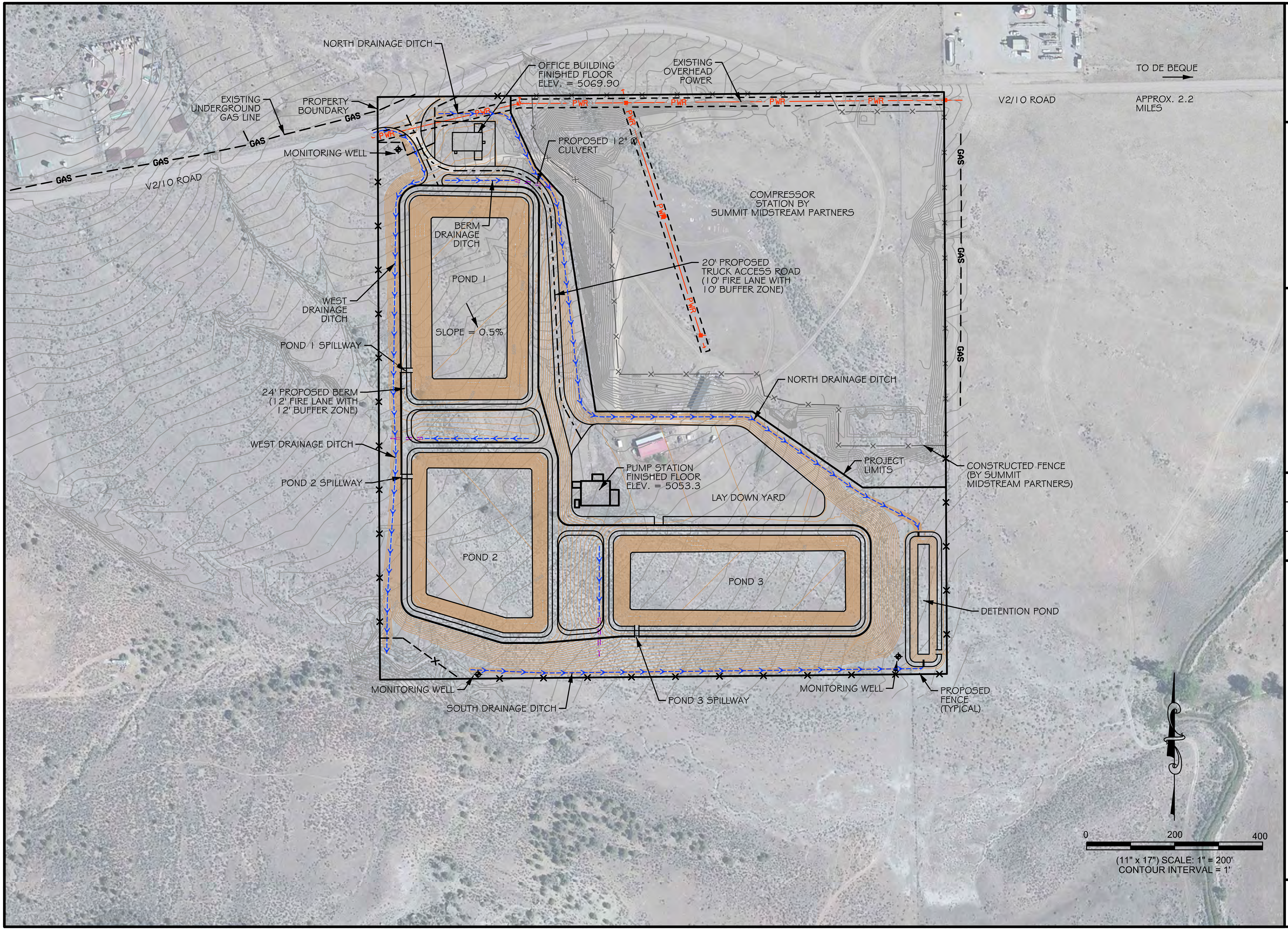
DE BEQUE WATER STATION

Existing Facilities

FIGURE
D



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10/30/2014

DSGN	DATE	CKD
DDP	10/03/14	STH
REV	DATE	CKD

JOB # 2013-134

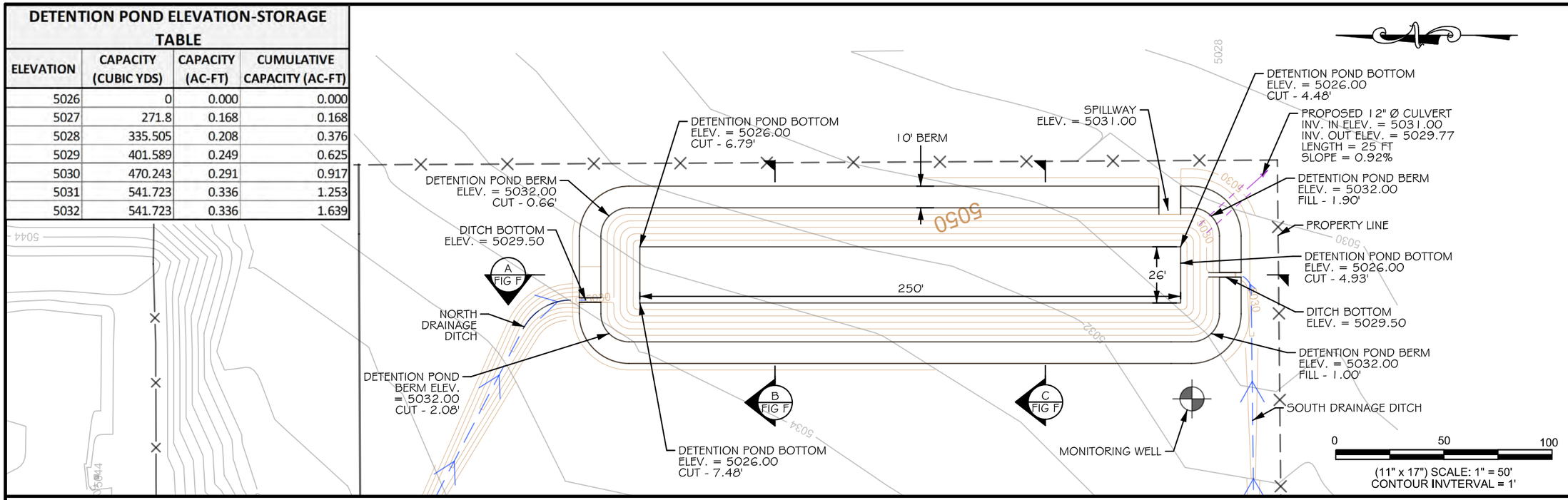
DE BEQUE WATER STATION

Proposed Facility Layout

FIGURE
E

DETENTION POND ELEVATION-STORAGE TABLE

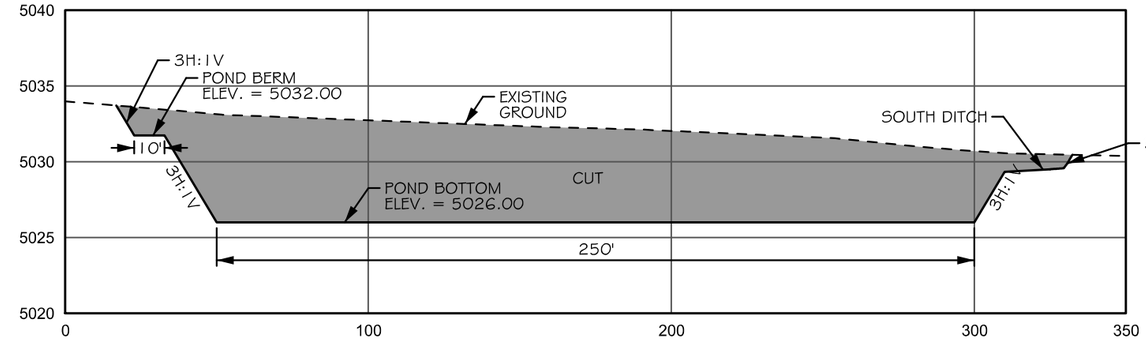
ELEVATION	CAPACITY (CUBIC YDS)	CAPACITY (AC-FT)	CUMULATIVE CAPACITY (AC-FT)
5026	0	0.000	0.000
5027	271.8	0.168	0.168
5028	335.505	0.208	0.376
5029	401.589	0.249	0.625
5030	470.243	0.291	0.917
5031	541.723	0.336	1.253
5032	541.723	0.336	1.639



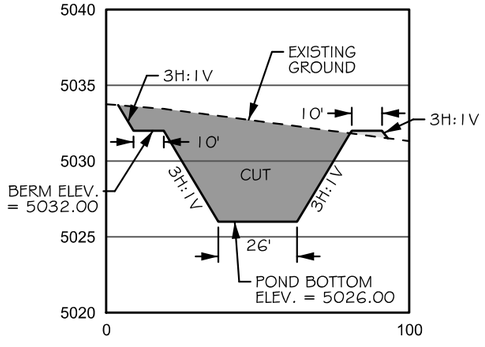
PROPOSED (PRIVATE) DETENTION POND DATA

Pond Bottom Elevation =	5026.00	feet
NOAA Atlas 2: 2-Year, 6-Hour Volume =	0.05	acre-feet
2-Year, 6-Hour Water Surface Elevation =	5026.32	feet
2-Year, 6-Hour Peak Inflow =	0.23	CFS
2-Year, 6-Hour Peak Outflow(1) =	0	CFS
Water Quality Capture Volume (WQCV) =	0.31	acre-feet
WQCV Water Surface Elevation =	5027.70	feet
NOAA Atlas 2: 100-Year, 6-Hour Volume =	0.57	acre-feet
100-Year, 6-Hour Water Surface Elevation =	5028.79	feet
100-Year, 6-Hour Peak Inflow =	3.88	CFS
100-Year, 6-Hour Peak Outflow(1) =	0	CFS
100-Year, 6-Hour Freeboard =	1.21	feet
12" Outlet Pipe Elevation =	5030.00	feet
Emergency Overflow Crest Elevation =	5031.00	feet
Emergency Overflow Capacity =	26.80	CFS
Top of Pond Elevation =	5032.00	feet

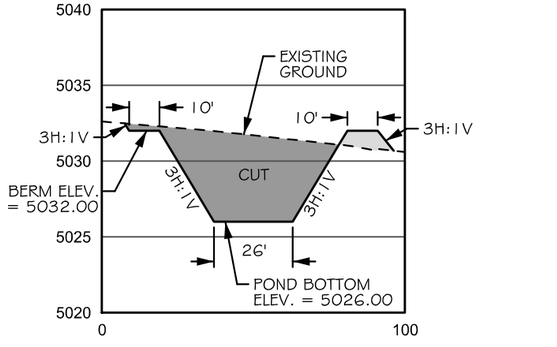
Notes: 1) The proposed detention pond will initially retain stormwater to minimize releases from the site. If the pond is storing water from a previous storm, the pond will detain the stormwater and release it at a flow rate below the allowable pre-development rate. If the pond surface elevation is 5,030.00 feet prior to a subsequent storm event, the maximum post-development outflow rates are 0.05 cfs for the 2-year, 6-hour event and 1.65 cfs for the 100-year, 6-hour event.



DETENTION POND SECTION (A FIG F)



DETENTION POND SECTION (B FIG F)



DETENTION POND SECTION (C FIG F)

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JOB # 2013-134

DE BEQUE WATER STATION

Detention Pond
Plan View and Cross Sections

FIGURE
F

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DETENTION POND
BOTTOM ELEV. = 5026.00

DETENTION POND
BERM ELEV. = 5032.00

DETENTION POND
BERM EDGE

DETENTION POND
SPILLWAY ELEV. = 5031.00

5030

10'

NORTH AMERICAN GREEN
P550 TURF REINFORCEMENT MAT
(OR APPROVED EQUAL)

10'

H
40

12'

DETENTION POND
BERM EDGE

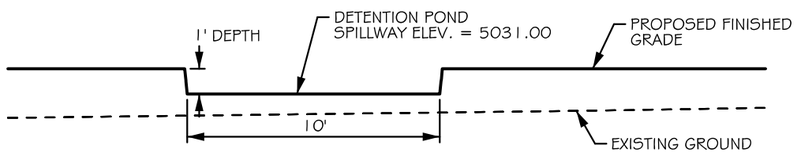
G
40

PROPOSED FENCE

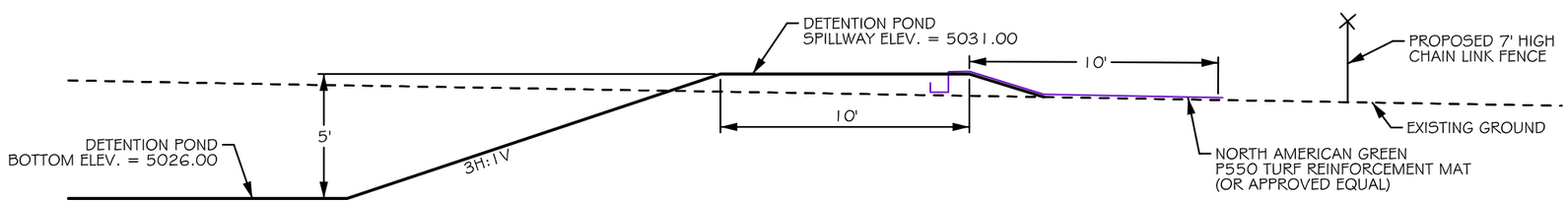
PERMANENT SEEDING

0 6 12

(11" x 17") SCALE: 1" = 6'



SECTION D
SCALE: 1" = 6'
FIG G



SECTION E
SCALE: 1" = 6'
FIG G

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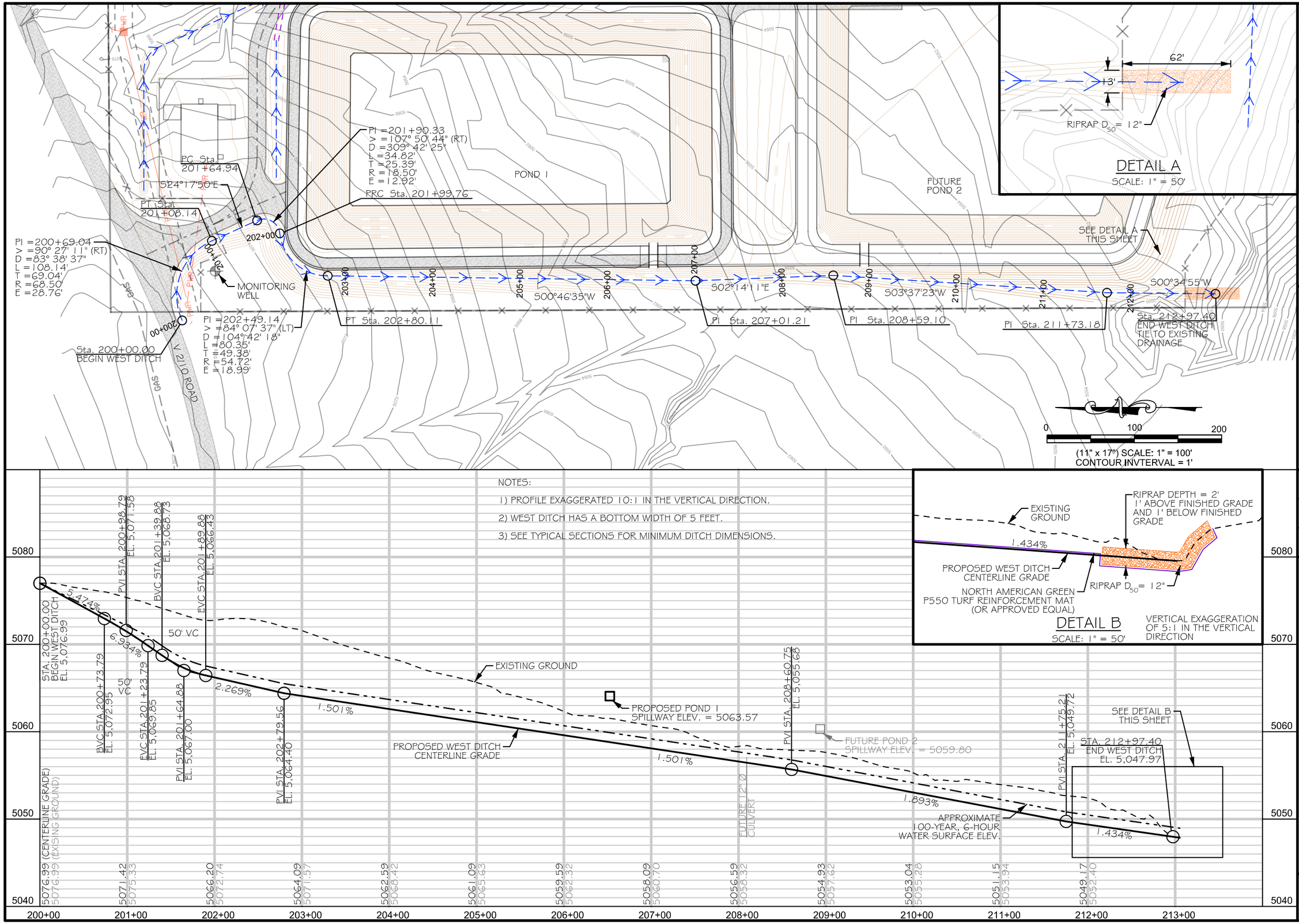
DDP	10/03/14	STH
REV	DATE	CKD
DDP	10/25/14	STH

JOB # 2013-134

DE BEQUE WATER STATION

Detention Pond Spillway Detail

FIGURE
G



NOTES:

1) PROFILE EXAGGERATED 10:1 IN THE VERTICAL DIRECTION.

2) WEST DITCH HAS A BOTTOM WIDTH OF 5 FEET.

3) SEE TYPICAL SECTIONS FOR MINIMUM DITCH DIMENSIONS.

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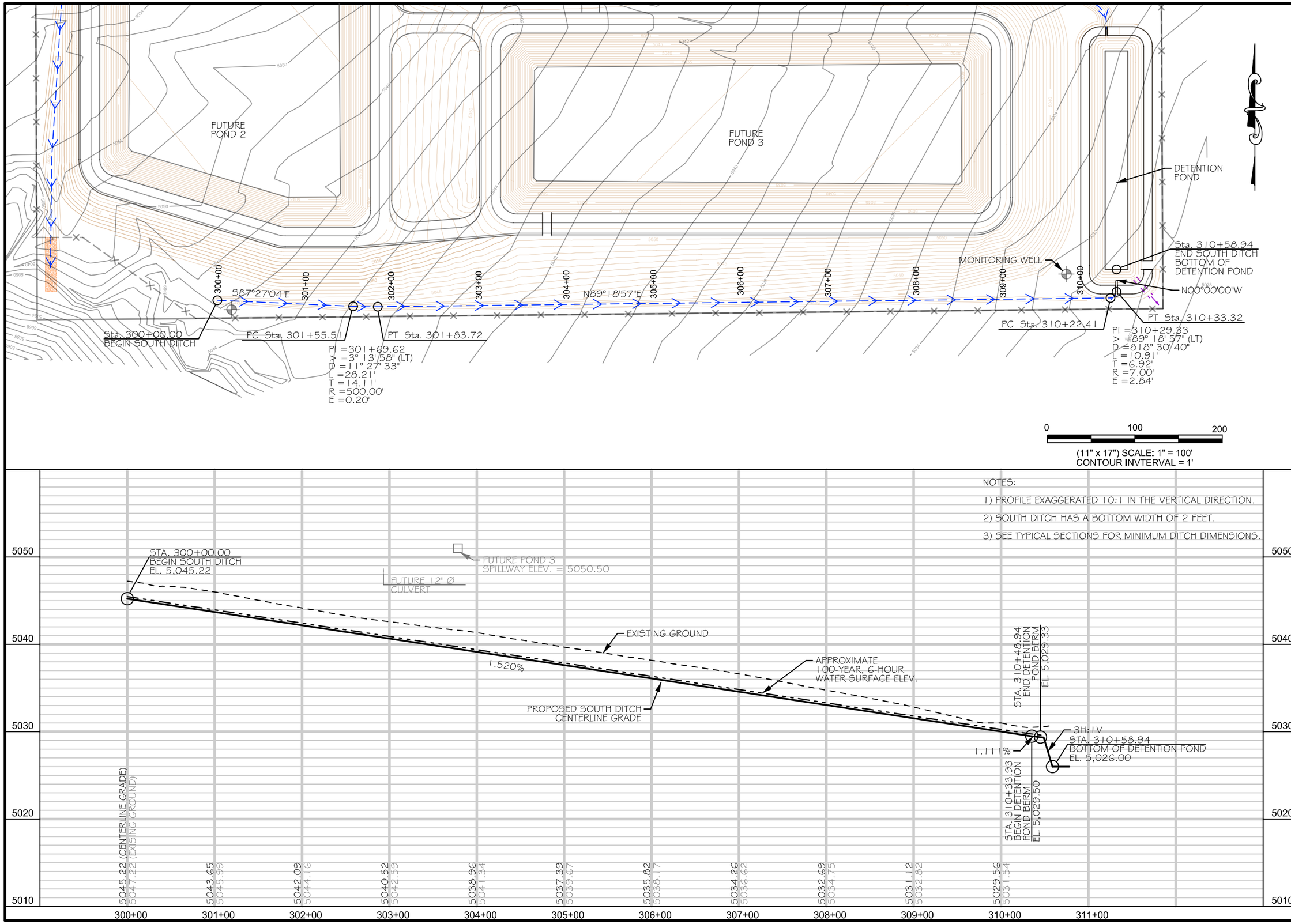
DDP	10/03/14	STH			

JOB # 2013-134

DE BEQUE WATER STATION

West Drainage Ditch Plan and Profile

FIGURE
H



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10/03/2014

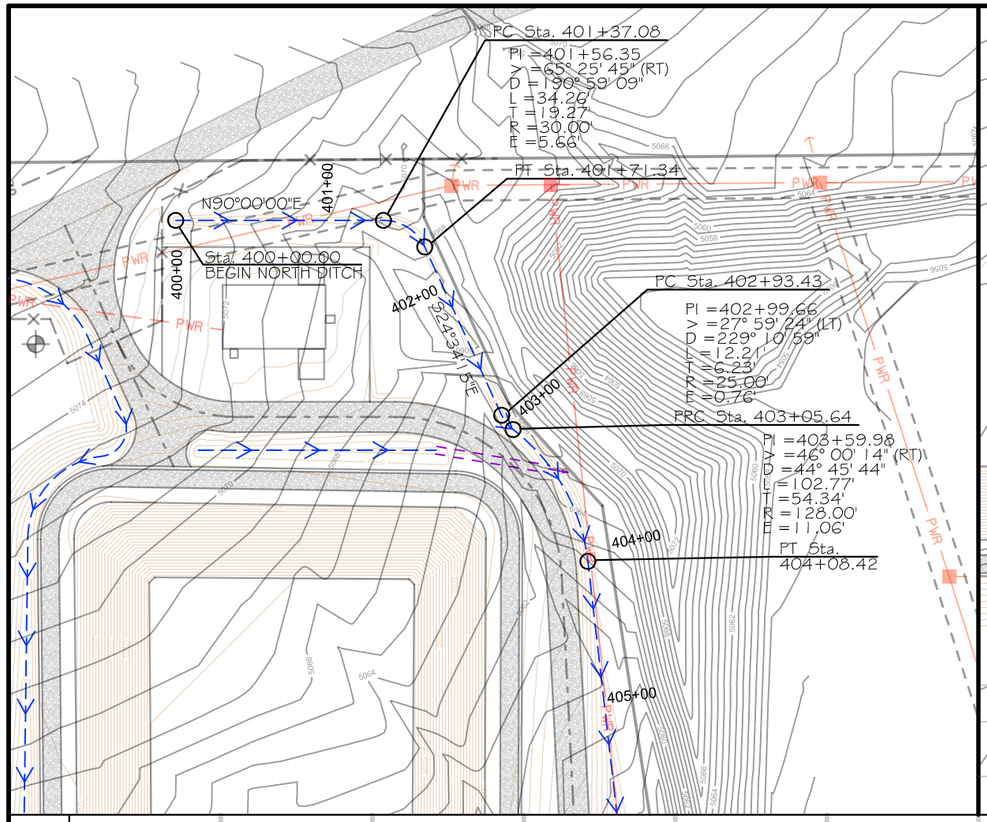
DSGN	DDP	REV
DATE	10/03/14	DATE
CKD	STH	CKD
		STH

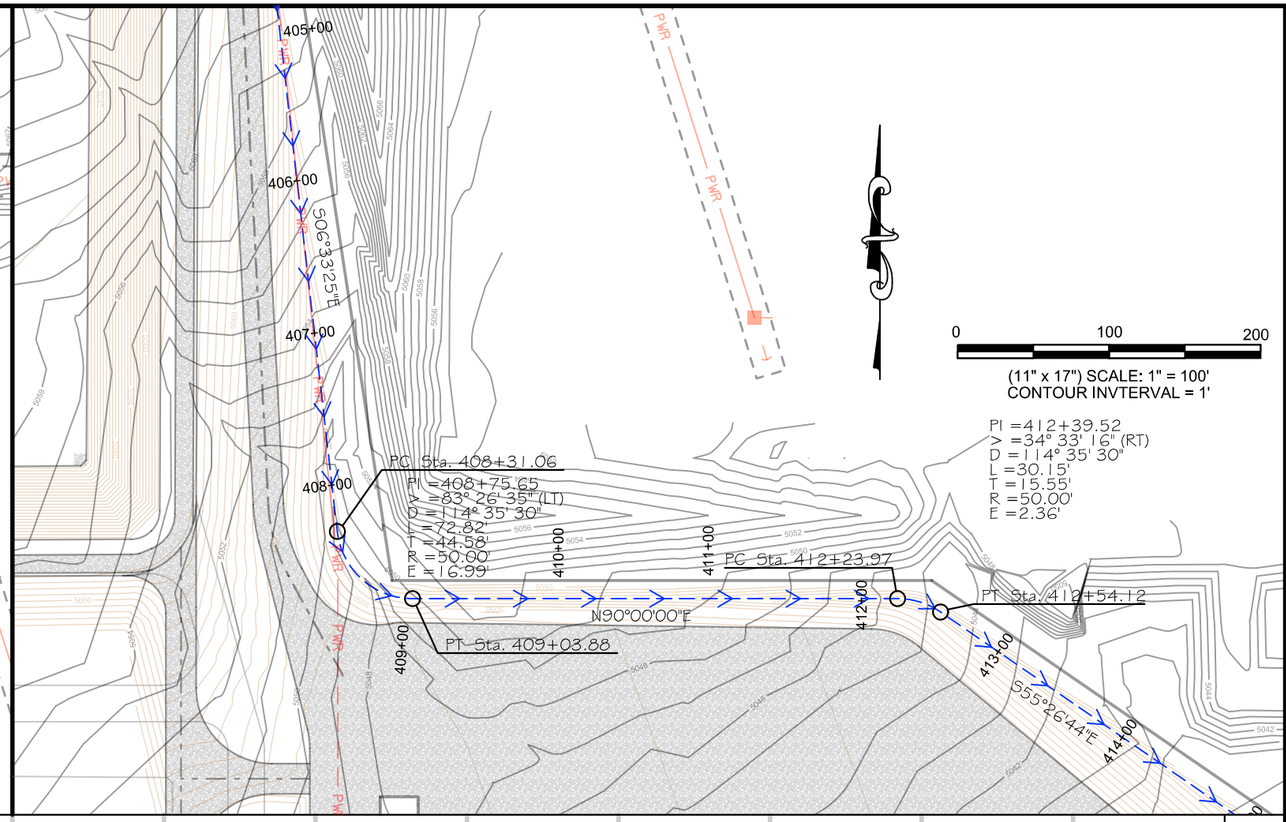
JOB # 2013-134

DE BEQUE WATER STATION

South Drainage Ditch
Plan and Profile

FIGURE
I

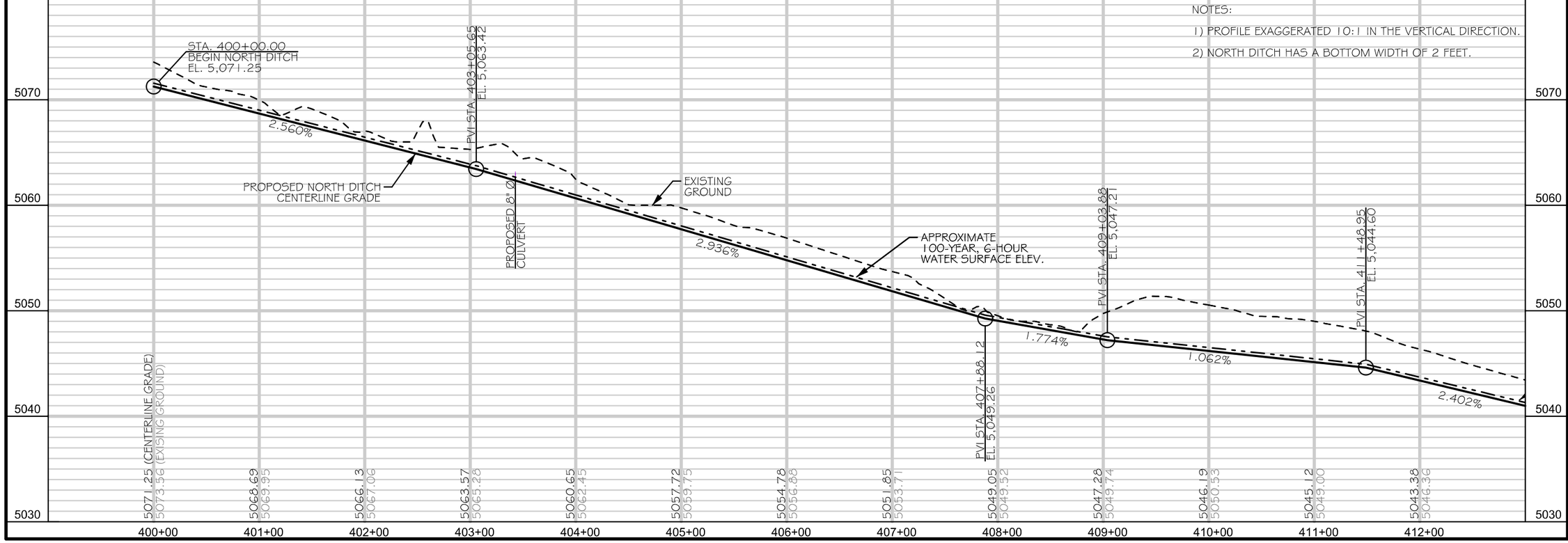




NOTES:

1) PROFILE EXAGGERATED 10:1 IN THE VERTICAL DIRECTION.

2) NORTH DITCH HAS A BOTTOM WIDTH OF 2 FEET.



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REV	DATE	CKD

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DE BEQUE WATER STATION

North Drainage Ditch Plan and Profile

FIGURE
J

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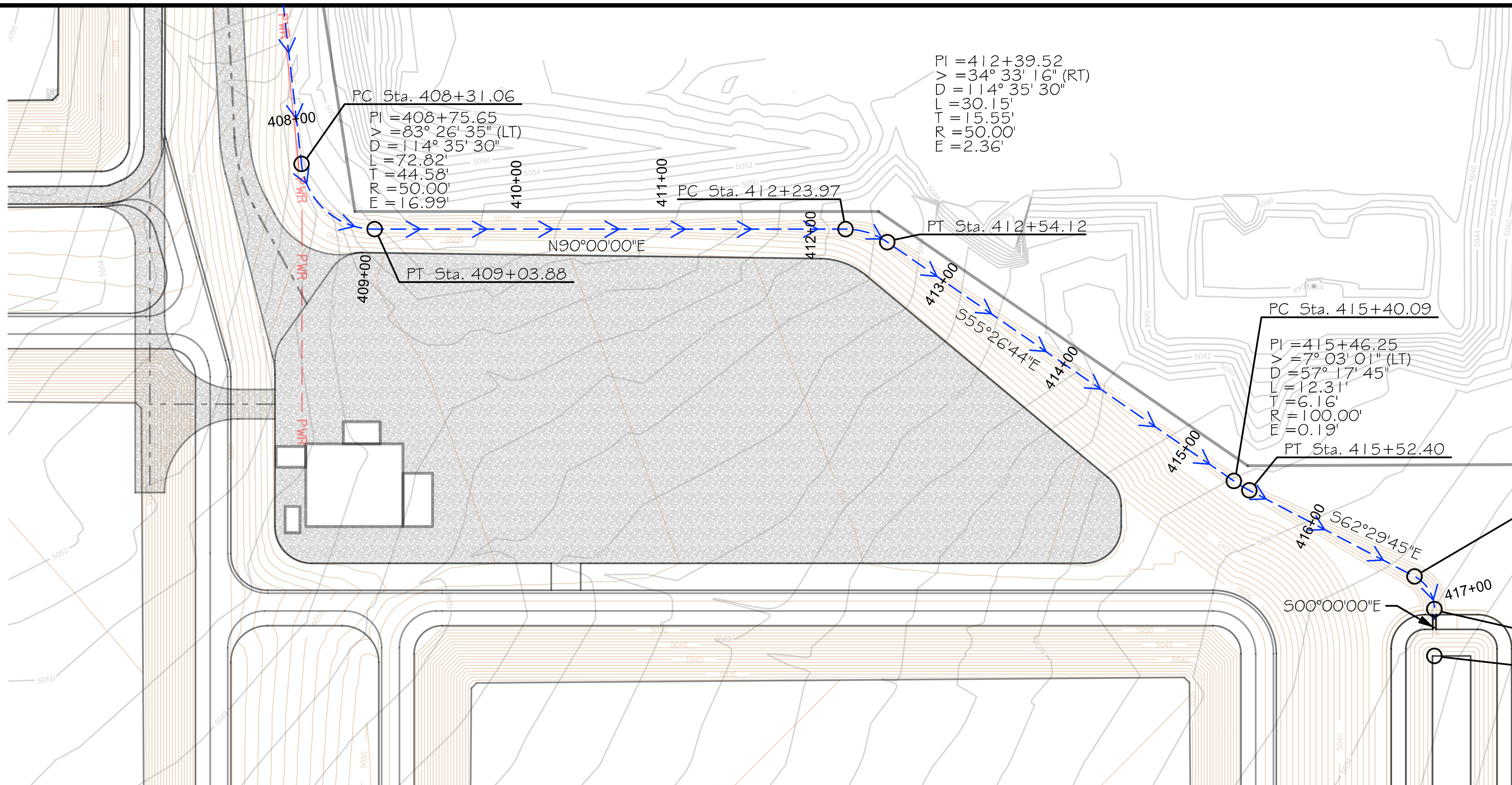

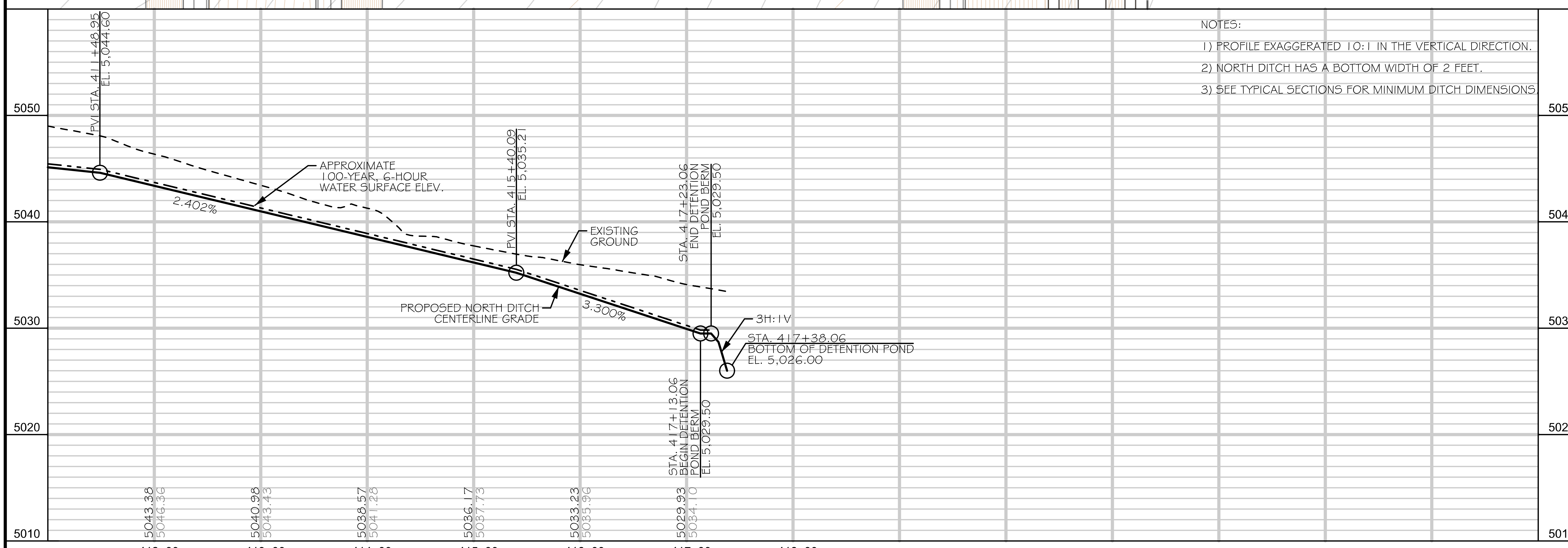

NOTES:

1) PROFILE EXAGGERATED 10:1 IN THE VERTICAL DIRECTION.

2) NORTH DITCH HAS A BOTTOM WIDTH OF 2 FEET.

3) SEE TYPICAL SECTIONS FOR MINIMUM DITCH DIMENSIONS.

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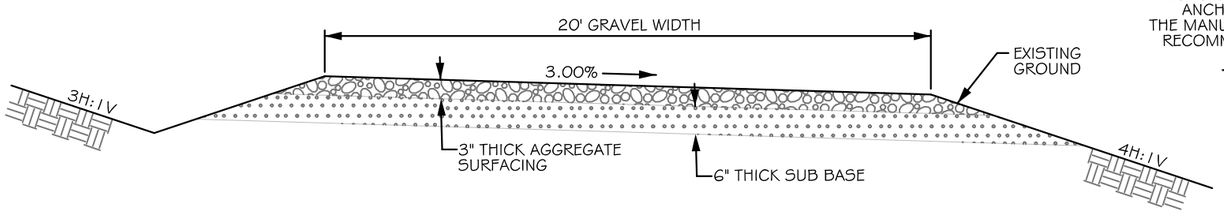
DDP	10/03/14	STH
REV	DATE	CKD

JOB # 2013-134

DE BEQUE WATER STATION

North Drainage Ditch Plan and Profile

FIGURE K



TYPICAL #1 ACCESS ROAD

NOT TO SCALE

NOTES:

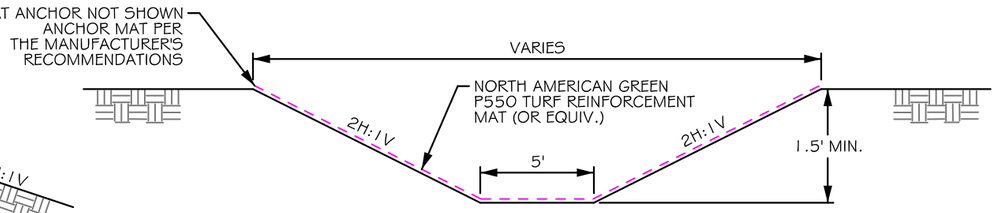
1) TYPICAL SECTION #1 APPLIES TO ALL ACCESS ROADS EXCLUDING MAINTENANCE ROADS LOCATED ON TOP OF BERMS SURROUNDING PONDS.

2) COVER ALL DISTURBED AREAS WITH 3" TOPSOIL AND REVEGETATE WITH APPROVED GRASS SPECIES.

3) CUT AND FILL SLOPES OF 4H:1V OR FLATTER ARE TYPICAL SLOPES. SEE CROSS SECTION SHEETS FOR ACTUAL SLOPE GRADES.

4) 3% CROSS SLOPE SHALL BE AWAY FROM PONDS AND TOWARD CONSTRUCTED DRAINAGE DITCHES EXCEPT AS NOTED ON THE ROAD PLAN AND PROFILE SHEET.

5) APPLY MAGNESIUM CHLORIDE TO THE GRAVELED SURFACE OF THE ACCESS ROAD TO PREVENT DUST.



TYPICAL #3 DRAINAGE DITCH

NOT TO SCALE

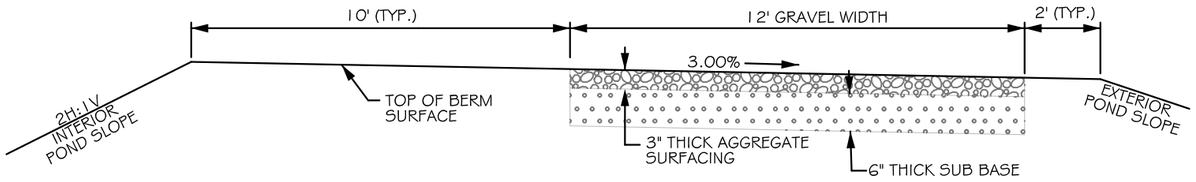
NOTES:

1) TYPICAL SECTION #3 APPLIES TO WEST DRAINAGE DITCH.

2) DITCH BOTTOM AND SIDE SLOPES SHALL BE SEEDED WITH APPROVED GRASS SPECIES PRIOR TO APPLICATION OF TURF REINFORCEMENT MAT.

3) NORTH AMERICAN GREEN P550 PERMANENT TURF REINFORCEMENT MAT (OR EQUIV.) SHALL COVER DITCH BOTTOMS AND EXTEND UP THE SIDE SLOPES TO A HEIGHT OF 3 FEET ABOVE DITCH BOTTOM OR TO THE TOP OF THE DITCH, WHICHEVER IS LESS. INSTALL TURF MAT PER THE MANUFACTURER'S RECOMMENDATIONS.

4) ALL DITCH CUT AND FILL SLOPES OF 2H:1V OR FLATTER ARE TYPICAL SLOPES.



TYPICAL #2 MAINTENANCE ROAD

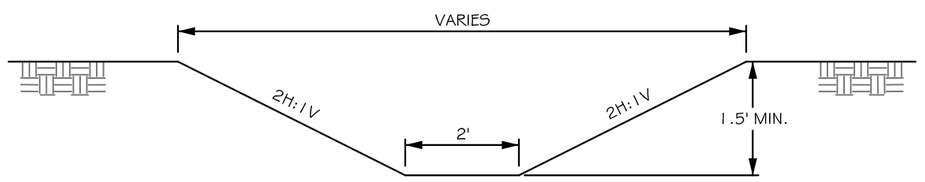
NOT TO SCALE

NOTES:

1) TYPICAL SECTION #2 (MAINTENANCE ROAD) APPLIES TO MAINTENANCE ROADS LOCATED ON TOP OF BERMS SURROUNDING PONDS.

2) SEE CROSS SECTION SHEETS FOR ACTUAL SLOPE GRADES.

3) ALL INTERIOR POND SLOPES ARE 2H:1V.



TYPICAL #4 DRAINAGE DITCH

NOT TO SCALE

NOTES:

1) TYPICAL SECTION #4 APPLIES TO THE NORTH AND SOUTH DRAINAGE DITCH.

2) DITCH BOTTOM AND SIDE SLOPES SHALL BE REVEGETATED WITH APPROVED GRASS SPECIES.

3) ALL DITCH CUT AND FILL SLOPES OF 2H:1V OR FLATTER ARE TYPICAL SLOPES.

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DDP	06/14	STH

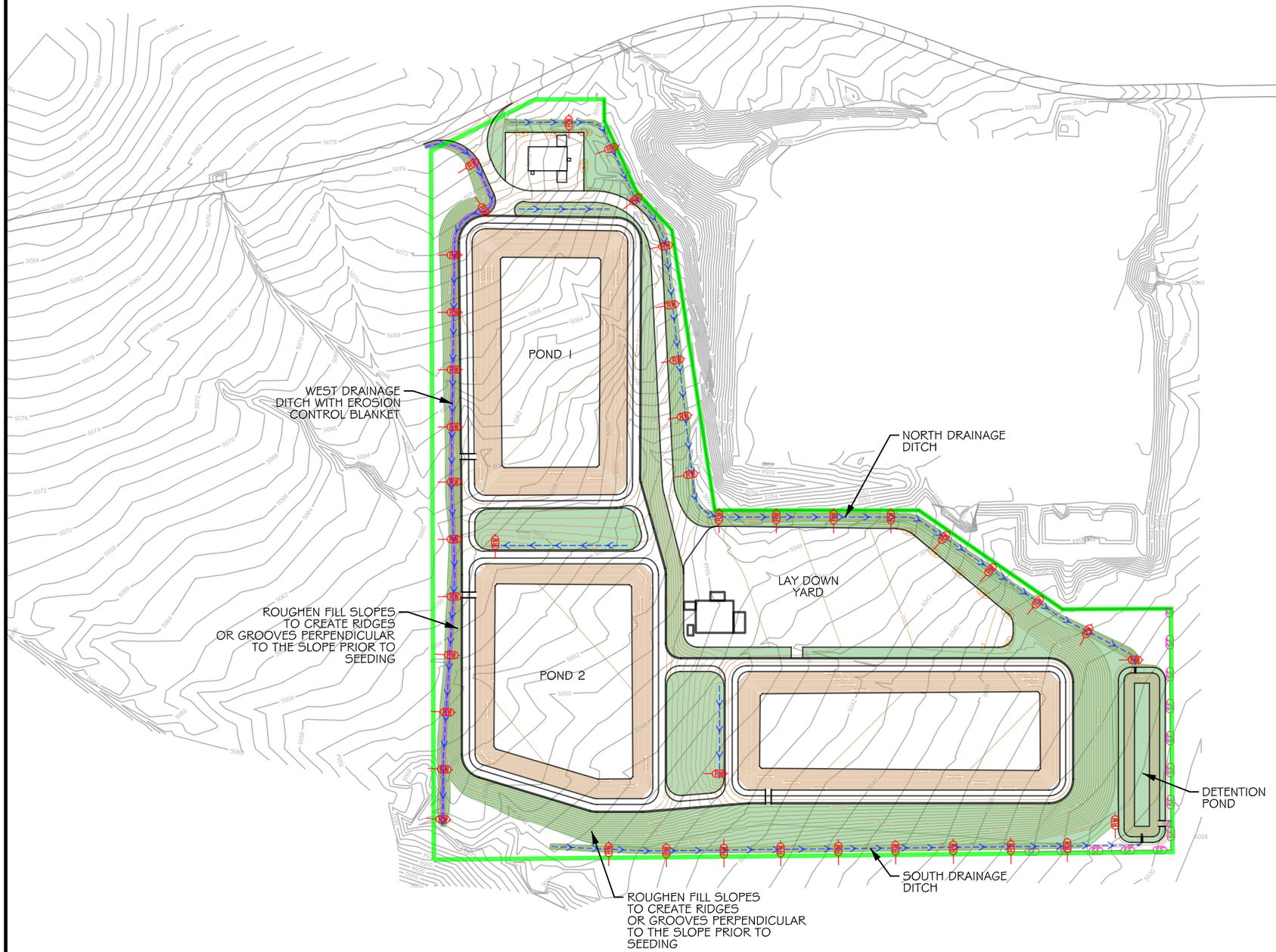
REV	DATE	CKD
DDP	08/14	STH

JOB # 2013-134

DE BEQUE WATER STATION
POND 1

Typical Sections

FIGURE
L



EROSION CONTROL

- ROCK WATTLE
- STRAW WATTLE
- SILT FENCE
- EROSION CONTROL BLANKET
- PERMANENT SEEDING

0 200 400

(11" x 17") SCALE: 1" = 200'
CONTOUR INVTERVAL = 1'

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DSGN	DATE	CKD	DATE	CKD
DDP	09/14	STH		
REV				

JOB # 2013-134

DE BEQUE WATER STATION

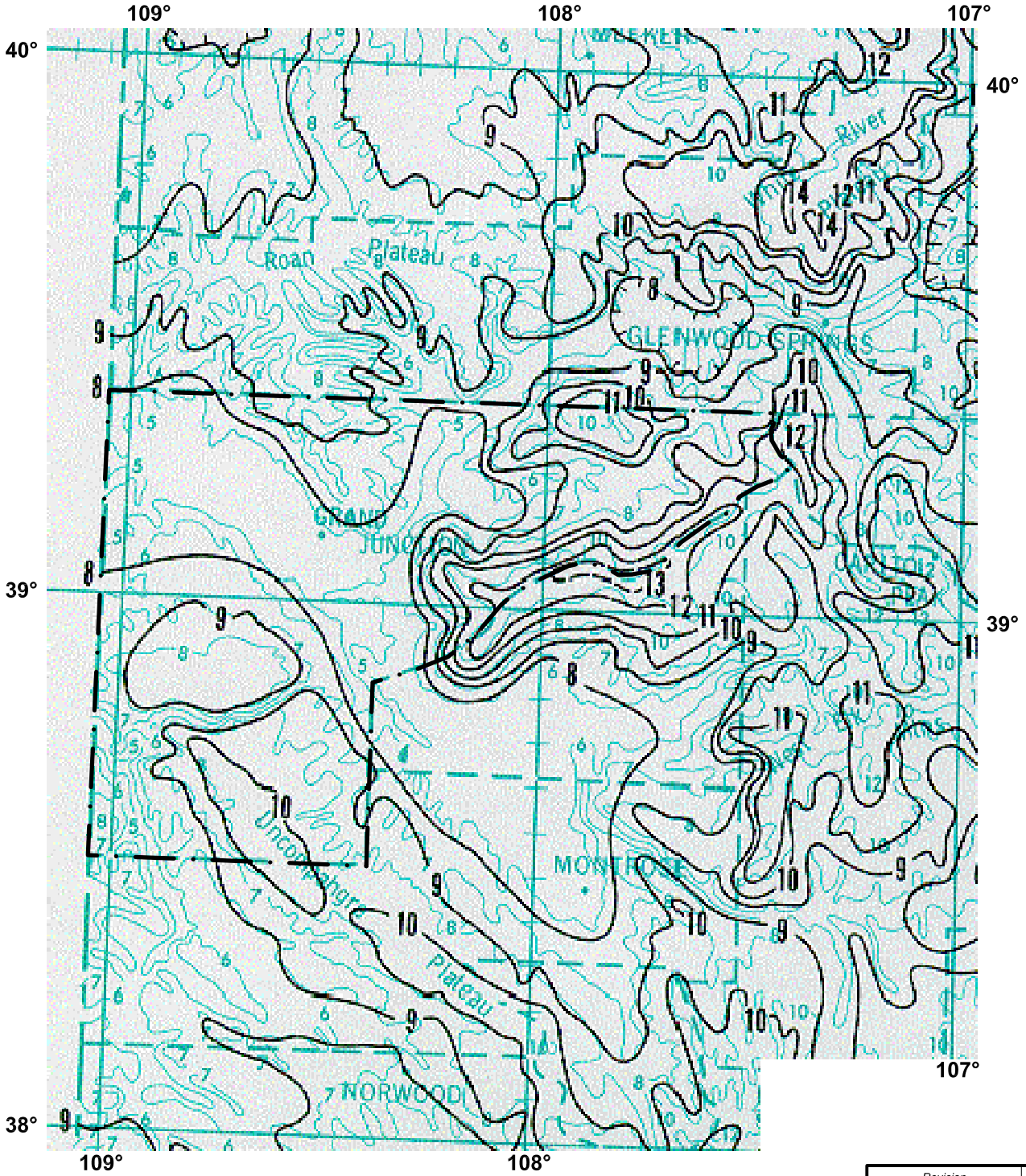
Erosion Control Plan

FIGURE
M

APPENDIX A

DESIGN CHARTS

RAINFALL DEPTH-DURATION-FREQUENCY
2-YEAR, 6-HOUR
(DEPTHS IN TENTHS OF INCHES)



20 10 5 0 20

SCALE: 1"=20 MI.

MESA COUNTY BOUNDARY

Revision	Date
ORIGINAL ISSUE	3/27/06

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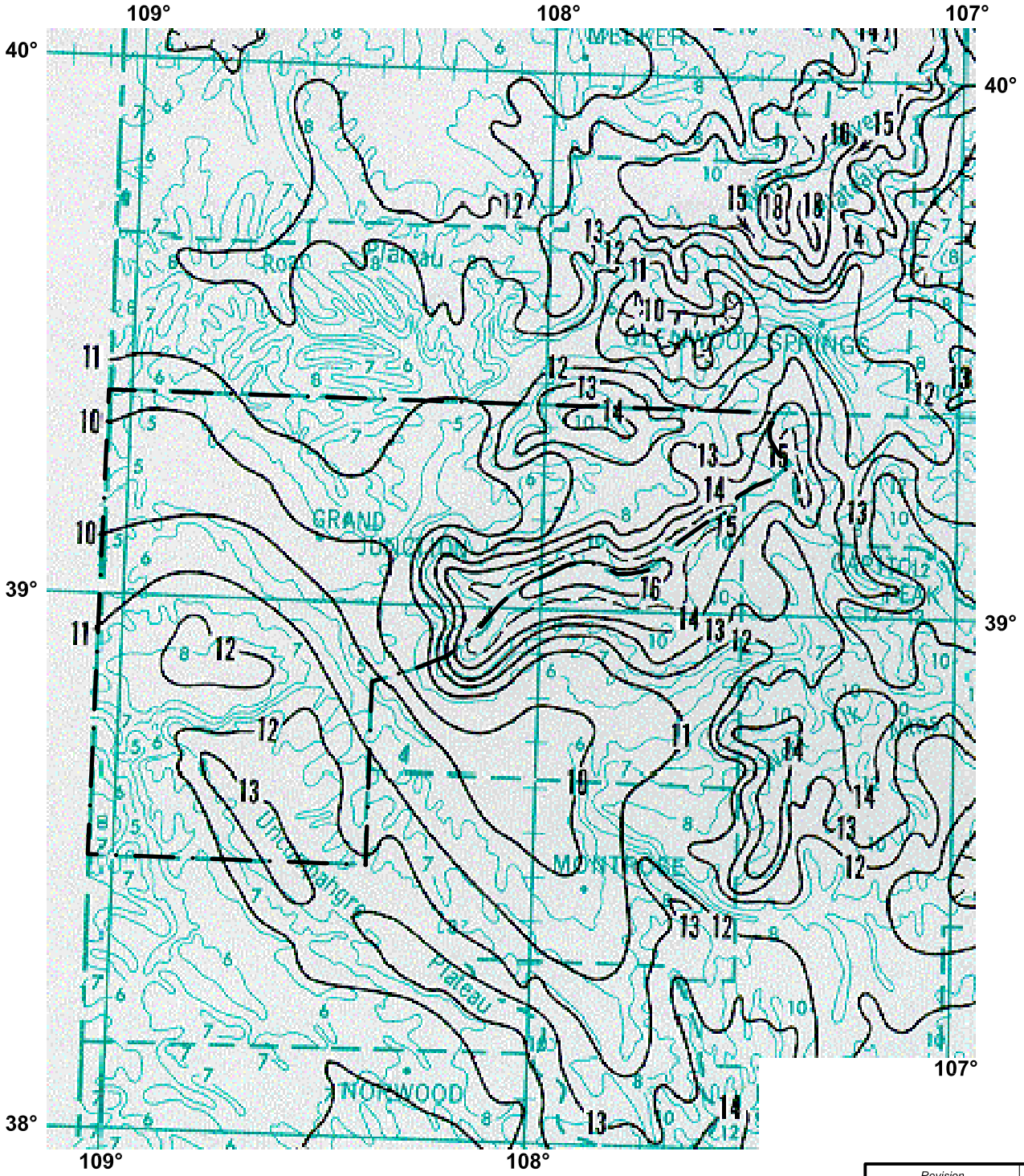
REFERENCE:
NOAA ATLAS 2, VOLUME III COLORADO, 1973

FIGURE 602

RAINFALL DEPTH-DURATION-FREQUENCY
5-YEAR, 6-HOUR
(DEPTHS IN TENTHS OF INCHES)



Revision	Date
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REFERENCE:
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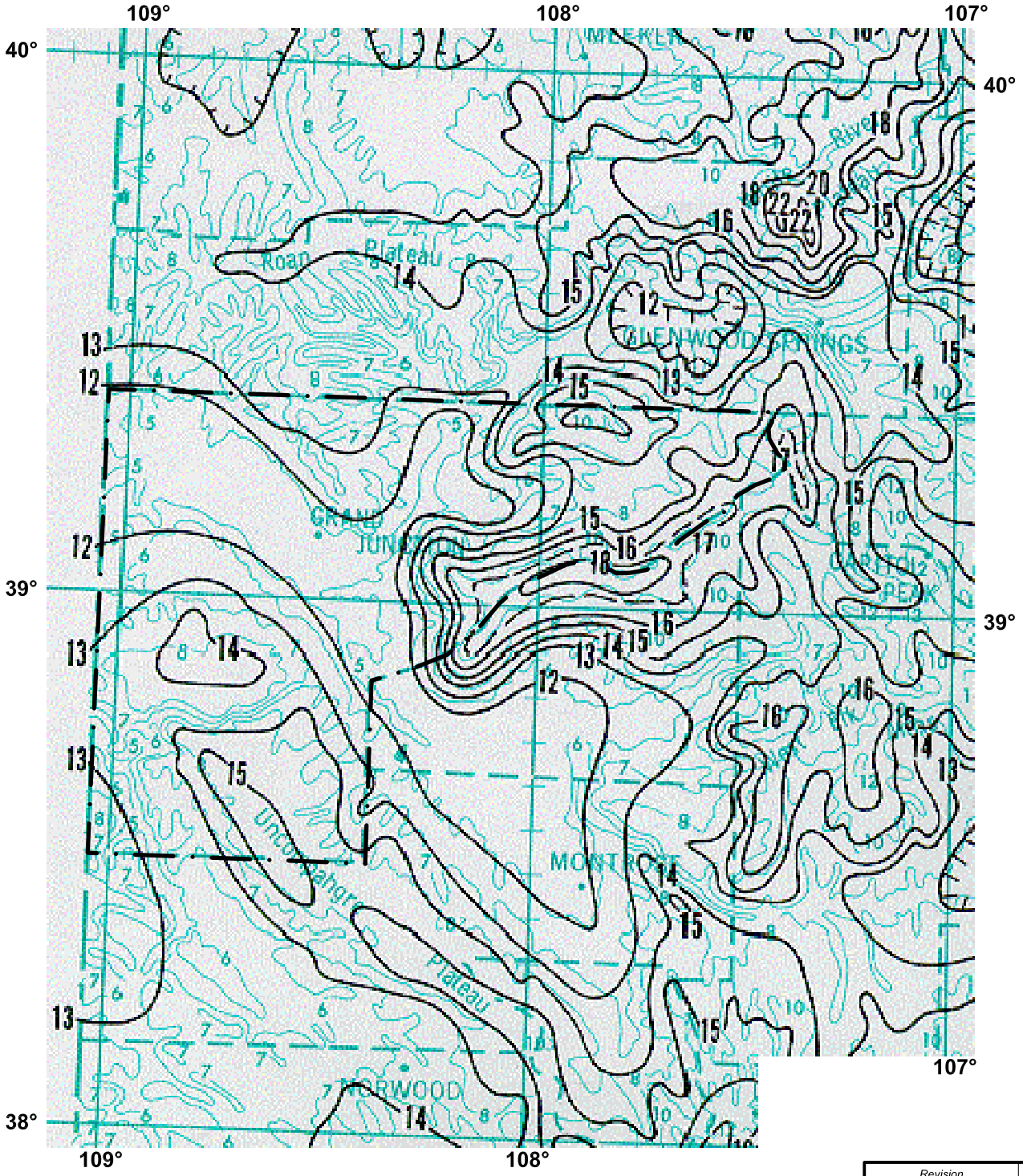
FIGURE 603

RAINFALL DEPTH-DURATION-FREQUENCY
10-YEAR, 6-HOUR
(DEPTHS IN TENTHS OF INCHES)



Revision	Date
ORIGINAL ISSUE	3/27/06

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REFERENCE:
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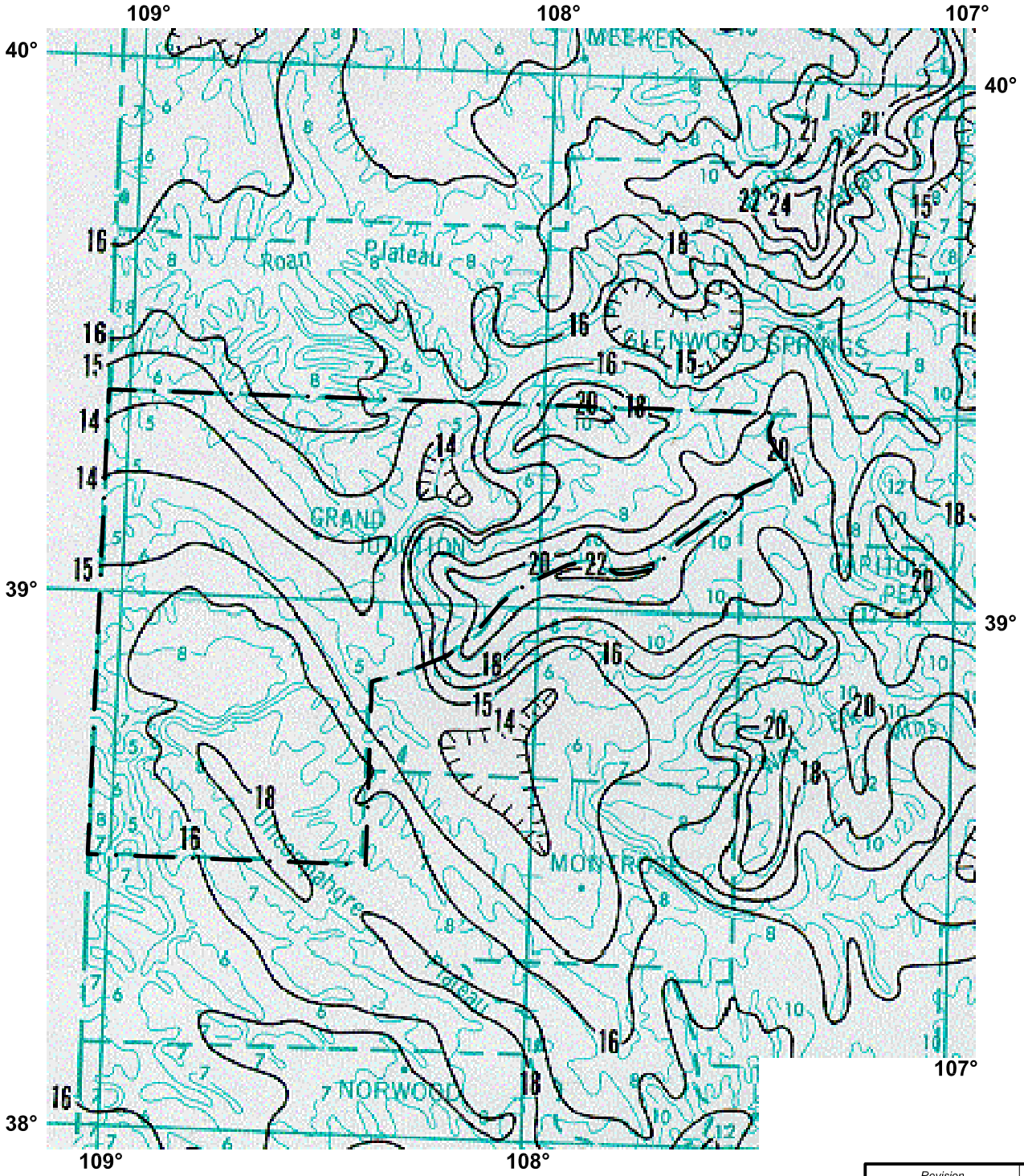
FIGURE 604

RAINFALL DEPTH-DURATION-FREQUENCY
25-YEAR, 6-HOUR
(DEPTHS IN TENTHS OF INCHES)



20 10 5 0 20

SCALE: 1"=20 MI.

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REFERENCE:
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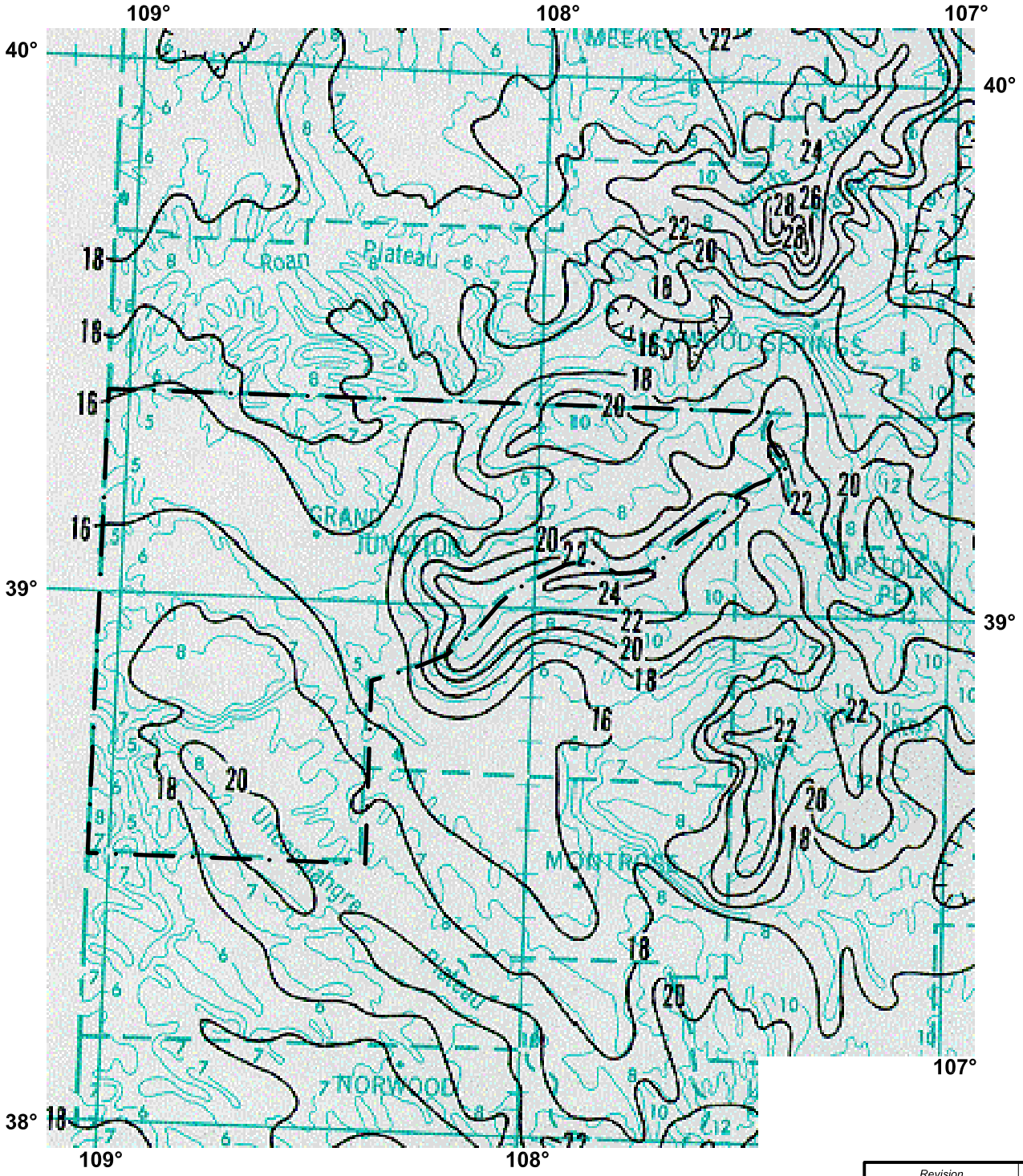
FIGURE 605

RAINFALL DEPTH-DURATION-FREQUENCY
50-YEAR, 6-HOUR
(DEPTHS IN TENTHS OF INCHES)



20 10 5 0 20

SCALE: 1"=20 MI.

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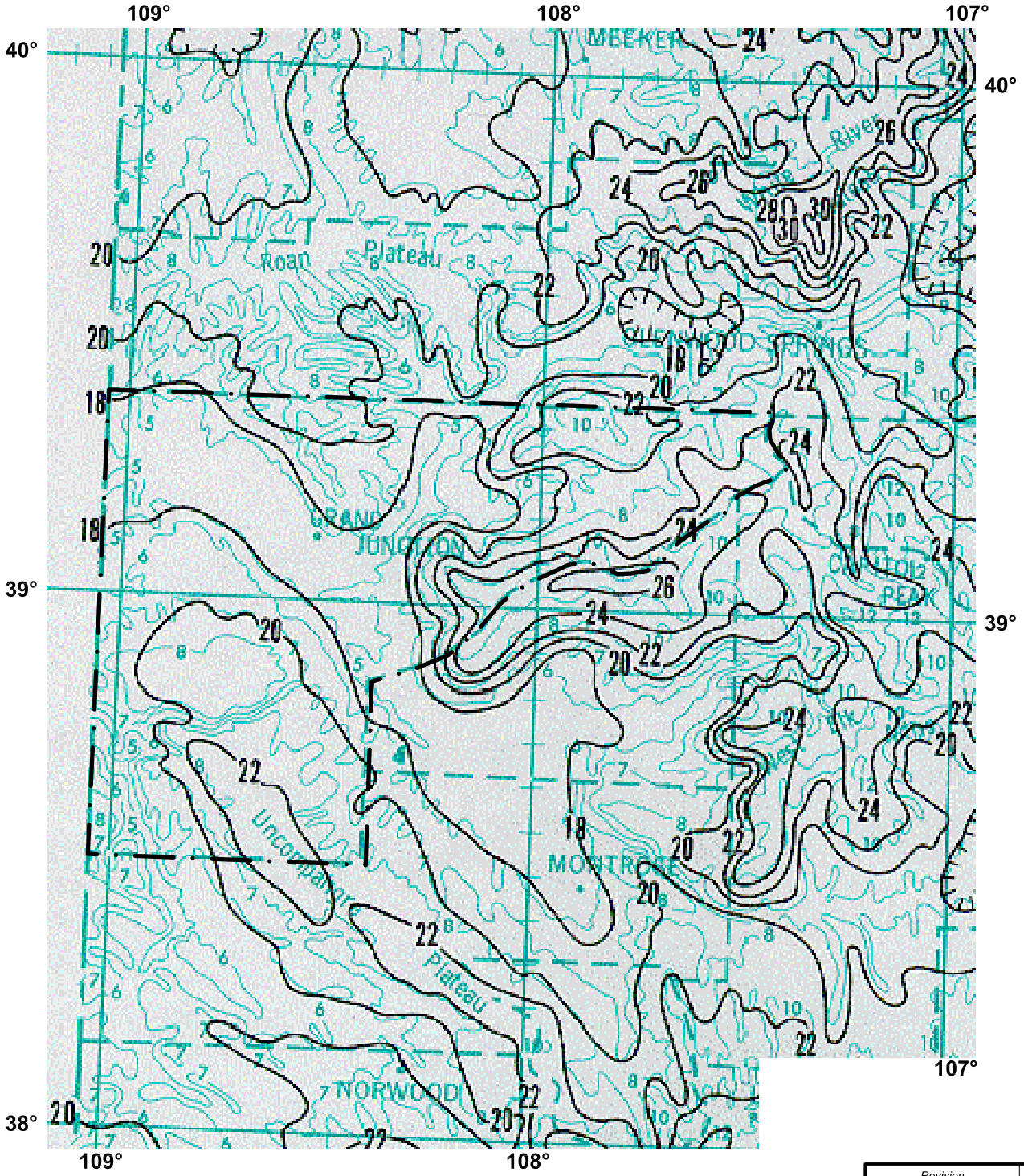
FIGURE 606

RAINFALL DEPTH-DURATION-FREQUENCY
100-YEAR, 6-HOUR
(DEPTHS IN TENTHS OF INCHES)



Revision	Date
ORIGINAL ISSUE	3/27/06

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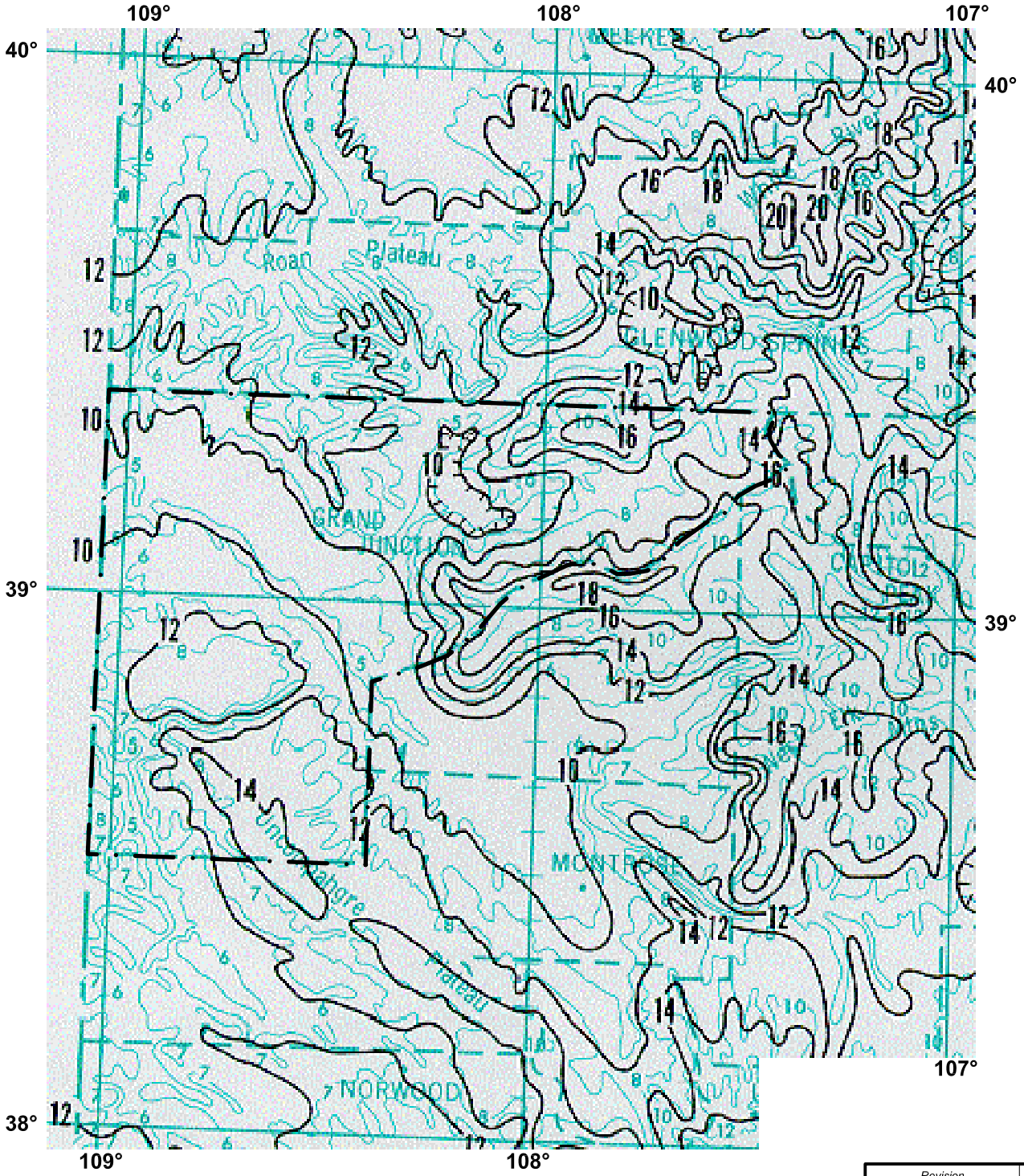
REFERENCE:
NOAA ATLAS 2, VOLUME III COLORADO, 1973

FIGURE 607

RAINFALL DEPTH-DURATION-FREQUENCY
2-YEAR, 24-HOUR
(DEPTHS IN TENTHS OF INCHES)



20 10 5 0 20

SCALE: 1"=20 MI.

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REFERENCE:
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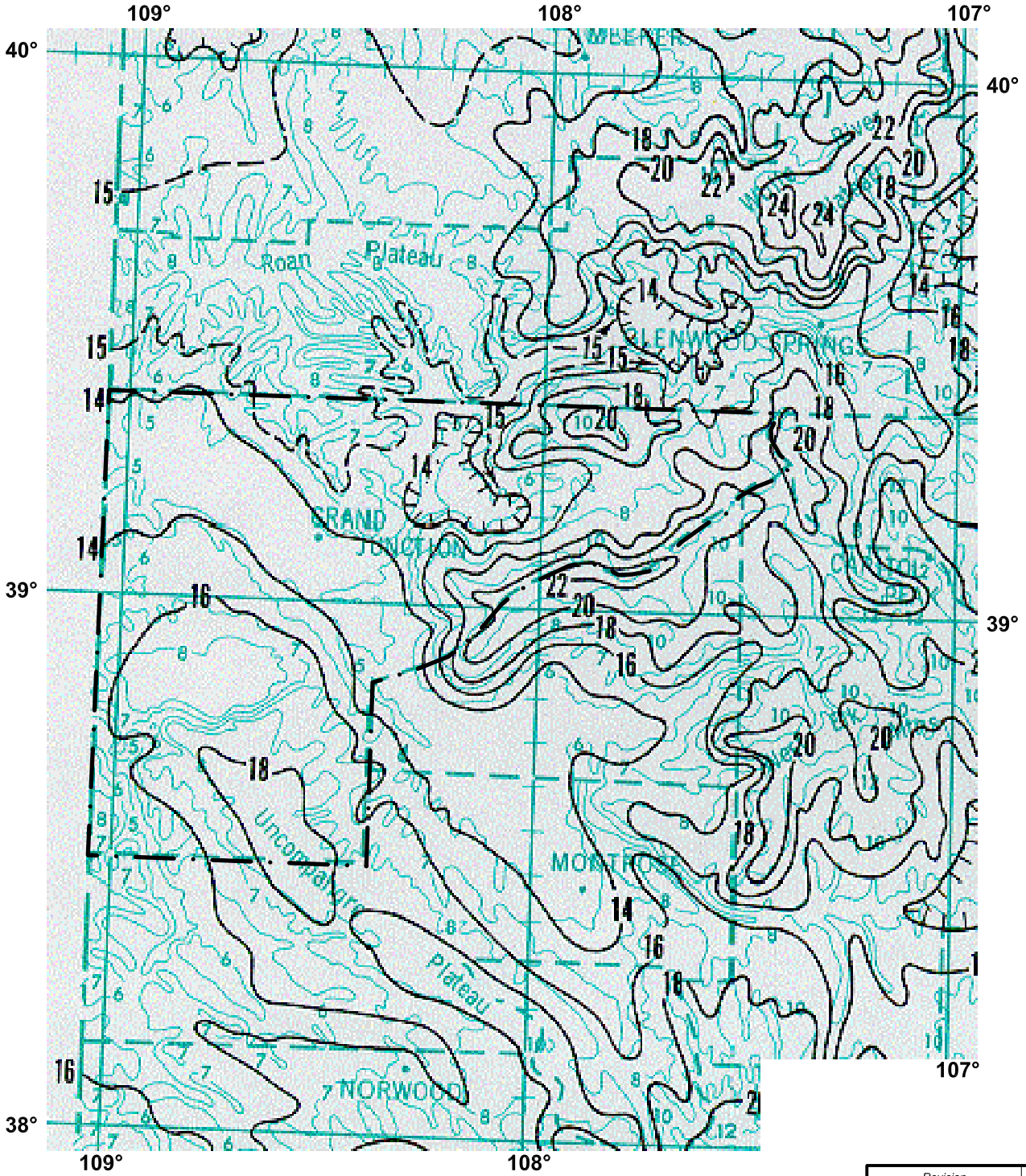
FIGURE 608

RAINFALL DEPTH-DURATION-FREQUENCY
5-YEAR, 24-HOUR
(DEPTHS IN TENTHS OF INCHES)



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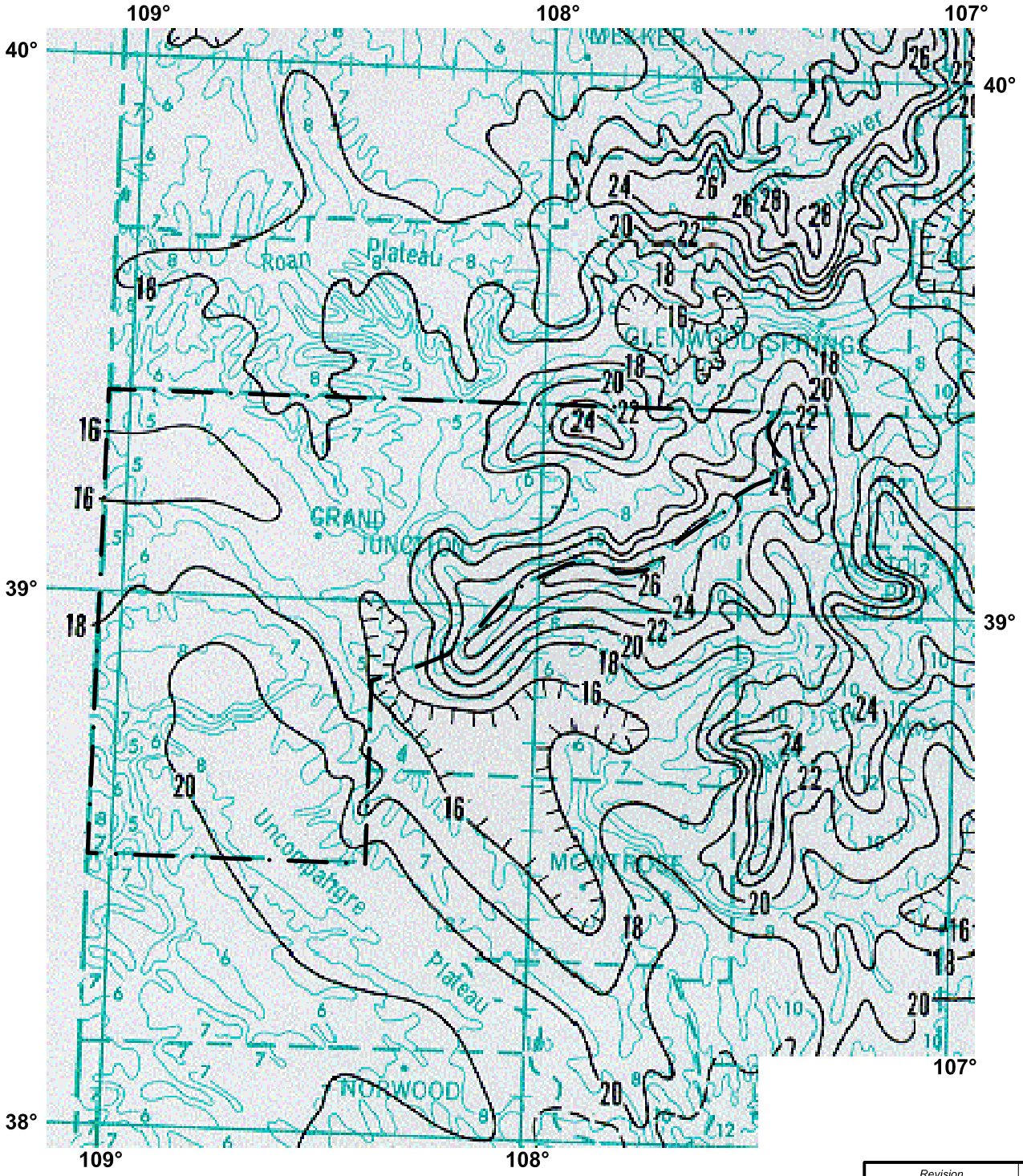
ORIGINAL ISSUE	3/27/06

WRC ENGINEERING, INC.

REFERENCE:
NOAA ATLAS 2, VOLUME III COLORADO, 1973

FIGURE 609

RAINFALL DEPTH-DURATION-FREQUENCY
10-YEAR, 24-HOUR
(DEPTHS IN TENTHS OF INCHES)



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REFERENCE:
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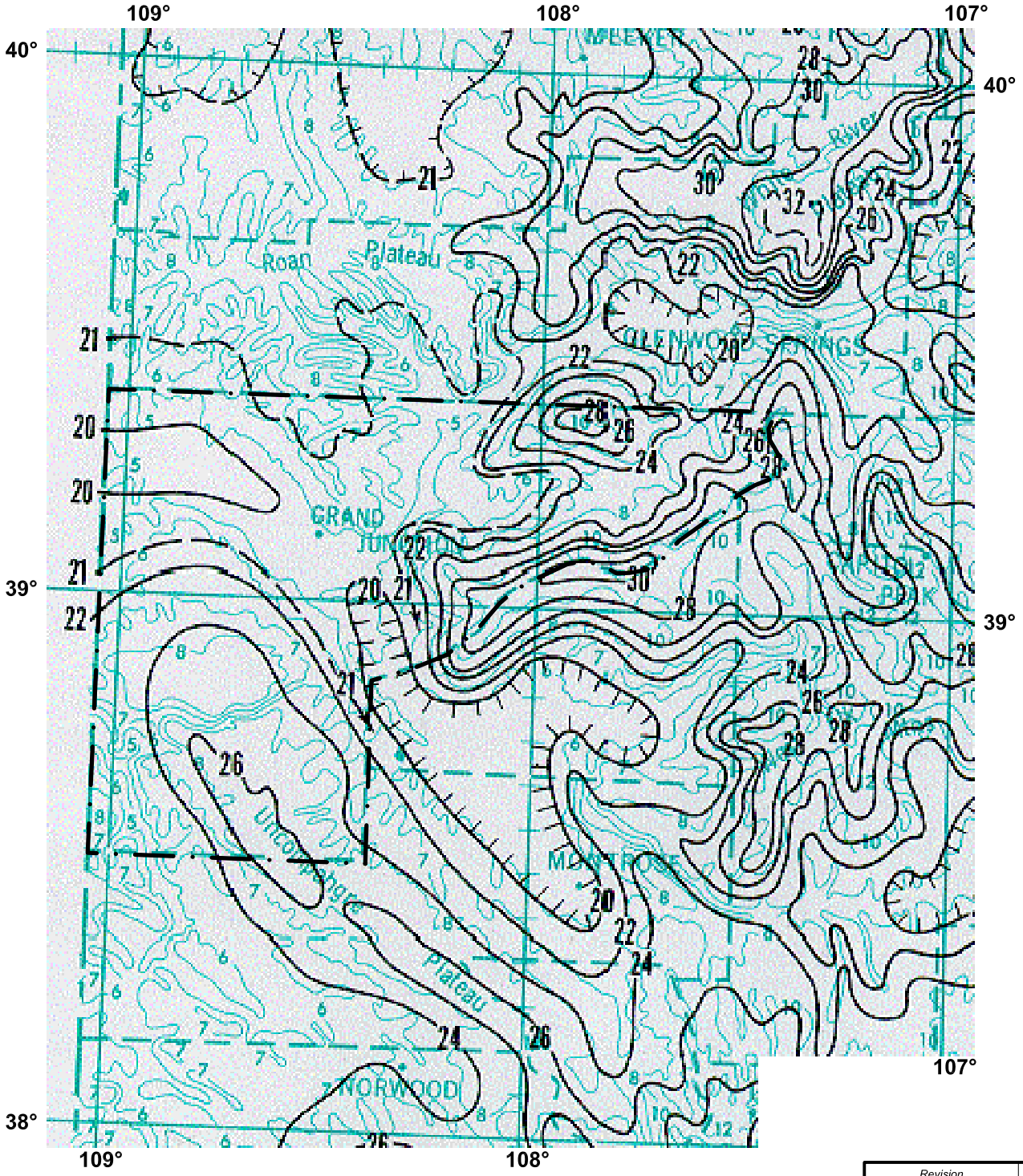
FIGURE 610

RAINFALL DEPTH-DURATION-FREQUENCY
25-YEAR, 24-HOUR
(DEPTHS IN TENTHS OF INCHES)



Revision	Date
ORIGINAL ISSUE	3/27/06

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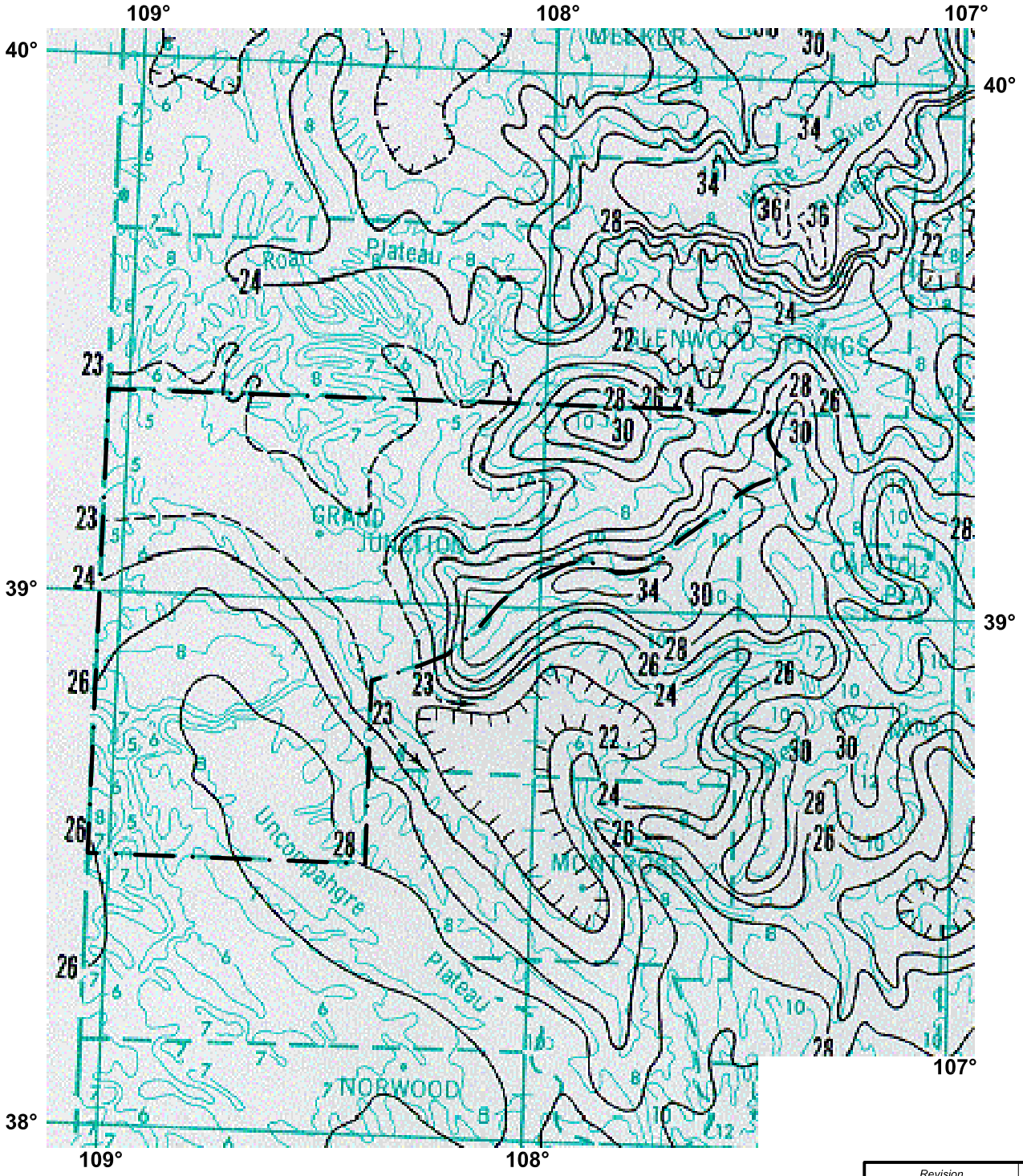
FIGURE 611

RAINFALL DEPTH-DURATION-FREQUENCY
50-YEAR, 24-HOUR
(DEPTHS IN TENTHS OF INCHES)



Revision	Date
ORIGINAL ISSUE	3/27/06

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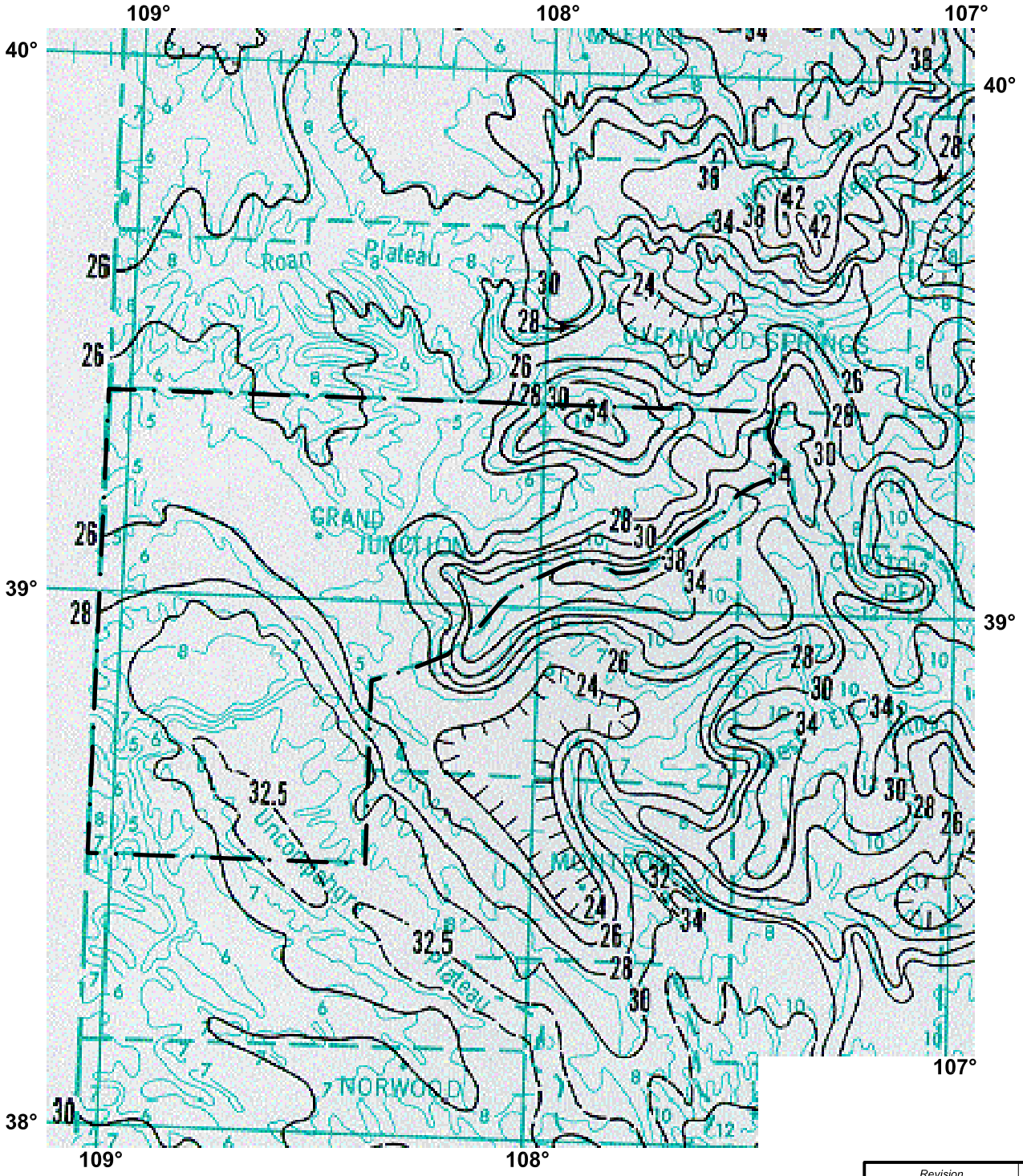
REFERENCE:
NOAA ATLAS 2, VOLUME III COLORADO, 1973

FIGURE 612

RAINFALL DEPTH-DURATION-FREQUENCY
100-YEAR, 24-HOUR
(DEPTHS IN TENTHS OF INCHES)



20 10 5 0 20

SCALE: 1"=20 MI.

MESA COUNTY BOUNDARY

Revision	Date
ORIGINAL ISSUE	3/27/06

WRC ENGINEERING, INC.

REFERENCE: NOAA ATLAS 2, VOLUME III COLORADO, 1973

FIGURE 613

RUNOFF CURVE NUMBERS

Land Use or Surface Characteristic	Average Imperv. (%)	Runoff Curve Number Soil Complex A	B	C	D
Business					
Commercial Areas	85	89	92	94	95
Neighborhood Areas	70	80	87	91	93
Residential					
Single Family (note 1)	(note 1)				
Multi-unit (detached)	60	74	83	88	91
Multi-unit (attached)	75	83	89	92	94
Apartments	80	86	91	93	94
Industrial					
Light	80	86	91	93	94
Heavy	90	92	94	96	96
Parks, cemeteries	5	42	63	75	81
Playgrounds	10	45	65	76	82
Schools	50	69	80	86	89
Railroad yards	15	48	67	78	83
Irrigated Areas					
Lawns, parks, golf course	0	39	61	74	80
Agriculture	0	39	61	74	80
Undeveloped Areas					
Pre-development conditions	2	40	62	74	80
Greenbelts, agriculture	2	40	62	74	80
Off-site analysis when land use Unknown	45	66	78	85	88
Outcrops	70	80	87		94
Streets/Roads					
Paved	100	98	98	98	98
Gravel	40	63	76	84	87
Drives/Walks	90	92	94	96	96
Roofs	90	92	94	96	96

NOTE:
ESTIMATE IMPERVIOUS FROM FIGURES 703, 704, 705. THEN COMPUTE CURVE NUMBER, CN, FROM EQUATION 708, BASED ON NRCS SOILS TYPE. USE OF THIS TABLE IS LIMITED TO EVALUATION OF IMPERVIOUSNESS FOR FUTURE DEVELOPMENT PROJECTIONS WITHIN REGIONAL WATERSHED MASTER PLANS, OR IN CONCEPTUAL DRAINAGE PLANS.

Revision	Date
ORIGINAL ISSUE	3/27/06

RECOMMENDED IMPERVIOUSNESS VALUES

Land Use or Surface Characteristic	Percentage Imperviousness
Business	
Commercial Areas	85
Neighborhood Areas	70
Residential	
Single Family	(see figures)
Multi-unit (detached)	60
Multi-unit (attached)	75
Half-acre lot or larger	(see figures)
Apartments	80
Industrial	
Light industrial	80
Heavy industrial	90
Parks, cemeteries	5
Playgrounds	10
Schools	50
Railroad yards	15
Undeveloped Areas	
Historic flow analysis	2
Greenbelts, agriculture	2
Off-site flow analysis (when land use not defined)	45
Streets	
Paved (concrete/asphalt)	100
Gravel	40
Drives and walks	90
Roofs	90
Lawns (all soils)	0

NOTES:

1. The imperviousness values are representative of land uses shown and are for future development projections only. Impervious values for existing land uses may vary.
2. For areas that will not be developed, 2% imperviousness is an appropriate assumption where soil and vegetative cover are present. Areas with geological features, including significant rock outcroppings, need to be accounted for. See Section 702.2.

Revision	Date
ORIGINAL ISSUE	3/27/06
CHANGED BUS. VALUES	12/6/07
ADDED NOTE 2	1/25/08

APPENDIX B

HYDROLOGIC CALCULATIONS

(NOTE: SOME HYDROLOGIC CALCULATIONS ARE PROVIDED IN ATTACHMENT C WITH THE HYDRAULIC CALCULATIONS FROM HYDROCAD™)

Table 1. NOAA Atlas 2 Precipitation-Frequency Data (in inches) for: DeBeque, CO

Return Period (Years)	Storm Duration									hr / min
	0.08	0.17	0.25	0.50	1	2	3	6	12	24
	5	10	15	30	60	120	180	360	720	1440
2	0.16	0.25	0.32	0.44	0.56	0.64	0.70	0.80	0.93	1.10
5	0.22	0.34	0.44	0.60	0.76	0.84	0.90	1.00	1.17	1.40
10	0.27	0.41	0.52	0.73	0.92	1.02	1.08	1.20	1.46	1.80
25	0.33	0.51	0.64	0.89	1.12	1.22	1.28	1.40	1.91	2.15
50	0.37	0.58	0.73	1.01	1.28	1.39	1.46	1.60	1.73	2.30
100	0.42	0.65	0.82	1.13	1.43	1.56	1.64	1.80	2.15	2.60

*6-Hour and 24-Hour precipitation values taken from the NOAA Atlas 2 maps in the Mesa County SWMM.

*5, 10, 25, & 50-Year, 1-Hour precipitation values determined from NOAA Atlas 2 figure in the Mesa Co SWMM.

*2-Year, 1-Hour precipitation value = Y2 = 0.011 + 0.942 [(x1) (x1 / x2)]

where X1 = 2-Year, 6-Hour precipitation value

X2 = 2-Year, 24-Hour precipitation value

*100-Year, 1-Hour precipitation value = Y100 = 0.494 + 0.755 [(x3) (x3 / x4)]

where X3 = 100-Year, 6-Hour precipitation value

X4 = 100-Year, 24-Hour precipitation value

*5, 10, 15, 30-Minute precipitation values are a percentage of the 1-Hour values according to the table below

Duration (minutes)	5	10	15	30	60
Ratio to 1-hour	0.29	0.45	0.57	0.79	1.00

*2-Hour precipitation values = 0.341 (6-hr) + 0.659 (1-hr)

*3-Hour precipitation values = 0.569 (6-hr) + 0.431 (1-hr)

*2, 5, 10, 25, 50, & 100-Year, 12-Hour precipitation values determined from NOAA Atlas 2

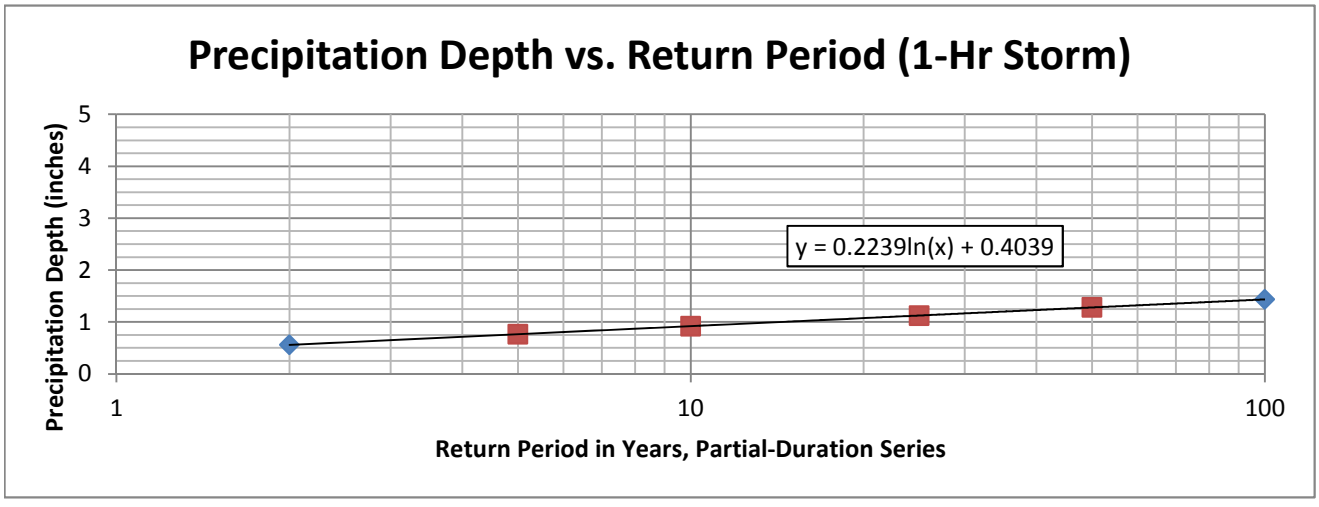


Table 2. Weighted Curve Numbers

SWS Name	SWS Soils Name	SWS Hydro. Group	Land Cover Description	Drainage Area Pre-Development (acres)	Drainage Area Post-Development (acres)	Curve Number Pre-Development	Curve Number Post-Development
SWS 1	Torriorthents	D	Range	159.39	159.39	80	80
	Biedsaw-Sunup	C	Range	21.78	21.78	74	74
	Domingues clay loam	C	Range	40.46	39.49	74	74
	Domingues clay loam	C	Roadway	0.59	1.56	92	92
	Badland	D	Range	36.64	36.64	80	80
				Weighted CN		**78.6**	**78.7**
SWS 2	Domingues clay loam	C	Range	9.01	4.98	74	74
	Domingues clay loam	C	Roadway	0.94	3.97	92	92
	Domingues clay loam	C	Building	0.00	0.15	98	98
	Bunkwater	C	Range	0.16	0.05	74	74
	Bunkwater	C	Roadway	0.00	0.13	92	92
				Weighted CN		**75.7**	**82.3**
SWS 3	Domingues clay loam	C	Range	0.84	0.65	74	74
	Domingues clay loam	C	Roadway	0.00	0.19	92	92
	Bunkwater	C	Range	2.32	1.76	74	74
	Bunkwater	C	Roadway	0.00	0.56	92	92
				Weighted CN		**74.0**	**78.3**
SWS 4	Domingues clay loam	C	Range	0.21	0.17	74	74
	Domingues clay loam	C	Roadway	0.00	0.05	92	92
	Bunkwater	C	Range	0.99	0.94	74	74
	Bunkwater	C	Roadway	0.00	0.05	92	92
				Weighted CN		**74.0**	**75.5**
SWS 5	Domingues clay loam	C	Range	2.84	2.84	74	74
				Weighted CN		**74.0**	**74.0**
SWS 6	Domingues clay loam	C	Range	2.34	2.34	74	74
	Bunkwater	C	Range	0.41	0.41	74	74
				Weighted CN		**74.0**	**74.0**
SWS 7	Domingues clay loam	C	Range	0.71	0.71	74	74
	Bunkwater	C	Range	1.95	1.95	74	74
				Weighted CN		**74.0**	**74.0**

Runoff Curve Numbers				
	SWS Hydrologic Group			
Land Cover Description	**A**	**B**	**C**	**D**
Building	98	98	98	98
Range	40	62	74	80
Roadway	83	89	92	93

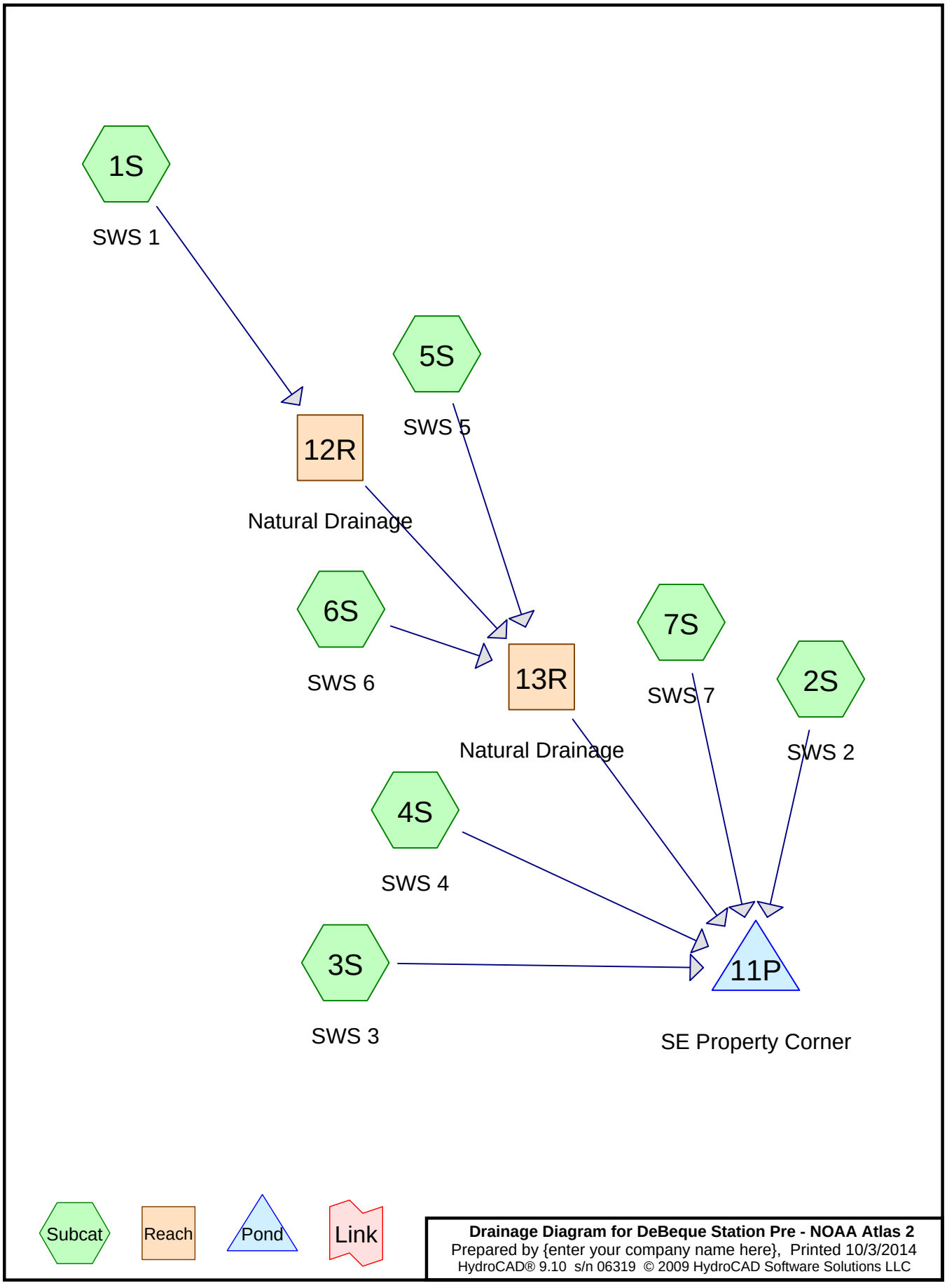
Blue Text or Values are manually entered into the cell.
Green Text or Values are referenced or interpolated from another table or cell.
Red Values are calculated within the cell.

APPENDIX C

HYDRAULIC CALCULATIONS

APPENDIX C1

HydroCAD Report
NOAA Atlas 2: Pre-Development
2-Year, 6-Hour Event



Drainage Diagram for DeBeque Station Pre - NOAA Atlas 2
Prepared by {enter your company name here}, Printed 10/3/2014
HydroCAD® 9.10 s/n 06319 © 2009 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
12.610	74	Weighted Curve Number (3S, 4S, 5S, 6S, 7S)
10.110	76	Weighted Curve Number (2S)
258.860	79	Weighted Curve Number (1S)
281.580		**TOTAL AREA**

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: SWS 1 Runoff Area=258.860 ac 0.00% Impervious Runoff Depth=0.02"
Flow Length=8,106' Tc=56.7 min CN=79 Runoff=2.29 cfs 0.531 af

Subcatchment 2S: SWS 2 Runoff Area=10.110 ac 0.00% Impervious Runoff Depth=0.01"
Flow Length=2,405' Tc=58.5 min CN=76 Runoff=0.03 cfs 0.007 af

Subcatchment 3S: SWS 3 Runoff Area=3.160 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=934' Tc=14.6 min CN=74 Runoff=0.01 cfs 0.001 af

Subcatchment 4S: SWS 4 Runoff Area=1.200 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=174' Tc=3.8 min CN=74 Runoff=0.00 cfs 0.000 af

Subcatchment 5S: SWS 5 Runoff Area=2.840 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=810' Slope=0.0296 '/' Tc=34.4 min CN=74 Runoff=0.00 cfs 0.001 af

Subcatchment 6S: SWS 6 Runoff Area=2.750 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=361' Slope=0.0220 '/' Tc=35.5 min CN=74 Runoff=0.00 cfs 0.001 af

Subcatchment 7S: SWS 7 Runoff Area=2.660 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=529' Slope=0.0208 '/' Tc=37.6 min CN=74 Runoff=0.00 cfs 0.001 af

Reach 12R: Natural Drainage Avg. Flow Depth=0.39' Max Vel=2.45 fps Inflow=2.29 cfs 0.531 af
n=0.030 L=510.0' S=0.0216 '/' Capacity=173.00 cfs Outflow=2.29 cfs 0.531 af

Reach 13R: Natural Drainage Avg. Flow Depth=0.40' Max Vel=2.36 fps Inflow=2.29 cfs 0.532 af
n=0.030 L=970.0' S=0.0196 '/' Capacity=164.87 cfs Outflow=2.28 cfs 0.532 af

Pond 11P: SE Property Corner Inflow=2.31 cfs 0.541 af
Primary=2.31 cfs 0.541 af

Total Runoff Area = 281.580 ac Runoff Volume = 0.541 af Average Runoff Depth = 0.02"
100.00% Pervious = 281.580 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: SWS 1

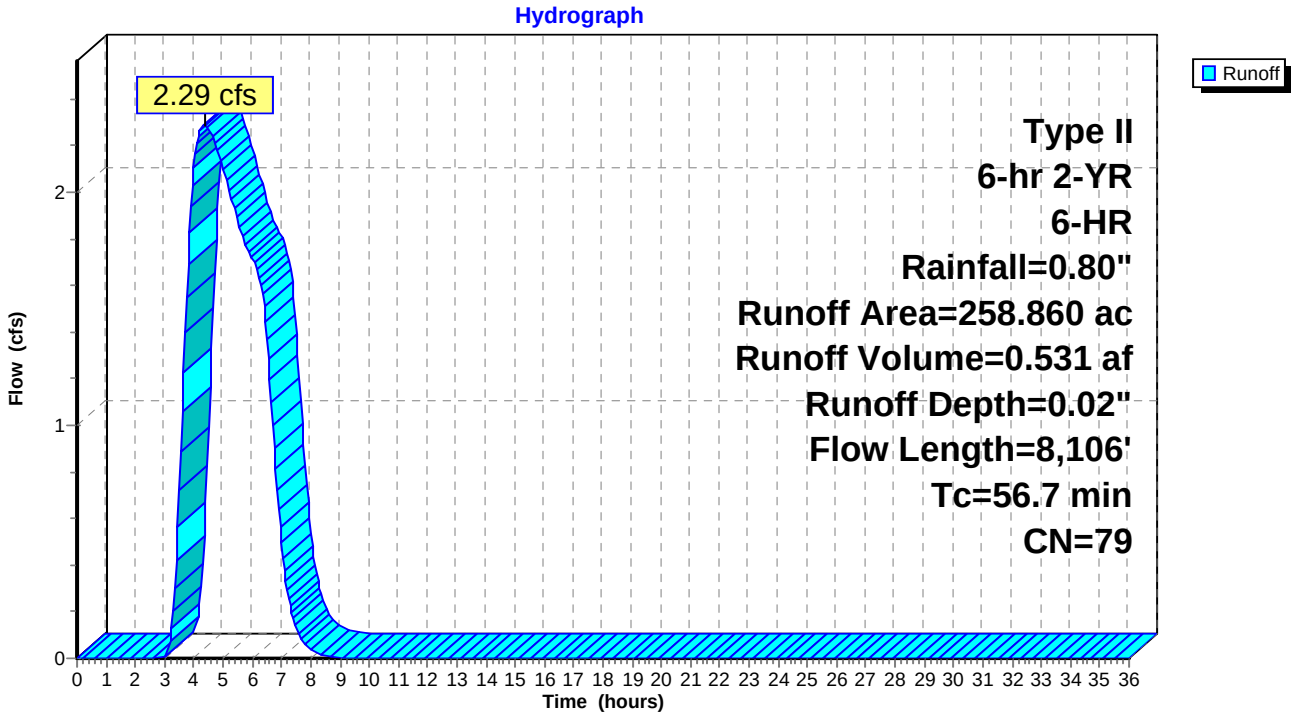
Runoff = 2.29 cfs @ 4.35 hrs, Volume= 0.531 af, Depth= 0.02"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 2-YR, 6-HR Rainfall=0.80"

	Area (ac)	CN	Description
*	258.860	79	Weighted Curve Number
	258.860		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	300	0.3900	0.45		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
45.6	7,806	0.0813	2.85		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
56.7	8,106	Total			

Subcatchment 1S: SWS 1



Summary for Subcatchment 2S: SWS 2

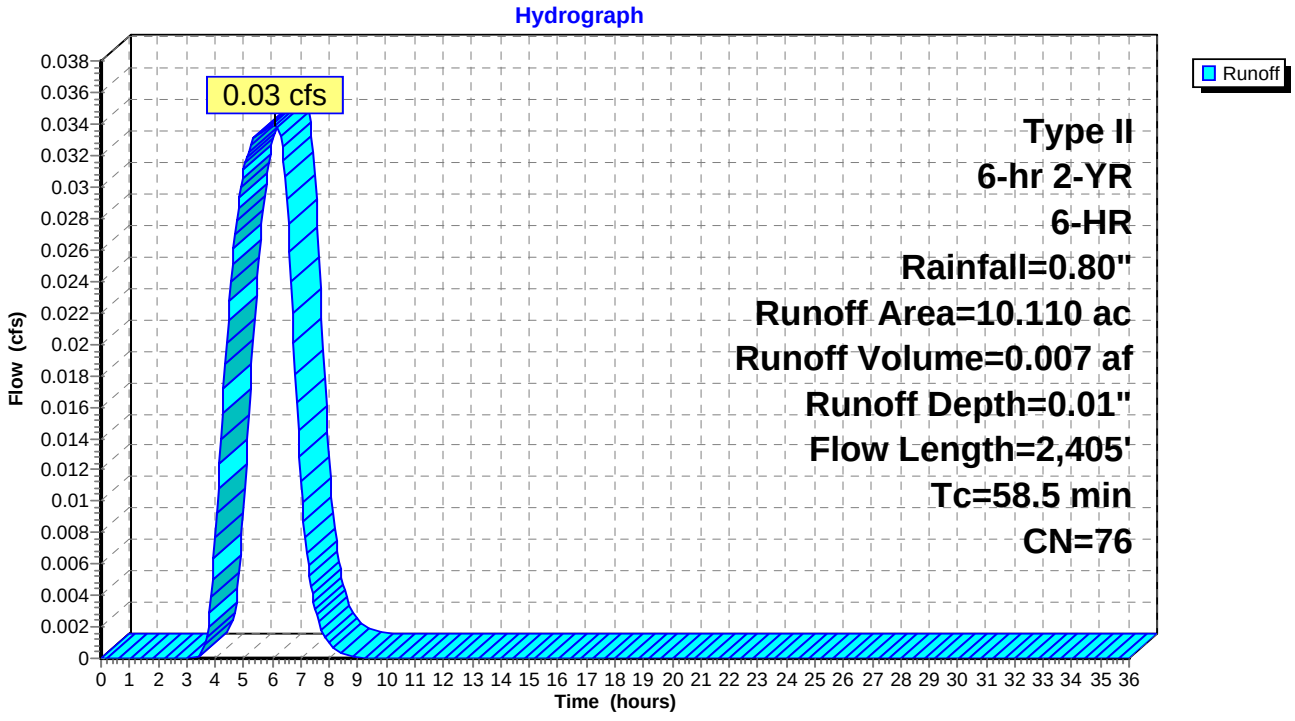
Runoff = 0.03 cfs @ 6.11 hrs, Volume= 0.007 af, Depth= 0.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 2-YR, 6-HR Rainfall=0.80"

	Area (ac)	CN	Description
*	10.110	76	Weighted Curve Number
	10.110		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.2	300	0.0233	0.15		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
24.3	2,105	0.0209	1.45		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
58.5	2,405	Total			

Subcatchment 2S: SWS 2



Summary for Subcatchment 3S: SWS 3

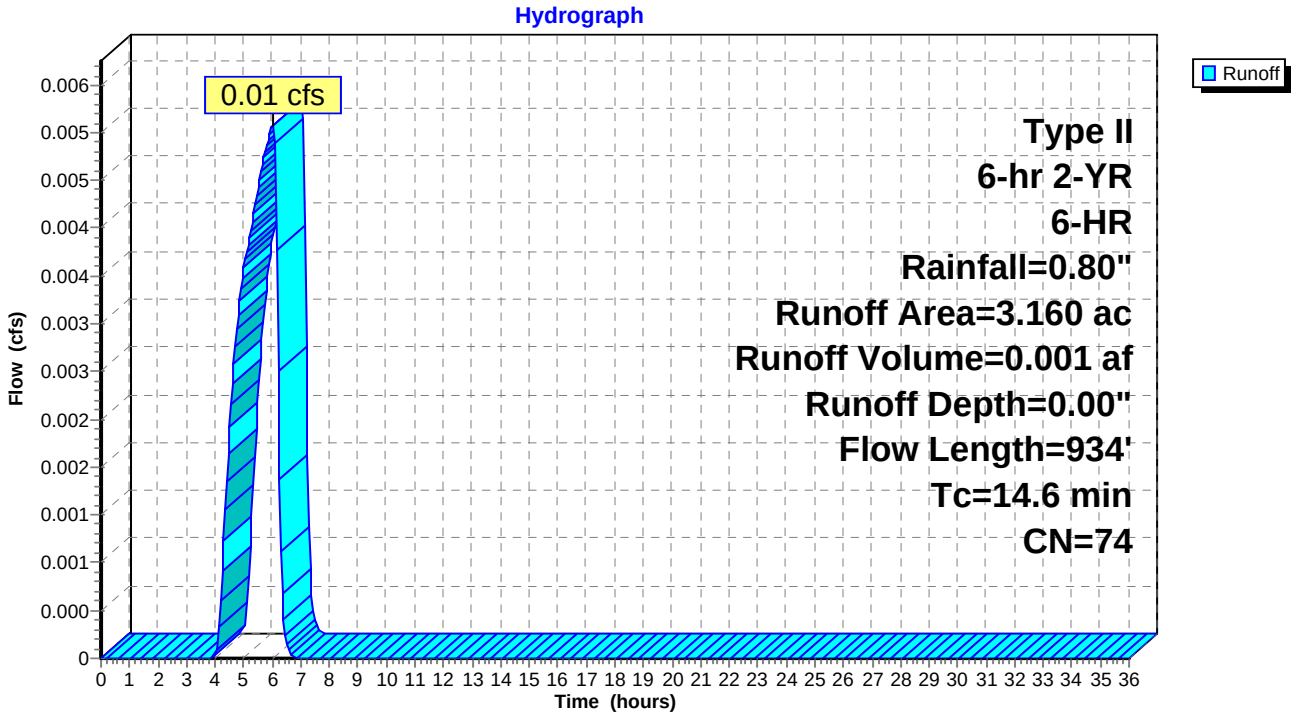
Runoff = 0.01 cfs @ 6.02 hrs, Volume= 0.001 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 2-YR, 6-HR Rainfall=0.80"

	Area (ac)	CN	Description
*	3.160	74	Weighted Curve Number
	3.160		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.2500	0.26		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
11.4	884	0.0166	1.29		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
14.6	934	Total			

Subcatchment 3S: SWS 3



Summary for Subcatchment 4S: SWS 4

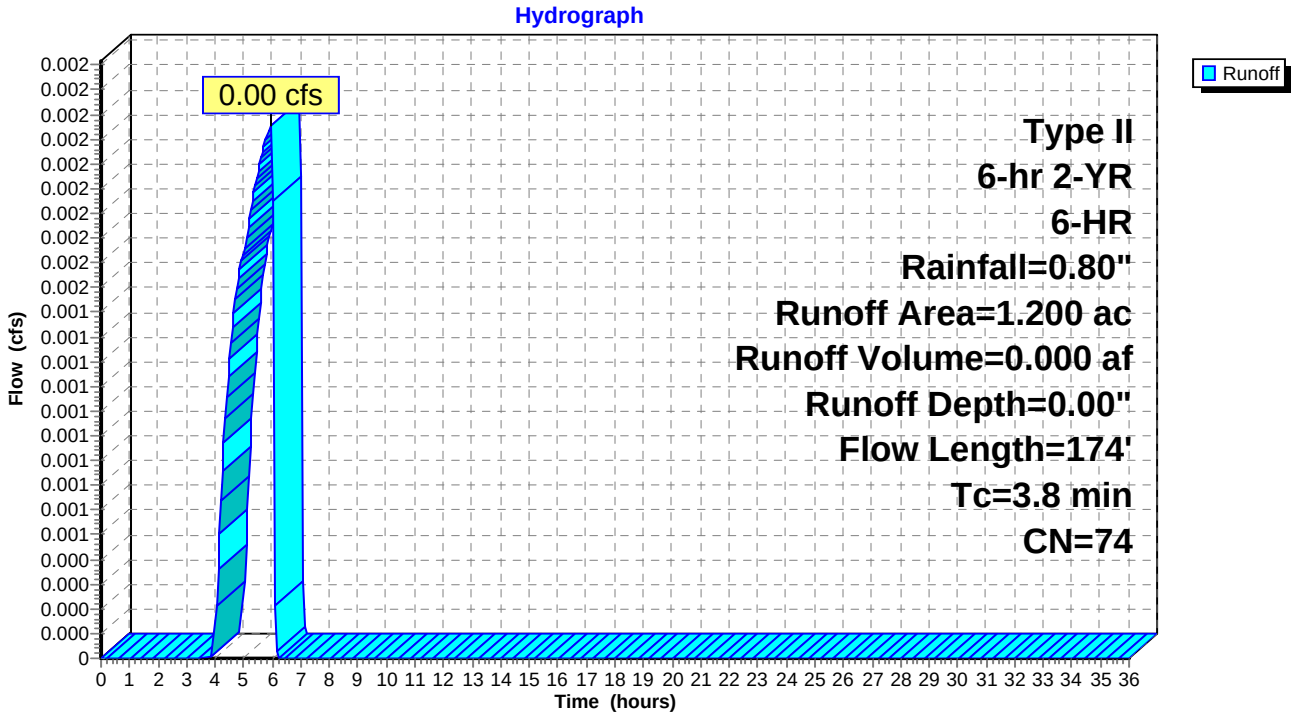
Runoff = 0.00 cfs @ 5.95 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 2-YR, 6-HR Rainfall=0.80"

	Area (ac)	CN	Description
*	1.200	74	Weighted Curve Number
	1.200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.2500	0.26		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
0.6	124	0.1149	3.39		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
3.8	174	Total			

Subcatchment 4S: SWS 4



Summary for Subcatchment 5S: SWS 5

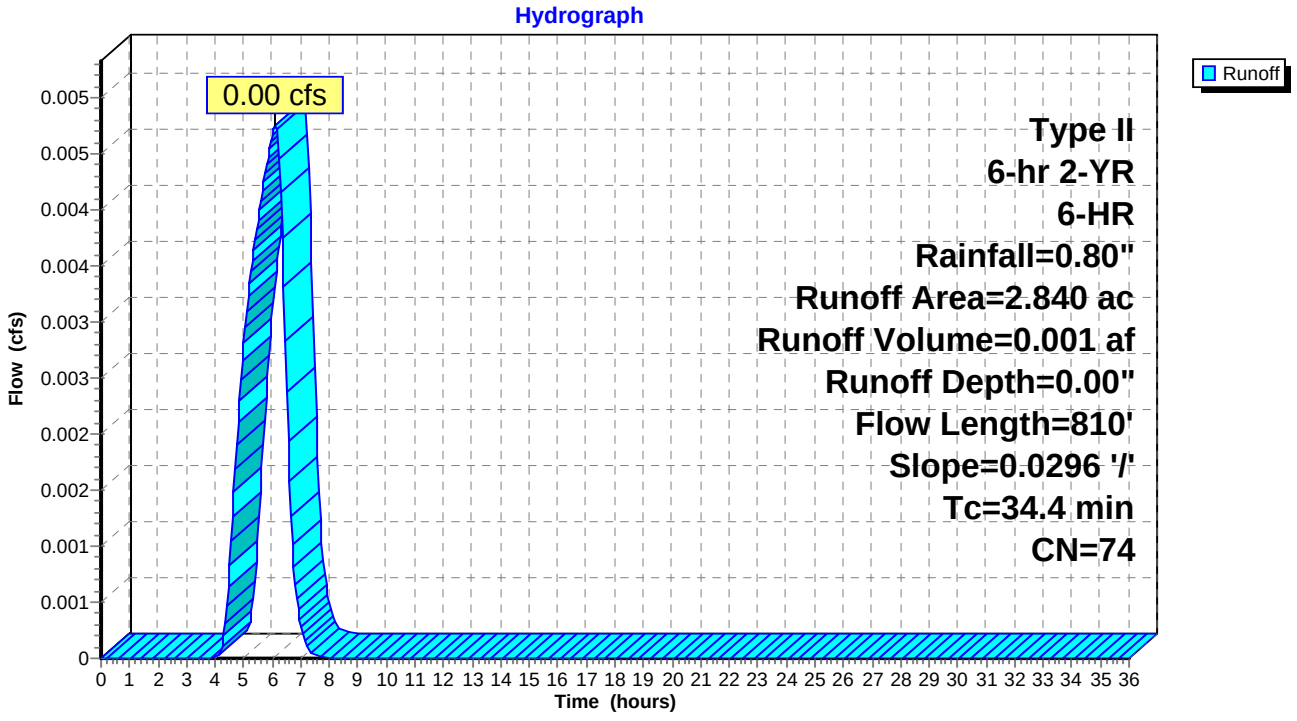
Runoff = 0.00 cfs @ 6.11 hrs, Volume= 0.001 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 2-YR, 6-HR Rainfall=0.80"

	Area (ac)	CN	Description
*	2.840	74	Weighted Curve Number
	2.840		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
31.1	300	0.0296	0.16		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
3.3	510	0.0296	2.58		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
34.4	810	Total			

Subcatchment 5S: SWS 5



Summary for Subcatchment 6S: SWS 6

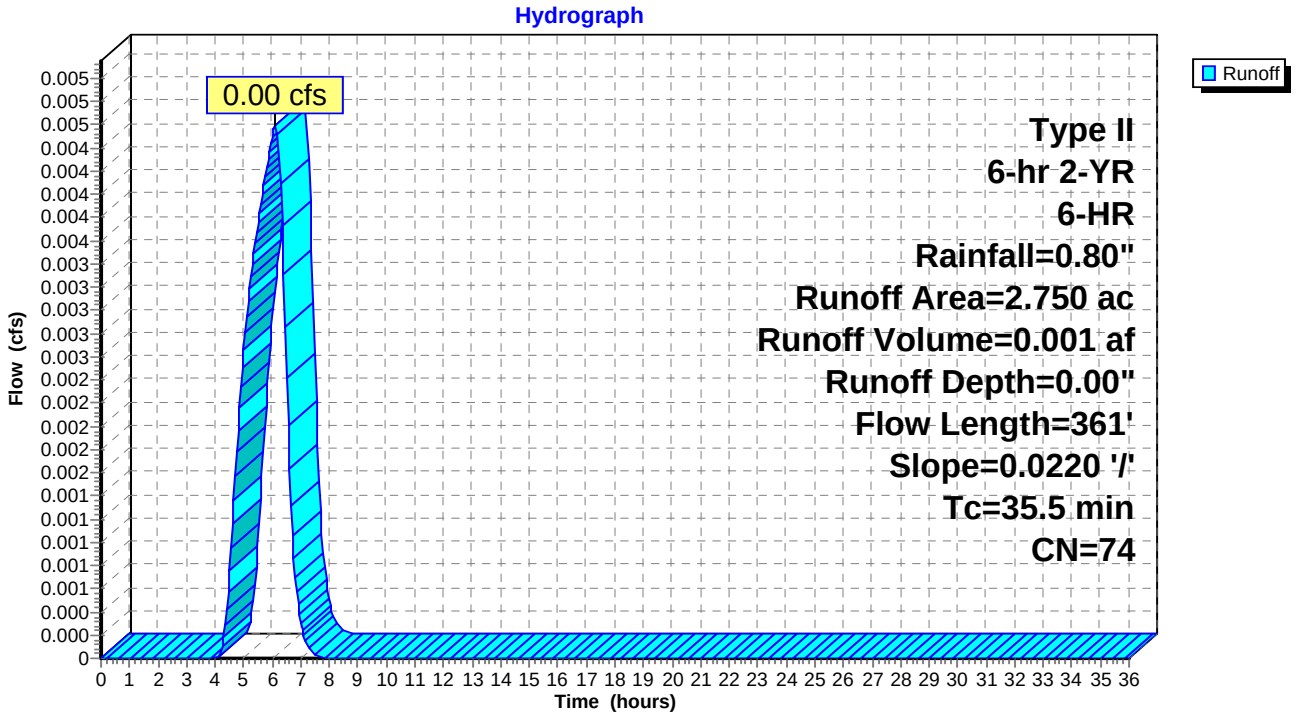
Runoff = 0.00 cfs @ 6.12 hrs, Volume= 0.001 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 2-YR, 6-HR Rainfall=0.80"

	Area (ac)	CN	Description
*	2.750	74	Weighted Curve Number
	2.750		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
35.0	300	0.0220	0.14		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
0.5	61	0.0220	2.22		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
35.5	361	Total			

Subcatchment 6S: SWS 6



Summary for Subcatchment 7S: SWS 7

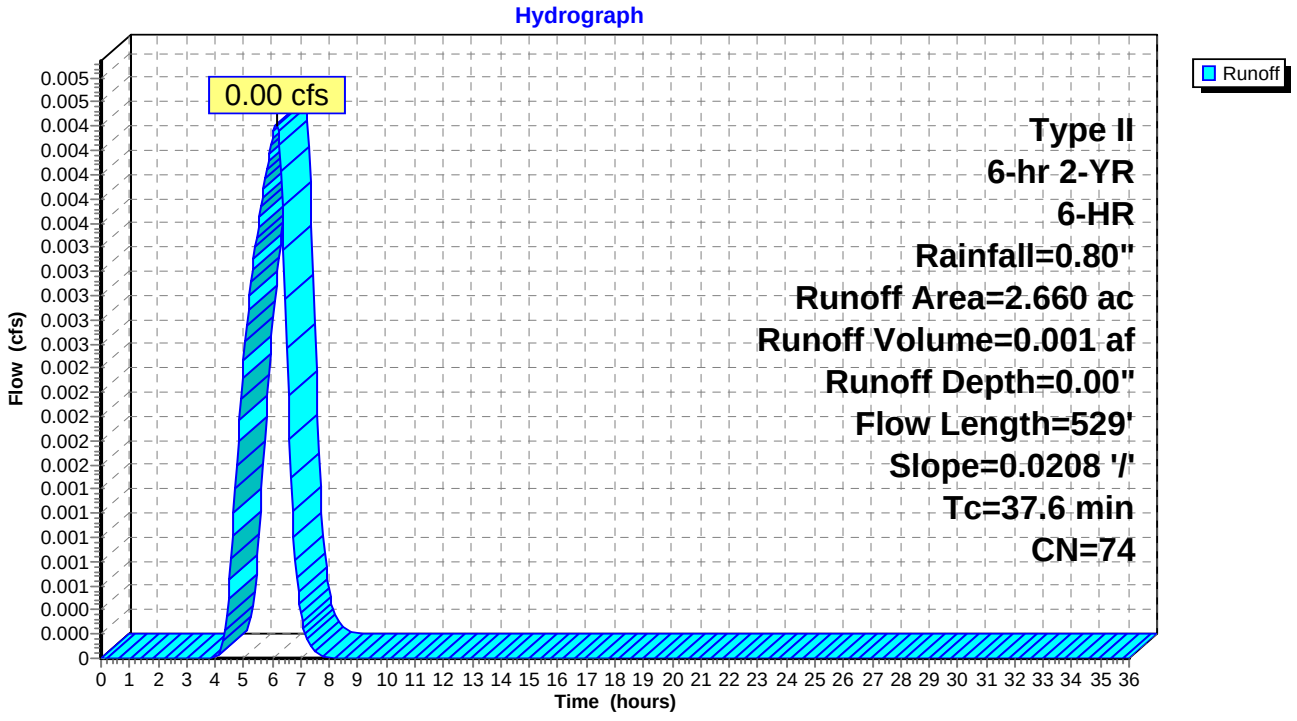
Runoff = 0.00 cfs @ 6.13 hrs, Volume= 0.001 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 2-YR, 6-HR Rainfall=0.80"

	Area (ac)	CN	Description
*	2.660	74	Weighted Curve Number
	2.660		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
35.8	300	0.0208	0.14		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
1.8	229	0.0208	2.16		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
37.6	529	Total			

Subcatchment 7S: SWS 7



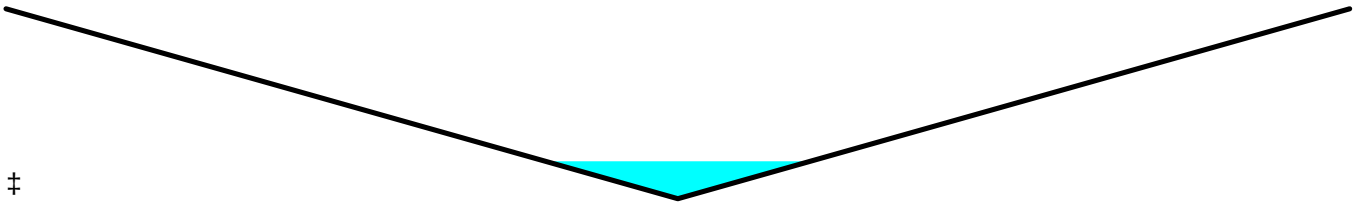
Summary for Reach 12R: Natural Drainage

Inflow Area = 258.860 ac, 0.00% Impervious, Inflow Depth = 0.02" for 2-YR, 6-HR event
Inflow = 2.29 cfs @ 4.35 hrs, Volume= 0.531 af
Outflow = 2.29 cfs @ 4.46 hrs, Volume= 0.531 af, Atten= 0%, Lag= 6.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.45 fps, Min. Travel Time= 3.5 min
Avg. Velocity = 1.44 fps, Avg. Travel Time= 5.9 min

Peak Storage= 477 cf @ 4.40 hrs
Average Depth at Peak Storage= 0.39'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 173.00 cfs

0.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 6.0 '/' Top Width= 24.00'
Length= 510.0' Slope= 0.0216 '/'
Inlet Invert= 5,060.00', Outlet Invert= 5,049.00'



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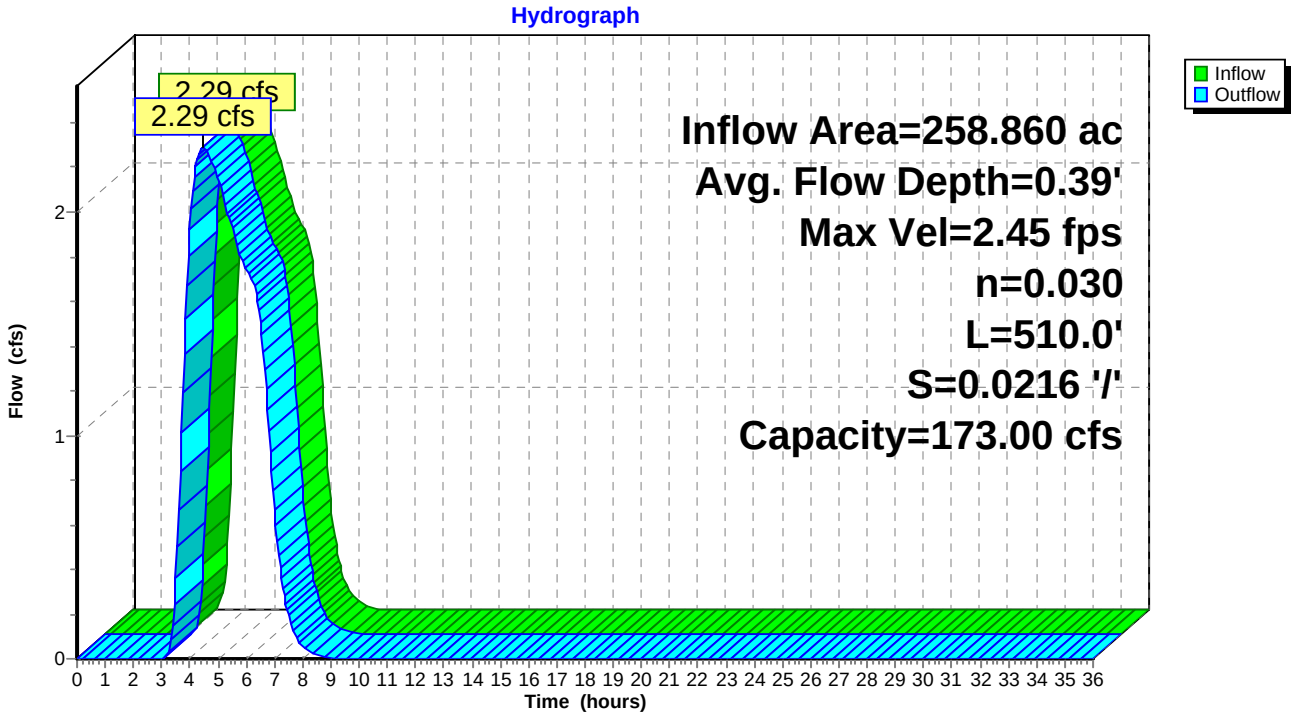
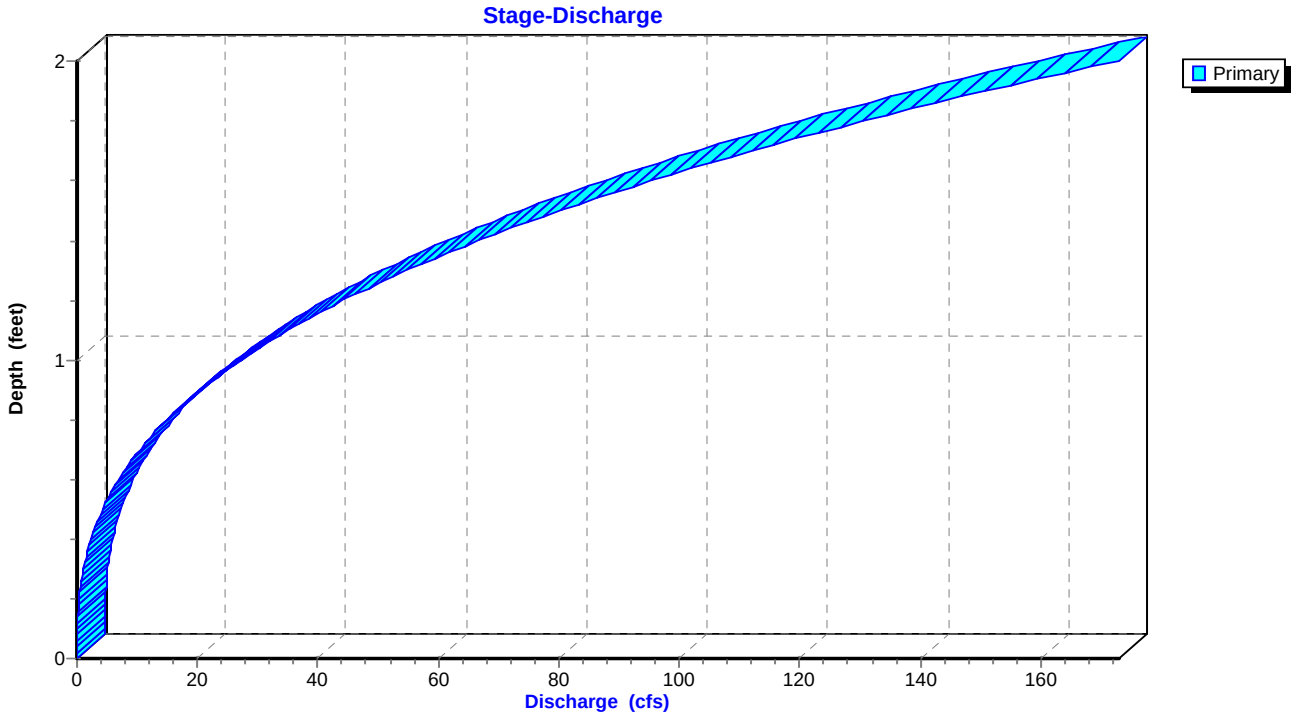
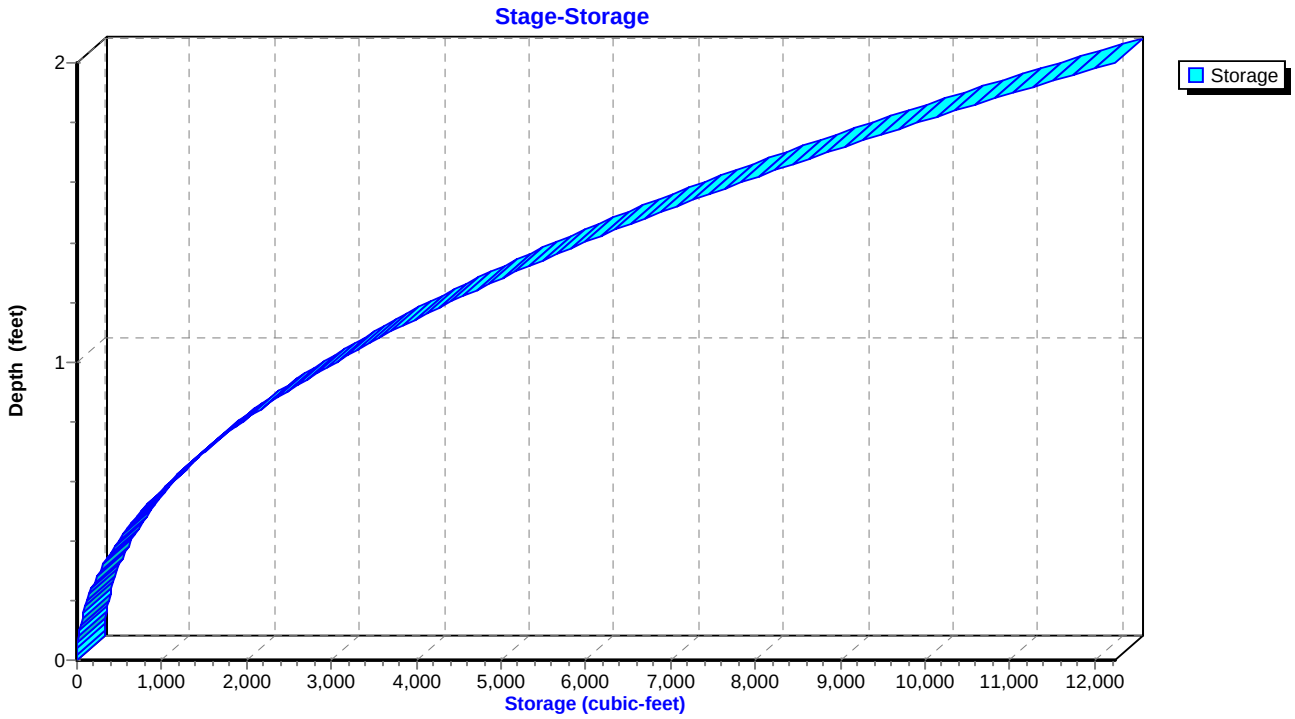
Reach 12R: Natural Drainage



Reach 12R: Natural Drainage



Reach 12R: Natural Drainage



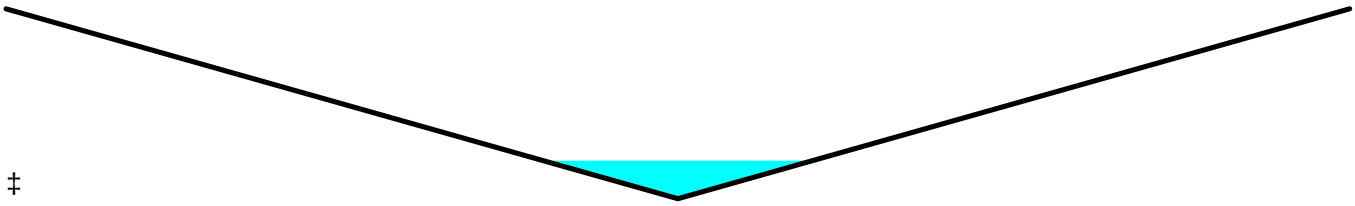
Summary for Reach 13R: Natural Drainage

Inflow Area = 264.450 ac, 0.00% Impervious, Inflow Depth = 0.02" for 2-YR, 6-HR event
Inflow = 2.29 cfs @ 4.46 hrs, Volume= 0.532 af
Outflow = 2.28 cfs @ 4.68 hrs, Volume= 0.532 af, Atten= 0%, Lag= 13.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.36 fps, Min. Travel Time= 6.9 min
Avg. Velocity = 1.15 fps, Avg. Travel Time= 14.0 min

Peak Storage= 939 cf @ 4.57 hrs
Average Depth at Peak Storage= 0.40'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 164.87 cfs

0.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 6.0 '/' Top Width= 24.00'
Length= 970.0' Slope= 0.0196 '/'
Inlet Invert= 5,049.00', Outlet Invert= 5,030.00'



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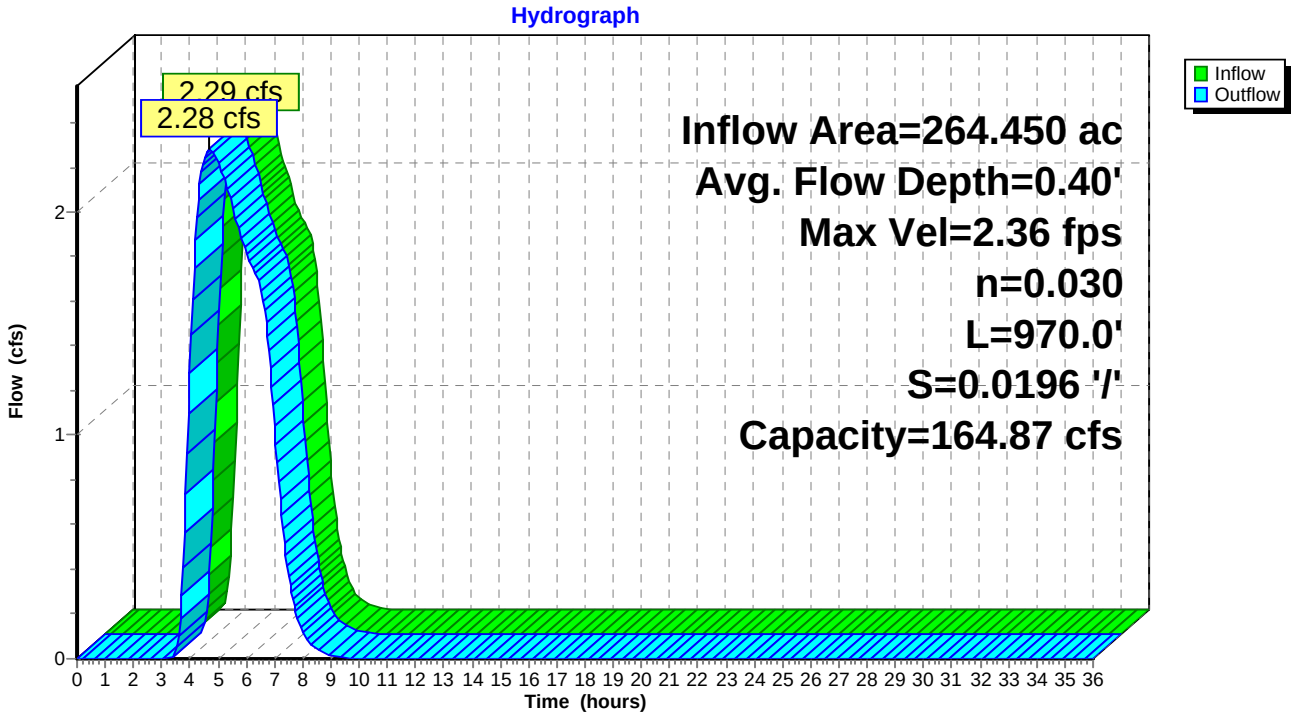
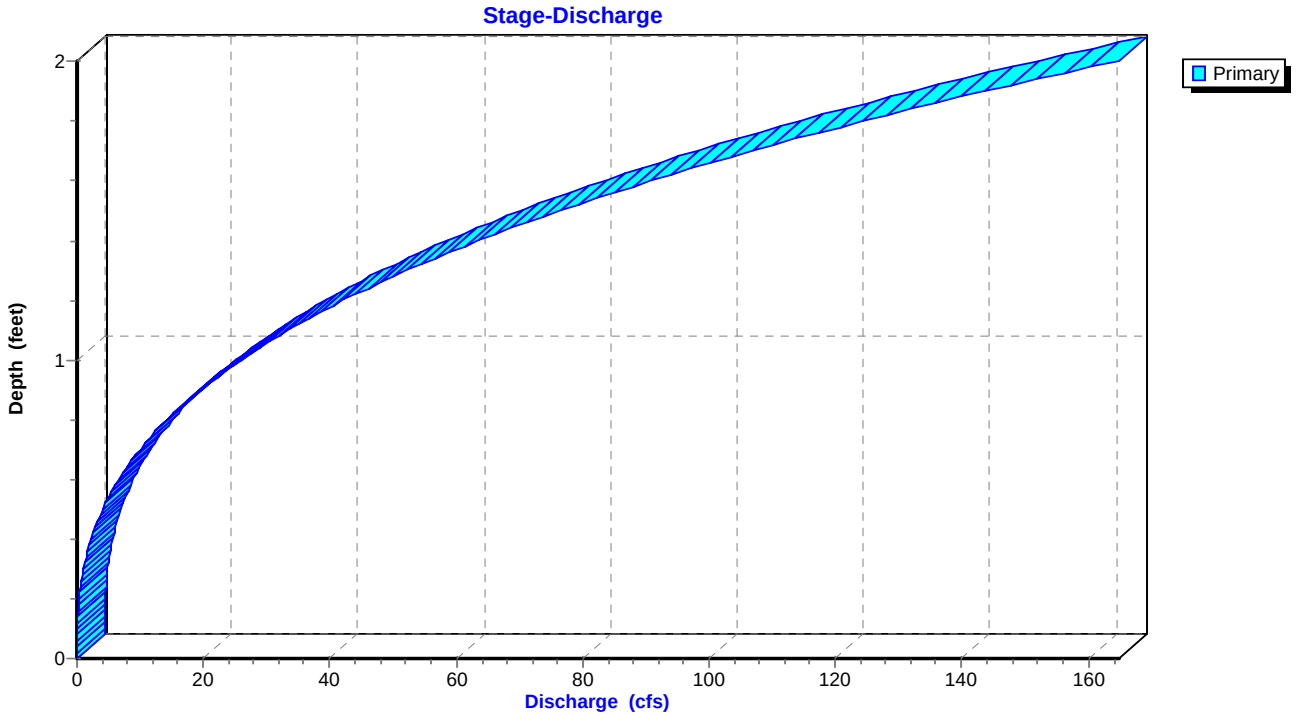
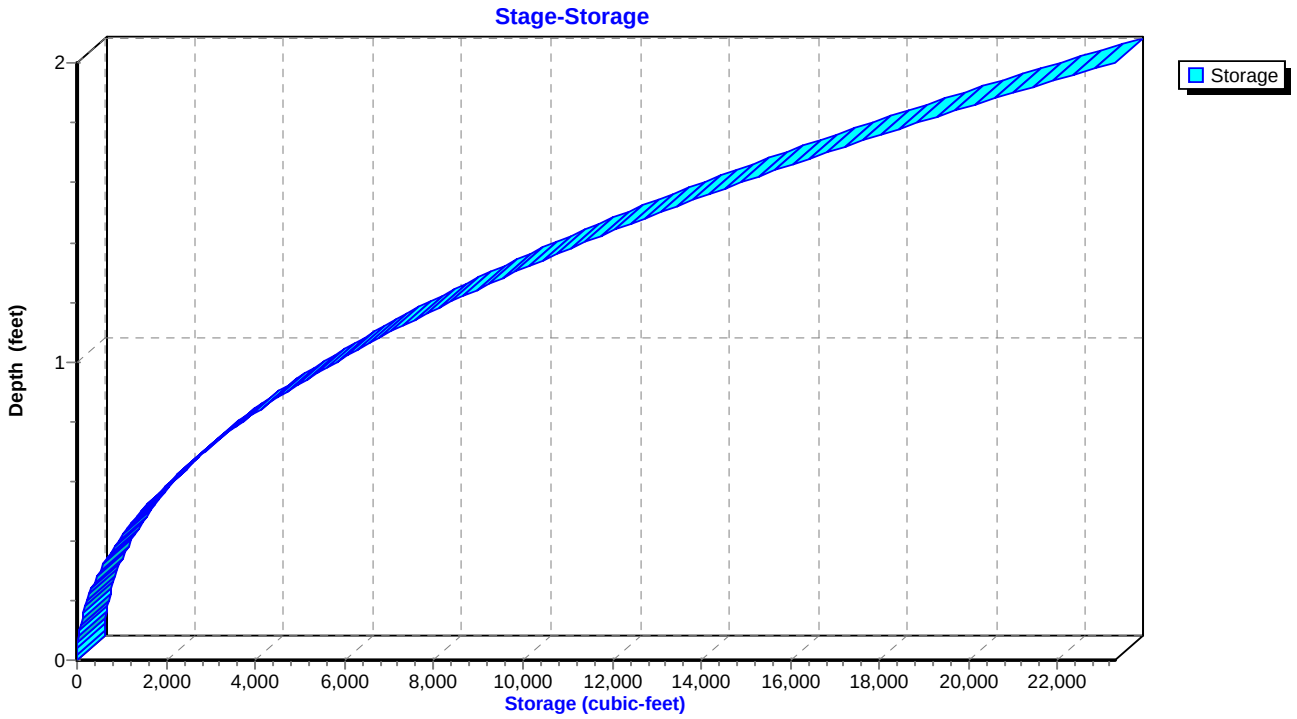
Reach 13R: Natural Drainage



Reach 13R: Natural Drainage



Reach 13R: Natural Drainage

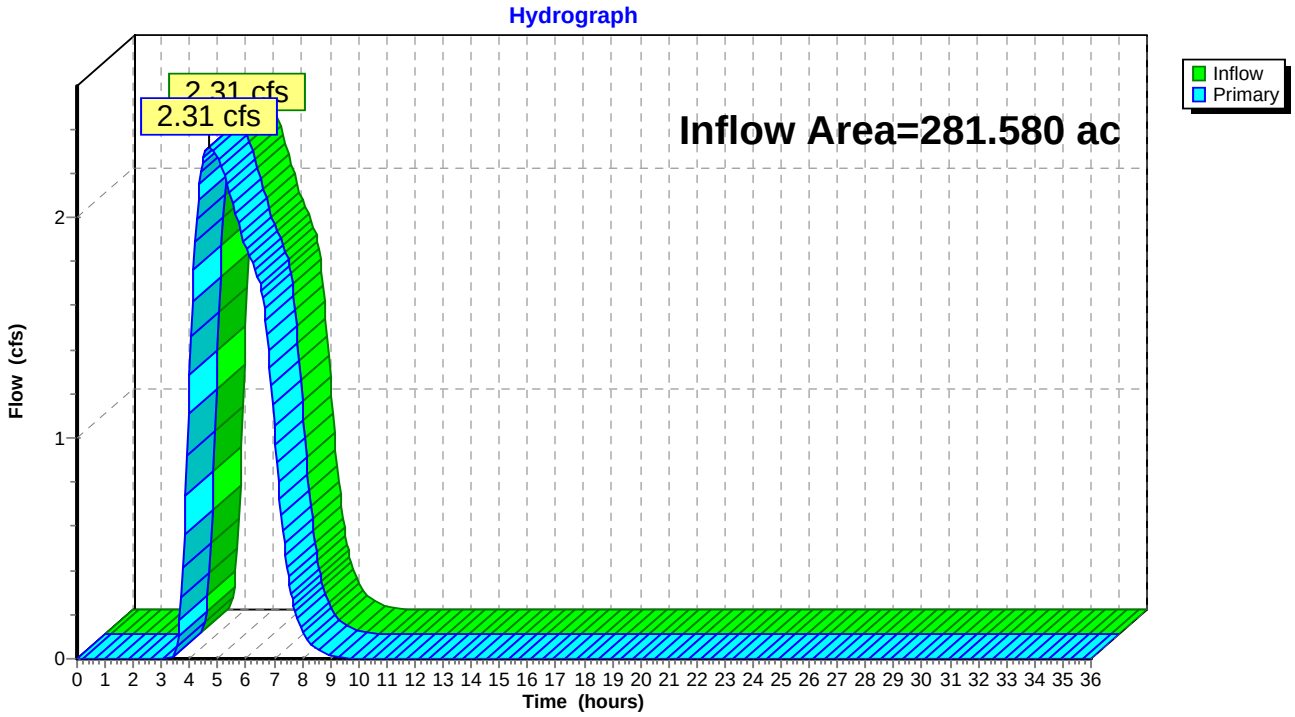


Summary for Pond 11P: SE Property Corner

Inflow Area = 281.580 ac, 0.00% Impervious, Inflow Depth = 0.02" for 2-YR, 6-HR event
Inflow = 2.31 cfs @ 4.70 hrs, Volume= 0.541 af
Primary = 2.31 cfs @ 4.70 hrs, Volume= 0.541 af, Atten= 0%, Lag= 0.0 min

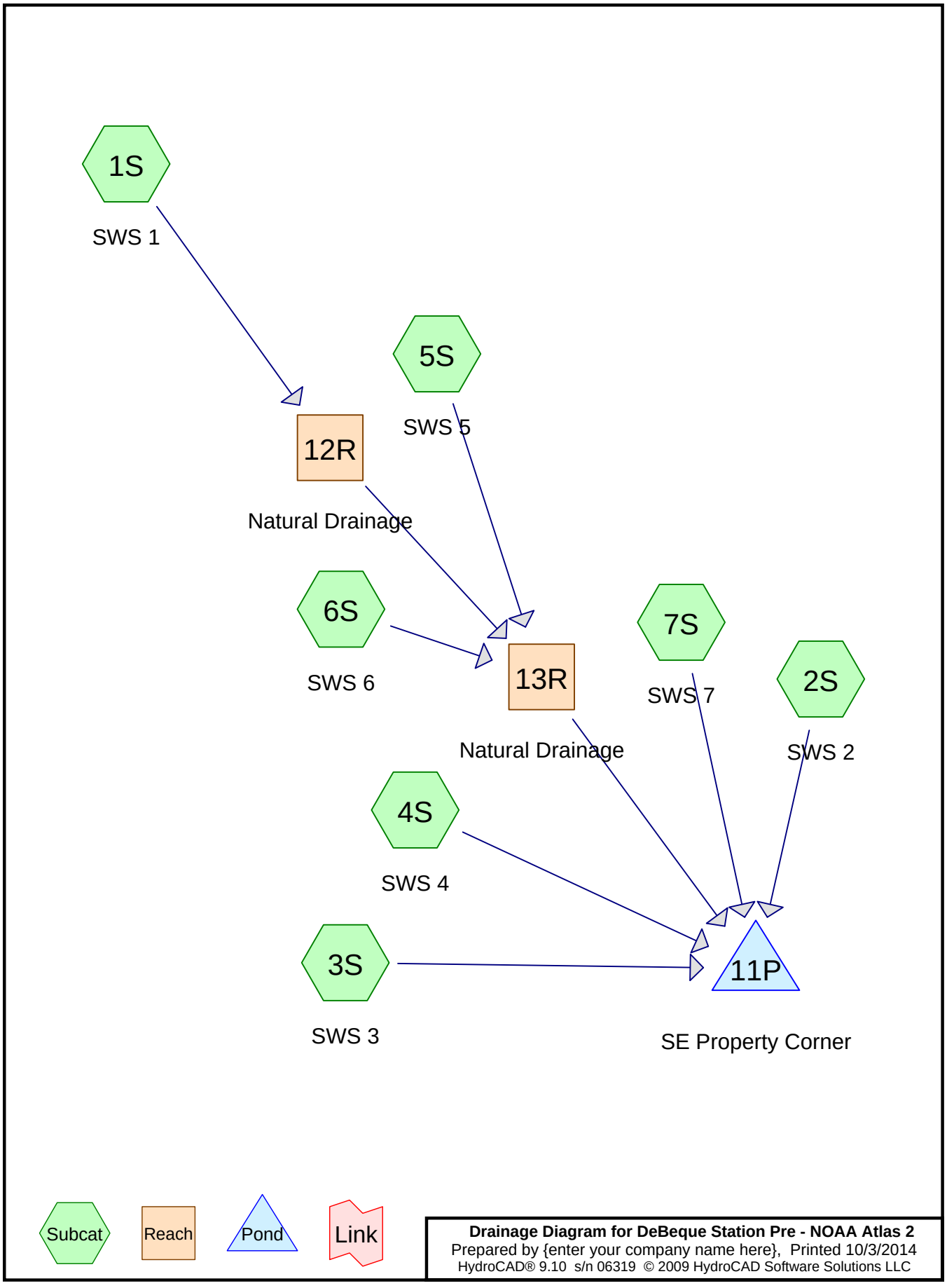
Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Pond 11P: SE Property Corner



APPENDIX C2

HydroCAD Report
NOAA Atlas 2: Pre-Development
100-Year, 6-Hour Event



Drainage Diagram for DeBeque Station Pre - NOAA Atlas 2
Prepared by {enter your company name here}, Printed 10/3/2014
HydroCAD® 9.10 s/n 06319 © 2009 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
12.610	74	Weighted Curve Number (3S, 4S, 5S, 6S, 7S)
10.110	76	Weighted Curve Number (2S)
258.860	79	Weighted Curve Number (1S)
281.580		**TOTAL AREA**

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: SWS 1 Runoff Area=258.860 ac 0.00% Impervious Runoff Depth=0.41"
Flow Length=8,106' Tc=56.7 min CN=79 Runoff=68.59 cfs 8.838 af

Subcatchment 2S: SWS 2 Runoff Area=10.110 ac 0.00% Impervious Runoff Depth=0.32"
Flow Length=2,405' Tc=58.5 min CN=76 Runoff=1.90 cfs 0.266 af

Subcatchment 3S: SWS 3 Runoff Area=3.160 ac 0.00% Impervious Runoff Depth=0.26"
Flow Length=934' Tc=14.6 min CN=74 Runoff=1.20 cfs 0.069 af

Subcatchment 4S: SWS 4 Runoff Area=1.200 ac 0.00% Impervious Runoff Depth=0.26"
Flow Length=174' Tc=3.8 min CN=74 Runoff=0.78 cfs 0.026 af

Subcatchment 5S: SWS 5 Runoff Area=2.840 ac 0.00% Impervious Runoff Depth=0.26"
Flow Length=810' Slope=0.0296 '/' Tc=34.4 min CN=74 Runoff=0.60 cfs 0.062 af

Subcatchment 6S: SWS 6 Runoff Area=2.750 ac 0.00% Impervious Runoff Depth=0.26"
Flow Length=361' Slope=0.0220 '/' Tc=35.5 min CN=74 Runoff=0.57 cfs 0.060 af

Subcatchment 7S: SWS 7 Runoff Area=2.660 ac 0.00% Impervious Runoff Depth=0.26"
Flow Length=529' Slope=0.0208 '/' Tc=37.6 min CN=74 Runoff=0.53 cfs 0.058 af

Reach 12R: Natural Drainage Avg. Flow Depth=1.41' Max Vel=5.72 fps Inflow=68.59 cfs 8.838 af
n=0.030 L=510.0' S=0.0216 '/' Capacity=173.00 cfs Outflow=68.36 cfs 8.838 af

Reach 13R: Natural Drainage Avg. Flow Depth=1.44' Max Vel=5.52 fps Inflow=69.12 cfs 8.960 af
n=0.030 L=970.0' S=0.0196 '/' Capacity=164.87 cfs Outflow=68.83 cfs 8.960 af

Pond 11P: SE Property Corner Inflow=71.36 cfs 9.378 af
Primary=71.36 cfs 9.378 af

Total Runoff Area = 281.580 ac Runoff Volume = 9.378 af Average Runoff Depth = 0.40"
100.00% Pervious = 281.580 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: SWS 1

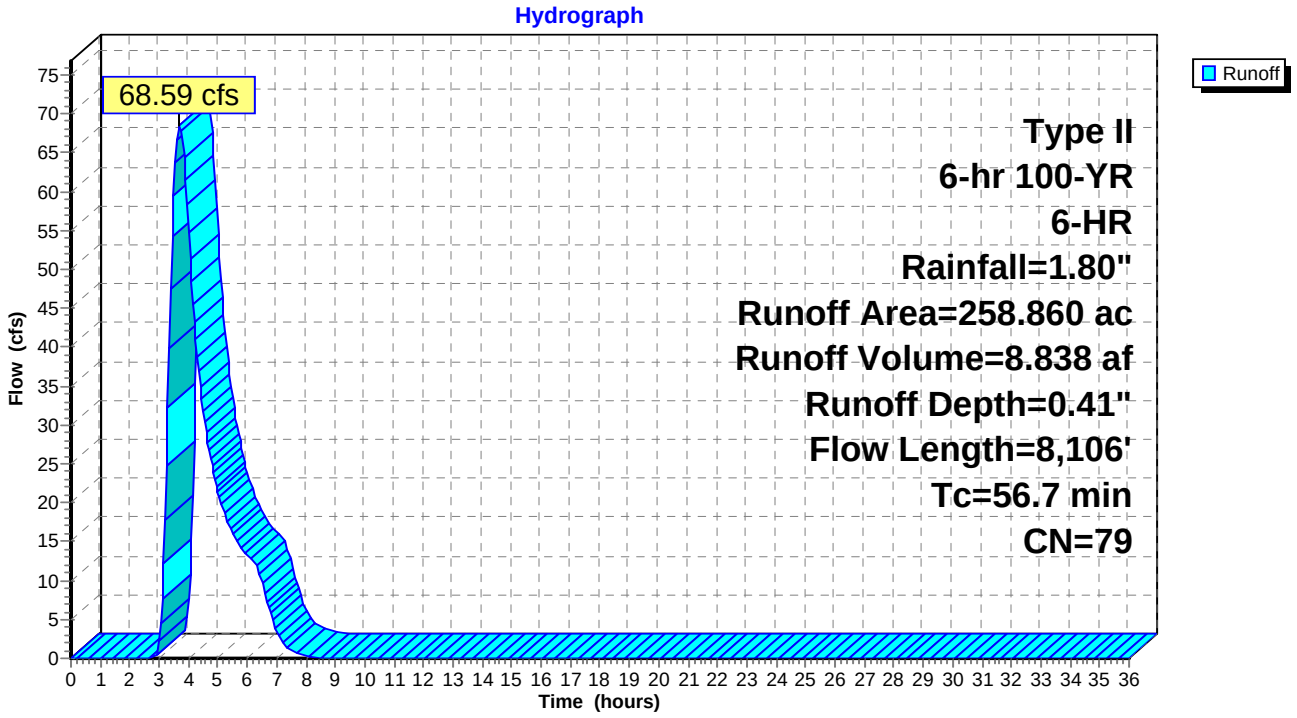
Runoff = 68.59 cfs @ 3.70 hrs, Volume= 8.838 af, Depth= 0.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-YR, 6-HR Rainfall=1.80"

	Area (ac)	CN	Description
*	258.860	79	Weighted Curve Number
	258.860		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	300	0.3900	0.45		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
45.6	7,806	0.0813	2.85		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
56.7	8,106	Total			

Subcatchment 1S: SWS 1



Summary for Subcatchment 2S: SWS 2

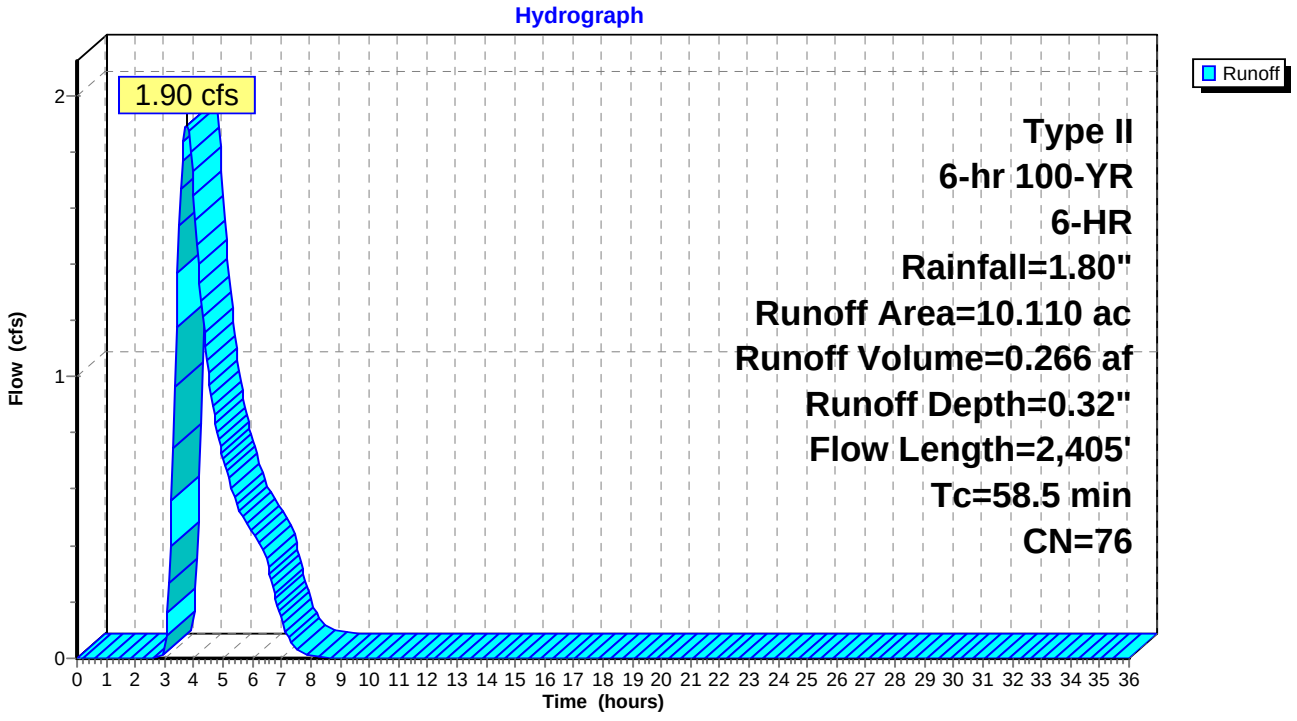
Runoff = 1.90 cfs @ 3.74 hrs, Volume= 0.266 af, Depth= 0.32"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-YR, 6-HR Rainfall=1.80"

	Area (ac)	CN	Description
*	10.110	76	Weighted Curve Number
	10.110		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.2	300	0.0233	0.15		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
24.3	2,105	0.0209	1.45		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
58.5	2,405	Total			

Subcatchment 2S: SWS 2



Summary for Subcatchment 3S: SWS 3

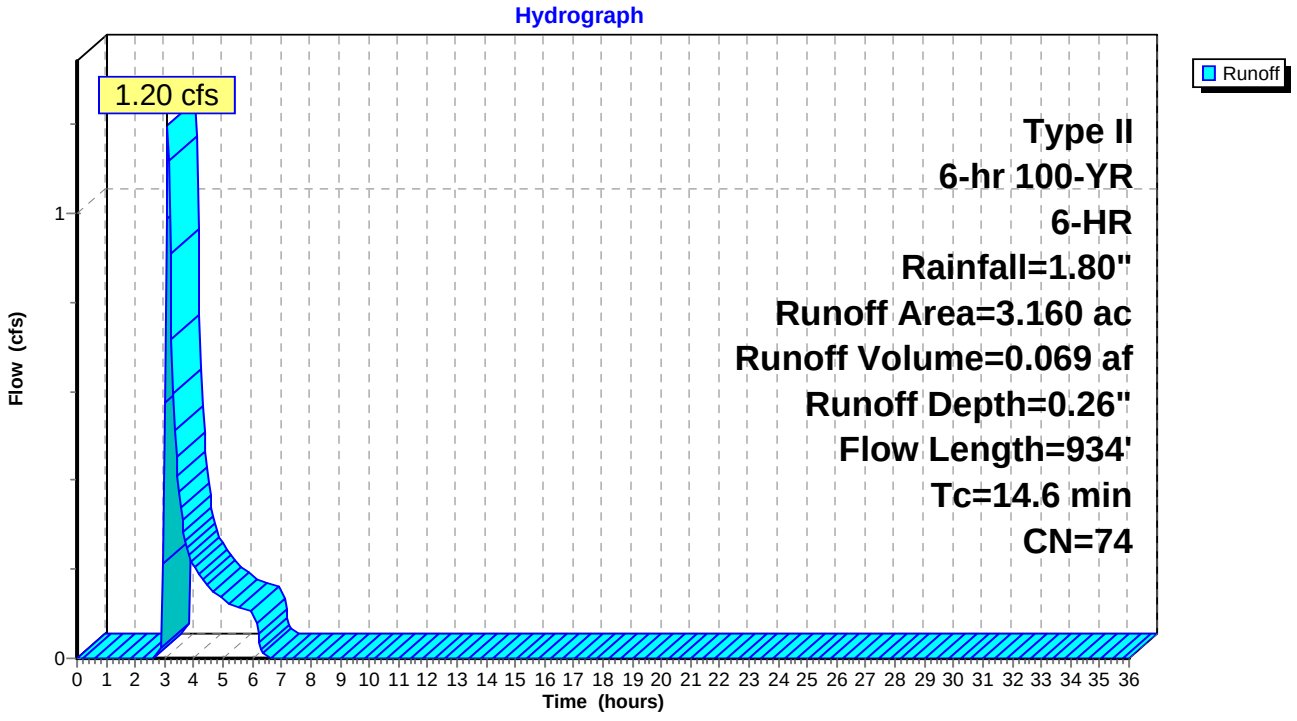
Runoff = 1.20 cfs @ 3.11 hrs, Volume= 0.069 af, Depth= 0.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-YR, 6-HR Rainfall=1.80"

	Area (ac)	CN	Description
*	3.160	74	Weighted Curve Number
	3.160		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.2500	0.26		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
11.4	884	0.0166	1.29		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
14.6	934	Total			

Subcatchment 3S: SWS 3



Summary for Subcatchment 4S: SWS 4

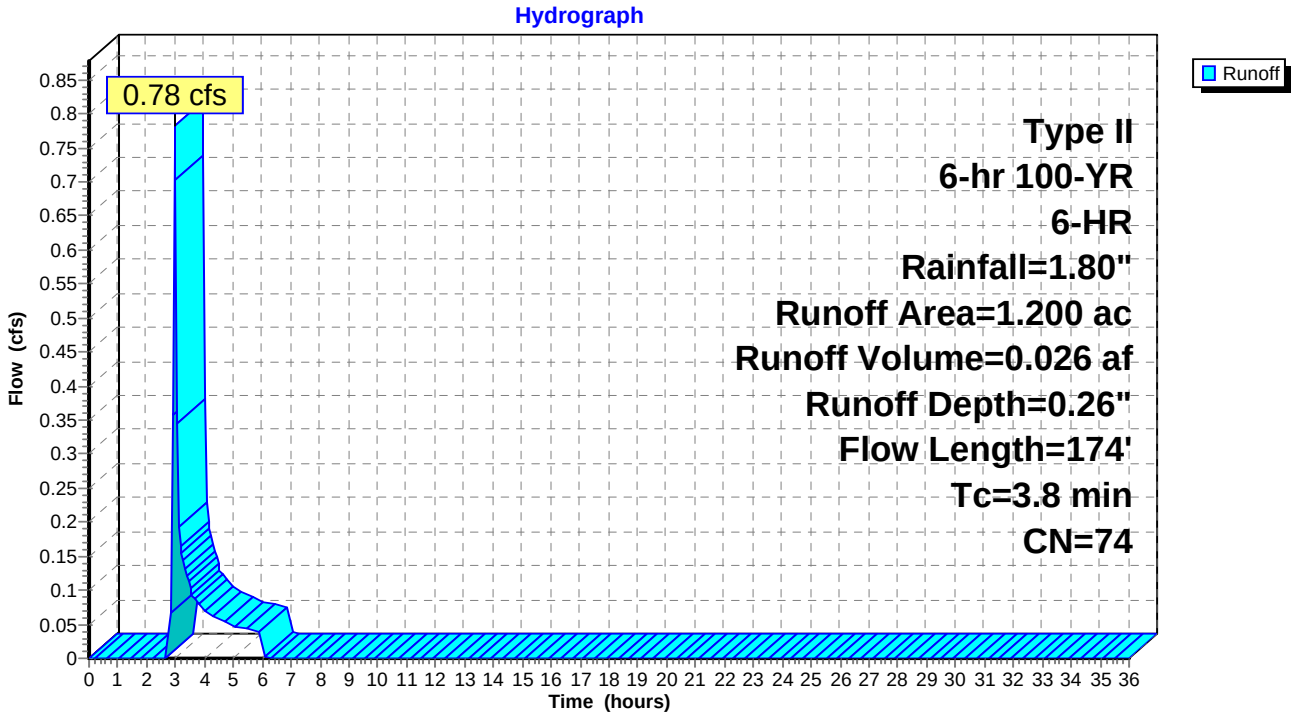
Runoff = 0.78 cfs @ 2.97 hrs, Volume= 0.026 af, Depth= 0.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-YR, 6-HR Rainfall=1.80"

	Area (ac)	CN	Description
*	1.200	74	Weighted Curve Number
	1.200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.2500	0.26		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
0.6	124	0.1149	3.39		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
3.8	174	Total			

Subcatchment 4S: SWS 4



Summary for Subcatchment 5S: SWS 5

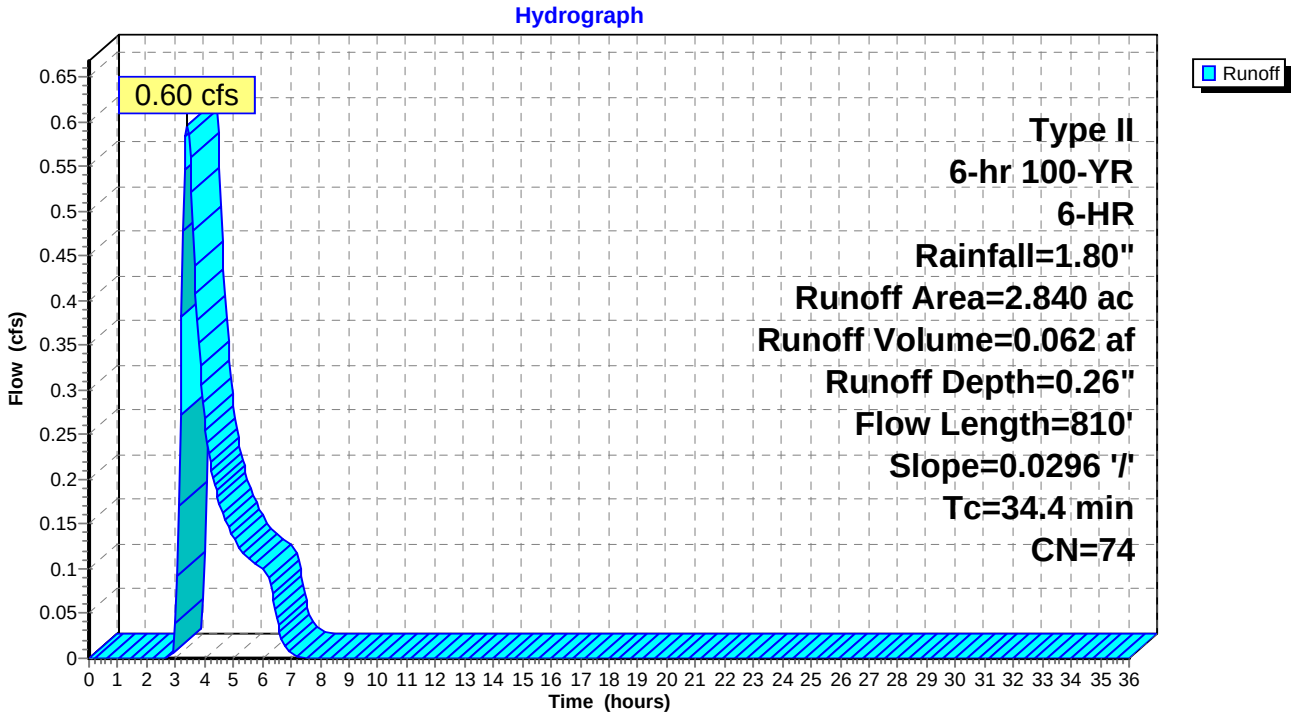
Runoff = 0.60 cfs @ 3.40 hrs, Volume= 0.062 af, Depth= 0.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-YR, 6-HR Rainfall=1.80"

	Area (ac)	CN	Description
*	2.840	74	Weighted Curve Number
	2.840		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
31.1	300	0.0296	0.16		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
3.3	510	0.0296	2.58		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
34.4	810	Total			

Subcatchment 5S: SWS 5



Summary for Subcatchment 6S: SWS 6

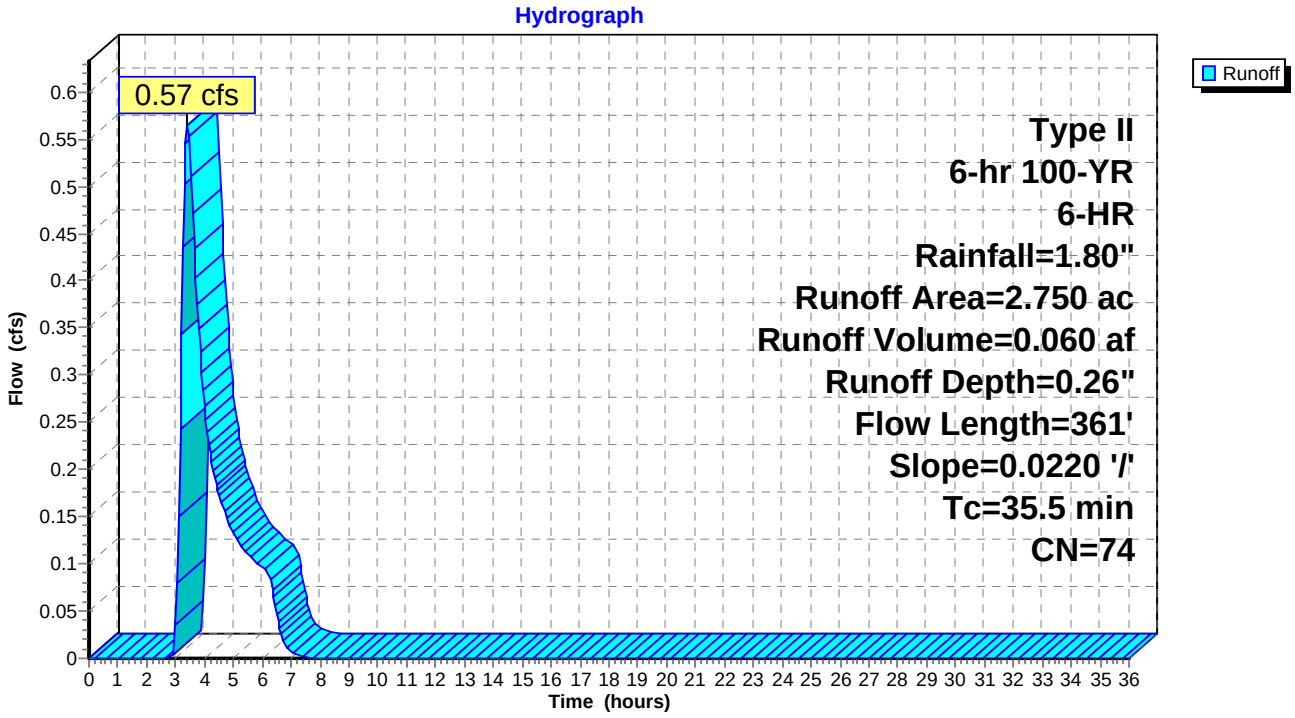
Runoff = 0.57 cfs @ 3.42 hrs, Volume= 0.060 af, Depth= 0.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-YR, 6-HR Rainfall=1.80"

	Area (ac)	CN	Description
*	2.750	74	Weighted Curve Number
	2.750		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
35.0	300	0.0220	0.14		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
0.5	61	0.0220	2.22		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
35.5	361	Total			

Subcatchment 6S: SWS 6



Summary for Subcatchment 7S: SWS 7

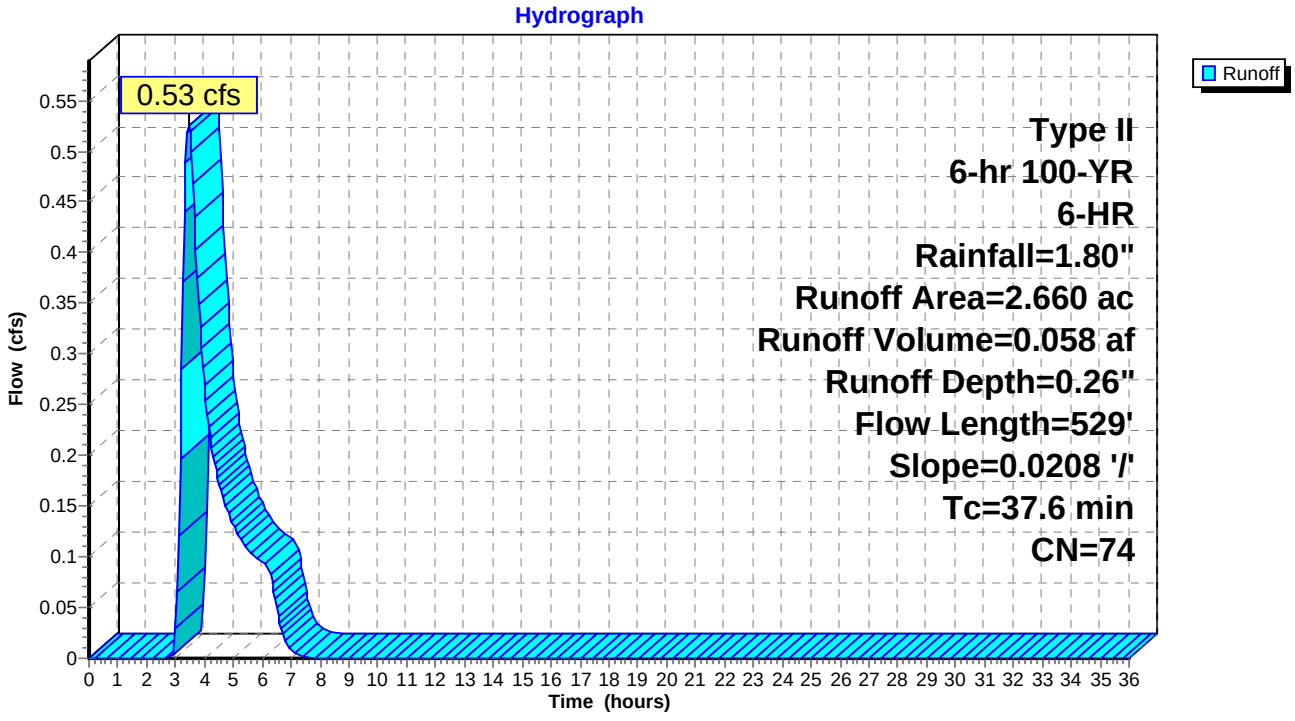
Runoff = 0.53 cfs @ 3.45 hrs, Volume= 0.058 af, Depth= 0.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-YR, 6-HR Rainfall=1.80"

	Area (ac)	CN	Description
*	2.660	74	Weighted Curve Number
	2.660		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
35.8	300	0.0208	0.14		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
1.8	229	0.0208	2.16		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
37.6	529	Total			

Subcatchment 7S: SWS 7



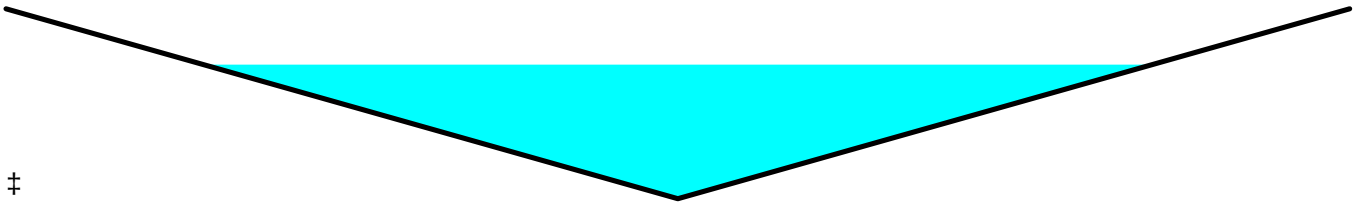
Summary for Reach 12R: Natural Drainage

Inflow Area = 258.860 ac, 0.00% Impervious, Inflow Depth = 0.41" for 100-YR, 6-HR event
Inflow = 68.59 cfs @ 3.70 hrs, Volume= 8.838 af
Outflow = 68.36 cfs @ 3.74 hrs, Volume= 8.838 af, Atten= 0%, Lag= 2.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.72 fps, Min. Travel Time= 1.5 min
Avg. Velocity = 2.59 fps, Avg. Travel Time= 3.3 min

Peak Storage= 6,108 cf @ 3.72 hrs
Average Depth at Peak Storage= 1.41'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 173.00 cfs

0.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 6.0 '/' Top Width= 24.00'
Length= 510.0' Slope= 0.0216 '/'
Inlet Invert= 5,060.00', Outlet Invert= 5,049.00'



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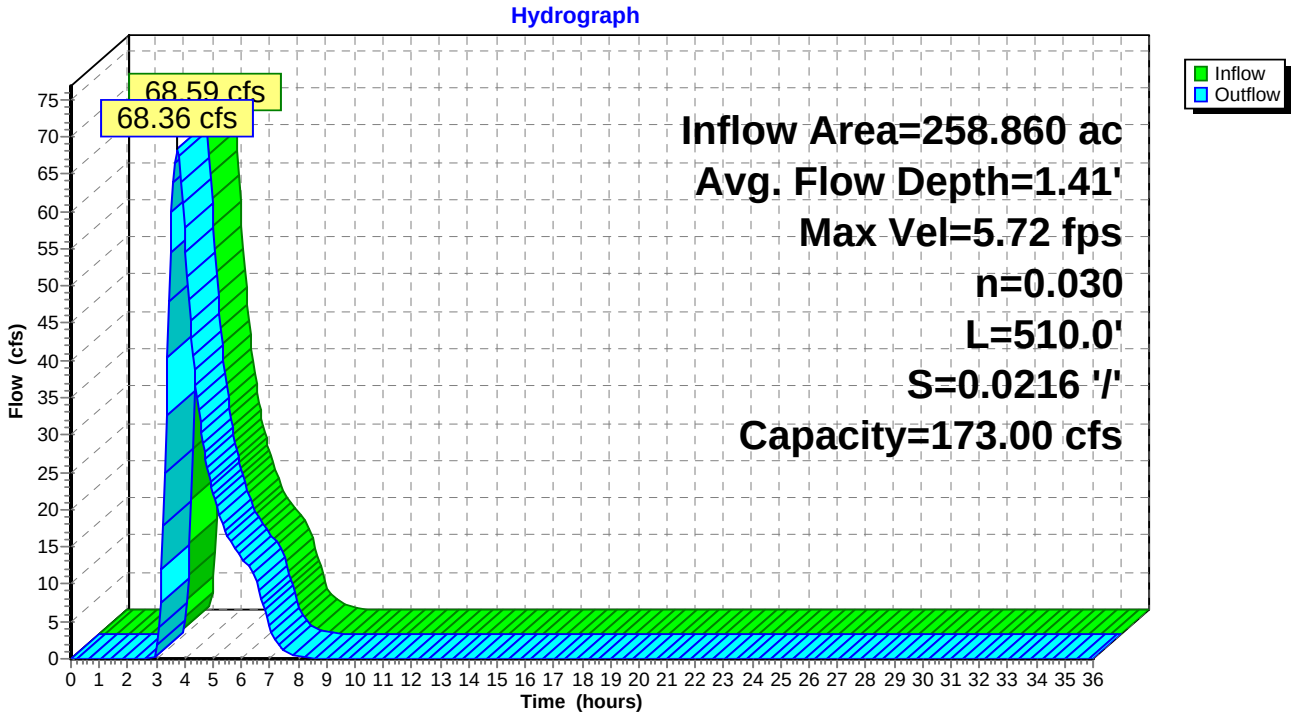
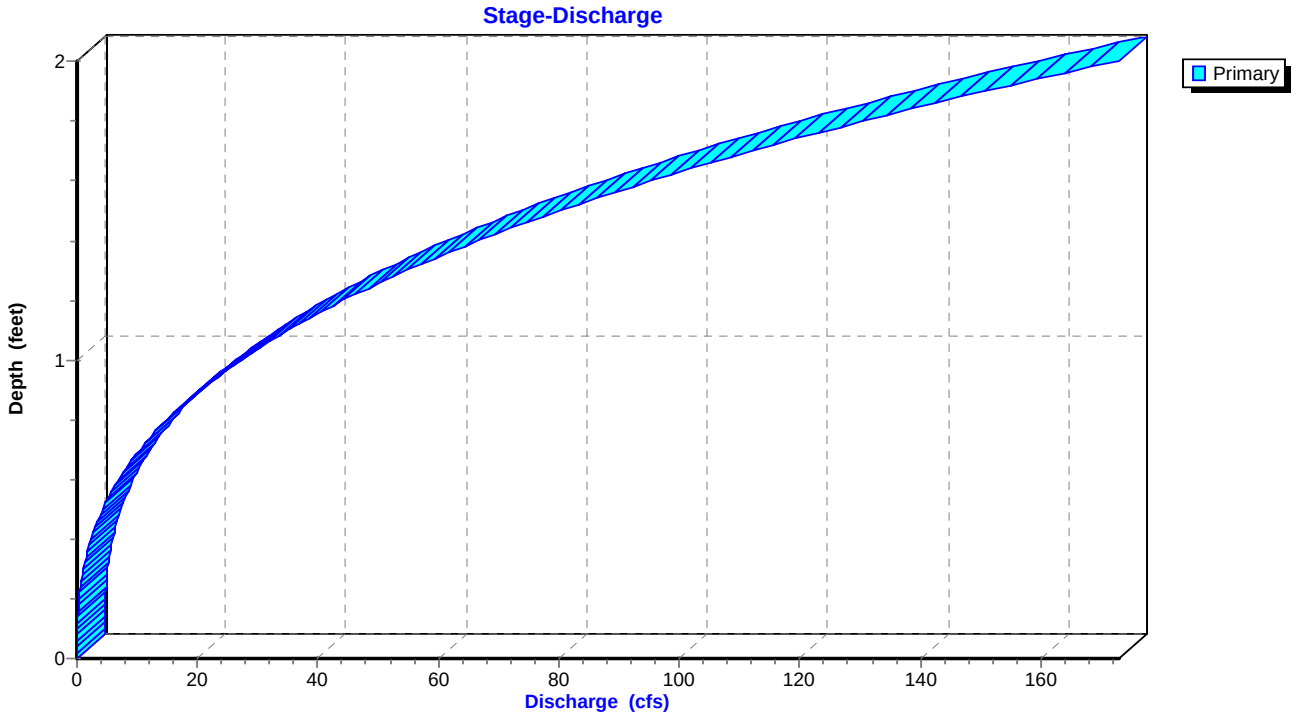
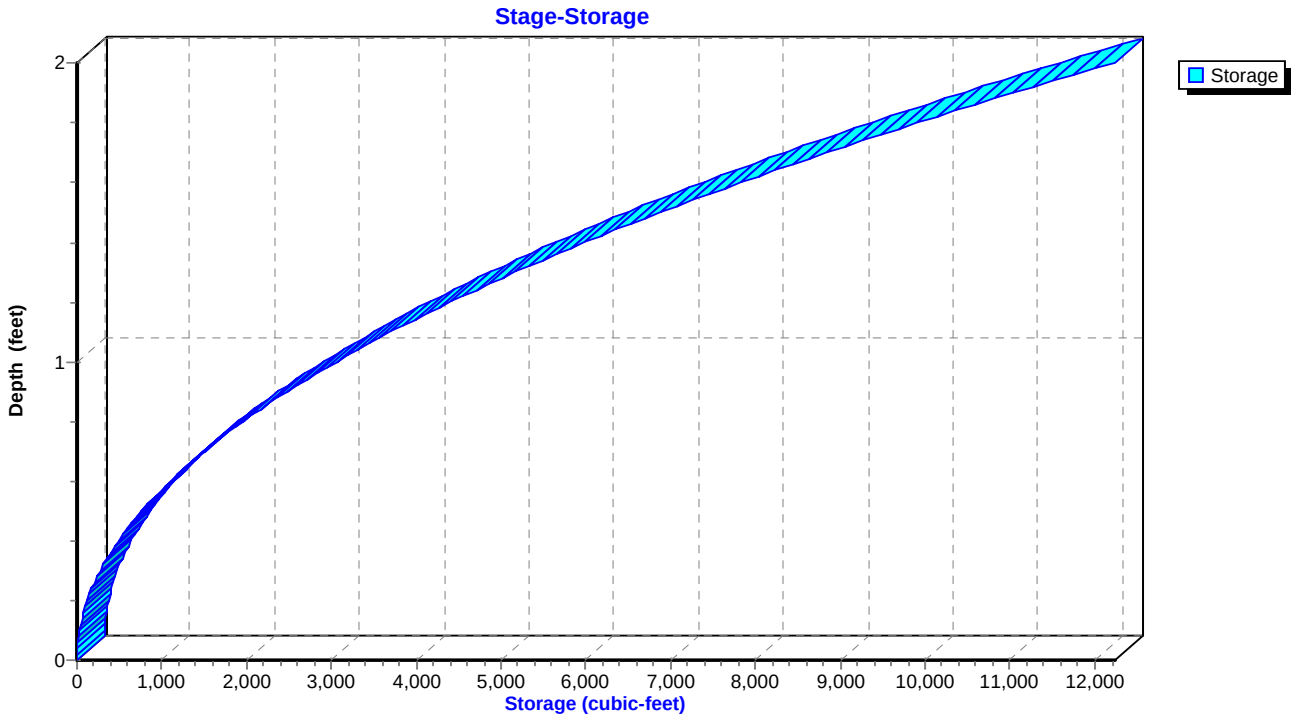
Reach 12R: Natural Drainage



Reach 12R: Natural Drainage



Reach 12R: Natural Drainage



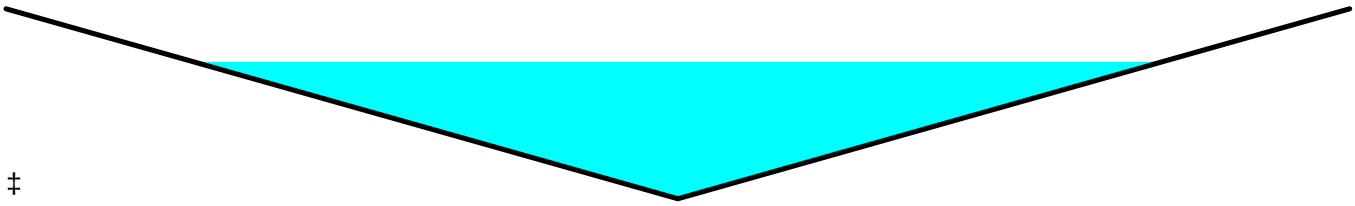
Summary for Reach 13R: Natural Drainage

Inflow Area = 264.450 ac, 0.00% Impervious, Inflow Depth = 0.41" for 100-YR, 6-HR event
Inflow = 69.12 cfs @ 3.74 hrs, Volume= 8.960 af
Outflow = 68.83 cfs @ 3.83 hrs, Volume= 8.960 af, Atten= 0%, Lag= 5.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.52 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 2.04 fps, Avg. Travel Time= 7.9 min

Peak Storage= 12,093 cf @ 3.78 hrs
Average Depth at Peak Storage= 1.44'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 164.87 cfs

0.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 6.0 '/' Top Width= 24.00'
Length= 970.0' Slope= 0.0196 '/'
Inlet Invert= 5,049.00', Outlet Invert= 5,030.00'



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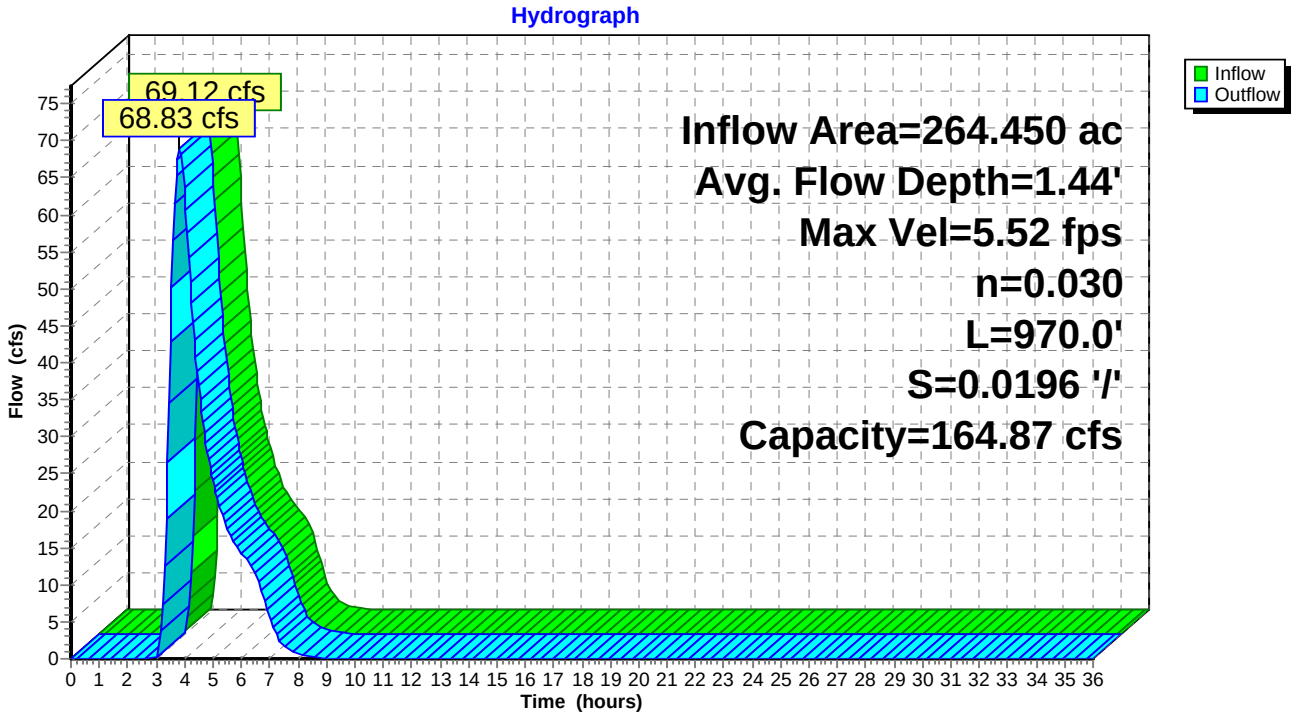
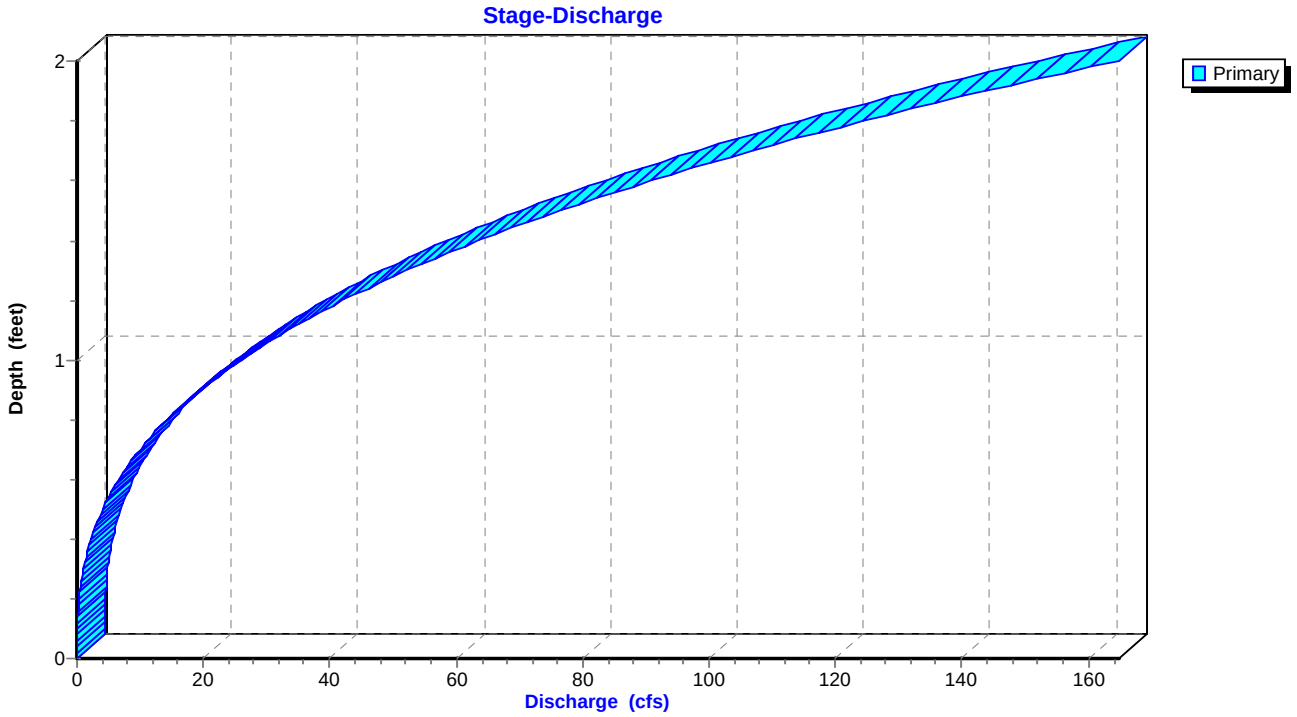
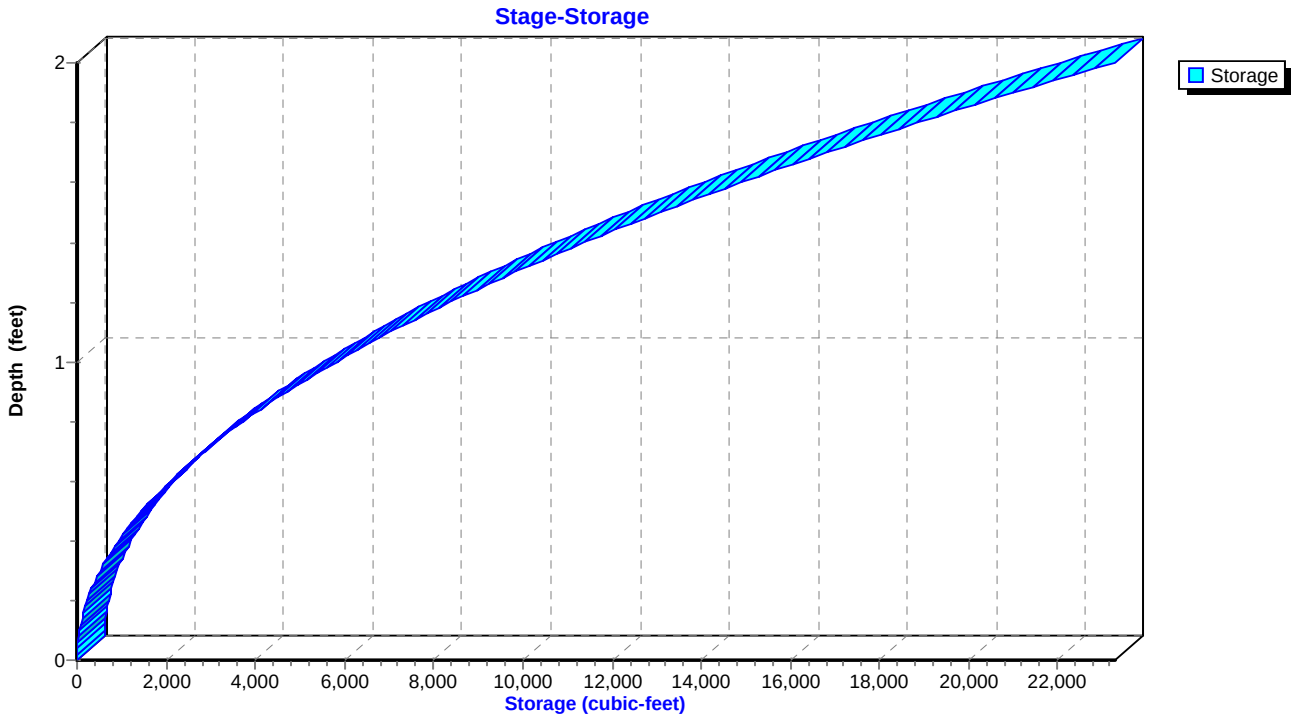
Reach 13R: Natural Drainage



Reach 13R: Natural Drainage



Reach 13R: Natural Drainage

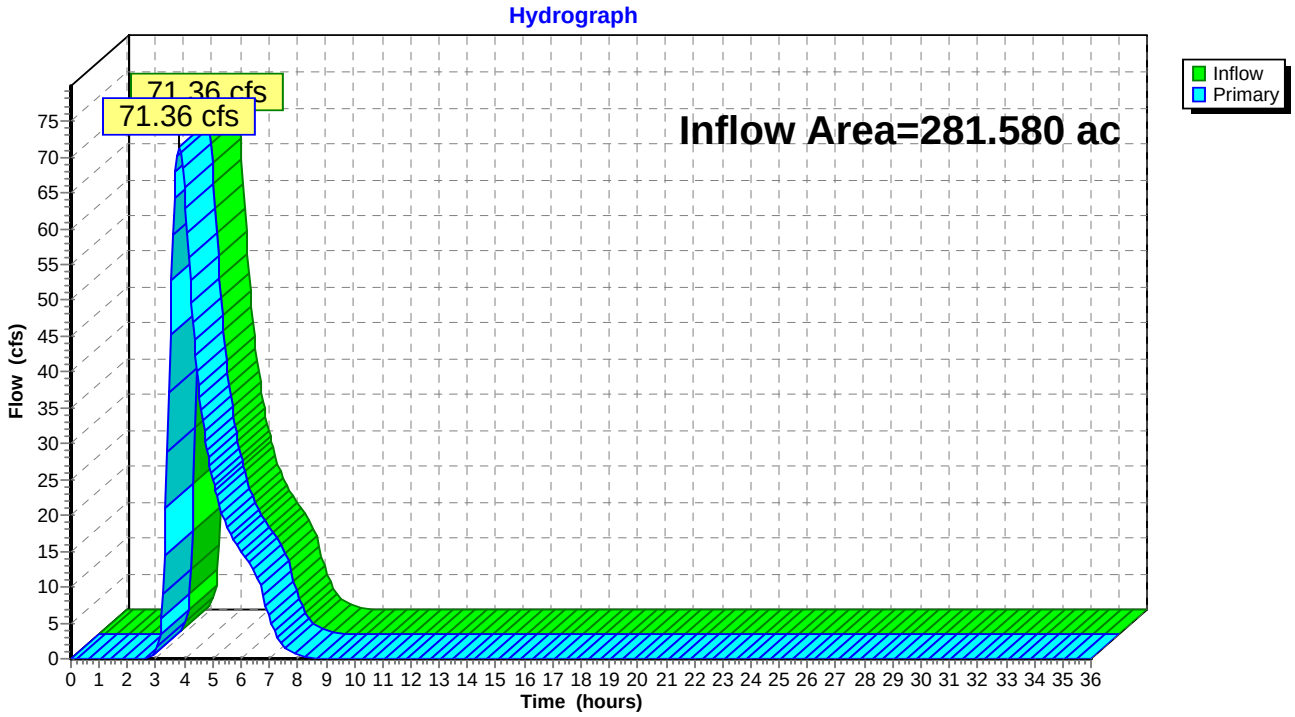


Summary for Pond 11P: SE Property Corner

Inflow Area = 281.580 ac, 0.00% Impervious, Inflow Depth = 0.40" for 100-YR, 6-HR event
Inflow = 71.36 cfs @ 3.82 hrs, Volume= 9.378 af
Primary = 71.36 cfs @ 3.82 hrs, Volume= 9.378 af, Atten= 0%, Lag= 0.0 min

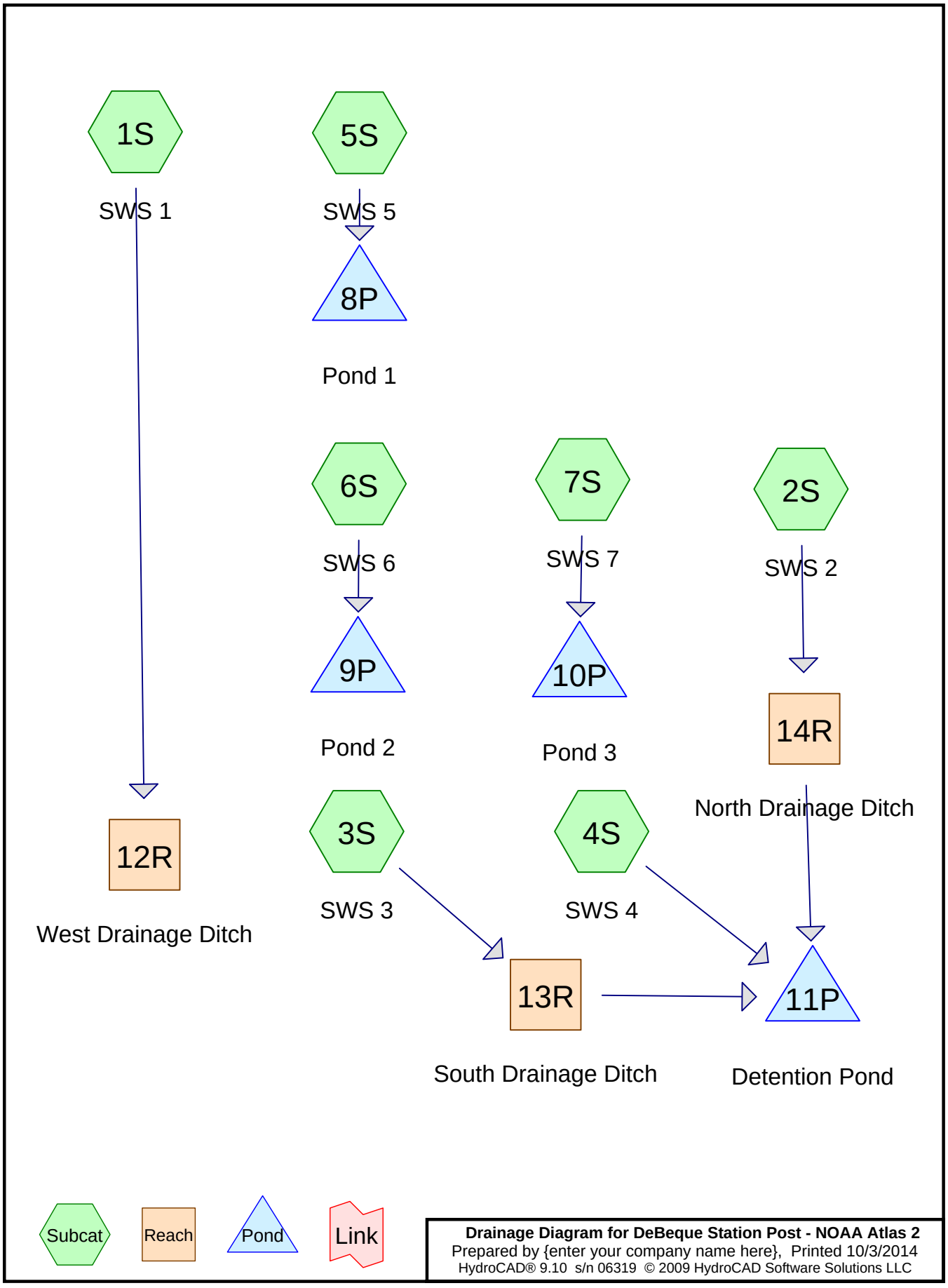
Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Pond 11P: SE Property Corner



APPENDIX C3

HydroCAD Report
NOAA Atlas 2: Post-Development
2-Year, 6-Hour Event



Drainage Diagram for DeBeque Station Post - NOAA Atlas 2
Prepared by {enter your company name here}, Printed 10/3/2014
HydroCAD® 9.10 s/n 06319 © 2009 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.200	76	Weighted Curve Number (4S)
3.160	78	Weighted Curve Number (3S)
258.860	79	Weighted Curve Number (1S)
10.110	82	Weighted Curve Number (2S)
8.250	100	Liner (5S, 6S, 7S)
281.580		**TOTAL AREA**

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: SWS 1 Runoff Area=258.860 ac 0.00% Impervious Runoff Depth=0.02"
Flow Length=8,106' Tc=56.7 min CN=79 Runoff=2.29 cfs 0.531 af

Subcatchment 2S: SWS 2 Runoff Area=10.110 ac 0.00% Impervious Runoff Depth=0.05"
Flow Length=2,405' Tc=58.5 min CN=82 Runoff=0.22 cfs 0.043 af

Subcatchment 3S: SWS 3 Runoff Area=3.160 ac 0.00% Impervious Runoff Depth=0.02"
Flow Length=934' Tc=14.6 min CN=78 Runoff=0.02 cfs 0.005 af

Subcatchment 4S: SWS 4 Runoff Area=1.200 ac 0.00% Impervious Runoff Depth=0.01"
Flow Length=174' Tc=3.8 min CN=76 Runoff=0.00 cfs 0.001 af

Subcatchment 5S: SWS 5 Runoff Area=2.840 ac 100.00% Impervious Runoff Depth=0.80"
Flow Length=15' Slope=0.5000 '/' Tc=0.1 min CN=100 Runoff=5.18 cfs 0.189 af

Subcatchment 6S: SWS 6 Runoff Area=2.750 ac 100.00% Impervious Runoff Depth=0.80"
Flow Length=15' Slope=0.5000 '/' Tc=0.1 min CN=100 Runoff=5.01 cfs 0.183 af

Subcatchment 7S: SWS 7 Runoff Area=2.660 ac 100.00% Impervious Runoff Depth=0.80"
Flow Length=15' Slope=0.5000 '/' Tc=0.1 min CN=100 Runoff=4.85 cfs 0.177 af

Reach 12R: West Drainage Ditch Avg. Flow Depth=0.15' Max Vel=2.81 fps Inflow=2.29 cfs 0.531 af
n=0.022 L=1,297.4' S=0.0231 '/' Capacity=219.29 cfs Outflow=2.28 cfs 0.531 af

Reach 13R: South Drainage Ditch Avg. Flow Depth=0.02' Max Vel=0.61 fps Inflow=0.02 cfs 0.005 af
n=0.022 L=1,015.0' S=0.0156 '/' Capacity=107.67 cfs Outflow=0.02 cfs 0.005 af

Reach 14R: North Drainage Ditch Avg. Flow Depth=0.06' Max Vel=1.57 fps Inflow=0.22 cfs 0.043 af
n=0.022 L=1,723.1' S=0.0242 '/' Capacity=134.16 cfs Outflow=0.21 cfs 0.043 af

Pond 8P: Pond 1 Peak Elev=5,061.64' Storage=40.466 af Inflow=5.18 cfs 0.189 af
Outflow=0.00 cfs 0.000 af

Pond 9P: Pond 2 Peak Elev=5,057.87' Storage=31.289 af Inflow=5.01 cfs 0.183 af
Outflow=0.00 cfs 0.000 af

Pond 10P: Pond 3 Peak Elev=5,048.57' Storage=30.141 af Inflow=4.85 cfs 0.177 af
Outflow=0.00 cfs 0.000 af

Pond 11P: Detention Pond Peak Elev=5,026.31' Storage=0.049 af Inflow=0.23 cfs 0.049 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 281.580 ac Runoff Volume = 1.129 af Average Runoff Depth = 0.05"
97.07% Pervious = 273.330 ac 2.93% Impervious = 8.250 ac

Summary for Subcatchment 1S: SWS 1

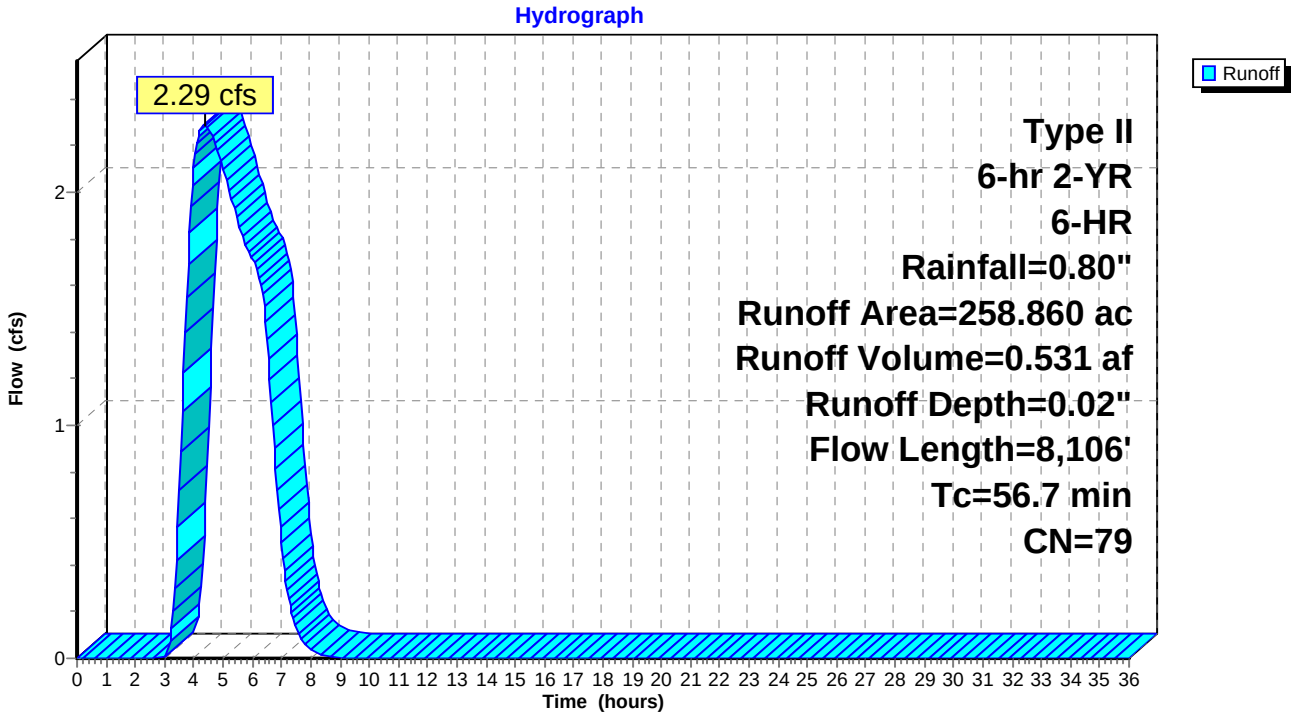
Runoff = 2.29 cfs @ 4.35 hrs, Volume= 0.531 af, Depth= 0.02"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 2-YR, 6-HR Rainfall=0.80"

	Area (ac)	CN	Description
*	258.860	79	Weighted Curve Number
	258.860		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	300	0.3900	0.45		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
45.6	7,806	0.0813	2.85		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
56.7	8,106	Total			

Subcatchment 1S: SWS 1



Summary for Subcatchment 2S: SWS 2

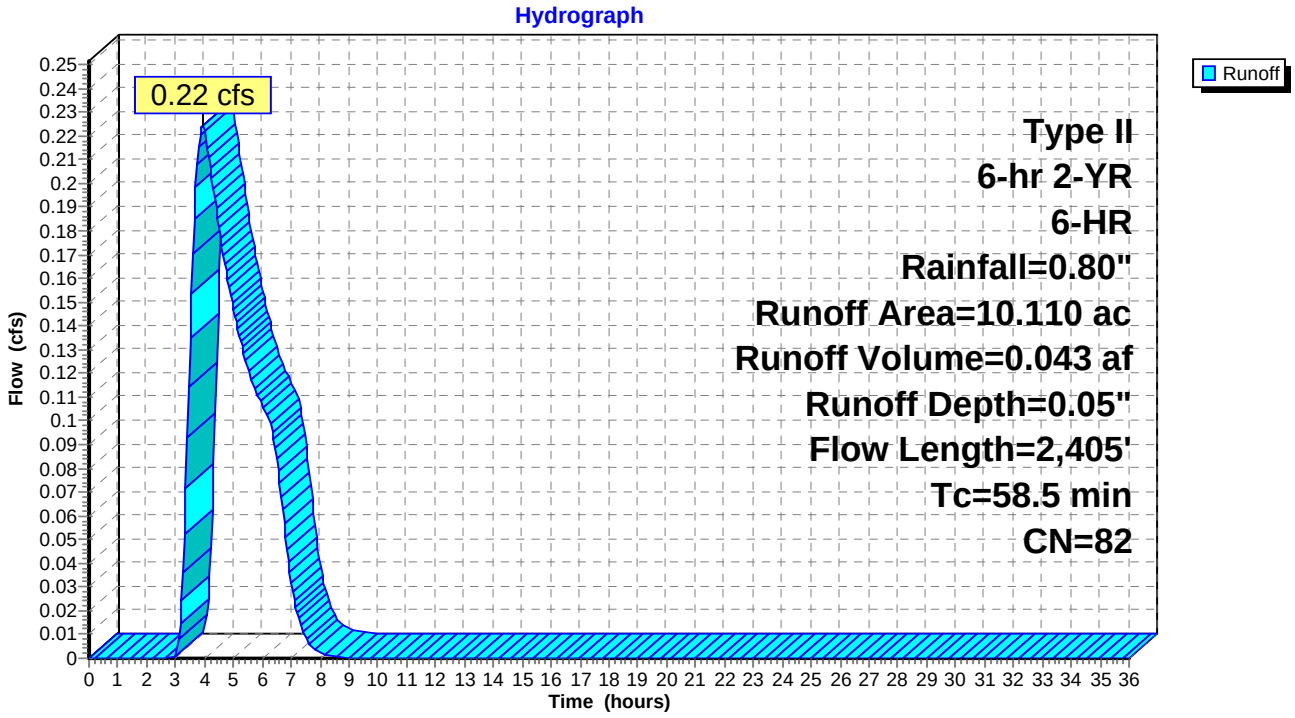
Runoff = 0.22 cfs @ 3.94 hrs, Volume= 0.043 af, Depth= 0.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 2-YR, 6-HR Rainfall=0.80"

	Area (ac)	CN	Description
*	10.110	82	Weighted Curve Number
	10.110		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.2	300	0.0233	0.15		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
24.3	2,105	0.0209	1.45		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
58.5	2,405	Total			

Subcatchment 2S: SWS 2



Summary for Subcatchment 3S: SWS 3

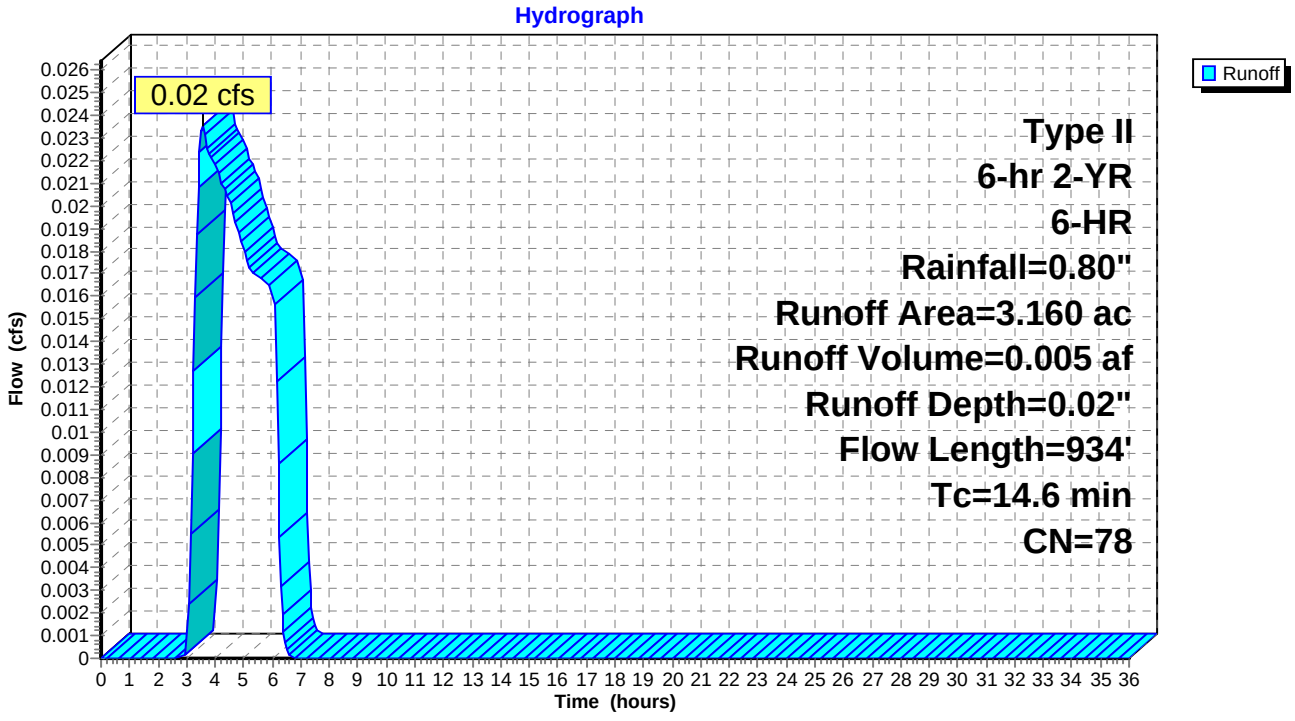
Runoff = 0.02 cfs @ 3.56 hrs, Volume= 0.005 af, Depth= 0.02"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 2-YR, 6-HR Rainfall=0.80"

	Area (ac)	CN	Description
*	3.160	78	Weighted Curve Number
	3.160		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.2500	0.26		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
11.4	884	0.0166	1.29		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
14.6	934	Total			

Subcatchment 3S: SWS 3



Summary for Subcatchment 4S: SWS 4

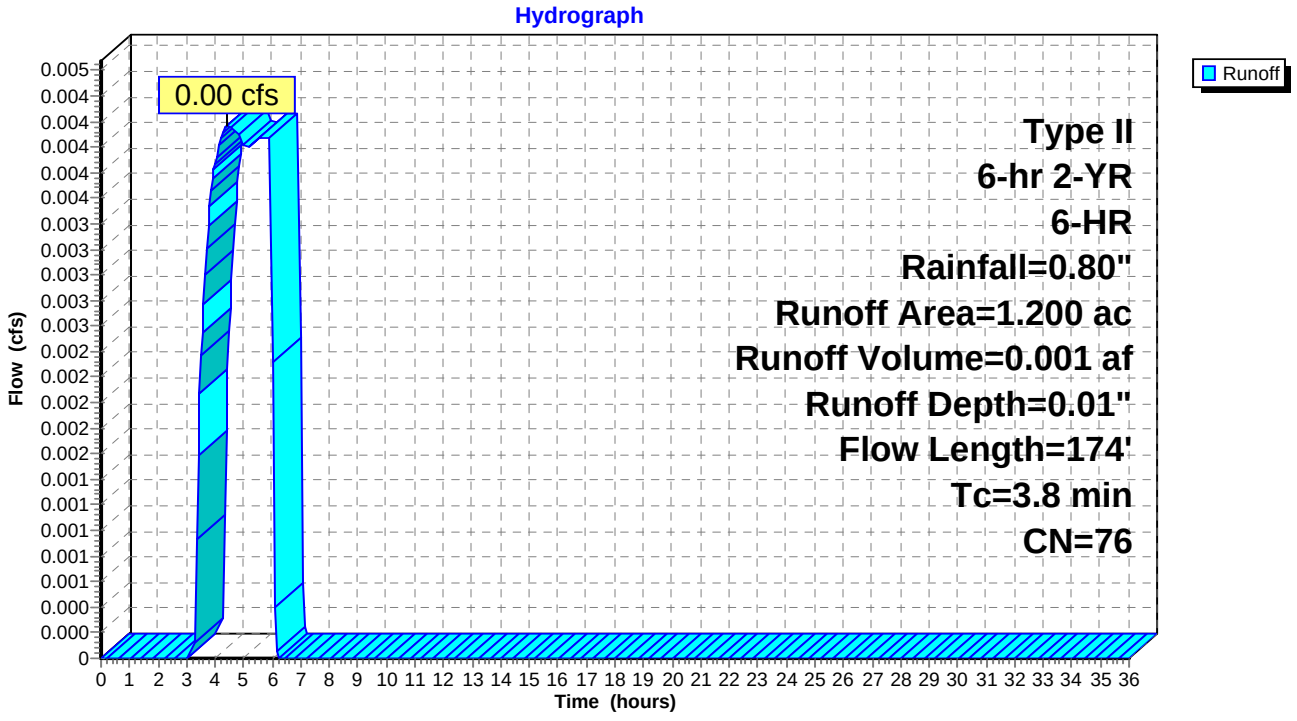
Runoff = 0.00 cfs @ 4.43 hrs, Volume= 0.001 af, Depth= 0.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 2-YR, 6-HR Rainfall=0.80"

	Area (ac)	CN	Description
*	1.200	76	Weighted Curve Number
	1.200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.2500	0.26		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
0.6	124	0.1149	3.39		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
3.8	174	Total			

Subcatchment 4S: SWS 4



Summary for Subcatchment 5S: SWS 5

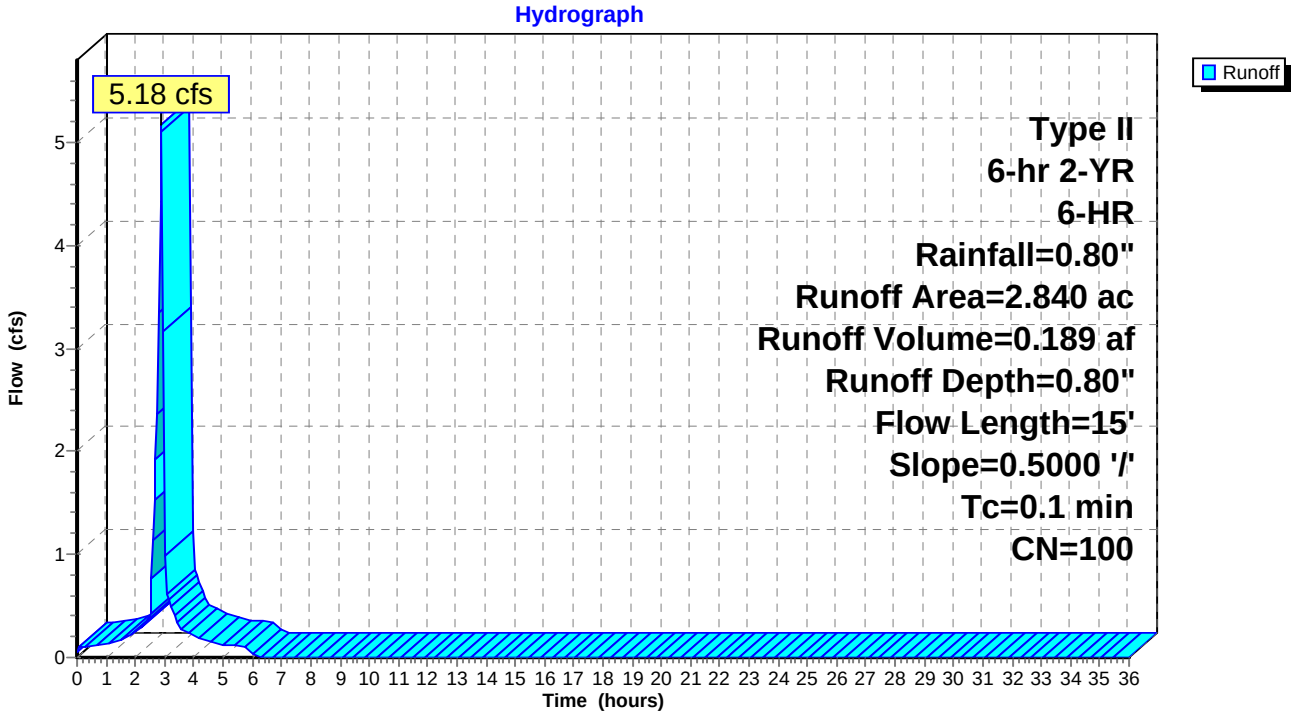
Runoff = 5.18 cfs @ 2.89 hrs, Volume= 0.189 af, Depth= 0.80"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 2-YR, 6-HR Rainfall=0.80"

	Area (ac)	CN	Description
*	2.840	100	Liner
	2.840		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	15	0.5000	1.97		**Sheet Flow, Overland Flow** Smooth surfaces n= 0.011 P2= 1.07"

Subcatchment 5S: SWS 5



Summary for Subcatchment 6S: SWS 6

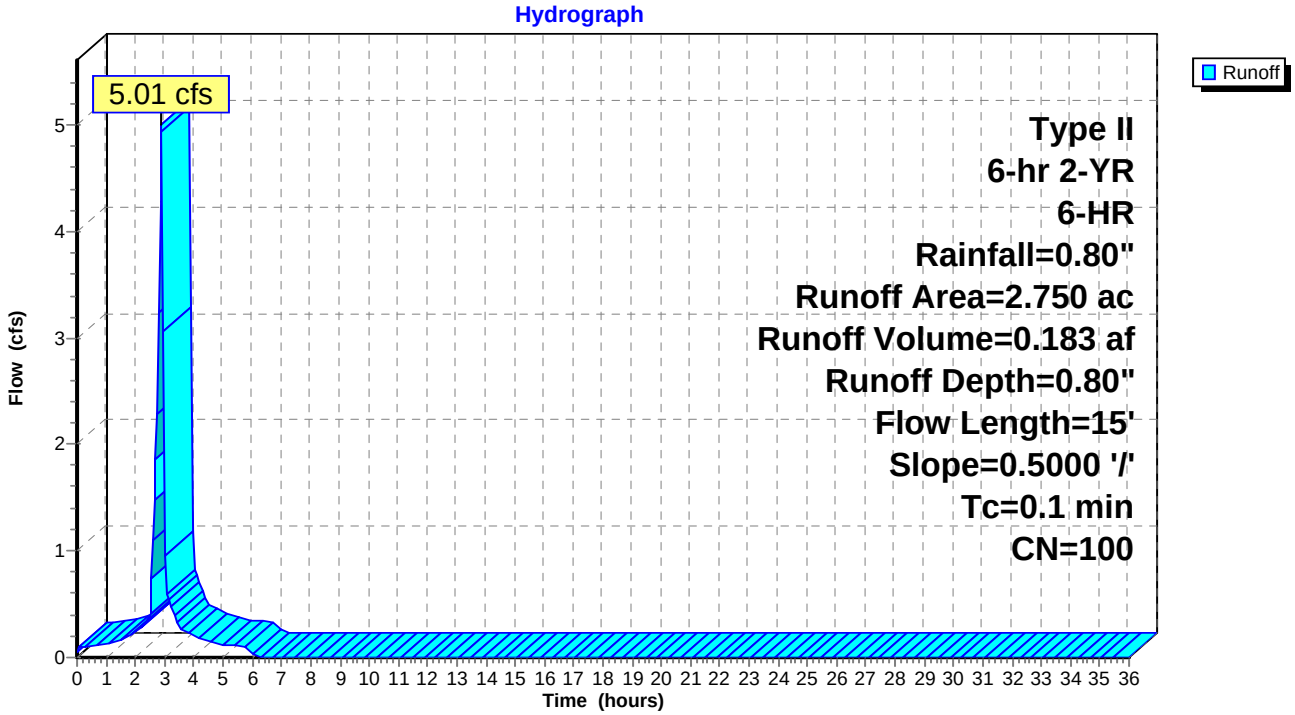
Runoff = 5.01 cfs @ 2.89 hrs, Volume= 0.183 af, Depth= 0.80"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 2-YR, 6-HR Rainfall=0.80"

	Area (ac)	CN	Description
*	2.750	100	Liner
	2.750		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	15	0.5000	1.97		**Sheet Flow, Overland Flow** Smooth surfaces n= 0.011 P2= 1.07"

Subcatchment 6S: SWS 6



Summary for Subcatchment 7S: SWS 7

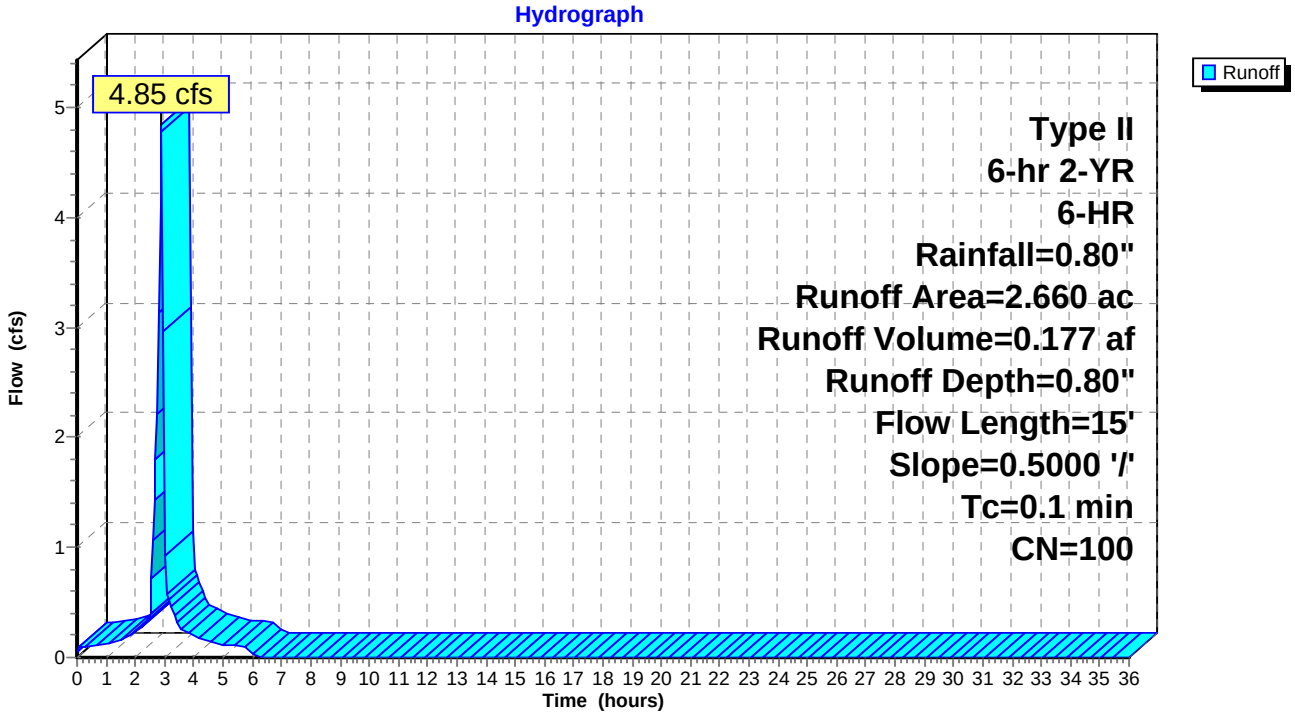
Runoff = 4.85 cfs @ 2.89 hrs, Volume= 0.177 af, Depth= 0.80"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 2-YR, 6-HR Rainfall=0.80"

	Area (ac)	CN	Description
*	2.660	100	Liner
	2.660		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	15	0.5000	1.97		**Sheet Flow, Overland Flow** Smooth surfaces n= 0.011 P2= 1.07"

Subcatchment 7S: SWS 7



Summary for Reach 12R: West Drainage Ditch

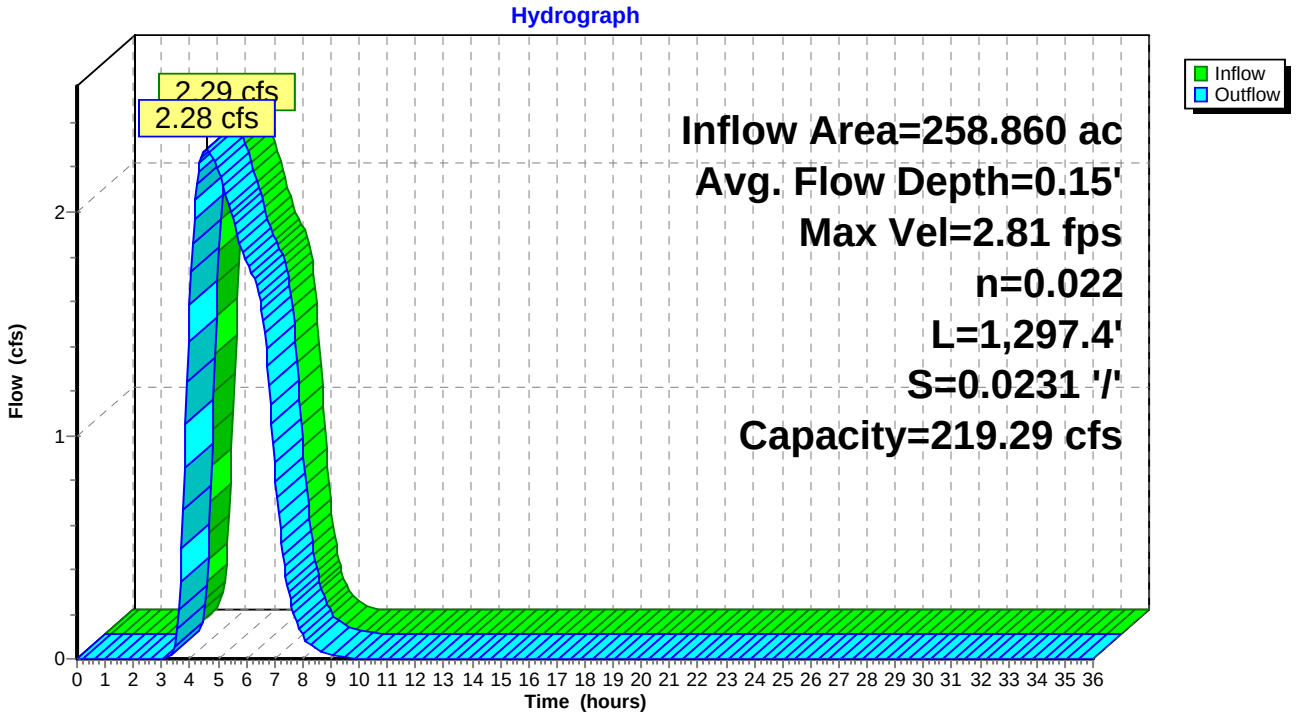
Inflow Area = 258.860 ac, 0.00% Impervious, Inflow Depth = 0.02" for 2-YR, 6-HR event
Inflow = 2.29 cfs @ 4.35 hrs, Volume= 0.531 af
Outflow = 2.28 cfs @ 4.58 hrs, Volume= 0.531 af, Atten= 0%, Lag= 13.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.81 fps, Min. Travel Time= 7.7 min
Avg. Velocity = 1.53 fps, Avg. Travel Time= 14.1 min

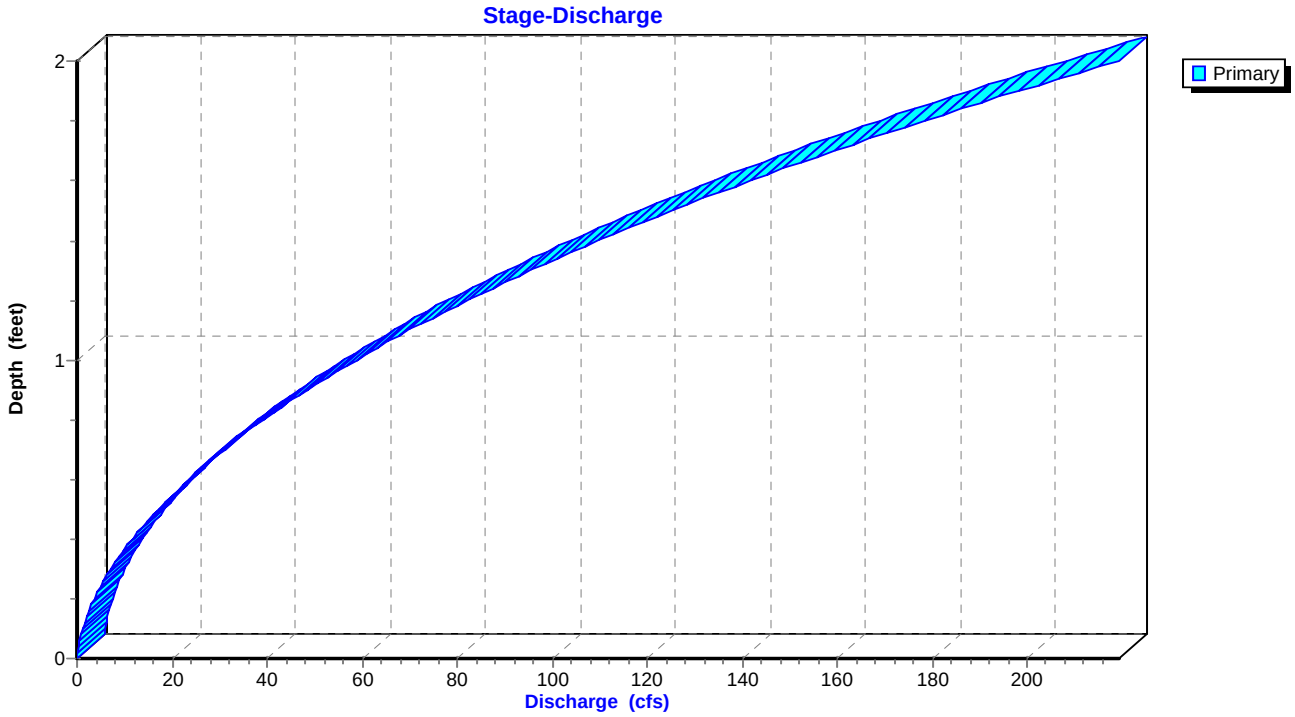
Peak Storage= 1,053 cf @ 4.45 hrs
Average Depth at Peak Storage= 0.15'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 219.29 cfs

5.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 2.0 '/' Top Width= 13.00'
Length= 1,297.4' Slope= 0.0231 '/'
Inlet Invert= 5,077.00', Outlet Invert= 5,046.97'

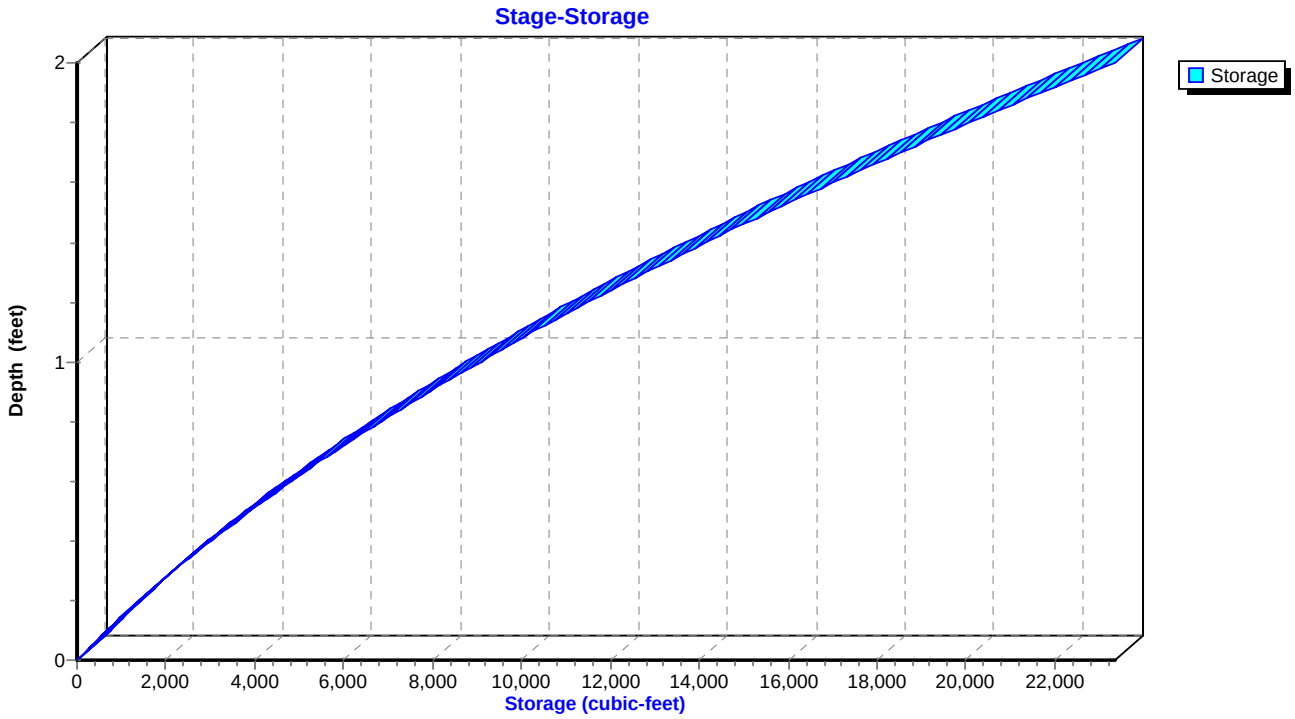
Reach 12R: West Drainage Ditch



Reach 12R: West Drainage Ditch



Reach 12R: West Drainage Ditch



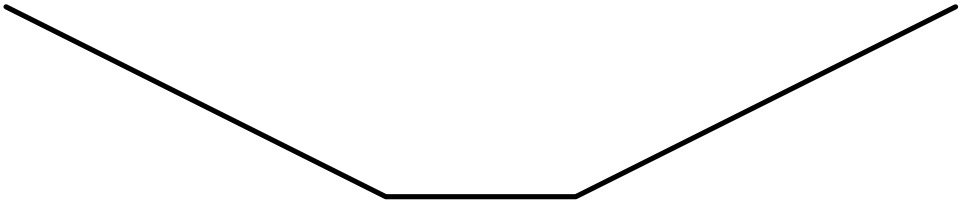
Summary for Reach 13R: South Drainage Ditch

Inflow Area = 3.160 ac, 0.00% Impervious, Inflow Depth = 0.02" for 2-YR, 6-HR event
Inflow = 0.02 cfs @ 3.56 hrs, Volume= 0.005 af
Outflow = 0.02 cfs @ 5.02 hrs, Volume= 0.005 af, Atten= 15%, Lag= 88.1 min

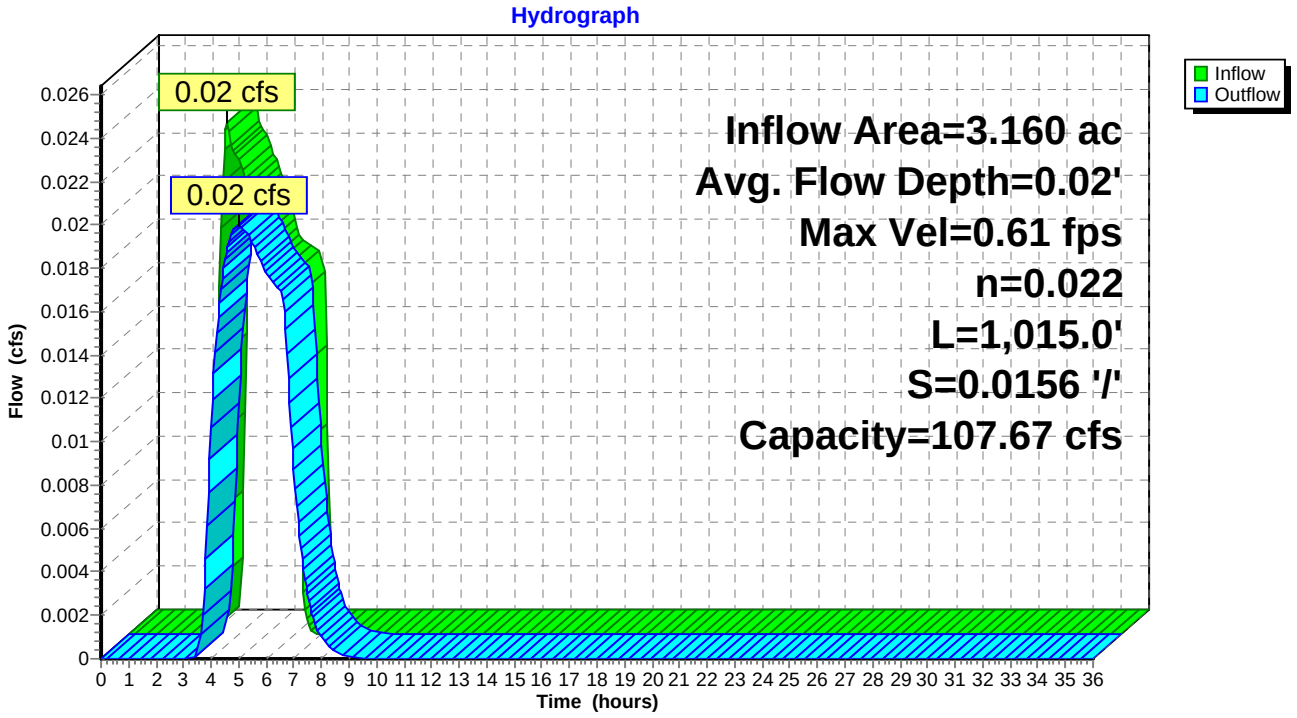
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.61 fps, Min. Travel Time= 27.6 min
Avg. Velocity = 0.61 fps, Avg. Travel Time= 27.6 min

Peak Storage= 33 cf @ 4.56 hrs
Average Depth at Peak Storage= 0.02'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 107.67 cfs

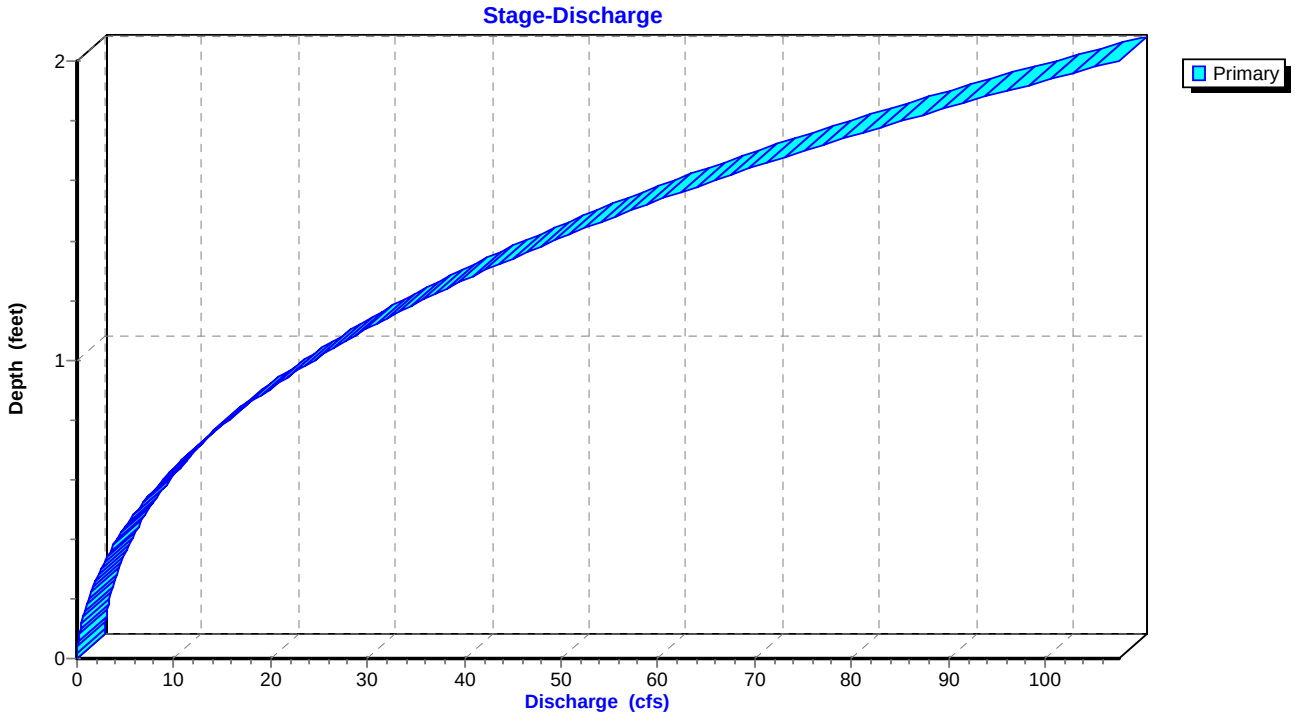
2.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 1,015.0' Slope= 0.0156 '/'
Inlet Invert= 5,045.22', Outlet Invert= 5,029.38'



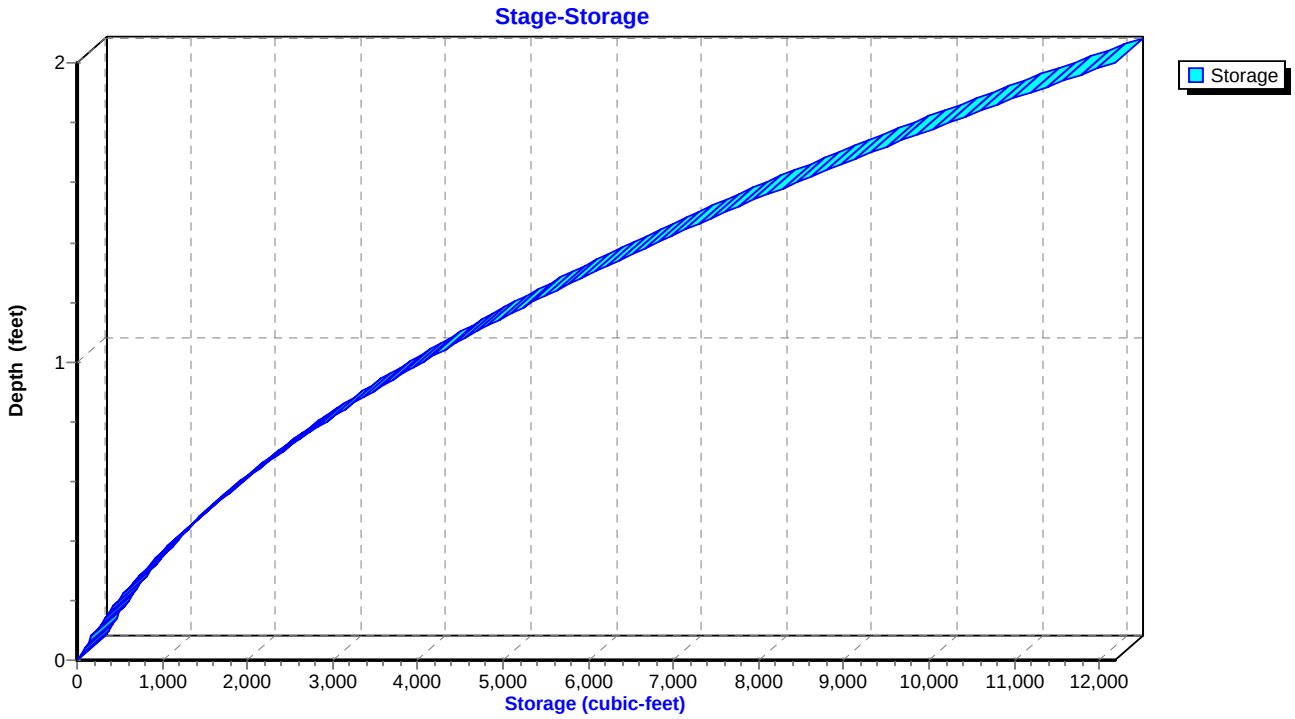
Reach 13R: South Drainage Ditch



Reach 13R: South Drainage Ditch



Reach 13R: South Drainage Ditch



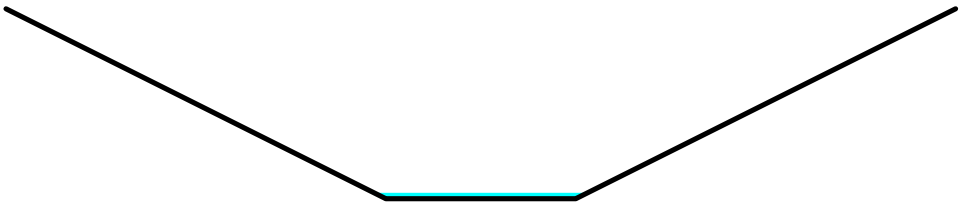
Summary for Reach 14R: North Drainage Ditch

Inflow Area = 10.110 ac, 0.00% Impervious, Inflow Depth = 0.05" for 2-YR, 6-HR event
Inflow = 0.22 cfs @ 3.94 hrs, Volume= 0.043 af
Outflow = 0.21 cfs @ 4.52 hrs, Volume= 0.043 af, Atten= 9%, Lag= 35.2 min

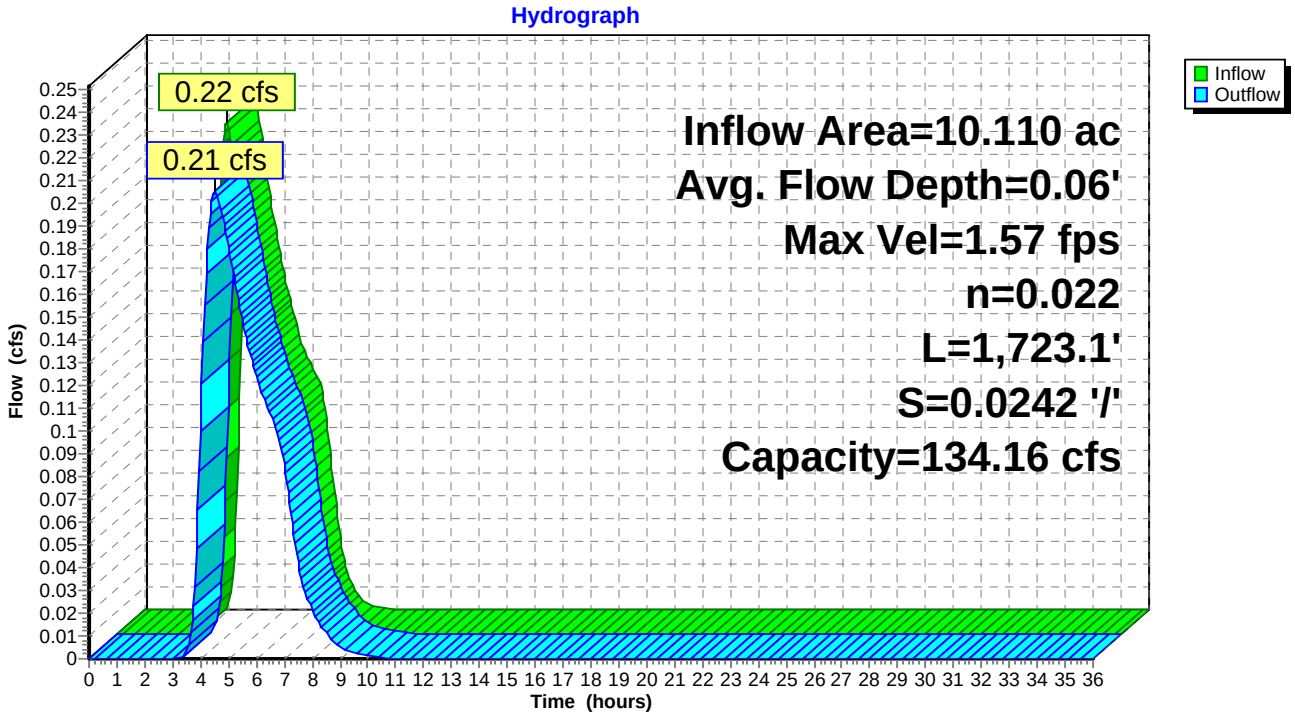
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.57 fps, Min. Travel Time= 18.3 min
Avg. Velocity = 1.01 fps, Avg. Travel Time= 28.5 min

Peak Storage= 225 cf @ 4.22 hrs
Average Depth at Peak Storage= 0.06'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 134.16 cfs

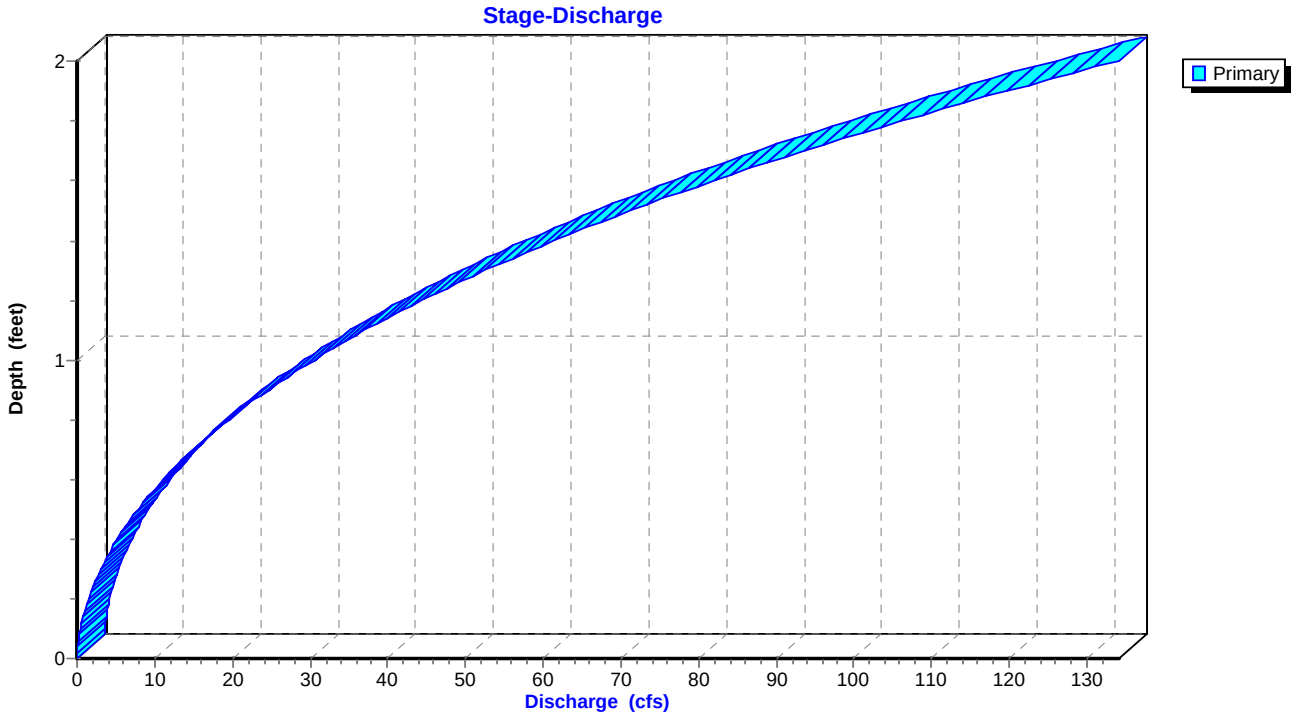
2.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 1,723.1' Slope= 0.0242 '/'
Inlet Invert= 5,071.25', Outlet Invert= 5,029.50'



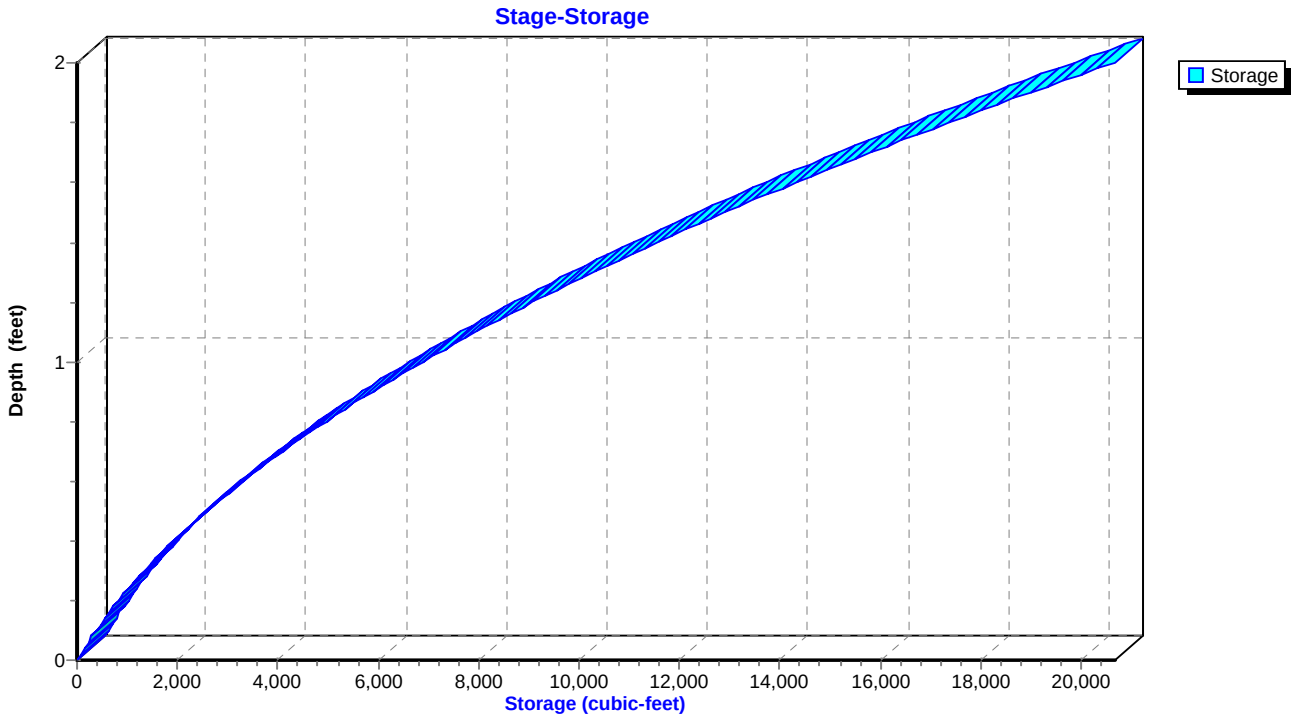
Reach 14R: North Drainage Ditch



Reach 14R: North Drainage Ditch



Reach 14R: North Drainage Ditch



Summary for Pond 8P: Pond 1

Inflow Area = 2.840 ac,100.00% Impervious, Inflow Depth = 0.80" for 2-YR, 6-HR event
Inflow = 5.18 cfs @ 2.89 hrs, Volume= 0.189 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Starting Elev= 5,061.57' Surf.Area= 0.000 ac Storage= 40.277 af
Peak Elev= 5,061.64' @ 6.05 hrs Surf.Area= 0.000 ac Storage= 40.466 af (0.189 af above start)
Flood Elev= 5,063.57' Surf.Area= 0.000 ac Storage= 45.571 af (5.294 af above start)

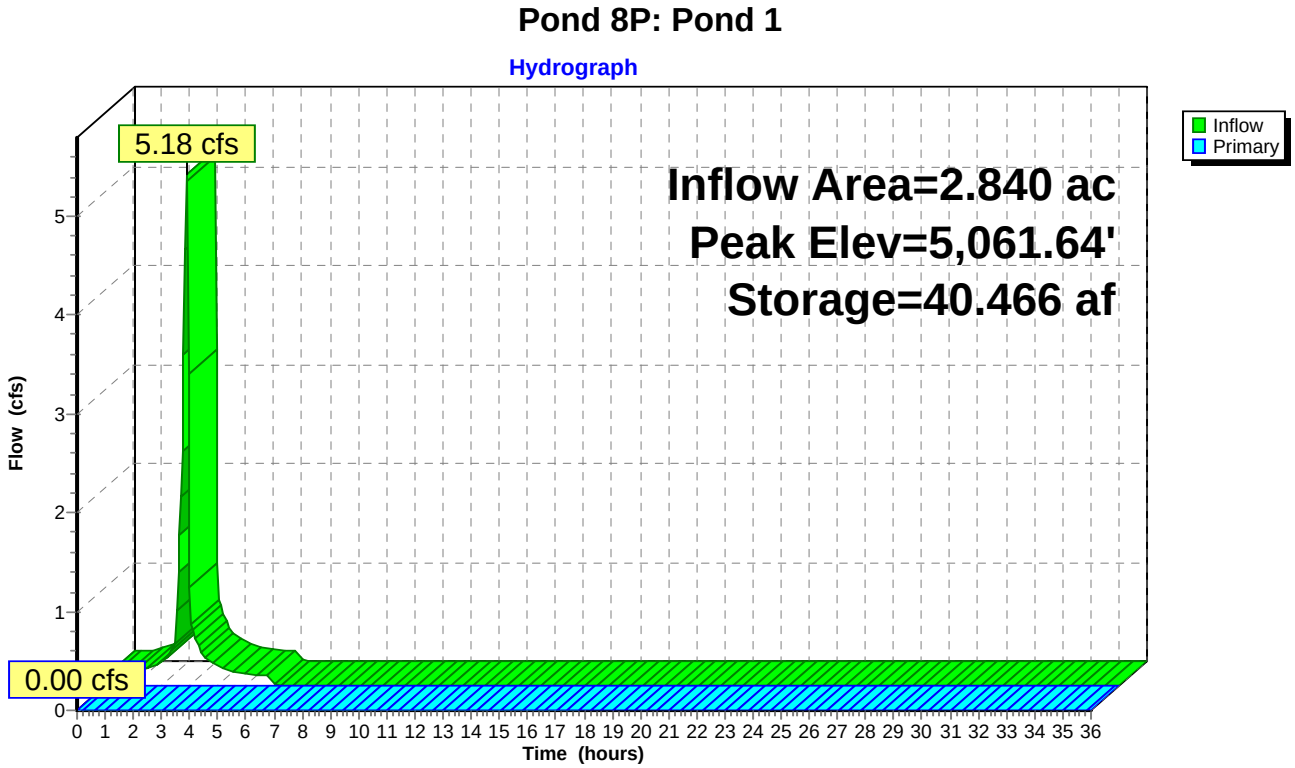
Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	5,040.33'	48.314 af	**Custom Stage Data** Listed below

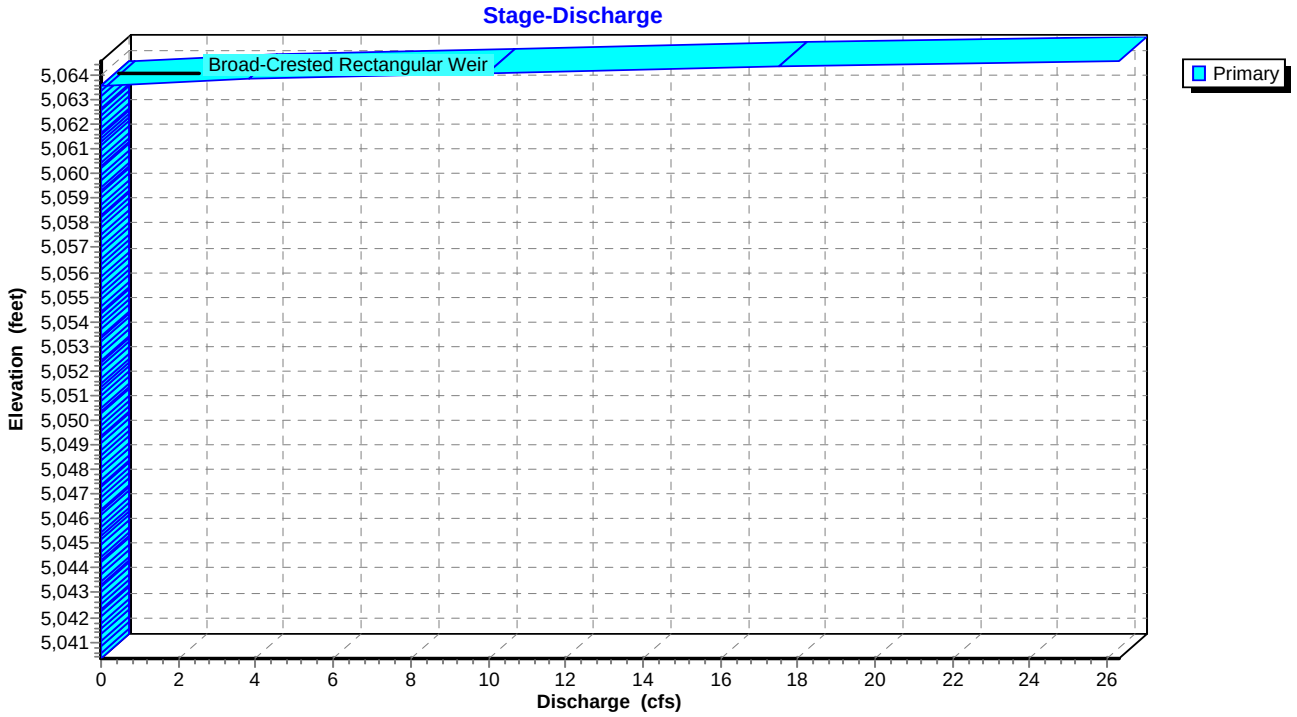
Elevation (feet)	Cum.Store (acre-feet)
5,040.33	0.000
5,041.33	0.264
5,042.33	1.457
5,043.33	2.977
5,044.33	4.548
5,045.33	6.170
5,046.33	7.844
5,047.33	9.570
5,048.33	11.350
5,049.33	13.184
5,050.33	15.073
5,051.33	17.017
5,052.33	19.017
5,053.33	21.074
5,054.33	23.189
5,055.33	25.362
5,056.33	27.593
5,057.33	29.885
5,058.33	32.236
5,059.33	34.649
5,060.33	37.123
5,061.33	39.659
5,061.57	40.277
5,062.57	42.892
5,063.57	45.571
5,064.57	48.314

Device	Routing	Invert	Outlet Devices
#1	Primary	5,063.57'	**10.0' long x 30.0' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60
			Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

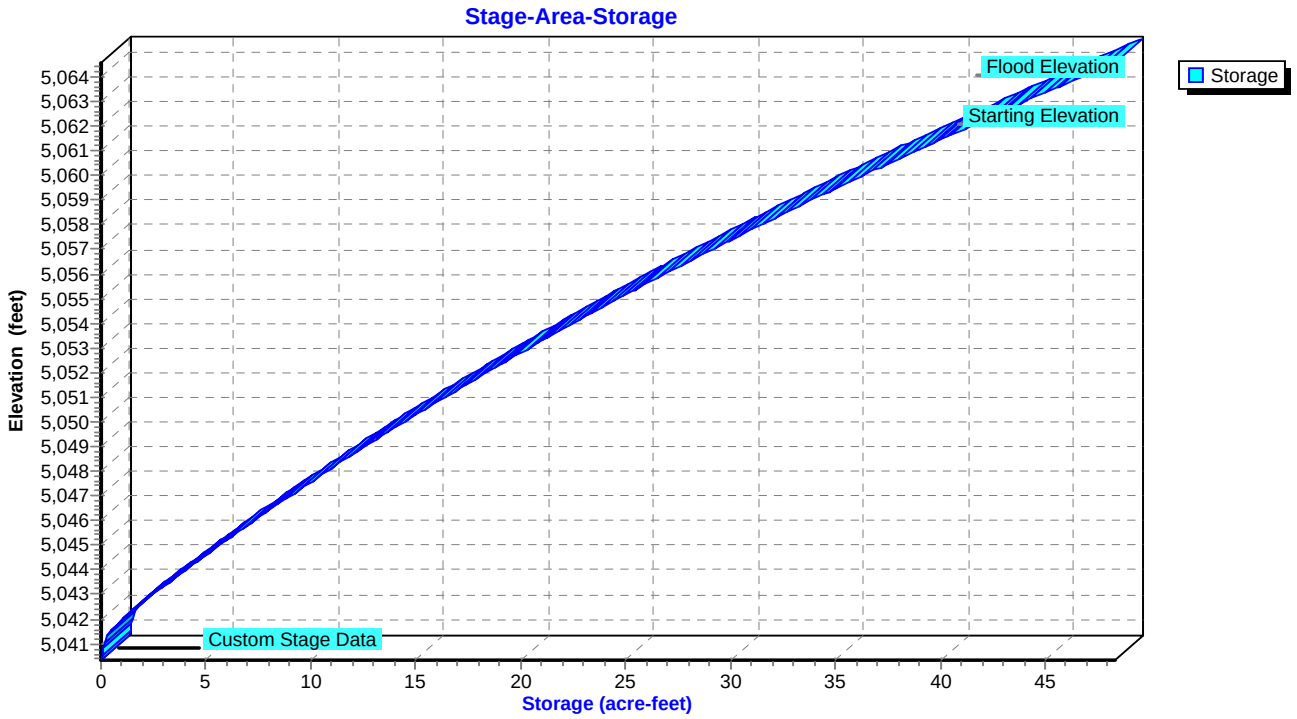
Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,061.57' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)



Pond 8P: Pond 1



Pond 8P: Pond 1



Summary for Pond 9P: Pond 2

Inflow Area = 2.750 ac,100.00% Impervious, Inflow Depth = 0.80" for 2-YR, 6-HR event
Inflow = 5.01 cfs @ 2.89 hrs, Volume= 0.183 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Starting Elev= 5,057.80' Surf.Area= 0.000 ac Storage= 31.106 af
Peak Elev= 5,057.87' @ 6.05 hrs Surf.Area= 0.000 ac Storage= 31.289 af (0.183 af above start)
Flood Elev= 5,059.80' Surf.Area= 0.000 ac Storage= 36.361 af (5.255 af above start)

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

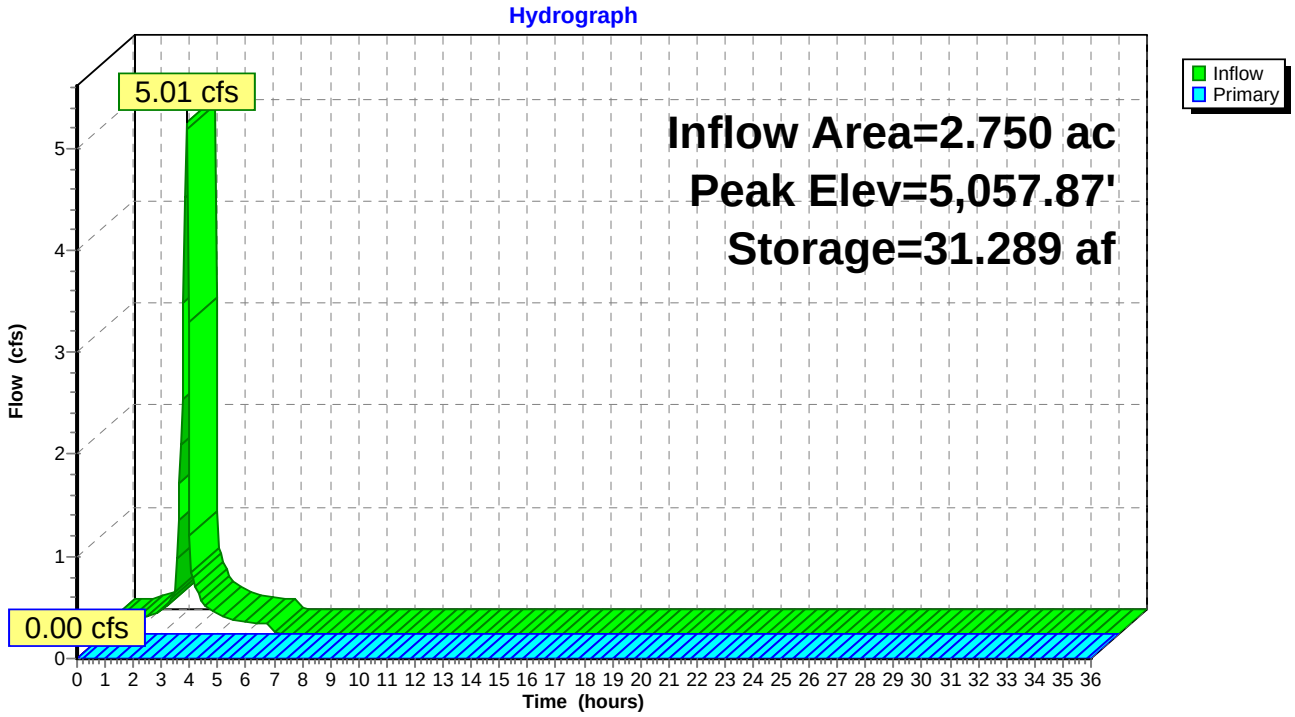
Volume	Invert	Avail.Storage	Storage Description
#1	5,042.42'	39.082 af	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (acre-feet)
5,042.42	0.000
5,043.42	0.335
5,044.42	1.897
5,045.42	3.742
5,046.42	5.638
5,047.42	7.588
5,048.42	9.591
5,049.42	11.649
5,050.42	13.761
5,051.42	15.929
5,052.42	18.152
5,053.42	20.433
5,054.42	22.771
5,055.42	25.167
5,056.42	27.621
5,057.42	30.135
5,057.80	31.106
5,058.80	33.704
5,059.80	36.361
5,060.80	39.082

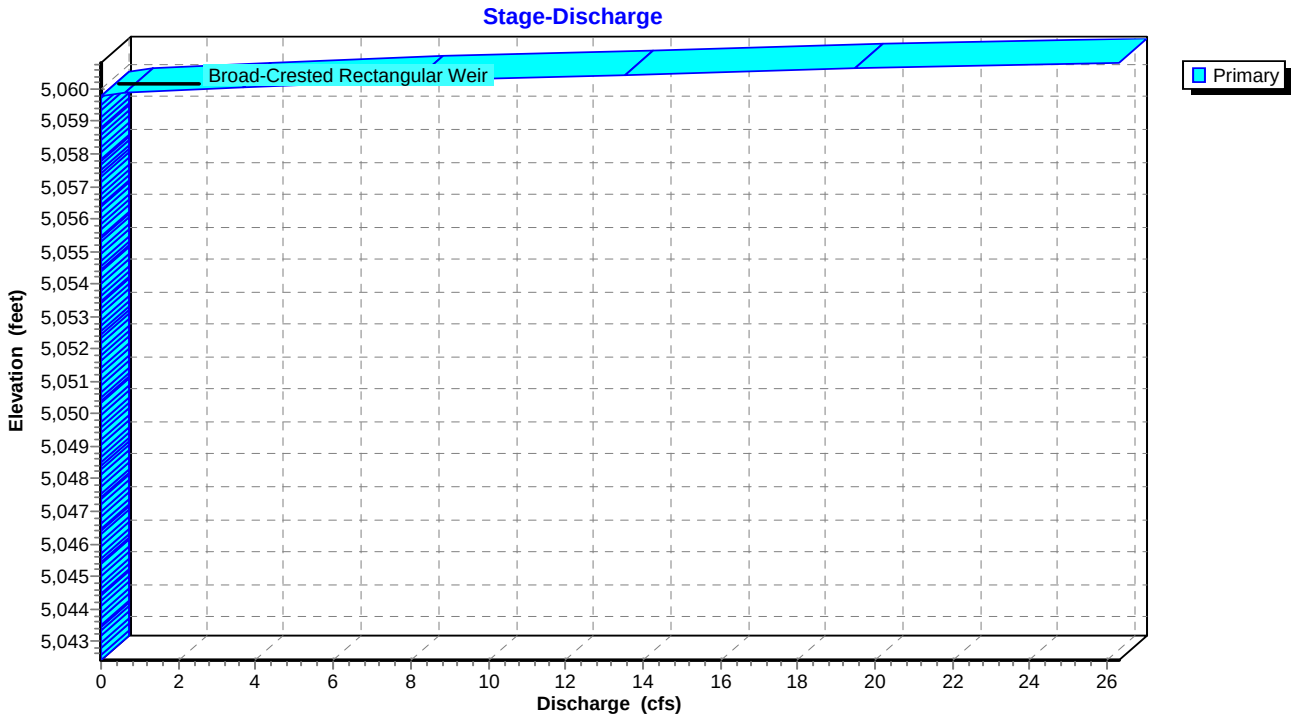
Device	Routing	Invert	Outlet Devices
#1	Primary	5,059.80'	**10.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,057.80' (Free Discharge)
1=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

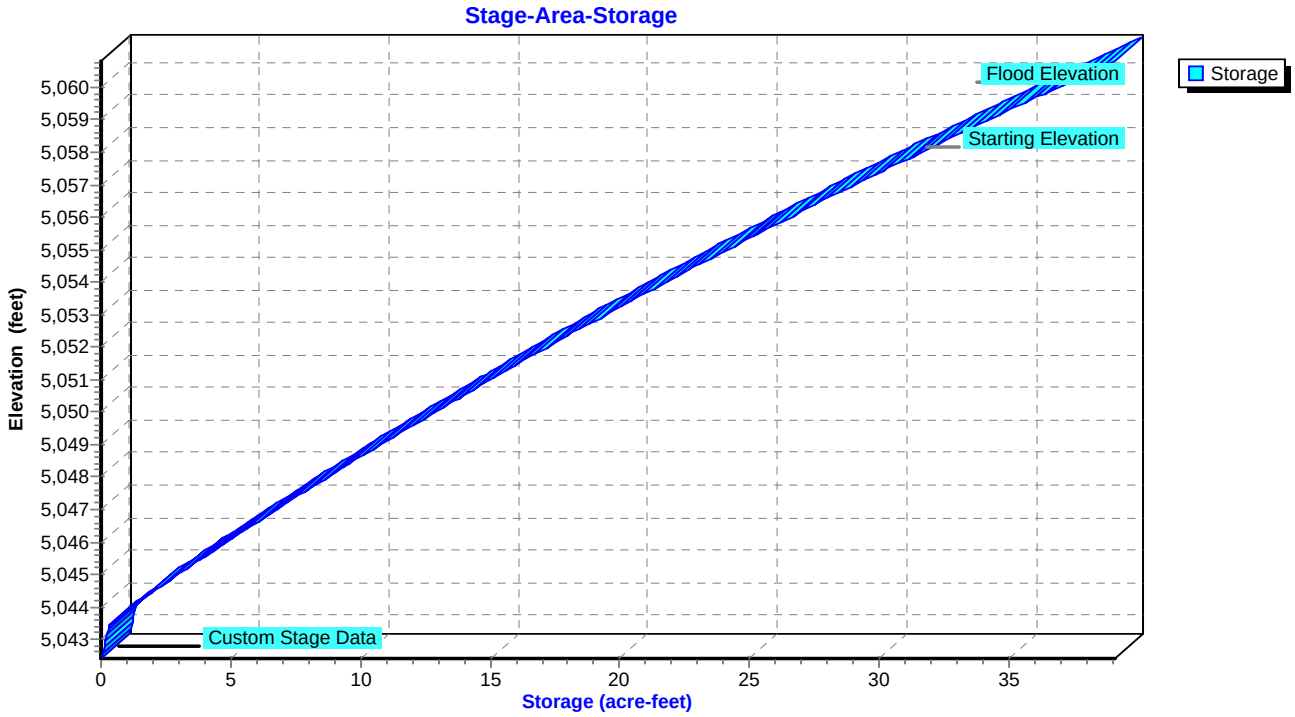
Pond 9P: Pond 2



Pond 9P: Pond 2



Pond 9P: Pond 2



Summary for Pond 10P: Pond 3

Inflow Area = 2.660 ac,100.00% Impervious, Inflow Depth = 0.80" for 2-YR, 6-HR event
Inflow = 4.85 cfs @ 2.89 hrs, Volume= 0.177 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Starting Elev= 5,048.50' Surf.Area= 0.000 ac Storage= 29.964 af
Peak Elev= 5,048.57' @ 6.05 hrs Surf.Area= 0.000 ac Storage= 30.141 af (0.177 af above start)
Flood Elev= 5,050.50' Surf.Area= 0.000 ac Storage= 34.999 af (5.035 af above start)

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

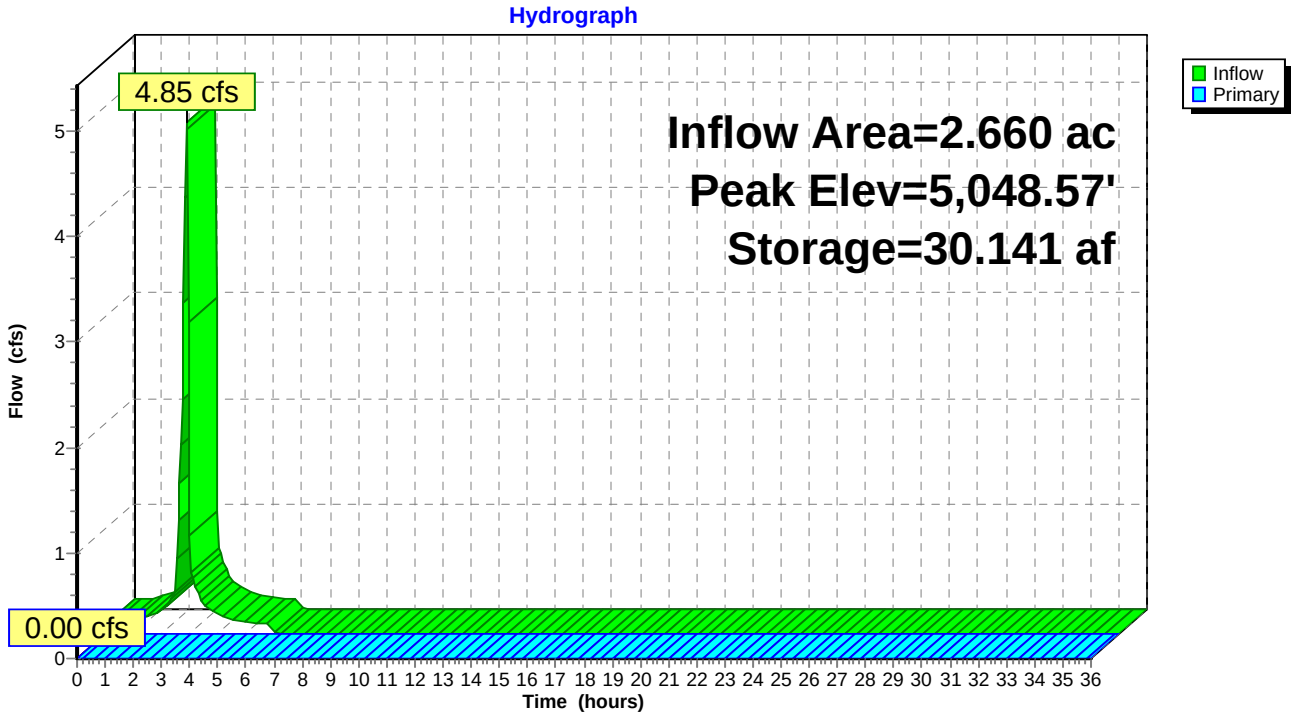
Volume	Invert	Avail.Storage	Storage Description
#1	5,032.00'	37.619 af	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (acre-feet)
5,032.00	0.000
5,033.00	0.217
5,034.00	1.183
5,035.00	2.730
5,036.00	4.364
5,037.00	6.057
5,038.00	7.809
5,039.00	9.622
5,040.00	11.495
5,041.00	13.429
5,042.00	15.426
5,043.00	17.486
5,044.00	19.609
5,045.00	21.796
5,046.00	24.047
5,047.00	26.365
5,048.00	28.748
5,048.50	29.964
5,049.50	32.448
5,050.50	34.999
5,051.50	37.619

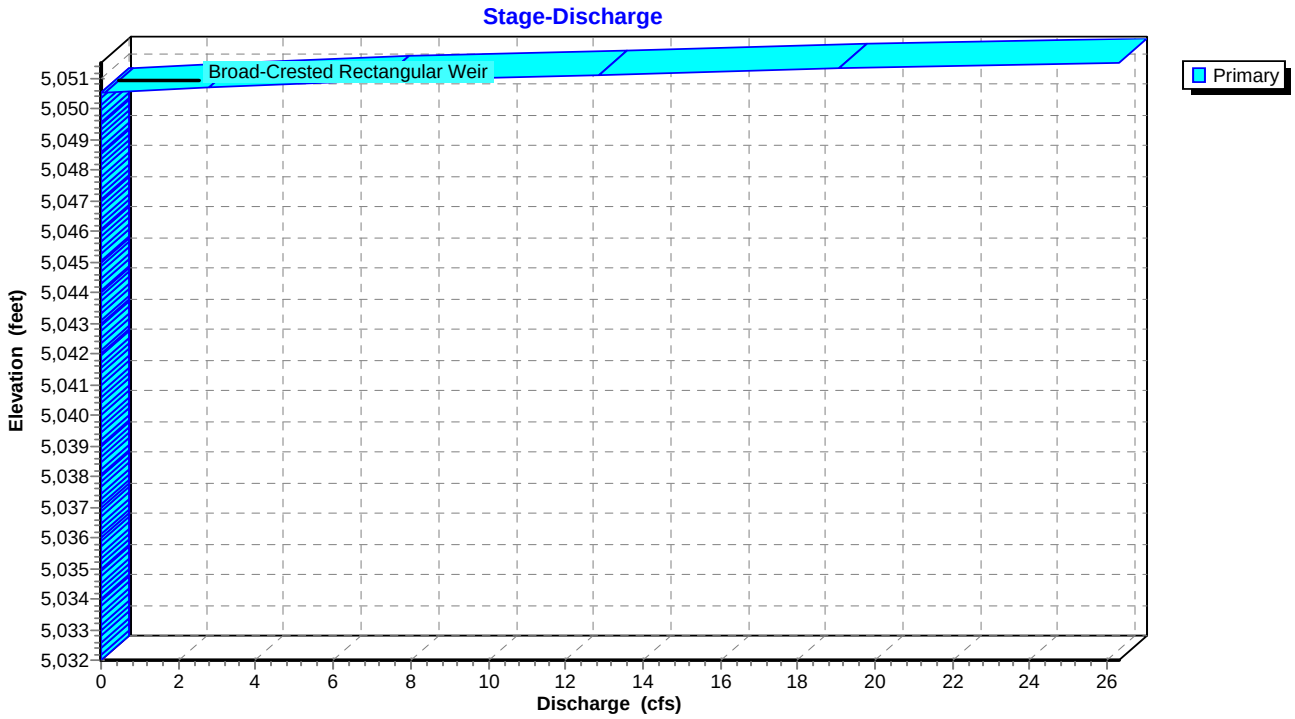
Device	Routing	Invert	Outlet Devices
#1	Primary	5,050.50'	**10.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,048.50' (Free Discharge)
1=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

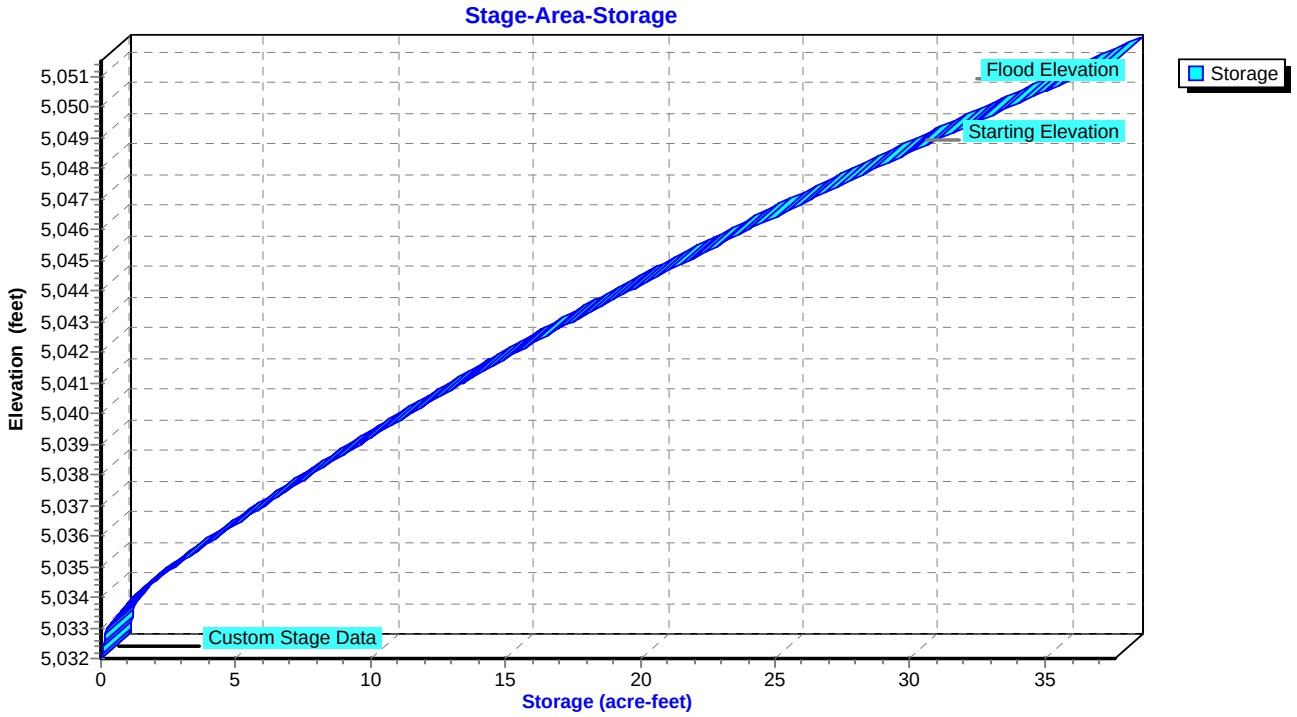
Pond 10P: Pond 3



Pond 10P: Pond 3



Pond 10P: Pond 3



Summary for Pond 11P: Detention Pond

Inflow Area = 14.470 ac, 0.00% Impervious, Inflow Depth = 0.04" for 2-YR, 6-HR event
Inflow = 0.23 cfs @ 4.54 hrs, Volume= 0.049 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 5,026.31' @ 22.75 hrs Surf.Area= 0.161 ac Storage= 0.049 af

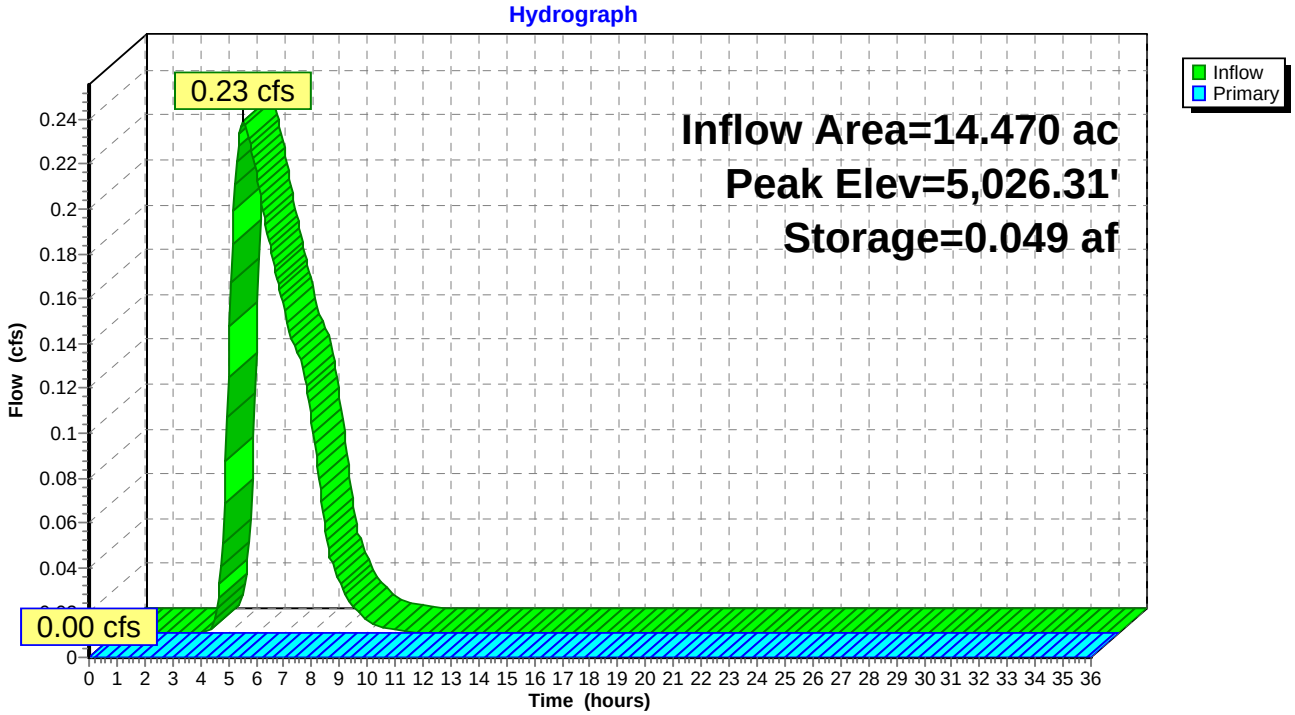
Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	5,026.00'	1.256 af	**26.00'W x 250.00'L x 5.00'H Prismatoid Z=3.0**

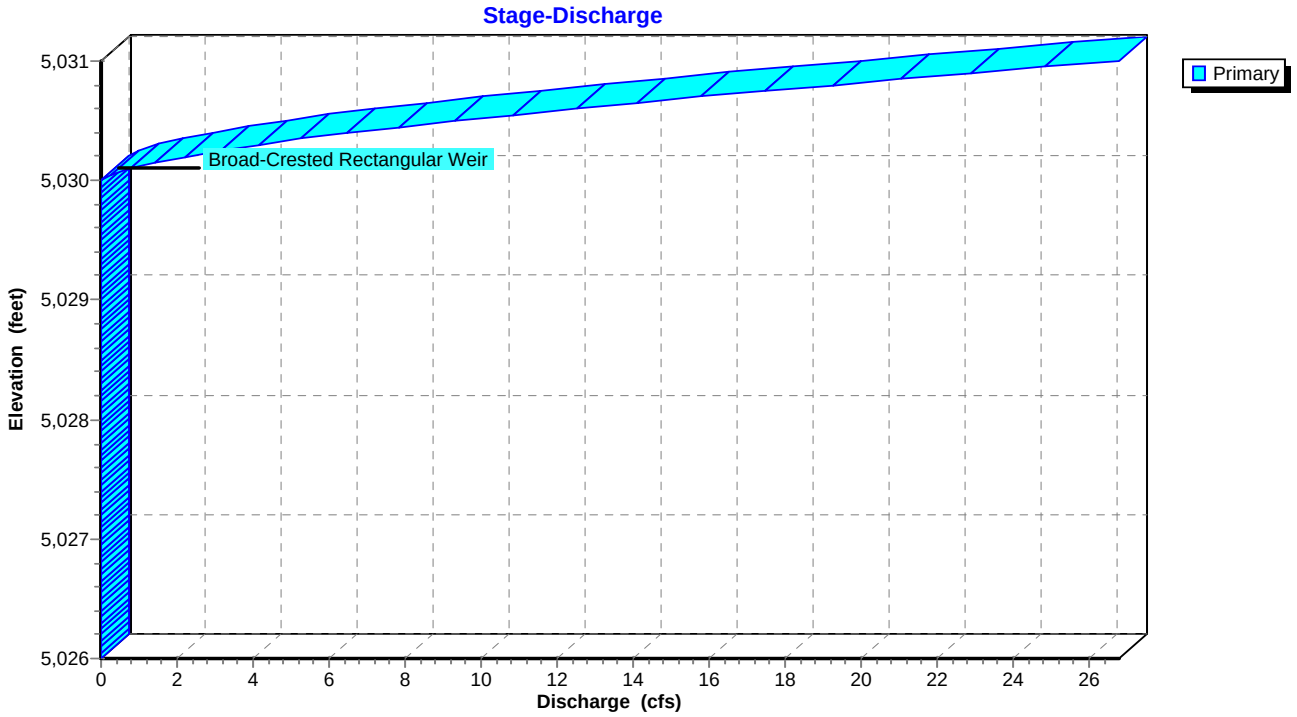
Device	Routing	Invert	Outlet Devices
#1	Primary	5,030.00'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,026.00' (Free Discharge)
1=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

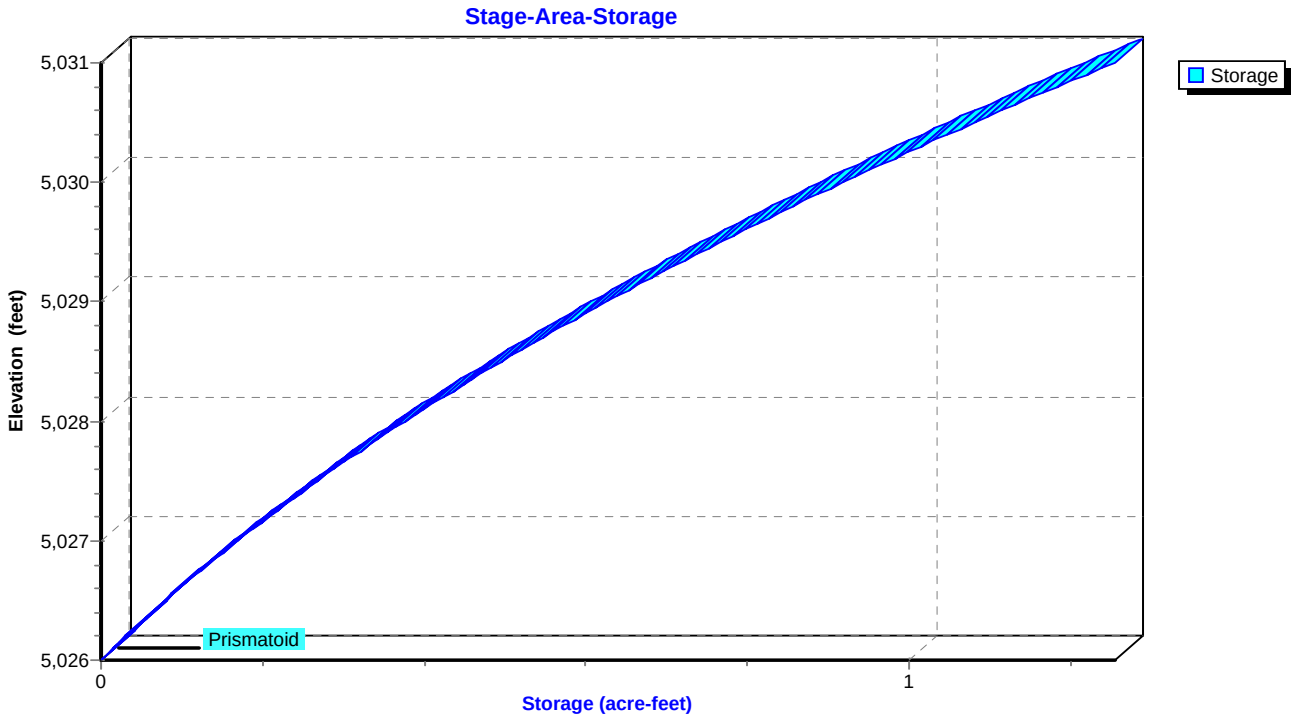
Pond 11P: Detention Pond



Pond 11P: Detention Pond

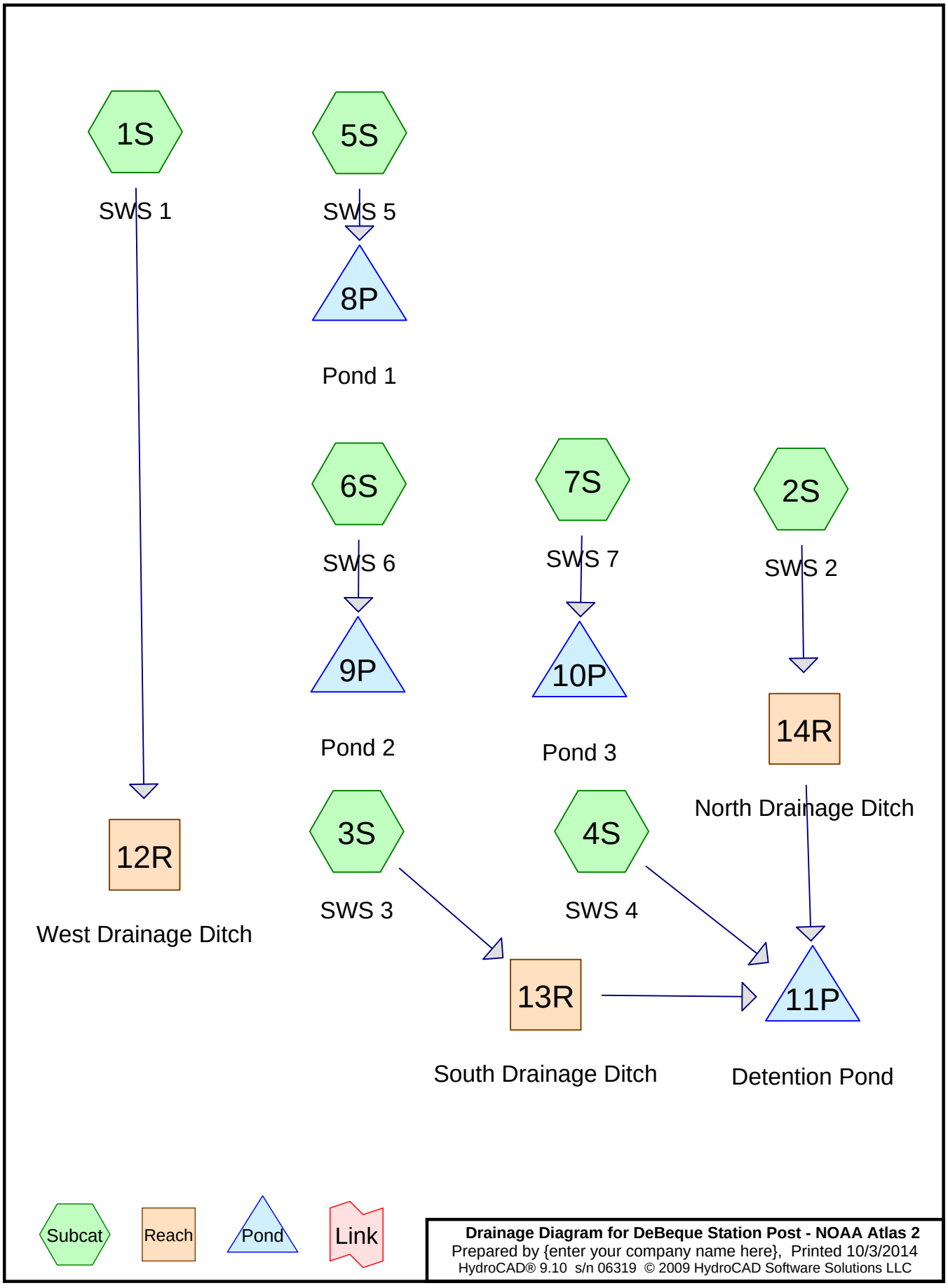


Pond 11P: Detention Pond



APPENDIX C4

HydroCAD Report
NOAA Atlas 2: Post-Development
100-Year, 6-Hour Event



Drainage Diagram for DeBeque Station Post - NOAA Atlas 2
Prepared by {enter your company name here}, Printed 10/3/2014
HydroCAD® 9.10 s/n 06319 © 2009 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.200	76	Weighted Curve Number (4S)
3.160	78	Weighted Curve Number (3S)
258.860	79	Weighted Curve Number (1S)
10.110	82	Weighted Curve Number (2S)
8.250	100	Liner (5S, 6S, 7S)
281.580		**TOTAL AREA**

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: SWS 1 Runoff Area=258.860 ac 0.00% Impervious Runoff Depth=0.41"
Flow Length=8,106' Tc=56.7 min CN=79 Runoff=68.59 cfs 8.838 af

Subcatchment 2S: SWS 2 Runoff Area=10.110 ac 0.00% Impervious Runoff Depth=0.52"
Flow Length=2,405' Tc=58.5 min CN=82 Runoff=3.51 cfs 0.439 af

Subcatchment 3S: SWS 3 Runoff Area=3.160 ac 0.00% Impervious Runoff Depth=0.38"
Flow Length=934' Tc=14.6 min CN=78 Runoff=1.95 cfs 0.099 af

Subcatchment 4S: SWS 4 Runoff Area=1.200 ac 0.00% Impervious Runoff Depth=0.32"
Flow Length=174' Tc=3.8 min CN=76 Runoff=0.99 cfs 0.032 af

Subcatchment 5S: SWS 5 Runoff Area=2.840 ac 100.00% Impervious Runoff Depth=1.80"
Flow Length=15' Slope=0.5000 '/' Tc=0.1 min CN=100 Runoff=11.64 cfs 0.426 af

Subcatchment 6S: SWS 6 Runoff Area=2.750 ac 100.00% Impervious Runoff Depth=1.80"
Flow Length=15' Slope=0.5000 '/' Tc=0.1 min CN=100 Runoff=11.27 cfs 0.413 af

Subcatchment 7S: SWS 7 Runoff Area=2.660 ac 100.00% Impervious Runoff Depth=1.80"
Flow Length=15' Slope=0.5000 '/' Tc=0.1 min CN=100 Runoff=10.91 cfs 0.399 af

Reach 12R: West Drainage Ditch Avg. Flow Depth=1.09' Max Vel=8.78 fps Inflow=68.59 cfs 8.838 af
n=0.022 L=1,297.4' S=0.0231 '/' Capacity=219.29 cfs Outflow=68.31 cfs 8.838 af

Reach 13R: South Drainage Ditch Avg. Flow Depth=0.24' Max Vel=2.78 fps Inflow=1.95 cfs 0.099 af
n=0.022 L=1,015.0' S=0.0156 '/' Capacity=107.67 cfs Outflow=1.62 cfs 0.099 af

Reach 14R: North Drainage Ditch Avg. Flow Depth=0.32' Max Vel=4.11 fps Inflow=3.51 cfs 0.439 af
n=0.022 L=1,723.1' S=0.0242 '/' Capacity=134.16 cfs Outflow=3.42 cfs 0.439 af

Pond 8P: Pond 1 Peak Elev=5,061.73' Storage=40.703 af Inflow=11.64 cfs 0.426 af
Outflow=0.00 cfs 0.000 af

Pond 9P: Pond 2 Peak Elev=5,057.96' Storage=31.519 af Inflow=11.27 cfs 0.413 af
Outflow=0.00 cfs 0.000 af

Pond 10P: Pond 3 Peak Elev=5,048.66' Storage=30.363 af Inflow=10.91 cfs 0.399 af
Outflow=0.00 cfs 0.000 af

Pond 11P: Detention Pond Peak Elev=5,028.79' Storage=0.570 af Inflow=3.88 cfs 0.570 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 281.580 ac Runoff Volume = 10.645 af Average Runoff Depth = 0.45"
97.07% Pervious = 273.330 ac 2.93% Impervious = 8.250 ac

Summary for Subcatchment 1S: SWS 1

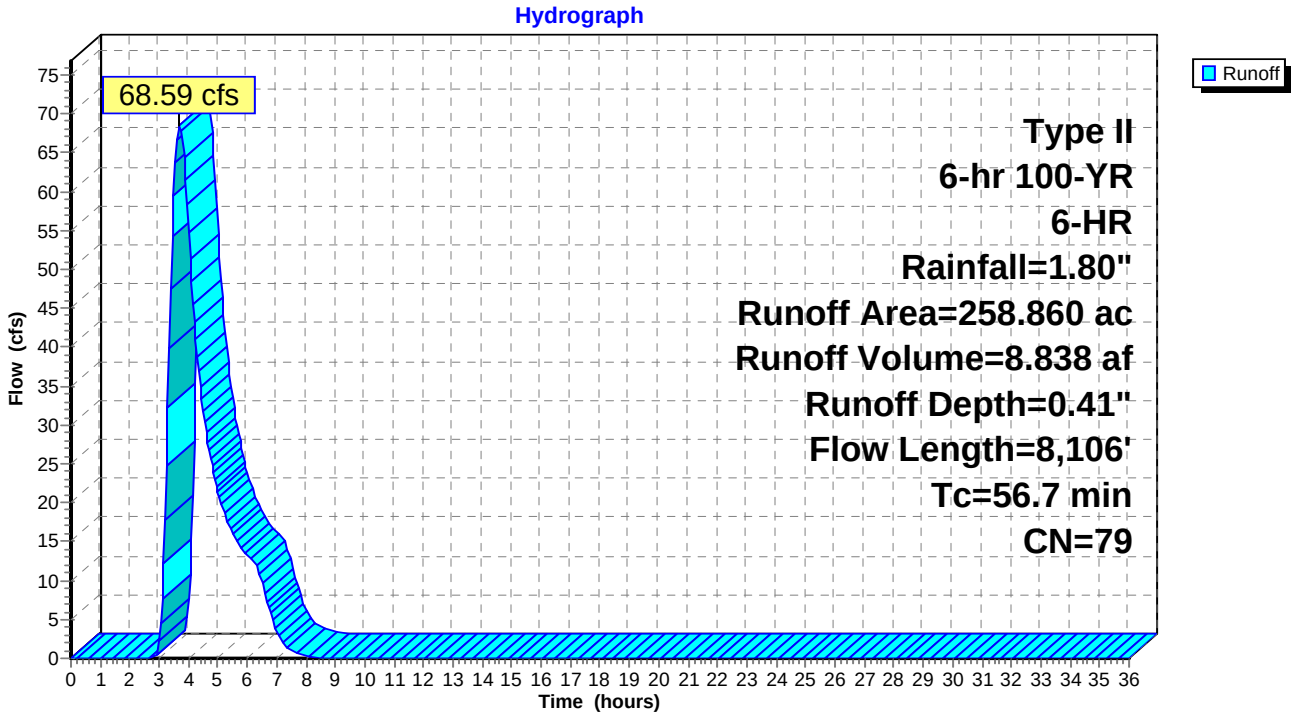
Runoff = 68.59 cfs @ 3.70 hrs, Volume= 8.838 af, Depth= 0.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-YR, 6-HR Rainfall=1.80"

	Area (ac)	CN	Description
*	258.860	79	Weighted Curve Number
	258.860		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	300	0.3900	0.45		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
45.6	7,806	0.0813	2.85		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
56.7	8,106	Total			

Subcatchment 1S: SWS 1



Summary for Subcatchment 2S: SWS 2

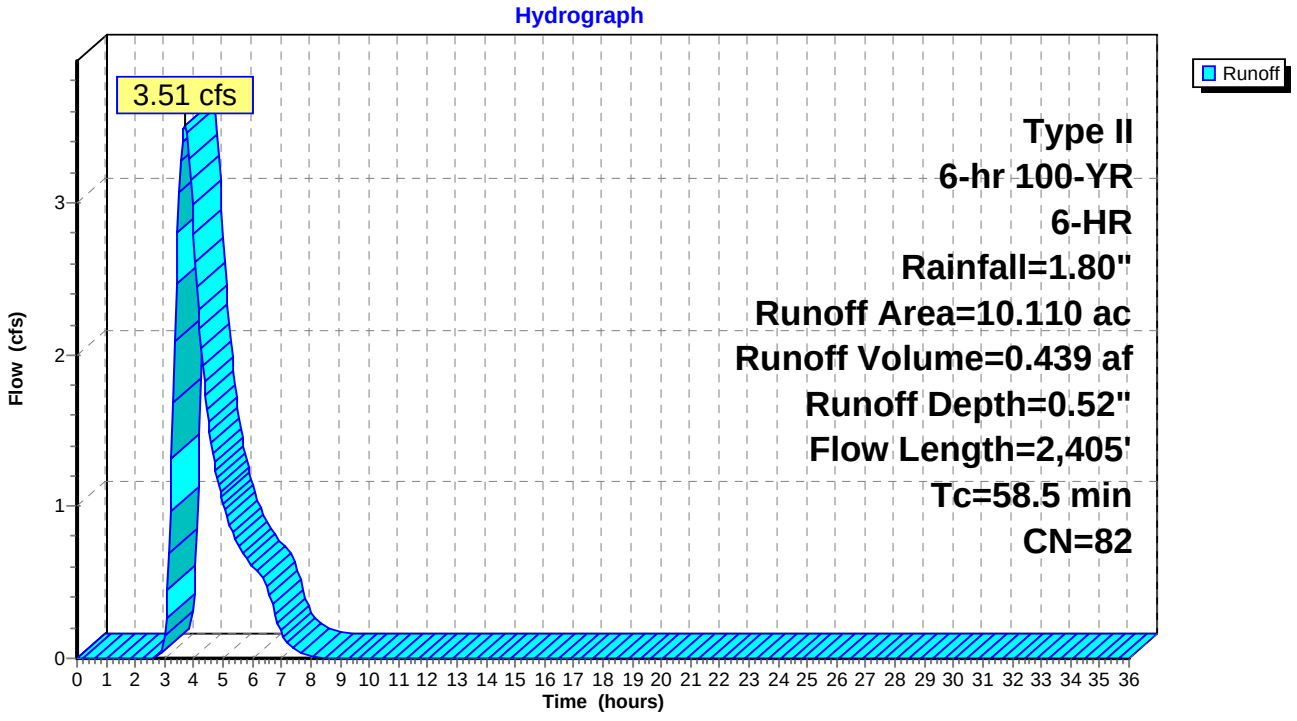
Runoff = 3.51 cfs @ 3.70 hrs, Volume= 0.439 af, Depth= 0.52"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-YR, 6-HR Rainfall=1.80"

	Area (ac)	CN	Description
*	10.110	82	Weighted Curve Number
	10.110		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.2	300	0.0233	0.15		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
24.3	2,105	0.0209	1.45		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
58.5	2,405	Total			

Subcatchment 2S: SWS 2



Summary for Subcatchment 3S: SWS 3

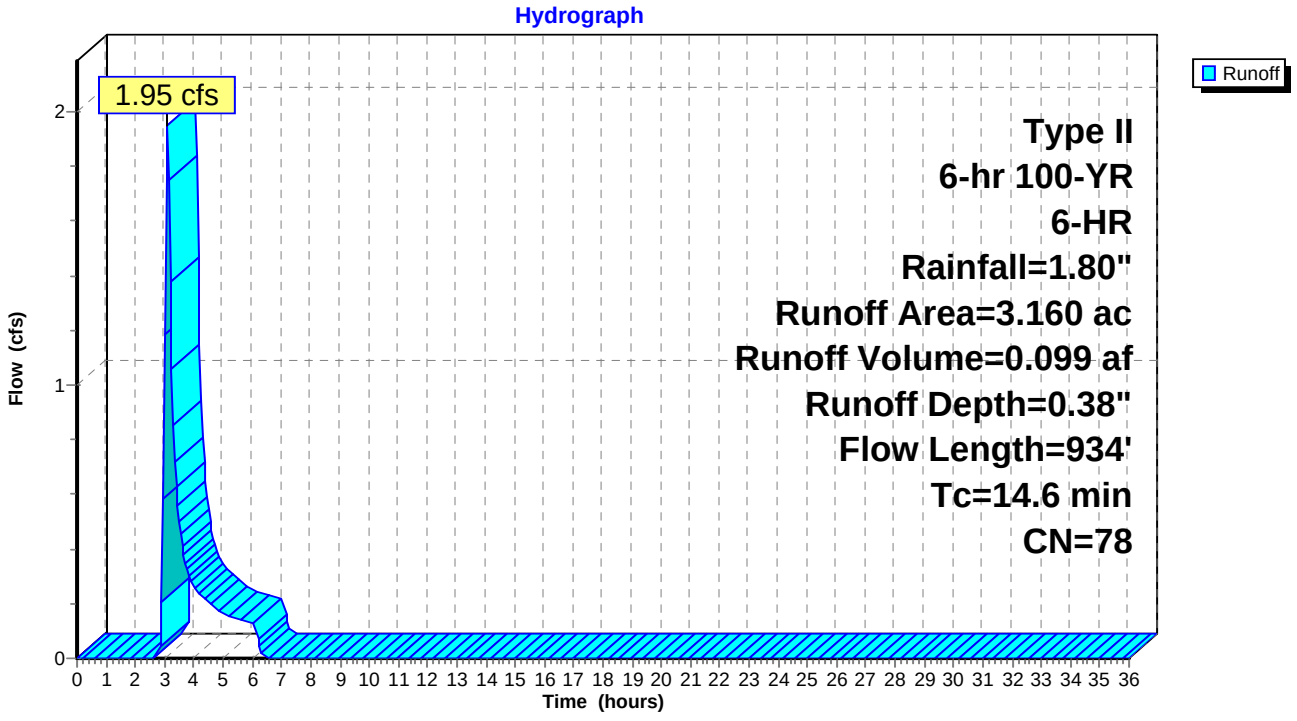
Runoff = 1.95 cfs @ 3.10 hrs, Volume= 0.099 af, Depth= 0.38"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-YR, 6-HR Rainfall=1.80"

	Area (ac)	CN	Description
*	3.160	78	Weighted Curve Number
	3.160		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.2500	0.26		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
11.4	884	0.0166	1.29		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
14.6	934	Total			

Subcatchment 3S: SWS 3



Summary for Subcatchment 4S: SWS 4

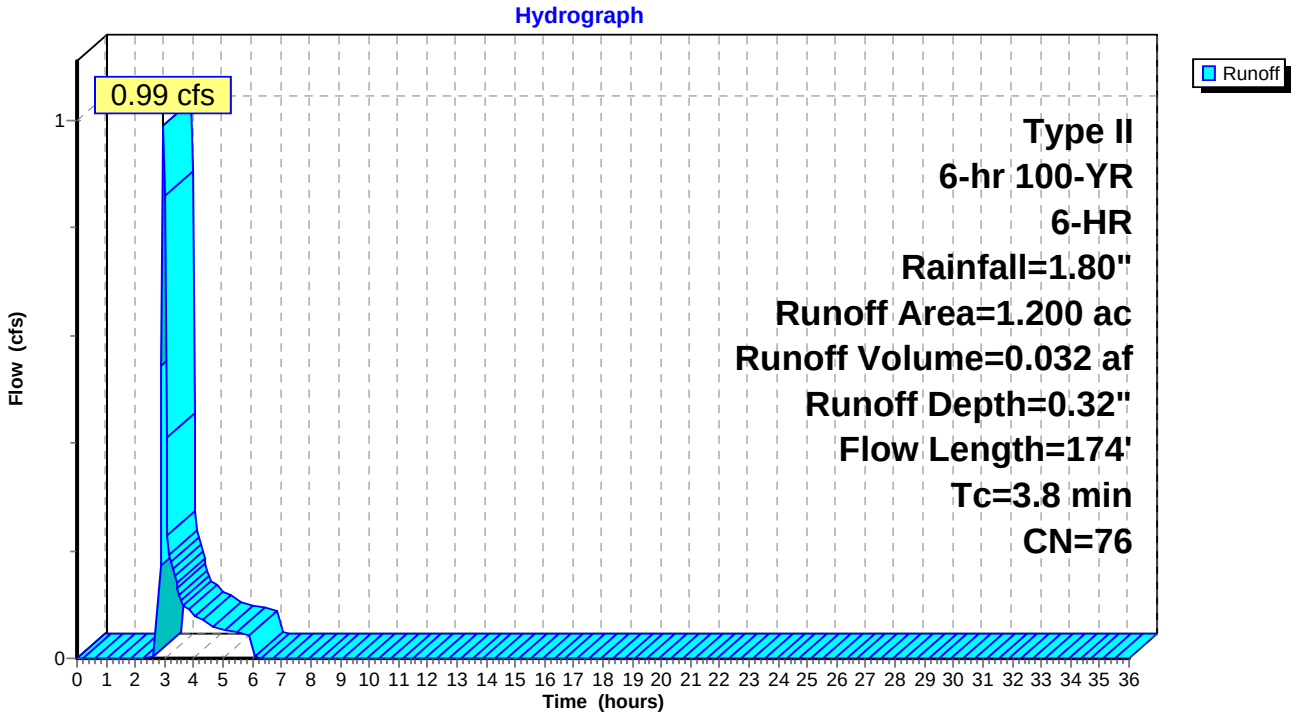
Runoff = 0.99 cfs @ 2.96 hrs, Volume= 0.032 af, Depth= 0.32"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-YR, 6-HR Rainfall=1.80"

	Area (ac)	CN	Description
*	1.200	76	Weighted Curve Number
	1.200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.2500	0.26		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
0.6	124	0.1149	3.39		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
3.8	174	Total			

Subcatchment 4S: SWS 4



Summary for Subcatchment 5S: SWS 5

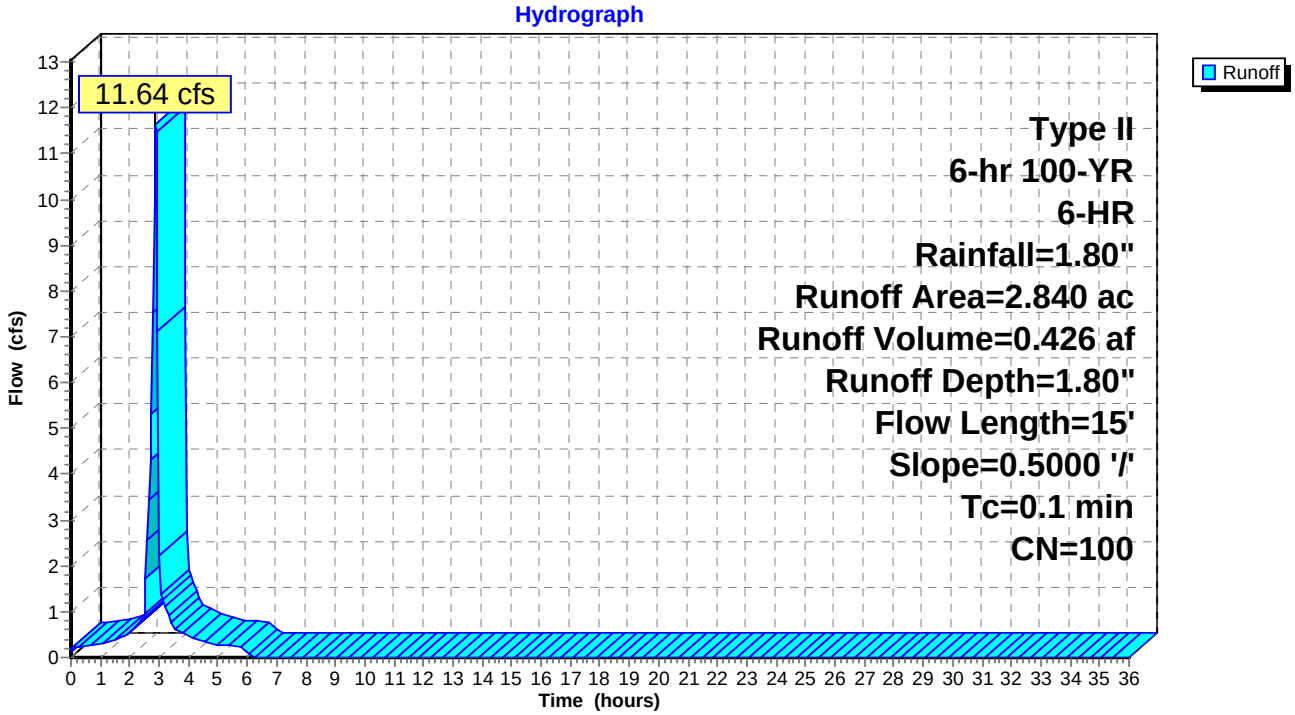
Runoff = 11.64 cfs @ 2.89 hrs, Volume= 0.426 af, Depth= 1.80"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-YR, 6-HR Rainfall=1.80"

	Area (ac)	CN	Description
*	2.840	100	Liner
	2.840		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	15	0.5000	1.97		**Sheet Flow, Overland Flow** Smooth surfaces n= 0.011 P2= 1.07"

Subcatchment 5S: SWS 5



Summary for Subcatchment 6S: SWS 6

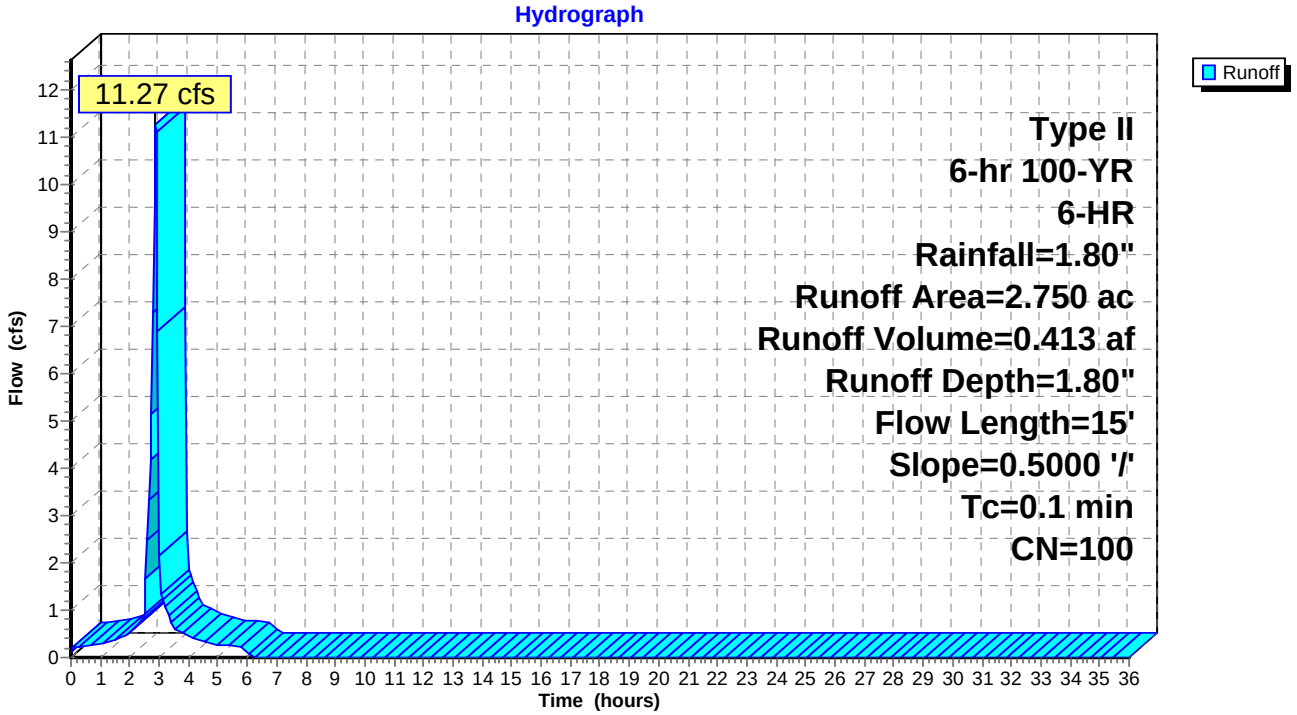
Runoff = 11.27 cfs @ 2.89 hrs, Volume= 0.413 af, Depth= 1.80"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-YR, 6-HR Rainfall=1.80"

	Area (ac)	CN	Description
*	2.750	100	Liner
	2.750		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	15	0.5000	1.97		**Sheet Flow, Overland Flow** Smooth surfaces n= 0.011 P2= 1.07"

Subcatchment 6S: SWS 6



Summary for Subcatchment 7S: SWS 7

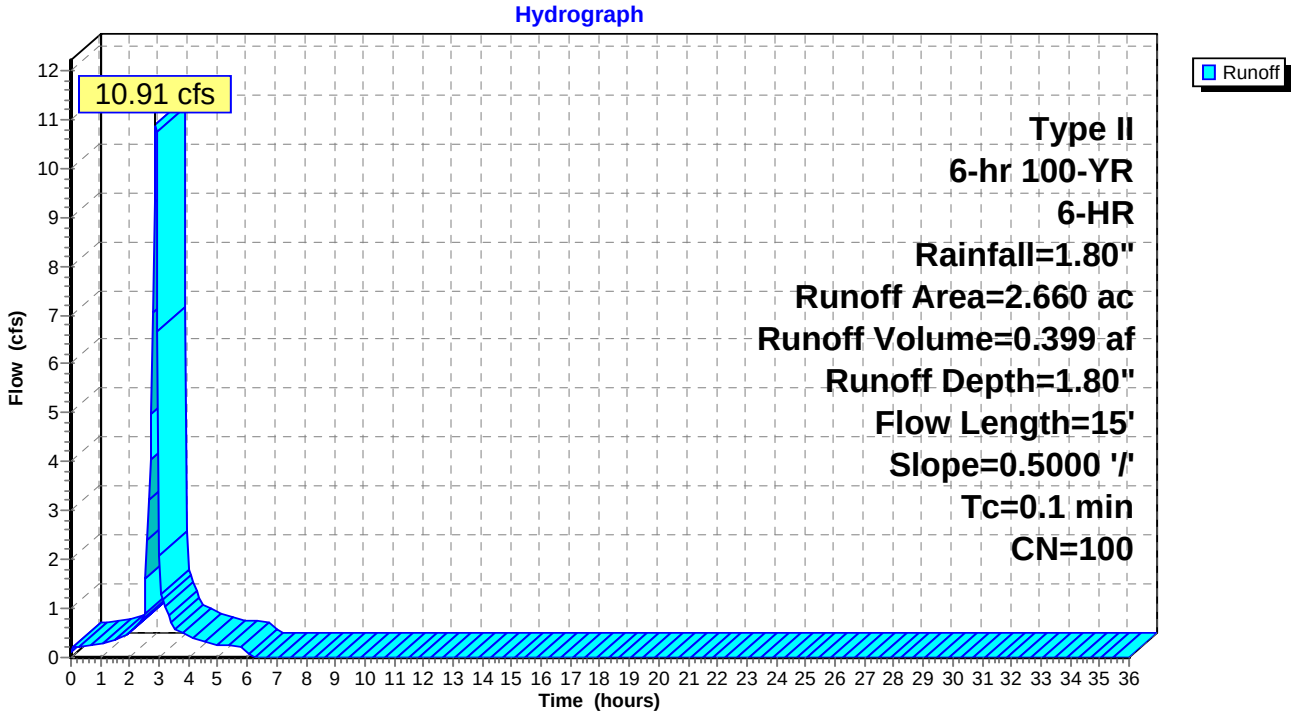
Runoff = 10.91 cfs @ 2.89 hrs, Volume= 0.399 af, Depth= 1.80"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-YR, 6-HR Rainfall=1.80"

	Area (ac)	CN	Description
*	2.660	100	Liner
	2.660		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	15	0.5000	1.97		**Sheet Flow, Overland Flow** Smooth surfaces n= 0.011 P2= 1.07"

Subcatchment 7S: SWS 7



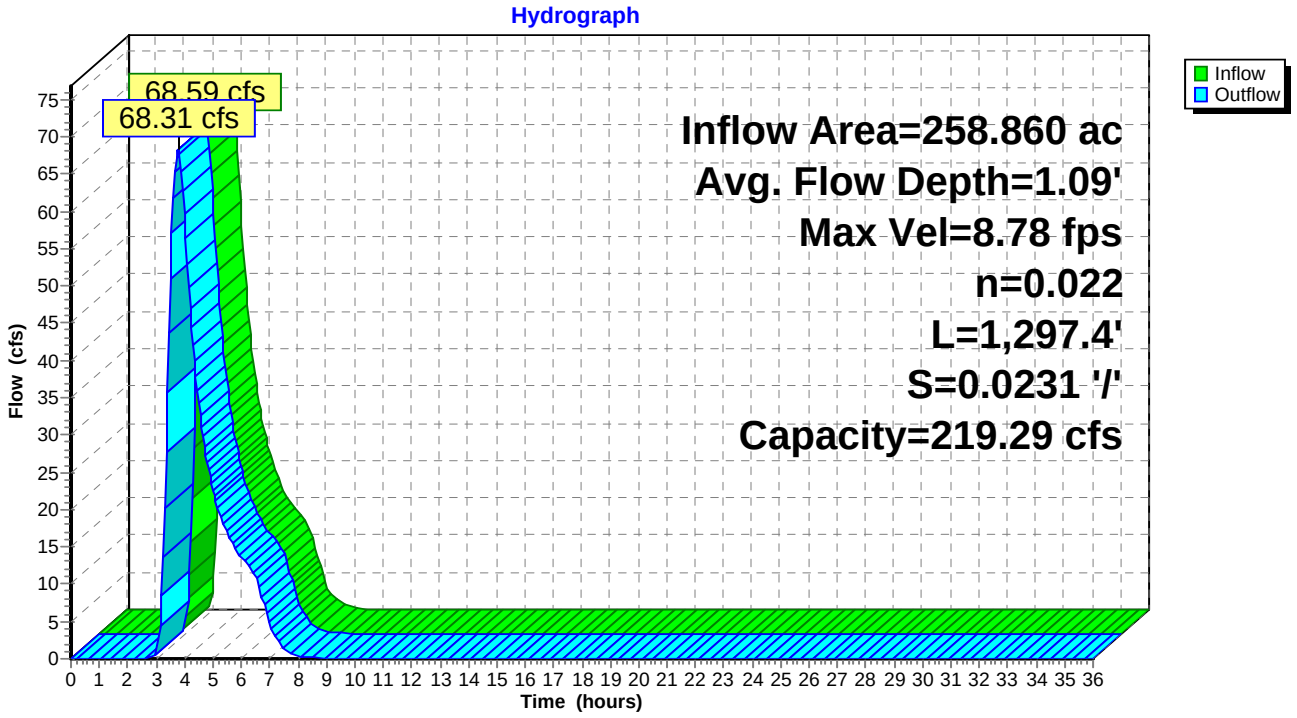
Summary for Reach 12R: West Drainage Ditch

Inflow Area = 258.860 ac, 0.00% Impervious, Inflow Depth = 0.41" for 100-YR, 6-HR event
Inflow = 68.59 cfs @ 3.70 hrs, Volume= 8.838 af
Outflow = 68.31 cfs @ 3.77 hrs, Volume= 8.838 af, Atten= 0%, Lag= 4.2 min

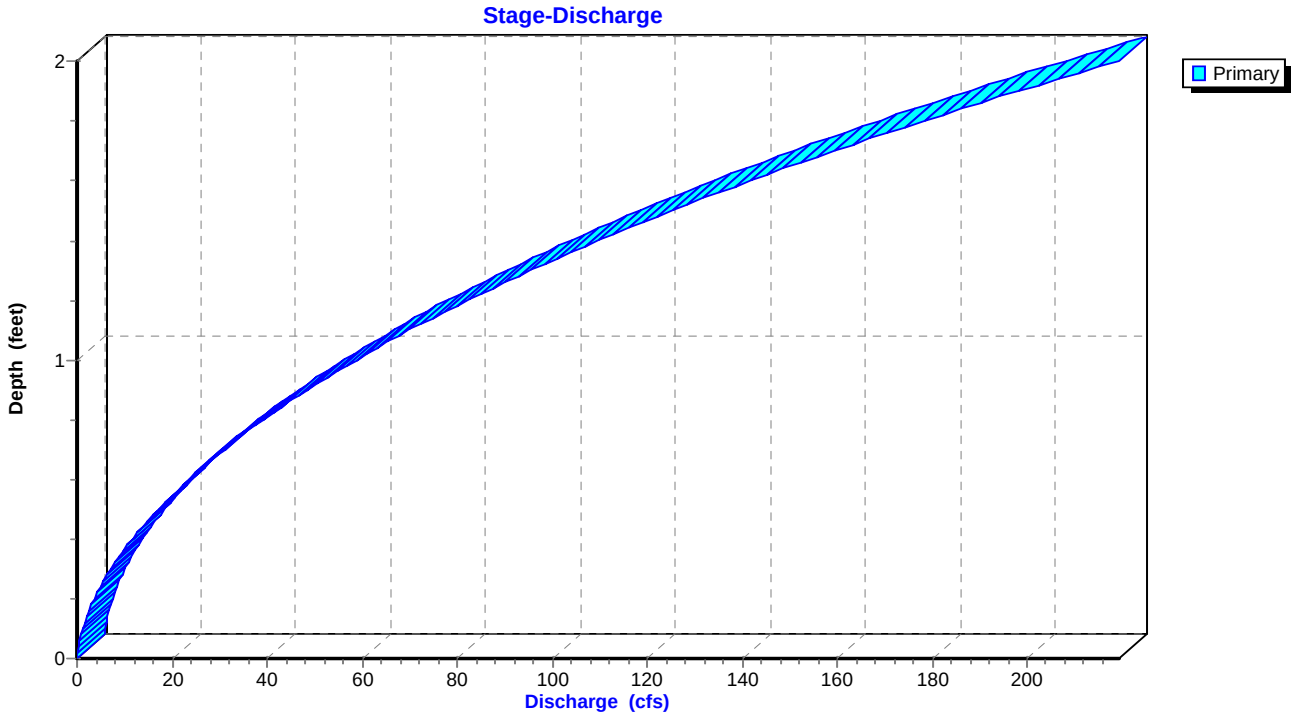
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Max. Velocity= 8.78 fps, Min. Travel Time= 2.5 min
Avg. Velocity = 3.26 fps, Avg. Travel Time= 6.6 min

Peak Storage= 10,103 cf @ 3.73 hrs
Average Depth at Peak Storage= 1.09'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 219.29 cfs

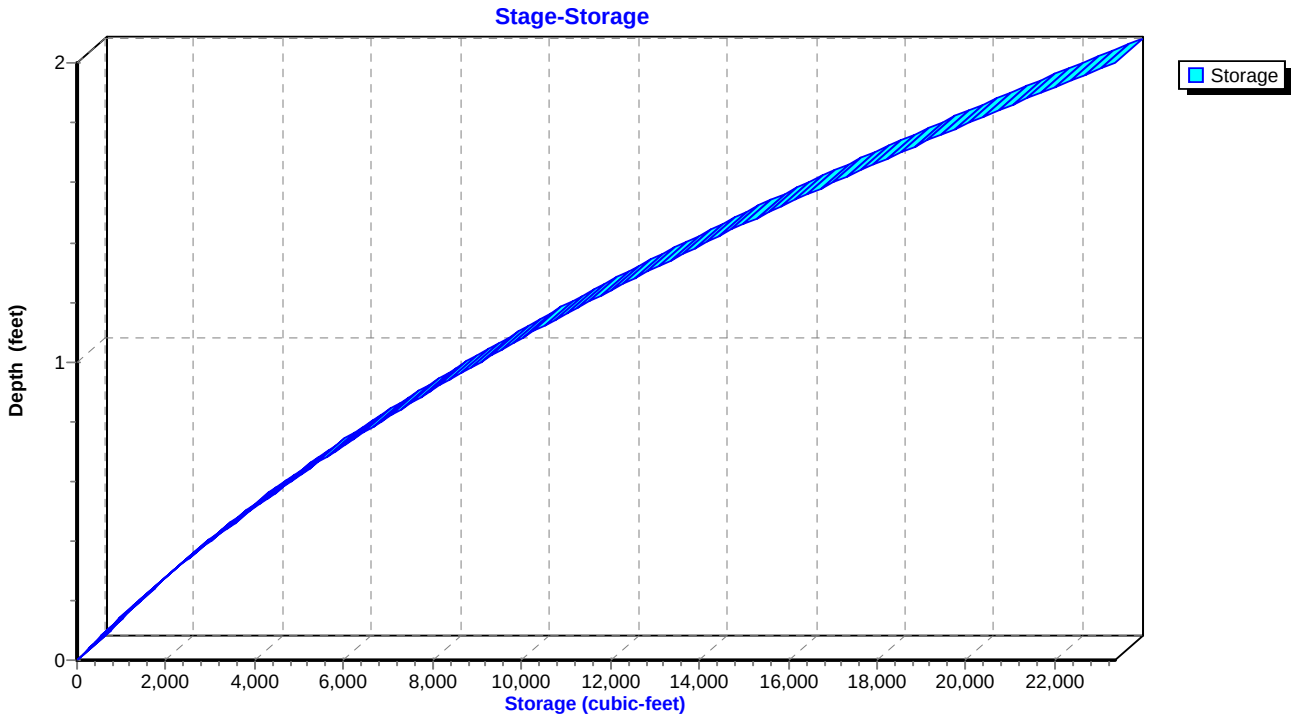
5.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 2.0 '/' Top Width= 13.00'
Length= 1,297.4' Slope= 0.0231 '/'
Inlet Invert= 5,077.00', Outlet Invert= 5,046.97'



Reach 12R: West Drainage Ditch



Reach 12R: West Drainage Ditch



Summary for Reach 13R: South Drainage Ditch

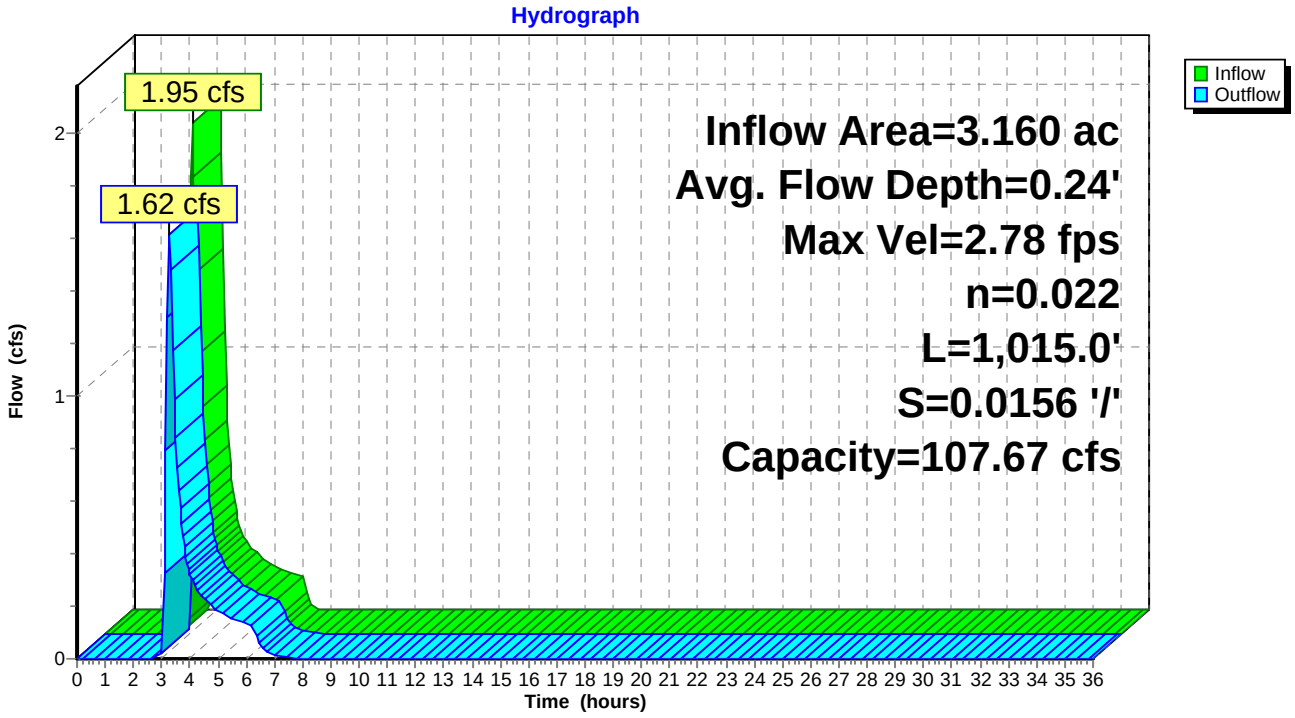
Inflow Area = 3.160 ac, 0.00% Impervious, Inflow Depth = 0.38" for 100-YR, 6-HR event
Inflow = 1.95 cfs @ 3.10 hrs, Volume= 0.099 af
Outflow = 1.62 cfs @ 3.27 hrs, Volume= 0.099 af, Atten= 17%, Lag= 10.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.78 fps, Min. Travel Time= 6.1 min
Avg. Velocity = 1.09 fps, Avg. Travel Time= 15.6 min

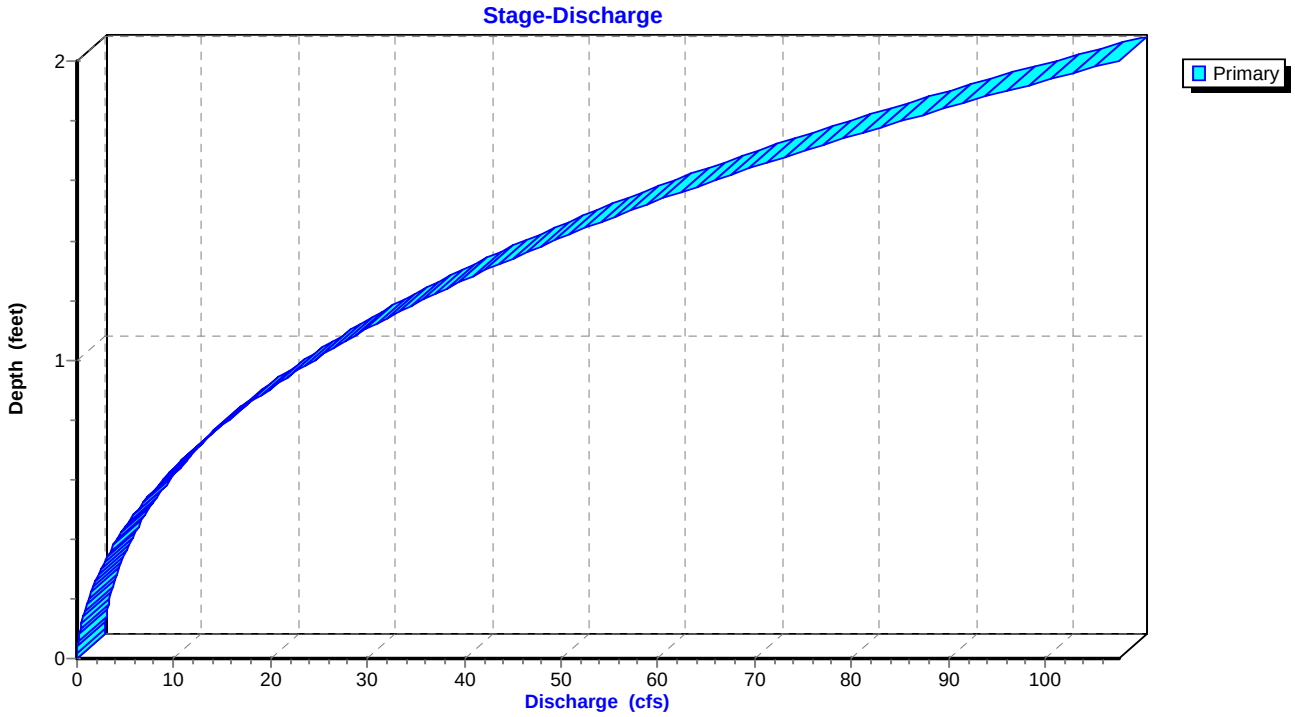
Peak Storage= 589 cf @ 3.17 hrs
Average Depth at Peak Storage= 0.24'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 107.67 cfs

2.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 1,015.0' Slope= 0.0156 '/'
Inlet Invert= 5,045.22', Outlet Invert= 5,029.38'

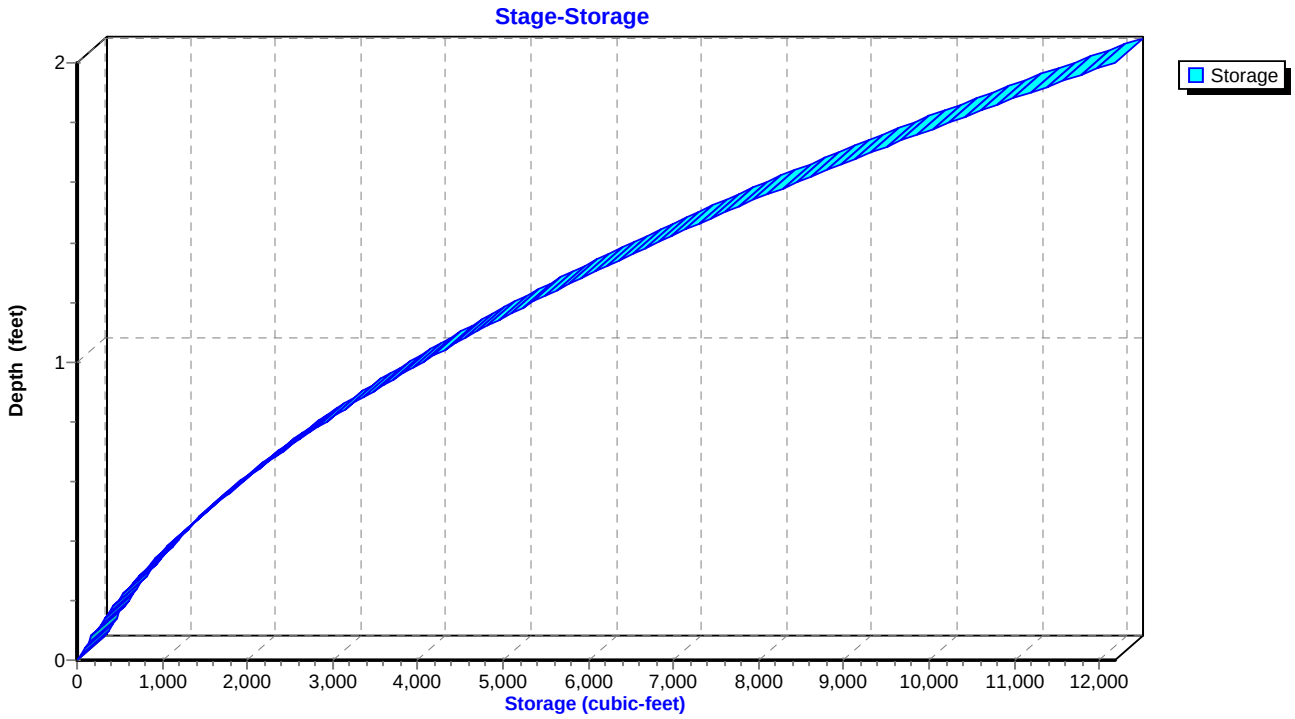
Reach 13R: South Drainage Ditch



Reach 13R: South Drainage Ditch



Reach 13R: South Drainage Ditch



Summary for Reach 14R: North Drainage Ditch

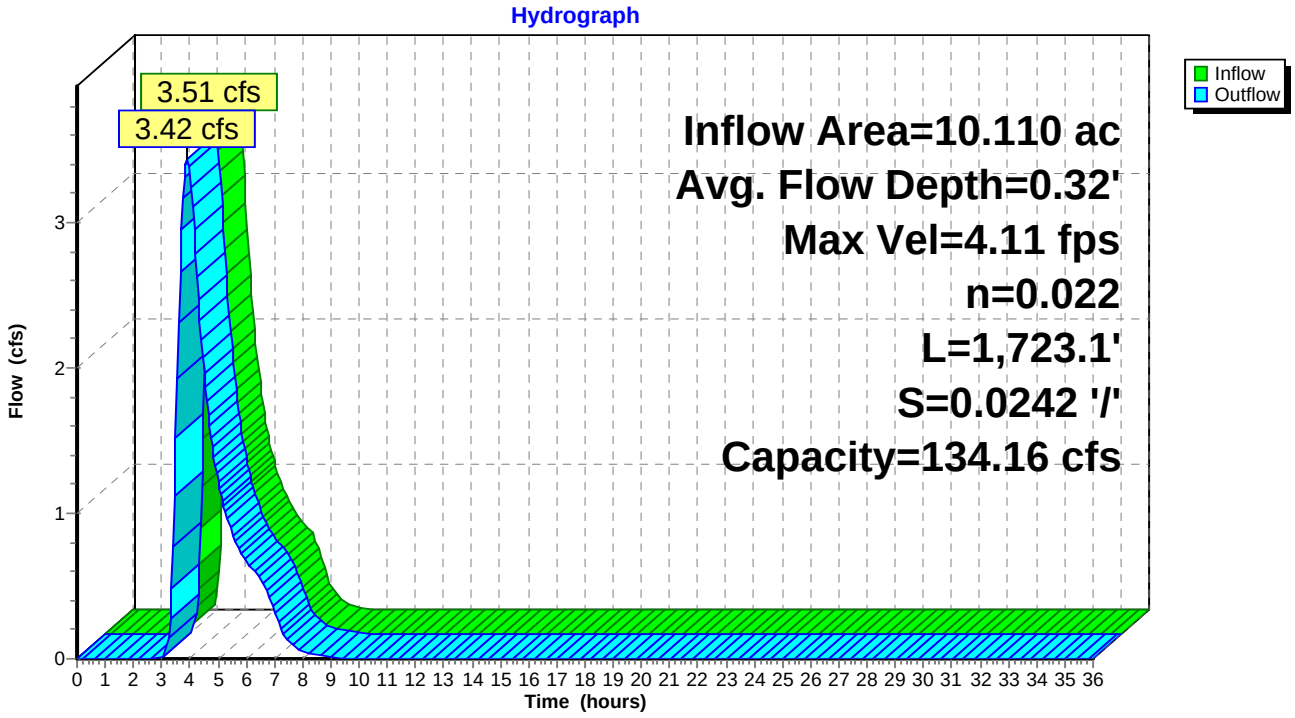
Inflow Area = 10.110 ac, 0.00% Impervious, Inflow Depth = 0.52" for 100-YR, 6-HR event
Inflow = 3.51 cfs @ 3.70 hrs, Volume= 0.439 af
Outflow = 3.42 cfs @ 3.90 hrs, Volume= 0.439 af, Atten= 3%, Lag= 12.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.11 fps, Min. Travel Time= 7.0 min
Avg. Velocity = 1.69 fps, Avg. Travel Time= 17.0 min

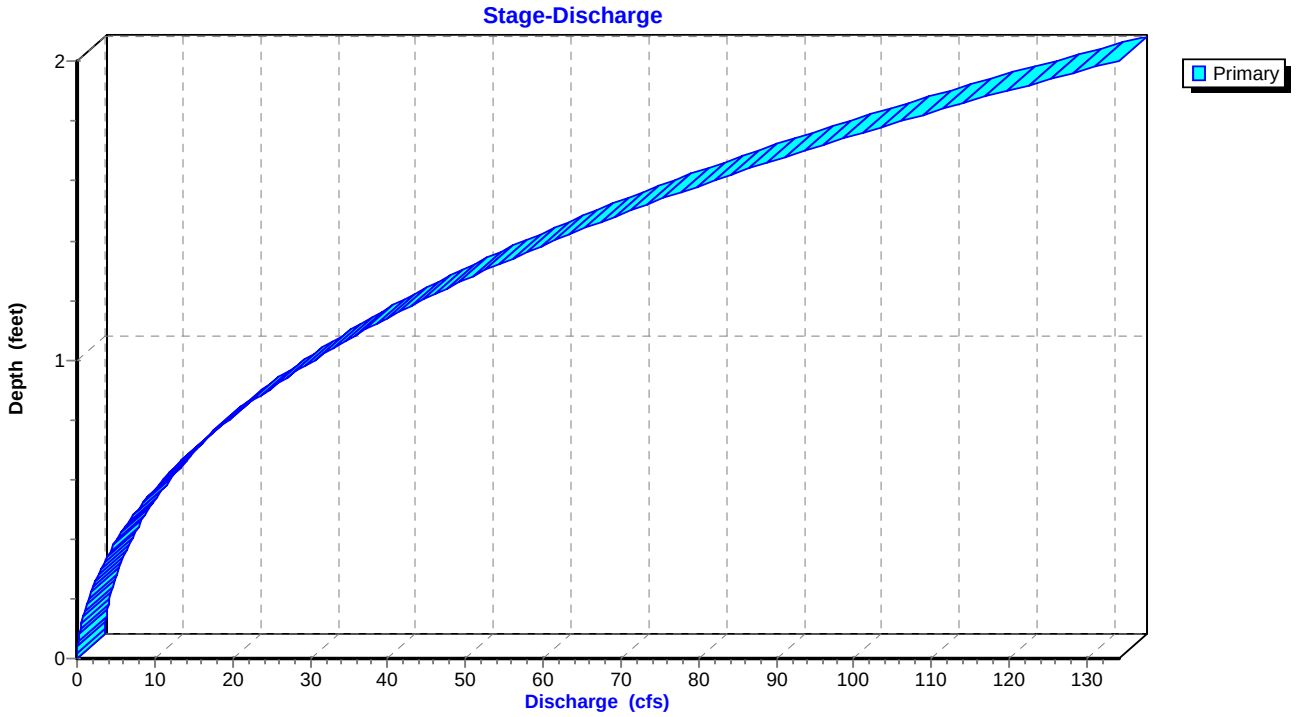
Peak Storage= 1,438 cf @ 3.78 hrs
Average Depth at Peak Storage= 0.32'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 134.16 cfs

2.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 1,723.1' Slope= 0.0242 '/'
Inlet Invert= 5,071.25', Outlet Invert= 5,029.50'

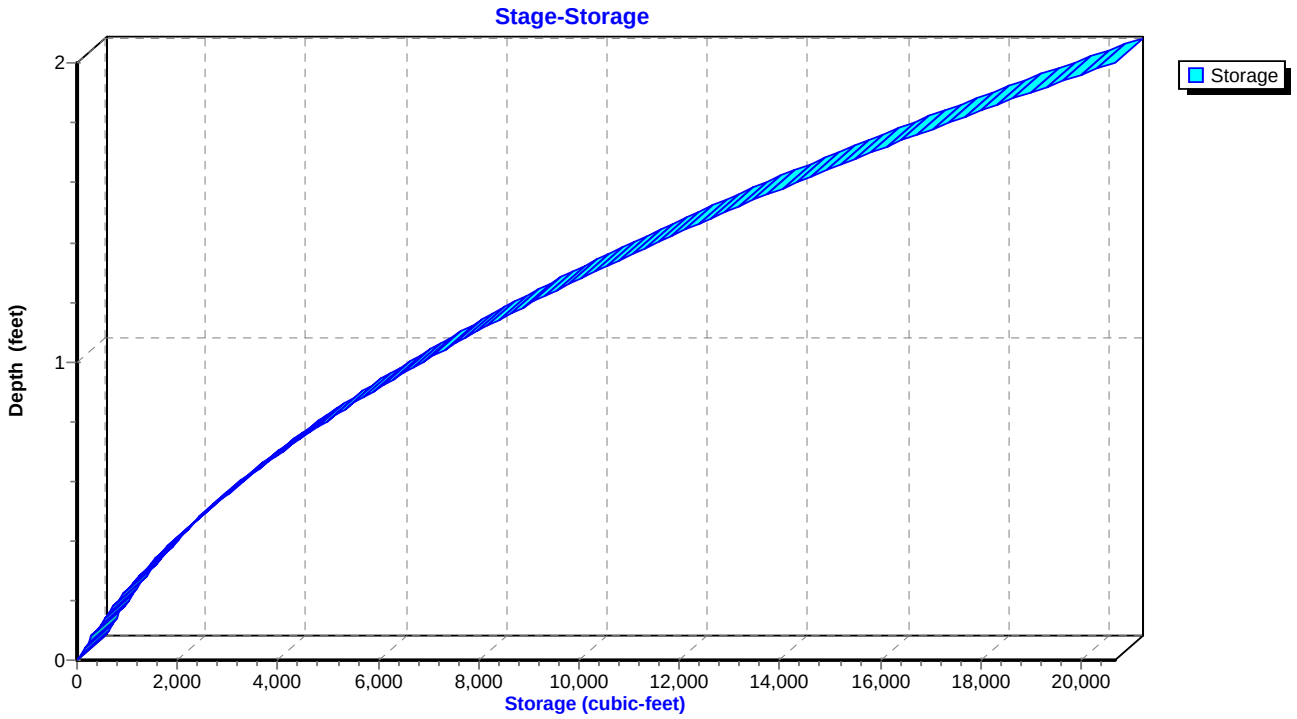
Reach 14R: North Drainage Ditch



Reach 14R: North Drainage Ditch



Reach 14R: North Drainage Ditch



Summary for Pond 8P: Pond 1

Inflow Area = 2.840 ac,100.00% Impervious, Inflow Depth = 1.80" for 100-YR, 6-HR event
Inflow = 11.64 cfs @ 2.89 hrs, Volume= 0.426 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Starting Elev= 5,061.57' Surf.Area= 0.000 ac Storage= 40.277 af
Peak Elev= 5,061.73' @ 6.05 hrs Surf.Area= 0.000 ac Storage= 40.703 af (0.426 af above start)
Flood Elev= 5,063.57' Surf.Area= 0.000 ac Storage= 45.571 af (5.294 af above start)

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

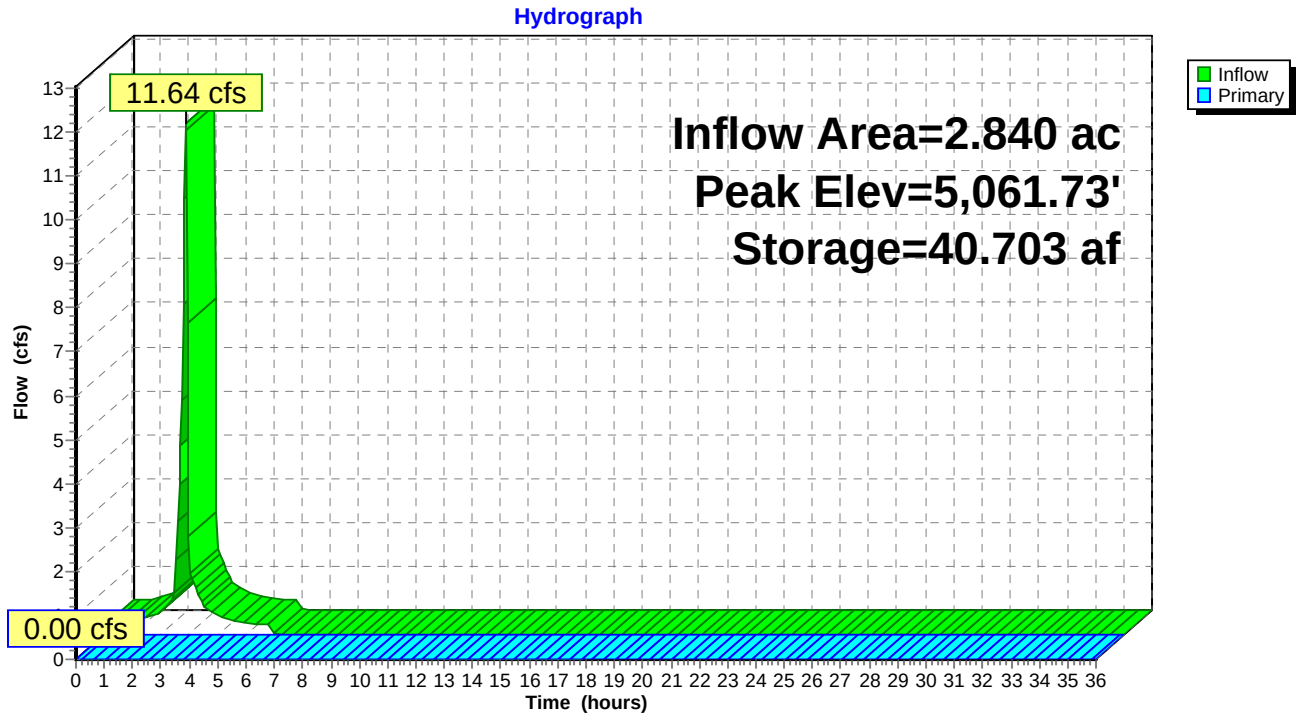
Volume	Invert	Avail.Storage	Storage Description
#1	5,040.33'	48.314 af	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (acre-feet)
5,040.33	0.000
5,041.33	0.264
5,042.33	1.457
5,043.33	2.977
5,044.33	4.548
5,045.33	6.170
5,046.33	7.844
5,047.33	9.570
5,048.33	11.350
5,049.33	13.184
5,050.33	15.073
5,051.33	17.017
5,052.33	19.017
5,053.33	21.074
5,054.33	23.189
5,055.33	25.362
5,056.33	27.593
5,057.33	29.885
5,058.33	32.236
5,059.33	34.649
5,060.33	37.123
5,061.33	39.659
5,061.57	40.277
5,062.57	42.892
5,063.57	45.571
5,064.57	48.314

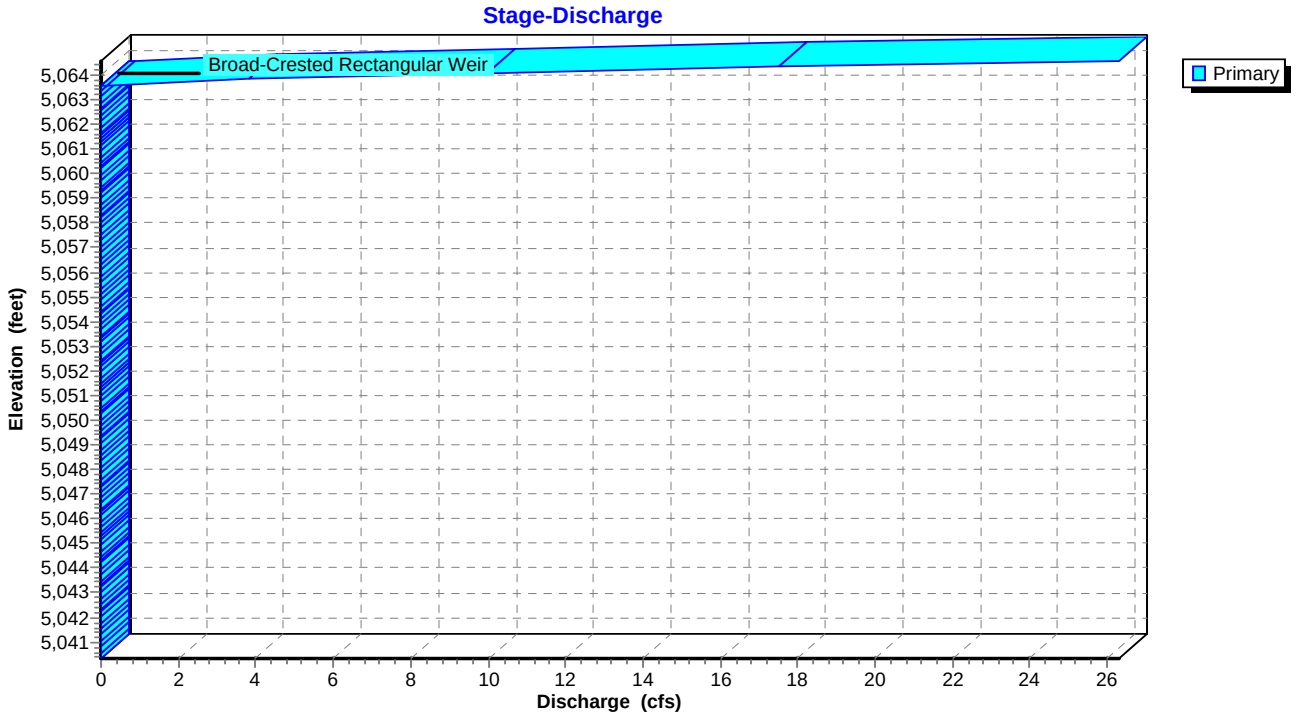
Device	Routing	Invert	Outlet Devices
#1	Primary	5,063.57'	**10.0' long x 30.0' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60
			Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,061.57' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

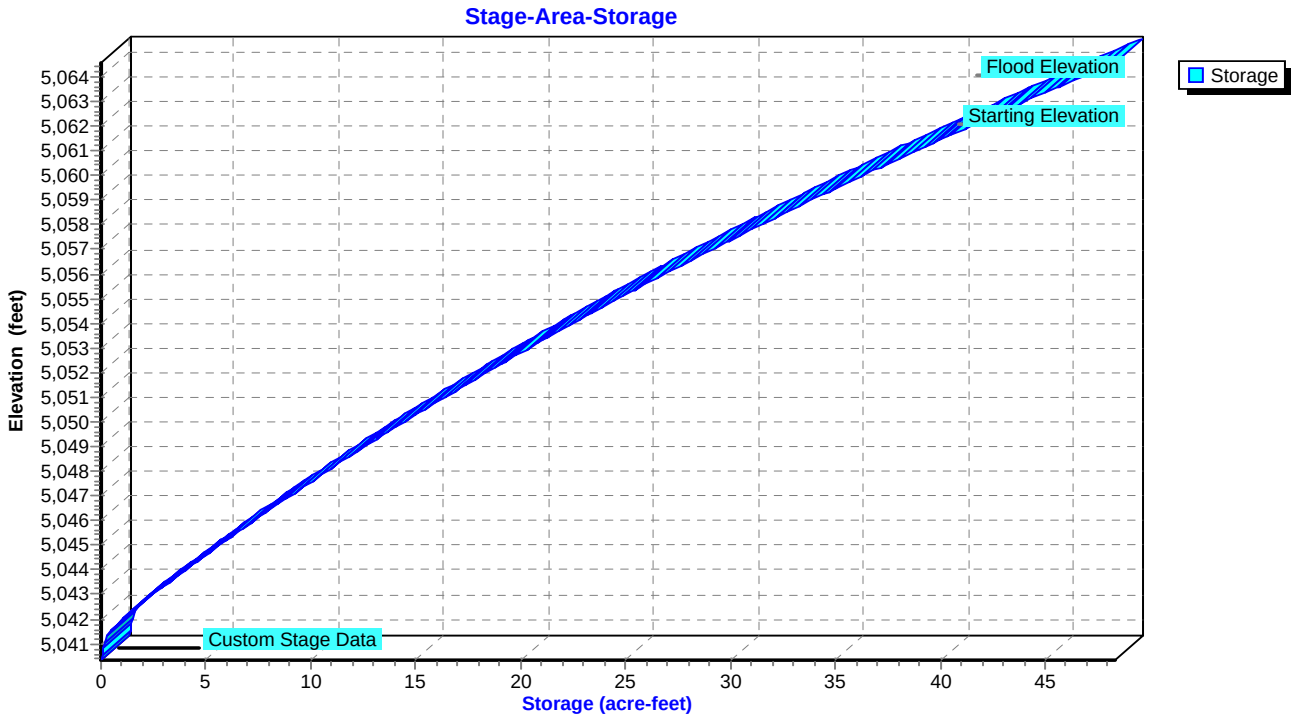
Pond 8P: Pond 1



Pond 8P: Pond 1



Pond 8P: Pond 1



Summary for Pond 9P: Pond 2

Inflow Area = 2.750 ac,100.00% Impervious, Inflow Depth = 1.80" for 100-YR, 6-HR event
Inflow = 11.27 cfs @ 2.89 hrs, Volume= 0.413 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Starting Elev= 5,057.80' Surf.Area= 0.000 ac Storage= 31.106 af
Peak Elev= 5,057.96' @ 6.05 hrs Surf.Area= 0.000 ac Storage= 31.519 af (0.413 af above start)
Flood Elev= 5,059.80' Surf.Area= 0.000 ac Storage= 36.361 af (5.255 af above start)

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

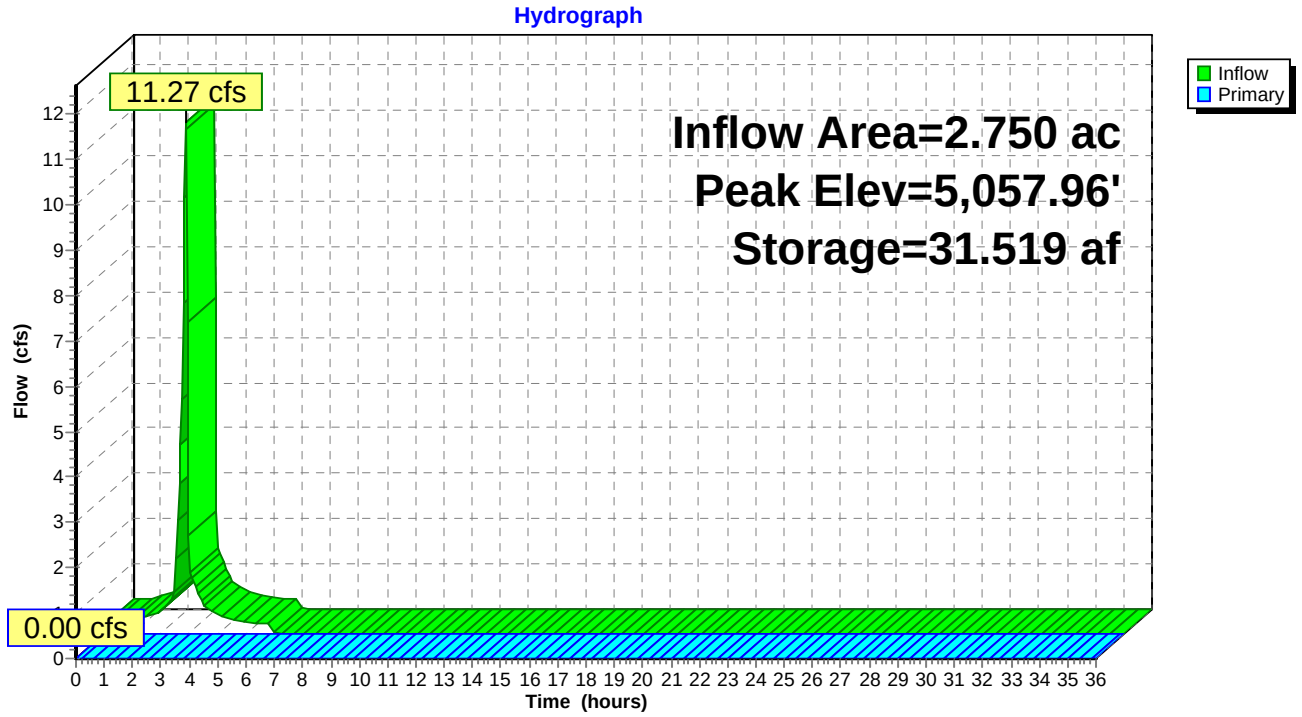
Volume	Invert	Avail.Storage	Storage Description
#1	5,042.42'	39.082 af	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (acre-feet)
5,042.42	0.000
5,043.42	0.335
5,044.42	1.897
5,045.42	3.742
5,046.42	5.638
5,047.42	7.588
5,048.42	9.591
5,049.42	11.649
5,050.42	13.761
5,051.42	15.929
5,052.42	18.152
5,053.42	20.433
5,054.42	22.771
5,055.42	25.167
5,056.42	27.621
5,057.42	30.135
5,057.80	31.106
5,058.80	33.704
5,059.80	36.361
5,060.80	39.082

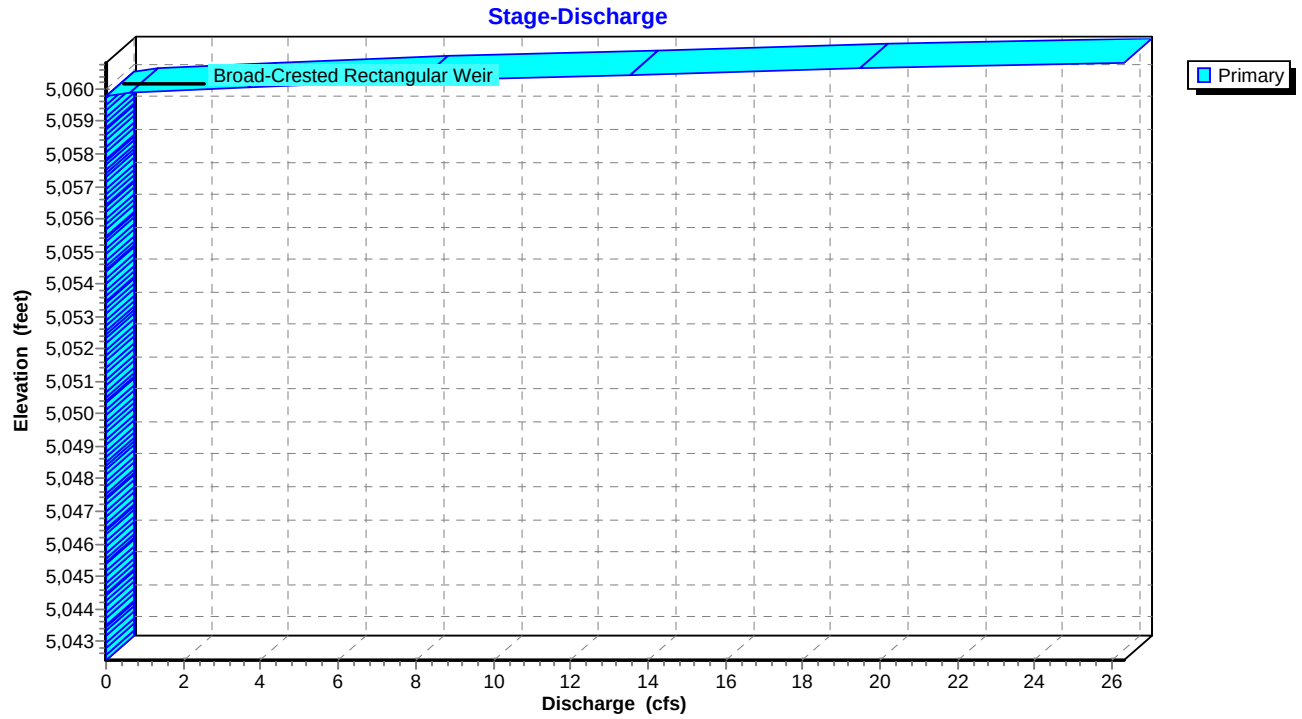
Device	Routing	Invert	Outlet Devices
#1	Primary	5,059.80'	**10.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,057.80' (Free Discharge)
1=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

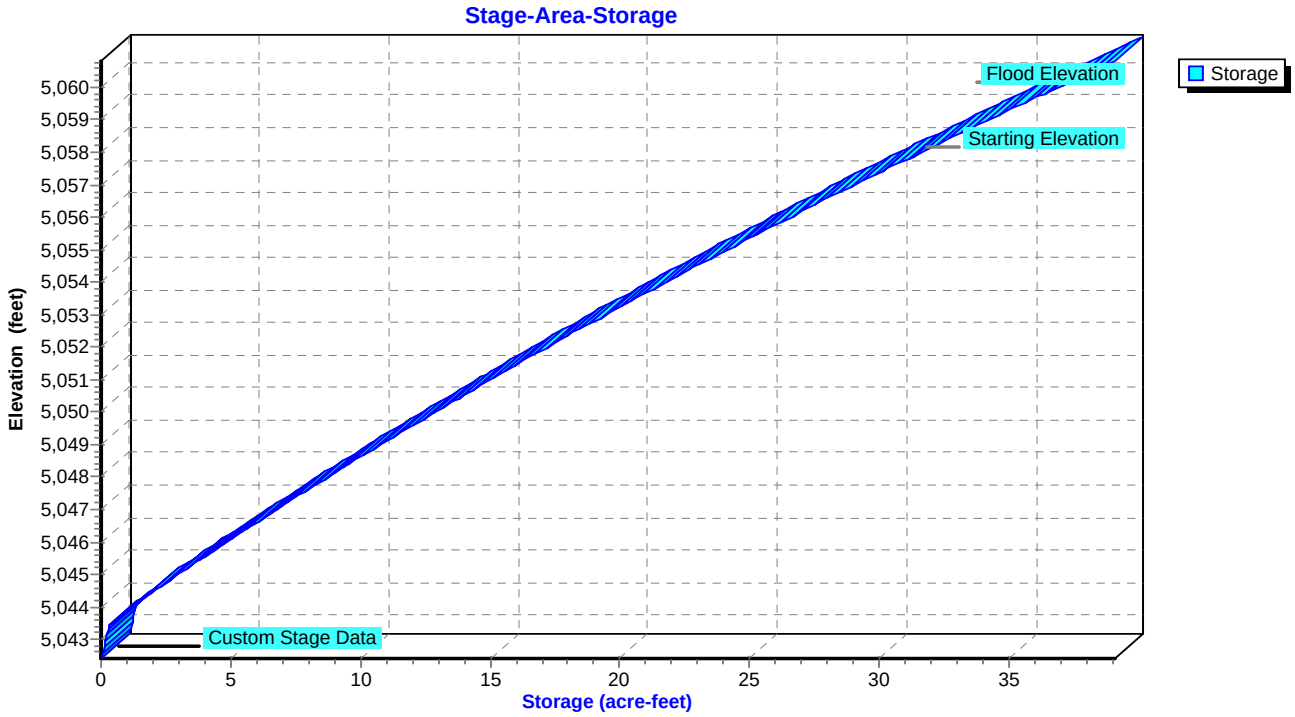
Pond 9P: Pond 2



Pond 9P: Pond 2



Pond 9P: Pond 2



Summary for Pond 10P: Pond 3

Inflow Area = 2.660 ac,100.00% Impervious, Inflow Depth = 1.80" for 100-YR, 6-HR event
Inflow = 10.91 cfs @ 2.89 hrs, Volume= 0.399 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Starting Elev= 5,048.50' Surf.Area= 0.000 ac Storage= 29.964 af
Peak Elev= 5,048.66' @ 6.05 hrs Surf.Area= 0.000 ac Storage= 30.363 af (0.399 af above start)
Flood Elev= 5,050.50' Surf.Area= 0.000 ac Storage= 34.999 af (5.035 af above start)

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

Volume	Invert	Avail.Storage	Storage Description
#1	5,032.00'	37.619 af	**Custom Stage Data** Listed below

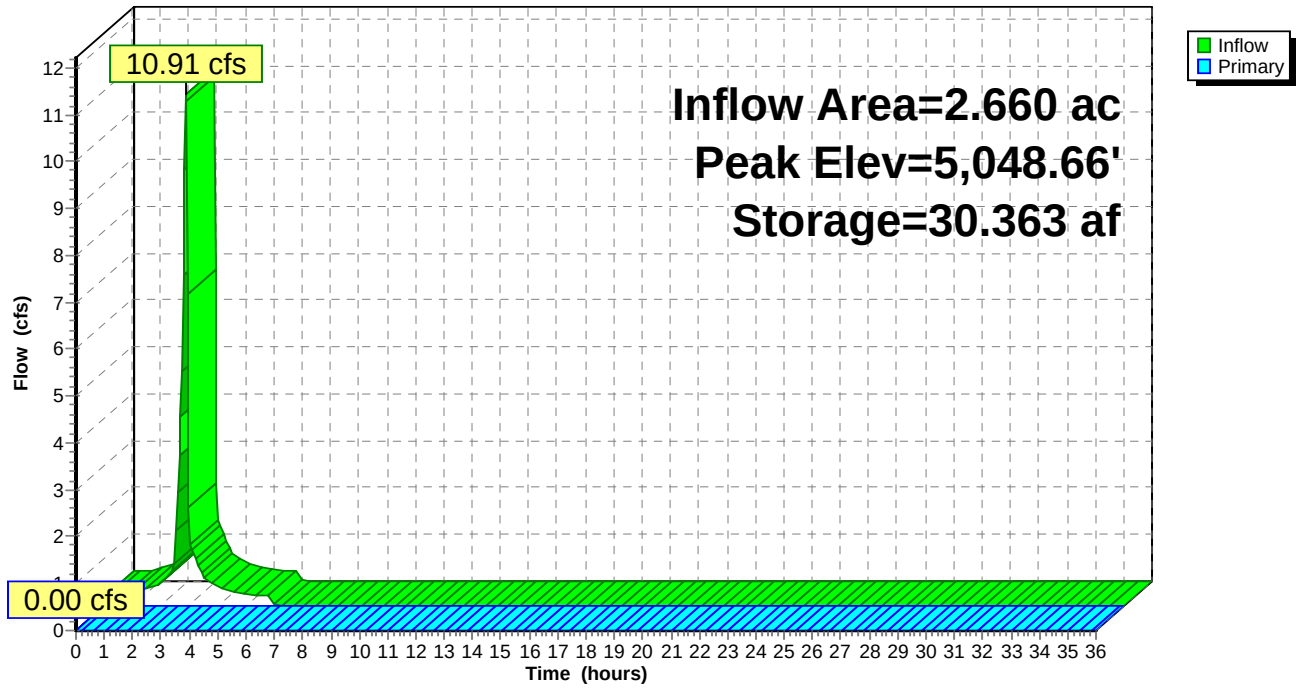
Elevation (feet)	Cum.Store (acre-feet)
5,032.00	0.000
5,033.00	0.217
5,034.00	1.183
5,035.00	2.730
5,036.00	4.364
5,037.00	6.057
5,038.00	7.809
5,039.00	9.622
5,040.00	11.495
5,041.00	13.429
5,042.00	15.426
5,043.00	17.486
5,044.00	19.609
5,045.00	21.796
5,046.00	24.047
5,047.00	26.365
5,048.00	28.748
5,048.50	29.964
5,049.50	32.448
5,050.50	34.999
5,051.50	37.619

Device	Routing	Invert	Outlet Devices
#1	Primary	5,050.50'	**10.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,048.50' (Free Discharge)
1=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

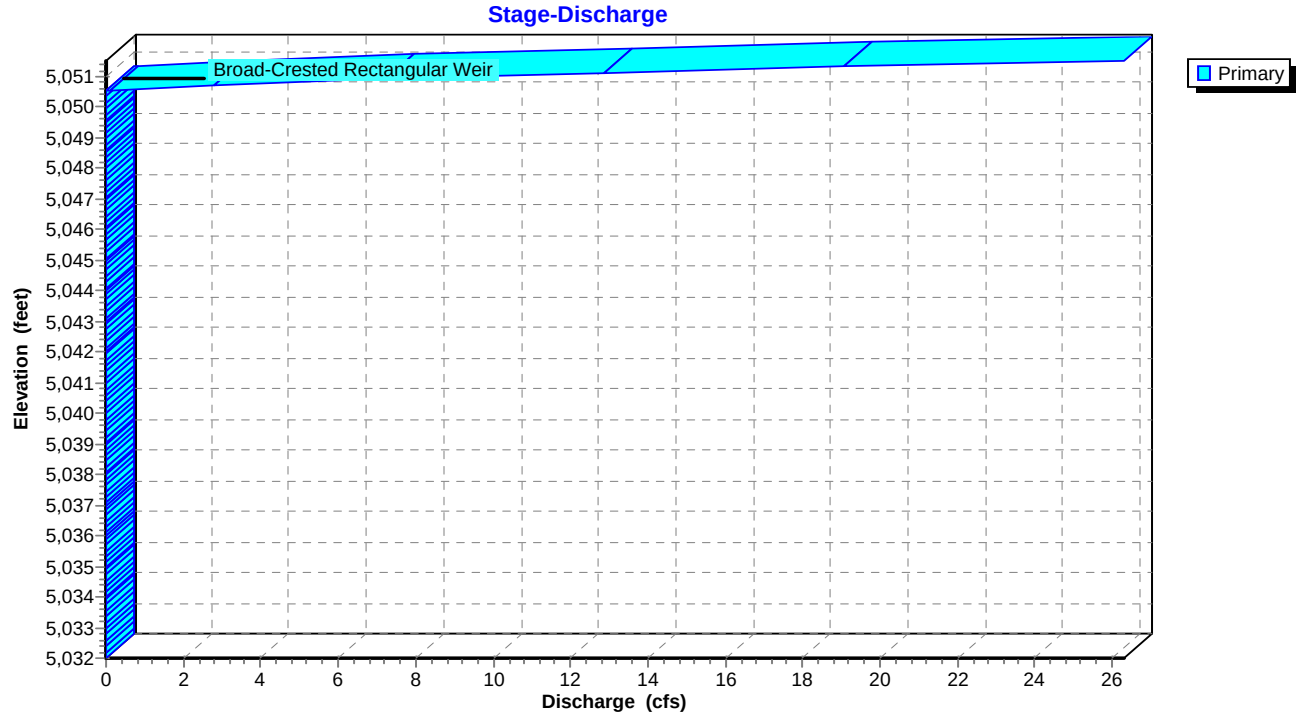
Pond 10P: Pond 3

Hydrograph

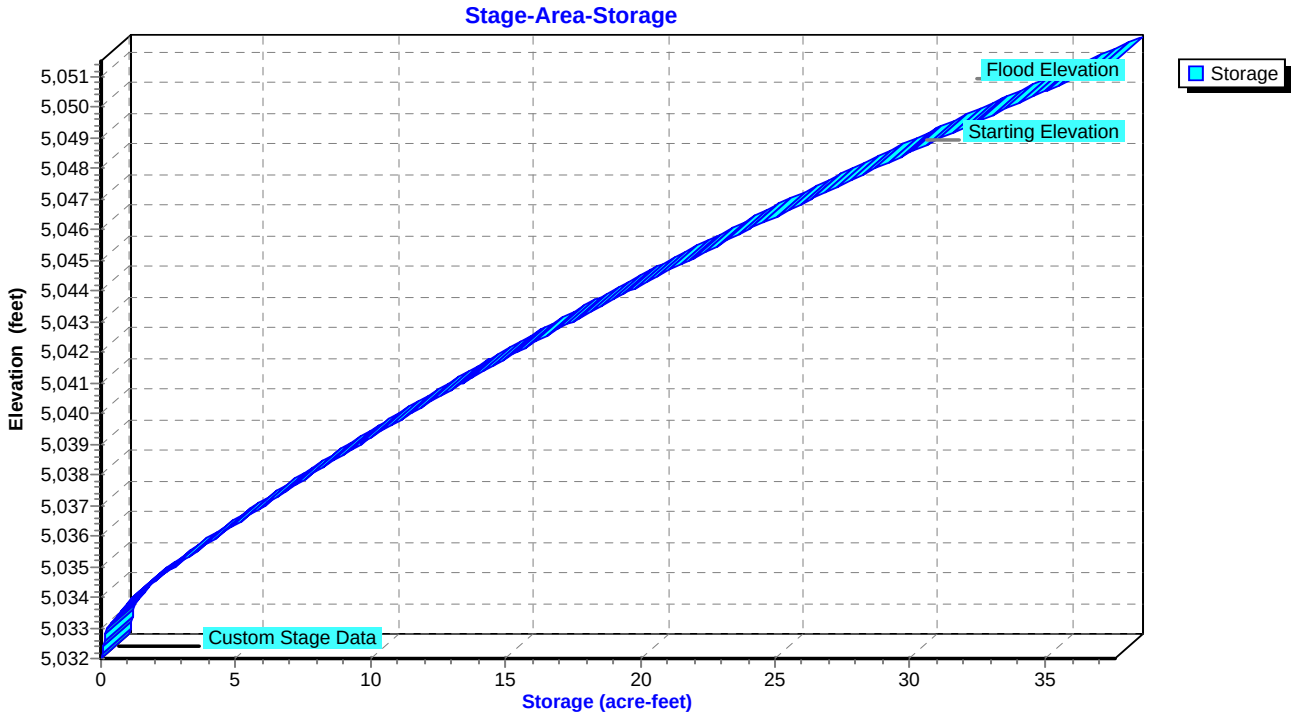


Pond 10P: Pond 3

Stage-Discharge



Pond 10P: Pond 3



Summary for Pond 11P: Detention Pond

Inflow Area = 14.470 ac, 0.00% Impervious, Inflow Depth = 0.47" for 100-YR, 6-HR event
Inflow = 3.88 cfs @ 3.87 hrs, Volume= 0.570 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 5,028.79' @ 23.20 hrs Surf.Area= 0.262 ac Storage= 0.570 af

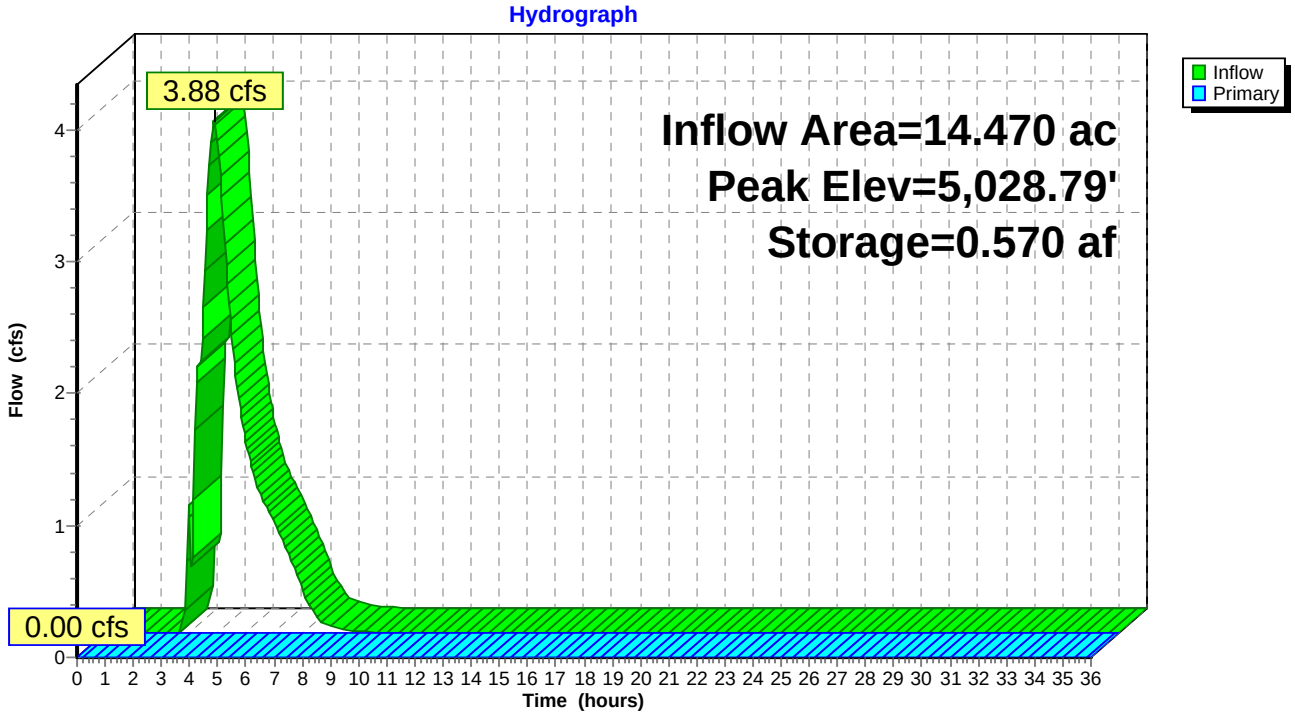
Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	5,026.00'	1.256 af	**26.00'W x 250.00'L x 5.00'H Prismatoid Z=3.0**

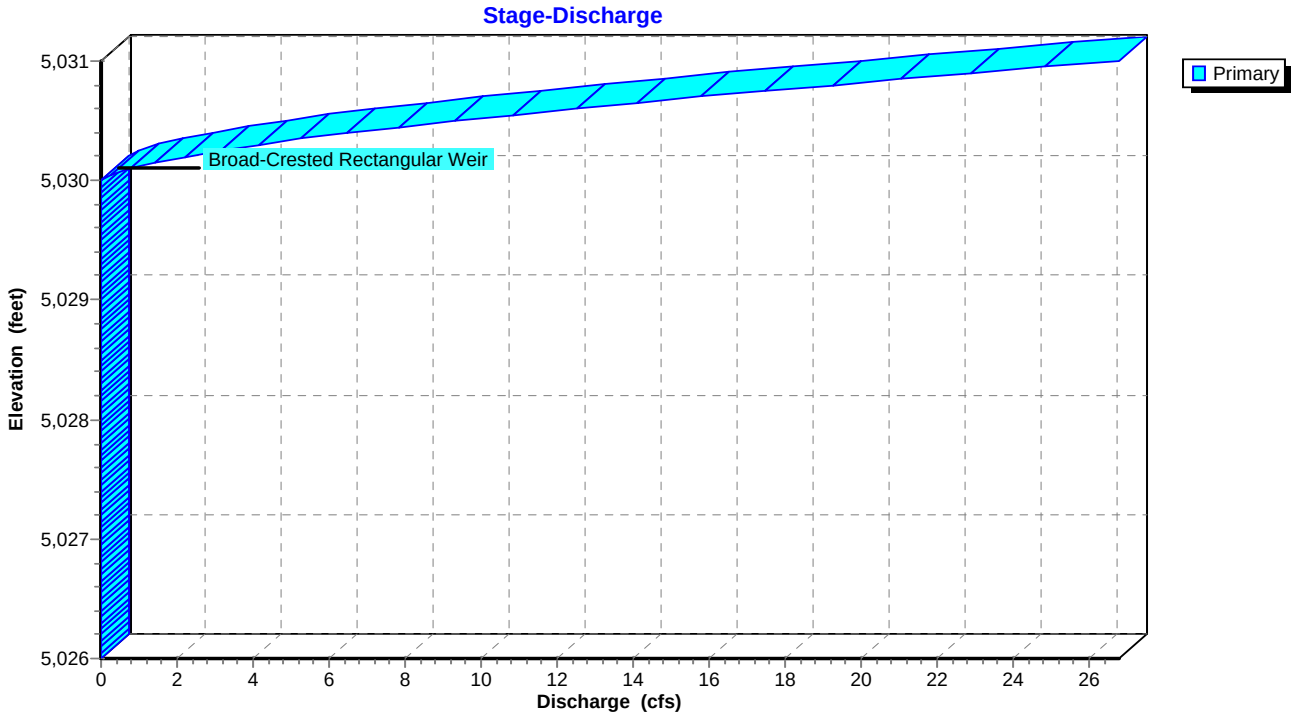
Device	Routing	Invert	Outlet Devices
#1	Primary	5,030.00'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,026.00' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

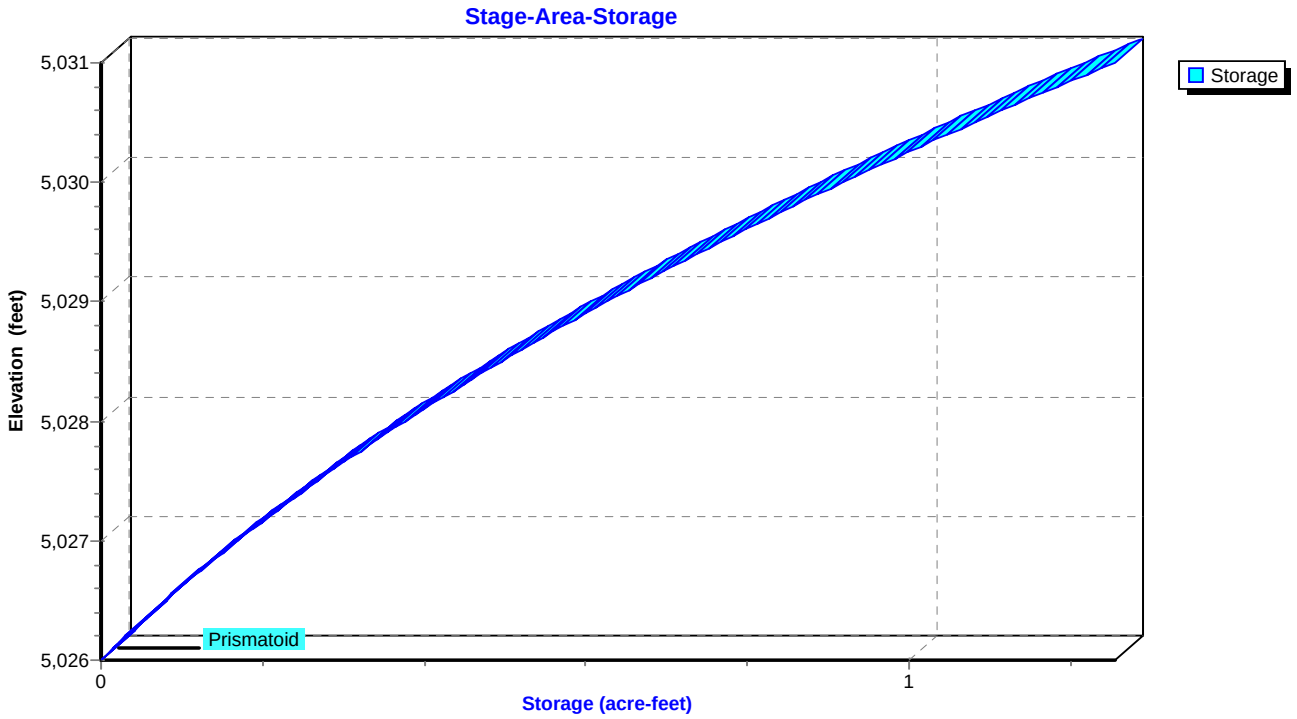
Pond 11P: Detention Pond



Pond 11P: Detention Pond

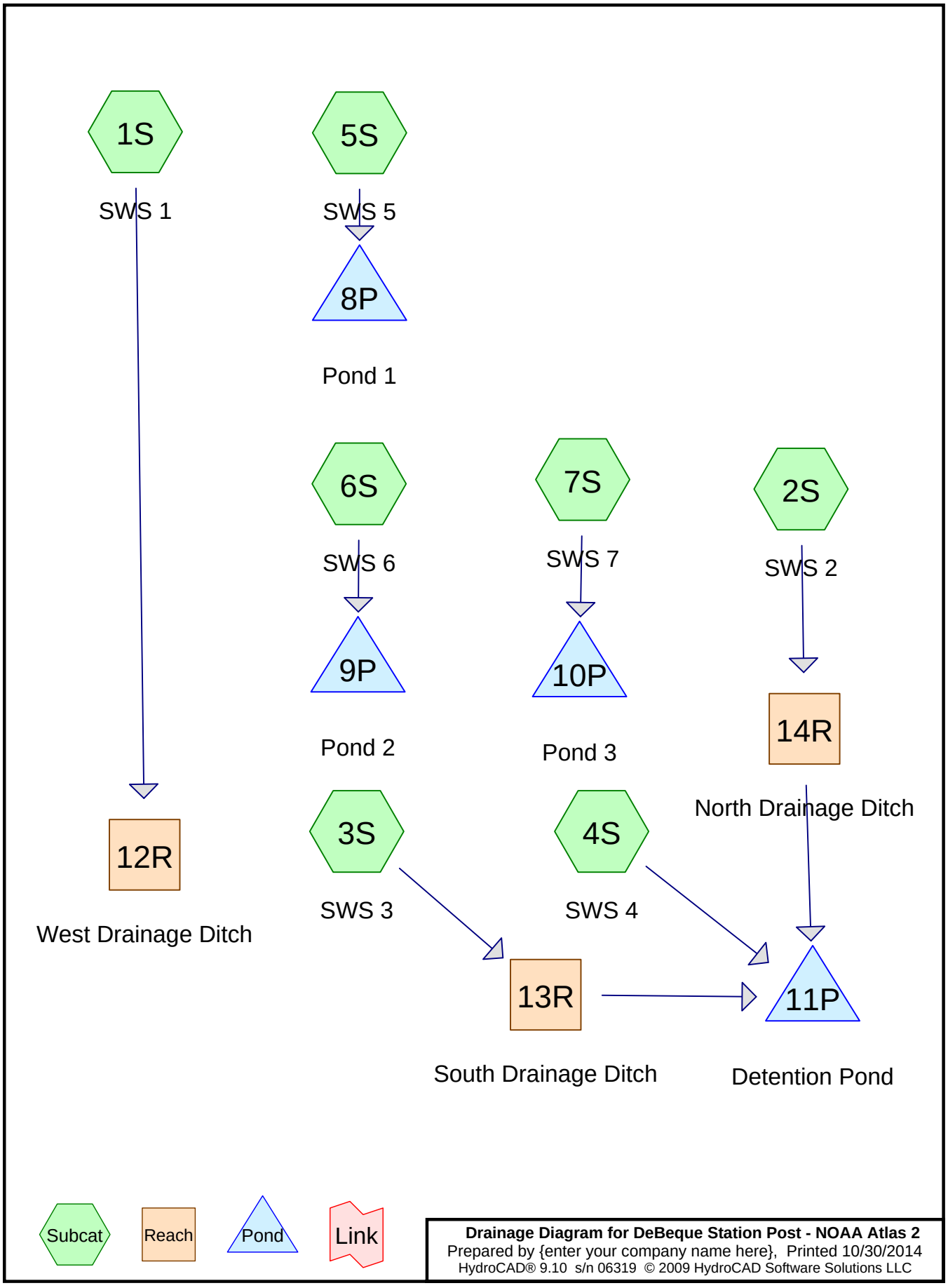


Pond 11P: Detention Pond



APPENDIX C5

HydroCAD Report
NOAA Atlas 2: Post-Development
100-Year, 6-Hour Event
Starting Storage Elevation = 5,030.00 FT



Drainage Diagram for DeBeque Station Post - NOAA Atlas 2
Prepared by {enter your company name here}, Printed 10/30/2014
HydroCAD® 9.10 s/n 06319 © 2009 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.200	76	Weighted Curve Number (4S)
3.160	78	Weighted Curve Number (3S)
258.860	79	Weighted Curve Number (1S)
10.110	82	Weighted Curve Number (2S)
8.250	100	Liner (5S, 6S, 7S)
281.580		**TOTAL AREA**

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: SWS 1 Runoff Area=258.860 ac 0.00% Impervious Runoff Depth=0.41"
Flow Length=8,106' Tc=56.7 min CN=79 Runoff=68.59 cfs 8.838 af

Subcatchment 2S: SWS 2 Runoff Area=10.110 ac 0.00% Impervious Runoff Depth=0.52"
Flow Length=2,405' Tc=58.5 min CN=82 Runoff=3.51 cfs 0.439 af

Subcatchment 3S: SWS 3 Runoff Area=3.160 ac 0.00% Impervious Runoff Depth=0.38"
Flow Length=934' Tc=14.6 min CN=78 Runoff=1.95 cfs 0.099 af

Subcatchment 4S: SWS 4 Runoff Area=1.200 ac 0.00% Impervious Runoff Depth=0.32"
Flow Length=174' Tc=3.8 min CN=76 Runoff=0.99 cfs 0.032 af

Subcatchment 5S: SWS 5 Runoff Area=2.840 ac 100.00% Impervious Runoff Depth=1.80"
Flow Length=15' Slope=0.5000 '/' Tc=0.1 min CN=100 Runoff=11.64 cfs 0.426 af

Subcatchment 6S: SWS 6 Runoff Area=2.750 ac 100.00% Impervious Runoff Depth=1.80"
Flow Length=15' Slope=0.5000 '/' Tc=0.1 min CN=100 Runoff=11.27 cfs 0.413 af

Subcatchment 7S: SWS 7 Runoff Area=2.660 ac 100.00% Impervious Runoff Depth=1.80"
Flow Length=15' Slope=0.5000 '/' Tc=0.1 min CN=100 Runoff=10.91 cfs 0.399 af

Reach 12R: West Drainage Ditch Avg. Flow Depth=1.09' Max Vel=8.78 fps Inflow=68.59 cfs 8.838 af
n=0.022 L=1,297.4' S=0.0231 '/' Capacity=219.29 cfs Outflow=68.31 cfs 8.838 af

Reach 13R: South Drainage Ditch Avg. Flow Depth=0.24' Max Vel=2.78 fps Inflow=1.95 cfs 0.099 af
n=0.022 L=1,015.0' S=0.0156 '/' Capacity=107.67 cfs Outflow=1.62 cfs 0.099 af

Reach 14R: North Drainage Ditch Avg. Flow Depth=0.32' Max Vel=4.11 fps Inflow=3.51 cfs 0.439 af
n=0.022 L=1,723.1' S=0.0242 '/' Capacity=134.16 cfs Outflow=3.42 cfs 0.439 af

Pond 8P: Pond 1 Peak Elev=5,061.73' Storage=40.703 af Inflow=11.64 cfs 0.426 af
Outflow=0.00 cfs 0.000 af

Pond 9P: Pond 2 Peak Elev=5,057.96' Storage=31.519 af Inflow=11.27 cfs 0.413 af
Outflow=0.00 cfs 0.000 af

Pond 10P: Pond 3 Peak Elev=5,048.66' Storage=30.363 af Inflow=10.91 cfs 0.399 af
Outflow=0.00 cfs 0.000 af

Pond 11P: Detention Pond Peak Elev=5,030.81' Storage=1.188 af Inflow=3.88 cfs 0.570 af
Outflow=1.65 cfs 0.560 af

Total Runoff Area = 281.580 ac Runoff Volume = 10.645 af Average Runoff Depth = 0.45"
97.07% Pervious = 273.330 ac 2.93% Impervious = 8.250 ac

Summary for Subcatchment 1S: SWS 1

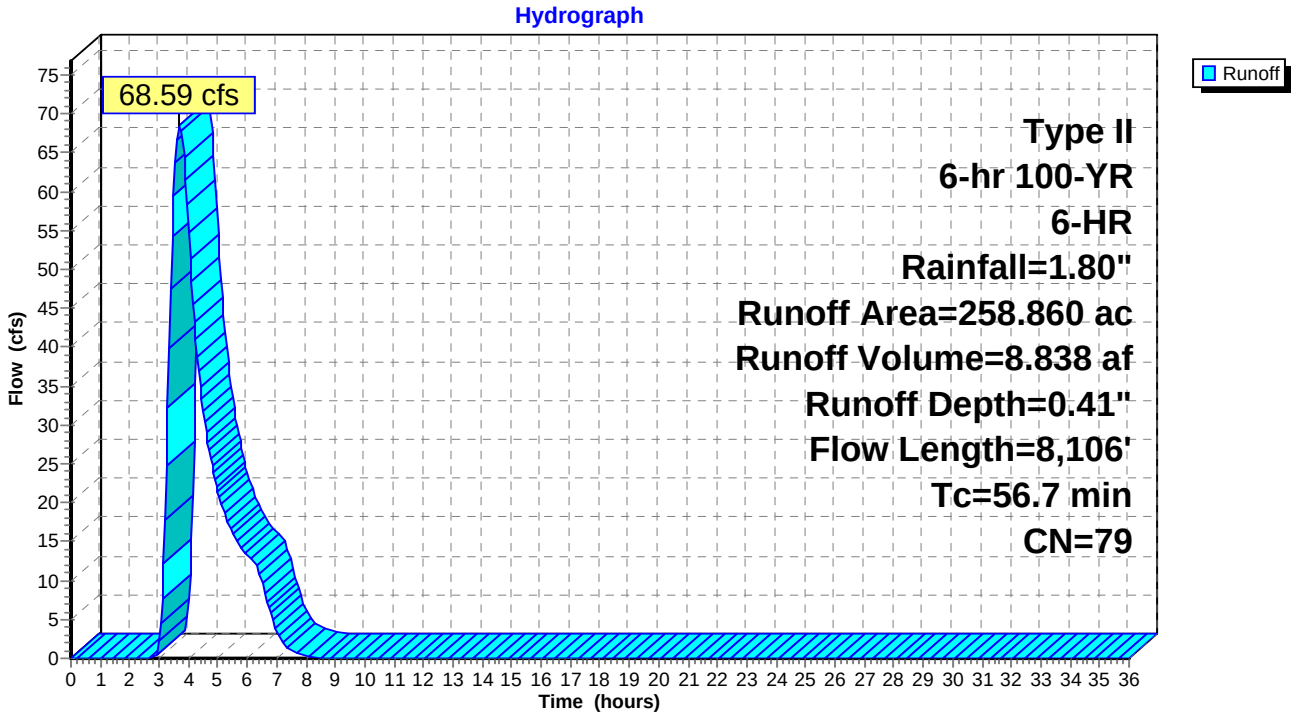
Runoff = 68.59 cfs @ 3.70 hrs, Volume= 8.838 af, Depth= 0.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-YR, 6-HR Rainfall=1.80"

	Area (ac)	CN	Description
*	258.860	79	Weighted Curve Number
	258.860		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	300	0.3900	0.45		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
45.6	7,806	0.0813	2.85		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
56.7	8,106	Total			

Subcatchment 1S: SWS 1



Summary for Subcatchment 2S: SWS 2

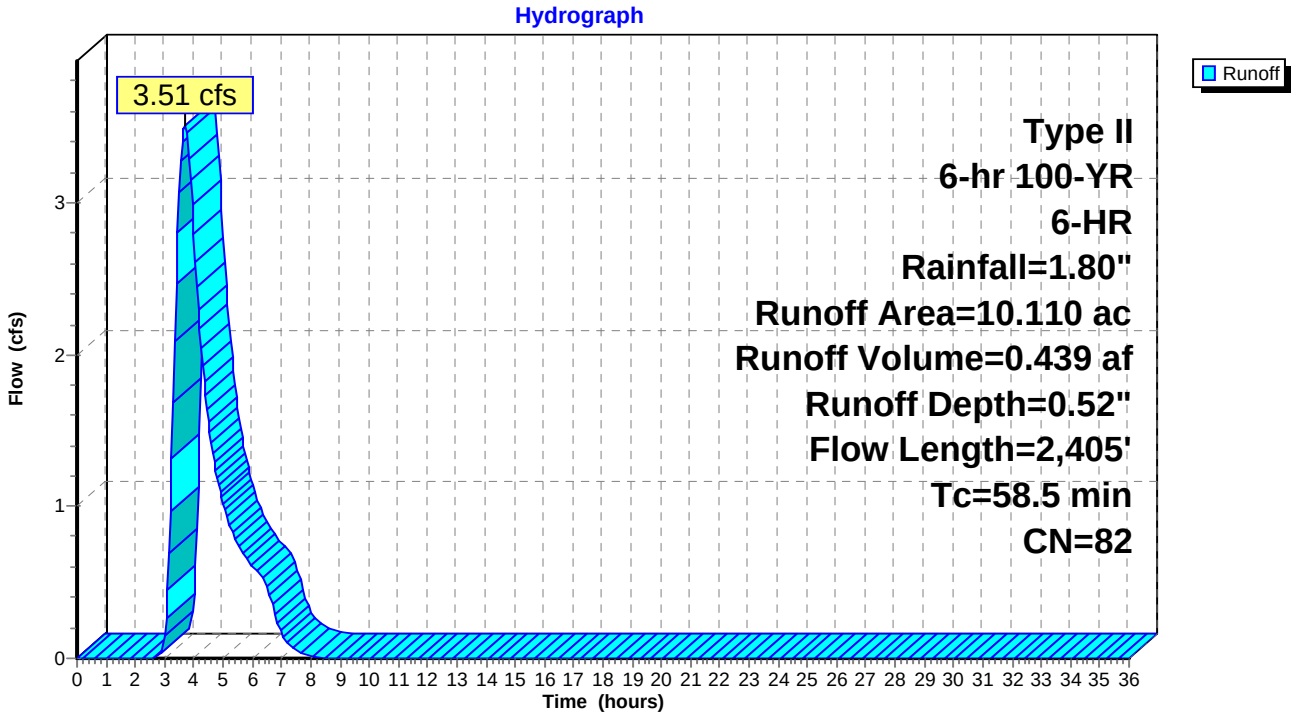
Runoff = 3.51 cfs @ 3.70 hrs, Volume= 0.439 af, Depth= 0.52"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-YR, 6-HR Rainfall=1.80"

	Area (ac)	CN	Description
*	10.110	82	Weighted Curve Number
	10.110		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.2	300	0.0233	0.15		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
24.3	2,105	0.0209	1.45		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
58.5	2,405	Total			

Subcatchment 2S: SWS 2



Summary for Subcatchment 3S: SWS 3

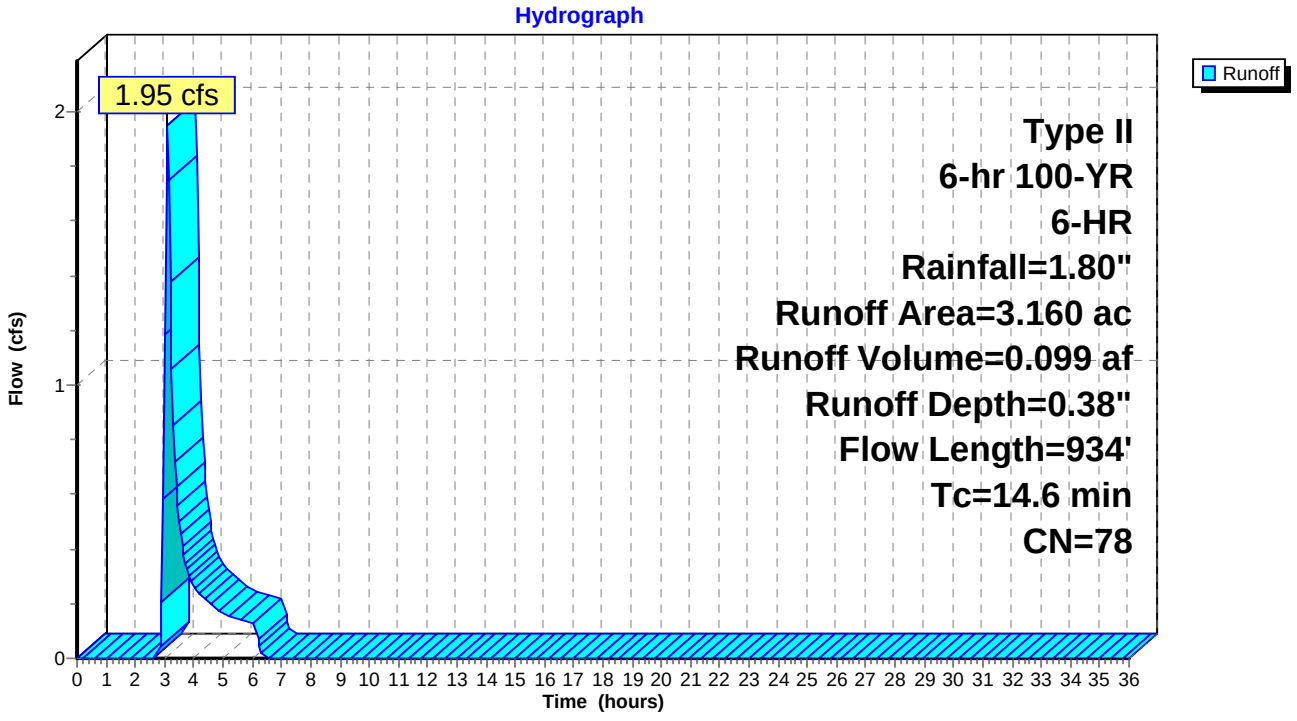
Runoff = 1.95 cfs @ 3.10 hrs, Volume= 0.099 af, Depth= 0.38"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-YR, 6-HR Rainfall=1.80"

	Area (ac)	CN	Description
*	3.160	78	Weighted Curve Number
	3.160		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.2500	0.26		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
11.4	884	0.0166	1.29		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
14.6	934	Total			

Subcatchment 3S: SWS 3



Summary for Subcatchment 4S: SWS 4

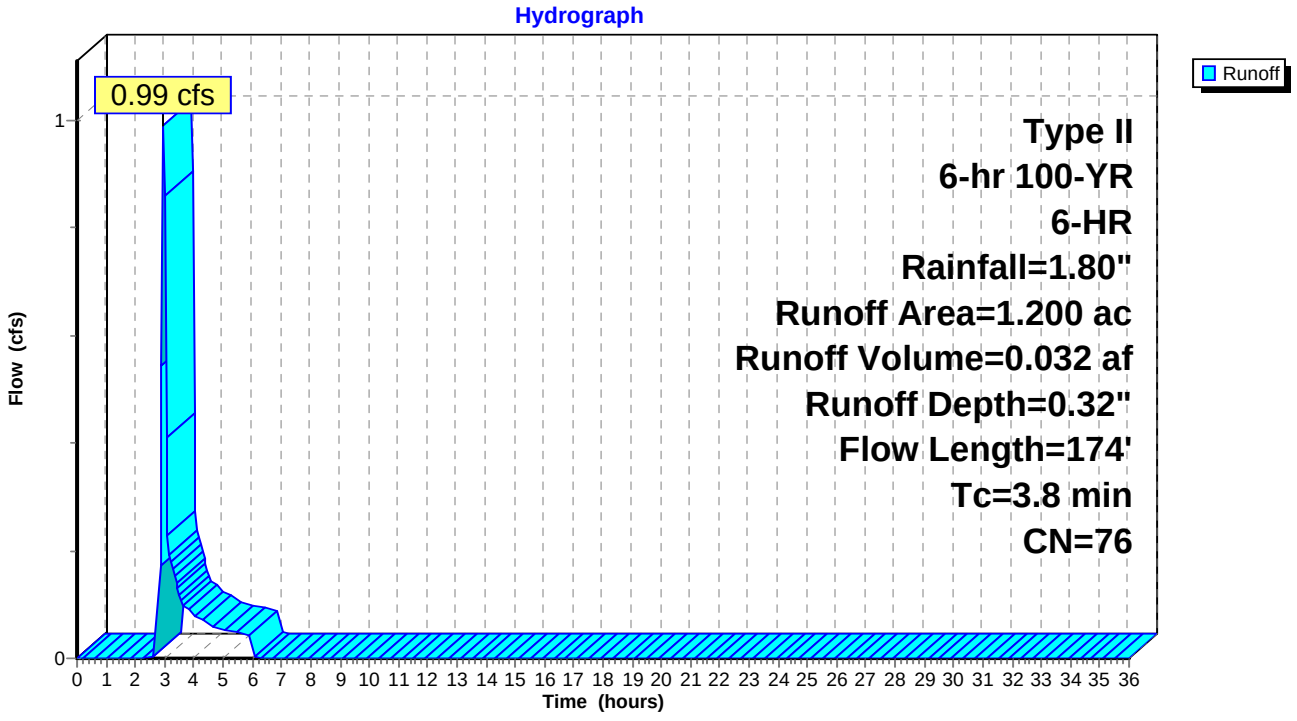
Runoff = 0.99 cfs @ 2.96 hrs, Volume= 0.032 af, Depth= 0.32"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-YR, 6-HR Rainfall=1.80"

	Area (ac)	CN	Description
*	1.200	76	Weighted Curve Number
	1.200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.2500	0.26		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
0.6	124	0.1149	3.39		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
3.8	174	Total			

Subcatchment 4S: SWS 4



Summary for Subcatchment 5S: SWS 5

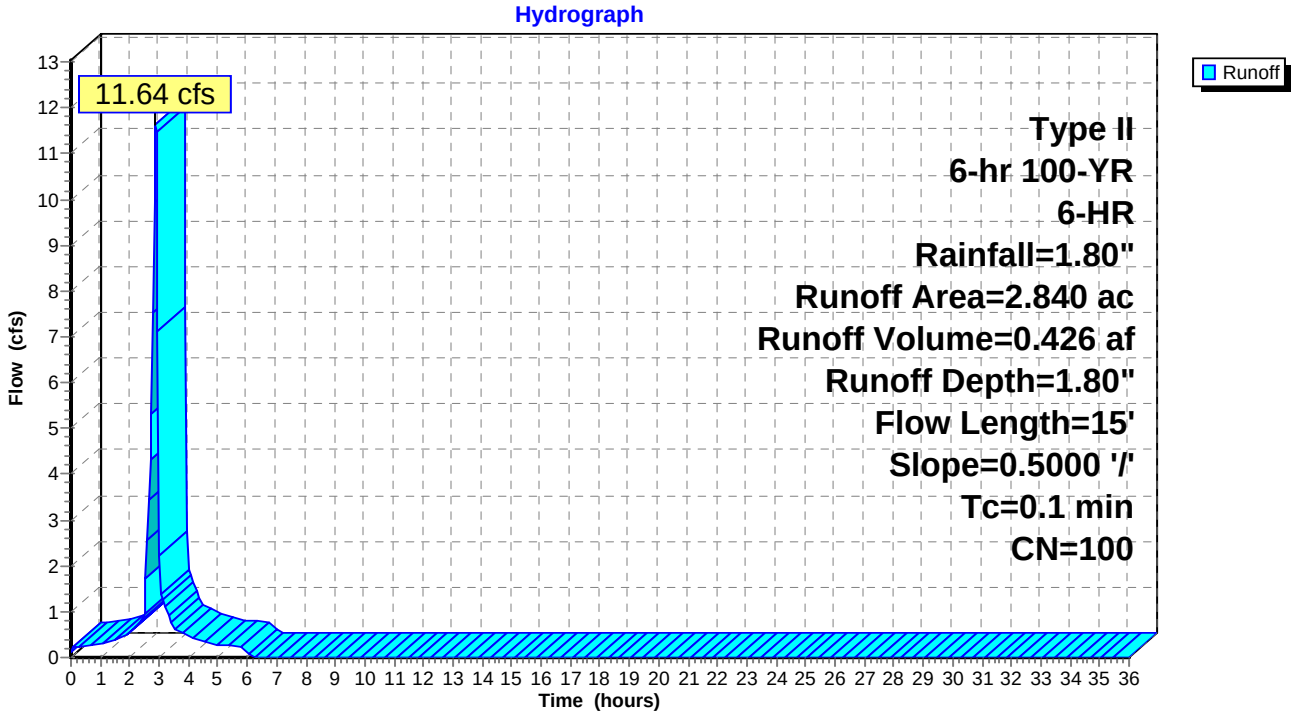
Runoff = 11.64 cfs @ 2.89 hrs, Volume= 0.426 af, Depth= 1.80"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-YR, 6-HR Rainfall=1.80"

	Area (ac)	CN	Description
*	2.840	100	Liner
	2.840		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	15	0.5000	1.97		**Sheet Flow, Overland Flow** Smooth surfaces n= 0.011 P2= 1.07"

Subcatchment 5S: SWS 5



Summary for Subcatchment 6S: SWS 6

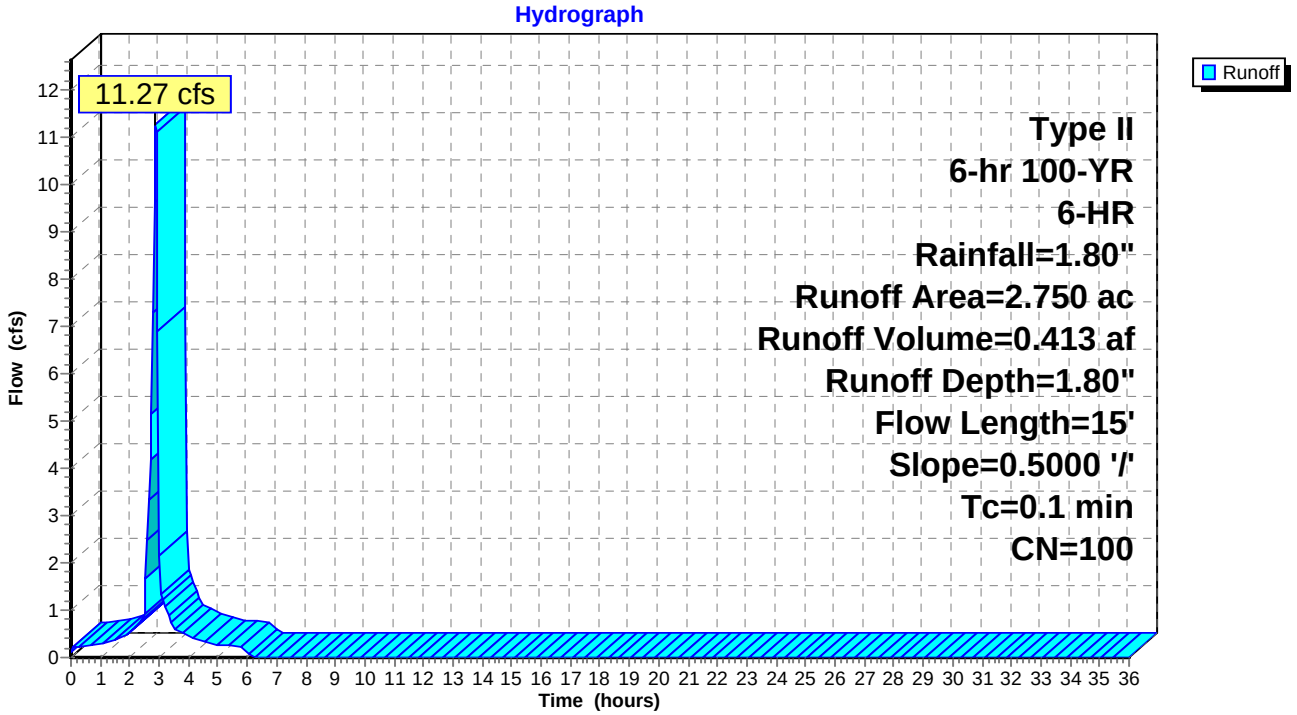
Runoff = 11.27 cfs @ 2.89 hrs, Volume= 0.413 af, Depth= 1.80"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-YR, 6-HR Rainfall=1.80"

	Area (ac)	CN	Description
*	2.750	100	Liner
	2.750		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	15	0.5000	1.97		**Sheet Flow, Overland Flow** Smooth surfaces n= 0.011 P2= 1.07"

Subcatchment 6S: SWS 6



Summary for Subcatchment 7S: SWS 7

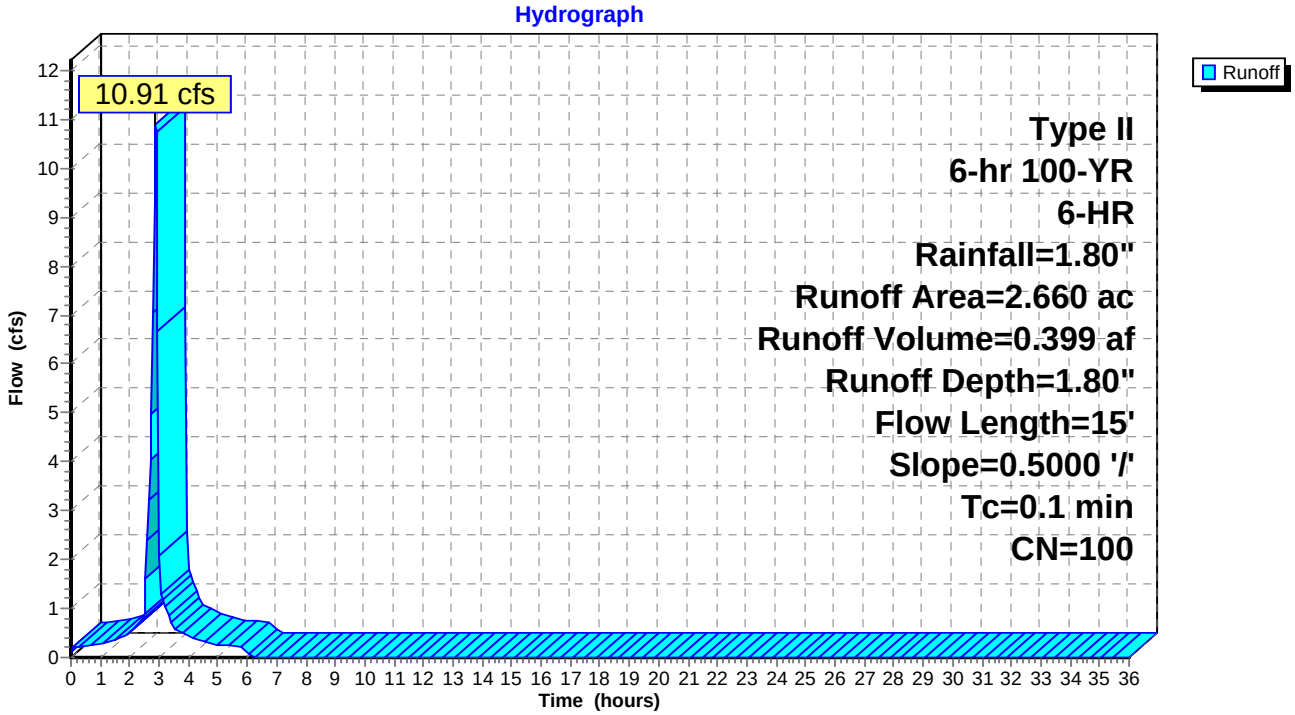
Runoff = 10.91 cfs @ 2.89 hrs, Volume= 0.399 af, Depth= 1.80"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-YR, 6-HR Rainfall=1.80"

	Area (ac)	CN	Description
*	2.660	100	Liner
	2.660		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	15	0.5000	1.97		**Sheet Flow, Overland Flow** Smooth surfaces n= 0.011 P2= 1.07"

Subcatchment 7S: SWS 7



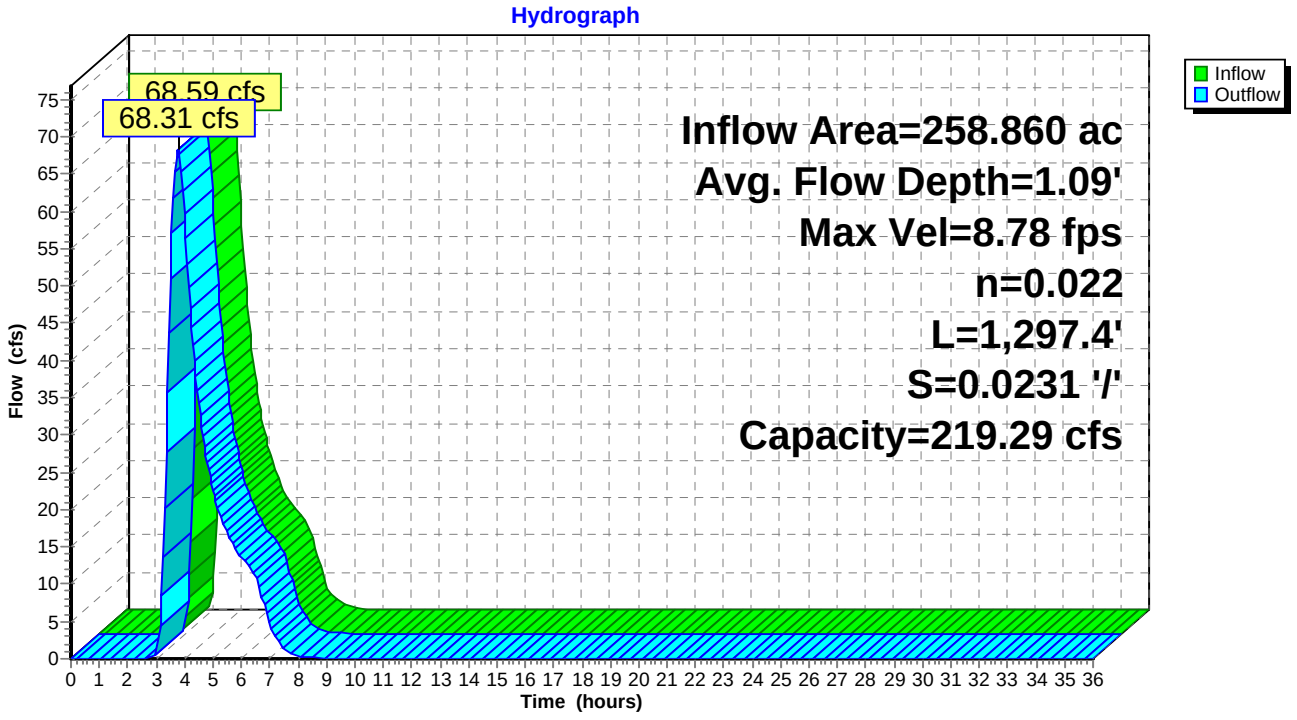
Summary for Reach 12R: West Drainage Ditch

Inflow Area = 258.860 ac, 0.00% Impervious, Inflow Depth = 0.41" for 100-YR, 6-HR event
Inflow = 68.59 cfs @ 3.70 hrs, Volume= 8.838 af
Outflow = 68.31 cfs @ 3.77 hrs, Volume= 8.838 af, Atten= 0%, Lag= 4.2 min

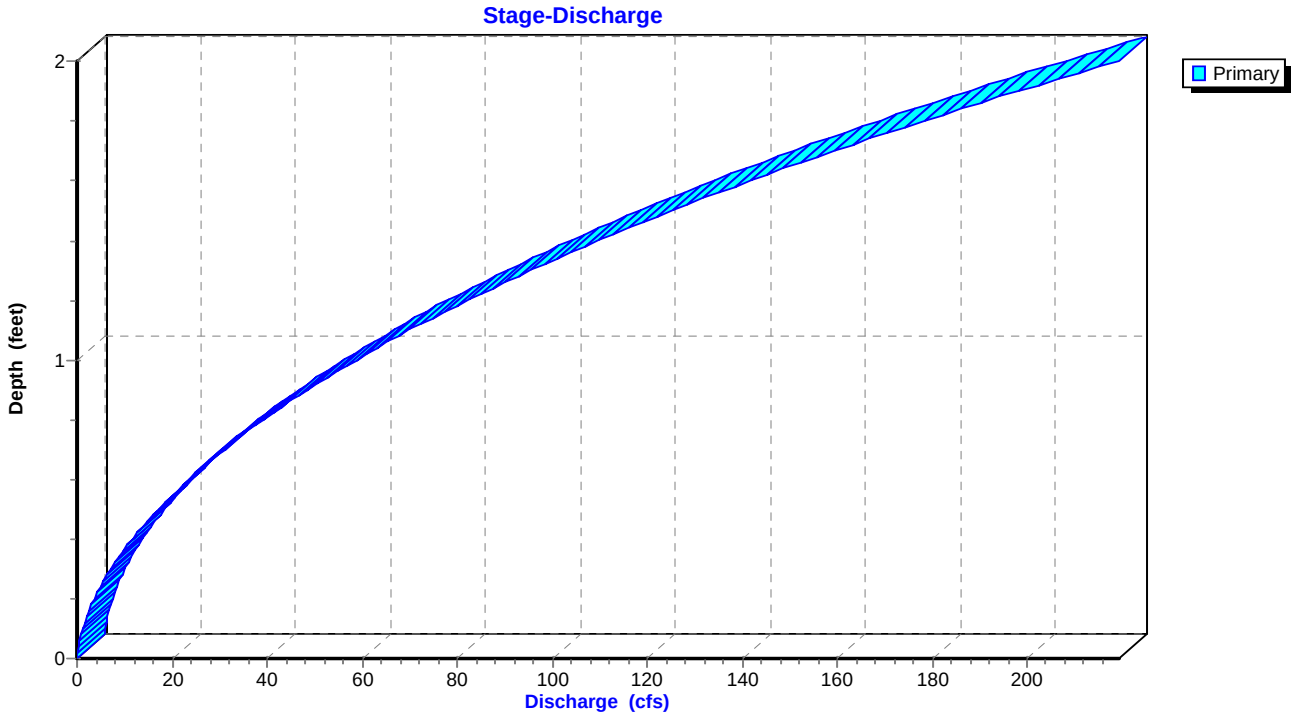
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Max. Velocity= 8.78 fps, Min. Travel Time= 2.5 min
Avg. Velocity = 3.26 fps, Avg. Travel Time= 6.6 min

Peak Storage= 10,103 cf @ 3.73 hrs
Average Depth at Peak Storage= 1.09'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 219.29 cfs

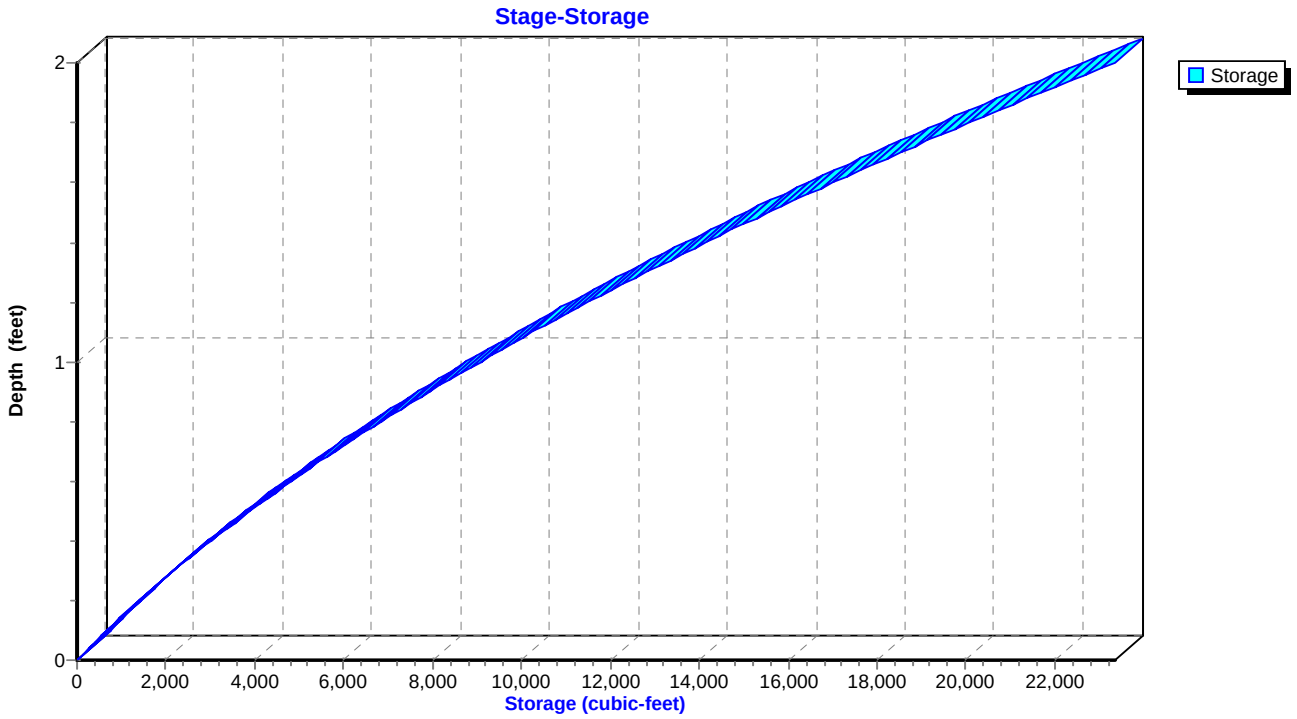
5.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 2.0 '/' Top Width= 13.00'
Length= 1,297.4' Slope= 0.0231 '/'
Inlet Invert= 5,077.00', Outlet Invert= 5,046.97'



Reach 12R: West Drainage Ditch



Reach 12R: West Drainage Ditch



Summary for Reach 13R: South Drainage Ditch

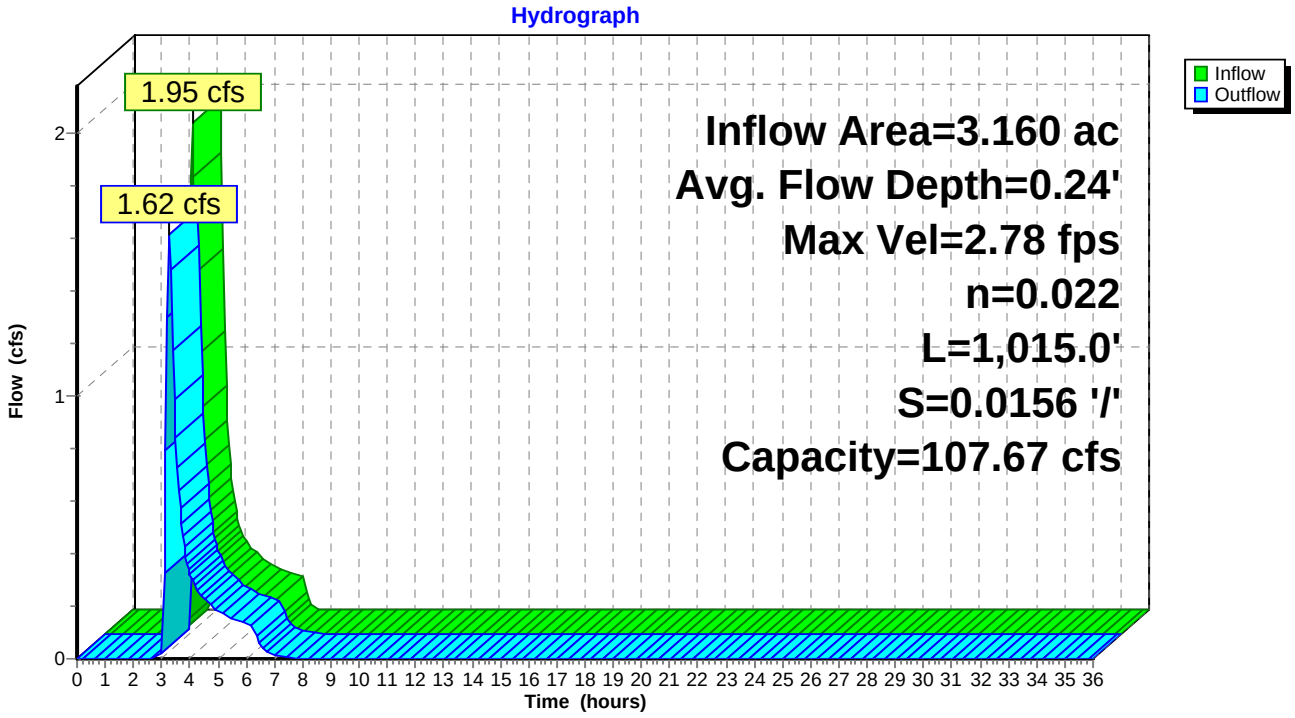
Inflow Area = 3.160 ac, 0.00% Impervious, Inflow Depth = 0.38" for 100-YR, 6-HR event
Inflow = 1.95 cfs @ 3.10 hrs, Volume= 0.099 af
Outflow = 1.62 cfs @ 3.27 hrs, Volume= 0.099 af, Atten= 17%, Lag= 10.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.78 fps, Min. Travel Time= 6.1 min
Avg. Velocity = 1.09 fps, Avg. Travel Time= 15.6 min

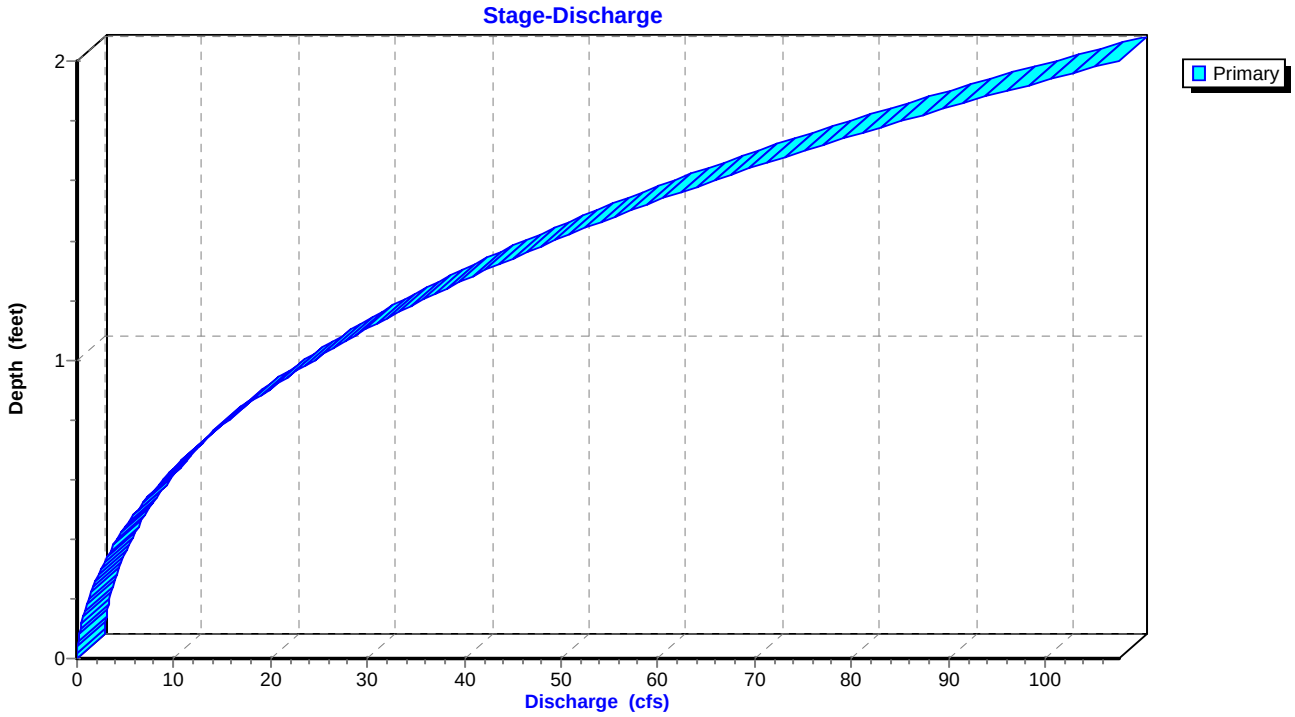
Peak Storage= 589 cf @ 3.17 hrs
Average Depth at Peak Storage= 0.24'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 107.67 cfs

2.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 1,015.0' Slope= 0.0156 '/'
Inlet Invert= 5,045.22', Outlet Invert= 5,029.38'

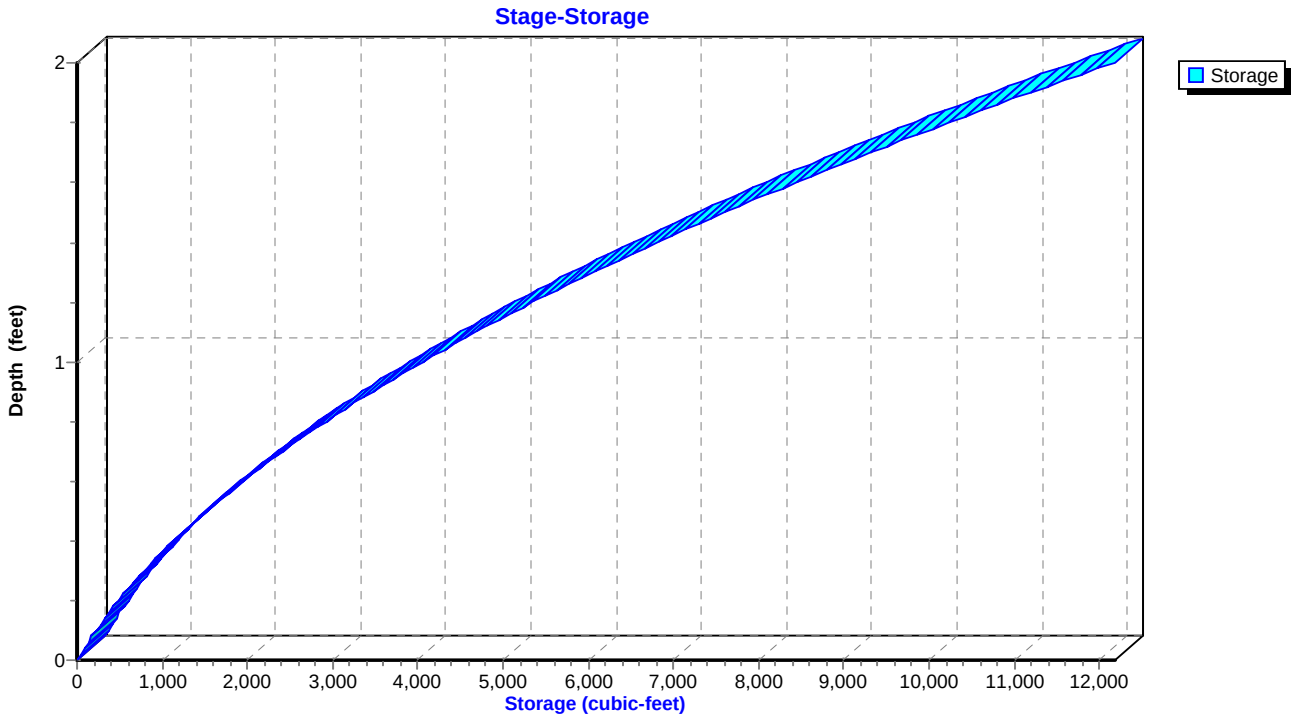
Reach 13R: South Drainage Ditch



Reach 13R: South Drainage Ditch



Reach 13R: South Drainage Ditch



Summary for Reach 14R: North Drainage Ditch

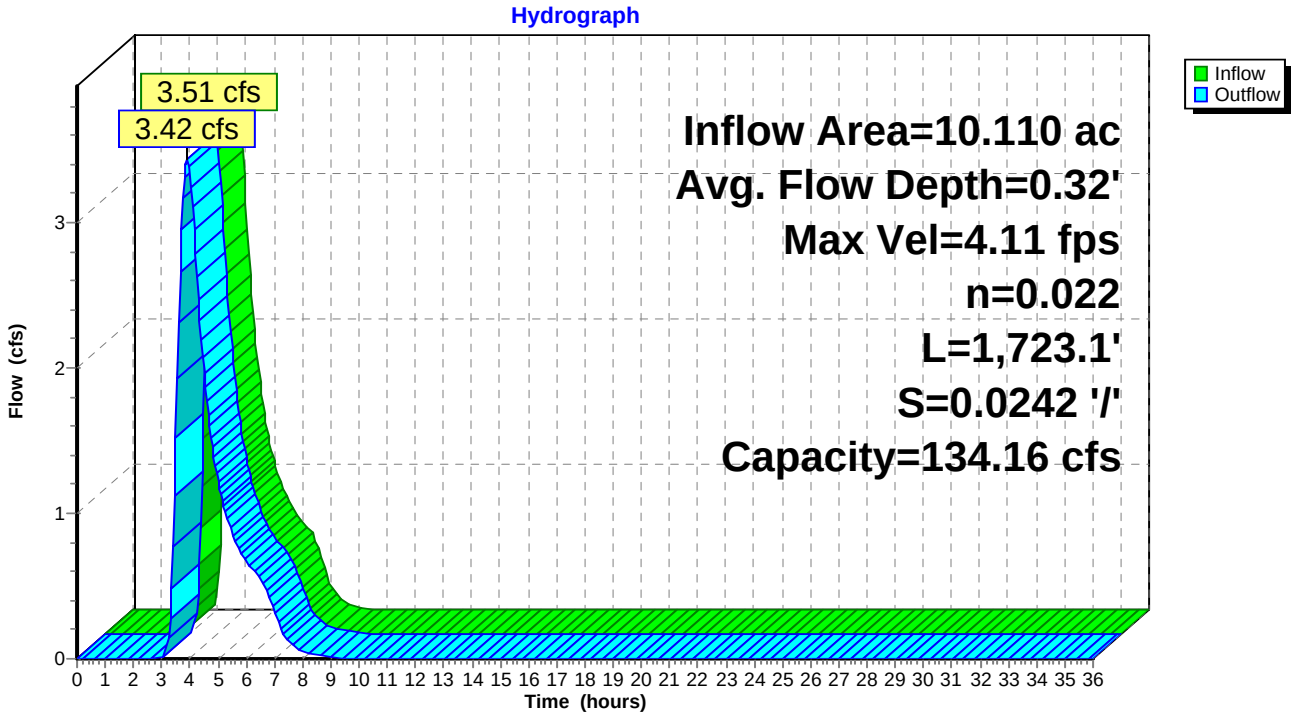
Inflow Area = 10.110 ac, 0.00% Impervious, Inflow Depth = 0.52" for 100-YR, 6-HR event
Inflow = 3.51 cfs @ 3.70 hrs, Volume= 0.439 af
Outflow = 3.42 cfs @ 3.90 hrs, Volume= 0.439 af, Atten= 3%, Lag= 12.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.11 fps, Min. Travel Time= 7.0 min
Avg. Velocity = 1.69 fps, Avg. Travel Time= 17.0 min

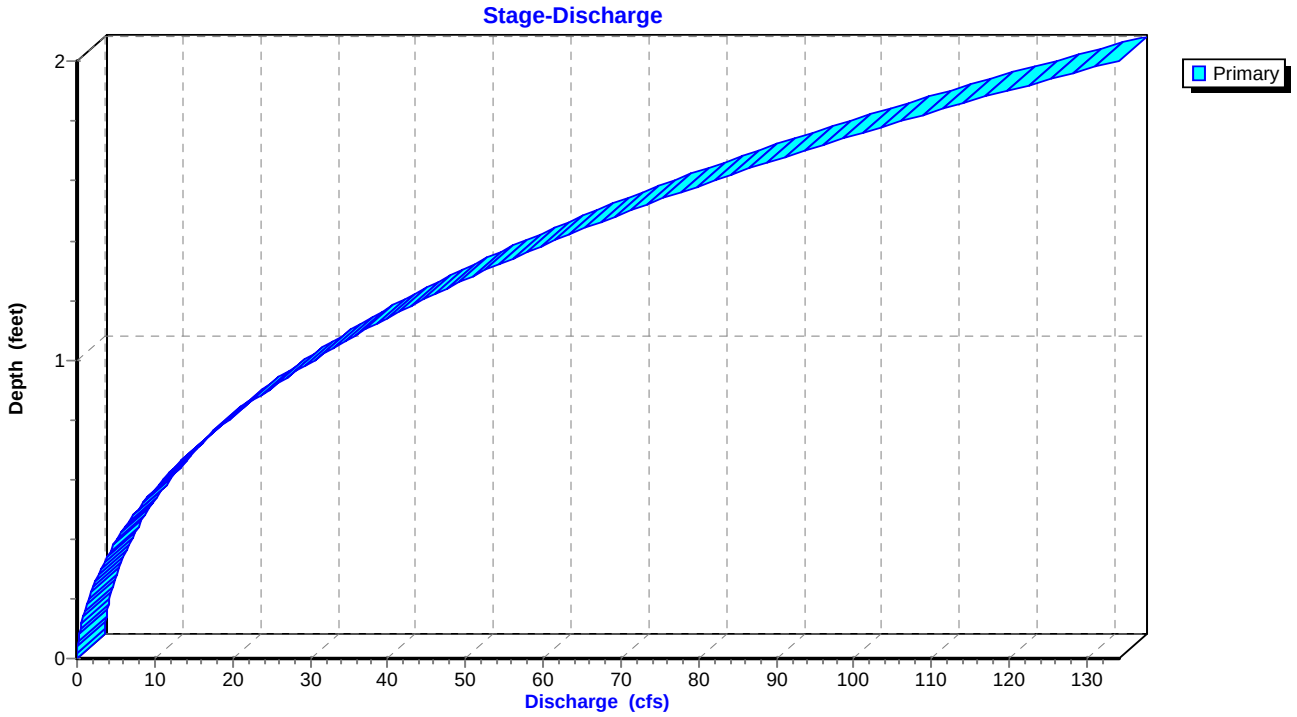
Peak Storage= 1,438 cf @ 3.78 hrs
Average Depth at Peak Storage= 0.32'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 134.16 cfs

2.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 1,723.1' Slope= 0.0242 '/'
Inlet Invert= 5,071.25', Outlet Invert= 5,029.50'

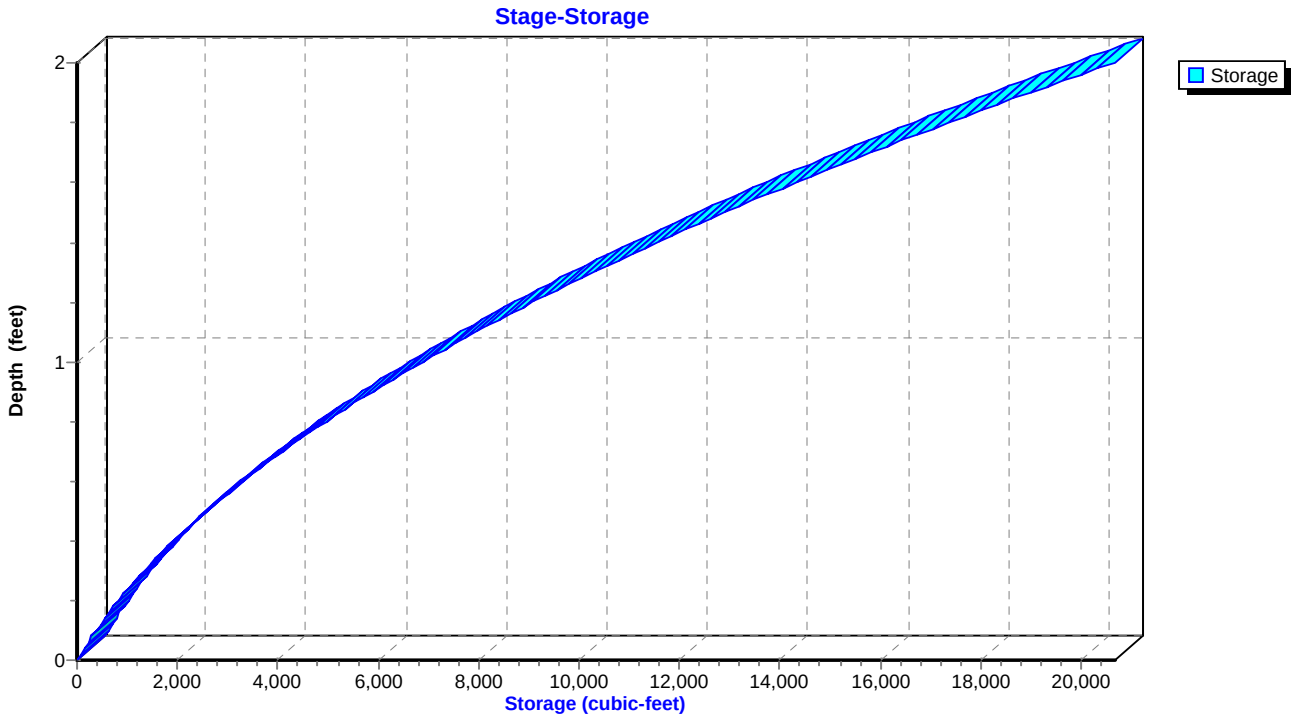
Reach 14R: North Drainage Ditch



Reach 14R: North Drainage Ditch



Reach 14R: North Drainage Ditch



Summary for Pond 8P: Pond 1

Inflow Area = 2.840 ac,100.00% Impervious, Inflow Depth = 1.80" for 100-YR, 6-HR event
Inflow = 11.64 cfs @ 2.89 hrs, Volume= 0.426 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Starting Elev= 5,061.57' Surf.Area= 0.000 ac Storage= 40.277 af
Peak Elev= 5,061.73' @ 6.05 hrs Surf.Area= 0.000 ac Storage= 40.703 af (0.426 af above start)
Flood Elev= 5,063.57' Surf.Area= 0.000 ac Storage= 45.571 af (5.294 af above start)

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

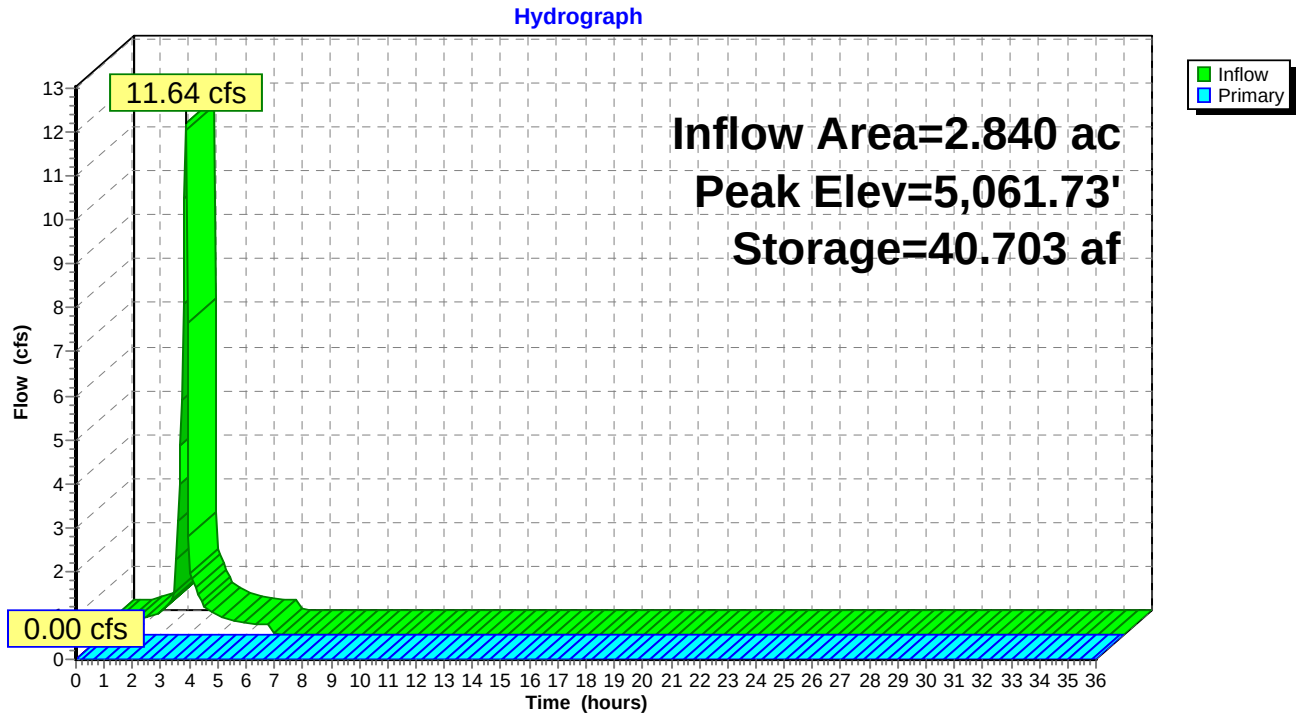
Volume	Invert	Avail.Storage	Storage Description
#1	5,040.33'	48.314 af	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (acre-feet)
5,040.33	0.000
5,041.33	0.264
5,042.33	1.457
5,043.33	2.977
5,044.33	4.548
5,045.33	6.170
5,046.33	7.844
5,047.33	9.570
5,048.33	11.350
5,049.33	13.184
5,050.33	15.073
5,051.33	17.017
5,052.33	19.017
5,053.33	21.074
5,054.33	23.189
5,055.33	25.362
5,056.33	27.593
5,057.33	29.885
5,058.33	32.236
5,059.33	34.649
5,060.33	37.123
5,061.33	39.659
5,061.57	40.277
5,062.57	42.892
5,063.57	45.571
5,064.57	48.314

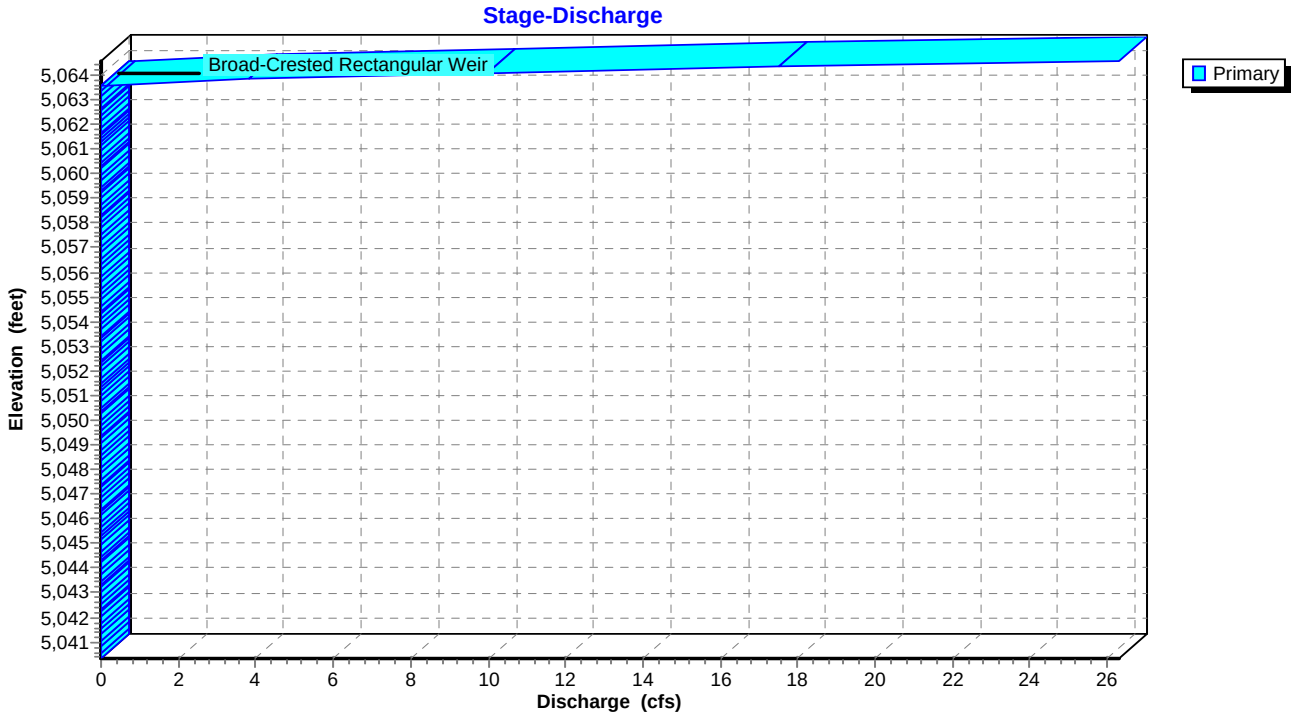
Device	Routing	Invert	Outlet Devices
#1	Primary	5,063.57'	**10.0' long x 30.0' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60
			Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,061.57' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

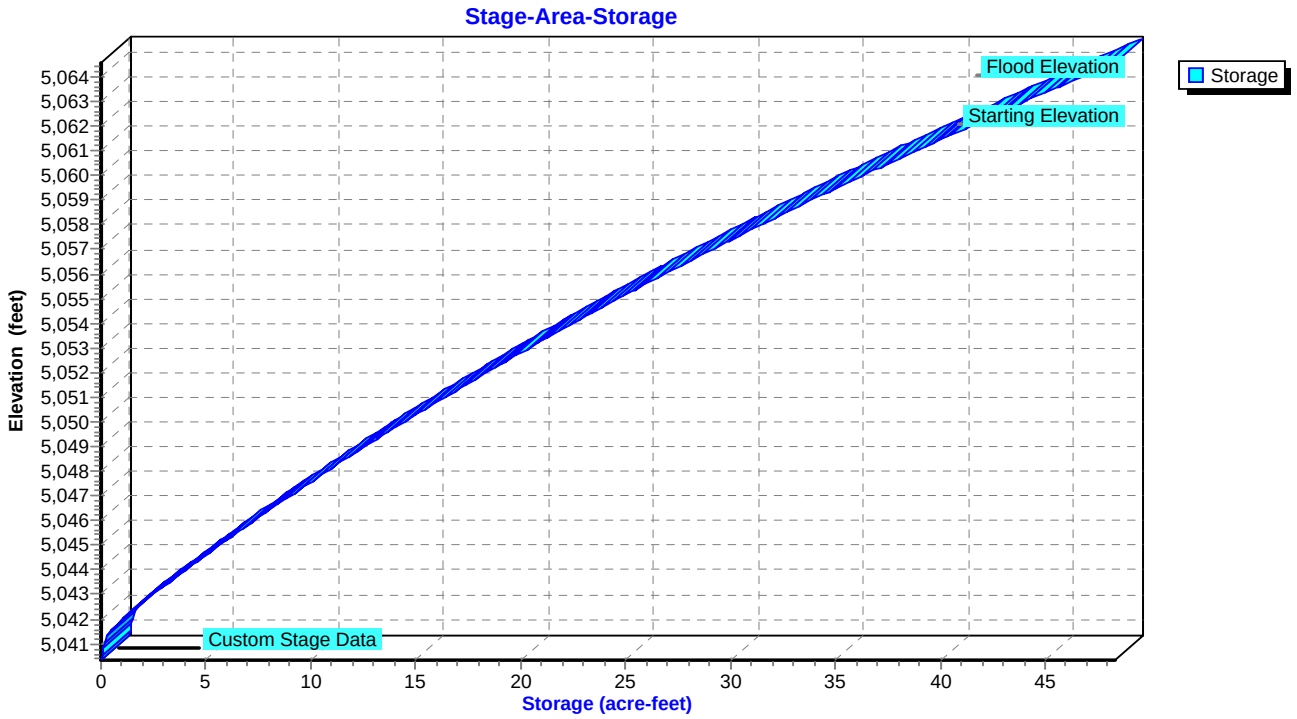
Pond 8P: Pond 1



Pond 8P: Pond 1



Pond 8P: Pond 1



Summary for Pond 9P: Pond 2

Inflow Area = 2.750 ac,100.00% Impervious, Inflow Depth = 1.80" for 100-YR, 6-HR event
Inflow = 11.27 cfs @ 2.89 hrs, Volume= 0.413 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Starting Elev= 5,057.80' Surf.Area= 0.000 ac Storage= 31.106 af
Peak Elev= 5,057.96' @ 6.05 hrs Surf.Area= 0.000 ac Storage= 31.519 af (0.413 af above start)
Flood Elev= 5,059.80' Surf.Area= 0.000 ac Storage= 36.361 af (5.255 af above start)

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

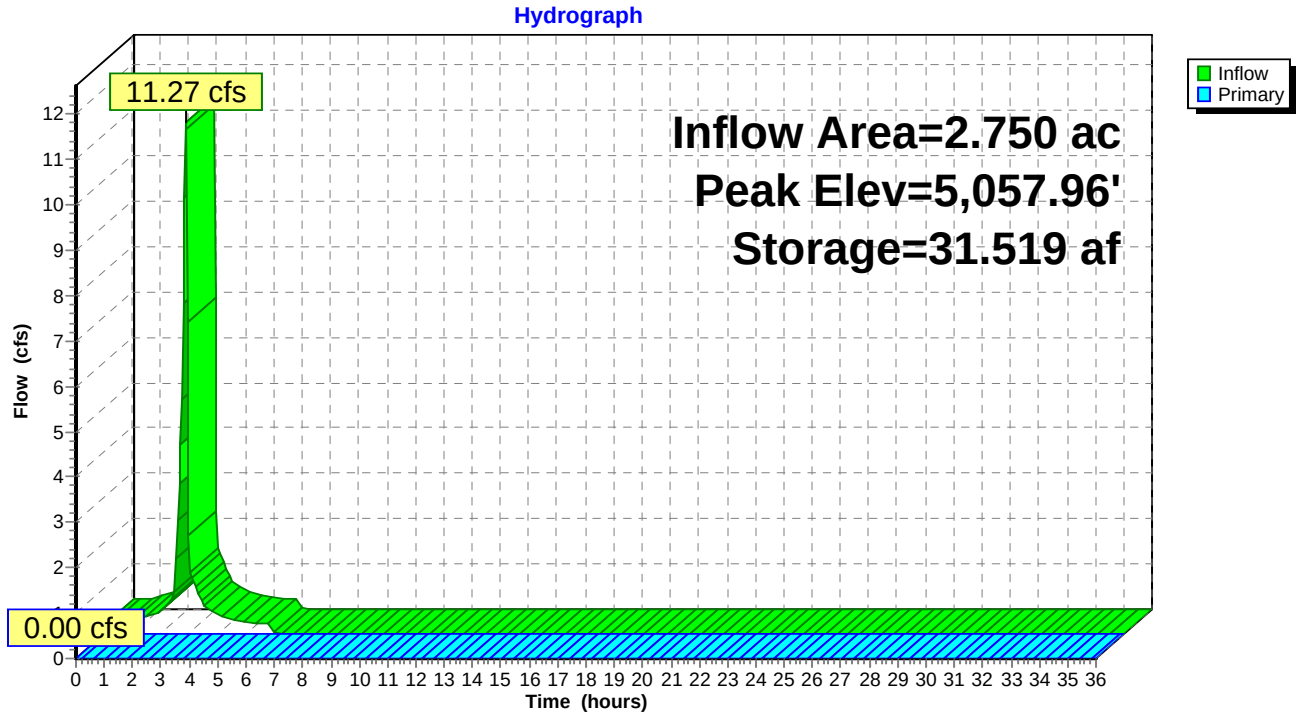
Volume	Invert	Avail.Storage	Storage Description
#1	5,042.42'	39.082 af	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (acre-feet)
5,042.42	0.000
5,043.42	0.335
5,044.42	1.897
5,045.42	3.742
5,046.42	5.638
5,047.42	7.588
5,048.42	9.591
5,049.42	11.649
5,050.42	13.761
5,051.42	15.929
5,052.42	18.152
5,053.42	20.433
5,054.42	22.771
5,055.42	25.167
5,056.42	27.621
5,057.42	30.135
5,057.80	31.106
5,058.80	33.704
5,059.80	36.361
5,060.80	39.082

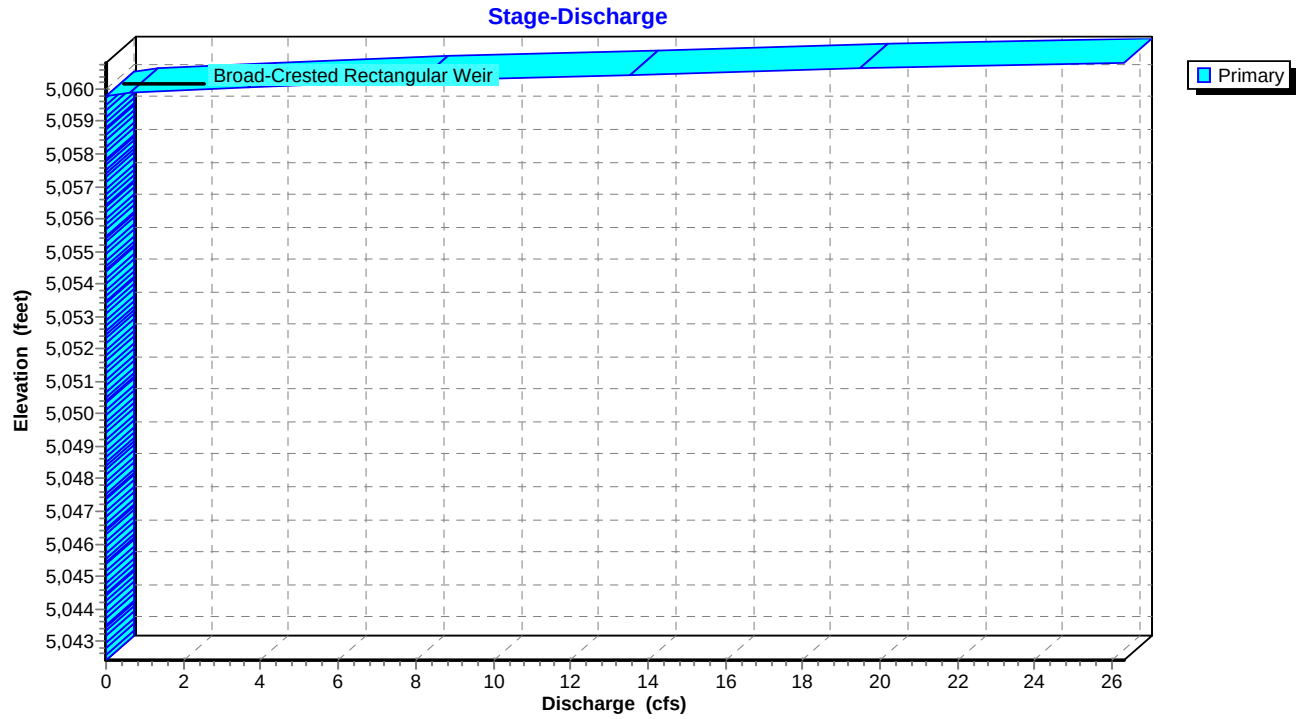
Device	Routing	Invert	Outlet Devices
#1	Primary	5,059.80'	**10.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,057.80' (Free Discharge)
1=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

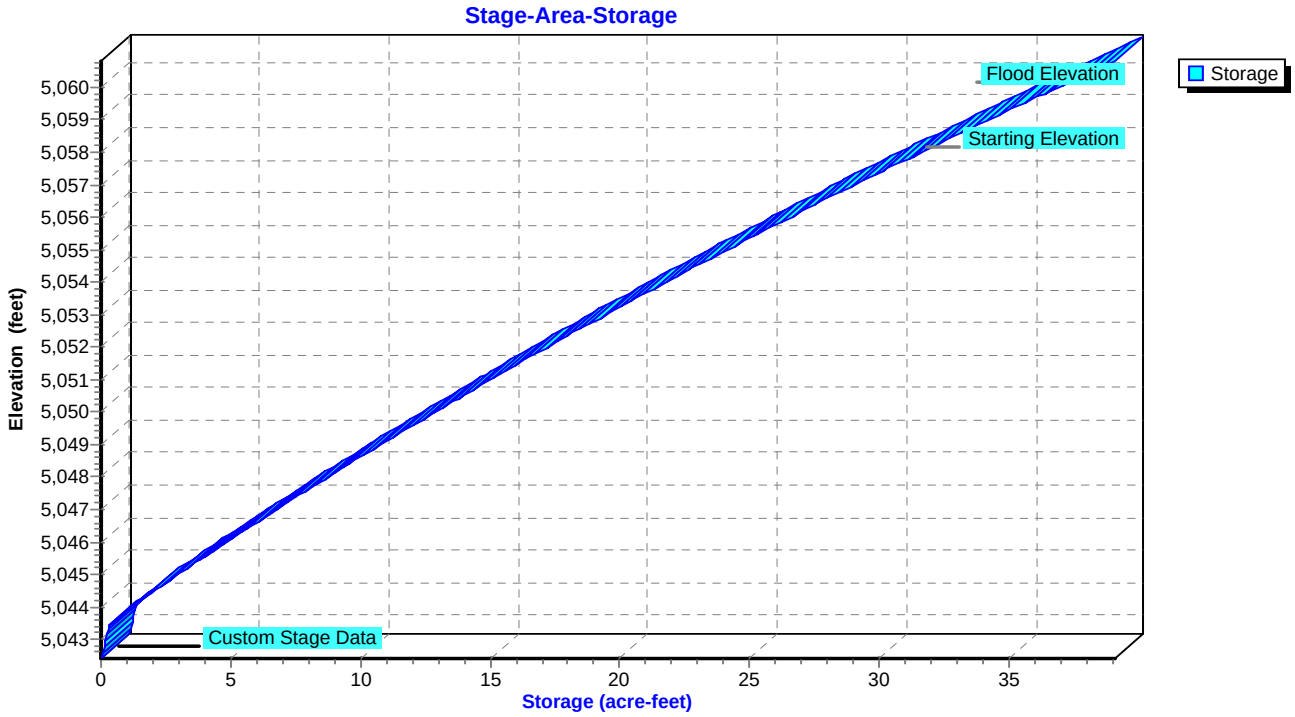
Pond 9P: Pond 2



Pond 9P: Pond 2



Pond 9P: Pond 2



Summary for Pond 10P: Pond 3

Inflow Area = 2.660 ac,100.00% Impervious, Inflow Depth = 1.80" for 100-YR, 6-HR event
Inflow = 10.91 cfs @ 2.89 hrs, Volume= 0.399 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Starting Elev= 5,048.50' Surf.Area= 0.000 ac Storage= 29.964 af
Peak Elev= 5,048.66' @ 6.05 hrs Surf.Area= 0.000 ac Storage= 30.363 af (0.399 af above start)
Flood Elev= 5,050.50' Surf.Area= 0.000 ac Storage= 34.999 af (5.035 af above start)

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

Volume	Invert	Avail.Storage	Storage Description
#1	5,032.00'	37.619 af	**Custom Stage Data** Listed below

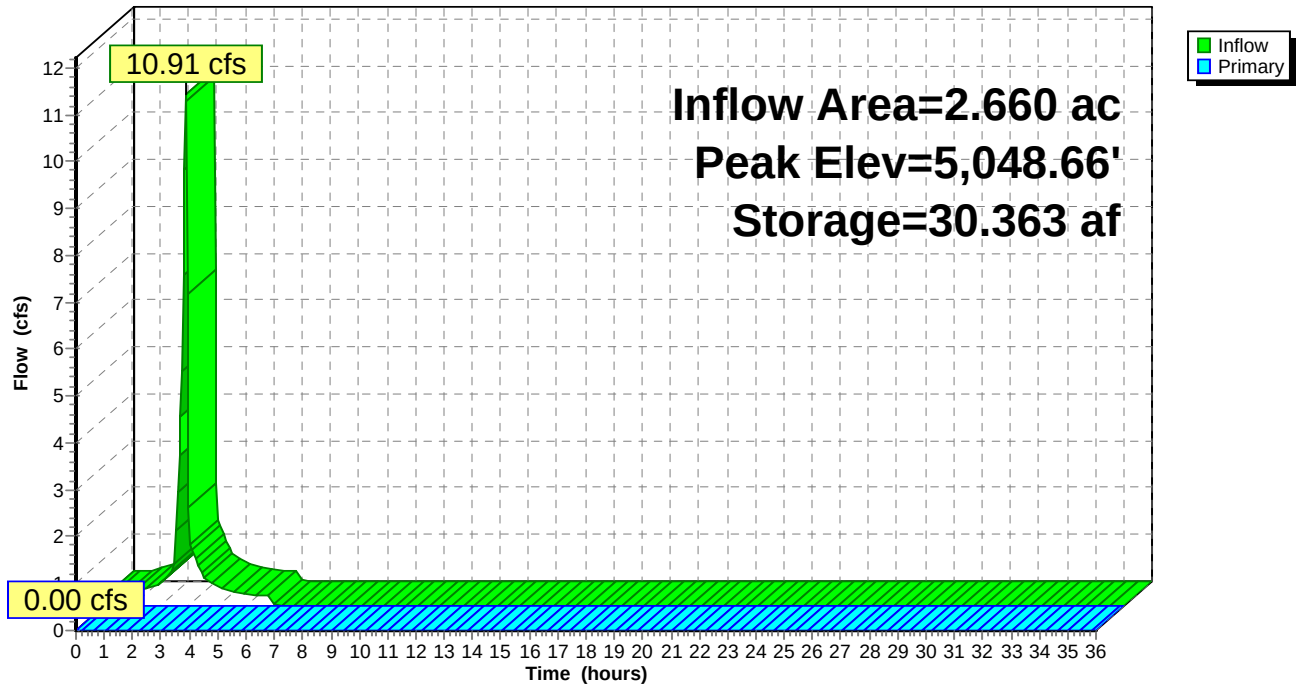
Elevation (feet)	Cum.Store (acre-feet)
5,032.00	0.000
5,033.00	0.217
5,034.00	1.183
5,035.00	2.730
5,036.00	4.364
5,037.00	6.057
5,038.00	7.809
5,039.00	9.622
5,040.00	11.495
5,041.00	13.429
5,042.00	15.426
5,043.00	17.486
5,044.00	19.609
5,045.00	21.796
5,046.00	24.047
5,047.00	26.365
5,048.00	28.748
5,048.50	29.964
5,049.50	32.448
5,050.50	34.999
5,051.50	37.619

Device	Routing	Invert	Outlet Devices
#1	Primary	5,050.50'	**10.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,048.50' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

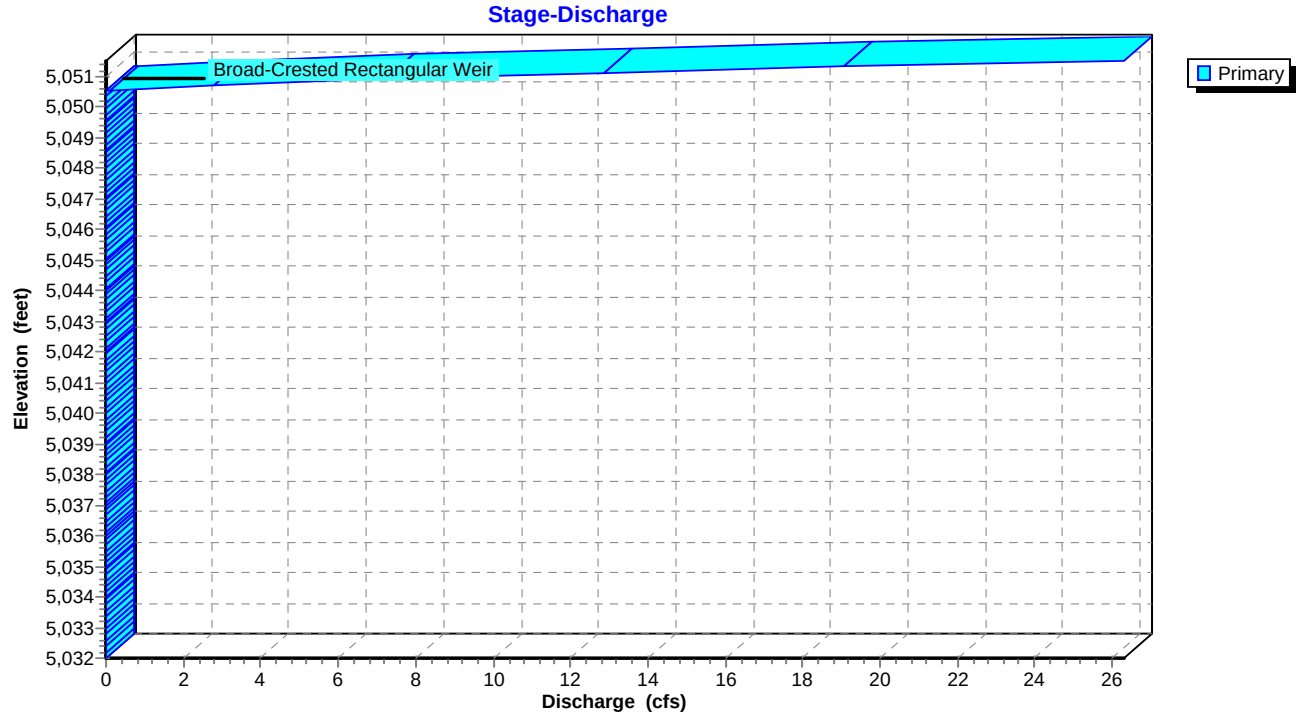
Pond 10P: Pond 3

Hydrograph

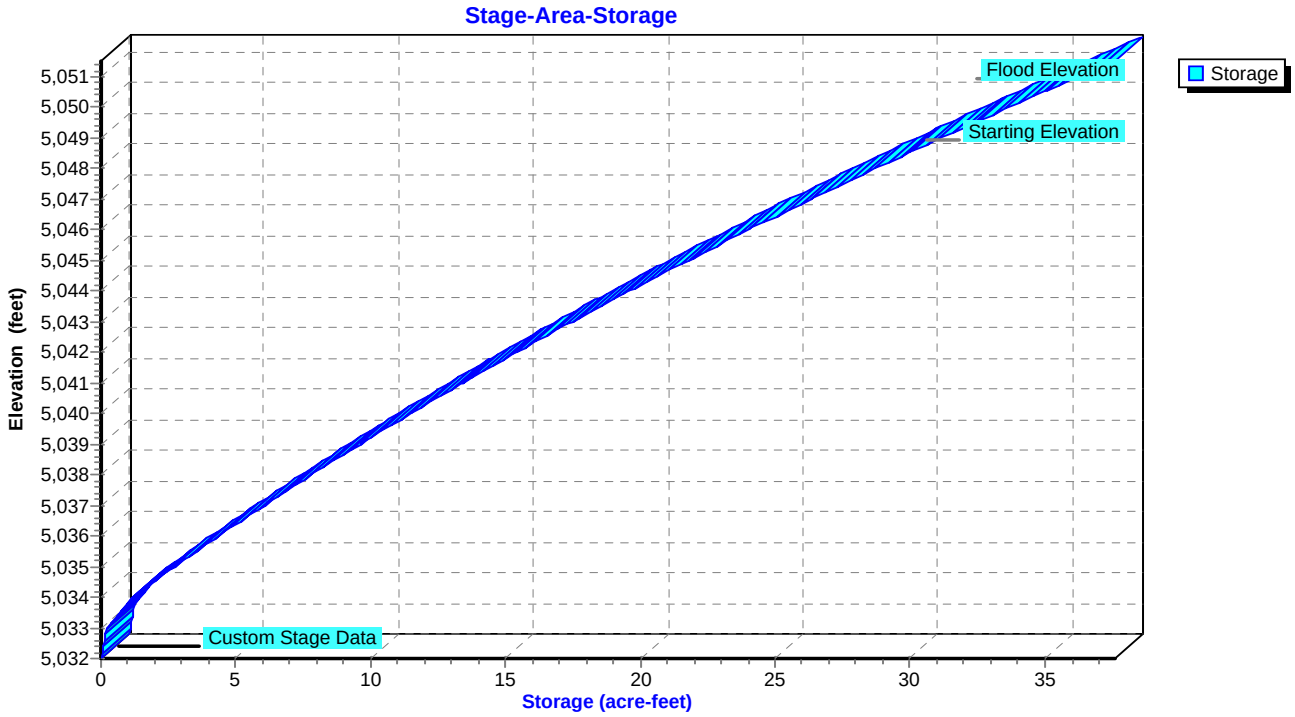


Pond 10P: Pond 3

Stage-Discharge



Pond 10P: Pond 3



Summary for Pond 11P: Detention Pond

Inflow Area = 14.470 ac, 0.00% Impervious, Inflow Depth = 0.47" for 100-YR, 6-HR event
Inflow = 3.88 cfs @ 3.87 hrs, Volume= 0.570 af
Outflow = 1.65 cfs @ 4.84 hrs, Volume= 0.560 af, Atten= 58%, Lag= 58.3 min
Primary = 1.65 cfs @ 4.84 hrs, Volume= 0.560 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Starting Elev= 5,030.00' Surf.Area= 0.315 ac Storage= 0.919 af
Peak Elev= 5,030.81' @ 4.84 hrs Surf.Area= 0.351 ac Storage= 1.188 af (0.269 af above start)

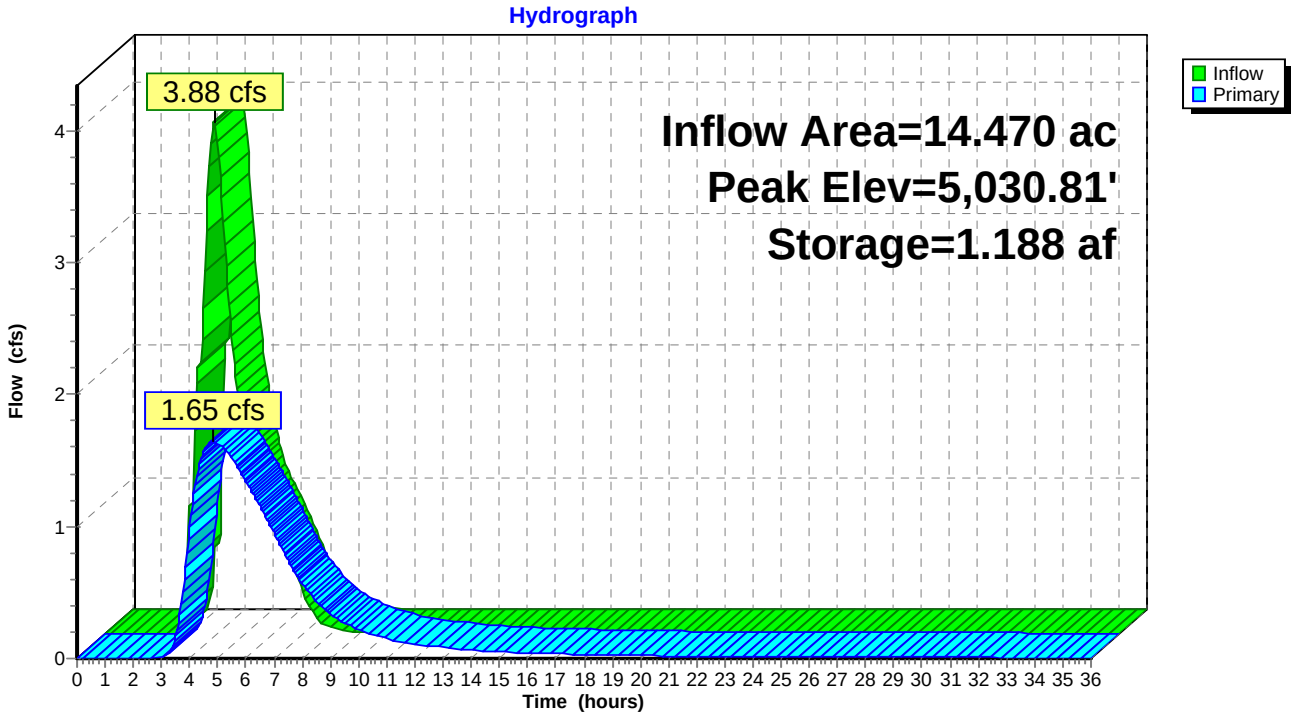
Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= 165.2 min (436.7 - 271.6)

Volume	Invert	Avail.Storage	Storage Description
#1	5,026.00'	1.639 af	**26.00'W x 250.00'L x 6.00'H Prismatoid Z=3.0**

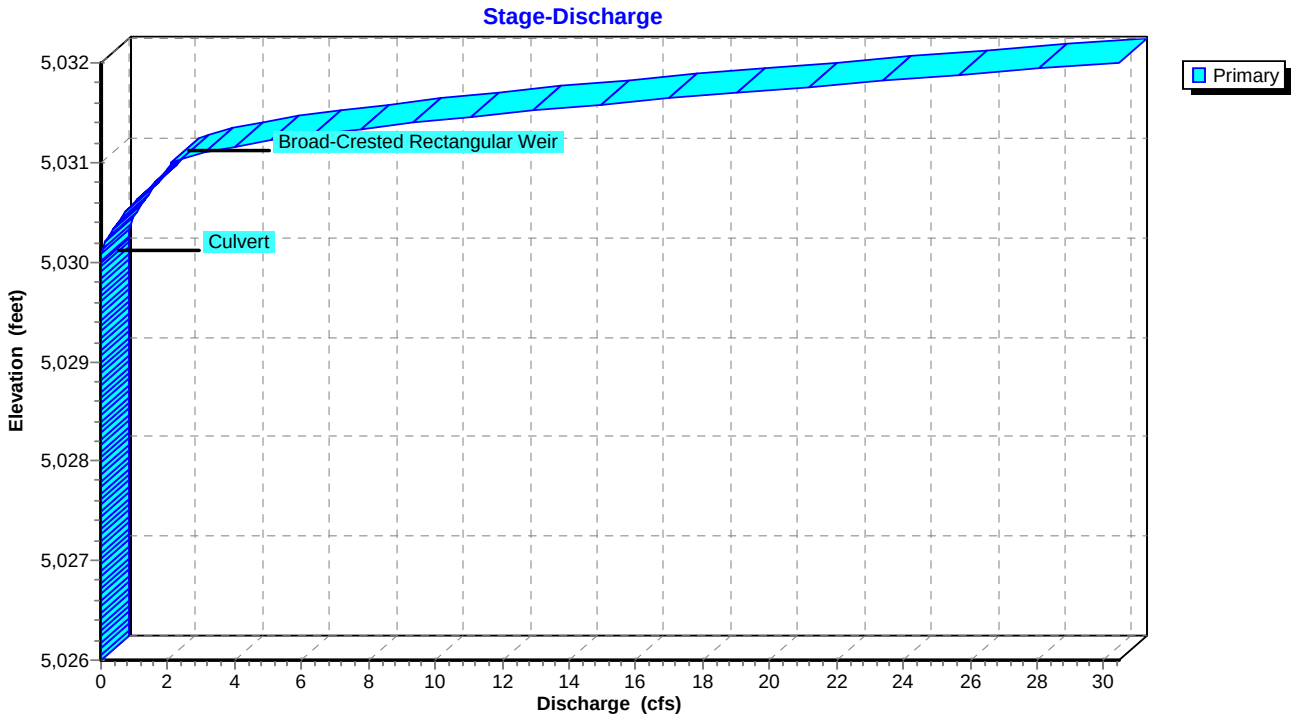
Device	Routing	Invert	Outlet Devices
#1	Primary	5,031.00'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Primary	5,030.00'	**12.0" Round Culvert** L= 25.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 5,030.00' / 5,029.77' S= 0.0092 '/' Cc= 0.900 n= 0.010 PVC, smooth interior

Primary OutFlow Max=1.65 cfs @ 4.84 hrs HW=5,030.81' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)
└**2=Culvert** (Inlet Controls 1.65 cfs @ 2.42 fps)

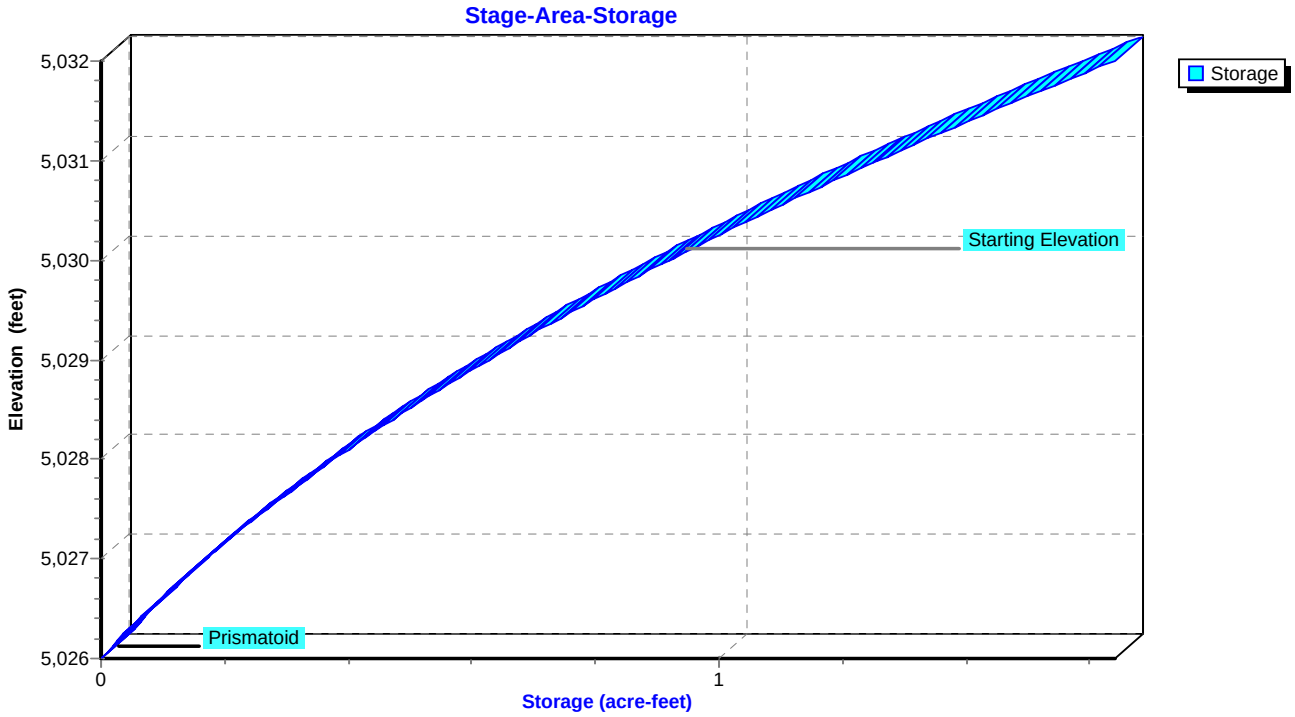
Pond 11P: Detention Pond



Pond 11P: Detention Pond

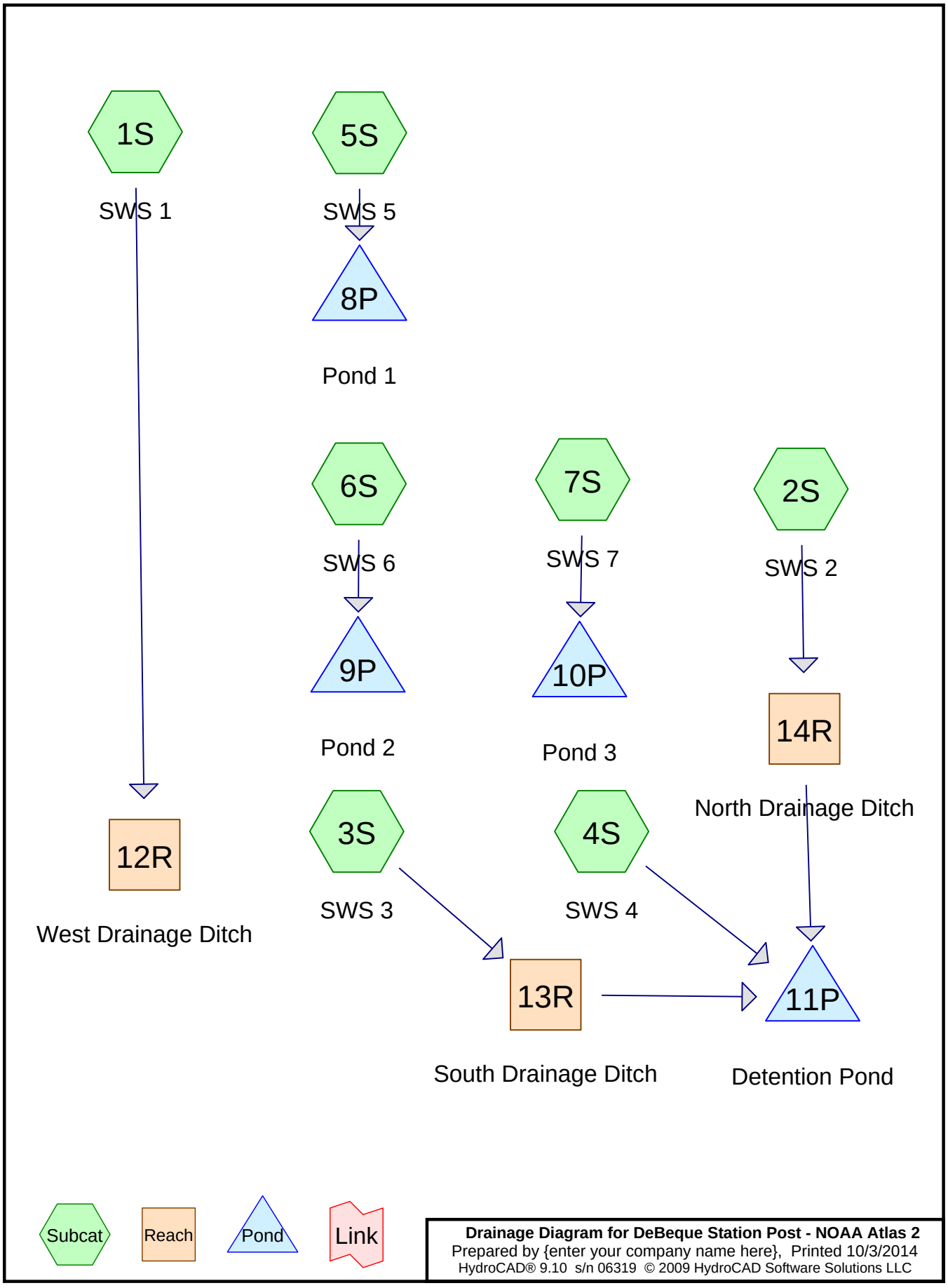


Pond 11P: Detention Pond



APPENDIX C6

HydroCAD Report
NOAA Atlas 2: Post-Development
50-Year, 24-Hour Event



Drainage Diagram for DeBeque Station Post - NOAA Atlas 2
Prepared by {enter your company name here}, Printed 10/3/2014
HydroCAD® 9.10 s/n 06319 © 2009 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.200	76	Weighted Curve Number (4S)
3.160	78	Weighted Curve Number (3S)
258.860	79	Weighted Curve Number (1S)
10.110	82	Weighted Curve Number (2S)
8.250	100	Liner (5S, 6S, 7S)
281.580		**TOTAL AREA**

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: SWS 1 Runoff Area=258.860 ac 0.00% Impervious Runoff Depth=0.61"
Flow Length=8,106' Tc=56.7 min CN=79 Runoff=37.58 cfs 13.211 af

Subcatchment 2S: SWS 2 Runoff Area=10.110 ac 0.00% Impervious Runoff Depth=0.75"
Flow Length=2,405' Tc=58.5 min CN=82 Runoff=1.97 cfs 0.631 af

Subcatchment 3S: SWS 3 Runoff Area=3.160 ac 0.00% Impervious Runoff Depth=0.57"
Flow Length=934' Tc=14.6 min CN=78 Runoff=0.87 cfs 0.150 af

Subcatchment 4S: SWS 4 Runoff Area=1.200 ac 0.00% Impervious Runoff Depth=0.49"
Flow Length=174' Tc=3.8 min CN=76 Runoff=0.36 cfs 0.049 af

Subcatchment 5S: SWS 5 Runoff Area=2.840 ac 100.00% Impervious Runoff Depth=2.15"
Flow Length=15' Slope=0.5000 '/' Tc=0.1 min CN=100 Runoff=4.81 cfs 0.509 af

Subcatchment 6S: SWS 6 Runoff Area=2.750 ac 100.00% Impervious Runoff Depth=2.15"
Flow Length=15' Slope=0.5000 '/' Tc=0.1 min CN=100 Runoff=4.65 cfs 0.493 af

Subcatchment 7S: SWS 7 Runoff Area=2.660 ac 100.00% Impervious Runoff Depth=2.15"
Flow Length=15' Slope=0.5000 '/' Tc=0.1 min CN=100 Runoff=4.50 cfs 0.477 af

Reach 12R: West Drainage Ditch Avg. Flow Depth=0.78' Max Vel=7.33 fps Inflow=37.58 cfs 13.211 af
n=0.022 L=1,297.4' S=0.0231 '/' Capacity=219.29 cfs Outflow=37.49 cfs 13.211 af

Reach 13R: South Drainage Ditch Avg. Flow Depth=0.15' Max Vel=2.13 fps Inflow=0.87 cfs 0.150 af
n=0.022 L=1,015.0' S=0.0156 '/' Capacity=107.67 cfs Outflow=0.72 cfs 0.150 af

Reach 14R: North Drainage Ditch Avg. Flow Depth=0.23' Max Vel=3.43 fps Inflow=1.97 cfs 0.631 af
n=0.022 L=1,723.1' S=0.0242 '/' Capacity=134.16 cfs Outflow=1.93 cfs 0.631 af

Pond 8P: Pond 1 Peak Elev=5,061.76' Storage=40.786 af Inflow=4.81 cfs 0.509 af
Outflow=0.00 cfs 0.000 af

Pond 9P: Pond 2 Peak Elev=5,057.99' Storage=31.599 af Inflow=4.65 cfs 0.493 af
Outflow=0.00 cfs 0.000 af

Pond 10P: Pond 3 Peak Elev=5,048.69' Storage=30.441 af Inflow=4.50 cfs 0.477 af
Outflow=0.00 cfs 0.000 af

Pond 11P: Detention Pond Peak Elev=5,029.72' Storage=0.831 af Inflow=2.25 cfs 0.831 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 281.580 ac Runoff Volume = 15.520 af Average Runoff Depth = 0.66"
97.07% Pervious = 273.330 ac 2.93% Impervious = 8.250 ac

Summary for Subcatchment 1S: SWS 1

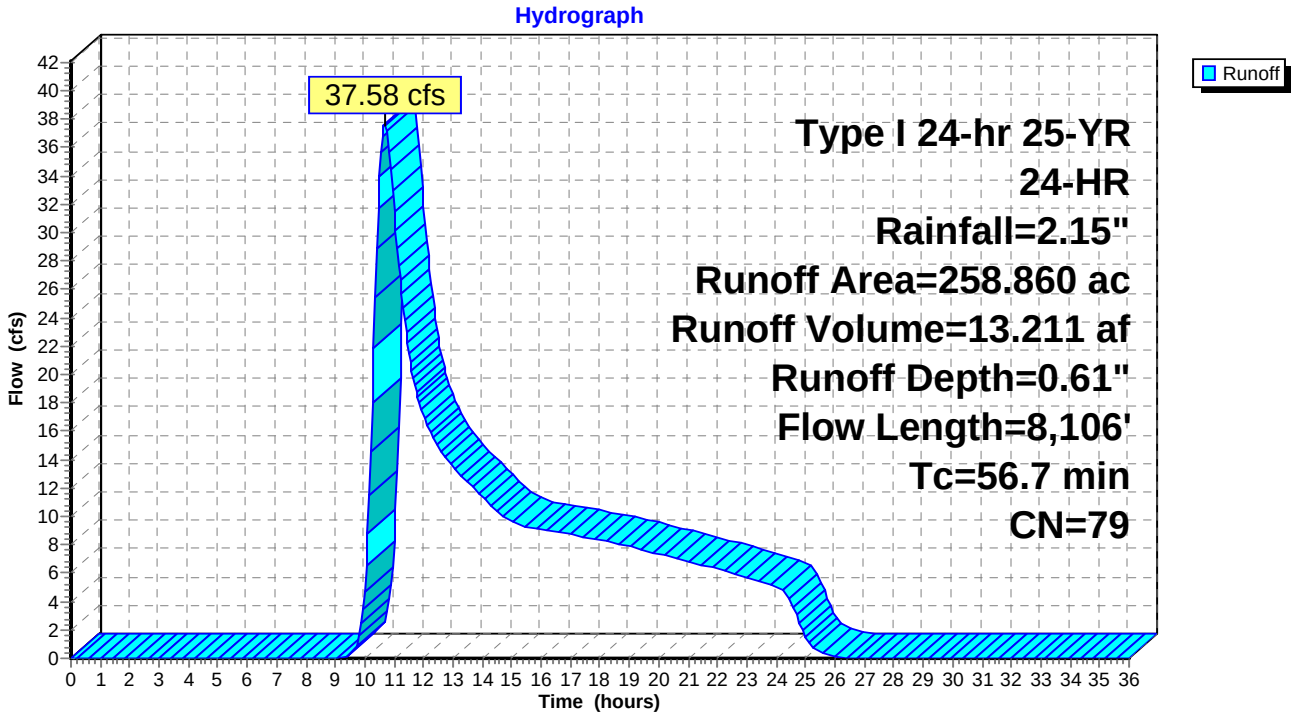
Runoff = 37.58 cfs @ 10.68 hrs, Volume= 13.211 af, Depth= 0.61"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type I 24-hr 25-YR, 24-HR Rainfall=2.15"

	Area (ac)	CN	Description
*	258.860	79	Weighted Curve Number
	258.860		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	300	0.3900	0.45		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
45.6	7,806	0.0813	2.85		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
56.7	8,106	Total			

Subcatchment 1S: SWS 1



Summary for Subcatchment 2S: SWS 2

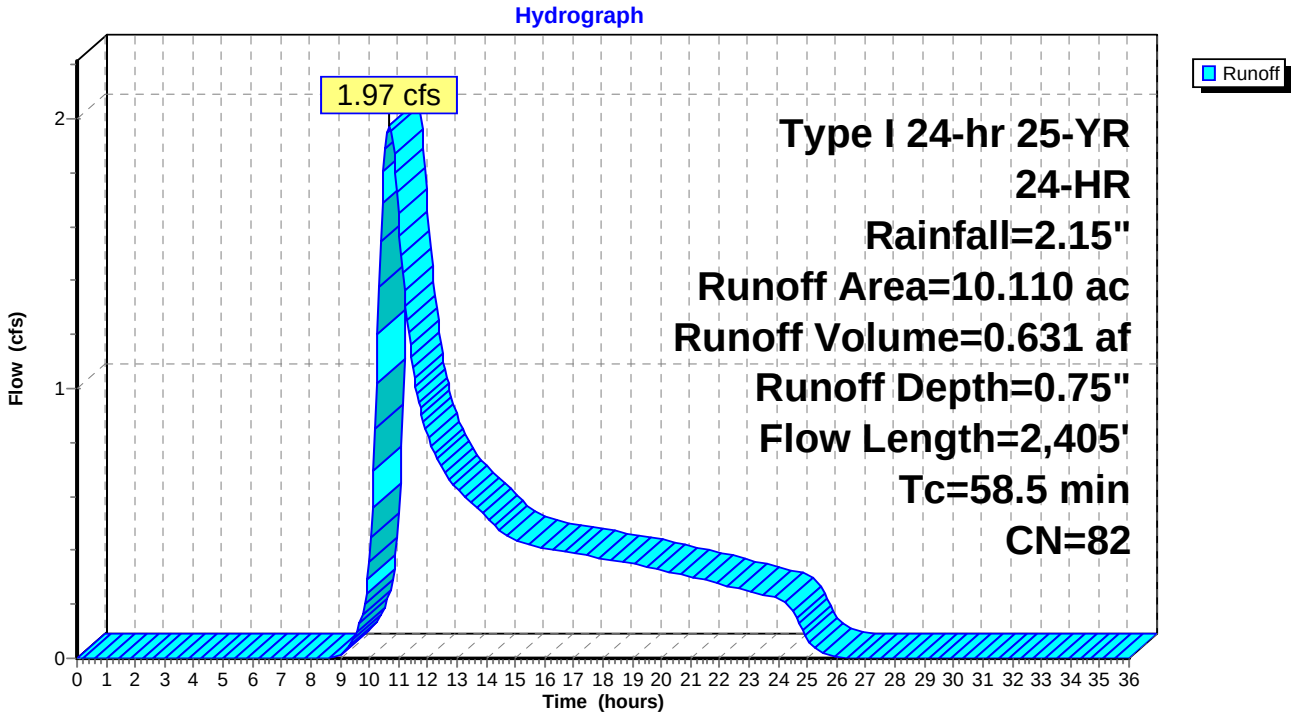
Runoff = 1.97 cfs @ 10.69 hrs, Volume= 0.631 af, Depth= 0.75"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type I 24-hr 25-YR, 24-HR Rainfall=2.15"

	Area (ac)	CN	Description
*	10.110	82	Weighted Curve Number
	10.110		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.2	300	0.0233	0.15		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
24.3	2,105	0.0209	1.45		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
58.5	2,405	Total			

Subcatchment 2S: SWS 2



Summary for Subcatchment 3S: SWS 3

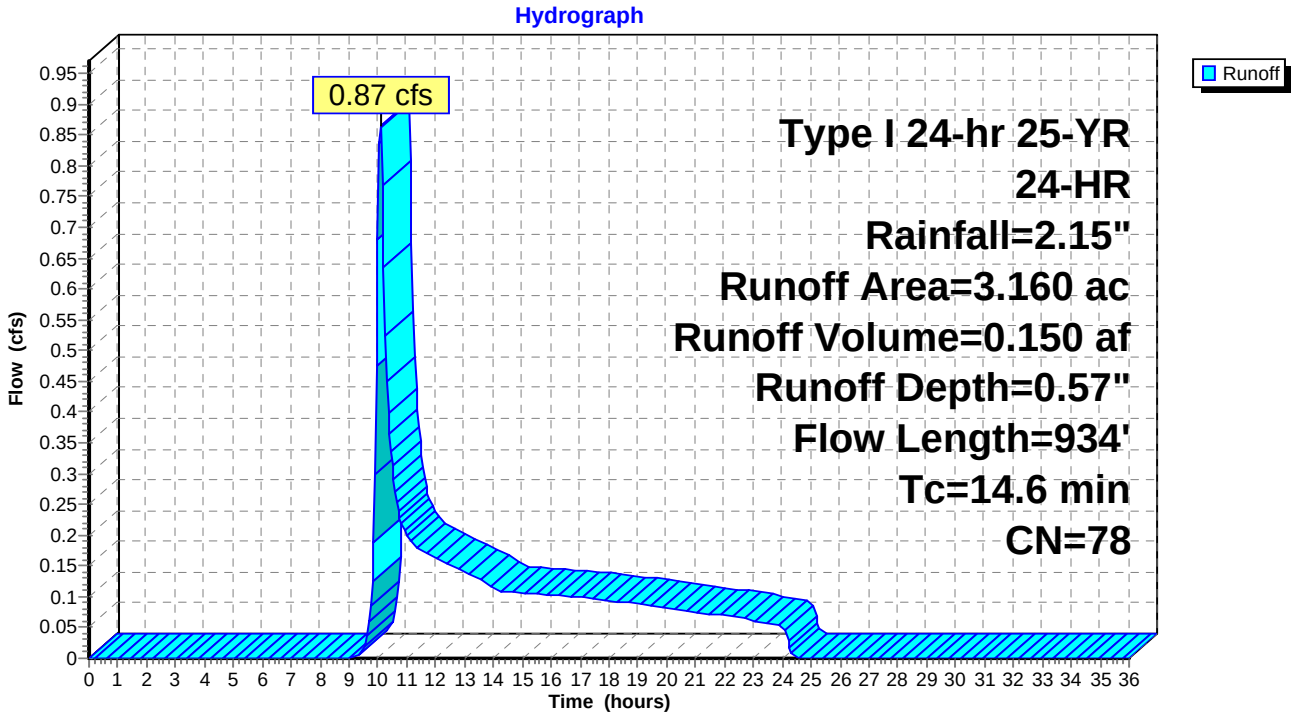
Runoff = 0.87 cfs @ 10.09 hrs, Volume= 0.150 af, Depth= 0.57"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type I 24-hr 25-YR, 24-HR Rainfall=2.15"

	Area (ac)	CN	Description
*	3.160	78	Weighted Curve Number
	3.160		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.2500	0.26		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
11.4	884	0.0166	1.29		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
14.6	934	Total			

Subcatchment 3S: SWS 3



Summary for Subcatchment 4S: SWS 4

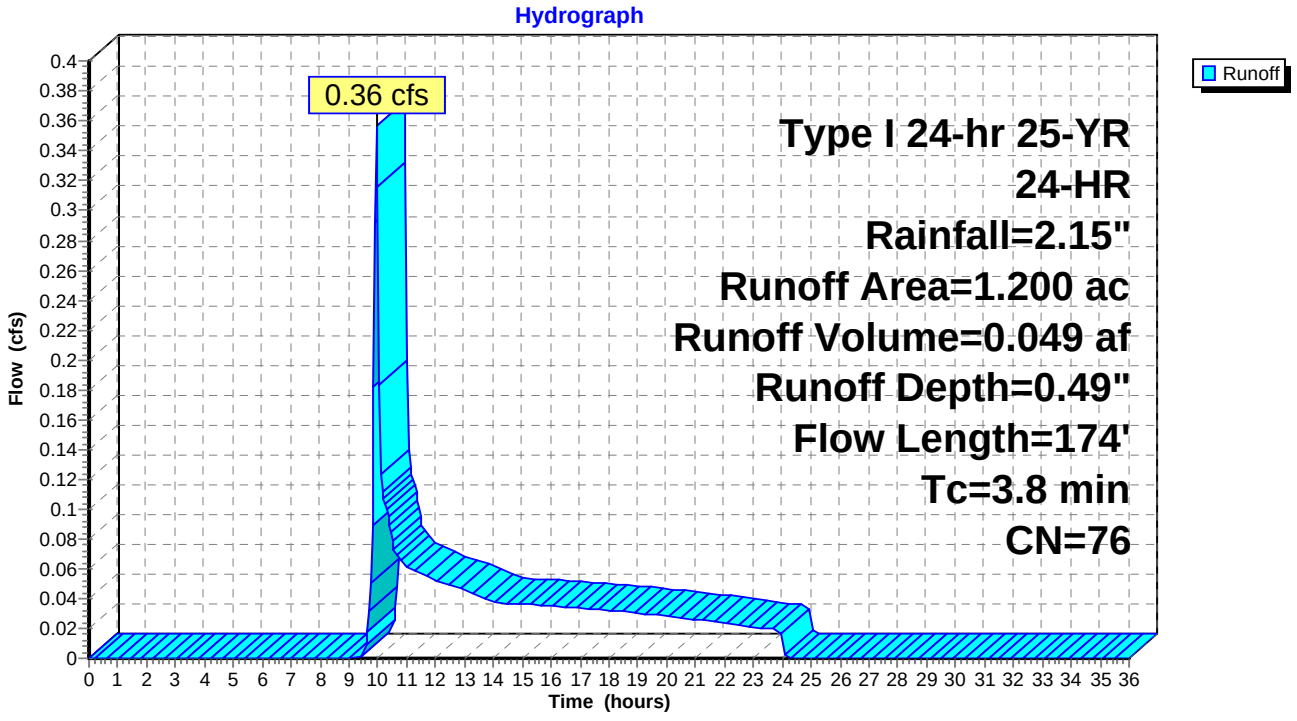
Runoff = 0.36 cfs @ 9.96 hrs, Volume= 0.049 af, Depth= 0.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type I 24-hr 25-YR, 24-HR Rainfall=2.15"

	Area (ac)	CN	Description
*	1.200	76	Weighted Curve Number
	1.200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.2500	0.26		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
0.6	124	0.1149	3.39		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
3.8	174	Total			

Subcatchment 4S: SWS 4



Summary for Subcatchment 5S: SWS 5

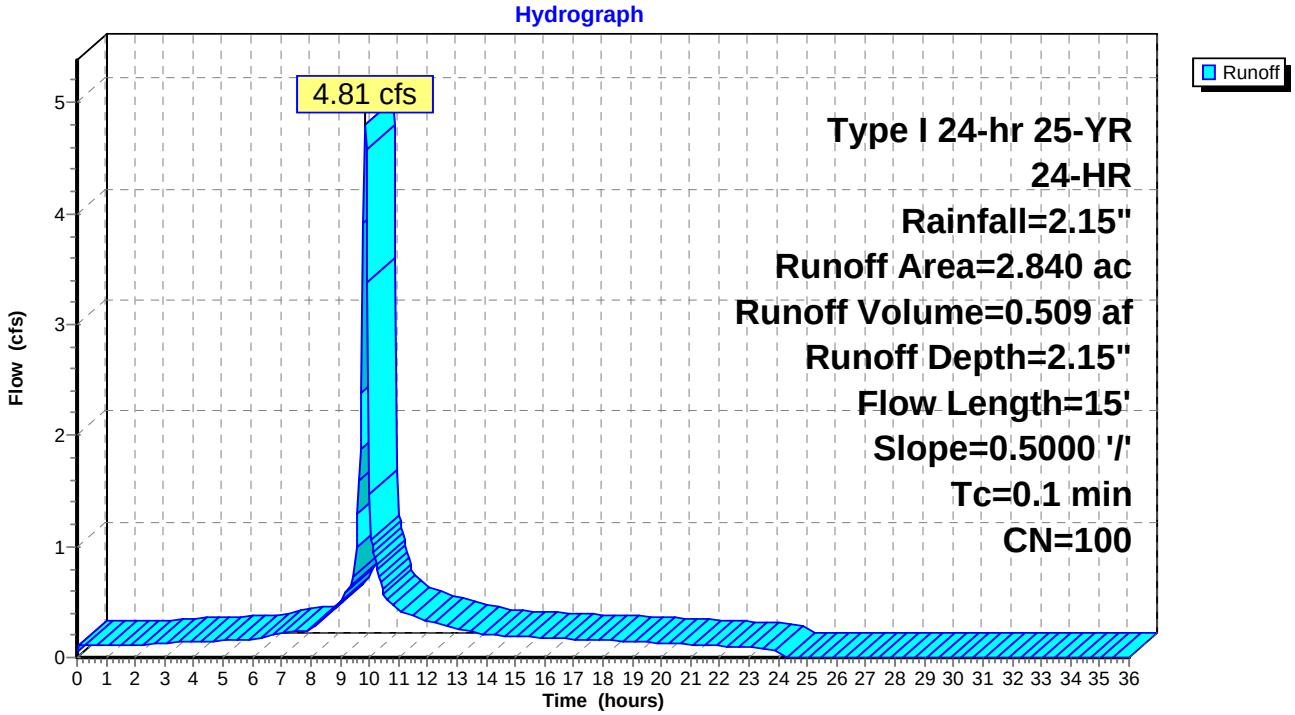
Runoff = 4.81 cfs @ 9.87 hrs, Volume= 0.509 af, Depth= 2.15"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type I 24-hr 25-YR, 24-HR Rainfall=2.15"

	Area (ac)	CN	Description
*	2.840	100	Liner
	2.840		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	15	0.5000	1.97		**Sheet Flow, Overland Flow** Smooth surfaces n= 0.011 P2= 1.07"

Subcatchment 5S: SWS 5



Summary for Subcatchment 6S: SWS 6

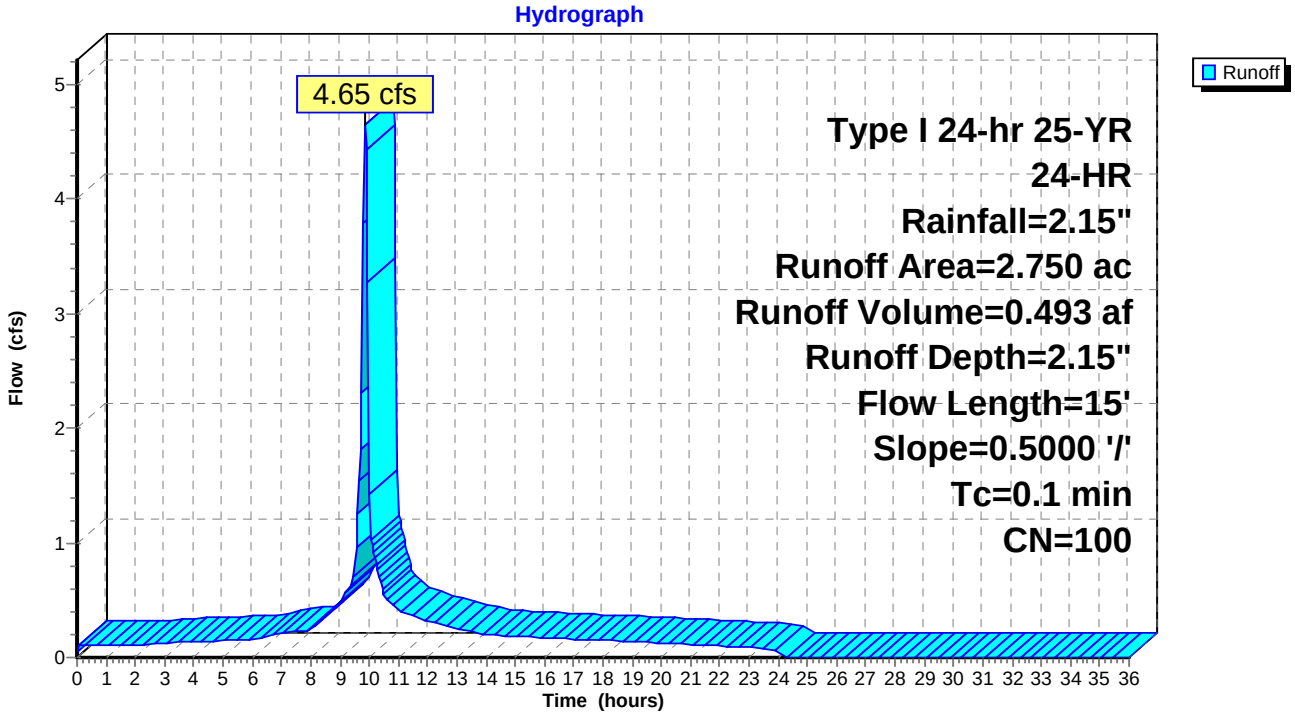
Runoff = 4.65 cfs @ 9.87 hrs, Volume= 0.493 af, Depth= 2.15"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type I 24-hr 25-YR, 24-HR Rainfall=2.15"

	Area (ac)	CN	Description
*	2.750	100	Liner
	2.750		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	15	0.5000	1.97		**Sheet Flow, Overland Flow** Smooth surfaces n= 0.011 P2= 1.07"

Subcatchment 6S: SWS 6



Summary for Subcatchment 7S: SWS 7

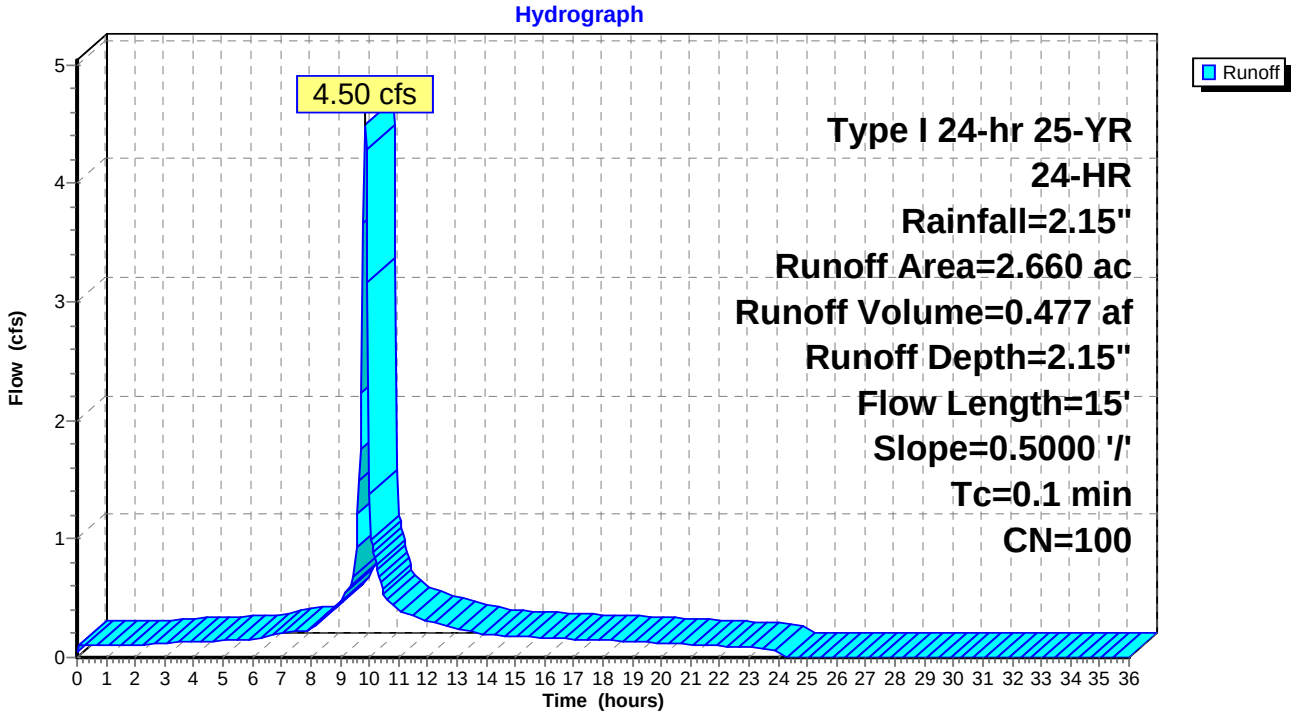
Runoff = 4.50 cfs @ 9.87 hrs, Volume= 0.477 af, Depth= 2.15"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type I 24-hr 25-YR, 24-HR Rainfall=2.15"

	Area (ac)	CN	Description
*	2.660	100	Liner
	2.660		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	15	0.5000	1.97		**Sheet Flow, Overland Flow** Smooth surfaces n= 0.011 P2= 1.07"

Subcatchment 7S: SWS 7



Summary for Reach 12R: West Drainage Ditch

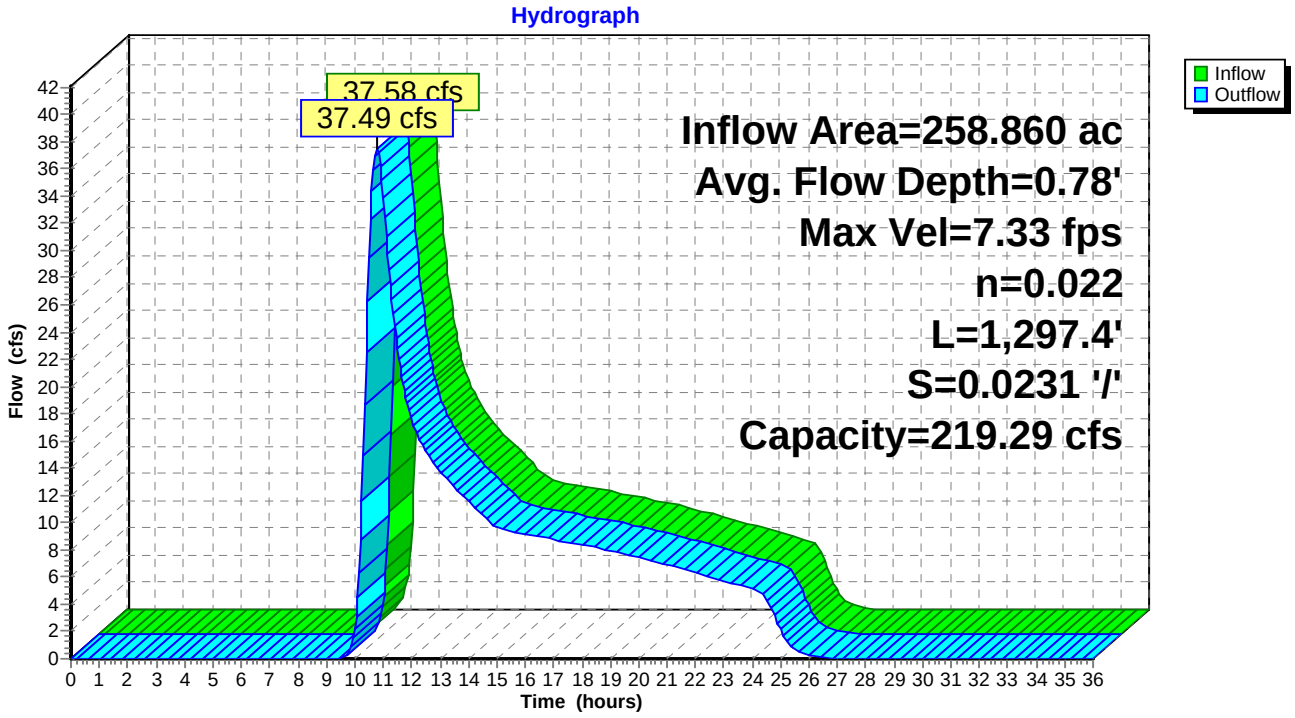
Inflow Area = 258.860 ac, 0.00% Impervious, Inflow Depth = 0.61" for 25-YR, 24-HR event
Inflow = 37.58 cfs @ 10.68 hrs, Volume= 13.211 af
Outflow = 37.49 cfs @ 10.77 hrs, Volume= 13.211 af, Atten= 0%, Lag= 5.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.33 fps, Min. Travel Time= 3.0 min
Avg. Velocity = 3.65 fps, Avg. Travel Time= 5.9 min

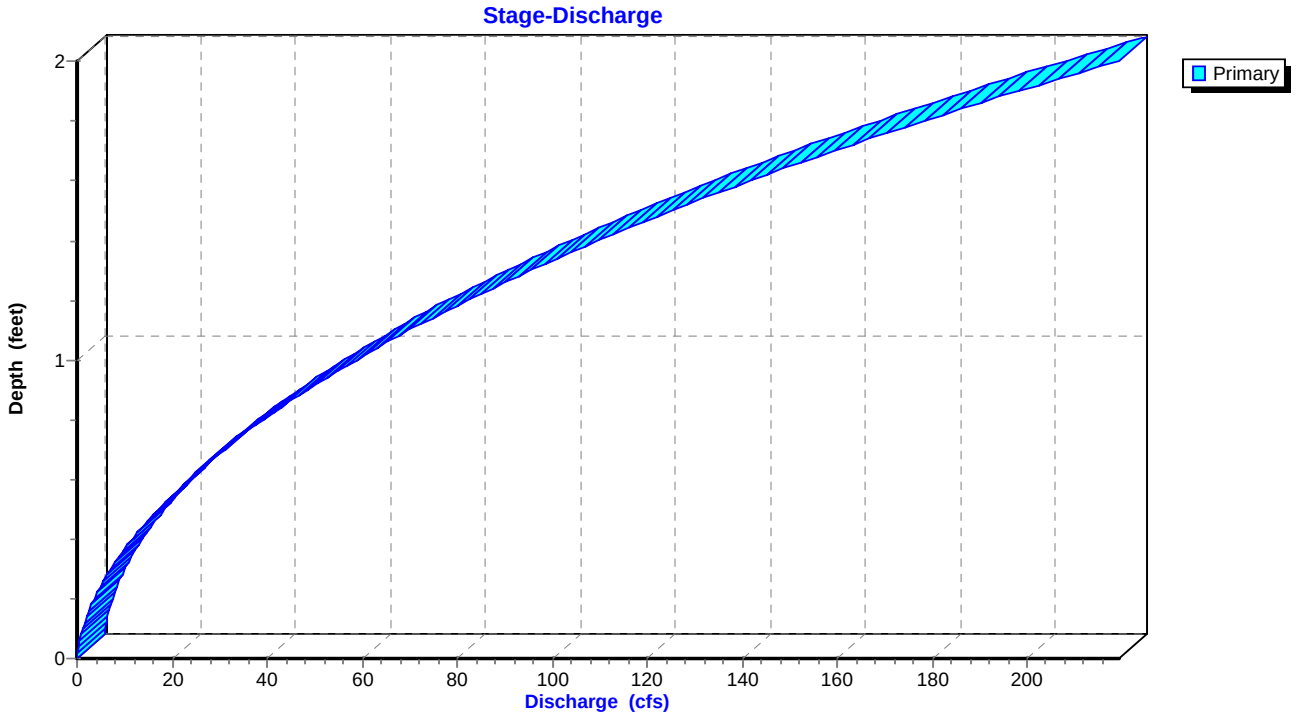
Peak Storage= 6,636 cf @ 10.72 hrs
Average Depth at Peak Storage= 0.78'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 219.29 cfs

5.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 2.0 '/' Top Width= 13.00'
Length= 1,297.4' Slope= 0.0231 '/'
Inlet Invert= 5,077.00', Outlet Invert= 5,046.97'

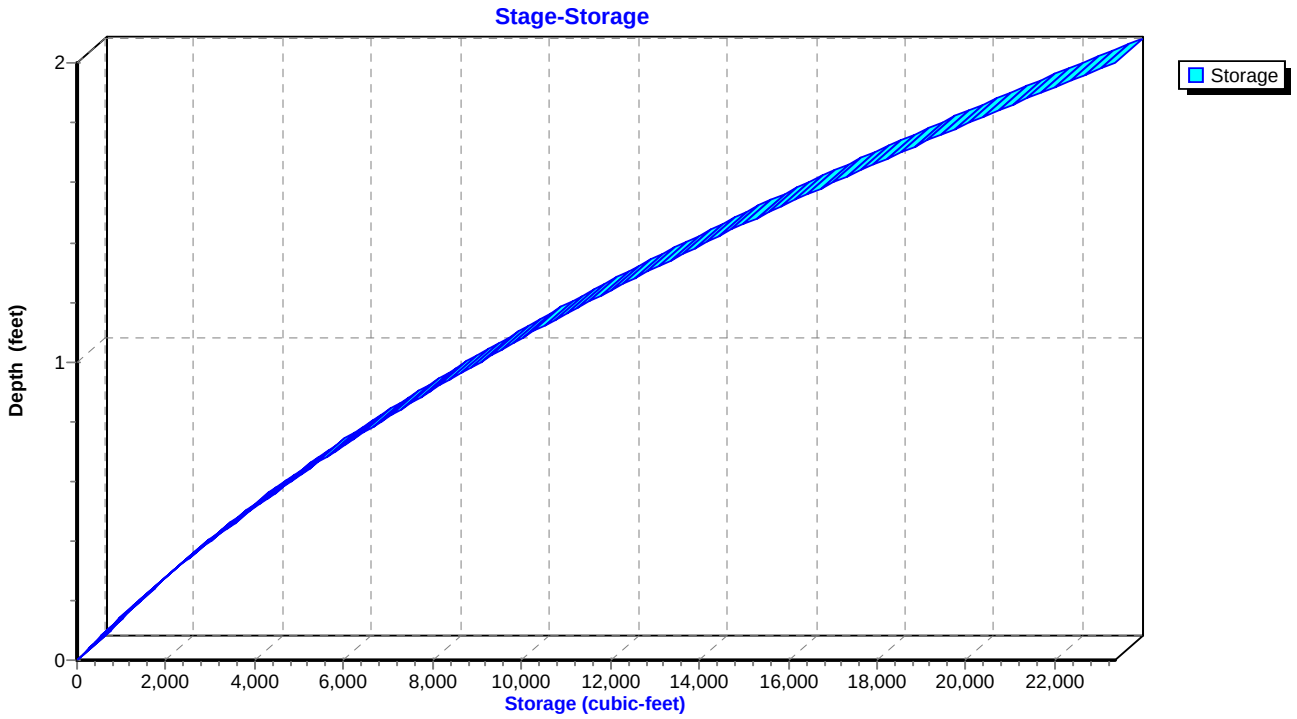
Reach 12R: West Drainage Ditch



Reach 12R: West Drainage Ditch



Reach 12R: West Drainage Ditch



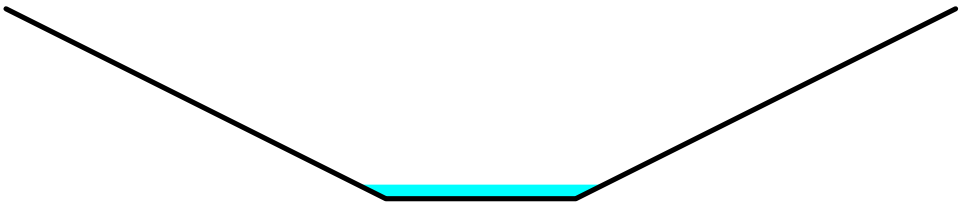
Summary for Reach 13R: South Drainage Ditch

Inflow Area = 3.160 ac, 0.00% Impervious, Inflow Depth = 0.57" for 25-YR, 24-HR event
Inflow = 0.87 cfs @ 10.09 hrs, Volume= 0.150 af
Outflow = 0.72 cfs @ 10.31 hrs, Volume= 0.150 af, Atten= 17%, Lag= 13.3 min

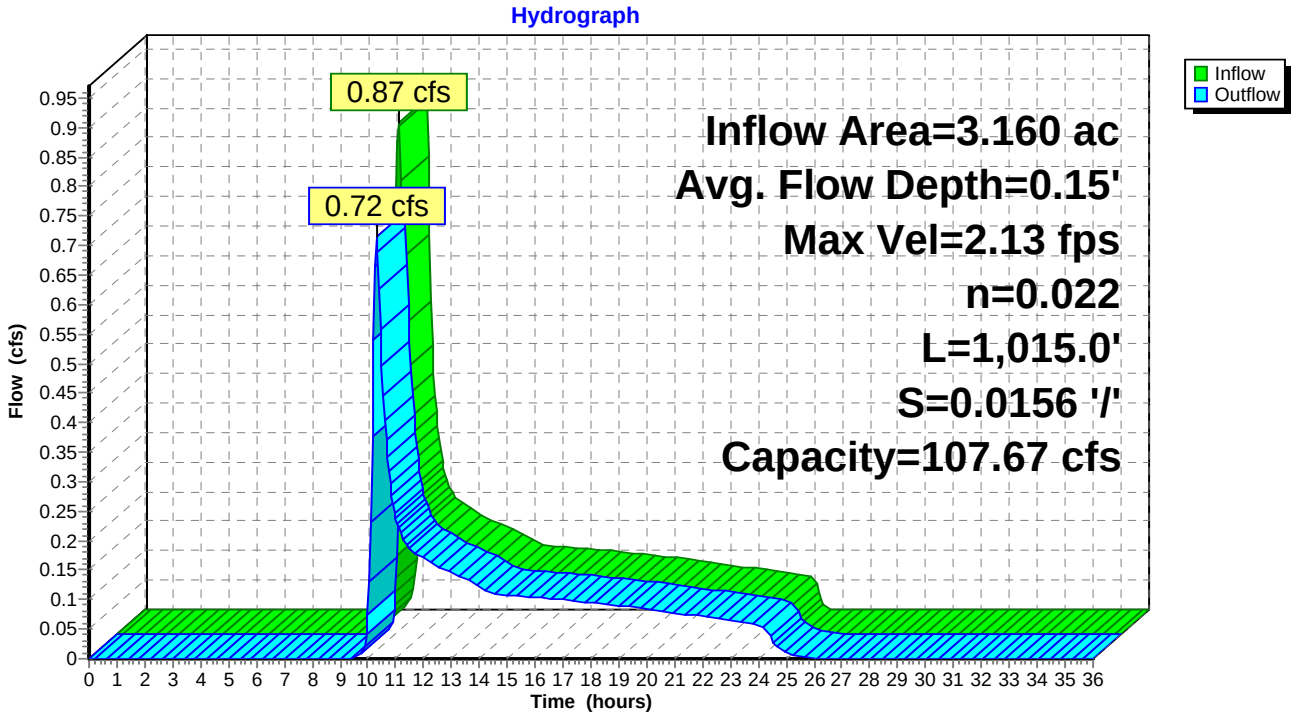
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.13 fps, Min. Travel Time= 7.9 min
Avg. Velocity = 1.00 fps, Avg. Travel Time= 16.8 min

Peak Storage= 344 cf @ 10.17 hrs
Average Depth at Peak Storage= 0.15'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 107.67 cfs

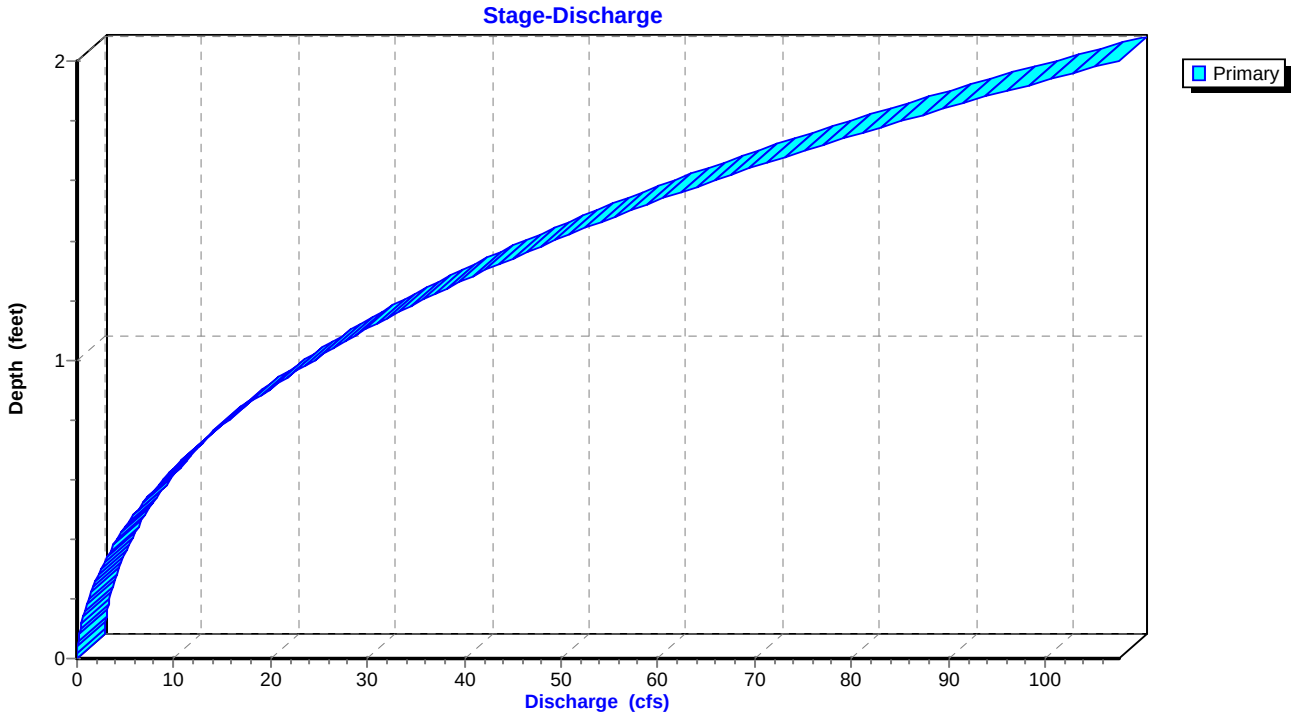
2.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 1,015.0' Slope= 0.0156 '/'
Inlet Invert= 5,045.22', Outlet Invert= 5,029.38'



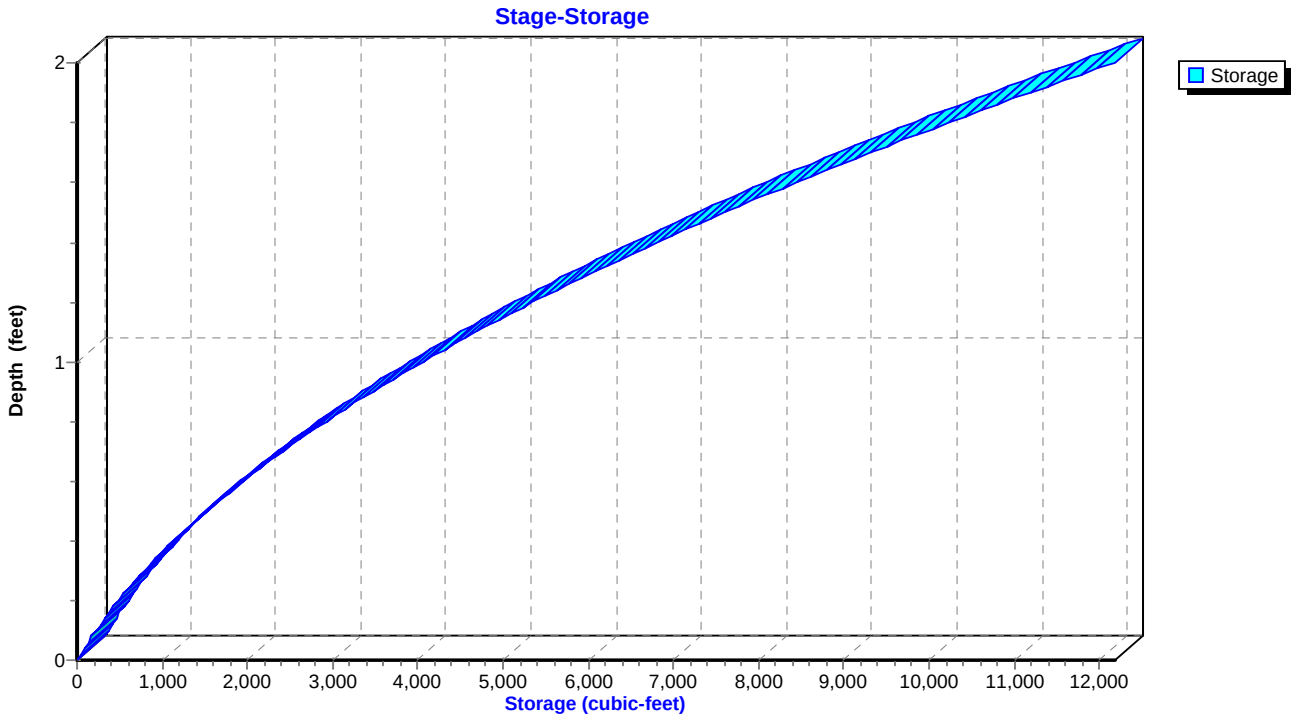
Reach 13R: South Drainage Ditch



Reach 13R: South Drainage Ditch



Reach 13R: South Drainage Ditch



Summary for Reach 14R: North Drainage Ditch

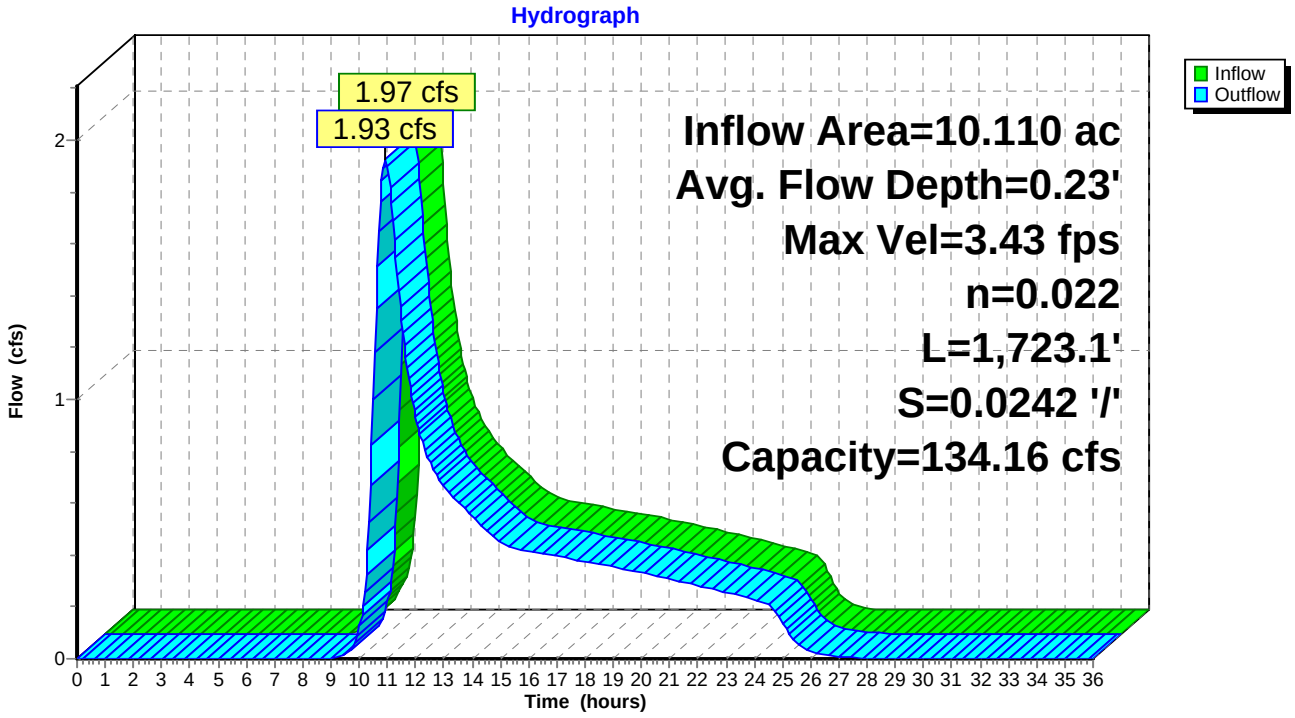
Inflow Area = 10.110 ac, 0.00% Impervious, Inflow Depth = 0.75" for 25-YR, 24-HR event
Inflow = 1.97 cfs @ 10.69 hrs, Volume= 0.631 af
Outflow = 1.93 cfs @ 10.93 hrs, Volume= 0.631 af, Atten= 2%, Lag= 14.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.43 fps, Min. Travel Time= 8.4 min
Avg. Velocity = 1.72 fps, Avg. Travel Time= 16.7 min

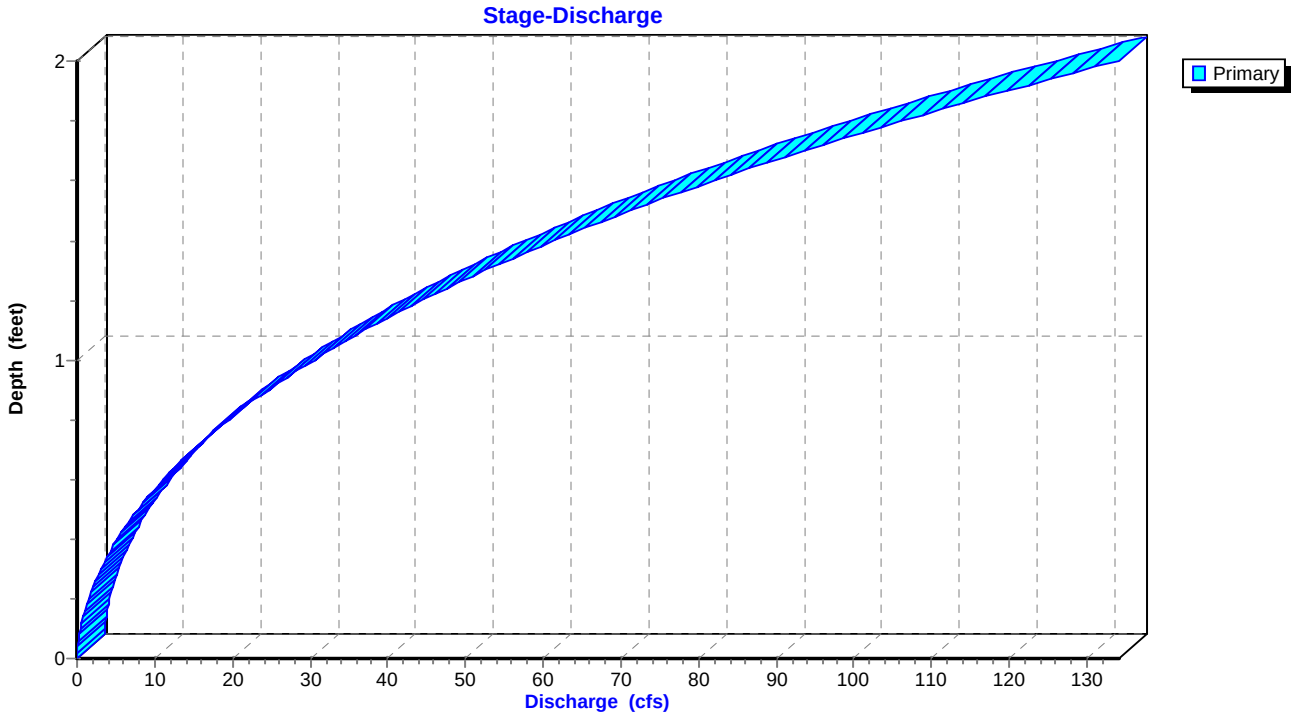
Peak Storage= 969 cf @ 10.79 hrs
Average Depth at Peak Storage= 0.23'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 134.16 cfs

2.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 1,723.1' Slope= 0.0242 '/'
Inlet Invert= 5,071.25', Outlet Invert= 5,029.50'

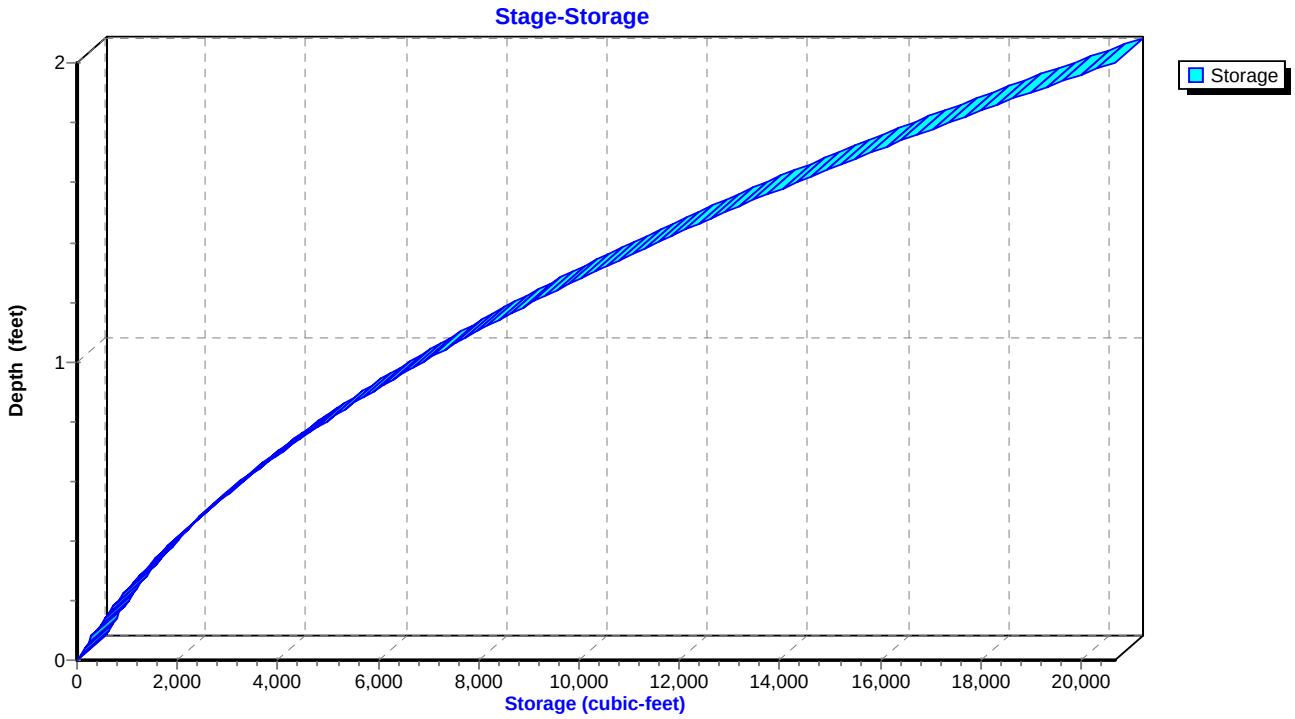
Reach 14R: North Drainage Ditch



Reach 14R: North Drainage Ditch



Reach 14R: North Drainage Ditch



Summary for Pond 8P: Pond 1

Inflow Area = 2.840 ac,100.00% Impervious, Inflow Depth = 2.15" for 25-YR, 24-HR event
Inflow = 4.81 cfs @ 9.87 hrs, Volume= 0.509 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Starting Elev= 5,061.57' Surf.Area= 0.000 ac Storage= 40.277 af
Peak Elev= 5,061.76' @ 24.05 hrs Surf.Area= 0.000 ac Storage= 40.786 af (0.509 af above start)
Flood Elev= 5,063.57' Surf.Area= 0.000 ac Storage= 45.571 af (5.294 af above start)

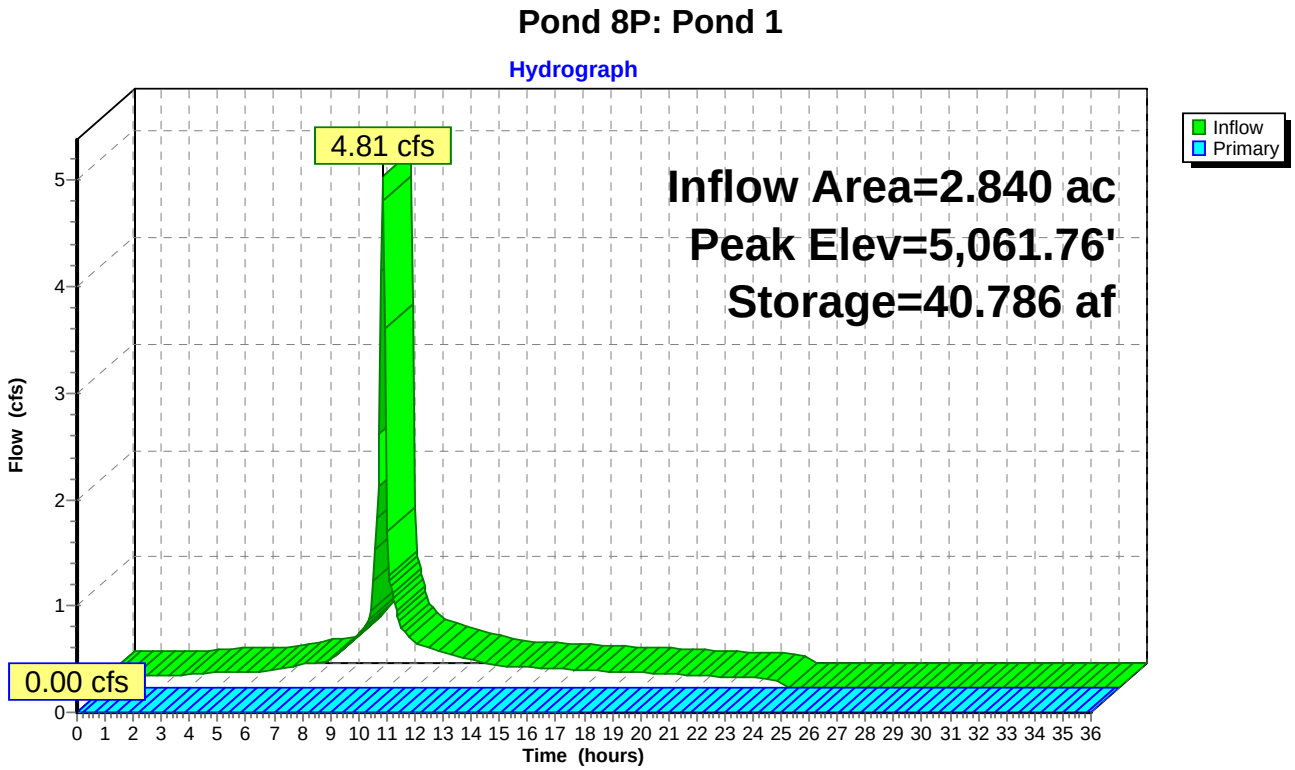
Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	5,040.33'	48.314 af	**Custom Stage Data** Listed below

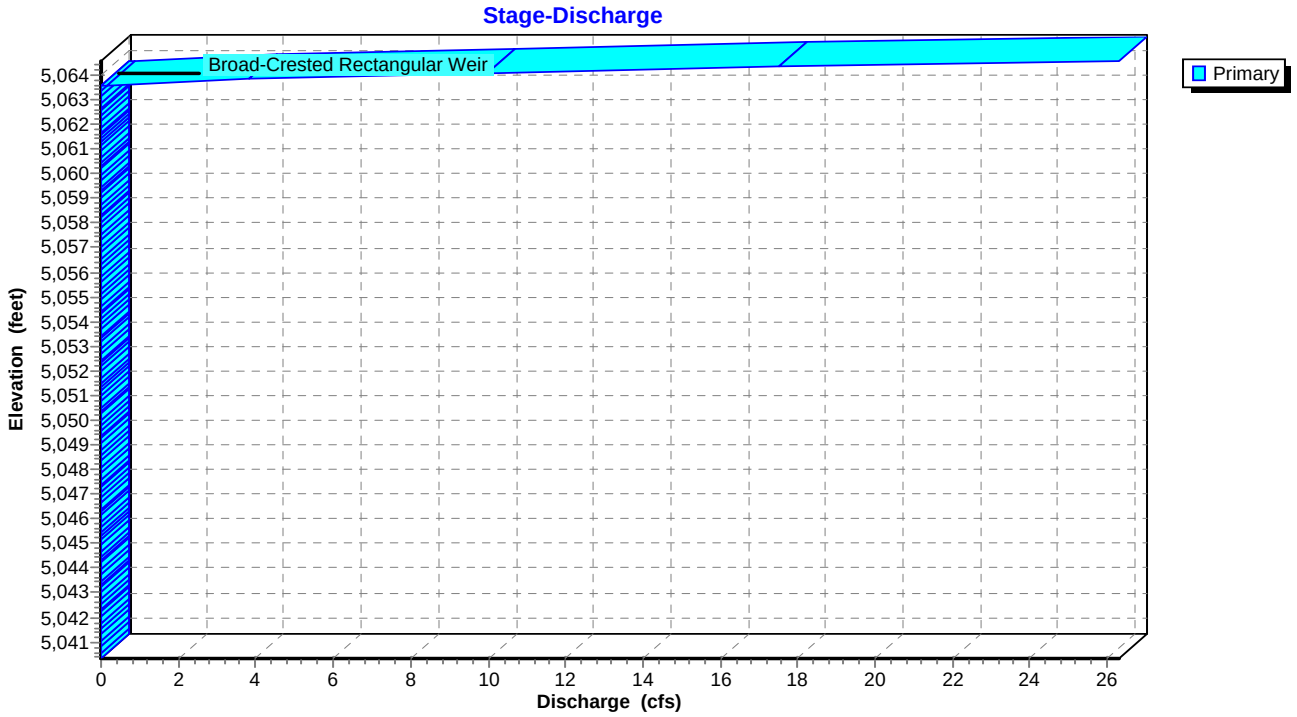
Elevation (feet)	Cum.Store (acre-feet)
5,040.33	0.000
5,041.33	0.264
5,042.33	1.457
5,043.33	2.977
5,044.33	4.548
5,045.33	6.170
5,046.33	7.844
5,047.33	9.570
5,048.33	11.350
5,049.33	13.184
5,050.33	15.073
5,051.33	17.017
5,052.33	19.017
5,053.33	21.074
5,054.33	23.189
5,055.33	25.362
5,056.33	27.593
5,057.33	29.885
5,058.33	32.236
5,059.33	34.649
5,060.33	37.123
5,061.33	39.659
5,061.57	40.277
5,062.57	42.892
5,063.57	45.571
5,064.57	48.314

Device	Routing	Invert	Outlet Devices
#1	Primary	5,063.57'	**10.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

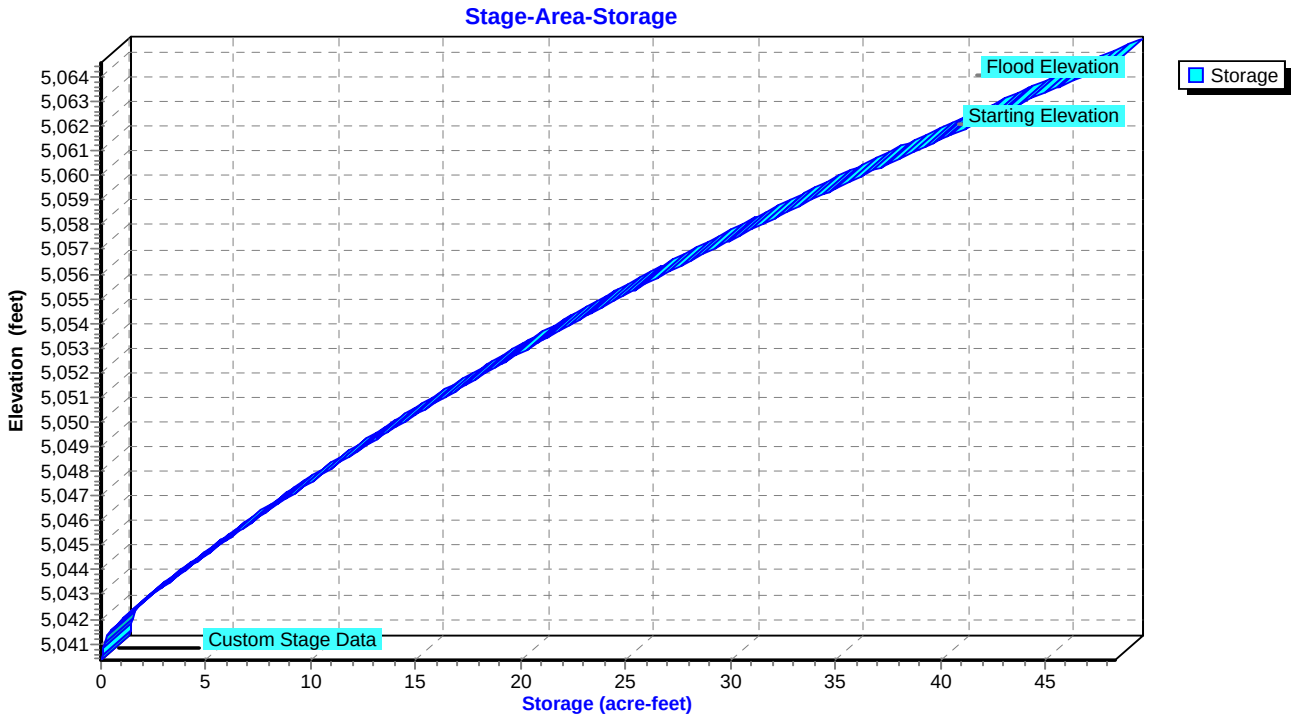
Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,061.57' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)



Pond 8P: Pond 1



Pond 8P: Pond 1



Summary for Pond 9P: Pond 2

Inflow Area = 2.750 ac,100.00% Impervious, Inflow Depth = 2.15" for 25-YR, 24-HR event
Inflow = 4.65 cfs @ 9.87 hrs, Volume= 0.493 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Starting Elev= 5,057.80' Surf.Area= 0.000 ac Storage= 31.106 af
Peak Elev= 5,057.99' @ 24.05 hrs Surf.Area= 0.000 ac Storage= 31.599 af (0.493 af above start)
Flood Elev= 5,059.80' Surf.Area= 0.000 ac Storage= 36.361 af (5.255 af above start)

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

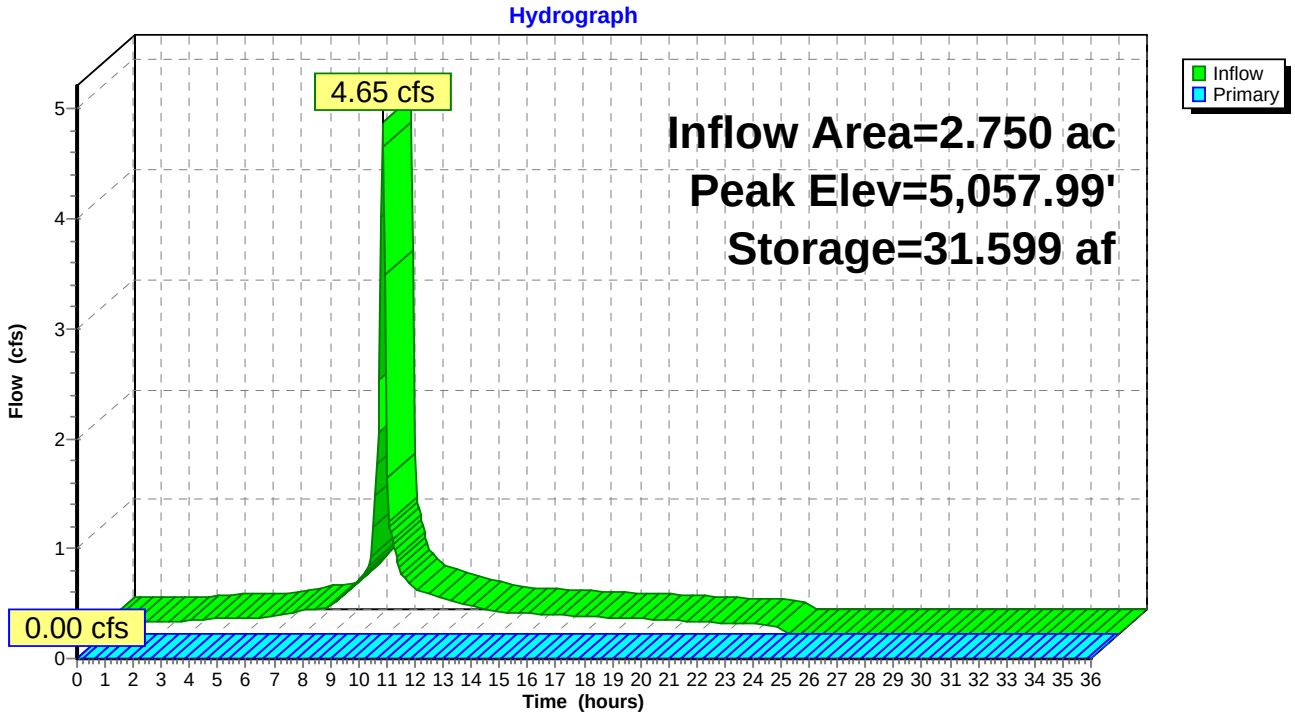
Volume	Invert	Avail.Storage	Storage Description
#1	5,042.42'	39.082 af	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (acre-feet)
5,042.42	0.000
5,043.42	0.335
5,044.42	1.897
5,045.42	3.742
5,046.42	5.638
5,047.42	7.588
5,048.42	9.591
5,049.42	11.649
5,050.42	13.761
5,051.42	15.929
5,052.42	18.152
5,053.42	20.433
5,054.42	22.771
5,055.42	25.167
5,056.42	27.621
5,057.42	30.135
5,057.80	31.106
5,058.80	33.704
5,059.80	36.361
5,060.80	39.082

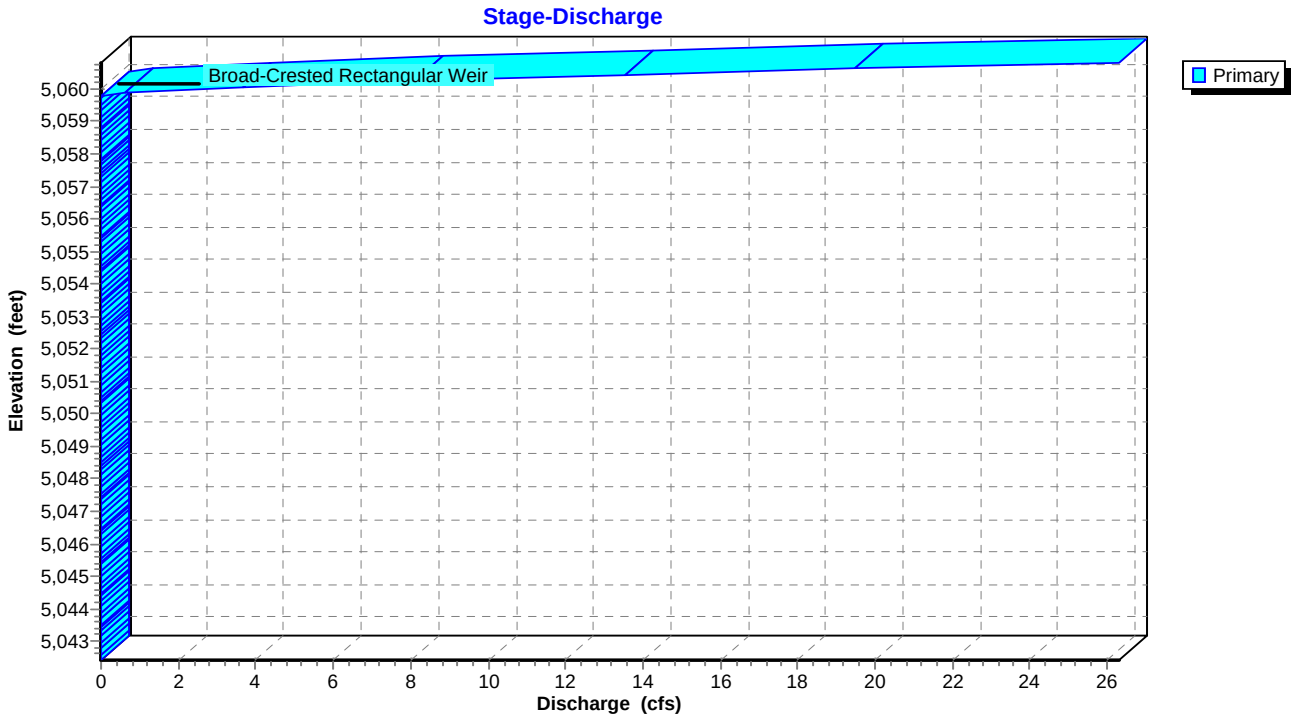
Device	Routing	Invert	Outlet Devices
#1	Primary	5,059.80'	**10.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,057.80' (Free Discharge)
↑**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

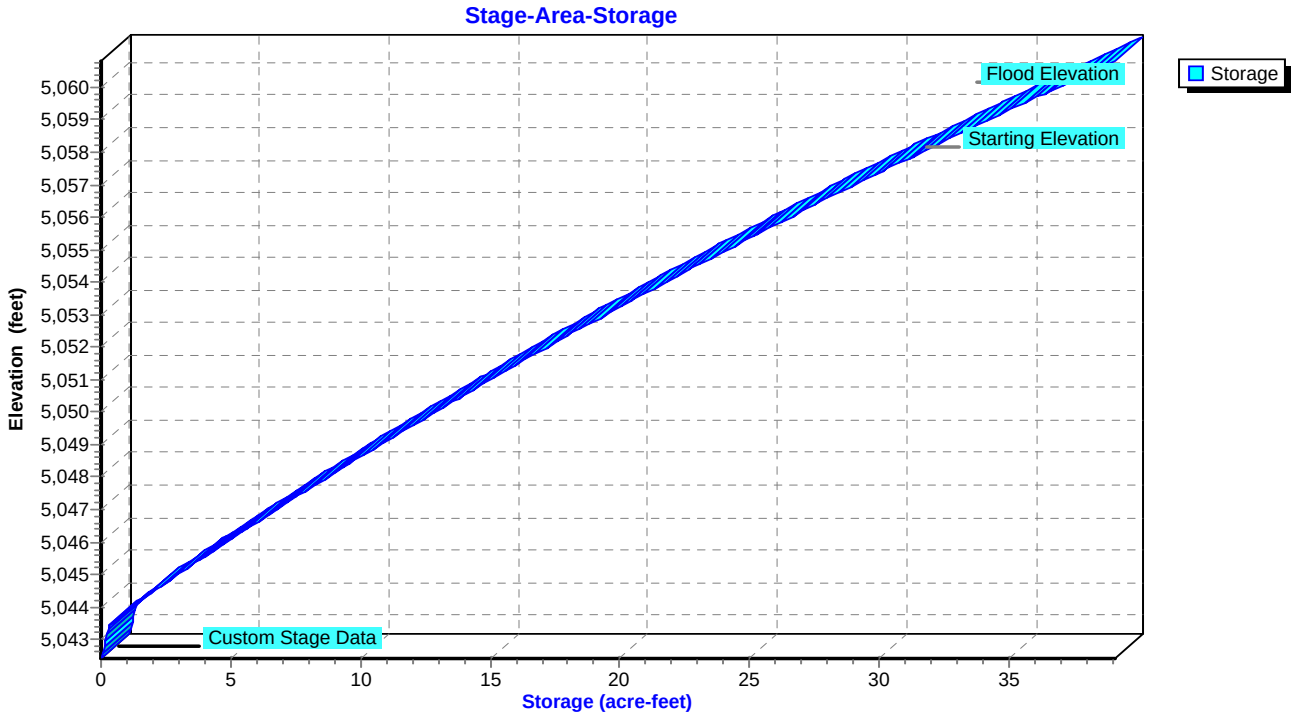
Pond 9P: Pond 2



Pond 9P: Pond 2



Pond 9P: Pond 2



Summary for Pond 10P: Pond 3

Inflow Area = 2.660 ac,100.00% Impervious, Inflow Depth = 2.15" for 25-YR, 24-HR event
Inflow = 4.50 cfs @ 9.87 hrs, Volume= 0.477 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Starting Elev= 5,048.50' Surf.Area= 0.000 ac Storage= 29.964 af
Peak Elev= 5,048.69' @ 24.05 hrs Surf.Area= 0.000 ac Storage= 30.441 af (0.477 af above start)
Flood Elev= 5,050.50' Surf.Area= 0.000 ac Storage= 34.999 af (5.035 af above start)

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

Volume	Invert	Avail.Storage	Storage Description
#1	5,032.00'	37.619 af	**Custom Stage Data** Listed below

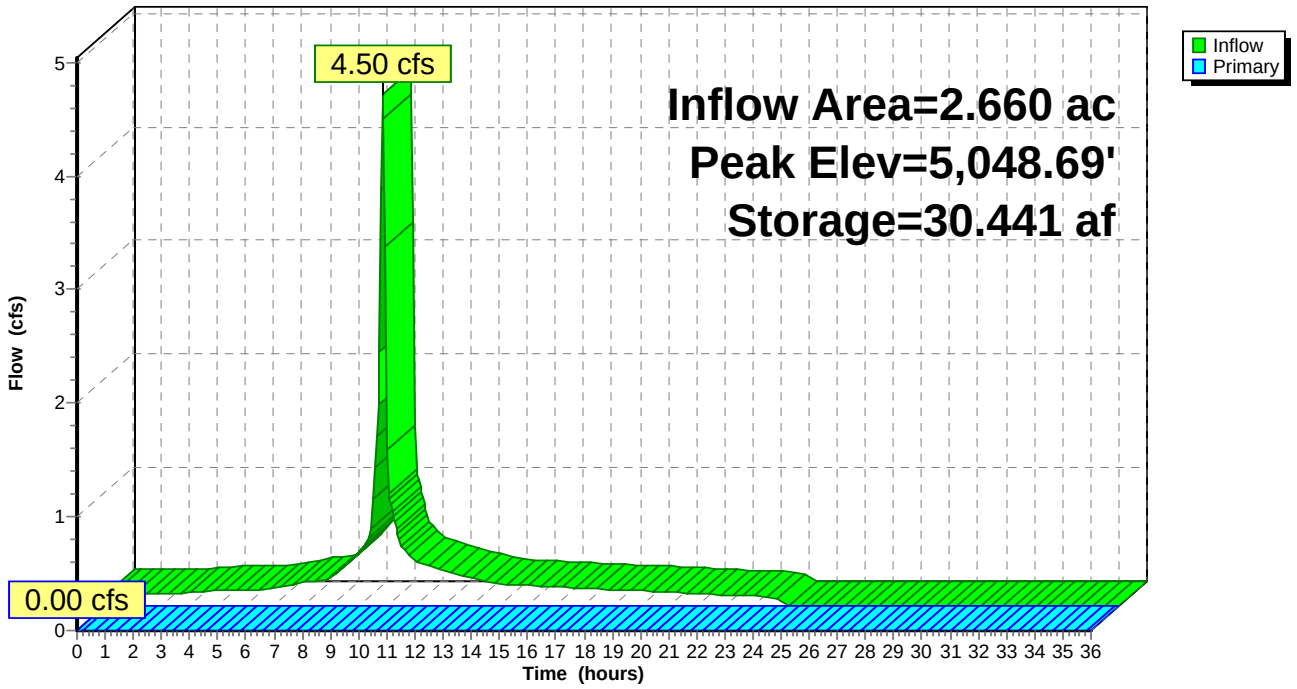
Elevation (feet)	Cum.Store (acre-feet)
5,032.00	0.000
5,033.00	0.217
5,034.00	1.183
5,035.00	2.730
5,036.00	4.364
5,037.00	6.057
5,038.00	7.809
5,039.00	9.622
5,040.00	11.495
5,041.00	13.429
5,042.00	15.426
5,043.00	17.486
5,044.00	19.609
5,045.00	21.796
5,046.00	24.047
5,047.00	26.365
5,048.00	28.748
5,048.50	29.964
5,049.50	32.448
5,050.50	34.999
5,051.50	37.619

Device	Routing	Invert	Outlet Devices
#1	Primary	5,050.50'	**10.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,048.50' (Free Discharge)
1=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

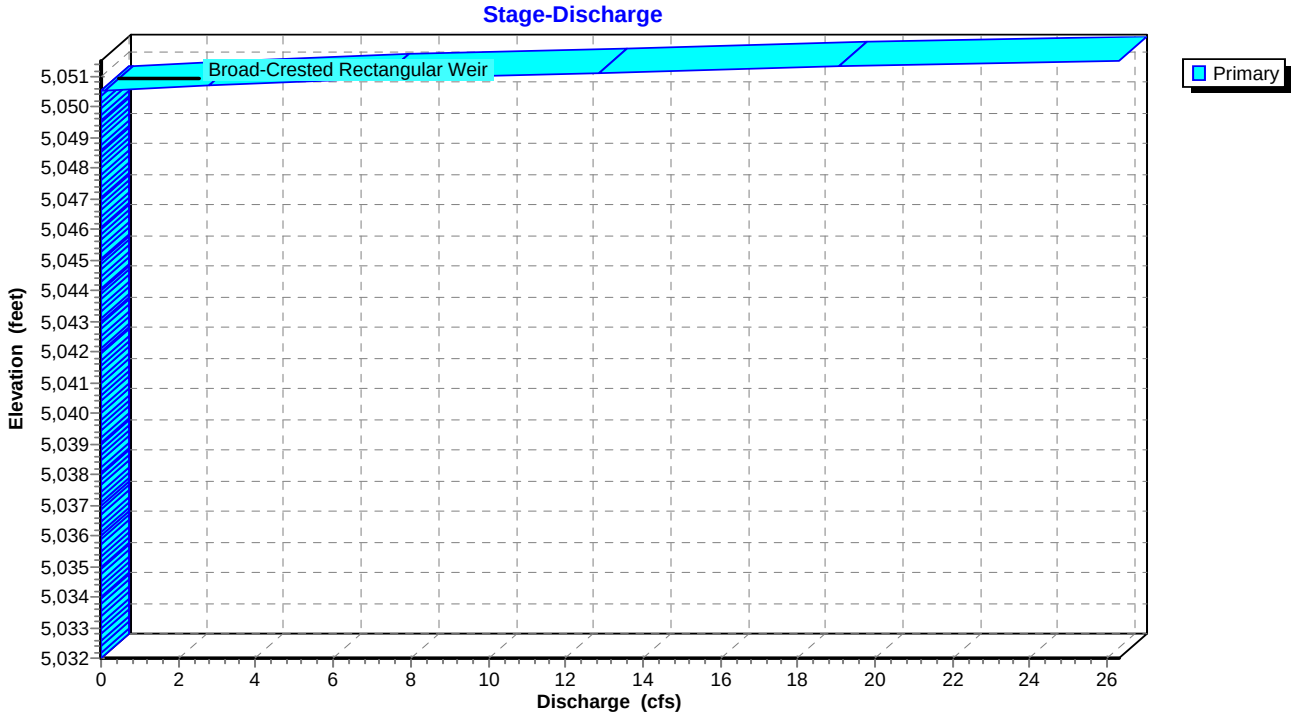
Pond 10P: Pond 3

Hydrograph

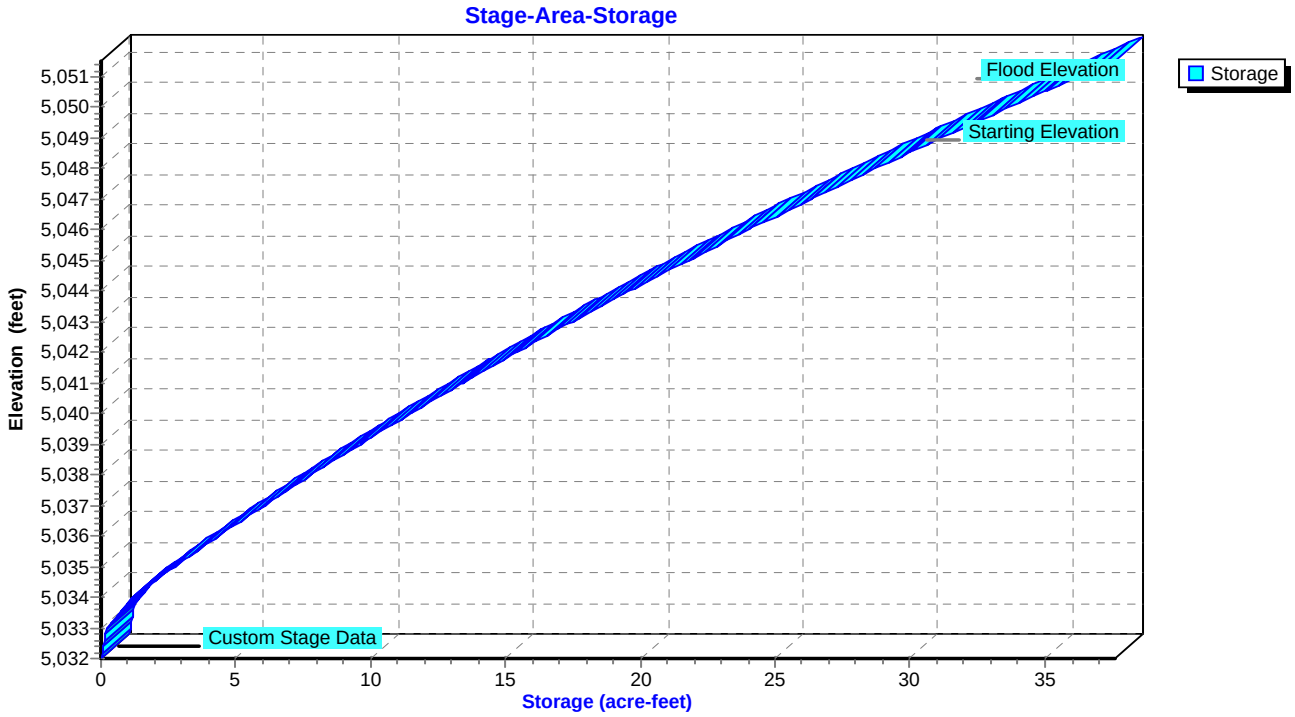


Pond 10P: Pond 3

Stage-Discharge



Pond 10P: Pond 3



Summary for Pond 11P: Detention Pond

Inflow Area = 14.470 ac, 0.00% Impervious, Inflow Depth = 0.69" for 25-YR, 24-HR event
Inflow = 2.25 cfs @ 10.90 hrs, Volume= 0.831 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 5,029.72' @ 36.00 hrs Surf.Area= 0.302 ac Storage= 0.831 af

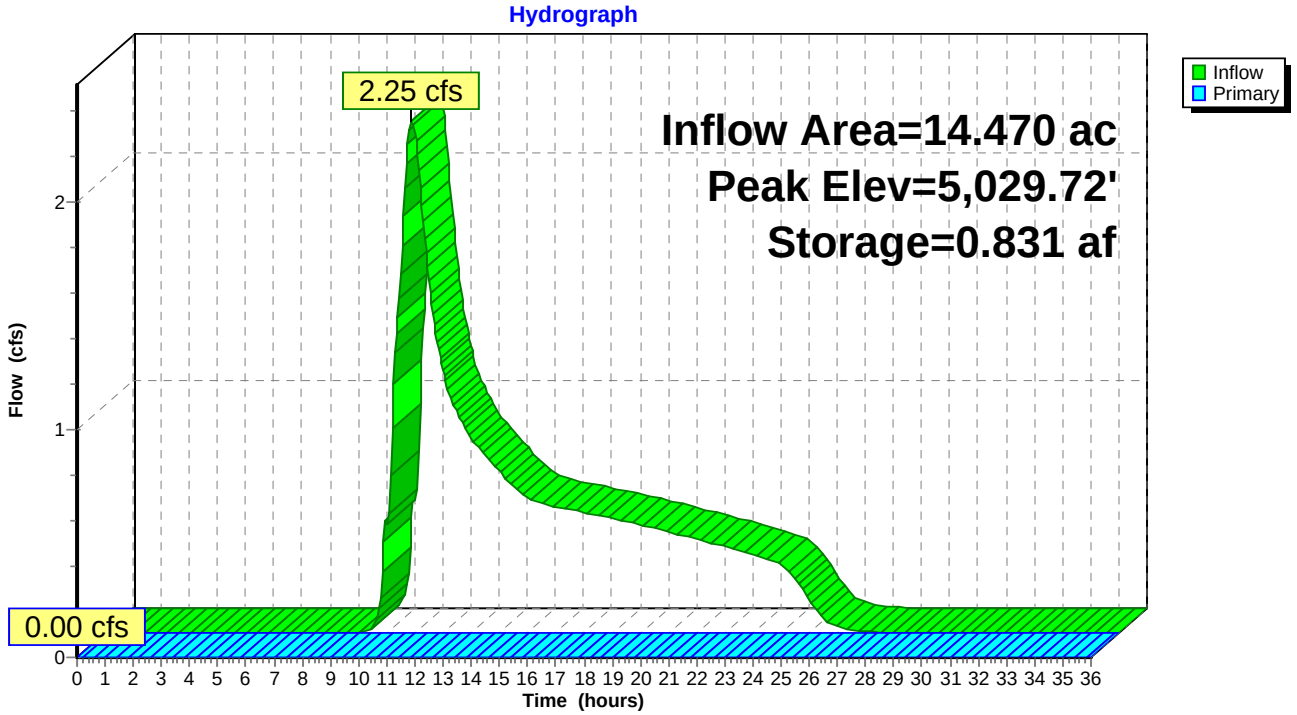
Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	5,026.00'	1.256 af	**26.00'W x 250.00'L x 5.00'H Prismatoid Z=3.0**

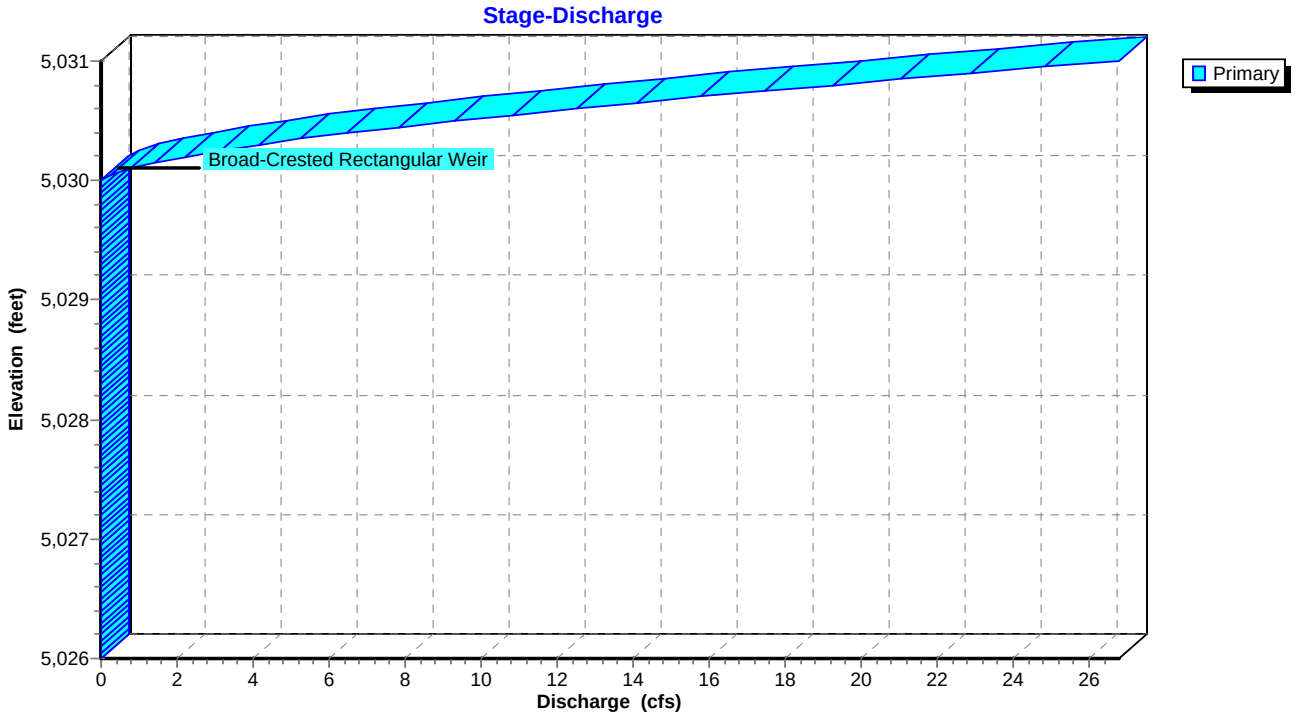
Device	Routing	Invert	Outlet Devices
#1	Primary	5,030.00'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,026.00' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

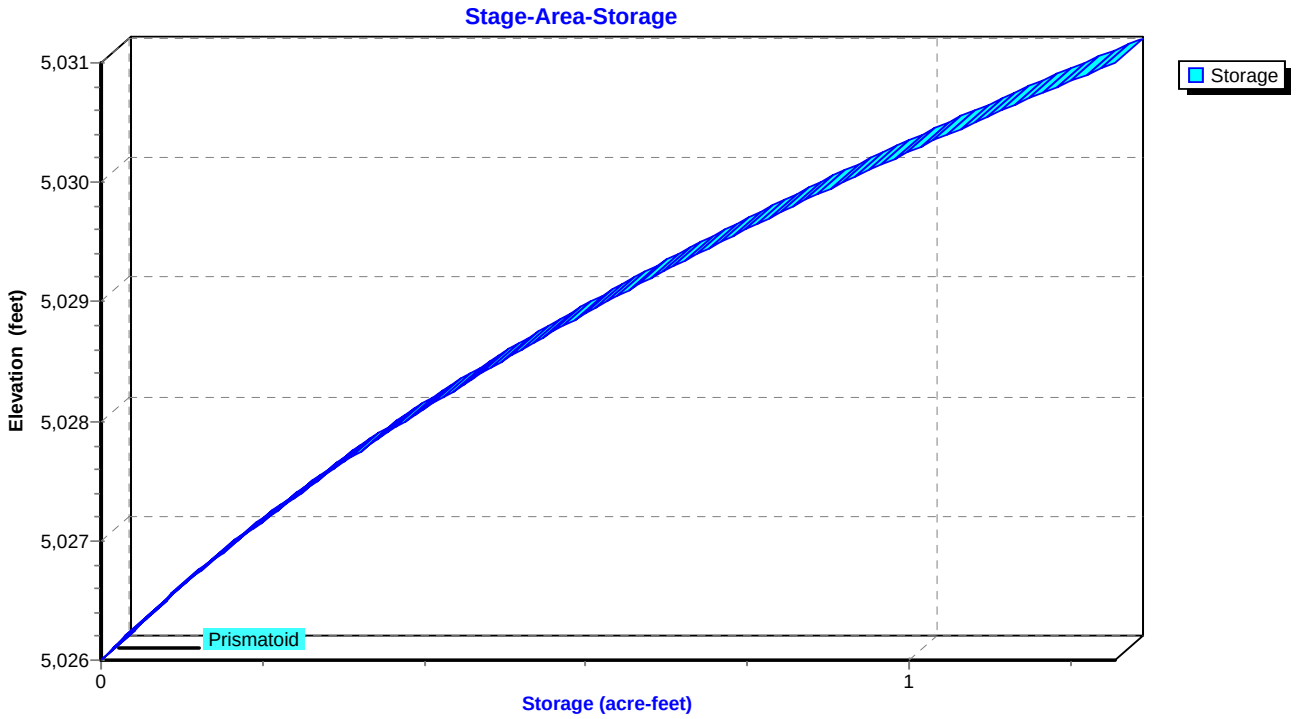
Pond 11P: Detention Pond



Pond 11P: Detention Pond



Pond 11P: Detention Pond



APPENDIX D

STORMWATER QUALITY CALCULATIONS

Mesa Co Water Quality Capture Volume

WQCV = K {a(0.91*I^3 - 1.19*I^2 + 0.78*I)}

K =	d_6/0.43	Adjustment to equation for Mesa County area
d_6 =	0.28	inches
a=	1.0	Adjustment for BMPs drain time
I =	80%	Light Industrial
WQCV =	0.214	inches

Required Storage = 1.2*(WQCV/12)*Area

Area = 14.47 acre

Required WQCV Storage = 0.309 acre-feet

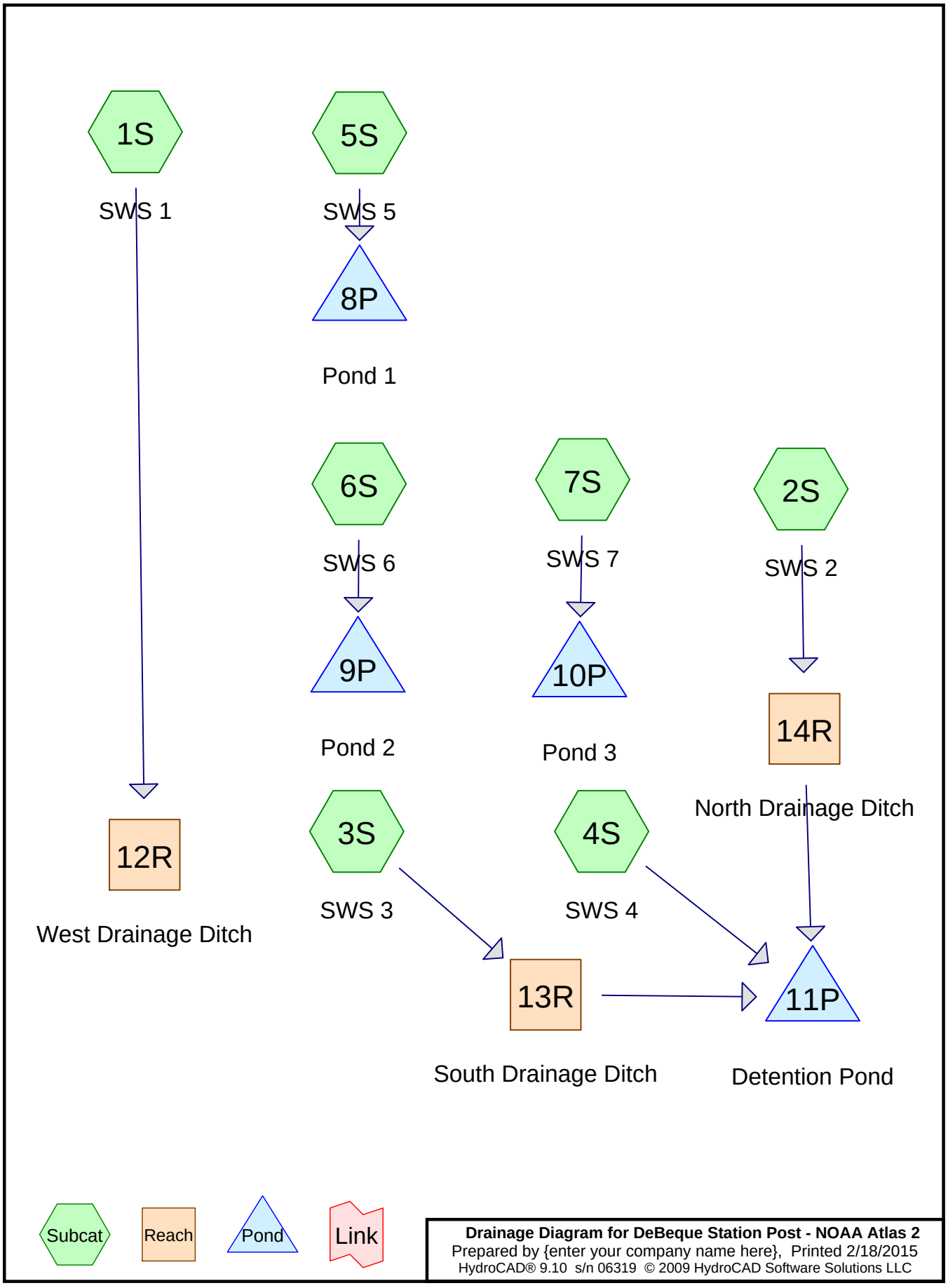
NOAA Atlas 2: 2-year, 6-hour Water Volume = 0.049 acre-feet
NOAA Atlas 2: 100-year, 6-hour Water Volume = 0.57 acre-feet

Detention Pond Stage-Storage Table

Elevation (feet)	Storage (acre-feet)	Notes
5026.00	0.000	Pond Bottom
5026.32	0.049	NOAA Atlas 2: 2-year, 6-hour volume
5026.50	0.079	Recommended sediment cleanout volume
5027.00	0.169	
5027.50	0.268	
5027.70	0.309	WQCV volume
5028.00	0.377	
5028.50	0.496	
5028.79	0.570	NOAA Atlas 2: 100-year, 6-hour volume
5029.00	0.626	
5029.50	0.767	
5030.00	0.919	12" Outlet Pipe Invert Elevation
5030.50	1.082	
5031.00	1.256	Spillway Elevation
5031.50	1.442	
5032.00	1.639	Pond Top

APPENDIX B-3

100-YR, 24-HR HYDROCAD REPORT



Drainage Diagram for DeBeque Station Post - NOAA Atlas 2
Prepared by {enter your company name here}, Printed 2/18/2015

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.200	76	Weighted Curve Number (4S)
3.160	78	Weighted Curve Number (3S)
258.860	79	Weighted Curve Number (1S)
10.110	82	Weighted Curve Number (2S)
8.250	100	Liner (5S, 6S, 7S)
281.580		**TOTAL AREA**

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: SWS 1 Runoff Area=258.860 ac 0.00% Impervious Runoff Depth=0.91"
Flow Length=8,106' Tc=56.7 min CN=79 Runoff=121.70 cfs 19.525 af

Subcatchment 2S: SWS 2 Runoff Area=10.110 ac 0.00% Impervious Runoff Depth=1.07"
Flow Length=2,405' Tc=58.5 min CN=82 Runoff=5.68 cfs 0.903 af

Subcatchment 3S: SWS 3 Runoff Area=3.160 ac 0.00% Impervious Runoff Depth=0.85"
Flow Length=934' Tc=14.6 min CN=78 Runoff=3.37 cfs 0.225 af

Subcatchment 4S: SWS 4 Runoff Area=1.200 ac 0.00% Impervious Runoff Depth=0.76"
Flow Length=174' Tc=3.8 min CN=76 Runoff=1.69 cfs 0.076 af

Subcatchment 5S: SWS 5 Runoff Area=2.840 ac 100.00% Impervious Runoff Depth=2.60"
Flow Length=15' Slope=0.5000 '/' Tc=0.1 min CN=100 Runoff=11.88 cfs 0.615 af

Subcatchment 6S: SWS 6 Runoff Area=2.750 ac 100.00% Impervious Runoff Depth=2.60"
Flow Length=15' Slope=0.5000 '/' Tc=0.1 min CN=100 Runoff=11.51 cfs 0.596 af

Subcatchment 7S: SWS 7 Runoff Area=2.660 ac 100.00% Impervious Runoff Depth=2.60"
Flow Length=15' Slope=0.5000 '/' Tc=0.1 min CN=100 Runoff=11.13 cfs 0.576 af

Reach 12R: West Drainage Ditch Avg. Flow Depth=1.48' Max Vel=10.35 fps Inflow=121.70 cfs 19.525 af
n=0.022 L=1,297.4' S=0.0231 '/' Capacity=219.29 cfs Outflow=121.22 cfs 19.525 af

Reach 13R: South Drainage Ditch Avg. Flow Depth=0.33' Max Vel=3.39 fps Inflow=3.37 cfs 0.225 af
n=0.022 L=1,015.0' S=0.0156 '/' Capacity=107.67 cfs Outflow=2.98 cfs 0.225 af

Reach 14R: North Drainage Ditch Avg. Flow Depth=0.41' Max Vel=4.76 fps Inflow=5.68 cfs 0.903 af
n=0.022 L=1,723.1' S=0.0242 '/' Capacity=134.16 cfs Outflow=5.59 cfs 0.903 af

Pond 8P: Pond 1 Peak Elev=5,061.81' Storage=40.892 af Inflow=11.88 cfs 0.615 af
Outflow=0.00 cfs 0.000 af

Pond 9P: Pond 2 Peak Elev=5,058.03' Storage=31.702 af Inflow=11.51 cfs 0.596 af
Outflow=0.00 cfs 0.000 af

Pond 10P: Pond 3 Peak Elev=5,048.73' Storage=30.540 af Inflow=11.13 cfs 0.576 af
Outflow=0.00 cfs 0.000 af

Pond 11P: Detention Pond Peak Elev=5,031.14' Storage=1.307 af Inflow=6.25 cfs 1.204 af
Outflow=3.73 cfs 1.179 af

Total Runoff Area = 281.580 ac Runoff Volume = 22.516 af Average Runoff Depth = 0.96"
97.07% Pervious = 273.330 ac 2.93% Impervious = 8.250 ac

Summary for Subcatchment 1S: SWS 1

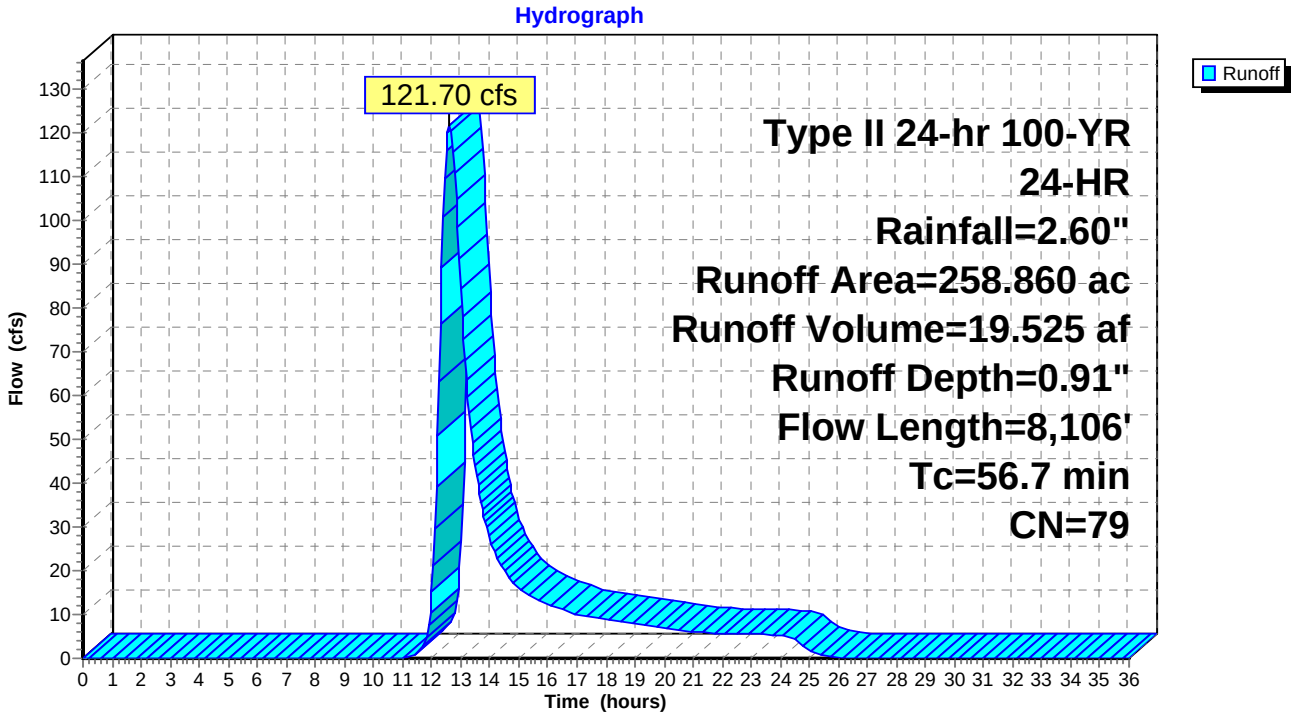
Runoff = 121.70 cfs @ 12.63 hrs, Volume= 19.525 af, Depth= 0.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-YR, 24-HR Rainfall=2.60"

	Area (ac)	CN	Description
*	258.860	79	Weighted Curve Number
	258.860		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	300	0.3900	0.45		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
45.6	7,806	0.0813	2.85		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
56.7	8,106	Total			

Subcatchment 1S: SWS 1



Summary for Subcatchment 2S: SWS 2

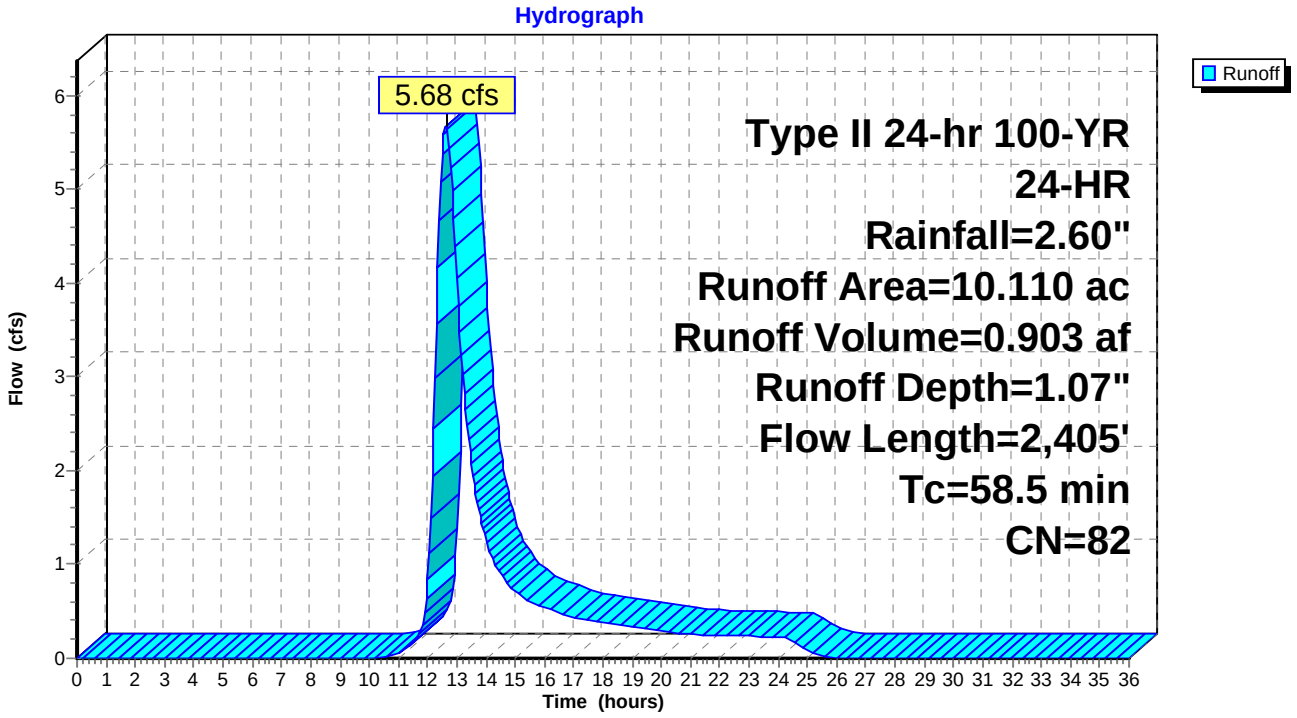
Runoff = 5.68 cfs @ 12.63 hrs, Volume= 0.903 af, Depth= 1.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-YR, 24-HR Rainfall=2.60"

	Area (ac)	CN	Description
*	10.110	82	Weighted Curve Number
	10.110		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.2	300	0.0233	0.15		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
24.3	2,105	0.0209	1.45		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
58.5	2,405	Total			

Subcatchment 2S: SWS 2



Summary for Subcatchment 3S: SWS 3

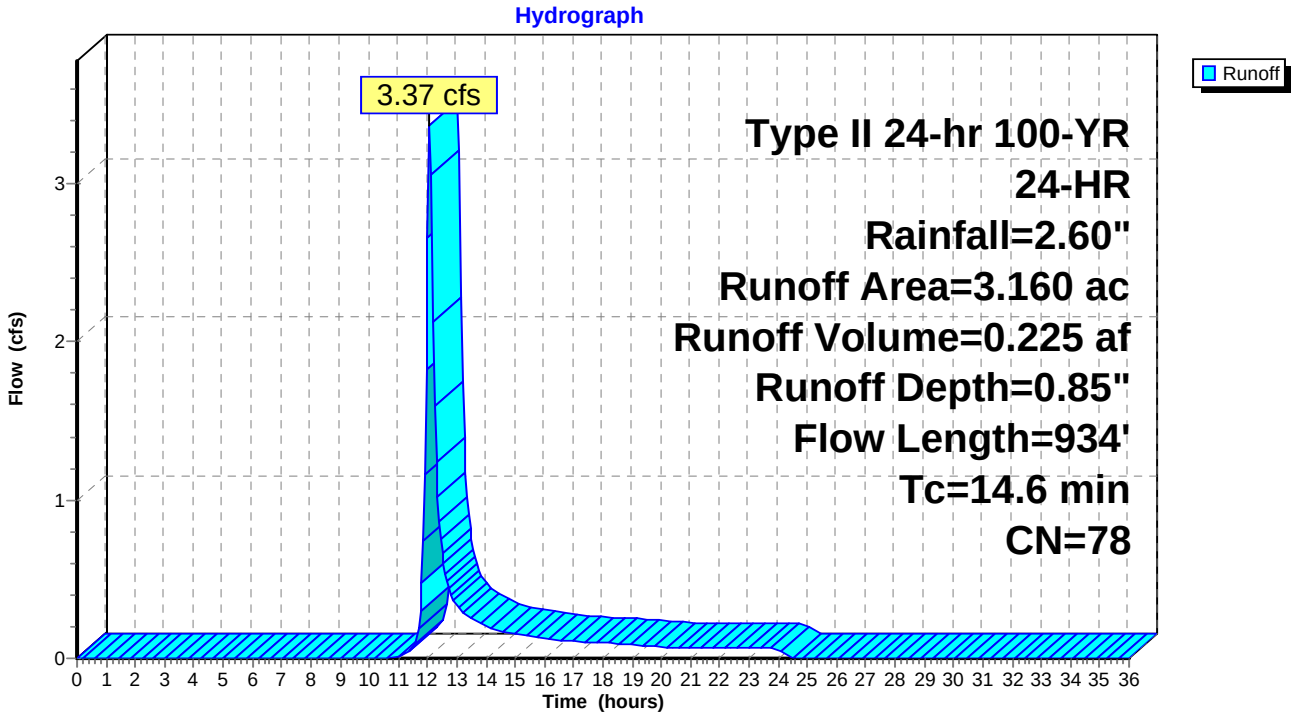
Runoff = 3.37 cfs @ 12.08 hrs, Volume= 0.225 af, Depth= 0.85"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-YR, 24-HR Rainfall=2.60"

	Area (ac)	CN	Description
*	3.160	78	Weighted Curve Number
	3.160		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.2500	0.26		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
11.4	884	0.0166	1.29		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
14.6	934	Total			

Subcatchment 3S: SWS 3



Summary for Subcatchment 4S: SWS 4

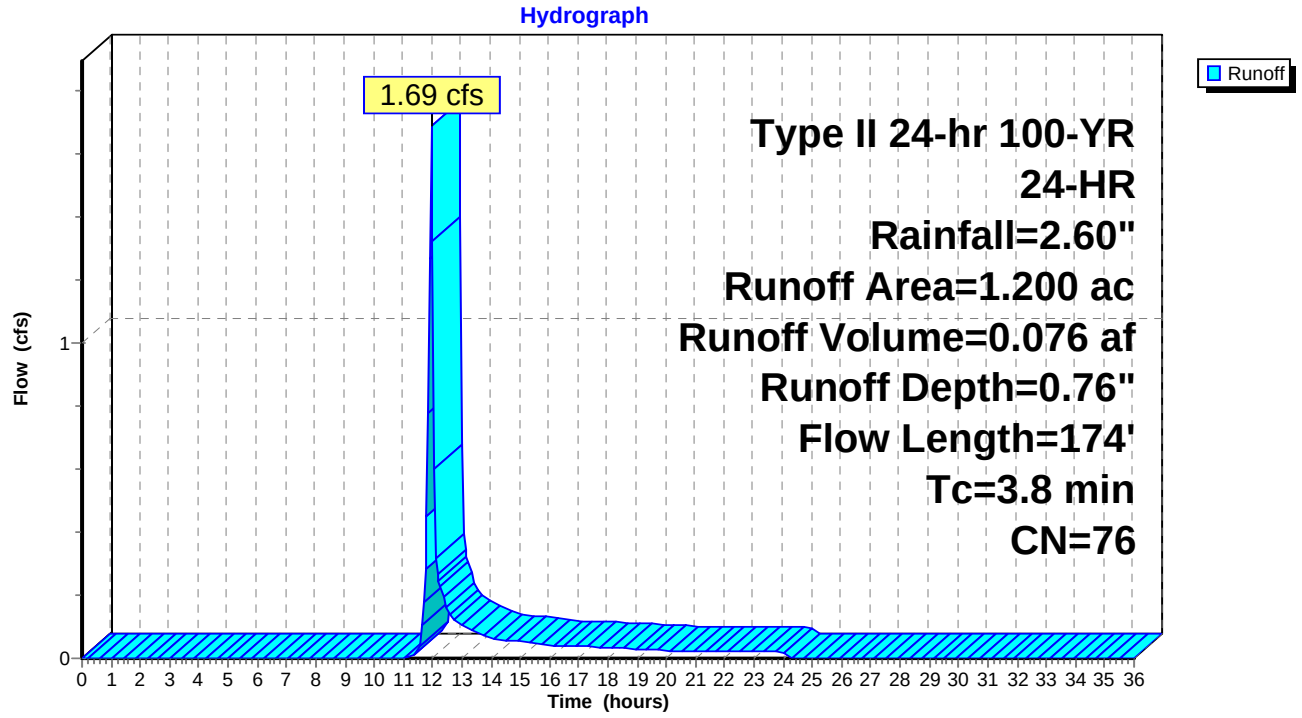
Runoff = 1.69 cfs @ 11.95 hrs, Volume= 0.076 af, Depth= 0.76"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-YR, 24-HR Rainfall=2.60"

	Area (ac)	CN	Description
*	1.200	76	Weighted Curve Number
	1.200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.2500	0.26		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
0.6	124	0.1149	3.39		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
3.8	174	Total			

Subcatchment 4S: SWS 4



Summary for Subcatchment 5S: SWS 5

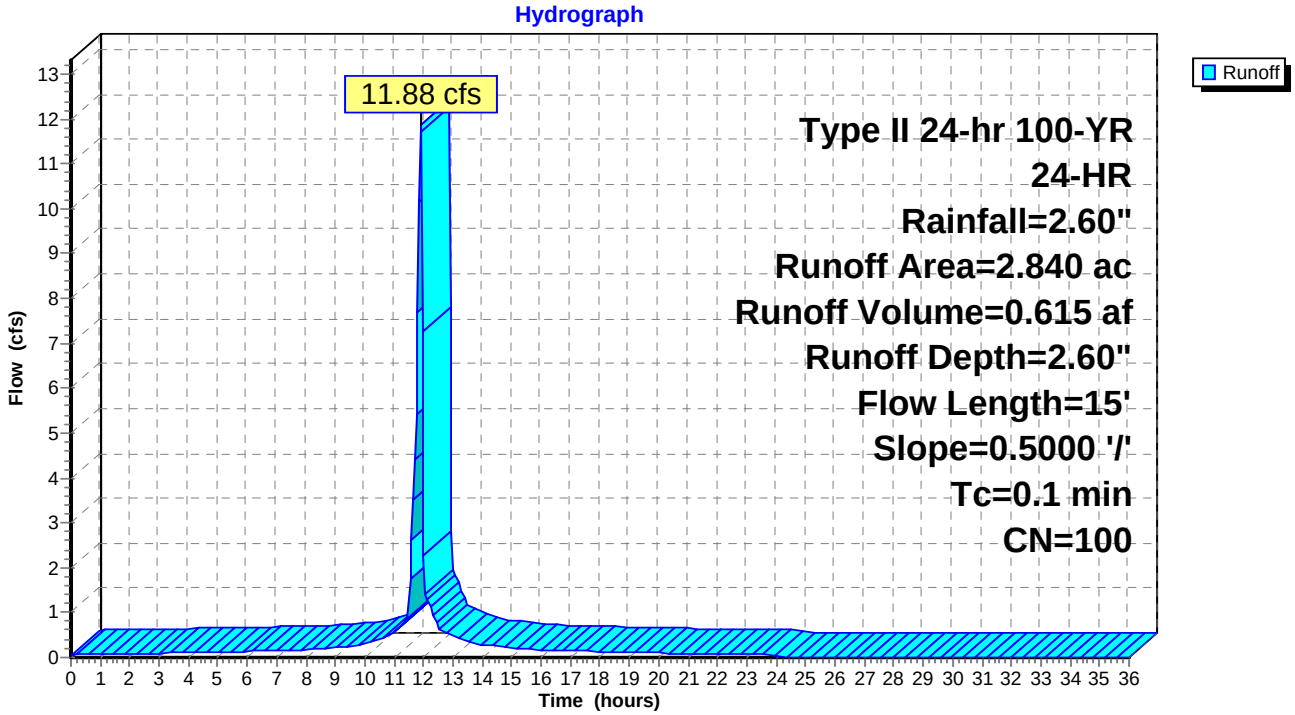
Runoff = 11.88 cfs @ 11.89 hrs, Volume= 0.615 af, Depth= 2.60"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-YR, 24-HR Rainfall=2.60"

	Area (ac)	CN	Description
*	2.840	100	Liner
	2.840		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	15	0.5000	1.97		**Sheet Flow, Overland Flow** Smooth surfaces n= 0.011 P2= 1.07"

Subcatchment 5S: SWS 5



Summary for Subcatchment 6S: SWS 6

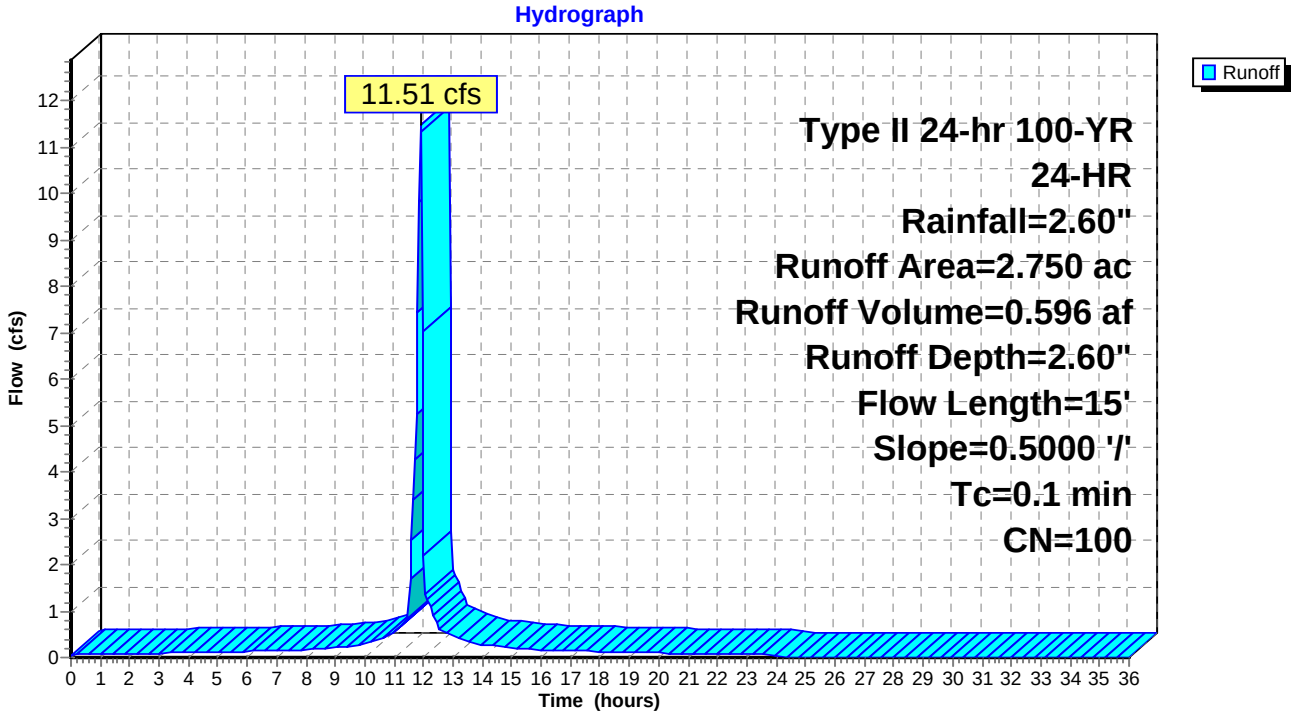
Runoff = 11.51 cfs @ 11.89 hrs, Volume= 0.596 af, Depth= 2.60"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-YR, 24-HR Rainfall=2.60"

	Area (ac)	CN	Description
*	2.750	100	Liner
	2.750		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	15	0.5000	1.97		**Sheet Flow, Overland Flow** Smooth surfaces n= 0.011 P2= 1.07"

Subcatchment 6S: SWS 6



Summary for Subcatchment 7S: SWS 7

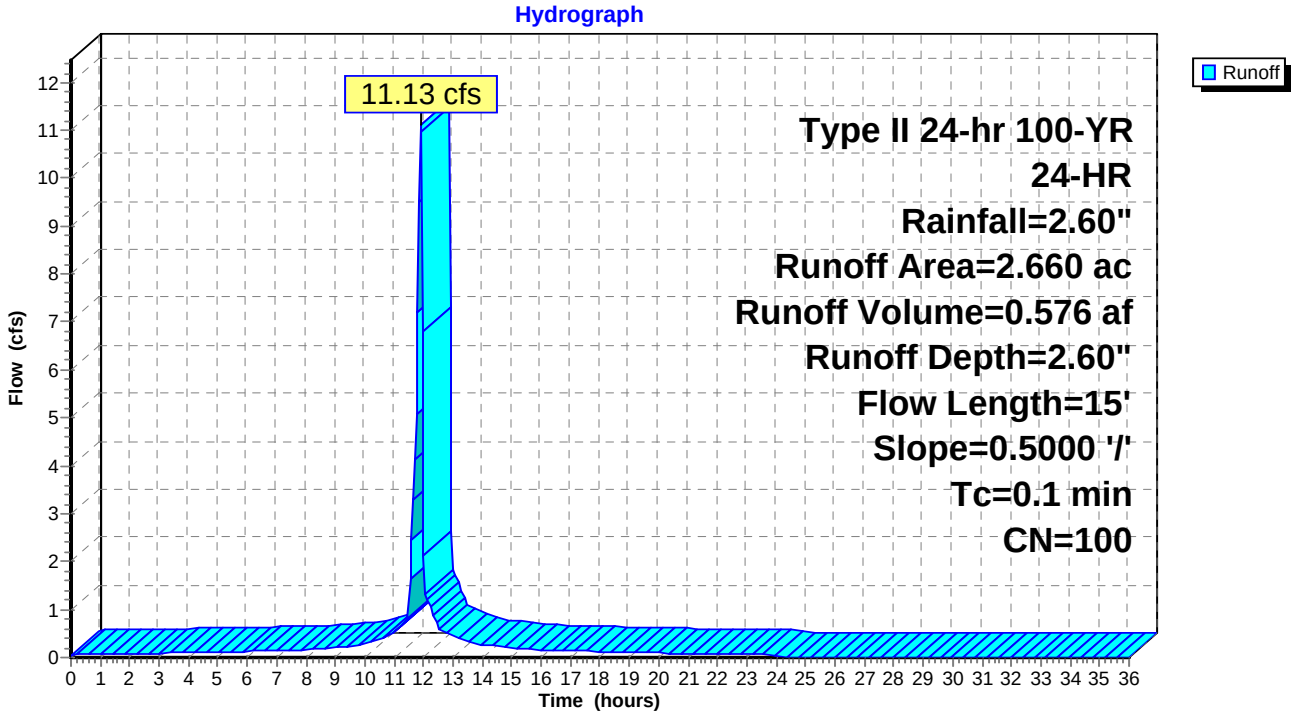
Runoff = 11.13 cfs @ 11.89 hrs, Volume= 0.576 af, Depth= 2.60"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-YR, 24-HR Rainfall=2.60"

	Area (ac)	CN	Description
*	2.660	100	Liner
	2.660		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	15	0.5000	1.97		**Sheet Flow, Overland Flow** Smooth surfaces n= 0.011 P2= 1.07"

Subcatchment 7S: SWS 7



Summary for Reach 12R: West Drainage Ditch

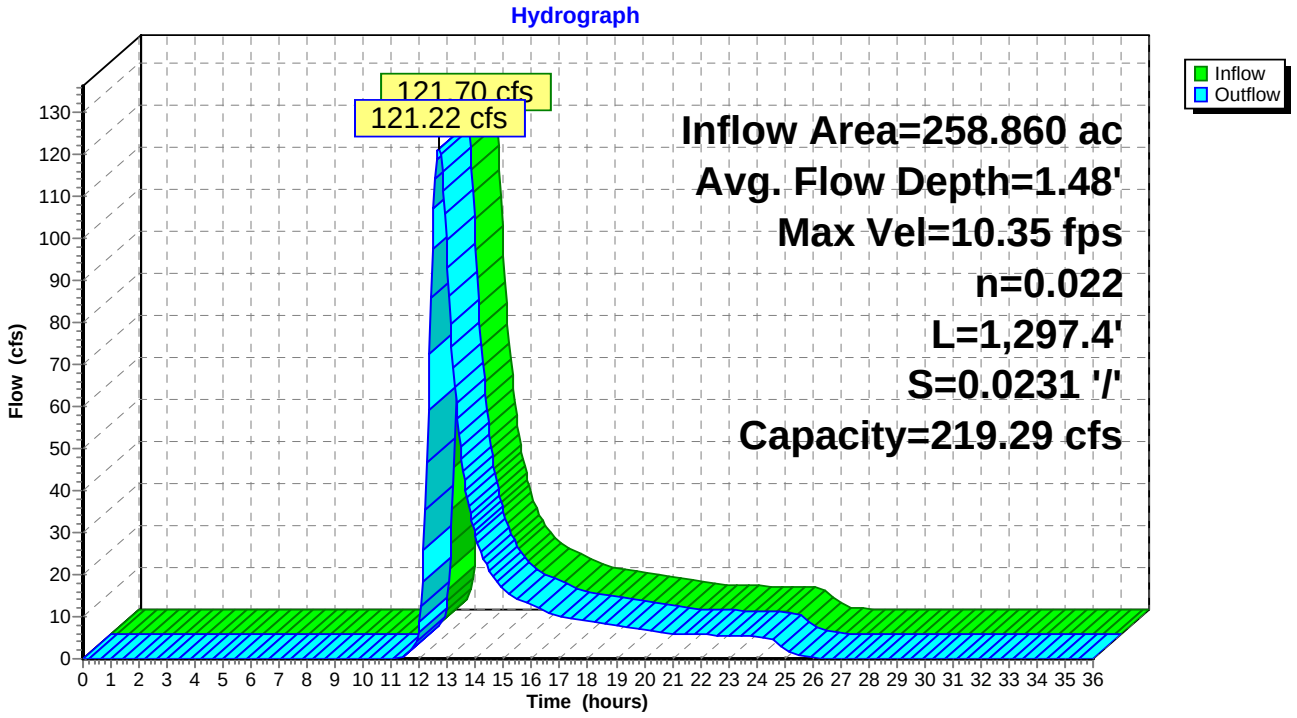
Inflow Area = 258.860 ac, 0.00% Impervious, Inflow Depth = 0.91" for 100-YR, 24-HR event
Inflow = 121.70 cfs @ 12.63 hrs, Volume= 19.525 af
Outflow = 121.22 cfs @ 12.68 hrs, Volume= 19.525 af, Atten= 0%, Lag= 3.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Max. Velocity= 10.35 fps, Min. Travel Time= 2.1 min
Avg. Velocity = 3.81 fps, Avg. Travel Time= 5.7 min

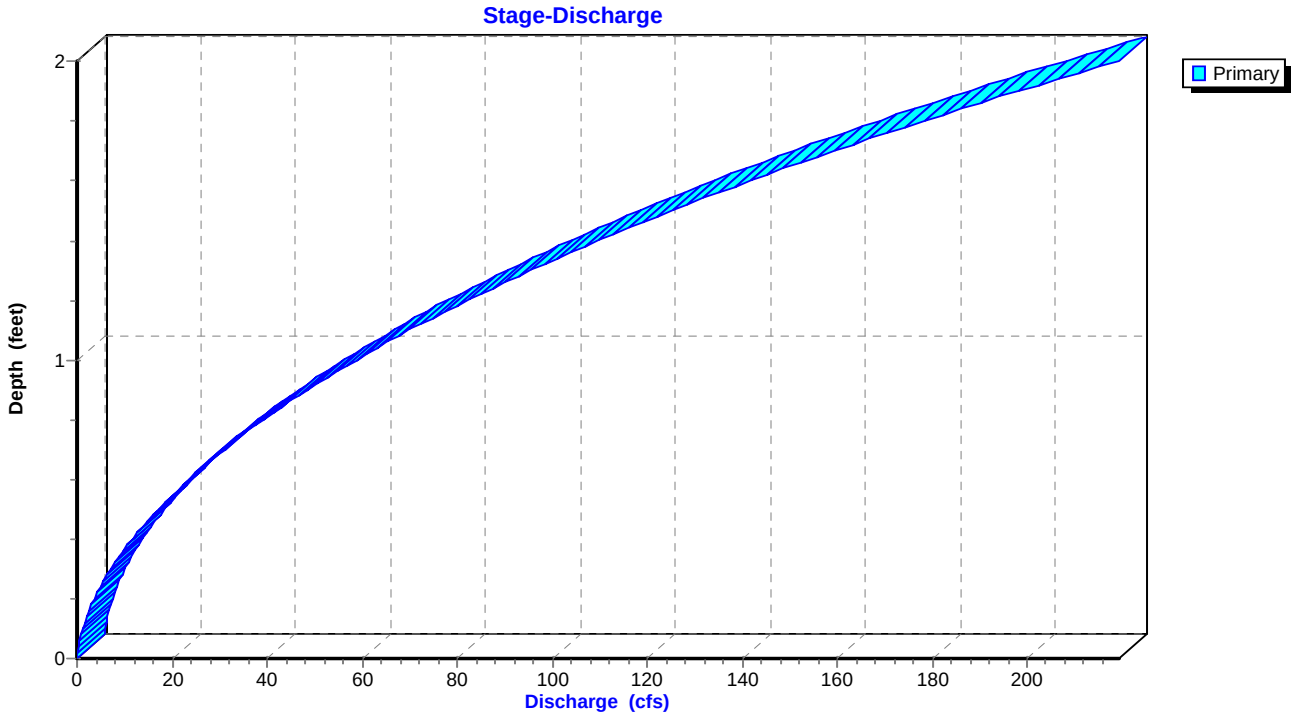
Peak Storage= 15,215 cf @ 12.64 hrs
Average Depth at Peak Storage= 1.48'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 219.29 cfs

5.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 2.0 '/' Top Width= 13.00'
Length= 1,297.4' Slope= 0.0231 '/'
Inlet Invert= 5,077.00', Outlet Invert= 5,046.97'

Reach 12R: West Drainage Ditch



Reach 12R: West Drainage Ditch



Summary for Reach 13R: South Drainage Ditch

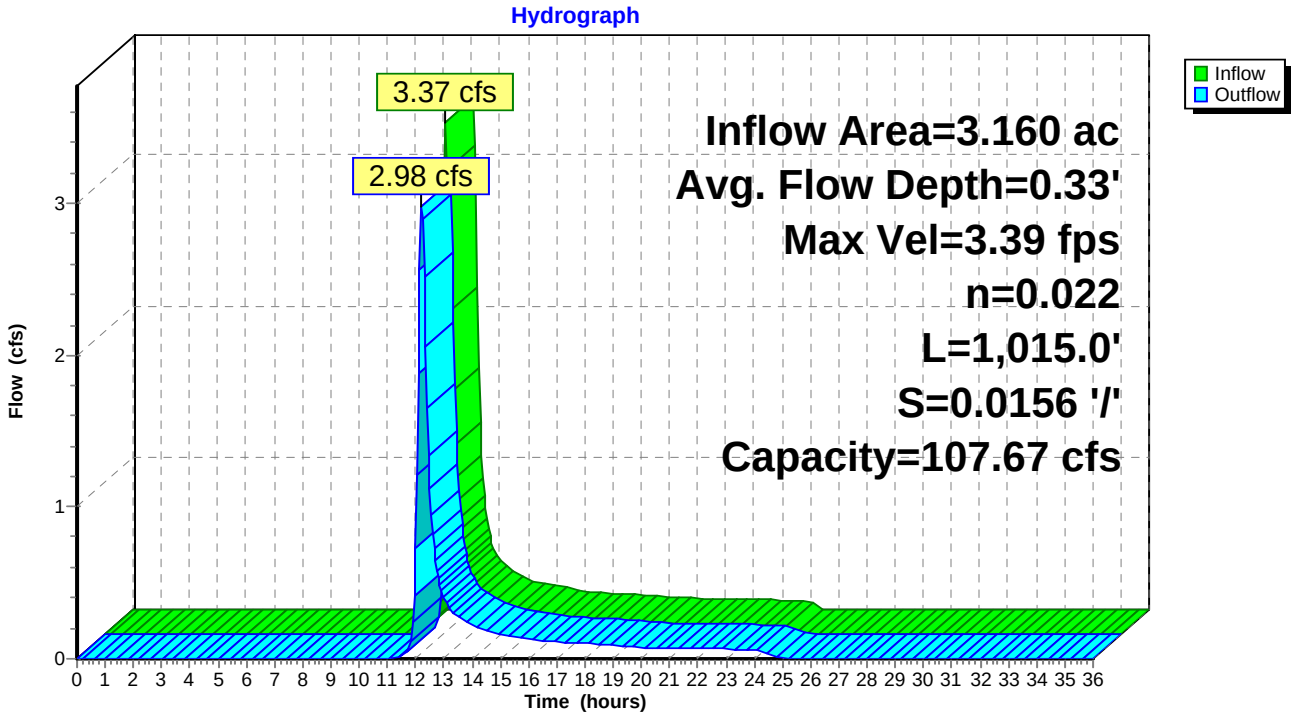
Inflow Area = 3.160 ac, 0.00% Impervious, Inflow Depth = 0.85" for 100-YR, 24-HR event
Inflow = 3.37 cfs @ 12.08 hrs, Volume= 0.225 af
Outflow = 2.98 cfs @ 12.22 hrs, Volume= 0.225 af, Atten= 12%, Lag= 8.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.39 fps, Min. Travel Time= 5.0 min
Avg. Velocity = 1.06 fps, Avg. Travel Time= 15.9 min

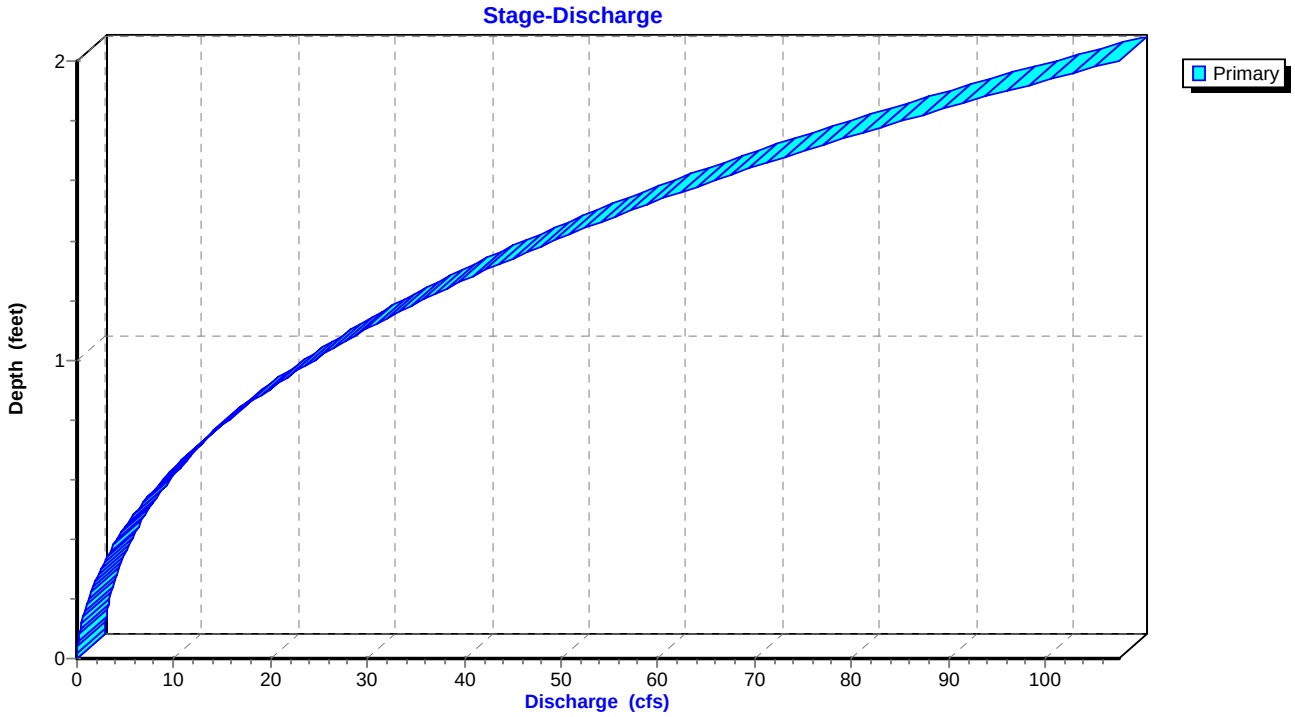
Peak Storage= 904 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.33'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 107.67 cfs

2.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 1,015.0' Slope= 0.0156 '/'
Inlet Invert= 5,045.22', Outlet Invert= 5,029.38'

Reach 13R: South Drainage Ditch



Reach 13R: South Drainage Ditch



Summary for Reach 14R: North Drainage Ditch

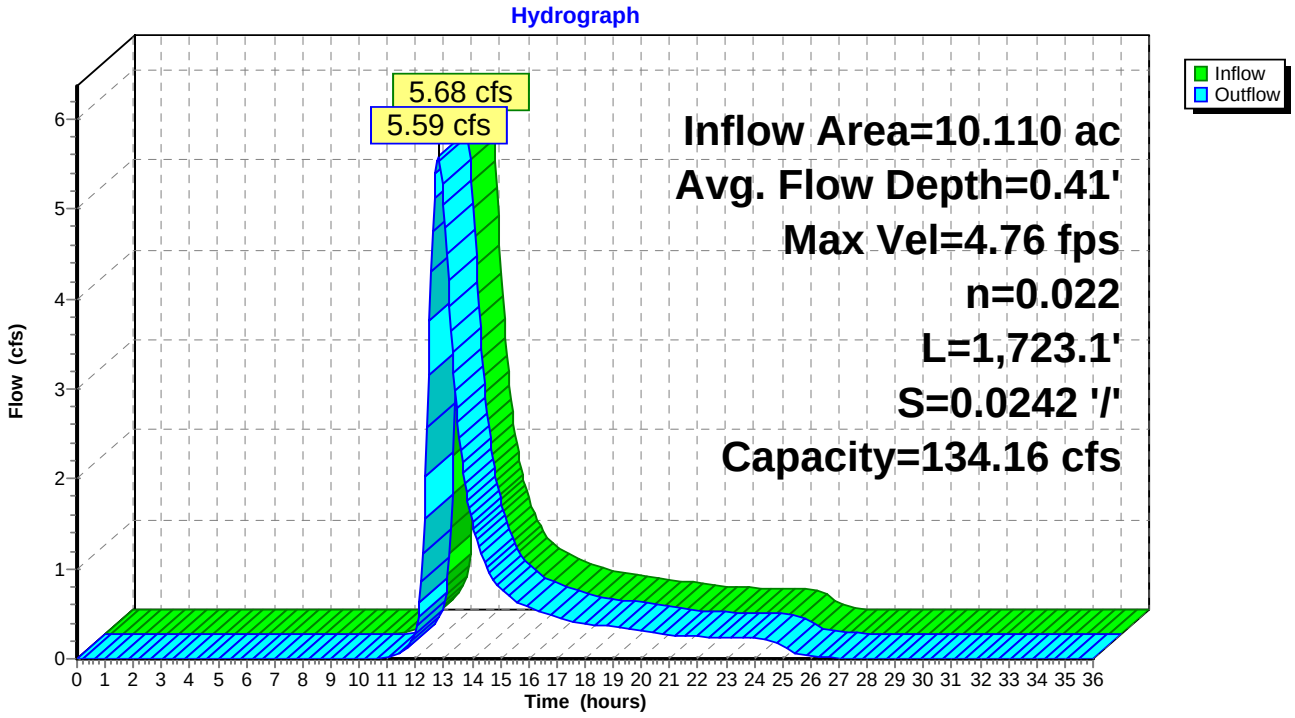
Inflow Area = 10.110 ac, 0.00% Impervious, Inflow Depth = 1.07" for 100-YR, 24-HR event
Inflow = 5.68 cfs @ 12.63 hrs, Volume= 0.903 af
Outflow = 5.59 cfs @ 12.81 hrs, Volume= 0.903 af, Atten= 2%, Lag= 10.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.76 fps, Min. Travel Time= 6.0 min
Avg. Velocity = 1.78 fps, Avg. Travel Time= 16.2 min

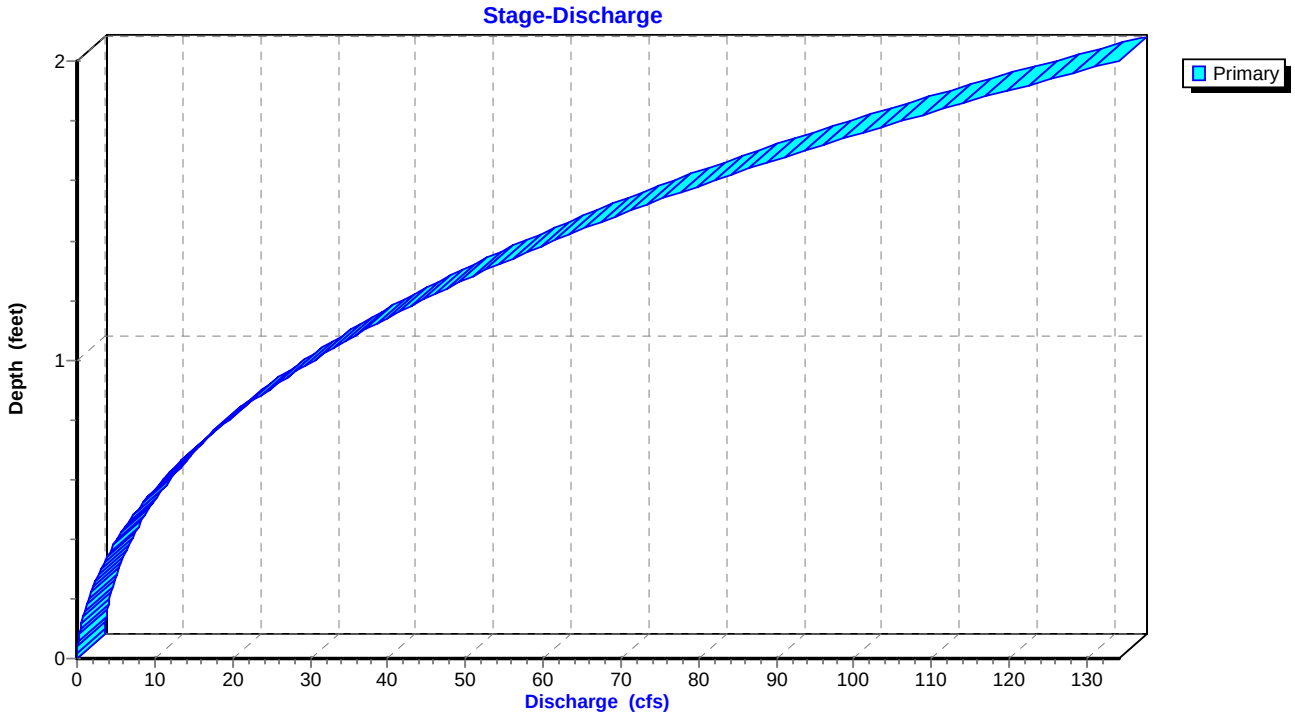
Peak Storage= 2,023 cf @ 12.71 hrs
Average Depth at Peak Storage= 0.41'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 134.16 cfs

2.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 1,723.1' Slope= 0.0242 '/'
Inlet Invert= 5,071.25', Outlet Invert= 5,029.50'

Reach 14R: North Drainage Ditch



Reach 14R: North Drainage Ditch



Summary for Pond 8P: Pond 1

Inflow Area = 2.840 ac,100.00% Impervious, Inflow Depth = 2.60" for 100-YR, 24-HR event
Inflow = 11.88 cfs @ 11.89 hrs, Volume= 0.615 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Starting Elev= 5,061.57' Surf.Area= 0.000 ac Storage= 40.277 af
Peak Elev= 5,061.81' @ 24.05 hrs Surf.Area= 0.000 ac Storage= 40.892 af (0.615 af above start)
Flood Elev= 5,063.57' Surf.Area= 0.000 ac Storage= 45.571 af (5.294 af above start)

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

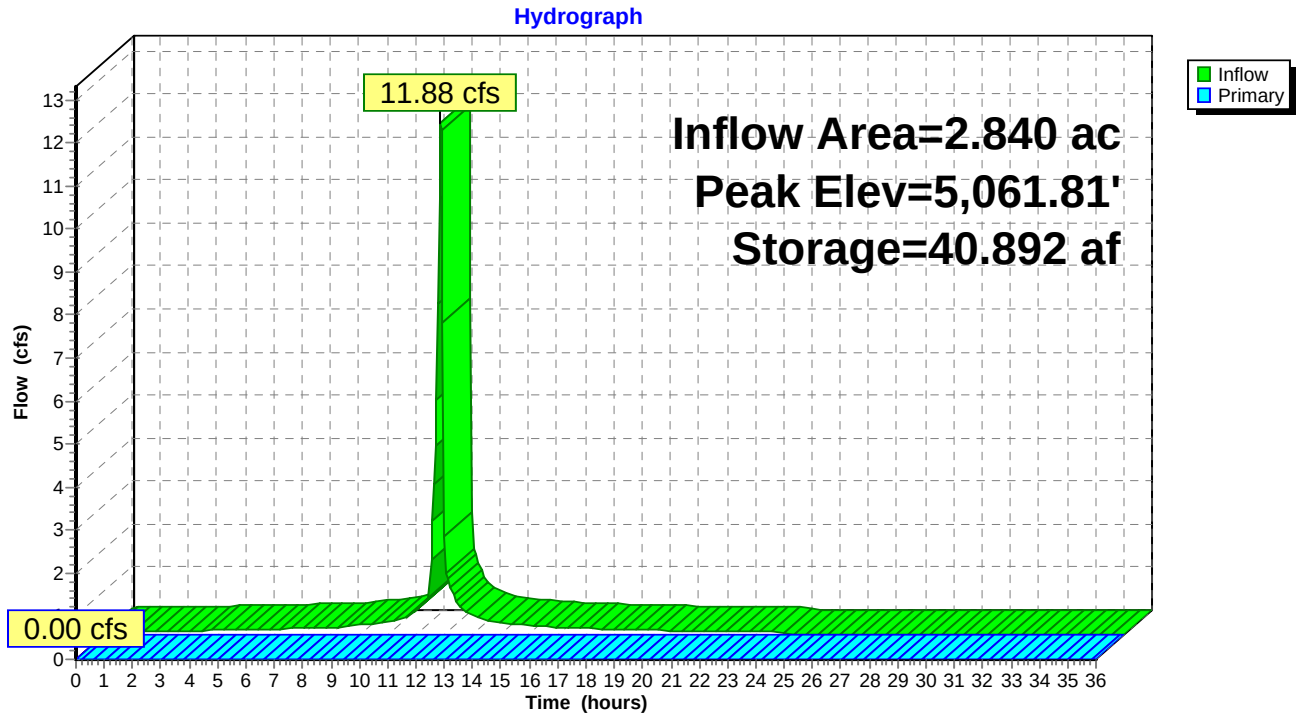
Volume	Invert	Avail.Storage	Storage Description
#1	5,040.33'	48.314 af	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (acre-feet)
5,040.33	0.000
5,041.33	0.264
5,042.33	1.457
5,043.33	2.977
5,044.33	4.548
5,045.33	6.170
5,046.33	7.844
5,047.33	9.570
5,048.33	11.350
5,049.33	13.184
5,050.33	15.073
5,051.33	17.017
5,052.33	19.017
5,053.33	21.074
5,054.33	23.189
5,055.33	25.362
5,056.33	27.593
5,057.33	29.885
5,058.33	32.236
5,059.33	34.649
5,060.33	37.123
5,061.33	39.659
5,061.57	40.277
5,062.57	42.892
5,063.57	45.571
5,064.57	48.314

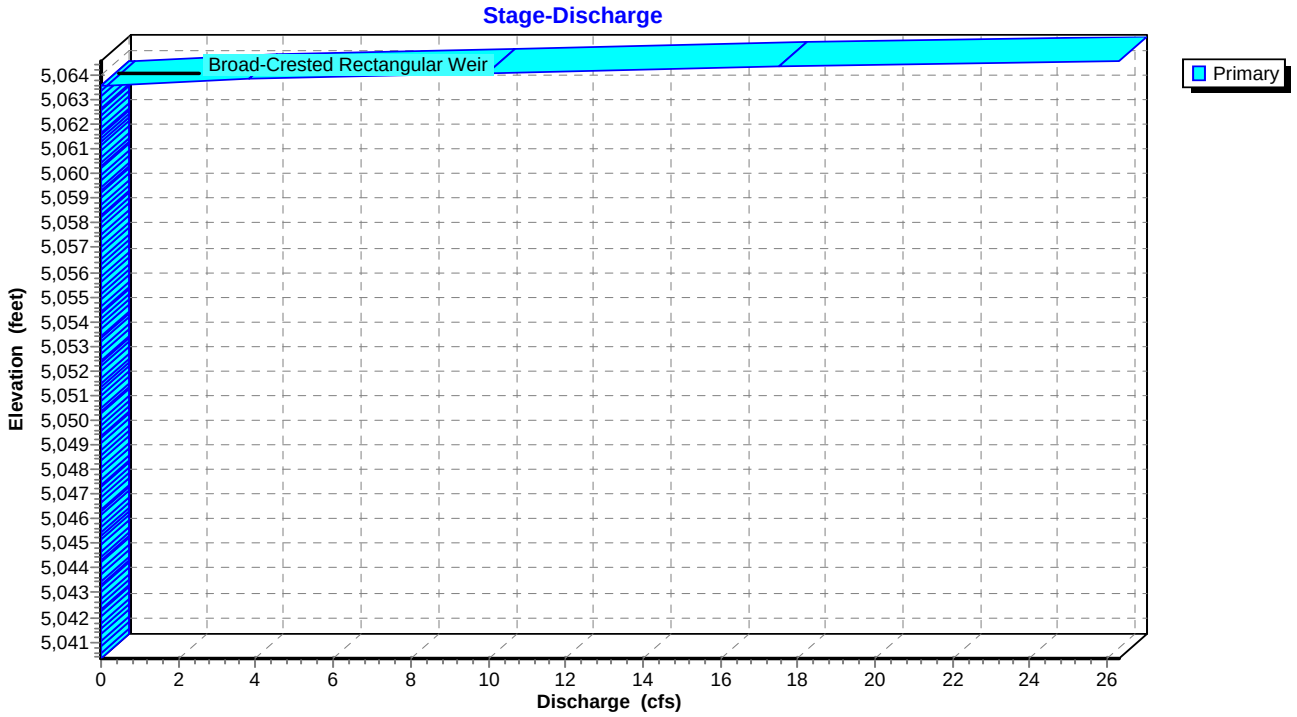
Device	Routing	Invert	Outlet Devices
#1	Primary	5,063.57'	**10.0' long x 30.0' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60
			Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,061.57' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 8P: Pond 1



Pond 8P: Pond 1



Summary for Pond 9P: Pond 2

Inflow Area = 2.750 ac,100.00% Impervious, Inflow Depth = 2.60" for 100-YR, 24-HR event
Inflow = 11.51 cfs @ 11.89 hrs, Volume= 0.596 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Starting Elev= 5,057.80' Surf.Area= 0.000 ac Storage= 31.106 af
Peak Elev= 5,058.03' @ 24.05 hrs Surf.Area= 0.000 ac Storage= 31.702 af (0.596 af above start)
Flood Elev= 5,059.80' Surf.Area= 0.000 ac Storage= 36.361 af (5.255 af above start)

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

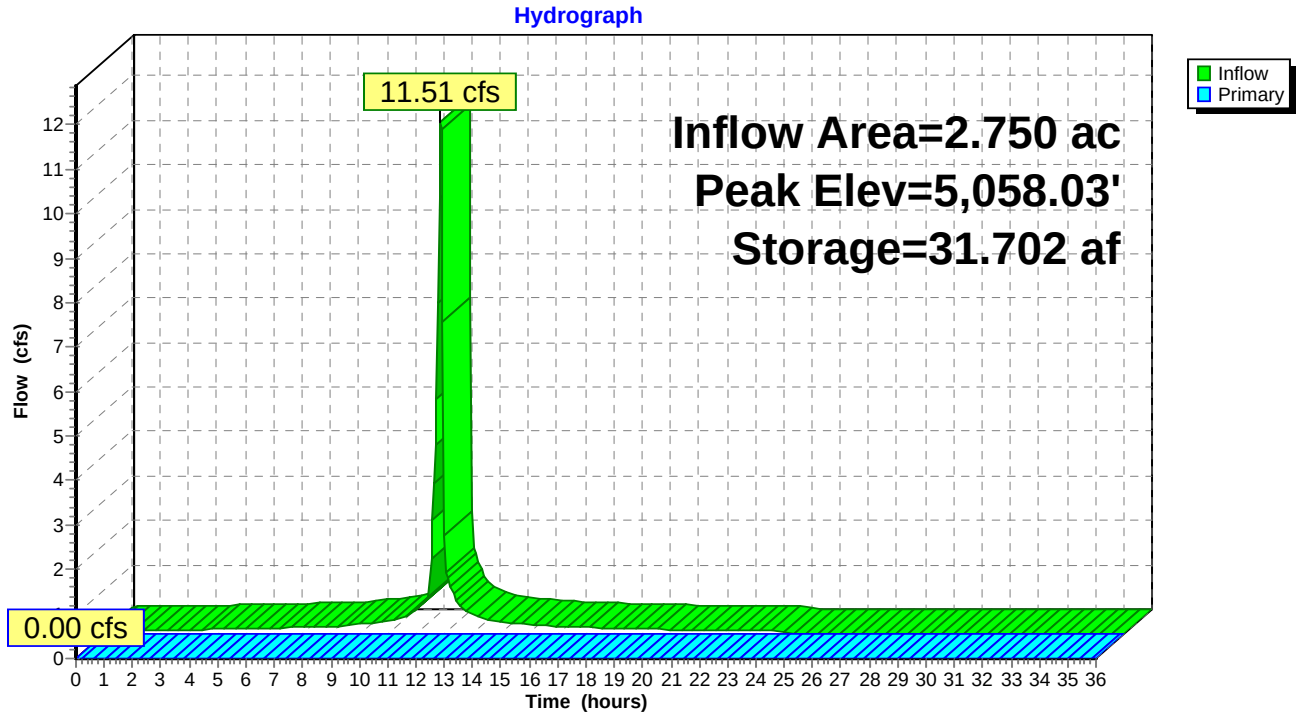
Volume	Invert	Avail.Storage	Storage Description
#1	5,042.42'	39.082 af	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (acre-feet)
5,042.42	0.000
5,043.42	0.335
5,044.42	1.897
5,045.42	3.742
5,046.42	5.638
5,047.42	7.588
5,048.42	9.591
5,049.42	11.649
5,050.42	13.761
5,051.42	15.929
5,052.42	18.152
5,053.42	20.433
5,054.42	22.771
5,055.42	25.167
5,056.42	27.621
5,057.42	30.135
5,057.80	31.106
5,058.80	33.704
5,059.80	36.361
5,060.80	39.082

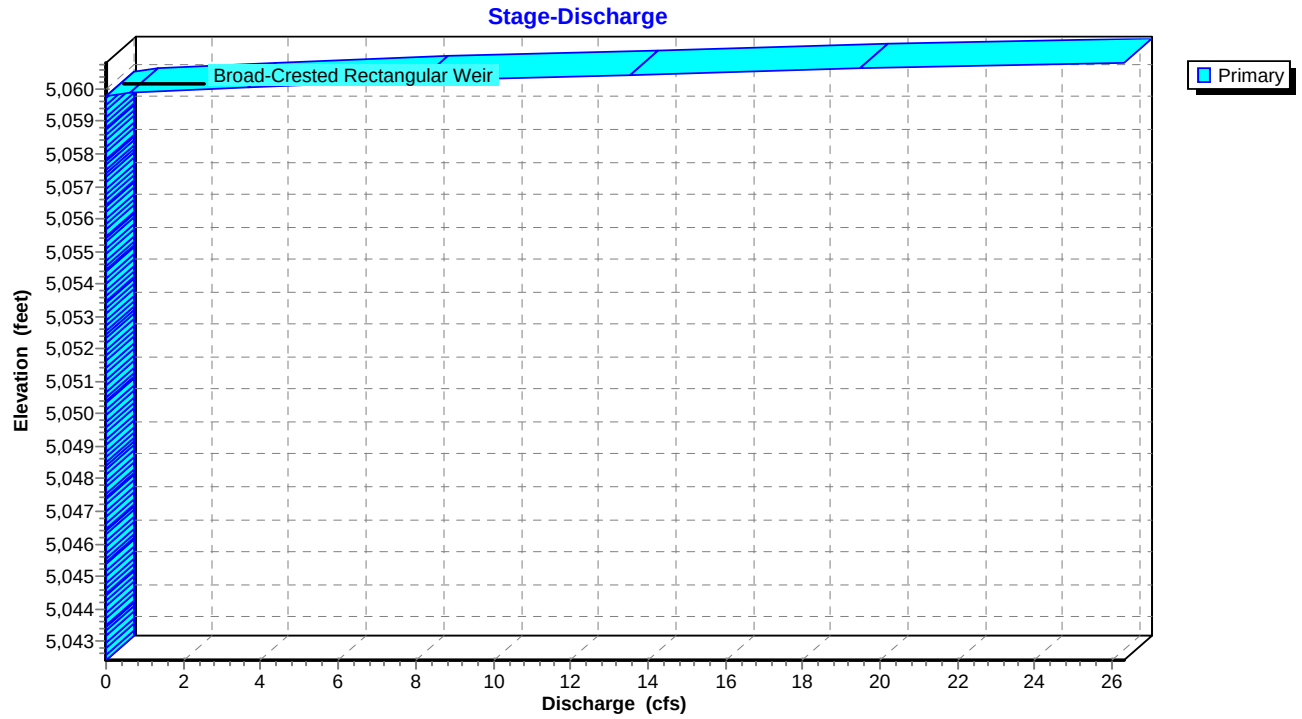
Device	Routing	Invert	Outlet Devices
#1	Primary	5,059.80'	**10.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,057.80' (Free Discharge)
1=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 9P: Pond 2



Pond 9P: Pond 2



Summary for Pond 10P: Pond 3

Inflow Area = 2.660 ac,100.00% Impervious, Inflow Depth = 2.60" for 100-YR, 24-HR event
Inflow = 11.13 cfs @ 11.89 hrs, Volume= 0.576 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Starting Elev= 5,048.50' Surf.Area= 0.000 ac Storage= 29.964 af
Peak Elev= 5,048.73' @ 24.05 hrs Surf.Area= 0.000 ac Storage= 30.540 af (0.576 af above start)
Flood Elev= 5,050.50' Surf.Area= 0.000 ac Storage= 34.999 af (5.035 af above start)

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

Volume	Invert	Avail.Storage	Storage Description
#1	5,032.00'	37.619 af	**Custom Stage Data** Listed below

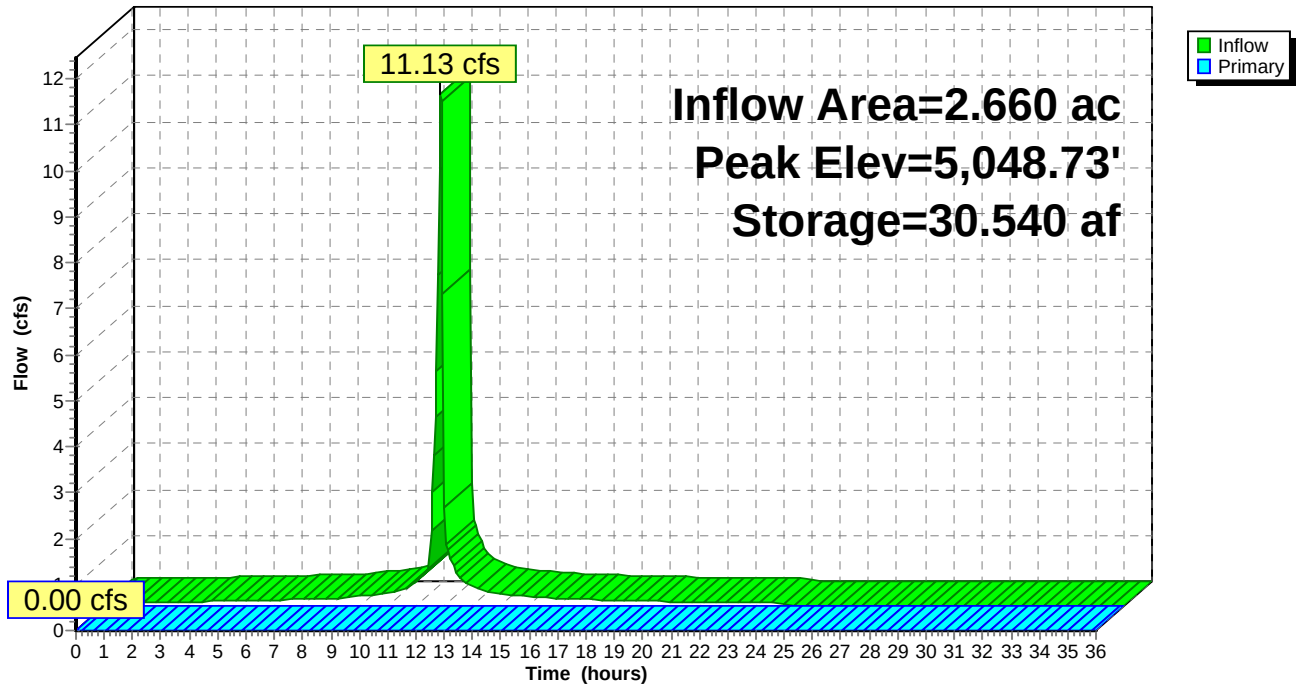
Elevation (feet)	Cum.Store (acre-feet)
5,032.00	0.000
5,033.00	0.217
5,034.00	1.183
5,035.00	2.730
5,036.00	4.364
5,037.00	6.057
5,038.00	7.809
5,039.00	9.622
5,040.00	11.495
5,041.00	13.429
5,042.00	15.426
5,043.00	17.486
5,044.00	19.609
5,045.00	21.796
5,046.00	24.047
5,047.00	26.365
5,048.00	28.748
5,048.50	29.964
5,049.50	32.448
5,050.50	34.999
5,051.50	37.619

Device	Routing	Invert	Outlet Devices
#1	Primary	5,050.50'	**10.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,048.50' (Free Discharge)
1=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

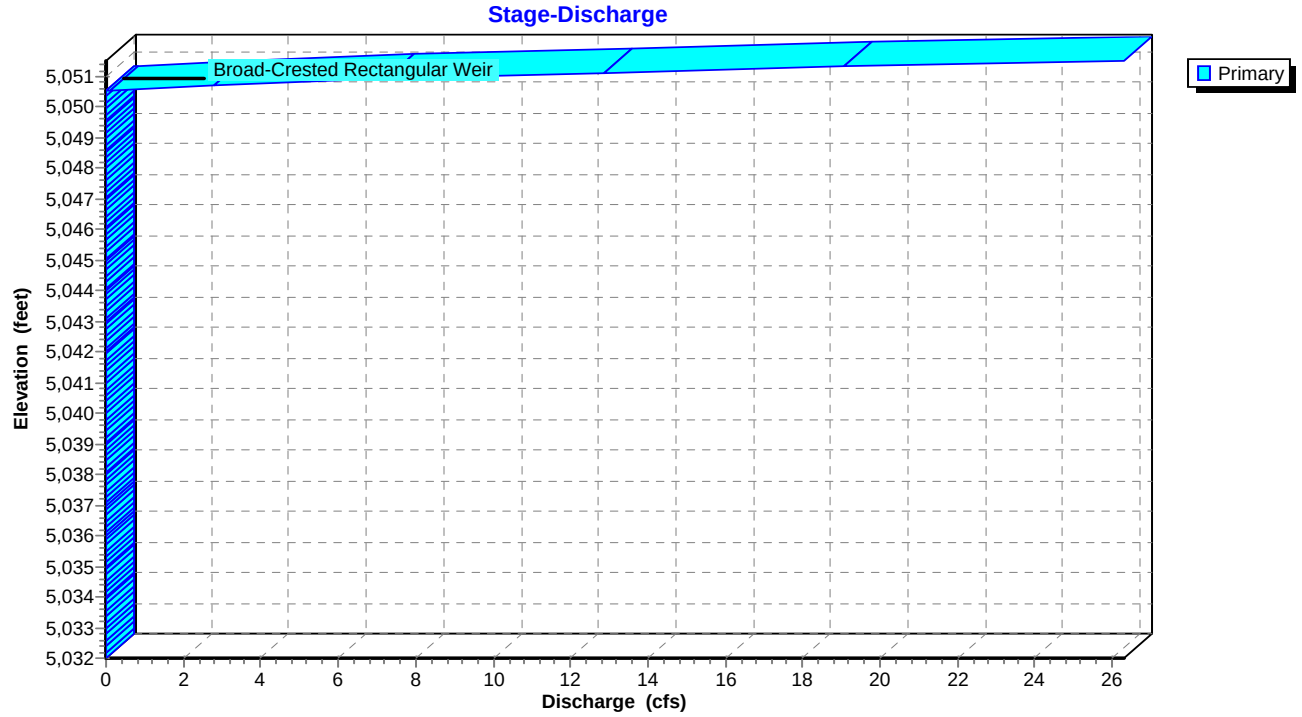
Pond 10P: Pond 3

Hydrograph



Pond 10P: Pond 3

Stage-Discharge



Summary for Pond 11P: Detention Pond

Inflow Area = 14.470 ac, 0.00% Impervious, Inflow Depth = 1.00" for 100-YR, 24-HR event
Inflow = 6.25 cfs @ 12.77 hrs, Volume= 1.204 af
Outflow = 3.73 cfs @ 13.32 hrs, Volume= 1.179 af, Atten= 40%, Lag= 32.7 min
Primary = 3.73 cfs @ 13.32 hrs, Volume= 1.179 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Starting Elev= 5,030.00' Surf.Area= 0.315 ac Storage= 0.919 af
Peak Elev= 5,031.14' @ 13.32 hrs Surf.Area= 0.367 ac Storage= 1.307 af (0.388 af above start)

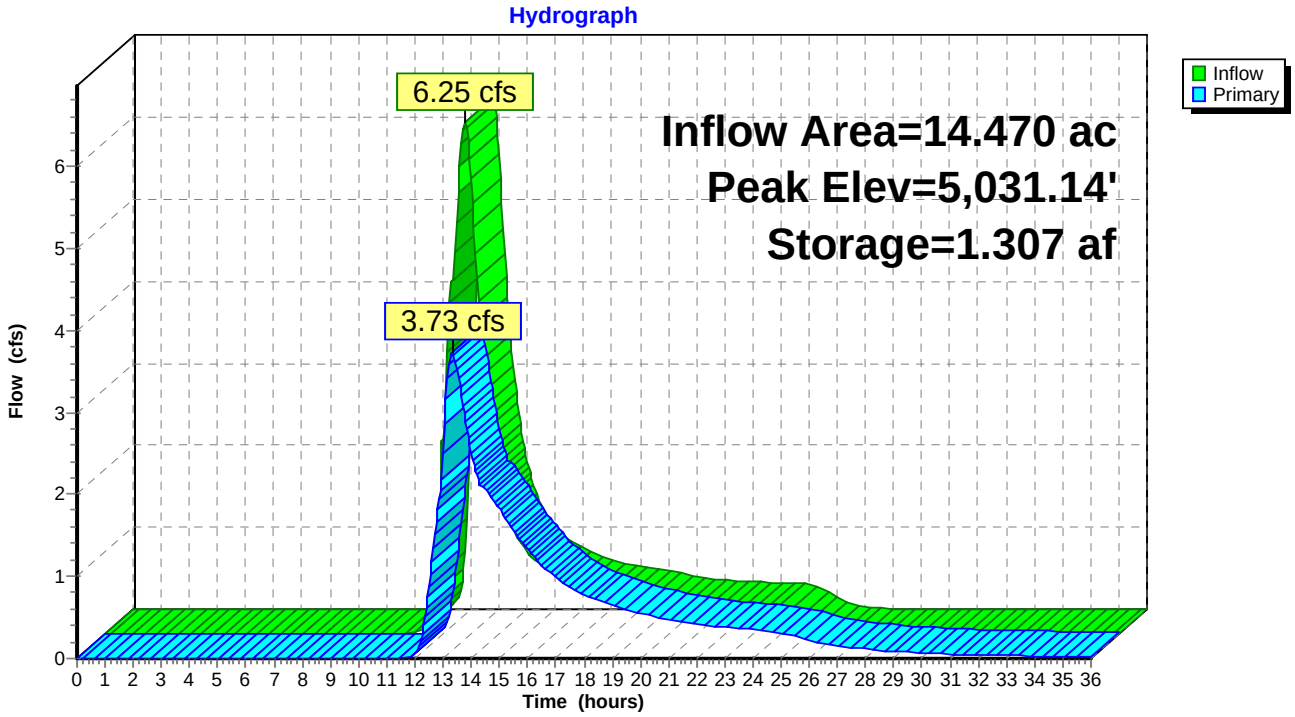
Plug-Flow detention time= 706.1 min calculated for 0.260 af (22% of inflow)
Center-of-Mass det. time= 123.9 min (1,024.4 - 900.5)

Volume	Invert	Avail.Storage	Storage Description
#1	5,026.00'	1.639 af	**26.00'W x 250.00'L x 6.00'H Prismatoid Z=3.0**

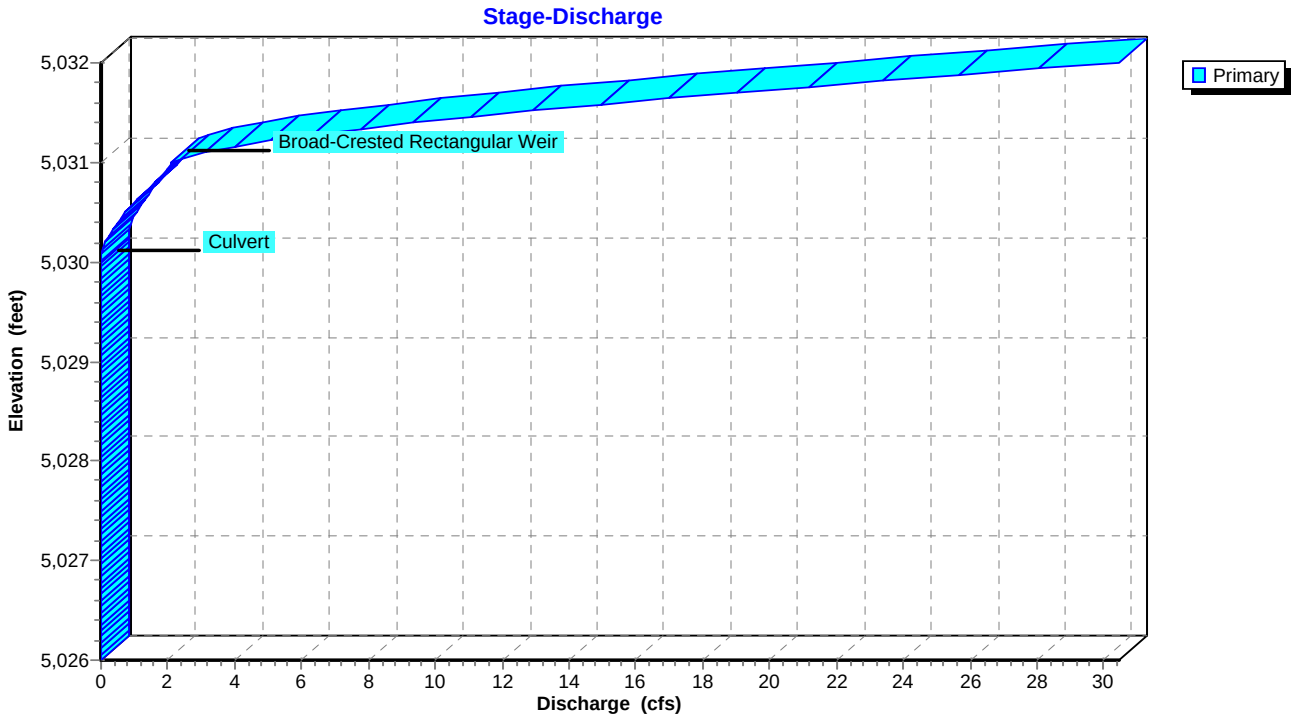
Device	Routing	Invert	Outlet Devices
#1	Primary	5,031.00'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Primary	5,030.00'	**12.0" Round Culvert** L= 25.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 5,030.00' / 5,029.77' S= 0.0092 '/' Cc= 0.900 n= 0.010 PVC, smooth interior

Primary OutFlow Max=3.71 cfs @ 13.32 hrs HW=5,031.14' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 1.32 cfs @ 0.93 fps)
└**2=Culvert** (Inlet Controls 2.39 cfs @ 3.04 fps)

Pond 11P: Detention Pond



Pond 11P: Detention Pond



APPENDIX B-4

WATER WELL LOGS

WRJ-25-70

Index No. 140
IDWD 5-70
~~Completion~~ use 3
Yield
Checked By

STATE OF COLORADO
DIVISION OF WATER RESOURCES
OFFICE OF THE STATE ENGINEER

MAP AND STATEMENT FOR WATER WELL FILING

PERMIT NUMBER ~~45327~~ 45237

De Beque
Qtr
TWO

STATE OF COLORADO) SS

CLAIMANT (s) Harvey Curl

being duly sworn upon oath deposes and says that he (they) is (are) the owner (s) of the well described hereon; the total number of acres of land irrigated from this well is None; work was commenced on this well by actual construction on the 15 day of April 19 71; the sustained yield from said well is 21 gpm, for which claim is hereby made for Domestic + Livestock purpose (s); the average annual amount to be diverted is _____ acre-feet; this map and statement is filed in compliance with law; he (they) has (have) read the statements made hereon; knows the content thereof; and that the same are true of his (their) own knowledge.

Signature (s) Tom Curl

Address: Box 154 DE BEQUE Co. De Beque Colo.

Subscribed and sworn to before me on this _____ day of _____, 19____

My Commission expires: _____
(Seal)

_____
Notary Public

WELL DATA

Date Completed April 23, 1971

Static Water Level 27' from Surface

Total Depth of Well 304

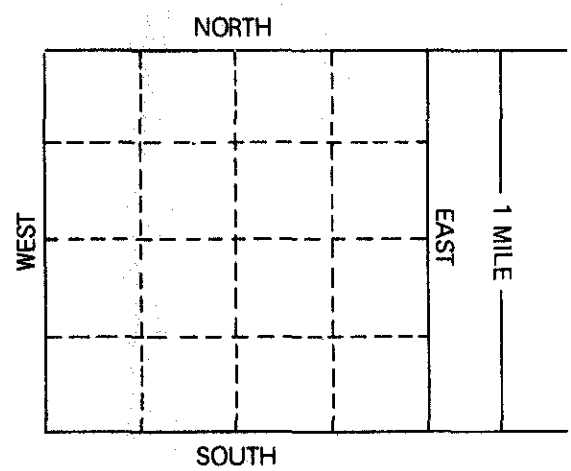
WELL LOCATION 39

~~Lot 19 Francisco Gardens Road 44~~ Mesa County

SE ¼ of NE ¼, sec. 32

T. 8S R. 97W, 6 P.M.

INDICATE WELL LOCATION ON DIAGRAM



WELL SHALL BE LOCATED WITH REFERENCE TO GOVERNMENT SURVEY CORNERS OR MONUMENTS, OR SECTION LINES BY DISTANCE AND BEARING.

_____ ft. from _____ section line.
(North or South)

_____ ft. from _____ section line.
(East or West)

Ground Water Basin _____

Water Management District _____

Domestic wells may be located by the following:

LOT Lot 19, BLOCK _____

SUBDIVISION Francisco Gardens 2445-332-00-055

FILING # Road 44

ACCEPTED FOR FILING IN THE OFFICE OF THE STATE ENGINEER OF COLORADO ON THIS _____ DAY OF _____, 19____.

_____
STATE ENGINEER

FORM TO BE MADE OUT IN QUADRUPLICATE: WHITE FORM must be an original copy on both sides and signed. WHITE AND GREEN copies must be filed with the State Engineer within 30 days after the well is completed or within 7 days after expiration date of the permit, whichever is sooner; PINK COPY is for the Owner and YELLOW COPY is for the Driller.

WELL LOG

From	To	Type & Color of Material	Water Loc.
0	4	overburden	
4	123	Shale (Dk ~~Blue~~ Gray)	
123	146	Sandstone + Shale (Gray)	
146	217	Shale (Blue)	
217	261	Sandstone (Gray) shale +	
261	281	Hard Coal Limestone (Gray)	
281	304	Sandstone (Caunase, milky)	

Use additional paper if necessary to complete log.

WELL DATA

Type Drilling Rotary

HOLE DIAMETER:

7 7/8 in. from 0 ft. to 22.5 ft.
5 5/8 in. from 22.5 ft. to 270 ft.
4 3/4 in. from 270 ft. to 304 ft.

CASING RECORD

Plain Casing

Size 6", kind Steel from 0 ft. to 22.5 ft.
Size 5", kind ~~Gals~~ Galv. from 2' ft. to 220 ft.
Size ___, kind ___ from ___ ft. to ___ ft.

Perforated Casing

Size 5", kind Galv. from 220 ft. to 270 ft.
Size ___, kind ___ from ___ ft. to ___ ft.
Size ___, kind ___ from ___ ft. to ___ ft.

GROUTING RECORD

Material Cement
Intervals 0 - 22.5
Placement Method Pumped + Gravity

GRAVEL PACK RECORD

none
Size ___ Interval ___

TEST DATA

Date Tested April 24, 1971
Type of Pump Sub
Length of Test 3 hrs
Sustained Yield (Metered) 15 GPM
Drawdown 110 feet

WELL DRILLERS STATEMENT

The undersigned, being duly sworn, deposes and says: he is the driller of the well hereon described; he has read the statement made hereon; knows the content thereof, and the same is true of his own knowledge.

x William E. Matthews

License No. 774

State of Colorado, County of ___) ss

Subscribed and sworn to before me this ___ day of ___, 19___

My Commission expires ___, 19___.

Notary Public

WRJ-5-69

DIVISION OF WATER RESOURCES, DEPARTMENT OF NATURAL RESOURCES

101 Columbine Bldg., 1845 Sherman Street, Denver, Colorado 80203

APR 1971 RECEIVED WATER RESOURCES STATE ENGINEER COLO.

APPLICATION FOR:
- ☐ A PERMIT TO USE GROUND WATER
- ☐ A PERMIT TO CONSTRUCT A WELL
- ☐ REPLACEMENT FOR NO. _____
- ☐ A PERMIT TO INSTALL A PUMP
- ☐ OTHER

PRINT OR TYPE

APPLICANT Harry Cox

Street Address DeBeque Colo

City & State _____

Use of ground water Domestic & Cattle

Owner of land on which well is located HARRY COX

Owner of irrigated land _____

Number of acres to be irrigated _____

Legal description of irrigated land _____

Other water rights on this land _____

Aquifer (s) ground water is to be obtained from _____

Storage capacity _____ AF

ANTICIPATED PUMPING RATE 25 GPM

AVERAGE ANNUAL AMOUNT OF GROUND WATER TO BE APPROPRIATED _____ Acre-feet

LOCATION OF WELL

COUNTY MESA

~~SE~~ 19 SE ¼, of the NE ¼, sec. 32

T. 8 S, R. 97W, 6 P.M.

Street or Lot & Block _____

City or Subdiv. _____ Filing _____

Ground Water Basin _____

Water Management District _____

LOCATE WELL ON THE BACK OF THIS SHEET

Driller W. Matthews No. 774

Driller's Address 2301 East St. Golden, Colo 80401

~~William E.~~

Signature of Applicant

CONDITIONS OF APPROVAL

ESTIMATED WELL DATA

Anticipated start of drilling 5-12 1971

Anticipated start of use 6-1 1971

Hole Diameter:

7 7/8 in. from 0 ft. to 23' ft.
5 5/8 in. from 23 ft. to 150 ft.

Casing:

Plain 6 5/8 in. from 0 ft. to 22.5 ft.
5" in. from 10 ft. to 100 ft.

Perf. 5" in. from 100 ft. to 150 ft.
_____ in. from _____ ft. to _____ ft.

ESTIMATED PUMP DATA

Type Sub HP 1/2 Outlet Size 1"

APPLICATION MUST BE COMPLETED SATISFACTORILY BEFORE ACCEPTANCE

APPLICATION APPROVED:
VALID FOR ONE (1) YEAR AFTER DATE ISSUED UNLESS EXTENDED FOR GOOD CAUSE SHOWN TO THE ISSUING AGENCY

PERMIT NO. 45237 CONDITIONAL ☐

DATE ISSUED APR 7 1971

STATE ENGINEER

BY Durlan W. Ecker

(OVER)

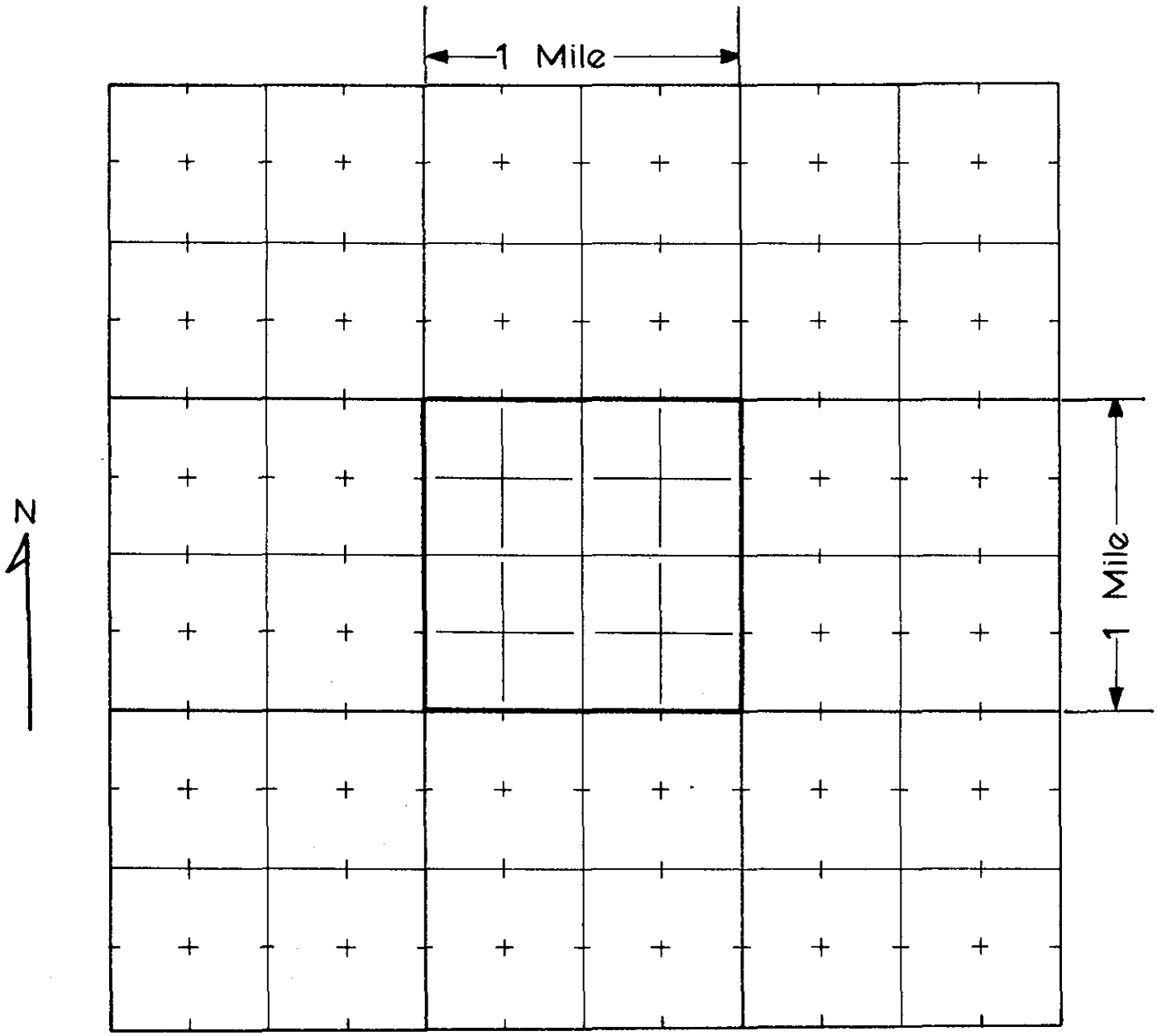
THE LOCATION OF THE PROPOSED WELL SHALL BE SHOWN ON THE DIAGRAM BELOW WITH REFERENCE TO SECTION LINES OR GOVERNMENT SURVEY CORNERS OR MONUMENTS.

_____ feet from _____ (North or South) section line

_____ feet from _____ (East or West) section line

IF WELL IS FOR IRRIGATION, THE AREA TO BE IRRIGATED MUST BE SHADED OR CROSS-HATCHED.

This diagram represents nine (9) sections. Use the CENTER SQUARE (one section) to indicate the location of the well.



THE SCALE OF THE DIAGRAM IS TWO INCHES EQUALS ONE-MILE

FORM NO. GWS-32 02/2005

PUMP INSTALLATION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER

1313 Sherman St., Room 818, Denver, CO 80203
Info (303) 866-3587 Main (303) 866-3581
Fax (303) 866-3589 http://www.water.state.co.us

For Office Use Only
RECEIVED
JUN 16 2005
WATER RESOURCES STATE ENGINEER COLO.

1. **WELL PERMIT NUMBER:** 249795

2. **WELL OWNER INFORMATION**
NAME OF OWNER: Darrel Kuhn
MAILING ADDRESS: 499 33 1/2 Road
CITY: Clifton | STATE: Colo. | ZIP CODE: 81520
TELEPHONE #: (970) 434- 4589

3. WELL LOCATION AS DRILLED: SW 1/4, SE 1/4 Sec. 30, Twp. 8 S ☐ N or ☒ S, Range 97 ☐ E or ☒ W
DISTANCES FROM SEC. LINES: xx ft. from ☐ N or ☐ S section line and xx ft. from ☐ E or ☐ W section line.
SUBDIVISION: None LOT x, BLOCK x, FILING (UNIT) x
Optional GPS Location: GPS Unit must use the following settings: Format must be **UTM**, Units must be **meters**, Datum must be **NAD83**, Unit must be set to **true N**, ☐ Zone 12 or ☐ Zone 13 Easting: _____ Northing: _____
STREET ADDRESS AT WELL LOCATION:

4. PUMP DATA: Type: Submersible Date Installed: 07/01/2004
Pump Manufacturer: Grundfos Pump Model No. 10-GS
Design GPM: 10 at RPM 3450 HP 1.5 Volts 230 Full Load Amps 11.5
Pump Intake Depth: 513 Feet, Drop/Column Pipe Size 1 Inches, Kind of Drop Pipe PVC Sch 80
ADDITIONAL INFORMATION FOR PUMPS GREATER THAN 50 GPM: Turbine Driver Type: ☐ Electric ☐ Engine ☐ Other _____
Design Head feet Number of Stages Shaft size inches

5. OTHER EQUIPMENT:
Airline Installed ☐ Yes ☒ No, Orifice Depth ft. _____ Monitor Tube Installed ☐ Yes ☒ No, Depth ft. _____
Flow Meter Mfg. _____ Meter Serial No. _____
Meter Readout: ☐ Gallons, ☐ Thousand Gallons, ☐ Acre feet Beginning Reading

6. TEST DATA: ☐ check box if Test Data is submitted on Supplemental Form.

	Date:	07/01/04	"	"	"
Total Well Depth: 680 ft.	Time:	0900	1000	1100	1200
Static Level: 325 ft.	Rate (gpm):	11	10	10	10
Date Measured: 07/01/04	Pumping Level (ft):	513	460	450	

7. DISINFECTION: Type HTH 65% Amt. Used 2.5 Cups

8. Water Quality analysis available: ☐ Yes ☒ No If yes, please submit with this report.

9. Remarks: Gas in Water Should Work Out after pumping

10. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. [The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license.]

Company Name:	Phone:	License Number:
Rocky Mountain Drlg. & Pump Ser.	( )970 434-8554	1372

Mailing Address: P.O.BOX 40061 Grand Junction, Colo. 81504

Signature:	Print Name and Title	Date
James M. Logue	James M. Logue, CWD/PI	07/04/2004

FORM NO. GWS-31 04/2005

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St., Room 818, Denver, CO 80203
Phone – Info (303) 866-3587 Main (303) 866-3581
Fax (303) 866-3589 http://www.water.state.co.us

For Office Use Only

RECEIVED
OCT 30 2008
WATER RESOURCES
STATE ENGINEER
COLO

1. WELL PERMIT NUMBER: 278939

2. WELL OWNER INFORMATION

NAME OF WELL OWNER: Marla R. Arnold

MAILING ADDRESS: PO Box 96

CITY: Debeque STATE: CO ZIP CODE: 81630

TELEPHONE NUMBER: (970) 260-7394

3. WELL LOCATION AS DRILLED: SE1/4, SE1/4, Sec. 30, Twp. 8 ☐ N or ☒ S, Range 97 ☐ E or ☒ W

DISTANCES FROM SEC. LINES: 500 ft. from ☐ N or ☒ S section line and 325 ft. from ☒ E or ☐ W section line.

SUBDIVISION: _____, LOT _____, BLOCK _____, FILING (UNIT) _____

Optional GPS Location: GPS Unit must use the following settings: Format must be **UTM**, Units must be **meters**, Datum must be **NAD83**, Unit must be set to **true N**, ☐ Zone 12 or ☐ Zone 13

Owner's Well Designation: _____

Easting: _____

STREET ADDRESS AT WELL LOCATION: Northing:

4. GROUND SURFACE ELEVATION _____ feet DRILLING METHOD air rotary

DATE COMPLETED 10/17/2008 TOTAL DEPTH 482 feet DEPTH COMPLETED 482 feet

5. GEOLOGIC LOG:

Depth	Type	Grain Size	Color	Water Loc.
0-40	Sand	fine	tan	
40-45	claystone	fine	grey	
45-70	sandstone	fine	Lt. grey	
70-100	sandstone	fine	dark grey	
100-120	claystone	fine	grey	
120-130	sandstone	fine	brown	
130-230	sandstone	fine	lt. grey	
230-250	claystone	fine	brown	
250-300	claystone	fine	grey	
300-320	sandstone	fine	grey	
320-370	claystone	fine	grey	
370-380	sandstone	fine	grey	
380-440	claystone	fine	grey	
440-482	sandstone	fine	grey	450-460

Remarks: hit some natural gas approx 450-460

6. HOLE DIAM (in.)

	From (ft)	To (ft)
9	0	39
6 1/2	39	482

7. PLAIN CASING:

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
7	steel	.188	+1	39
4 1/2	pvc	sch 40	12	422

PERFORATED CASING: Screen Slot Size (in): .030

4 1/2	pvc	.188	422	482

8. FILTER PACK:

Material silica san
Size 8-12
Interval 410-482

9. PACKER PLACEMENT:

Type _____
Depth _____

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement
cement	5 bags	# 15	4-39	poured

11. DISINFECTION: Type HTH Amt. Used 1 cup

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.

TESTING METHOD air

Static Level 90 ft. Date/Time measured: _____, Production Rate 10 gpm.

Pumping Level _____ ft. Date/Time measured _____, Test Length (hrs) 1 1/2.

Remarks:

13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. [The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license.]

Company Name:	Phone:	License Number:
McCracken Well Drilling, Inc.	(970)323-6332	1398

Mailing Address: 60999 Gunnison Road Montrose, CO 81401

Signature:	Print Name and Title	Date
	Alan McCracken, President	10/27/2008

FORM NO. GWS-31 05/2011

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St., Room 821, Denver, CO 80203
Main (303) 866-3581 Fax (303) 866-3589

For Office Use Only

RECEIVED
JUN 17 2013
WATER RESOURCES
STATE ENGINEER
COLO

1. WELL PERMIT NUMBER: 279019

2. WELL OWNER INFORMATION

NAME OF WELL OWNER: KIM HEIDEL

MAILING ADDRESS: P.O BOX 314

CITY: DEBEQUE STATE: CO ZIP CODE: 81630

TELEPHONE NUMBER: (970) 216-3261

3. WELL LOCATION AS DRILLED: SW1/4, SW1/4, Sec. 29, Twp. 8 ☐ N or XS, Range 97 ☐ E or XW

DISTANCES FROM SEC. LINES: 200 ft. from ☐ N or X S section line and 100 ft. from ☐ E or XW section line.

SUBDIVISION: _____, LOT _____, BLOCK _____, FILING (UNIT) _____

Optional GPS Location: GPS Unit must use the following settings: Format must be **UTM**, Units must be **meters**, Datum must be **NAD83**, Unit must be set to **true N**, ☐ Zone 12 or ☐ Zone 13

Owner's Well Designation: _____

Easting: _____

STREET ADDRESS AT WELL LOCATION: Northing: _____

4. GROUND SURFACE ELEVATION _____ feet DRILLING METHOD air rotary

DATE COMPLETED 5/27/13 TOTAL DEPTH 344 feet DEPTH COMPLETED 344 feet

5. GEOLOGIC LOG:

Depth	Type	Grain Size	Color	Water Loc.
0-4	Top soil	f	brown	
4-40	cs	f	gray	
40-100	ss	f	gray	
100-200	ss	f	white	
200-310	cs	f	gray	260
310-310	Ss	f	white	
310-344	cs	f	gray	

6. HOLE DIAM (in.)

	From (ft)	To (ft)
10	0	39
6 1/2	39	344

7. PLAIN CASING:

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
7	steel	.188	+1	39
5	pvc	Sch 40	14	244
5	pvc	Sch 40	264	284
5	pvc	Sch 40	304	324

PERFORATED CASING: Screen Slot Size (in): .032

5	pvc	Sch 40	244	264
5	pvc	Sch 40	284	304
5	pvc	Sch 40	324	344

8. FILTER PACK:
Material _____
Size _____
Interval

9. PACKER PLACEMENT:
Type _____
Depth

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement
cement	8 bags	15#	4-39	poured

Remarks: _____

11. DISINFECTION: Type hth Amt. Used 1 3/4 cup

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.

TESTING METHOD air

Static Level 106 ft. Date/Time measured: 5/27/13, Production Rate 1 1/2 gpm.

Pumping Level 344 ft. Date/Time measured _____, Test Length (hrs) 2.

Remarks:

13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed and certified in accordance with Rule 17 4 of the Water Well Construction Rules, 2 CCR 402-2. [The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license.]

Company Name:		License Number:
McCracken Well Drilling	970-323-6332	1398

Mailing Address: 60999 Gunnison rd Montrose Co 81401

Signature:	Print Name and Title	Date
	Alan McCracken Driller	6/17/13

WELL CONSTRUCTION AND TEST REPORT
STATE OF COLORADO, OFFICE OF THE STATE ENGINEER

FOR OFFICE USE ONLY
RECEIVED
APR 15 2014
WATER RESOURCES
STATE ENGINEER
COLO

APPROVAL # GWS31-91-03

1. **WELL PERMIT NUMBER** 292780

2. Owner Name(s): Red Rock Gathering Co LLC
Mailing Address: 2128 Railroad Ave # 203
City, State, Zip : Rifle, Co 81650
Phone # :

3. WELL LOCATION AS DRILLED
DISTANCES FROM SEC. LINES SE 1/4 SW 1/4 Sec: 29 Twp: 8 S Range: 97 W 6th PM
ft. from Sec. line and ft. from Sec. line OR Easting: 2 20 290 Northing: 43 58 073
SUBDIVISION: LOT: BLOCK: FILING (UNIT):
STREET ADDRESS AT LOCATION 4325 V 2/10 Road DeBeque

4. GROUND SURFACE ELEVATION ft. DRILLING METHOD Air Rotary
DATE COMPLETED: 1/16/2014 TOTAL DEPTH: 430 DEPTH COMPLETION: 430

5. GEOLOGIC LOG

Depth	Type of Material (Size, Color, and Type)
000-020	Dirt, Clay
020-430	Wasatch Formation

6. HOLE DIAMETER

HOLE DIAMETER (in)	FROM (ft)	TO (ft)
9.0	0	42
6.5	42	430

7. PLAIN CASING

OD (in)	Kind	Wall Size	From (ft)	To (ft)
7.0	Steel	0.188	-1	42
5.5	PVC	0.250	33	370
5.5	PVC	0.250	380	405
5.5	PVC	0.250	410	430

PERF. CASING : Screen Slot Size

5.5	PVC	0.250	370	380
5.5	PVC	0.250	405	410

Water Located: 370+

Remarks :

8. Filter Pack
Material :
Size :
Interval :

9. Packer Placement
Type :
Depth :

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement
Cement	7 sks	6 gal/sk	10-40	poured

11. DISINFECTION : Type : HTH Amt. Used : 16 oz.

12. WELL TEST DATA : ( ) Check Box If Test Data Is Submitted On Supplemental

TESTING METHOD : Air Compressor

Static Level : 36 ft. Date/Time Measured 1/16/2014 Production Rate 4-5 gpm

Pumping Level : Total ft. Date/Time Measured 1/16/2014 Test Length : 2 hours

Test Remarks:

13. I have read the statements made herein and know the contents thereof, and that they are true to my knowledge (Pursuant to Section 24-4-1-4 (13)(a) CRS, the making of false statements constitutes perjury in the second degree and is punishable as a class 1 misdemeanor)

CONTRACTOR : Shelton Drilling Corp. Phone : (970) 927-4182
Mailing Address : P.O. Box 1059 Basalt, Co 81621 Lic. No. 1095

Name / Title (Please Type or Print)	Signature	Date
Wayne Shelton / President		1/23/2014

APPENDIX C

CLOSURE PLAN & COST ESTIMATE

DE BEQUE WATER STATION RECLAMATION PLAN

PREPARED FOR:

Black Hills Exploration & Production
A Black Hills Corporation Enterprise

BLACK HILLS PLATEAU PRODUCTION
1515 WYNKOOP STREET, SUITE 500
DENVER CO 80202

PREPARED BY:

WWC ENGINEERING

1275 MAPLE STREET, SUITE F
HELENA, MT 59601
(406) 443-3962
www.WWCengineering.com

Innovation
Quality
Value

MARCH 2015

De Beque Water Station Reclamation Plan

Prepared for: Black Hills Plateau Production
ATTN: Brett Hurlbut
1515 Wynkoop Street, Suite 500
Denver, CO 80202
(303) 566-3356

Prepared by: WWC Engineering
1275 Maple Street Suite F
Helena, MT 59601
(406) 443-3962
Fax: (406) 449-0056

Principal Authors: Drew Pearson, P.E.

Reviewed by: Shawn Higley, P.E., Helena Branch Manager
Kevin Grabinski, P.E., Project Manager

Date: March 2015

TABLE OF CONTENTS

Appendices

DE BEQUE WATER STATION RECLAMATION PLAN

This Reclamation Plan is specifically intended for the Black Hills De Beque Water Station Facility located west of De Beque, CO in Mesa County. This facility is more specifically located in the SE ¼ of the SW ¼ of Section 29, Township 8 South, Range 97 West, 6th P.M.

INTERIM RECLAMATION

Interim reclamation work will begin as soon as practicable on all areas where final reclamation cannot be applied. Areas disturbed during construction including cut and fill slopes, access roads, and the lay down yard will be stabilized, via grading and contouring, to prevent erosion, reduce soil loss, and reduce the chance of slope failure. Erosion and sediment control measures, such as rock and straw waddle Best Management Practices (BMPs) will be applied and maintained until a stable vegetative cover is established. Storm water and erosion control BMPs will be chosen based on site-specific conditions and may include the maintenance of BMPs that had been in place during construction.

Where required to establish seed growth during re-vegetation of bare soil, topsoil will be placed over the finished grade. For further aid in re-vegetation, the seedbed may be prepared by harrowing, disking, pitting, and/or ripping. Areas that have been seeded will be monitored for establishment and the presence of erosional features would be re-stabilized and reseeded until adequate vegetative cover is established.

Upon interim reclamation completion, Black Hills shall submit a Sundry Notice, Form 4 to describe reclamation actions performed and the final land use. This Form will include photographs of the site taken during the growing season and facing each cardinal direction to document the success of reclamation. One photograph of adjacent undisturbed vegetation will also be included.

DE BEQUE WATER STATION CLOSURE

The proposed De Beque Water Station will be in operation at this location for the productive life of the nearby production wells or until Black Hills determines that the facility is no longer necessary or until the facility becomes incapable of supporting the required operations. Black Hills anticipates the useful operational life of the proposed facility to be 20 years. The ponds will be emptied and the liner will be inspected every 3 to 5 years, or as the Director sees necessary.

A Site Investigation and Remediation Work plan, Form 27, will be provided to the COGCC for approval at least 60 days prior to closure. If it is determined that soils and/or

surface and groundwater were detrimentally impacted by the facility, the necessary remediation efforts will be implemented immediately. Implementation details for site remediation and emergency response procedures and contacts are included in the preliminary Operating Plan.

The facility will undergo final reclamation within six months following the shutdown of permanent operations. Final closure will include removal of all mechanical and electrical equipment, buildings, removal and disposal of synthetic liners, final grading and seeding.

CLOSURE SEQUENCE

Following the shutdown of permanent operations of the facility and upon decommissioning the pit, the facility will be closed and reclaimed as outlined below:

- Storm water and erosion control BMPs will be installed prior to closure construction activities and will remain in place until final stabilization is achieved.
- All remaining produced water will be drained and disposed of off-site in accordance with COGCC rules.
- All equipment, structures, and fencing will be disassembled and removed from the site.
- Pit sediment will be removed and placed in an area lined with a pit liner so that it can be dried, tested, and determined if the soil is ready for final disposal.
- The synthetic liners will be bundled and rolled to one end of the pit.
- The synthetic liners will be removed and recycled or otherwise disposed of at an approved facility.
- Compacted surfaces will be ripped to loosen the soil and allow mixing with subgrade material.
- Aggregate surfacing material and clean soil will be used to fill in the pit; if the concentrations exceed the levels in Table 910-1 the waste will be disposed of at an off-site facility.
- Following facility closure, groundwater and surface water samples will be taken within one mile of the site.

FINAL RECLAMATION

Following the removal of all structures, equipment, and materials, final reclamation will be initiated. All final reclamation activities will be conducted in accordance with COGCC 1000 Series Rules and Mesa County standards. Final Reclamation includes the practices of Interim Reclamation as discussed above. The site will be graded to match original contours and any remaining stockpile will be spread evenly over the area. Additionally, native vegetation will be established to 80 percent of the pre-disturbance

levels. The area will be stabilized so that the site meets future land uses including livestock grazing, wildlife habitat, and mineral exploration.

After reclamation has been completed, a 3rd party re-vegetation/reclamation specialist will inspect the site annually until the site is re-vegetated. Observations will be made for weed presence, fence damage, erosion occurrences, and bare ground resulting from lack of germination. Evaluation of the reclamation will be based on species types present, diversity, and ground cover. Monitoring will commence during the first growing season and will continue until re-vegetation meets or exceed pre-disturbance vegetation.

Final reclamation will be complete when a final Sundry Notice, Form 4, is submitted describing the final reclamation procedures and designated final land use, there are no outstanding compliance issues for the site, and upon approval from the Director.

APPENDIX C-1

DE BEQUE RECLAMATION COST

OVERALL SITE RECLAMATION ESTIMATE

DE BEQUE WATER STATION FACILITIES

Black Hills Exploration and Production
Job Number: 2013-134
Mesa County

Prepared By: DRD
Date: Mar-15
Location: De Beque, CO
Type of Work: Reclamation

Item	Description	Unit	Quantity	Unit Price Dollars	Cost Dollars
PROJECT MOB. & MISC. FEES					
100	Mobilization/Prep Work	LS	1	$55,000.00	$55,000.00
101	Permits, Bonds and Insurance	LS	1	$25,000.00	$25,000.00
				Subtotal	**$80,000.00**
OFFICE BUILDING					
200	Interior Walls - Demo	LS	1	$6,600.00	$6,600.00
201	Interior Kitchen Cabinets - Demo	LS	1	$3,200.00	$3,200.00
202	Interior Bathroom Fixtures - Demo	LS	1	$4,300.00	$4,300.00
203	Sheet Rock - Demo	LS	1	$5,500.00	$5,500.00
204	Insulation - Demo	LS	1	$6,300.00	$6,300.00
205	Removal of Doors, Windows and Heating System	LS	1	$4,000.00	$4,000.00
206	Removal Electrical Fixtures and Control Panel	LS	1	$1,400.00	$1,400.00
207	Removal of Roof Metal Sheeting	LS	1	$8,000.00	$8,000.00
208	Removal of Siding Sheet Metal	LS	1.0	$17,500.00	$17,500.00
209	Removal of Super Structure	LS	1.0	$25,000.00	$25,000.00
210	Removal and Disposal of Concrete Slab and Doors	LS	1.0	$7,000.00	$7,000.00
211	Removal and Disposal of Main Floor Slab	LS	1	$19,000.00	$19,000.00
212	Removal and Disposal of Concrete Footings and Stem Walls	LS	1	$16,200.00	$16,200.00
213	Removal and Disposal of Bollards, Handrails, Misc.	LS	1	$3,000.00	$3,000.00
214	Removal of Underground Water Tank	LS	1	$7,500.00	$7,500.00
215	Removal of Sewage Septic System	LS	1	$3,000.00	$3,000.00
216	Removal of Parking and Building	LS	1	$18,500.00	$18,500.00
				Subtotal	**$156,000.00**
PUMP STATION BUILDING					
300	Removal of Centrifugal Pumps	LS	1	$12,000.00	$12,000.00
301	Removal of VFD Electrical Pump Panels	LS	1	$2,000.00	$2,000.00
302	Removal of High Pressure Pipe Lines	LS	1	$23,000.00	$23,000.00
303	Removal of Supply Lines	LS	1	$17,800.00	$17,800.00
304	Removal of Skimming Chamber	LS	1	$9,800.00	$9,800.00
305	Removal of Diffuser Piping	LS	1	$6,400.00	$6,400.00
306	Removal of Control System	LS	1	$1,390.00	$1,400.00
307	Interior Windows and Doors - Demo	LS	1	$2,850.00	$2,900.00
308	Interior Walls - Demo	LS	1	$5,600.00	$5,600.00
309	Removal of Exterior Doors	LS	1	$3,000.00	$3,000.00
310	Removal of Interior Sheet Rock and Insulation	LS	1	$10,500.00	$10,500.00
311	Removal of Ceiling Sheet Rock and Insulation	LS	1	$10,200.00	$10,200.00
312	Removal of all Electrical Fixtures	LS	1	$3,000.00	$3,000.00
313	Removal of Exterior Sheet Metal Siding	LS	1	$28,000.00	$28,000.00
314	Removal of Roof Purlins	LS	1	$16,800.00	$16,800.00
315	Removal of Siding Purlins	LS	1	$35,000.00	$35,000.00
316	Removal of Structural Steel	LS	1	$38,500.00	$38,500.00
317	Removal of Anchor Systems	LS	1	$7,400.00	$7,400.00
318	Removal of Transformer	LS	1	$7,600.00	$7,600.00
319	Removal of Exterior Concrete Pads and Doors	LS	1	$18,600.00	$18,600.00
320	Removal of Building Floor Slab	LS	1	$27,700.00	$27,700.00
321	Removal of Pump Foundation	LS	1	$26,600.00	$26,600.00
322	Removal of Underground Pipe Lines to Exterior	LS	1	$16,100.00	$16,100.00
323	Regrading Building Site	LS	1	$2,900.00	$2,900.00
324	Topsoil Placement at Building Site	LS	1	$40,700.00	$40,700.00
				Subtotal	**$373,500.00**
POND RECLAMATION					
400	Removal and Disposal of Pond 1 Piping	LS	1	$40,000.00	$40,000.00
401	Removal and Disposal of Pond 2 Piping	LS	1	$40,000.00	$40,000.00
402	Removal and Disposal of Pond 3 Piping	LS	1	$40,000.00	$40,000.00
403	Removal and Salvage of Submersible Pump	LS	1	$28,000.00	$28,000.00
404	Plug all Piping going into each Pond	LS	1	$13,000.00	$13,000.00
405	Removal and Disposal of Liner from Ponds 1, 2 and 3	SF	406,110	$0.60	$243,700.00
406	Removal of Miscellaneous Structures	LS	1	$1,200.00	$1,200.00
407	Excavate and Backfill Ponds 1, 2 and 3	CY	148,500	$3.20	$475,200.00
408	Fine Grade Surface to Final Profile	LS	1	$8,300.00	$8,300.00
409	Place 6" of Topsoil	AC	23	$3,500.00	$80,500.00
410	Seeding with Fertilizer and Erosion Controls	AC	23	$2,000.00	$46,000.00
411	Installation of Storm Water Controls	AC	23	$2,000.00	$46,000.00
412	Soil Sampling for Backfill Approval	EA	25	$100.00	$2,500.00
				Subtotal	**$1,064,400.00**
OVERALL SITE RECLAMATION					
500	Maintenance Reseeding	LS	1	$31,060.00	$31,100.00
501	Long-term storm water protection	LS	1	$5,000.00	$5,000.00
502	Long-term Water and Soil Sampling	EA	10	$1,600.00	$16,000.00
503	Plug and Abandon Monitoring Wells	EA	3	$1,000.00	$3,000.00
504	Weed Maintenance - 5 years	LS	1	$5,000.00	$5,000.00
				Subtotal	**$60,100.00**
				Capital Cost Subtotal	**$1,734,000.00**
600	Contingency		15%		$266,000.00
	Total Capital Cost				**$2,000,000.00**

Note: All remaining water in the facility that has not evaporated will be pumped by the Owner to an injection well disposal facility prior to reclamation.

APPENDIX D

LIABILITY INSURANCE

CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY) 02/18/2015

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER 1-612-333-3323 Hays Companies 80 South 8th Street Suite 700 Minneapolis, MN 55402 Ted W. Dimitry	CONTACT NAME: Lori Lock PHONE (A/C, No, Ext): 612-333-3323 FAX (A/C, No): 612-373-7270 E-MAIL ADDRESS: llock@hayscompanies.com
INSURED Black Hills Exploration and Production, Inc. PO Box 1400 625 9th Street Rapid City, SD 57701	INSURER(S) AFFORDING COVERAGE — NAIC # INSURER A : LIBERTY MUT FIRE INS CO — 11748 INSURER B : LIBERTY INS CORP — 42404 INSURER C : INSURER D : INSURER E : INSURER F :

COVERAGES **CERTIFICATE NUMBER:** 43041633 **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSR	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
A	GENERAL LIABILITY			TB2641437957104 (BHEP)	07/01/14	07/01/15	EACH OCCURRENCE	$ 2,000,000
	[X] COMMERCIAL GENERAL LIABILITY						DAMAGE TO RENTED PREMISES (Ea occurrence)	$ 100,000
	[ ] CLAIMS-MADE [X] OCCUR						MED EXP (Any one person)	$ 10,000
							PERSONAL & ADV INJURY	$ 2,000,000
							GENERAL AGGREGATE	$ 4,000,000
	GEN'L AGGREGATE LIMIT APPLIES PER:						PRODUCTS - COMP/OP AGG	$ 4,000,000
	[X] POLICY [ ] PRO-JECT [ ] LOC							$
A	AUTOMOBILE LIABILITY			AS2641437957034	07/01/14	07/01/15	COMBINED SINGLE LIMIT (Ea accident)	$ 2,000,000
	[X] ANY AUTO						BODILY INJURY (Per person)	$
	[ ] ALL OWNED AUTOS [ ] SCHEDULED AUTOS						BODILY INJURY (Per accident)	$
	[ ] HIRED AUTOS [ ] NON-OWNED AUTOS						PROPERTY DAMAGE (Per accident)	$
								$
	[ ] UMBRELLA LIAB [ ] OCCUR						EACH OCCURRENCE	$
	[ ] EXCESS LIAB [ ] CLAIMS-MADE						AGGREGATE	$
	[ ] DED [ ] RETENTION $							$
B	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? Y / N [N] (Mandatory in NH) If yes, describe under DESCRIPTION OF OPERATIONS below	N / A		WA764D437957044	07/01/14	07/01/15	[X] WC STATU-TORY LIMITS [ ] OTH-ER	
							E.L. EACH ACCIDENT	$ 2,000,000
							E.L. DISEASE - EA EMPLOYEE	$ 2,000,000
							E.L. DISEASE - POLICY LIMIT	$ 2,000,000

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (Attach ACORD 101, Additional Remarks Schedule, if more space is required)

FOR INFORMATIONAL PURPOSES ONLY.

CERTIFICATE HOLDER

Colorado Oil & Gas Conservation Commission

1120 Lincoln Street, Suite 801

Denver, CO 80203

USA

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE

SUPPLEMENT TO CERTIFICATE OF INSURANCE

DATE
02/18/2015

NAME OF INSURED: Black Hills Exploration and Production, Inc.

BLACK HILLS CORPORATION - NAMED INSUREDS

BHEP COMMERCIAL GENERAL LIABILITY (GC) -104:

Black Hills Exploration and Production, Inc. (FIRST NAMED INSURED)
Black Hills Corporation
Black Hills Non-Regulated Holdings, LLC
Black Hills Cabresto Pipeline, LLC
Black Hills Gas Resources, Inc.
Black Hills Gas Holdings Corp.
Black Hills Plateau Production, LLC
Mallon Oil Company, Sucursal Costa Rica

APPENDIX E

WILDLIFE BMP PLAN

WWC ENGINEERING
1275 Maple Street, Suite F - Helena, MT 59601 - (406) 443-3962
Fax (406) 449-0056 - Email: infohln@wwcengineering.com

January 23, 2014

Jim Komatinsky
Land Use Specialist
Colorado Parks and Wildlife
711 Independent Avenue
Grand Junction, CO 81505

RE: De Beque Station Wildlife BMP Plan

Mr. Komatinksy:

On behalf of Black Hills Exploration and Production, WWC Engineering is submitting a proposed wildlife BMP plan for the De Beque Station project for review and approval. Approval of this plan will be submitted to the Colorado Oil and Gas Conservation Commission (COGCC) with permit Form 2A.

The De Beque station project is a proposed production water reuse and raw water facility to conserve water by recycling flow-back and produced water for re-use in well stimulations or drilling. The project is located in the SE ¼ of the SW ¼ of Section 29, Township 8 South, Range 97 West, 6th P.M. A site map is located in Attachment A. At this location, it was identified by Mr. Komatinsky that the project will be within mule deer critical winter range, black bear habitat, and potentially white-tailed prairie dog colonies. To mitigate impacts to these wildlife sensitive areas, the following wildlife best management practices will be incorporated into the project design and permitting:

1. A copy of the Colorado Parks and Wildlife Actions to Minimize Adverse Impacts to Wildlife Resources is located in Attachment B. This document provides general and species specific wildlife BMP guidelines that shall be followed.
2. Night lighting shall be of the full-cutoff type and/or timed or otherwise minimized to reduce disruption to wildlife.
3. The proposed location lies within year-round black bear habitat. There is potential for human/bear conflicts with gas exploration employees who are working and/or camping in these areas during development operations. The potential for human/bear conflicts within these project areas will be greatly reduced by placing and utilizing “bear proof” trash containers at work-site/camping locations during construction activities. Furthermore, workers affiliated with these projects shall be advised not to feed bears, whether intentional or not, since this activity is a violation of Colorado Parks and Wildlife Commission Regulations and is detrimental to wild bears. CPW has information on the design and purchase of “bear proof” trash containers, and will provide this information to anyone who is interested in preventing conflicts with bears during construction activities.

4. Following the completion of construction activities, newly exposed soils shall be revegetated as soon as possible to prevent erosion and to reduce the likelihood of non-native plants becoming established in the area. Seed mix used for revegetation shall be certified as weed-free and consist of native seeds from plants that are common to the area.
5. To reduce the likelihood of truck – wildlife collisions, proper speed limits (< 25 mph) shall be posted and enforced on all service roads.
6. Fencing around the pit shall consist of a minimum of a 7-foot chain-link fence capable of preventing elk, deer and other wildlife from entering the pit; concurrently it shall have a small mesh type of fencing along the bottom of the fence (buried one-foot below grade level and extending a minimum of two-feet above grade) capable of preventing small animals from entering between the gaps (gaps should be no larger than three-inches).
7. The pits shall be constructed with a 4:1 slope escape ramp and/or with chain-link fencing in one corner of the pit to allow entrapped wildlife to escape.
8. The pits shall be adequately protected to ensure that waterfowl and other birds are prevented – excluded – from entering or coming in contact with water in the pits. Blacks Hill would like to use an innovative product called Hexprotect Cover. This HDPE cover has an AQUA version that self ballasts and is wind resistant up to 130 mph. Documentation for this product is included in Attachment C.
9. CPW shall be notified immediately if any birds and/or wildlife are found dead or trapped within or around the pits, netting, or fences.

It is our sincere hope that this plan adequately addresses the requirements of CPW and that the **De Beque Station Wildlife BMP Plan** be approved as soon as possible. Please do not hesitate to contact us should you have any further questions or require additional clarification.

Sincerely,

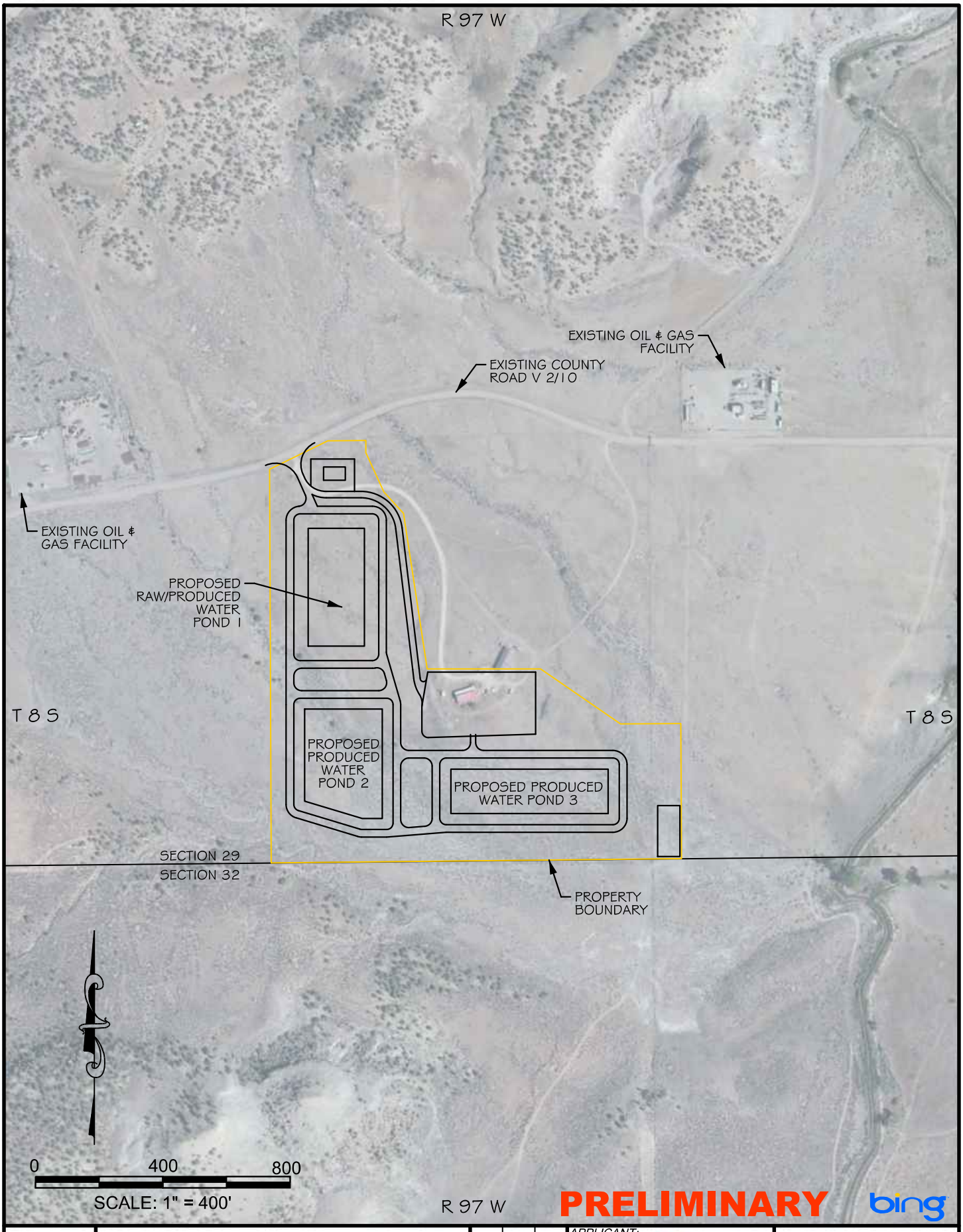
Drew Pearson, P.E.
Project Engineer

cc: File

Encl.: As Noted
DP

ATTACHMENT A

SITE MAP



ATTACHMENT A

DE BEQUE STATION
SECTION 29, T8S, R97W 6TH P.M.

SITE MAP

DSGN	DATE	CKD
DDP	01/14	STH
REV	DATE	CKD
DDP	2/7/14	STH

JOB # 2013-134

APPLICANT:
Black Hills Exploration & Production
1515 WYNKOOP ST., SUITE 500
DENVER, CO 80202
(303) 566-3356

WWC ENGINEERING
1275 MAPLE STREET, SUITE F
HELENA, MT 59601
(406) 443-3962

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ATTACHMENT B

COLORADO PARKS AND WILDLIFE ACTIONS TO MINIMIZE ADVERSE IMPACTS TO WILDLIFE RESOURCES

ACTIONS TO MINIMIZE ADVERSE IMPACTS TO WILDLIFE RESOURCES

The purpose of this document is to enumerate potential actions that may avoid, minimize, and/or mitigate adverse impacts of oil and gas operations on Colorado's wildlife resources.

I. PLANNING INFRASTRUCTURE PLACEMENT AND DEVELOPMENT ACTIVITIES

Planning infrastructure placement and the timing of development activities to avoid and minimize impacts to wildlife resources is a critical component to any development strategy that balances the needs of wildlife with the rights of the oil and gas operator to produce oil and gas. To accomplish this objective, a Wildlife Impact Avoidance and Minimization Plan should be prepared prior to development that incorporates the following strategies:

A. Bring operators, CDOW personnel and surface owners together early in the planning process to assess wildlife needs and operational constraints, and to collaborate on a planning document that provides guidelines to avoid or minimize impacts to wildlife resources.

B. Plan development activities at the largest scale possible (i.e. landscape level) in order to allow for phased or clustered development to avoid or minimize impacts to wildlife resources. Use unitization, operator agreements, and other agreements to improve communication, to consolidate and minimize infrastructure, and to allow for effective landscape level planning.

C. Develop and implement an adaptive management program that provides for monitoring and evaluation, that documents environmental changes, and that implements mid-course corrections to development and operational practices. Correlate oil and gas operations with environmental changes through ongoing monitoring and evaluation and adaptively adjust future oil and gas development activities as necessary to protect wildlife resources.

II. ELEMENTS OF AN IMPACT AVOIDANCE AND MINIMIZATION PLAN

The following elements may be used collectively for the development of a landscape Wildlife Impact Avoidance and Minimization Plan, or individually as Avoidance Measures on a well-by-well basis.

A. GENERAL WILDLIFE AND ENVIRONMENTAL PROTECTION MEASURES: *These measures are meant to educate field personnel regarding specific wildlife concerns.*

1. Provide annual educational training for staff and contractors on specific wildlife issues of concern, (e.g., how to recognize lek sites, the location and importance of seasonal wildlife habitats and migratory patterns, how to locate mountain plover nests, the effects of winter range disturbance on wildlife, etc.,) and on the overall aspects of the landscape planning documents and any agreements with CDOW.
2. Establish policies to protect wildlife (e.g., no poaching, no firearms, no dogs on location, no feeding of wildlife, etc.).
3. Promptly report spills that affect wildlife to the Water Quality Control Division of CDPHE and CDOW.
4. Store and stage emergency spill response equipment at strategic locations along perennial water courses so that it is available to expedite effective spill response.
5. Avoid locating staging, refueling, and storage areas within 300 feet of any reservoir, lake, wetland, or natural perennial or seasonally flowing stream or river.

6. Install automated emergency response systems (e.g., high tank alarms, emergency shut- down systems, etc.).

B. INFRASTRUCTURE LAYOUT WILDLIFE PROTECTION MEASURES (including production facilities, ancillary facilities, and roads): *The purpose of these measures is to consolidate development activities and production facilities in order to minimize direct habitat loss and fragmentation, and to minimize displacement of wildlife due to audible, olfactory and visual disturbances.*

1. Avoid new surface disturbance and placing new facilities in key wildlife habitats in consultation with CDOW.
2. Phase and concentrate all development activities, so that large areas of undisturbed habitat for wildlife remain. Maintain undeveloped areas within development boundaries sufficient to allow wildlife to persist within development boundaries during all phases of construction, drilling, and production. Minimize the duration of development and avoid repeated or chronic disturbance of developed areas. Complete all anticipated drilling within a phased, concentrated, development area during a single, uninterrupted time period.
3. Develop a transportation plan to incorporate the following strategies:
    - **a.** Minimize the number, length, and footprint of oil and gas development roads;
    - **b.** Use existing routes where possible;
    - **c.** Combine utility infrastructure (gas, electric, and water) planning with roadway planning to avoid separate utility corridors;
    - **d.** Combine and share roads to minimize habitat fragmentation
    - **e.** Place roads to avoid obstructions to migratory routes for wildlife, and to avoid displacement of wildlife from public to private lands.
    - **f.** Design roads with visual and auditory buffers or screens (e.g., topographic barriers, vegetation, and distance).
    - **g.** Surface roads to ensure that the anticipated volume of traffic and the weight and speed of vehicles using the road do not cause environmental damage, including generation of fugitive dust and contribution of sediment to downstream areas.
    - **h.** Locate roads as far from riparian areas and bottoms of drainages as possible and outside of riparian habitat.
    - **i.** Avoid constructing any road segment in the channel of an intermittent or perennial stream.
    - **j.** Avoid low water crossings. Structures for perennial or intermittent stream channel crossings should be engineered using bridges or appropriately sized culverts.
    - **k.** Design road crossings of streams to allow fish passage at all flows and to minimize the generation of sediment.
    - **l.** Design road crossings of streams at right angles to all riparian corridors and streams to minimize the area of disturbance.
    - **m.** Construct stream crossings “in the dry” to minimize sedimentation.
    - **n.** Protect culvert inlets from erosion and sedimentation and install energy dissipation structures at outfalls.
    - **o.** Implement fugitive dust control measures.
    - **p.** Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.
    - **q.** Coordinate employee transport, encourage carpooling or provide bus transport to work sites.

r. Prohibit or substantially limit the amount of traffic on lease roads in important wildlife habitats within 3 hours of sunrise and sunset.

s. Install and use locked gates or other means to prevent unauthorized vehicular travel on roads and facility rights-of-way.

t. Limit parking to already disturbed areas.

u. Use man camps to reduce travel related disturbance when the benefits outweigh the disadvantages of developing human concentrations in wildlife habitats.

4. Develop and implement appropriate density caps or thresholds on wells sites, facilities and infrastructure (see the species-specific well site density recommendations in this document).

5. Maximize the utility of surface facilities by developing multiple wells from a single pad (directional drilling), and by co-locating multipurpose facilities (for example, well pads and compressors) to avoid unnecessary habitat fragmentation and disturbance of additional geographic areas.

6. Minimize the number, size and distribution of well pads and locate pads along existing roads where possible.

7. Cluster well pads in the least environmentally sensitive areas.

8. Consolidate and centralize fluid collection and distribution facilities.

9. Share/consolidate corridors for pipeline ROW's to the maximum extent possible.

10. Engineer pipelines to avoid field fitting and reduce excessive ROW widths and reclamation.

11. Adequately size infrastructure and facilities to accommodate both current and future gas production. Economize gas transportation.

C. AQUATIC and WETLAND ENVIRONMENT PROTECTION MEASURES: *The purpose of these measures is to avoid, minimize or mitigate disturbances to aquatic and wetland habitats and the unique wildlife communities associated with these habitats.*

1. Minimize activities and operations within 300 feet of the ordinary high water mark of any reservoir, lake, wetland, or natural perennial or seasonally flowing stream or river.

2. Schedule necessary construction in stream courses to avoid critical spawning times. General spawning avoidance guidelines are found under Species Specific chapters in this document.

3. Bore pipelines that cross perennial streams.

4. Use the minimum right-of-way width where pipelines cross riparian areas and streams.

5. Construct all crossings at right angles to the stream.

6. Do not remove native riparian canopy or stream bank vegetation where possible.

7. Avoid direct discharge of pipeline hydrostatic test water to any reservoir, lake, wetland, or natural perennial or seasonally flowing stream or river.

8. Avoid dust suppression activities within 300 feet of the ordinary high water mark of any reservoir, lake, wetland, or natural perennial or seasonally flowing stream or river.

9. Screen water suction hoses to exclude fish.

10. Disinfect heavy equipment, hand tools, boots and any other equipment that was previously used in a river, stream, lake, pond, or wetland prior to moving the equipment to another water body. The disinfection practice should follow this outline:

a. Remove all mud and debris from equipment and spray/soak equipment with a 1:15 solution of disinfection solution containing the following ingredients:

1. Dialkyl dimethyl ammonium chloride, 5-10% by weight;
2. Alkyl dimethyl benzyl ammonium chloride, 5-10% by weight;
3. Nonyl phenol ethoxylate, 5-10% by weight;
4. Sodium sesquicarbonate, 1-5%;

5. Ethyl alcohol, 1-5%; and
6. Tetrasodium ethylene diaminetetraacetate, 1-5%;
7. and water, keeping the equipment moist for at least 10 minutes and managing rinsate as a solid waste in accordance with local, county, state, or federal regulations; or

b. Spray/soak equipment with water greater than 140 degrees Fahrenheit for at least 10 minutes.

c. Sanitize water suction hoses and water transportation tanks (using methods described above) and discard rinse water at an appropriately permitted disposal facility.

D. DRILLING AND PRODUCTION OPERATIONS WILDLIFE PROTECTION MEASURES: *The purpose of these measures is to reduce disturbance on the actual drill site and the surrounding area, to reduce direct conflict with wildlife and hunters, and to prevent wildlife access to equipment.*

1. Schedule construction, drilling, and completion activities to avoid particularly sensitive seasonal wildlife habitats in consultation with CDOW.

2. Schedule construction, drilling, and completion activities to avoid seasons and locations when public use of lands is at its highest (e.g., big game hunting seasons).

3. Reduce visits to well-sites through remote monitoring (i.e. SCADA) and the use of multi-function contractors.

4. Use centralized hydraulic fracturing operations.

5. Transport water through centralized pipeline systems rather than by trucking.

6. Where possible, locate pipeline systems under existing roadways, or roadways that are planned for development.

7. Maximize use of state-of-the-art drilling technology (e.g., high efficiency rigs, coiled-tubing unit rigs, closed-loop or pitless drilling, etc.) to minimize disturbance.

8. Conduct well completions with drilling operations to limit the number of rig moves and traffic.

9. Employ state-of-the-art technology to protect existing vegetation (e.g., use mats if possible to preserve topsoil/vegetative root stock).

10. Install exclusionary devices to prevent bird and other wildlife access to equipment stacks, vents and openings.

11. Ensure that surface discharged produced water meets minimum standards for Total Dissolved Solids (TDS) and Sodium Adsorption Ratio (SAR) to benefit wildlife.

12. Reduce noise by using effective sound dampening devices or techniques (e.g., hospital-grade mufflers, equipment housing, insulation, installation of sound barriers, earthen berms, vegetative buffers, etc.). Appropriate noise limits are included in the species-specific recommendations in included in this document.

13. Locate above-ground facilities to minimize the visual effect (e.g., low profile equipment, appropriate paint color, vegetation screening in wooded areas, etc.).

14. During pipeline installations install trench plugs, earthen ramps, or other means as necessary to ensure that open pipeline trenches do not trap wildlife, and that pipe strings to not impair wildlife movements.

E. FLUID PIT WILDLIFE PROTECTION MEASURES: *The purpose of these measures is to prevent wildlife access to fluid pits and to reduce potential for contamination of water and soil by pit contents.*

1. Avoid locating fluid pits within 300 feet of the ordinary high water mark of any reservoir, lake, wetland, or natural perennial or seasonally flowing stream or river.
2. Install and maintain adequate measures to exclude all types of wildlife (e.g., big game, birds, and small rodents) from all fluid pits (e.g., fencing, netting, and other appropriate exclusion measures).
3. Construct fluid pit fences and nets that are capable of withstanding animal pressure and environmental conditions and that are appropriately sized for the wildlife encountered.
4. Install impermeable barriers beneath fluid pits to protect groundwater, riparian areas and wetlands.
5. Skim and eliminate oil from produced water ponds and fluid pits at a rate sufficient to prevent oiling of birds or other wildlife that could gain access to the pit.
6. Construct fluid pits with a 4:1 escape ramp to allow entrapped wildlife to escape.
7. Treat waste water pits and/or any associated pit containing water with Bti (*B. thuringiensis v. israelensis*)**,** commonly known as Mosquito Dunks, to control mosquito larvae that may spread West Nile Virus to wildlife or take other effective approaches to controlling mosquito larvae in ponds and pits.
    a. The appropriate application rate of Bti is 1 dunk/100 sq. ft. of standing water, applied each 30 day period during 1 June – 30 September.

F. INVASIVE/NON-NATIVE VEGETATION CONTROL: *The purpose of these measures is to ensure proper planning, assessment and control of weed infestations on all locations.*

1. Develop an aggressive, integrated, noxious and invasive weed management plan. Utilize an adaptive management strategy that permits effective responses to monitored findings and reflects local site and geologic conditions. Use of dedicated personnel with single responsibility for weed control is often the most effective approach.
2. Map the occurrence of existing weed infestations prior to development to effectively monitor and target areas that will likely become issues after development.
3. Establish a systematic and thorough noxious and invasive monitoring program for all disturbed areas and maintain monitoring records.
4. Continue control programs for the life of the well field.
5. Use reclamation as a weed management tool. Plant competition provided by established reclamation is the most effective weed management tool.
6. Thoroughly clean vehicles and other equipment to remove weed seeds before moving equipment to new sites.
7. Educate employees and contractors about noxious and invasive weed issues.

G. RESTORATION, RECLAMATION AND ABANDONMENT: *The purpose of these measures is to restore disturbed sites to their pre-development conditions, using native vegetation that can be used by the indigenous wildlife. Develop a reclamation plan in consultation with CDOW, NRCS, and the land owner or land management agency that incorporates wildlife species-specific goals and that defines reclamation performance standards, including the following components:*

1. Soil
    a. Store topsoil in windrows no higher than 5 feet.
    b. Strip and segregate topsoil prior to construction. Appropriately configure topsoil piles and immediately seed to control erosion, prevent weed establishment and maintain soil microbial activity.

c. Maintain separation between pit contents and soils.
d. Salvage topsoil from all road construction and other rights-of-way and re-apply during interim and final reclamation.
e. Evaluate the utility of soil amendment application or consider importing topsoil to achieve effective reclamation.

2. Seed
a. Use only certified weed-free native seed in seed mixes, unless use of non-native plant materials is recommended by CDOW.
b. Test seed rigorously and frequently for purity, germination/viability, and the presence of weeds.
c. Use locally adapted seed whenever available, especially for species which have wide geographic ranges and much genetic variation (e.g., big sagebrush (*Artemesia tridentata*), antelope bitterbrush (*Purshia tridentata*), etc.).
d. Where more than one ecotype of a given species is available and potentially adapted to the site, include more than one ecotype per species in the seed mix.
e. Use appropriately diverse reclamation seed mixes that mirror an appropriate reference area for the site being reclaimed (see also species-specific recommendations).
f. Conduct seeding in a manner that ensures that seedbed preparation and planting techniques are targeted toward the varied needs of grasses, forbs and shrubs (e.g., seed forbs and shrubs separately from grasses, broadcast big sagebrush but drill grasses, etc.).
g. Emphasize bunchgrass over sod-forming grasses in seed mixes in order to provide more effective wildlife cover and to facilitate forb and shrub establishment.
h. Seed immediately after recontouring and spreading topsoil. Spread topsoil and conduct seeding during optimal periods for seed germination and establishment. Use of the same contractor for re-contouring land as used for seeding is often the most effective approach.
i. Do not include aggressive, non-native grasses (e.g., intermediate wheatgrass, pubescent wheatgrass, crested wheatgrass, smooth brome, etc.) in reclamation seed mixes. Site specific exceptions may be considered.
j. Distribute quick germinating site adapted native seed or sterile non-native seed for interim reclamation on cut and fill slopes and topsoil piles.
k. Plan for reclamation failure and be prepared to repeat seeding as necessary to meet vegetation cover, composition, and diversity standards.
l. Consider reclaiming with tubelings/plantings where seed failure is likely or has occurred.

3. Vegetative Cover Standard
a. Choose reference areas as goals for reclamation that have high wildlife value, with attribute such a diverse and productive understory of vegetation, productive and palatable shrubs, and a high prevalence of native species.
b. Establish vegetation with total perennial non-invasive plant cover of at least eighty (80) percent of pre-disturbance or reference area levels.
c. Establish vegetation with plant diversity of non-invasive species which is at least half that of pre-disturbance or reference area levels. Quantify diversity of vegetation that considers only species with at least 3 percent relative plant cover.
d. Establish permanent and monumented photo points and vegetation measurement plots or transects; monitor at least annually until plant cover, composition, and diversity standards have been met.

e. Observe and maintain a performance standard for reclamation success characterized by the establishment of a self-sustaining, vigorous, diverse, locally appropriate plant community on the site, with a density sufficient to control erosion and non-native plant invasion and diversity sufficient to allow for normal plant community development.

4. Timing
- **a.** Use early and effective reclamation techniques, including interim reclamation to accelerate return of disturbed areas for use by wildlife.
- **b.** Remove all unnecessary infrastructure.
- **c.** Close and reclaim roads not necessary for development immediately, including removing all bridges and culverts and recontouring/reclaiming all stream crossings.
- **d.** Reclaim reserve pits as quickly as possible after drilling and ensure that pit contents do not contaminate soil.
- **e.** Remediate hydrocarbon spills on disturbed areas prior to reclamation.
- **f.** Reclaim sites during optimum seasons (e.g. late fall/early winter or early spring).
- **g.** Complete final reclamation activities so that seeding occurs during the first optimal season following plugging and abandonment of oil and gas wells.

5. Interim reclamation
- **a.** Use a variety of native grasses and forbs to establish effective, interim reclamation on all disturbed areas (e.g., road shoulders and borrow areas), including disturbed areas where additional future ground disturbance is expected to occur.
- **b.** Perform interim reclamation to final reclamation species composition and establishment standards.
- **c.** Perform "interim" reclamation on all disturbed areas not needed for active support of production operations.

6. Riparian areas
- **a.** Replace all riparian vegetation removed during development at a rate of at least 3:1.
- **b.** Restore both form and function of impacted wetlands and riparian areas and mitigate erosion.

7. Disposal
- **a.** Remove well pad and road surface materials that are incompatible with post-production land use and re-vegetation requirements.
- **b.** Remove and properly dispose of degraded silt fencing and erosion control materials after their utility has expired.
- **c.** Remove and properly dispose of pit contents where contamination of surface water, groundwater, or soil by pit contents cannot be effectively prevented.

8. Establishing reclaimed areas
- **a.** Apply certified weed free mulch and crimp or tacify to remain in place to reclaim areas for seed preservation and moisture retention.
- **b.** Utilize staked soil retention blankets for erosion control and reclamation of large surface areas with 3:1 or steeper slopes. Avoid use of plastic blanket materials, known to cause mortality of snakes.
- **c.** Install cattle guards to regulate livestock pasture utilization;
- **d.** Control weeds in areas surrounding reclamation areas in order to reduce weed competition.

9. Educate employees and contractors about weed issues. Fencing

a. Support development and implementation of portable wildlife-proof fencing that could be used to protect vegetation during early stages of development then moved to another area. These should be implemented in areas where establishment of browse species is a priority. Monitor production of browse in areas receiving protection and compare to browse production in an adjacent area.

b. Fence livestock and/or wildlife out of newly reclaimed areas until reclamation standards have been met and plants are capable of sustaining herbivory.

c. Inventory, monitor and remove obsolete, degraded, or hazardous fencing.

H. MONITORING: *These measures assess the ecological condition of a disturbed area and measure the success or failure of the reclamation effort as well as measuring effects of development activities on other resources.*

1. Conduct necessary reclamation and invasive plant monitoring.
2. Census and assess the utilization of the reclaimed areas by the target species.
3. Maintain pre and post development site inspection records and monitor operations for compliance.
4. For those surface waters supporting fisheries, establish baseline water chemistry prior to development and establish a regular and repeated water chemistry monitoring and reporting program for groundwater, surface waters, and produced water discharged on the surface to detect and allow effective response to water quality issues that may impact aquatic wildlife. Quantify levels of pH, alkalinity, specific conductance, major cations/anions (including Cl, Fl, Sulphate, Sodium), total dissolved solids, BTEX/GRO/DRO, TPH, PAH (including benzo (a) pyrene), and metals (including As, Ba, Ca, Cd, Cr, Fe, Mg, Pb, Se), nitrate, nitrite, ammonia-N, turbidity, dissolved oxygen, hydrogen sulfide, and water temperature.
5. Monitor soil chemistry and structure where CBM or other produced water is put to a beneficial use (i.e., irrigation, water sources for wildlife, etc.).
6. Utilize GIS technologies to assess the extent of disturbance and document the reclamation progression and the footprint of disturbances.

III. RESEARCH

These measures are suggested where questions or uncertainties exist about the degree of impact to specific resources or other aspects of oil and gas development or reclamation is unknown.

A. Collaborate and/or fund research investigation into the impacts of oil and gas development activities on wildlife resources.

B. Support research to test the effectiveness of specific Best Management Practices.

C. Identify native species for which commercial seed sources are not available. Provide support to contractors for developing cultivation and seed production techniques for needed species.

D. Conduct reclamation field trials to match seed mixes, soil preparation techniques, and planting methods to local conditions.

IV. SPECIES SPECIFIC RECOMMENDATIONS

These reasonable recommendations are derived from the best available science and represent preferred management actions to protect wildlife and wildlife habitats where oil and gas development is occurring.

BAT ROOST SITES

- Consult with CDOW regarding locations of known bat roost sites.
- Avoid surface disturbance activities within 0.25 mile of all Townsend's Big-Eared Bat, Fringed Myotis, and Brazilian Free-Tailed Bat roost sites.

BIGHORN SHEEP

- Consult with CDOW regarding big game seasonal restrictions on wintering or production areas.
- Avoid surface disturbance and construction activities on or within any bighorn sheep production or wintering areas.
- Where oil and gas activities must occur in bighorn sheep production areas, avoid conducting these activities from April 15 to June 30 for Rocky Mountain Bighorn Sheep and from February 28 to May 1 for Desert Bighorn Sheep.
- Where oil and gas activities must occur in bighorn sheep winter range, avoid conducting these activities from November 1 through April 15.
- Avoid low elevation (below 500 feet altitude) helicopter overflights within 1 mile radius of bighorn sheep winter range between November 1 and April 15.
- Avoid low elevation (below 500 feet altitude) helicopter overflights within 1 mile radius of bighorn sheep production areas from April 15 to June 30 for Rocky Mountain Bighorn Sheep and from February 28 to May 1 for Desert Bighorn Sheep.
- Avoid surface facility density in excess of 10 well pads per 10-square mile area (one well pad per section) in bighorn sheep winter range and production areas.
- When surface density of oil and gas facilities exceeds 1 well pad/section, initiate a Comprehensive Development Plan (CDP) that includes recommendations for off-site and compensatory mitigation actions.
- Gate single-purpose roads to reduce traffic disruptions to wildlife.
- Close and immediately reclaim all roads that are redundant, not used regularly, or have been abandoned to the maximum extent possible to minimize disturbance and habitat fragmentation.
- Identify critical habitat types and adjust development sites to avoid these areas.
- Restrict post-development well site visitations to the hours of 10:00 a.m. to 3:00 p.m. and reduce well site visitations during winter months.

BLACK BEAR

- Identify, avoid and protect climax mast producing vegetation that annually provides a significant source of fall forage for black bear, especially those areas that can be identified as being consistently frost-free and that provide mast when unfavorable conditions exist elsewhere.
- Initiate a food and waste/refuse management program that uses bear-proof food storage containers and trash receptacles.
- Initiate an education program that reduces bear conflicts.
- Establish policy to prohibit keeping food and trash in sleeping quarters.
- Establish policy to support enforcement of state prohibition on feeding of black bear.
- Report bear conflicts immediately to CDOW.

BLACK-FOOTED FERRET

- Place surface facilities outside of prairie dog colonies in the Wolf Creek Management Area, the Coyote Basin Management Area, and the valley bisected by Highway 40 running from the Utah/Colorado border to the town of Dinosaur.

- Avoid oil and gas activities in prairie dog colonies where documented sightings of black-footed ferrets have occurred since 2005.
- Avoid surface disturbances between March 1 and July 15, with special attention to the period between May 1 and July 15, in prairie dog colonies where black-footed ferrets have been released or documented since 2001.
- Conduct seismic activity outside the period from March 1 to July 15 in prairie dog colonies where black-footed ferrets have been released or where black-footed ferret occurrence has been documented since 2001.
- Limit seismic activity to daylight hours in these colonies.
- Limit development of new roads within Wolf Creek Management Area and Coyote Basin Management Area.
- Gate single-purpose roads and restrict general public access to reduce traffic disruptions to wildlife.
- Close and immediately reclaim all roads that are redundant, not used regularly, or have been abandoned to the maximum extent possible to minimize disturbance and habitat fragmentation.
- Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.
- Promptly reclaim disturbed areas within prairie dog colonies within the Wolf Creek Management Area, the Coyote Basin Management Area, and the valley bisected by Highway 40 running from the Utah/Colorado border to the town of Dinosaur, CO with native grasses and forbs appropriate to the ecological site.
- Aggressively control non-native and invasive weeds, particularly cheatgrass, in reclamation areas within the Wolf Creek Management Area, the Coyote Basin Management Area, and the valley bisected by Highway 40 running from the Utah/Colorado border to the town of Dinosaur, CO.
- Survey for black-footed ferret when impacting prairie dog colonies unless the site is less than 80 acres in size for black-tailed prairie dogs, less than 200 acres in size for white-tailed prairie dogs or Gunnison's prairie dogs, or within a designated block-cleared area.

COLUMBIAN SHARP-TAILED GROUSE

- Consult with CDOW at the earliest stage of development to review detailed maps of Columbian sharp-tailed grouse seasonal habitats and to help select development sites.
- Conduct comprehensive development planning that provides a clear point of reference in evaluating, avoiding, and mitigating large scale and cumulative impacts.
- No surface occupancy within 0.4 mile of any known Columbian sharp-tailed grouse lek.
- Avoid oil and gas operations within 1.25 miles of any known Columbian sharp-tailed grouse lek, and within mapped Columbian sharp-tailed grouse breeding, summer, and winter habitat outside the 1.25 mile buffer. Select sites for development that will not disturb suitable nest cover or brood-rearing habitats within 1.25 miles of an active lek, or within identified nesting and brood-rearing habitats outside the 1.25 mile perimeter.
- Where oil and gas activities must occur within 1.25 miles of Columbian sharp-tailed grouse leks or within other mapped Columbian sharp-tailed grouse breeding or summer habitat, conduct these activities outside the period between March 15 and July 30.
- Where oil and gas activities must occur within mapped Columbian sharp-tailed grouse winter habitat, conduct these activities outside the period between December 1 and March 15.
- Restrict well site visitations to portions of the day between 9:00 a.m. and 4:00 p.m. during the lekking season (March 1 to June 1).
- Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.

- Avoid surface facility density in excess of 10 well pads per 10-square mile area (one well pad per section) in Columbian sharp-tailed grouse breeding and summer habitat (within 1.25 miles of active leks).
- When surface density of oil and gas facilities exceeds 1 well pad/section, initiate a Comprehensive Development Plan (CDP) that includes recommendations for off-site and compensatory mitigation actions.
- Phase and concentrate all development activities, so that large areas of undisturbed habitat for wildlife remain and thorough reclamation occurs immediately after development and before moving to new sites. Development should progress at a pace commensurate with reclamation success.
- Retain core habitat areas and limit disturbance to ensure Columbian sharp-tailed grouse survival.
- Implement the species appropriate Infrastructure Layout and Drilling and Production Operations Wildlife Protection Measures found in Section II B. and Section II D. of this document.
- Minimize surface disturbance and fragmentation of Columbian sharp-tailed grouse habitat through use of the smallest facility footprints possible, use of multiple well pads, clustering of roads and pipelines, and the widest possible spacing of surface facilities.
- When compressor stations must be sited within 1.25 miles of Columbian sharp-tailed grouse active and inactive (within last 10 years) lek sites, locate compressor stations no closer than 2500 feet from the lek.
- Use noise reduction equipment on compressors and other development and production equipment.
- Use topographical features to provide visual concealment of facilities from known lek locations and as a noise suppressant.
- Muffle or otherwise control exhaust noise from pump jacks and compressors so that operational noise will not exceed 49 dB measured at 30 feet from the source.
- Design tanks and other facilities with structures such that they do not provide perches or nest substrates for raptors, crows and ravens.
- Install raptor perch deterrents on equipment, fences, cross arms and pole tops in Columbian sharp-tailed grouse habitat.
- Utilize a central generator to feed the entire field via underground electrical lines.
- Where feasible, bury new power lines and retrofit existing power lines by burying them or installing perch guards to prevent their use as raptor perches.
- Design wastewater pits to minimize retention of stagnant surface water.
- Treat waste water pits and any associated pit containing water that provides a medium for breeding mosquitos with Bti (*Bacillus thuringiensis v. israelensis*) or take other effective action to control mosquito larvae that may spread West Nile Virus to wildlife, especially grouse.
- In consultation with CDOW, replace any permanently impacted, disturbed, or altered Columbian sharp-tailed grouse seasonal habitats by enhancing marginal sagebrush steppe communities (sagebrush and mountain shrub) and grassland within or immediately adjacent to mapped seasonal Columbian sharp-tailed grouse habitat.
- Implement the species appropriate reclamation guidelines found in Section II G. of this document.
- Use early and effective reclamation techniques, including an aggressive interim reclamation program to return habitat to use by Columbian sharp-tailed grouse as quickly as possible.

- Reclaim/restore Columbian sharp-tailed grouse habitats with native grasses and forbs conducive to optimal Columbian sharp-tailed grouse habitat and other wildlife appropriate to the ecological site.
- Use high diversity (10 species or more) reclamation seed mixes in Columbian sharp-tailed grouse habitat.
- Use approved CP-4D (Columbian sharp-tailed grouse) seed mixes, based on soil type, available from Farm Service Agency or Natural Resources Conservation Service, or other seed mixes approved by CDOW.
- Avoid aggressive non-native grasses in Columbian Sharp-tailed Grouse habitat reclamation.
- A small percentage of the appropriate species of big sagebrush should be re-seeded on disturbed sites.
- Reclamation of breeding habitat should include a substantially higher percentage of forbs than other areas.
- Native and select non-native forbs and legumes should be considered a vital component of reclamation seed mixes.

CUTTHROAT TROUT

- No surface disturbance within 300 feet of any water within a Designated Cutthroat Trout Habitat watershed.
- Avoid surface facility density in excess of 10 well pads per 10-square mile area (one well pad per section) in Designated Cutthroat Trout Habitat watersheds.
- When surface density of oil and gas facilities exceeds 1 well pad/section, initiate a Comprehensive Development Plan (CDP) that includes recommendations for off-site and compensatory mitigation actions.
- Bridge stream crossings or use culverts to prevent stream bed damages and the transfer of disease organisms.
- Minimize stream disturbances during June and July to avoid impacts to spawning cutthroat trout.
- When working in designated cutthroat trout habitat, disinfect heavy equipment, hand tools, boots and any other equipment that was previously used in a river, stream, lake, pond, or wetland prior to moving the equipment to another water body. The disinfection practice should follow this outline:
    - Remove all mud and debris from equipment and spray/soak equipment with a 1:15 solution of disinfection solution containing the following ingredients:
        - Dialkyl dimethyl ammonium chloride, 5-10% by weight;
        - Alkyl dimethyl benzyl ammonium chloride, 5-10% by weight;
        - Nonyl phenol ethoxylate, 5-10% by weight;
        - Sodium sesquicarbonate, 1-5%;
        - Ethyl alcohol, 1-5%; and
        - Tetrasodium ethylene diaminetetraacetate, 1-5%
        - and water, keeping the equipment moist for at least 10 minutes and managing rinsate as a solid waste in accordance with local, county, state, or federal regulations; or
    - Spray/soak equipment with water greater than 140 degrees Fahrenheit for at least 10 minutes.
    - Sanitize water suction hoses and water transportation tanks (using methods described above) and discard rinse water at an appropriately permitted disposal facility.

DEER AND ELK

- Consult with CDOW at the earliest stage of development to identify the locations of mule deer and elk important wintering habitats and production areas. Adjust development sites to avoid critical habitat patches.
- Conduct comprehensive development planning that provides a clear point of reference in evaluating, avoiding, and mitigating large scale and cumulative impacts.
- Avoid oil and gas activities within mule deer critical winter range, elk winter concentration areas, elk production areas, and migration corridors.
- Where oil and gas activities must occur in mule deer critical winter range or elk winter concentration areas, conduct these activities outside the time period from December 1 through April 15.
- Where oil and gas activities must occur in elk production areas, conduct these activities outside the time period from May 15 through June 30.
- Restrict post-development well site visitations to between the hours of 10:00 a.m. and 3:00 p.m. and reduce well site visitations between December 1 and April 15 in mule deer and elk winter range.
- Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.
- Avoid surface facility density in excess of 10 well pads per 10-square mile area (one well pad per section) in mule deer and elk winter range and in elk production areas.
- When surface density of oil and gas facilities exceeds 1 well pad/section, initiate a Comprehensive Development Plan (CDP) that includes recommendations for off-site and compensatory mitigation actions.
- Phase and concentrate all development activities, so that large areas of undisturbed habitat for wildlife remain and thorough reclamation occurs immediately after development and before moving to new sites. Development should progress at a pace commensurate with reclamation success.
- Implement the species appropriate Infrastructure Layout and Drilling and Production Operations Wildlife Protection Measures found in Section II B. and Section II D. of this document.
- Identify critical habitat types and patches and adjust development sites to avoid these areas.
- Prior to development, establish baseline vegetation condition and inventory and to provide a basis for post-development habitat restoration.
- Gate single-purpose roads and restrict general public access to reduce traffic disruptions to wildlife.
- Close and immediately reclaim all roads that are redundant, not used regularly, or have been abandoned to the maximum extent possible to minimize disturbance and habitat fragmentation.
- Implement the species appropriate reclamation guidelines found in Section II G. of this document.
- Avoid aggressive non-native grasses and shrubs in mule deer and elk habitat restoration.
- Reclaim mule deer and elk habitats with native shrubs, grasses, and forbs appropriate to the ecological site disturbed.
- Restore appropriate sagebrush species or subspecies on disturbed sagebrush sites. Use locally collected seed for reseeding where possible.

GREATER PRAIRIE CHICKEN

- Consult with CDOW at the earliest stage of development to review detailed maps of greater prairie chicken seasonal habitats and to help select development sites.

- Conduct comprehensive development planning that provides a clear point of reference in evaluating, avoiding, and mitigating large scale and cumulative impacts.
- No surface occupancy within 0.6 mile of any active or inactive (within past 10 years) greater prairie chicken leks.
- Avoid oil and gas operations within 2.2 miles of active leks and within greater prairie chicken nesting and early brood-rearing habitat outside the 2.2 mile buffer. Select sites for development that will not disturb suitable nest cover or brood-rearing habitats within 2.2 miles of an active lek, or within identified nesting and brood-rearing habitats outside the 2.2 mile perimeter.
- Where oil and gas activities must occur within 2.2 miles of active leks, conduct these activities outside the period between March 1 and June 30.
- Restrict well site visitations to portions of the day between 9:00 a.m. and 4:00 p.m. during the lekking season (March 1 to May 15).
- Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.
- Avoid surface facility density in excess of 10 well pads per 10-square mile area (one well pad per section) in greater prairie chicken nesting and early brood-rearing habitat (within 2.2 miles of active leks).
- When surface density of oil and gas facilities exceeds 1 well pad/section, initiate a Comprehensive Development Plan (CDP) that includes recommendations for off-site and compensatory mitigation actions.
- Phase and concentrate all development activities, so that large areas of undisturbed habitat for wildlife remain and thorough reclamation occurs immediately after development and before moving to new sites. Development should progress at a pace commensurate with reclamation success.
- Implement the species appropriate Infrastructure Layout and Drilling and Production Operations Wildlife Protection Measures found in Section II B. and Section II D. of this document.
- Locate compressor stations at least 2.2 miles away from greater prairie chicken active and historic (within last 10 years) lek sites. When compressor stations must be sited within 2.2 miles of greater prairie chicken active and historic (within last 10 years) lek sites, locate compressor stations farther than 0.6 mile (3200 feet) from greater prairie chicken lek sites.
- Use topographical features to provide visual concealment of facilities from known lek locations and as a noise suppressant.
- Muffle or otherwise control exhaust noise from pump jacks and compressors so that operational noise will not exceed 49 dB measured at 30 feet from the source.
- Utilize a central generator to feed the entire field via underground electrical lines.
- Design tanks and other facilities with structures such that they do not provide perches or nest substrates for raptors, crows and ravens.
- Install raptor perch deterrents on equipment, fences, cross arms and pole tops in greater prairie-chicken habitat.
- Bury new power lines and retrofit existing power lines by burying them or installing perch guards to prevent their use as raptor perches.
- Design wastewater pits to minimize retention of stagnant surface water.
- Treat waste water pits and any associated pit containing water that provides a medium for breeding mosquitos with Bti (*Bacillus thuringiensis v. israelensis*) or take other effective action to control mosquito larvae that may spread West Nile Virus to wildlife, especially grouse.
- In consultation with CDOW, replace any permanently impacted, disturbed, or altered sand sagebrush habitat within identified nesting and brood rearing range through enhancement of

existing or marginal sand sagebrush habitat or reclamation of altered or converted habitat within or immediately adjacent to mapped nesting or brood rearing habitat.

- Implement the species appropriate reclamation guidelines found in Section II G. of this document.
- Use early and effective reclamation techniques, including an aggressive interim reclamation program, to return habitat to use by greater prairie-chicken as quickly as possible.
- Restore greater prairie chicken habitat with native grasses and forbs conducive to optimal greater prairie chicken habitat and other wildlife appropriate to the ecological site.
- Use one of several approved CP-4D (greater prairie chicken) seed mixes, based on soil type, available from Farm Service Agency or Natural Resources Conservation Service, or other seed mixes approved by CDOW.
- Do not plant buffalo grass, blue grama and sideoats grama in greater prairie chicken habitat as they will eventually dominate the resulting stand and will not provide greater prairie chicken habitat.
- Restore appropriate native shrub species to disturbed sites.
- Do not use non-native grasses or shrubs in greater prairie chicken habitat reclamation.
- Reclamation of breeding habitat should include a substantially higher percentage of forbs than other areas.
- Utilize native and select non-native forbs and legumes in seed mixes as they are a vital component of brood-rearing habitat. Dryland adapted varieties of alfalfa and yellow sweet clover should be the primary non-native forbs used.

GUNNISON AND GREATER SAGE-GROUSE

- Consult with CDOW at the earliest stage of development to review detailed maps of Gunnison or greater sage-grouse seasonal habitats and to help select development sites.
- Identify seasonal habitats and migratory patterns of sage-grouse. Map all seasonal habitats using CDOW habitat selection models as they become available.
- Conduct comprehensive development planning that provides a clear point of reference in evaluating, avoiding, and mitigating large scale and cumulative impacts.
- No surface occupancy within 0.6 mile of any known Gunnison or greater sage-grouse lek.
- Avoid oil and gas operations within 4 miles of any known Gunnison or greater sage-grouse lek, and within mapped Gunnison or greater sage-grouse breeding, summer, and winter habitat outside the 4 mile buffer. Select sites for development that will not disturb suitable nest cover or brood-rearing habitats within 4 miles of an active lek, or within identified nesting and brood-rearing habitats outside the 4-mile perimeter.
- Where oil and gas activities must occur within 4 miles of Gunnison or greater sage-grouse leks or within other mapped Gunnison or greater sage-grouse breeding or summer habitat, conduct these activities outside the period between March 1 and June 30.
- Where oil and gas activities must occur within mapped Gunnison or greater sage-grouse winter habitat, conduct these activities outside the period between December 1 and March 15.
- Restrict well site visitations to portions of the day between 9:00 a.m. and 4:00 p.m. during the lekking season (March 1 to May 15).
- Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.
- Avoid surface facility density in excess of 10 well pads per 10-square mile area (one well pad per section) in Gunnison or greater sage-grouse breeding and summer habitat (within 4 miles of active leks).

- When surface density of oil and gas facilities exceeds 1 well pad/section, initiate a Comprehensive Development Plan (CDP) that includes recommendations for off-site and compensatory mitigation actions.
- Phase and concentrate all development activities, so that large areas of undisturbed habitat for wildlife remain and thorough reclamation occurs immediately after development and before moving to new sites. Development should progress at a pace commensurate with reclamation success.
- Avoid core areas as outlined in the Greater Sage-Grouse Statewide Plan, available from CDOW to ensure sage-grouse persistence and retain Gunnison sage-grouse core areas to ensure Gunnison sage-grouse persistence
- Implement the species appropriate Infrastructure Layout and Drilling and Production Operations Wildlife Protection Measures found in Section II B. and Section II D. of this document.
- Minimize surface disturbance and fragmentation of Gunnison or greater sage-grouse habitat through use of the smallest facility footprints possible, use of multiple well pads, clustering of roads and pipelines, and the widest possible spacing of surface facilities.
- Locate facilities in vegetation types other than sagebrush to avoid impacts to sage-grouse breeding and wintering habitat.
- Use drill mats to prevent habitat loss or disturbance and reduce reclamation costs.
- When compressor stations must be sited within 4 miles of Gunnison or greater sage-grouse active and inactive (within last 10 years) lek sites, locate compressor stations farther than 0.6 mile (3,200 feet) from sage-grouse lek sites. Use noise reduction equipment on compressors and other development and production equipment.
- Use topographical features to provide visual concealment of facilities from known lek locations and as a noise suppressant.
- Muffle or otherwise control exhaust noise from pump jacks and compressors so that operational noise will not exceed 49 dB measured at 30 feet from the source.
- Design tanks and other facilities with structures such that they do not provide perches or nest substrates for raptors, crows and ravens.
- Install raptor perch deterrents on equipment, fences, cross arms and pole tops in Gunnison or greater sage-grouse habitat.
- Remove all unnecessary infrastructure.
- Utilize a central generator to feed the entire field via underground electrical lines.
- Where feasible, bury new power lines and retrofit existing power lines by burying them or installing perch guards to prevent their use as raptor perches.
- Design wastewater pits to minimize retention of stagnant surface water.
- Treat waste water pits and any associated pit containing water that provides a medium for breeding mosquitos with Bti (*Bacillus thuringiensis v. israelensis*) or take other effective action to control mosquito larvae that may spread West Nile Virus to wildlife, especially grouse.
- In consultation with CDOW, replace any permanently impacted, disturbed, or altered Gunnison or greater sage-grouse seasonal habitats by enhancing marginal sagebrush steppe communities (big sagebrush and related communities) and grasslands within or immediately adjacent to mapped seasonal Gunnison or greater sage-grouse habitat.
- Implement the species appropriate reclamation guidelines found in Section II G. of this document.
- Use early and effective reclamation techniques, including an aggressive interim reclamation program, to return habitat to use by Gunnison or greater sage-grouse as quickly as possible.

- Reclaim/restore Gunnison or greater sage-grouse habitats with native grasses, forbs, and shrubs conducive to optimal Gunnison or greater sage-grouse habitat and other wildlife appropriate to the ecological site.
- Use high diversity (10 species or more) reclamation seed mixes in Gunnison or greater sage-grouse habitat.
- Use approved CP-4D (Gunnison or greater sage-grouse) seed mixes, based on soil type, precipitation, and elevation, available from Farm Service Agency or Natural Resources Conservation Service, or other seed mixes approved by CDOW.
- Avoid aggressive non-native grasses in Gunnison or greater sage-grouse habitat reclamation.
- Restore disturbed sagebrush sites with the appropriate sagebrush species or subspecies on disturbed sagebrush sites. Use locally collected seed for reseeding where possible.
- Reclaim mapped summer habitat with a substantially higher percentage of forbs (> 15 percent cover post establishment) than used in other areas.
- Utilize native and select non-native forbs and legumes in seed mixes as they are a vital component of brood-rearing habitat.

KIT FOX

- Survey for kit fox den sites in appropriate habitats before development and avoid surface disturbance within 0.25 mile of den sites while young are den dependent (Feb 1 to May 1).
- Gate single-purpose roads and restrict general public access to reduce traffic disruptions to wildlife.
- Close and immediately reclaim all roads that are redundant, not used regularly, or have been abandoned to the maximum extent possible to minimize disturbance and habitat fragmentation.
- Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.
- Utilize native vegetation for reclamation within kit fox overall range.
- Restrict use of pesticides for rodent control in kit fox overall range to prevent reduction of kit fox food supplies and secondary toxicity.
- Limit or restrict artificial water sources within kit fox overall range to prevent the spread of competitive predators into kit fox habitat.

LEAST TERN

- No surface occupancy within 300 feet of the high water mark of mapped least tern nesting habitat usually occurring on bare sandy shorelines of reservoirs, islands in reservoirs, or sand bars along major rivers in eastern Colorado.
- No surface disturbance to least tern foraging areas during the nesting season (April 1 to July 31) to include shallow water areas in lakes, ponds, and river backwater areas within 0.5 mile of known least tern production areas.

LESSER PRAIRIE CHICKEN

- Consult with CDOW at the earliest stage of development to review detailed maps of lesser prairie chicken seasonal habitats and to help select development sites.
- Conduct comprehensive development planning that provides a clear point of reference in evaluating, avoiding, and mitigating large scale and cumulative impacts.
- No surface occupancy within 0.6 mile of any active or inactive (within past 10 years) lesser prairie chicken leks.
- Avoid oil and gas operations within 2.2 miles of active leks and within lesser prairie chicken nesting and early brood-rearing habitat outside the 2.2 mile buffer. Select sites for

development that will not disturb suitable nest cover or brood-rearing habitats within 2.2 miles of an active lek, or within identified nesting and brood-rearing habitats outside the 2.2 mile perimeter.

- Where oil and gas activities must occur within 2.2 miles of active leks, conduct these activities outside the period between March 15 and June 15.
- Restrict well site visitations to portions of the day between 9:00 a.m. and 4:00 p.m. during the lekking season (March 15 to June 15).
- Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.
- Avoid surface facility density in excess of 10 well pads per 10-square mile area (one well pad per section) in lesser prairie chicken nesting and early brood-rearing habitat (within 2.2 miles of active leks).
- When surface density of oil and gas facilities exceeds 1 well pad/section, initiate a Comprehensive Development Plan (CDP) that includes recommendations for off-site and compensatory mitigation actions.
- Phase and concentrate all development activities, so that large areas of undisturbed habitat for wildlife remain and thorough reclamation occurs immediately after development and before moving to new sites. Development should progress at a pace commensurate with reclamation success.
- Implement the species appropriate Infrastructure Layout and Drilling and Production Operations Wildlife Protection Measures found in Section II B. and Section II D. of this document.
- Locate compressor stations at least 2.2 miles away from lesser prairie chicken active and historic (within last 10 years) lek sites. When compressor stations must be sited within 2.2 miles of lesser prairie chicken active and historic (within last 10 years) lek sites, locate compressor stations farther than 0.6 mile (3,200 feet) from lesser prairie chicken lek sites.
- Use topographical features to provide visual concealment of facilities from known lek locations and as a noise suppressant.
- Muffle or otherwise control exhaust noise from pump jacks and compressors so that operational noise will not exceed 49 dB measured at 30 feet from the source.
- Utilize a central generator to feed the entire field via underground electrical lines.
- Design tanks and other facilities with structures such that they do not provide perches or nest substrates for raptors, crows and ravens.
- Install raptor perch deterrents on equipment, fences, cross arms and pole tops in lesser prairie-chicken habitat.
- Bury new power lines and retrofit existing power lines by burying them or installing perch guards to prevent their use as raptor perches.
- Design wastewater pits to minimize retention of stagnant surface water.
- Treat waste water pits and any associated pit containing water that provides a medium for breeding mosquitos with Bti (*Bacillus thuringiensis v. israelensis*) or take other effective action to control mosquito larvae that may spread West Nile Virus to wildlife, especially grouse.
- Use early and effective reclamation techniques, including an aggressive interim reclamation program to return habitat to use by lesser prairie-chicken as quickly as possible.
- In consultation with CDOW, replace any permanently impacted, disturbed, or altered sand sagebrush habitat within identified nesting and brood rearing range through enhancement of existing or marginal sand sagebrush habitat or reclamation of altered or converted habitat within or immediately adjacent to mapped nesting or brood rearing habitat.
- Implement the species appropriate reclamation guidelines found in Section II G. of this document.

- When reclaiming breeding habitat, include a substantially higher percentage of forbs than used in other areas.
- Reclaim lesser prairie chicken habitats with native grasses including switchgrass, big bluestem, little bluestem, sand bluestem, yellow Indian grass, and prairie sandreed.
- Do not plant buffalo grass, blue grama and sideoats grama in lesser prairie chicken habitat as they will eventually dominate the resulting stand and will not provide lesser prairie chicken habitat.
- Restore appropriate native shrub species to disturbed sites.
- Do not use aggressive non-native grasses or shrubs in lesser prairie chicken habitat reclamation.
- Utilize native and select non-native forbs and legumes in seed mixes as they are a vital component of brood-rearing habitat. Dry land adapted varieties of alfalfa and yellow sweet clover should be the primary non-native forb species used.

LYNX

- Consult with DOW regarding lynx use of the development area.
- Avoid locating facilities within lynx breeding habitat (spruce-fir forest south of Interstate 70 above 9,000 feet in elevation and with slopes greater than 25%).
- Prior to development, establish baseline vegetation condition and inventory and to provide a basis for post-development habitat restoration.
- Identify, avoid, and protect vegetation used by snowshoe hare.
- Apply stipulations during programmatic planning stage for oil and gas that limit occupancy, control surface use or control timing of activities in lynx habitats.
- On projects where over-the-snow access is required, restrict use to designated routes.
- Minimize snow compaction when authorizing and monitoring developments.
- Utilize remote monitoring of sites that are located in lynx habitat, to reduce disturbance from well visitation.
- Restrict public access on single purpose roads during project activities.
- Close and immediately reclaim all roads that are redundant, not used regularly, or have been abandoned to the maximum extent possible to minimize disturbance and habitat fragmentation.
- Report all lynx sightings to DOW.
- Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.
- Minimize traffic in occupied lynx habitat between 3:00 p.m. and 7:00 a.m.
- Reclaim newly constructed pipelines immediately following construction and do not allow any motorized vehicles access to pipeline (i.e.,. install barriers, boulders etc).
- Encourage developers to pipe produced water to a central site for transport, in order to reduce truck traffic to each well pad site.
- Minimize upgrading of roads used to access oil/gas developments or transmission pipelines in lynx habitat or linkage areas.
- Develop a reclamation plan (e.g. road reclamation and vegetation rehabilitation) for abandoned well sites to restore suitable habitat for lynx.

MOUNTAIN PLOVER

- Survey suitable nesting habitat within the known range of mountain plover that is proposed for development during the appropriate season. Flag active nests and apply the seasonal restriction described below.
- No surface occupancy within 300 feet of active mountain plover nest sites until young are hatched and independent of nest.

PIPING PLOVER

- No surface occupancy within 300 feet of the high water mark of mapped piping plover nesting habitat usually occurring on sandy open shorelines of reservoirs and lakes, or islands in reservoirs or lakes in eastern Colorado.
- No surface disturbance to piping plover foraging areas during the nesting season (April 1 to July 31) to include shallow water areas along exposed beach substrates associated with lakes, ponds, and beaches, and dry, barren sandbars along backwater river areas with abundant macro-invertebrate and insect populations within 0.5 mile of known piping plover production areas.

PLAINS SHARP-TAILED GROUSE

- Consult with CDOW at the earliest stage of development to review detailed maps of plains sharp-tailed grouse seasonal habitats and to help select development sites.
- Conduct comprehensive development planning that provides a clear point of reference in evaluating, avoiding, and mitigating large scale and cumulative impacts.
- No surface occupancy within 0.4 mile of any known plains sharp-tailed grouse lek.
- Avoid oil and gas operations within 1.25 miles of any known plains sharp-tailed grouse lek, and within mapped plains sharp-tailed grouse breeding or summer habitat outside the 1.25 mile buffer. Select sites for development that will not disturb suitable nest cover or brood-rearing habitats within 1.25 miles of an active lek, or within identified nesting and brood-rearing habitats outside the 1.25 mile perimeter.
- Where oil and gas activities must occur within 1.25 miles of plains sharp-tailed grouse leks or within other mapped plains sharp-tailed grouse breeding or summer habitat, conduct these activities outside the period between March 1 and June 30.
- Restrict well site visitations to portions of the day between 9:00 a.m. and 4:00 p.m. during the lekking season (March 1 to June 1).
- Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.
- Avoid surface facility density in excess of 10 well pads per 10-square mile area (one well pad per section) in plains sharp-tailed grouse breeding and summer habitat (within 1.25 miles of active leks).
- When surface density of oil and gas facilities exceeds 1 well pad/section, initiate a Comprehensive Development Plan (CDP) that includes recommendations for off-site and compensatory mitigation actions.
- Phase and concentrate all development activities, so that large areas of undisturbed habitat for wildlife remain and thorough reclamation occurs immediately after development and before moving to new sites. Development should progress at a pace commensurate with reclamation success.
- Retain core habitat areas and limit disturbance to ensure plains sharp-tailed grouse survival.
- Implement the species appropriate Infrastructure Layout and Drilling and Production Operations Wildlife Protection Measures found in Section II B. and Section II D. of this document.
- Minimize surface disturbance and fragmentation of plains sharp-tailed grouse habitat through use of the smallest facility footprints possible, use of multiple well pads, clustering of roads and pipelines, and the widest possible spacing of surface facilities.
- When compressor stations must be sited within 1.25 miles of plains sharp-tailed grouse active and inactive (within last 10 years) lek sites, locate compressor stations no closer than 2500 feet from the lek.

- Use noise reduction equipment on compressors and other development and production equipment.
- Use topographical features to provide visual concealment of facilities from known lek locations and as a noise suppressant.
- Muffle or otherwise control exhaust noise from pump jacks and compressors so that operational noise will not exceed 49 dB measured at 30 feet from the source.
- Design tanks and other facilities with structures such that they do not provide perches or nest substrates for raptors, crows and ravens.
- Install raptor perch deterrents on equipment, fences, cross arms and pole tops in plains sharp-tailed grouse habitat.
- Utilize a central generator to feed the entire field via underground electrical lines.
- Bury new power lines and retrofit existing power lines by burying them or installing perch guards to prevent their use as raptor perches.
- Design wastewater pits to minimize retention of stagnant surface water.
- Treat waste water pits and any associated pit containing water that provides a medium for breeding mosquitos with Bti (*Bacillus thuringiensis v. israelensis*) or take other effective action to control mosquito larvae that may spread West Nile Virus to wildlife, especially grouse.
- In consultation with CDOW, replace any permanently impacted, disturbed, or altered plains sharp-tailed grouse habitat within identified nesting and brood rearing range through enhancement of existing or marginal plains sharp-tailed grouse habitat or reclamation of altered or converted habitat within or immediately adjacent to mapped nesting or brood rearing habitat.
- Implement the species appropriate reclamation guidelines found in Section II G. of this document.
- Use early and effective reclamation techniques, including an aggressive interim reclamation program to return habitat to use by plains sharp-tailed grouse as quickly as possible.
- Reclaim/restore plains sharp-tailed grouse habitats with native grasses and forbs conducive to optimal plains sharp-tailed grouse habitat and other wildlife appropriate to the ecological site.
- Use approved CP-4D (plains sharp-tailed grouse) seed mixes, based on soil type, available from Farm Service Agency or Natural Resources Conservation Service, or other seed mixes approved by CDOW.
- Do not use aggressive non-native grasses in plains sharp-tailed grouse habitat reclamation.
- Establish a small percentage (i.e., less than 5% cover) of adapted native shrubs listed in the Farm Service Agency and Natural Resources Conservation Service's CP-4D plains sharp-tailed grouse seed mixes on disturbed sites.
- Reclaim brood rearing areas with a substantially higher percentage of forbs than other areas.
- Utilize native and select non-native forbs and legumes in seed mixes as they are a vital component of brood-rearing habitat. Suitable species include those forbs approved by the Farm Service Agency and the Natural Resources Conservation Service's CP-4D seed mixes for CRP. Dryland adapted varieties of alfalfa and yellow sweet clover should be the primary non-native forb species used.

PRAIRIE DOGS (White-Tailed & Gunnison's)

- Survey for active and inactive prairie dog colonies within development areas prior to development.
- Avoid construction on or in prairie dog colonies wherever possible.

- Where oil and gas activities must occur on or in white-tailed or Gunnison's prairie dog colonies, conduct these activities outside the period between March 1 and June 15.
- Avoid surface facility density in excess of 10 well pads per 10-square mile area (one well pad per section) in White-tailed and Gunnison's Prairie Dog Management Emphasis Areas that will be described in the Colorado Statewide Implementation Plan for the species.
- When surface density of oil and gas facilities exceeds 1 well pad/section, initiate a Comprehensive Development Plan (CDP) that includes recommendations for off-site and compensatory mitigation actions.
- Manage oil and gas activities within prairie dog colonies to minimize impacts to attributes that maintain the functional integrity of the prairie dog colony (e.g., vegetation, soils, burrow systems, etc.).
- Minimize road development and close roads to recreational use.
- Promptly reclaim disturbed areas within prairie dog colonies with native grasses and forbs appropriate to the ecological site.
- Aggressively control non-native and invasive weeds, particularly cheatgrass, in reclamation areas within prairie dog habitat.
- Install raptor perch deterrents on equipment, fences, cross arms and pole tops in prairie dog habitat.

PREBLE'S MEADOW JUMPING MOUSE

- No surface occupancy within 300 feet either side of centerline along streams of known or potentially occupied habitat along the northern Front Range from the Colorado Wyoming state line through northern El Paso County.
- Consult with the U.S. Fish and Wildlife Service and the U.S. Army Corps of Engineers when permitting any permanent or temporary activity within known or potentially occupied habitat Preble's meadow jumping mouse habitat.

PRONGHORN ANTELOPE

- Avoid surface disturbance to and construction activities within pronghorn winter concentration areas west of I-25 from January 1 through March 31.
- Identify critical habitat types and adjust development sites to avoid these areas.
- Gate single-purpose roads to reduce traffic disruptions to wildlife.
- Close and immediately reclaim all roads that are redundant, not used regularly, or have been abandoned to the maximum extent possible to minimize disturbance and habitat fragmentation.
- Limit fence construction in pronghorn habitat. Use CDOW recommended pronghorn fence designs.
- Prior to development, establish baseline vegetation condition and inventory to provide a basis for post-development habitat restoration.
- Avoid aggressive non-native grasses and shrubs in pronghorn habitat restoration.
- Reclaim pronghorn habitats with native shrubs, grasses, and forbs appropriate to the ecological site disturbed.
- Restore appropriate sagebrush species or subspecies on disturbed sagebrush sites. Use locally collected seed for reseeding where possible. Sagebrush is less important in pronghorn reclamation on the eastern plains than it is in western Colorado (west of I-25).

RAPTORS

General Raptor Mitigation Measures

- Prior to ground disturbing activities, determine either through consultation with CDOW or surveys the locations of raptor nesting and roosting sites.
- Provide raptor survey data for incorporation into the CDOW raptor database.
- Consult with and implement CDOW recommendations regarding raptor protection measures including seasonal timing restrictions and recommended buffer zones.
- Avoid disturbance of raptor nesting habitat during the breeding season (variable by species--January 1 to July 15).
- Avoid impacts to raptor roost sites during the wintering period (variable by species--November 15 to April 1).
- Survey any suitable habitat (cliffs, large trees, snags) within 1 mile of a proposed project site for raptor nests. Where raptor nests are found, site the project to provide a suitable buffer zone, and/or place sufficient seasonal limitations on construction activity to protect the nest site.
- Bury utility lines in defined areas with high collision risk for birds.
- Implement recommendations from both *"Suggested Practices for Avian Protection on Power Lines, the State of the Art in 2006"* and the *"Avian Protection Plan (APP) Guidelines"* (2005) for proper design and retrofit considerations for powerlines and poles to minimize raptor electrocution. These documents can be ordered at the Edison Electric Institute web site (www.eei.org) or can be downloaded at the Avian Power Line Interaction Committee web site (www.aplic.org).

Bald Eagle

- No surface occupancy (beyond that which historically occurred in the area) within 0.25 mile of any active or historic bald eagle nest site.
- No human disturbance or construction activity within 0.5 mile of any active bald eagle nest from November 15 to July 31. Activity within 0.5 mile of bald eagle nest sites would be best conducted between August 15 and October 15.
- No surface occupancy or construction within 0.25 mile of any active bald eagle winter night roost site, where there is no direct line of sight to the roost, between December 1 and February 28 and within 0.5 mile of any active bald eagle winter night roost site, where there is a direct line of sight to the roost, between December 1 and February 28.
- No human disturbance within 0.5 mile of any active bald eagle winter roost site from November 15 to March 15 except for periodic visits such as oil maintenance and monitoring Maintenance and monitoring work within the buffer zone after development should be restricted to the period between 10:00 a.m. and 2:00 p.m.
- No human disturbance within any mapped winter concentration areas between November 15 and March 15.

Ferruginous Hawk

- No surface occupancy (beyond that which historically occurred in the area) within 0.5 mile of active nest sites and associated alternate nests.
- No human encroachment or construction activity within 0.5 mile of any active ferruginous hawk nest or alternate nest site from February 1 to July 15.

Golden Eagle

- No surface occupancy (beyond that which historically occurred in the area) within 0.25 mile of any active golden eagle nest site.

- No human encroachment or construction activity within 0.5 mile of any active golden eagle nest from December 15 to July 15.

Mexican Spotted Owl

- No surface occupancy (beyond that which historically occurred in the area) within designated Mexican spotted owl protected activity centers (PAC's) without USFWS consultation.
- No surface disturbance between March 1 to August 31 within and adjacent to Mexican spotted owl protected activity centers (PAC's) without USFWS consultation.

Osprey

- No surface occupancy (beyond that which historically occurred in the area) within 0.25 mile of any active osprey nest site.
- No human encroachment or construction activity within 0.25 mile of any active osprey nest from April 1 to August 31.

Peregrine Falcon

- No surface occupancy (beyond that which historically occurred in the area) within 0.5 mile of any active or historic peregrine falcon nest site.
- No human encroachment or construction activity within 0.5 mile of any active peregrine falcon nest site from March 15 to July 31.

Burrowing Owl

- Adhere to recommended survey protocol and actions to protect nesting Burrowing Owls (e.g. survey active and inactive prairie dog colonies for presence of Burrowing Owls when construction will occur between March 1 and October 31).
- Conduct surface disturbance within 300 feet of any active burrowing owl nest site outside the period between March 1 and August 15.

RIVER OTTER

- Avoid or limit the use of pesticides, herbicides, and fertilizers within the flood plain in occupied river otter habitat.
- Minimize disturbance of riparian vegetation adjacent to waterways (i.e., within 300 feet) of occupied river otter habitat.
- Minimize road development within 300 feet of occupied river otter habitat, especially the creation of new stream or river crossings (bridges) in occupied river otter habitat.
- Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.
- Provide information on sightings of live or dead river otters for incorporation into the CDOW river otter sightings database. Sighting forms are located at: http://wildlife.state.co.us/WildlifeSpecies/SpeciesOfConcern/Mammals/RiverOtterObservation.htm

SOUTHWEST WILLOW FLYCATCHER

- Survey for active nest sites during the breeding season within southwest willow flycatcher overall range.
- No Surface Occupancy within 300 feet of southwest willow flycatcher nest sites.
- No surface disturbance or removal of riparian habitat within 300 feet from stream edge within potential southwest willow flycatcher habitat

- Restrict activities May 15 to August 1 in potential southwest willow flycatcher habitat.

SWIFT FOX

- Survey for swift fox den sites and avoid surface disturbance within 0.25 mile while young are den dependent (March 15 to June 15).
- Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.
- Utilize native vegetation for reclamation within swift fox overall range
- Restrict use of pesticides for rodent control in swift fox overall range.

WESTERN BOREAL TOAD

- No Surface Occupancy within 0.5 mile of known breeding sites.
- Consult with CDOW prior to any surface disturbance or construction activities within 600 feet of any documented western boreal toad field sighting or production area.

AQUATIC SPECIES/AMPHIBIANS

- Consult with CDOW or collect baseline aquatic species and macro-invertebrate inventory data both pre and post development.
- Conduct two pass population estimations for streams potentially affected. Report species composition, length-frequency and individual weights.
- Collect water samples to monitor water quality before, during and after occupation and document data and changes.
- No surface disturbance within 300 feet of any designated Gold Medal water.
- Design stream crossings to minimize the total number of crossings and so that crossings are at or as near to 90 degrees to the direction of stream flow.
- Construct stream crossings “in the dry” and avoid impacts to trout during spawning and hatching periods.
- Restrict trucks from crossing streams and utilize appropriate and effective culverts that don’t preclude upstream movement of fish.
- Avoid using low water crossings.
- Control erosion and sedimentation, and manage storm water runoff; reclaim sites as quickly as possible to restore vegetation.
- Control weeds along riparian corridors and manage livestock grazing to maintain riparian corridor health.
- Consider fencing riparian areas.
- Avoid changes to water quality and quantity.
- Repair incised channels where excessive erosion and sedimentation is occurring.
- Consider directional boring of pipeline crossings of perennial streams.
- Replace non-native riparian vegetation such as tamarisk and Russian olive with appropriate native plantings such as cottonwood or willow.
- Protect groundwater, riparian areas and wetlands by installing impermeable barriers beneath fluid pits.
- When working in designated Gold Medal waters, disinfect heavy equipment, hand tools, boots and any other equipment that was previously used in a river, stream, lake, pond, or wetland prior to moving the equipment to another water body. The disinfection practice should follow this outline:
    - Remove all mud and debris from equipment and spray/soak equipment with a 1:15 solution of disinfection solution containing the following ingredients:

        - Dialkyl dimethyl ammonium chloride, 5-10% by weight;
        - Alkyl dimethyl benzyl ammonium chloride, 5-10% by weight;
        - Nonyl phenol ethoxylate, 5-10% by weight;
        - Sodium sesquicarbonate, 1-5%;
        - Ethyl alcohol, 1-5%; and
        - Tetrasodium ethylene diaminetetraacetate, 1-5%
        - and water, keeping the equipment moist for at least 10 minutes and managing rinsate as a solid waste in accordance with local, county, state, or federal regulations; or
    - Spray/soak equipment with water greater than 140 degrees Fahrenheit for at least 10 minutes.
    - Sanitize water suction hoses and water transportation tanks (using methods described above) and discard rinse water at an appropriately permitted disposal facility.
- Avoid stream channel disturbances during fish spawning seasons. Fish spawn at specific times of the year. The eggs incubate in the gravel until the yolk sac is absorbed and the larval fish can swim up through the gravel and into the main body of water. Eggs incubating in the redds can be smothered by the excessive deposition of sediment, and further affected by fungal spores carried in the sediment. Adults can be affected by the same fungal species with high mortality rates. Fish spawning dates and incubation times vary by elevation and temperatures, but in general the following intervals will apply in Colorado:
    - Rainbow trout: March 1 - June 15
    - Brown trout: October 1 – May 1
    - Brook trout: August 15 – May 1
    - Cutthroat trout: June 1 – September 1
    - Bluehead sucker: May 1 – July 15
    - Flannelmouth sucker: April 1 – July 1
    - Roundtail chub: May 15 – July 15

ATTACHMENT C

HEXPROTECT COVER

Hexprotect Cover

Advanced Water Treatment Technologies
Engineered for a lifetime

Wind resistant hexagonal tile cover.

AWTT INC. **Hexprotect** cover system is the result of intense and extensive research leading to a product which fulfills demands of an affordable and wind resistant floating cover for liquids.

This innovative hexagonal floating cover offers highly effective solutions to problematic liquid storage systems such as municipal and industrial wastewater, treatment processing plants, metal and petrochemical plants, leachate ponds, airports, raw water reservoirs and other applications for heat retention, photosynthesis prevention and or a wildlife deterrent.

The Hexprotect system ensures coverage of up to 99%. The resulting thermal insulation barrier combines the insulation factor of the air held in each tile with the poor heat conductivity of plastic. While the small air pockets between the tiles are not sealed, they also contribute to this insulation system, which dramatically reduces heat loss and light transfer. The cover also reduces liquid loss through evaporation and prevents odor problems.

The Hexprotect tile barrier, contrary to standard covers, does not represent an obstacle to static, moving or dipping equipment. The tiles can be easily pushed aside and the cover reforms itself as the basin and obstacles change configuration, as in a clarifier.

In fact, the tiles will keep up with liquid level, rising, lowering and restacking themselves as needed.

Hexprotect is also an effective wildlife deterrent. When entirely covered, the body of water becomes un-attractive to waterfowl and other wildlife such as deer. They simply don't recognize it as water. Compared to netting, Hexprotect is not sensitive to ice or snow damage and do not require any kind of support.

Hexprotect is produced with high quality high density polyethylene. The expected life time is 25 years.

Hexprotect features:

- Quick and simple to install
- Up to 99% surface coverage
- Decrease liquid loss by evaporation by up to 95%
- Decrease emission by up to 95%
- Heating cost reduced by up to 85%
- Wind resistant up to 75 mph

Hexprotect added benefits :

- Deters waterfowl from landing on covered waters
- Each tile is made of long lasting, UV resistant, high quality HDPE
- Allow movement of equipment through liquid. Unlimited and easy access to the liquid.
- Adjust to the variation of the liquid level by spreading & stacking
- Naturally Self arrange and interlock on the liquid surface
- Fast and Effective solution to odor problems
- Virtually maintenance free
- Cannot tear like conventional membrane cover
- Reduces penetration of UV rays: prohibit growth of algae and clogging weeds.
- Aeration can be installed underneath the Hexprotect
- Reduce chemical consumption.
- Unaffected by rain water
- Life expectancy of 25 years

Technical Data:

Diagonal measure:	220 mm
Weight dry:	172 g
Weight installed:	455g
Height:	60 mm
No. per m2:	32
No. per square foot:	3

AWTT INC.
ADVANCED WATER TREATMENT TECHNOLOGIES
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Hexprotect™ AQUA: technical data

Wind resistant

Product Info

Hexprotect™ technical data

Hexprotect™ tiles are made of virgin or recycled, high density polyethylene HDPE (FDA (3) and NSF approved HDPE resins available for special applications). The cover self ballasts, increasing its weight more than 260%, making it suitable for high wind applications. The proprietary features and manufacturing process ensures the cover floats with slightly more than 50% of its shell above water. Compared to other hexagonal tile covers, the Hexprotect cover is often cheaper to ship and offers improved wind resistance. Installation remains extremely simple, and simply consists of unloading the product directly onto the liquid.

Description	Water ballasted hexagonal tile
Construction	100% HDPE shell
Diameter	220 mm
Average total weight (dry)	400g
Average total weight (installed)	400g
Number per sq. ft	3
Number per square meter	32
Wind resistant (up to) (1)	209 km/h (130 MPH)
Operating temperature range (1)	-50°C / + 80 °C
Projected Life Expectancy	25+ years

Resin & Ballast Properties (1)(2)

Shell Material	High Density Blow Molding polyethylene
Melt Flow Index (190°C/2.16 kg)	0.35
Density	0.955
Melting Point, °F	264
Tensile Strength (PSI)	4000
Elongation at Break, %	600
Flexure Modulus (PSI)	200,000
Ballast Filler	Drinking water

(1) Data developed under laboratory conditions.
(2) Some of the data listed was determined on compression molded specimens and may, therefore, vary from specimen taken from molded articles.
(3) Complies with FDA 21 CFR § 177.1520, Para. (c) 2.1 and 2.

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'*Thanks for the communication and for keeping everything on schedule. [...] Your scheduling, production, shipping and communication have been a welcome change from how everything else has gone*'. Mike

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APPENDIX F

SPILLWAY POLICY MEMORANDUM NO. 01-14

Colorado Division of Water Resources
Dam Safety Branch

DRAFT Policy Memorandum No. 01-14
Subject: Produced Water Pond Dams

1.0 Background

Ponds constructed for storage or treatment of water produced from oil and gas exploration and extraction operations are regulated by the Colorado Department of Public Health and Environment (CDPHE) and/or the Colorado Oil and Gas Conservation Commission (COGCC). However, produced water ponds are sometimes constructed to store water above the original ground surface and should be considered dams, which are generally regulated by the Colorado Division of Water Resources (CDWR). Although most dams associated with mining and similar extractive development are exempt from the CDWR dam safety requirements, it is generally accepted that produced water should be prevented from entering the surface waters of the state. Policies are currently being developed between the three state regulatory agencies to reduce duplication of efforts and minimize regulatory conflicts in permitting and regulating produced water pond dams. In the interim, this draft policy memorandum defines the spillway design criteria for produced water pond dams.

2.0 Produced water pond dams that meet the size criteria for jurisdictional dams (Rule 4.2.5.1) will be designed and constructed in accordance with the Rules and Regulations for Dam Safety and Dam Construction as follows:

2.1. The minimum spillway capacity must be as required by Table 5.2 plus one foot of residual freeboard, or

2.2. The dam can be designed with no spillway, but the dam must have 5 feet of total freeboard or adequate freeboard to retain the direct Probable Maximum Precipitation, whichever freeboard is greater.

2.3. No surface runoff will be permitted to flow into the pond.

3.0 Produced water pond dams that meet the size criteria for non-jurisdictional dams (Rule 4.2.5.2) will be permitted, regulated, and inspected by CDPHE and/or COGCC in accordance with the rules and policies of those agencies. CDPHE and COGCC will communicate with the Dam Safety Branch of CDWR to evaluate the hazard classification of non-jurisdictional produced water pond dams and define the spillway design criteria.

3.1. Spillways on Low Hazard dams must be capable of passing the 50-year precipitation event with on foot of residual freeboard.

3.2. Spillways on Significant Hazard or High Hazard non-jurisdictional dams must be designed according to the requirements for jurisdictional dams listed in paragraphs 2.1-2.3 above.

4.0 The above spillway freeboard requirements are in addition to any limitations placed by CDPHE or COGCC on the maximum permitted pond level.

5.0 The CDWR Dam Safety Branch reserves the right to alter the procedures and requirements of this policy memo as necessary to meet the goals of the Dam Safety Branch.

APPENDIX G

FACILITY DESIGN

DEBEQUE STATION GEOTECHNICAL REPORT

PREPARED FOR:

Black Hills Exploration & Production
A Black Hills Corporation Enterprise

BLACK HILLS PLATEAU PRODUCTION
1515 WYNKOOP STREET, SUITE 500
DENVER CO 80202

PREPARED BY:

WWC ENGINEERING

1275 MAPLE STREET, SUITE F
HELENA, MT 59601
(406) 443-3962
www.WWCengineering.com

Innovation
Quality
Value

AUGUST 2014

DeBeque Station Geotechnical Report

Prepared for: Black Hills Plateau Production
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Date: August 2014

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INTRODUCTION

The De Beque Water Station will be designed for the collection of produced water from surrounding oil and gas operations along with raw water from the Colorado River. The proposed facility is located approximately 2.2 miles southwest of De Beque, Colorado in the SE ¼ of the SW ¼ of Section 29, Township 8 South, Range 97 West, 6th P.M. A project location map is provided on Exhibit 1.

The De Beque Station will consist of three ponds labeled as Pond 1, Pond 2, and Pond 3. The layout of these facilities can be seen on Exhibit 2. This report presents the field investigation, laboratory testing, and geotechnical analysis conducted for the project to evaluate the suitability of on-site soils for construction and stability of the proposed ponds.

PROJECT DESCRIPTION

The De Beque Station facility will consist of three lined reservoirs for the storage of produced water and raw water, a pump station, a laydown yard and an office building. A layout of the facility is shown on Exhibit 2. Pond 1 is designated as a produced and raw water pond while Ponds 2 and 3 are designated as produced water only. This gives the operator more flexibility for water storage.

In order to classify the size and jurisdiction of the ponds the State of Colorado *Rules and Regulations for Dam Safety and Dam Construction* was used. The document defines a jurisdictional size dam as “a dam creating a reservoir with a capacity of more than 100 acre-feet, or creates a reservoir with a surface area in excess of 20 acres at the high-water line, or exceeds 10 feet in height measured vertically from the elevation of the lowest point of the natural surface of the ground where that point occurs along the longitudinal centerline of the dam up to the crest of the emergency spillway of the dam.”

Pond 1 has a storage volume of 40.3 acre-feet, a water surface area of 2.59 acres, and a height from the spillway crest elevation to natural ground of 9.89 feet. Under the state’s guidelines, **Pond 1 is classified as a non-jurisdictional size dam**.

Pond 2 has a storage volume of 31.2 acre-feet, a water surface area of 2.58 acres, and a height from the spillway crest elevation to natural ground of 14.00 feet. Under the state’s guidelines, **Pond 2 is classified as a “Low Hazard” minor jurisdictional size dam** as the height from the spillway crest elevation to natural ground is between 10 and 20 feet.

Pond 3 has a storage volume of 30.0 acre-feet, a water surface area of 2.46 acres, and a height from the spillway crest elevation to natural ground of 16.76 feet. Under the state’s guidelines, **Pond 3 is classified as a “Low Hazard” minor jurisdictional size**

dam as the height from the spillway crest elevation to natural ground is between 10 and 20 feet.

Details of the jurisdictional classification of each pond can be found in the *De Beque Station Hazard Classification Report* submitted to the Colorado Division of Water Resources.

SCOPE OF WORK

As Pond 2 and Pond 3 are classified as "Low Hazard" minor jurisdictional size dams, the field investigation, laboratory testing, and geotechnical analysis were performed with the purpose of addressing the following applicable rules pertaining to *Rule 5.4.3 Geotechnical Report* contained within the Colorado Division of Water Resources "Rules and Regulations for Dam Safety and Dam Construction."

- *Rule 5.4.3 requires the submission of a geotechnical report that evaluates the suitability of the foundation, stability of the dam and the slopes along the reservoir rim, and addresses issues regarding suitability and quantity of material available for construction of the dam as designed.*

- *Rule 5.4.3.4 requires that for Low Hazard dams, the geotechnical report shall include field classification of soils, logs of borings and test pits, standard penetration test results, and the requirements of Rules 5.4.3.3.1 (standard index tests and soil classification of all materials), 5.4.3.3.2 (compressibility and/or consolidation tests of soils), and 5.4.3.3.5 (proctor compaction tests). Rule 5.4.3.4 also requires that the foundation exploration shall include drilling to a depth of 1.5 times the height of the dam or 10 feet into bedrock, whichever is less.*

A geotechnical field investigation of the proposed area for the De Beque Station facilities was performed by Olsson Associates. Boreholes were drilled in February 2014 with six (6) boreholes being drilled to a depth of 30 feet and three (3) boreholes being drilled to a depth of 100 feet. Bulk soil samples were obtained in March 2014 with the purpose of performing multiple laboratory tests to determine soil properties. Exhibit 2 shows the approximate location of each borehole and bulk sample.

Olsson Associates performed an extensive laboratory testing program on soil samples obtained during the site investigation. The program included soil classification, Atterberg limits tests, sieve analyses, triaxial tests, proctor compaction tests, and permeability tests. The testing program was selected to determine the suitability of on-site soils for construction and stability of the proposed ponds.

WWC Engineering performed a geotechnical analysis of the in-situ soils to determine their suitability for construction of the proposed pond berms. Information from the field investigation and laboratory testing results were used in this analysis. The geotechnical analysis included an examination of the pond berm foundation soils using accepted dam design criteria, berm slope stability modeling using the Geo-Slope SLOPEW program, and quantity of on-site material to construct the ponds as designed.

EXPLORATION AND LABORATORY TEST PROCEDURES

FIELD EXPLORATIONS

The field exploration and completion of boreholes for the De Beque Station facilities was performed by Olsson Associates. A truck-mounted drill rig was utilized to complete the nine (9) boreholes. Boreholes were drilled in February 2014 with six (6) boreholes being drilled to a depth of 30 feet and three (3) boreholes being drilled to a depth of 100 feet. Bulk soil samples were obtained from the site in March 2014. Exhibit 2 indicates the approximate location of each borehole and bulk sample. It must be noted that groundwater was not encountered in any of the nine (9) borehole locations.

The Standard Penetration Testing (SPT) method described in ASTM D1586 was used for each of the boreholes, and split-barrel sampling procedure was used to obtain samples throughout the bores. The split-barrel procedure involved driving a split-barrel sampling spoon in 6-inch increments to a total of 18 inches (when possible) into the subsurface strata using a 140-pound drop hammer falling 30 inches onto drill rods. The number of blows required to advance the sampler in six-inch increments was recorded, and the total number of blows required to advance the sampler the final 12 inches was recorded as the penetration resistance “N value”. The samples were then sealed and returned to the laboratory for classification and testing. The Borehole logs containing SPT N-values and a field classification of the subsurface soil stratigraphy are provided in Attachment A.

LABORATORY TESTING

Samples obtained during the field exploration were transported to a laboratory for classification and testing. The soil samples were classified utilizing the Unified Soil Classification System (USCS). To assist in this classification, Atterberg limits tests and multiple sieve analyses were performed on representative samples to assist in the classification of the subsurface soils, and the results of these tests are provided in Attachment B.

Multiple triaxial shear tests were performed on reconstituted bulk samples obtained from the site to determine soil strength parameters. To best represent the proposed soils for embankment construction, the four bulk samples used for the triaxial tests were

obtained from locations that were within the pond excavation areas and were located throughout the project area. Bulk sample locations were strategically chosen following an analysis of the borehole logs in order to provide test results that represent the average and worst-case soil strengths encountered throughout the site.

Two types of triaxial tests were completed, an unconsolidated undrained test (UU) and a consolidated undrained test (CU). The triaxial testing schedule consisted of two (2) CU tests and two (2) UU tests, and the triaxial test results indicated friction angles of 22.8 to 33.1 degrees and cohesion values between 0 and 411.3 psf. Results from the triaxial tests on Bulk Sample 1 indicate the worst (sandiest) material encountered, as evidenced by the B-2 borehole description (located near the Bulk Sample 1 location) and high friction angle. These materials will either be utilized on exterior slopes, in the laydown yard, or mixed with higher clay content material to provide a more suitable material for embankment fill. The results of each triaxial test are provided in Attachment B.

Several proctor compaction tests were performed on soils obtained from the bulk samples to determine the maximum dry density of the soil as well as the associated moisture content. The tests were performed in accordance with ASTM D698. Four (4) separate proctor tests were performed. To best represent the soil that will be used for construction, the composite bulk samples were averaged. The average maximum dry density of the soil was found to be 116.15 pcf and 95% of the maximum dry density is 110.3 pcf. In addition, the associated optimum moisture content was found to be 16.5%. The results of each test are provided in Attachment B.

Flexible wall permeability tests were performed on reconstituted bulk samples obtained from the site to determine the permeability of the in-situ soils. The tests were performed on material obtained from Bulk Sample Location 2 and Bulk Sample Location 5. The tests were conducted per ASTM D 5084-03 and resulted in an average permeability of 2.44×10^{-7} cm/s at Bulk Sample Location 2 and 3.75×10^{-8} cm/s at Bulk Sample Location 5. The results of these tests are provided in Attachment B.

GEOTECHNICAL RESULTS

SOIL STRATIGRAPHY

The subsurface soil stratification is presented in detail on the borehole logs provided in Attachment A. The stratification lines contained on the borehole logs represent the approximate depth at which the boundaries between soil types were encountered. It must be noted that the actual transition between soil layers may be gradual and/or discontinuous between multiple boreholes.

The Unified Soil Classification System (USCS) was used to classify the soils encountered during borehole drilling. As indicated in the attached borehole logs, the subsurface strata encountered in each borehole was relatively consistent across the site and generally contained clayey sand (SC) and/or lean clay (CL) layers extending from immediately below the topsoil to depths ranging from 18 to 30 feet (maximum depth of boreholes B-1 through B-6) below the ground surface. The soils that were encountered ranged from stiff to hard. In addition, these layers were relatively homogenous throughout the site and generally penetrated to a depth greater than the proposed excavation depth of 21 feet.

Two boreholes, B-6 and B-7, encountered an underlying sandstone layer at depths of 13 and 10 feet below the ground surface, respectively. Both boreholes terminated in this sandstone layer at depths of 30 feet and 100 feet. It is assumed that this sandstone layer would have been encountered in the remaining boreholes if they had been drilled to greater depths. This sandstone layer is assumed to be relatively thick and located beneath the clayey sand and lean clay layers throughout the site.

GROUNDWATER

Observations of groundwater levels occurred during drilling as well as after completion of each borehole. Boreholes were drilled to depths of 30 feet and 100 feet below the ground surface, and groundwater was not observed or encountered in any of the boreholes. Therefore, it is assumed that groundwater levels were deeper than 100 feet below the ground surface throughout the entire site.

It must be noted that short-term variations in groundwater levels may occur due to changes in season, precipitation, site drainage, and land use. Monitoring wells were installed at the three 100-foot deep borehole locations for long-term monitoring of groundwater levels. By monitoring these three wells, a more accurate representation of the range of groundwater levels will occur.

GEOTECHNICAL ANALYSIS

In order to satisfy Rule 5.4.3 of the Colorado Division of Water Resources “Rules and Regulations for Dam Safety and Dam Construction”, this section contains an evaluation of the suitability of the pond berm foundations, stability of the pond berm slopes, and the suitability and quantity of construction materials. The following sections provide details of these evaluations.

POND BERM FOUNDATIONS

The following provides a list of the potential failure modes of small dams, and the following sections address each potential failure mode. The potential failure modes

include the following: differential settlement, internal piping, base sliding, and seismic induced liquefaction.

Differential Settlement

The first failure mode analyzed with respect to the pond berm foundations involved irregular deformation or differential settlement that could cause cracking within the pond berms. The subsurface strata encountered during the geotechnical site investigation involved predominantly stiff, sandy lean clays that are typically not susceptible to large settlements and have low shrinkage and swell potential. For this reason along with the relatively low berm heights included in the design (max height of approximately 17 feet above existing ground), no consolidation testing was prescribed after encountering the in-situ soils. The relatively large SPT N-values encountered throughout the site indicate that the majority of the subsurface strata existed in an overconsolidated condition and was not prone to large consolidation deformations. In addition, all subgrade and fill materials will be compacted to a minimum of 95% of the maximum dry density as determined from the Proctor compaction tests. Therefore, consolidation settlements will primarily occur during construction and prior placement of pond liners and storage of water within the ponds. Furthermore, the placement of multiple liners and leak detection system will compensate for the unlikely event that cracking occurs due to differential settlement.

Internal Piping

The presence of multiple liners and leak detection will eliminate the possibility of seepage occurring from the interior towards the exterior of the pond berms. Additionally, groundwater was not encountered in any of the boreholes drilled throughout the site, indicating that groundwater was not present within the initial 100 feet of depth. Site grading has been designed to facilitate drainage away from the pond berms to the exterior of the facility. Therefore, internal piping, internal erosion, and a rapid increase in pore water pressures are unable to occur due to the absence of phreatic conditions within the pond berms and foundations.

Base Sliding

Base sliding as a failure mode typically occurs during earthquake loading with large and/or rapid horizontal displacements occurring at the project site. As indicated in the *De Beque Station Hazard Classification Report* submitted to the Colorado Division of Water Resources, Ponds 1 is classified as a non-jurisdictional dam. Ponds 2 and 3 are classified as “Low Hazard” minor jurisdictional dams. As a result of these hazard classifications, a seismic analysis was not performed for the project. Triaxial tests performed on bulk samples obtained from the site resulted in relatively large soil strength properties (friction angles in excess of 30 degrees and cohesions in excess of 400 psf). In addition, the soils encountered at the site generally consisted of a

homogenous sandy lean clay layer extending to depths ranging from 18 to 30 feet below the ground surface. As a result, the presence of a localized weak layer of soil was not encountered.

Seismic Induced Liquefaction

As previously stated, Pond 1 is classified as a non-jurisdictional dam, and Ponds 2 and 3 are classified as “Low Hazard” minor jurisdictional dams. Consequently, a seismic analysis was not performed for any of the ponds designed for the site. However, the potential for liquefaction of the pond berms is low as the pond liners, leak detection system, and deep groundwater levels significantly reduce the possibility of excess pore water pressures developing, which is the primary cause of seismic induced liquefaction. Additionally, the sandy lean clay encountered throughout the entirety of the site is not prone to seismic induced liquefaction.

Slope Stability

A slope stability analysis was performed for the interior and exterior berm slopes contained within each pond. The purpose of this analysis was to determine whether on-site materials would provide a sufficient factor of safety against slope failure for the slopes specified in the design. The primary design criterion involved achieving a minimum factor of safety on all slopes of 1.5. To remain conservative, a worst-case scenario with regard to soil strength properties was modeled for each pond using the program, Geo-Slope SLOPEW.

Due to the service road that follows the peripheral of the embankment’s crest, an additional live load was implemented in the SLOPEW model to represent vehicle traffic. A 10,000-lb vehicle load was applied to the model as point-loads with an axle load distribution of 70% and 30%. The resulting critical case was two separate point loads of 3,500-lb. Additionally, phreatic water conditions were neglected due to the depth of groundwater being greater than 100-feet and the pond being lined with an impermeable liner and a leak detection system being implemented. In the event that the liner was damaged, the pond would be evacuated, and the liner would be repaired.

To represent the most critical embankment condition, effective stress and an empty pond scenario were used. The effective stresses, obtained from the triaxial tests, were used due to effective stress resulting in a weaker structure than total stresses. Although typical soil cohesion values for sandy lean clay (CL) tend to be greater than 750 psf, a cohesion value of 75 psf (10% of typical values) was used to produce an ultra-conservative model. Although cohesion values of 0 to 18 psf were reported for soil obtained from Bulk Sample 1, this soil represents a worst-case scenario sandy material that will not be utilized in the embankment fill core by itself. This material represents only a small portion of the on-site soils available for use and was tested to obtain a

worst-case scenario. This material will either be utilized on exterior slopes, in the laydown yard, or mixed with higher clay content material to provide a more suitable material for embankment fill. The triaxial tests performed on soil obtained from Bulk Sample 4 (near Borehole B-5) are more representative of the typical on-site soils available for embankment fill. Therefore, the cohesion value of 75 psf utilized in the analysis will provide a conservative evaluation of the proposed embankment berms.

As the depth of water stored in the pond increases in elevation, the slope's associated factor of safety also increases. Therefore, the empty pond represents the critical condition. An in situ unit weight was assumed to be 106 pcf for the sandy lean clay and a compacted fill unit weight was determined to be 110.3 pcf.

Cross-sections included in the slope stability analysis were chosen to represent the worst-case scenario with respect to proposed geometries. These worst-case scenarios involved the largest height differences between the top of the berm and the toe of the berm slopes. A total of six (6) slopes were analyzed, and the results of each analysis are presented in Table 1. The locations of each cross-section referenced in Table 1 are provided on Exhibit 3.

Table 1. Results of Slope Stability Analysis

Cross-Section	Cross-Section Location	Slope Analyzed	Factor of Safety with Respect to Slope Stability
1	North end of Pond 1 with entire embankment in cut.	Pond 1 Interior Slope	1.679
2	Southeast edge of Pond 1 with the top half of the embankment consisting of compacted fill.	Pond 1 Interior Slope	1.564
3	Shared berm between Pond 2 and Pond 3	Pond 2 Interior Slope	1.803
		Pond 3 Interior Slope	1.761
4	Southeast edge of Pond 3 with entire embankment consisting of compacted fill.	Pond 3 Interior Slope	1.827
		Pond 3 Exterior Slope	1.673

As seen in Table 1, all analyses resulted in a factor of safety with respect to slope stability greater than the minimum 1.5 required. To remain conservative, each of the six analyses were performed assuming worst-case scenario soil strength properties and berm geometries. Therefore, the proposed berms are adequately designed to resist slope failure.

Suitability and Quantity of Construction Materials

As demonstrated in the previous sections, the in-situ soils encountered throughout the site will provide suitable material for the construction of the pond berm foundations. The sandy lean clay that exists throughout the site as well as the absence of groundwater will significantly reduce the risk of berm failure caused by differential settlement, internal piping, base sliding, and seismic induced liquefaction. Multiple slope stability analyses were performed for varying berm geometries as designed for Ponds 1, 2, and 3. These analyses concluded that the minimum factor of safety against slope failure of 1.5 was achieved for the worst case scenarios involving strength parameters and berm geometries.

The earthwork design of the facility has been performed such that excluding topsoil removal and accounting for approximately 5% shrinkage during fill placement, the final cut volume is approximately 7% larger than the final fill volume. Earthwork quantities were determined using the three-dimensional design software, Microstation GEOPAK Site. Additionally, the borehole logs indicate the presence of sandy lean clay layer with an average thickness of approximately 23 feet across all boreholes. Therefore, an adequate quantity of construction material is located on-site, and no offsite fill material will be necessary for construction of the facility.

EXHIBITS

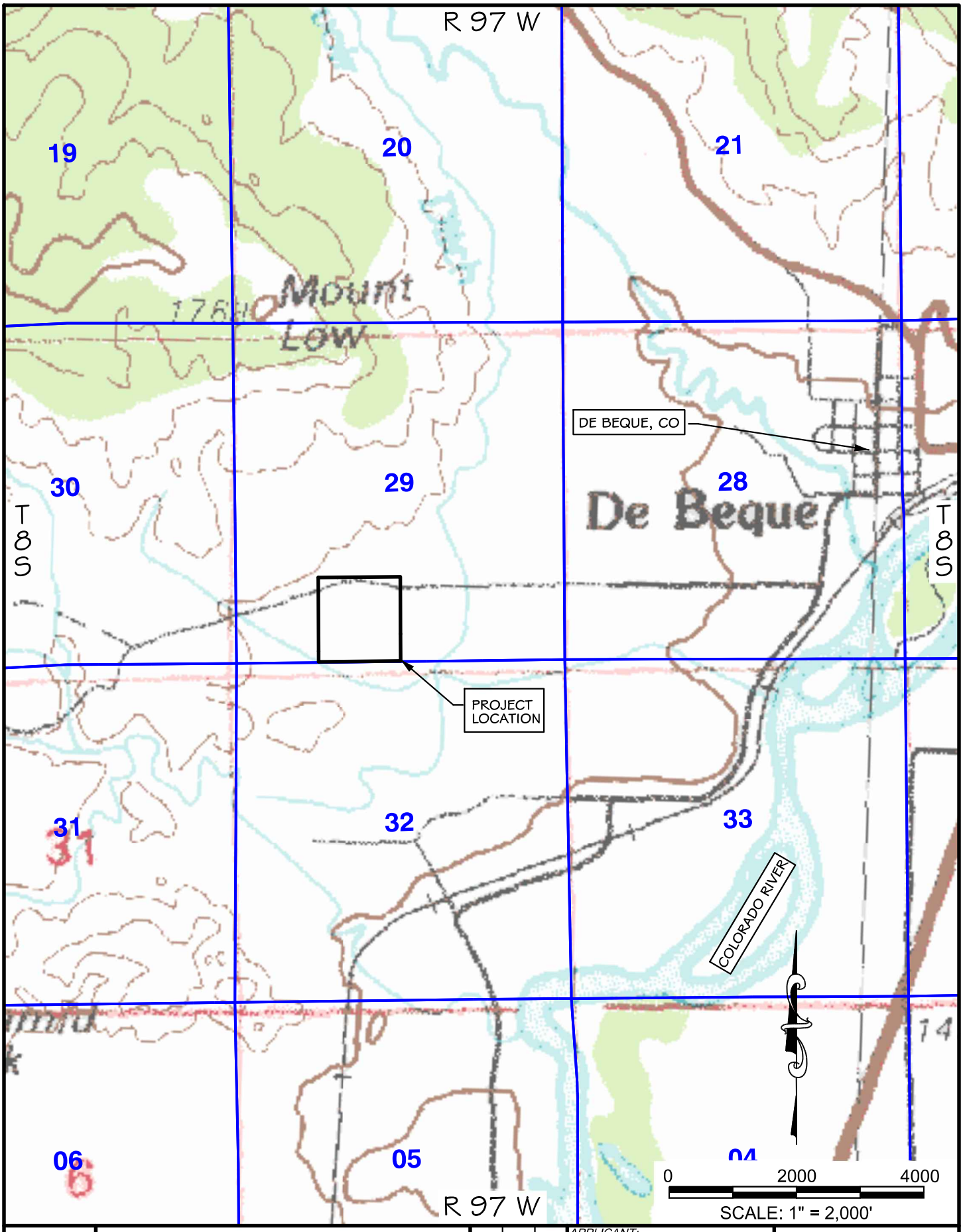


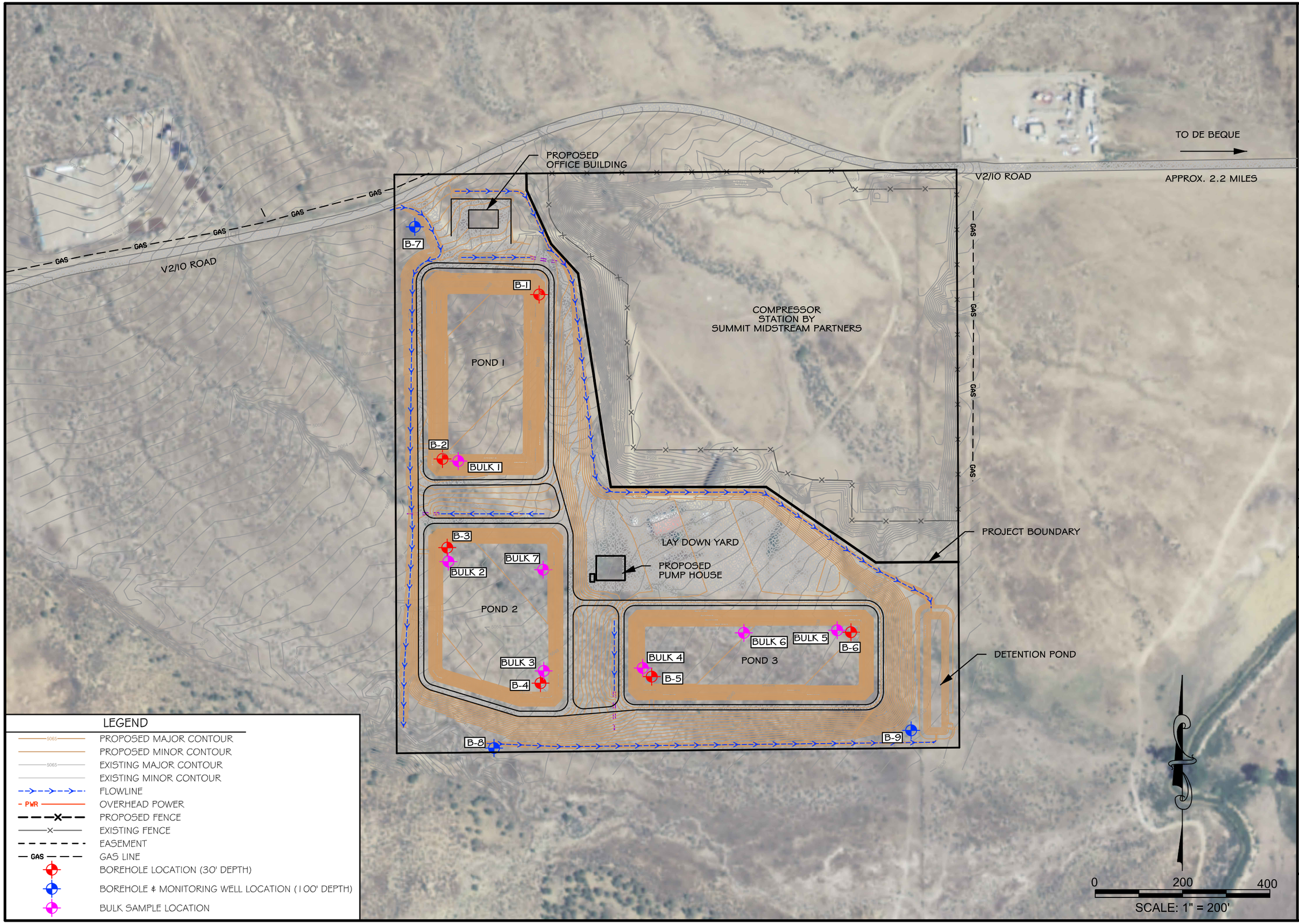
EXHIBIT 1	DE BEQUE STATION SECTION 29, T8S, R97W 6TH P.M. LOCATION MAP	JOB # 2013-134

DSGN	DATE	CKD
MRS	7/24/14	STH
REV	DATE	CKD

APPLICANT:
Black Hills Exploration & Production
A Black Hills Corporation Enterprise
1515 WYNKOOP ST., SUITE 500
DENVER, CO 80202
(303) 566-3356

WWC ENGINEERING
1275 MAPLE STREET, SUITE F
HELENA, MT 59601
(406) 443-3962

PEN TABLE PATH: K:\Helena\BLACK HILLS\13134 - DE BEQUE STATION\EXHIBITS\DEBEQUE PONDS COLOR.tbl
7/24/2014 FILE PATH: K:\Helena\BLACK HILLS\13134 - DE BEQUE STATION\DGN\GEOTECH REPORT\13-134 DE BEQUE STATION GEOTECH EX



WWC ENGINEERING
1275 MAPLE STREET, SUITE F
HELENA, MT 59601
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Black Hills Exploration & Production
A Black Hills Corporation Enterprise
1515 WYNKOOP ST., SUITE 500
DENVER, CO 80202
(303) 566-3356

DSGN	DATE	CKD
MRS	7/24/14	STH

REV	DATE	CKD

JOB # 2013-134

PEN TABLE PATH: K:\Admin\BLACK HILLS\13134 - DE BEQUE STATION\EXHIBITS\DEBEQUE PONDS COLOR.tbl
FILE PATH: K:\Helena\BLACK HILLS\13134 - DE BEQUE STATION\DGN\GEOTECH REPORT\13-134 DE BEQUE STATION GEOTECH EXHIBITS.dgn
7/30/2014

DE BEQUE STATION

BOREHOLE AND BULK SAMPLE LOCATIONS

EXHIBIT
2

WWC ENGINEERING
1275 MAPLE STREET, SUITE F
HELENA, MT. 59601
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A Black Hills Corporation Enterprise
1515 WYNKOOP ST., SUITE 500
DENVER, CO 80202
(303) 566-3356

DSGN	MRS
DATE	7/24/14
REV	

CKD	STH
DATE	
CKD	

JOB # 2013-134

PEN TABLE PATH: K:\Helena\BLACK HILLS\13134 - DE BEQUE STATION\EXHIBITS\DEBEQUE PONDS COLOR.tbl
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7/30/2014

DE BEQUE STATION

SLOPE STABILITY CROSS-SECTION LOCATIONS

EXHIBIT
3

ATTACHMENT A

Soil Bore Logs

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-1

CLIENT: **Western Water Consultants, Inc**

PROJECT NO.: **014-0292**

LOCATION: **DeBeque, CO**

PROJECT NAME: **WWC DeBeque Station CO Monitoring Wells**

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
		0.0								
DEVELOPED ZONE										
1.0'										
SANDY CLAY										
Stiff, light brown with gray			SS 1		8-6-6 N=12					
		2.5								
3.0'										
Trace cemented sand, light brown with gray			SS 2	CL	4-5-9 N=14				37/16	P-200 = 64.5%
		5.0								
			SS 3		4-7-7 N=14					
7.5'		7.5								
CLAYEY SAND										
Silty, very dense, light gray			SS 4		7-11-15 N=26					
		10.0								
		12.5								
13.0'										
SANDY CLAY										
Trace sandstone fragments, hard, light gray			SS 5		13-33-50 N=83					
		15.0								

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WATER LEVEL OBSERVATIONS	
WD	Not Encountered
AB	Not Encountered
AD	Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/18/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

LOG OF BOREHOLE NO. B-1

CLIENT: Western Water Consultants, Inc

PROJECT NO.: 014-0292

LOCATION: DeBeque, CO

PROJECT NAME: WWC DeBeque Station CO Monitoring Wells

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
SANDY CLAY		15.0								
Trace sandstone fragments, hard, light gray (continued)		17.5								
		20.0	SS 6		25-33-50 N=83					P-200 = 83.0%
		22.5								
			SS 7		38-50 N=88					
		25.0								
		27.5								
28.0'										
Trace sand, hard, light gray			SS 8		50/5" N=50					
30.0'		30.0								
BASE OF BORING AT 30.0 FEET										

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
AB	Not Encountered
AD	Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/18/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

LOG OF BOREHOLE NO. B-2

CLIENT: **Western Water Consultants, Inc**

PROJECT NO.: **014-0292**

LOCATION: **DeBeque, CO**

PROJECT NAME: **WWC DeBeque Station CO Monitoring Wells**

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
DEVELOPED ZONE		0.0								
1.0'										
LEAN CLAY										
Sandy, very stiff, dark brown			SS 1		10-12-13 N=25					
		2.5								
			SS 2		5-11-11 N=22					
4.5'										
Sandy, with sandstone fragments, very stiff to hard, dark brown		5.0	SS 3	CL	6-9-19 N=28				40/19	P-200 = 60.8%
7.0'										
SANDY CLAY		7.5	SS 4		11-17-22 N=39					
Trace gravel, hard, dark brown										
		10.0	SS 5		14-20-24 N=44					
		12.5								
13.0'										
With sandstone fragments, brown			SS 6	CL	17-24-23 N=47				34/18	P-200 = 69.4%
		15.0								

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WATER LEVEL OBSERVATIONS

WD	▽ Not Encountered
AB	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/18/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-2

CLIENT	PROJECT NO.
Western Water Consultants, Inc	014-0292
LOCATION	**PROJECT NAME**
DeBeque, CO	WWC DeBeque Station CO Monitoring Wells

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
With sandstone fragments, brown (continued)		15.0								
		17.5								
18.0'										
LEAN CLAY			SS 7		50/6" N=50					
Hard, light brown with gray		20.0								
		22.5								
23.0'										
SANDY CLAY			SS 8		25-20 N=45					
Hard, light brown with gray		25.0								
		27.5								
28.0'										
WEATHERED SHALE			SS 9		38-50 N=88					
Hard, gray		30.0								
30.0'										
BASE OF BORING AT 30.0 FEET										

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
AB	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/18/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

LOG OF BOREHOLE NO. B-3

CLIENT: Western Water Consultants, Inc

PROJECT NO.: 014-0292

LOCATION: DeBeque, CO

PROJECT NAME: WWC DeBeque Station CO Monitoring Wells

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
DEVELOPED ZONE		0.0								
1.0'										
LEAN CLAY										
With sand, very stiff, brown			SS 1		5-12-17 N=29					
3.0'		2.5								
SANDY CLAY			SS 2		16-22-33 N=55				41/19	
Hard, brown		5.0	SS 3		18-31-38 N=69					P-200 = 75.5%
		7.5	SS 4		25-20-16 N=36					
8.5'										
With silt, very stiff, dark brown		10.0								
		12.5	SS 5	CL	10-6-12 N=18				41/19	P-200 = 59.1%
		15.0								

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WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
AB	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/18/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

LOG OF BOREHOLE NO. B-3

CLIENT: Western Water Consultants, Inc

PROJECT NO.: 014-0292

LOCATION: DeBeque, CO

PROJECT NAME: WWC DeBeque Station CO Monitoring Wells

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
		15.0								
With silt, very stiff, dark brown (continued)										
		17.5								
18.0'										
LEAN CLAY *With weathered shale, hard, brown with grayish green*			SS 6		20-22-32 N=54					
		20.0								
		22.5								
23.0'										
With sand, hard, light gray			SS 7		28-36-50 N=86					
		25.0								
		27.5								
30.0'		30.0								
BASE OF BORING AT 30.0 FEET										

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
AB	Not Encountered
AD	Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/18/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

LOG OF BOREHOLE NO. B-4

CLIENT: Western Water Consultants, Inc

PROJECT NO.: 014-0292

LOCATION: DeBeque, CO

PROJECT NAME: WWC DeBeque Station CO Monitoring Wells

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
DEVELOPED ZONE		0.0								
1.0'										
SANDY CLAY										
Hard, brown			SS 1		13-16-26 N=42					
		2.5								
			SS 2	CL	7-18-24 N=42				39/18	P-200 = 63.8%
		5.0								
			SS 3		17-24-26 N=50					
		7.5								
			SS 4		15-18-23 N=41					
9.5'										
With gravel, hard, light brown with yellowish brown		10.0								
		12.5								
			SS 5		23-30-50 N=80					
		15.0								
CONTINUED NEXT PAGE										

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
AB	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/19/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-4

CLIENT: Western Water Consultants, Inc

PROJECT NO.: 014-0292

LOCATION: DeBeque, CO

PROJECT NAME: WWC DeBeque Station CO Monitoring Wells

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
		15.0								
With gravel, hard, light brown with yellowish brown (continued)		17.5								
18.0'										
Hard, light brown with olive brown			SS 6		16-27-33 N=60					
		20.0								
		22.5	SS 7		24-34-50 N=84					
		25.0								
		27.5	SS 8		32-50 N=82					
30.0'		30.0								
BASE OF BORING AT 30.0 FEET										

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
AB	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/19/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

LOG OF BOREHOLE NO. B-5

CLIENT: Western Water Consultants, Inc

PROJECT NO.: 014-0292

LOCATION: DeBeque, CO

PROJECT NAME: WWC DeBeque Station CO Monitoring Wells

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
DEVELOPED ZONE		0.0								
1.0'										
SANDY CLAY										
With silt, hard, light brown			SS 1		12-21-23 N=44					
		2.5								
			SS 2		12-18-20 N=38					P-200 = 76.7%
		5.0								
			SS 3	CL	9-14-23 N=37				47/26	P-200 = 63.4%
		7.5								
			SS 4		12-18-20 N=38					
		10.0								
		12.5								
13.0'										
LEAN CLAY										
Hard, olive brown			SS 5		15-16-16 N=32					
		15.0								

CONTINUED NEXT PAGE

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
AB	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
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Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/19/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-5

CLIENT: Western Water Consultants, Inc

PROJECT NO.: 014-0292

LOCATION: DeBeque, CO

PROJECT NAME: WWC DeBeque Station CO Monitoring Wells

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
LEAN CLAY		15.0								
Hard, olive brown (continued)		17.5	SS 6		14-20-29 N=49					
		20.0								
		22.5	SS 7		29-50 N=79					
		25.0								
		27.5	SS 8		50/4" N=50					
30.0'		30.0								
BASE OF BORING AT 30.0 FEET										

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
AB	Not Encountered
AD	Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/19/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

LOG OF BOREHOLE NO. B-6

CLIENT: Western Water Consultants, Inc

PROJECT NO.: 014-0292

LOCATION: DeBeque, CO

PROJECT NAME: WWC DeBeque Station CO Monitoring Wells

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
DEVELOPED ZONE		0.0								
1.0'										
SANDY CLAY										
Hard, light brown			SS 1		3-14-21 N=35					
		2.5								
3.0'										
Stiff, dark brown			SS 2		12-5-5 N=10					
		5.0								
			SS 3	CL	4-5-10 N=15				42/21	P-200 = 67.7%
6.5'										
Hard, brown		7.5	SS 4		17-21-38 N=59					
		10.0								
		12.5								
13.0'										
SANDSTONE										
Very dense, brown			SS 5		27-35-50 N=85					
		15.0								
CONTINUED NEXT PAGE										

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
AB	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/19/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

LOG OF BOREHOLE NO. B-6

CLIENT: Western Water Consultants, Inc

PROJECT NO.: 014-0292

LOCATION: DeBeque, CO

PROJECT NAME: WWC DeBeque Station CO Monitoring Wells

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
15.0										
SANDSTONE *Very dense, brown (continued)*		17.5	SS 6		30-50 N=80					
20.0'		20.0								
		22.5	SS 7		50/4" N=50					
		25.0								
		27.5								
30.0'		30.0								
CONTINUED NEXT PAGE										

WATER LEVEL OBSERVATIONS

WD	▽ Not Encountered
AB	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/19/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-6

CLIENT	PROJECT NO.
Western Water Consultants, Inc	014-0292
LOCATION	**PROJECT NAME**
DeBeque, CO	WWC DeBeque Station CO Monitoring Wells

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
SANDY CLAY *Hard, light brown* ***BASE OF BORING AT 30.0 FEET***										

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
AB	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/19/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-8

This bore log corresponds to B-7. No bore logs were completed for B-8 and B-9.

CLIENT: Western Water Consultants, Inc

PROJECT NO.: 014-0292

LOCATION: DeBeque, CO

PROJECT NAME: WWC DeBeque Station CO

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSIT (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
DEVELOPED ZONE		0.0								
1.0'										
LEAN CLAY										
With sand and silt, brown		2.5								
5.0'		5.0								
Brown		7.5								
10.0'		10.0								
SANDSTONE										
With clay, brown with gray		12.5								
		15.0								
CONTINUED NEXT PAGE										

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
AB	Not Encountered
AD	Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-8

This bore log corresponds to B-7. No bore logs were completed for B-8 and B-9.

CLIENT: Western Water Consultants, Inc

PROJECT NO.: 014-0292

LOCATION: DeBeque, CO

PROJECT NAME: WWC DeBeque Station CO

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSIT (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
		15.0								
SANDSTONE										
With clay, brown with gray (continued)		17.5								
		20.0								
		22.5								
		25.0								
		27.5								
		30.0								
CONTINUED NEXT PAGE										

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
AB	Not Encountered
AD	Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

LOG OF BOREHOLE NO. B-8

This bore log corresponds to B-7. No bore logs were completed for B-8 and B-9.

CLIENT: Western Water Consultants, Inc

PROJECT NO.: 014-0292

LOCATION: DeBeque, CO

PROJECT NAME: WWC DeBeque Station CO

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSIT (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
SANDSTONE		30.0								
With clay, brown with gray (continued)		32.5								
35.0'		35.0								
Silty, clayey, grayish green		37.5								
		40.0								
		42.5								
		45.0								
CONTINUED NEXT PAGE										

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
AB	Not Encountered
AD	Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-8

This bore log corresponds to B-7. No bore logs were completed for B-8 and B-9.

CLIENT: Western Water Consultants, Inc

PROJECT NO.: 014-0292

LOCATION: DeBeque, CO

PROJECT NAME: WWC DeBeque Station CO

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSIT (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
		45.0								
Silty, clayey, grayish green (continued)		47.5								
		50.0								
		52.5								
		55.0								
		57.5								
		60.0								
CONTINUED NEXT PAGE										

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
AB	Not Encountered
AD	Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-8

This bore log corresponds to B-7. No bore logs were completed for B-8 and B-9.

CLIENT: Western Water Consultants, Inc

PROJECT NO.: 014-029

LOCATION: DeBeque, CO

PROJECT NAME: WWC DeBeque Station C

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSIT (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
		60.0								
Silty, clayey, grayish green (continued)		62.5								
		65.0								
		67.5								
		70.0								
		72.5								
		75.0								
CONTINUED NEXT PAGE										

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
AB	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-8

This bore log corresponds to B-7. No bore logs were completed for B-8 and B-9.

CLIENT: Western Water Consultants, Inc

PROJECT NO.: 014-0292

LOCATION: DeBeque, CO

PROJECT NAME: WWC DeBeque Station CO M

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSI (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
		75.0								
Silty, clayey, grayish green (continued)		77.5								
		80.0								
		82.5								
		85.0								
		87.5								
		90.0								
CONTINUED NEXT PAGE										

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
AB	Not Encountered
AD	Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-8

This bore log corresponds to B-7. No bore logs were completed for B-8 and B-9.

CLIENT: Western Water Consultants, Inc

PROJECT NO.: 014-0292

LOCATION: DeBeque, CO

PROJECT NAME: WWC DeBeque Station CO

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
		90.0								
Silty, clayey, grayish green (continued)		92.5								
		95.0								
		97.5								
100.0'		100.0								

BASE OF BORING AT 100.0 FEET

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
AB	Not Encountered
AD	Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

ATTACHMENT B

Soil Test Results

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, KS 66061
TEL 913.829.0078
FAX 913.829.0258
www.olssonassociates.com

Moisture - Density Relationship

Project Information	
Project Name:	WWC DeBeque Station
Project Number:	014-0292
Client Name:	Western Water Consultants, Inc.
Project Location:	DeBeque, CO

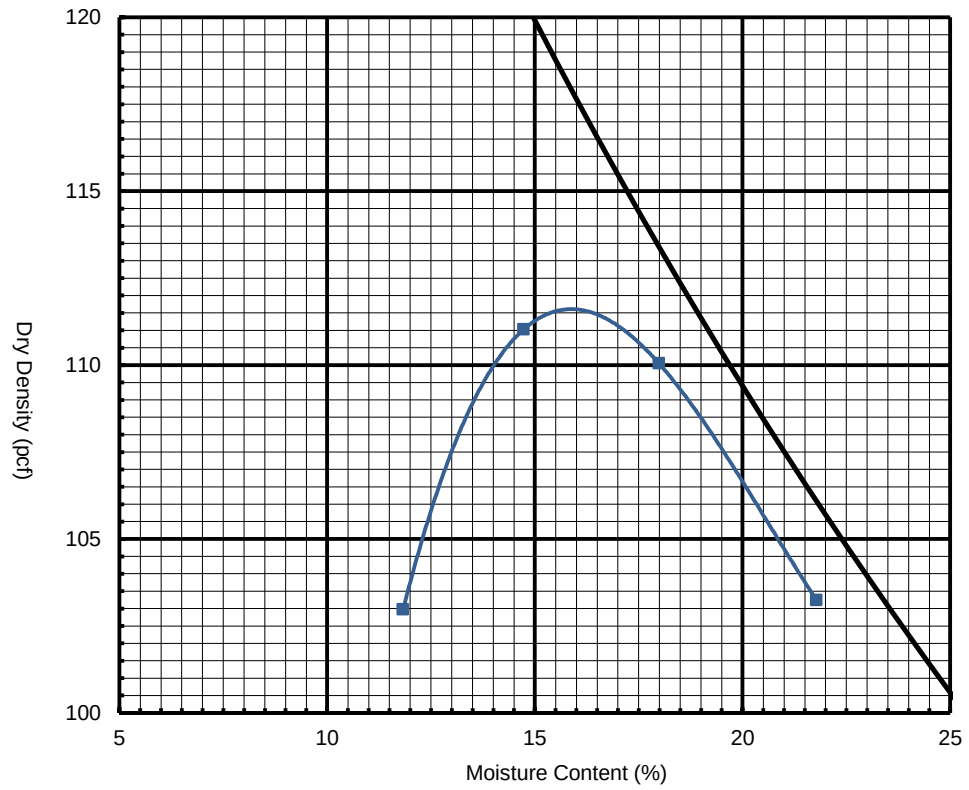
Sample Information	
Sample ID/Proctor #:	Bulk Sample 6
Sample Location:	See Boring Location Map
Date Sampled:	
Date Tested:	27-Mar-14
Sample Description:	CL, with silt, dark brown

Test Method	
Type of Test:	ASTM D-698
Method of Test:	A
Preparation Method:	Moist
Rammer Type:	Mechanical
Specific Gravity:	2.7
Gs Determination:	Estimated

Remarks

N/A

Test Results	
Maximum Dry Density:	111.5 pcf
Optimum Moisture Content:	15.8 %
Liquid Limit:	N/A
Plastic Limit:	N/A
Plasticity Index:	N/A
Classification:	N/A
Retained on 3/4" (%)	N/A
Retained on 3/8" (%)	N/A
Retained on No.4 (%)	< 5



LEGEND

100% Saturation Curve:

Proctor Curve:

Corrected Proctor Curve:

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1802 East 123rd Street
Olathe, KS 66061
TEL 913.829.0078
FAX 913.829.0258
www.olssonassociates.com

Moisture - Density Relationship

Project Information	
Project Name:	WWC DeBeque Station
Project Number:	014-0292
Client Name:	Western Water Consultants, Inc.
Project Location:	DeBeque, CO

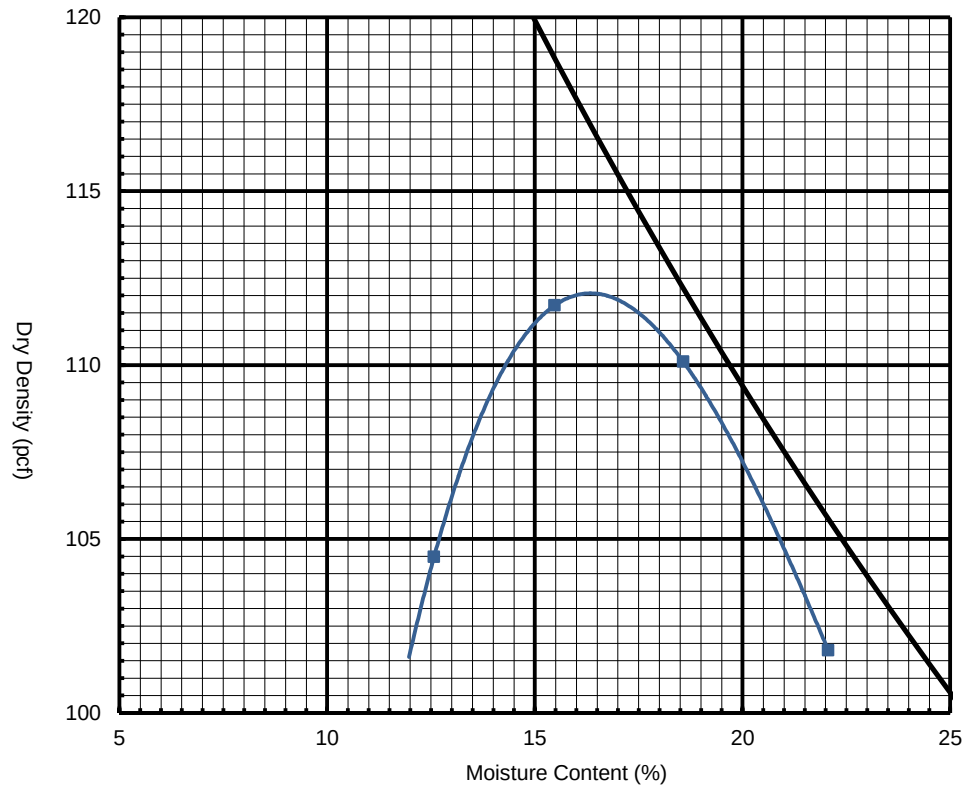
Sample Information	
Sample ID/Proctor #:	Bulk Sample 7
Sample Location:	See Boring Location Map
Date Sampled:	
Date Tested:	27-Mar-14
Sample Description:	CL, with silt, dark brown

Test Method	
Type of Test:	ASTM D-698
Method of Test:	A
Preparation Method:	Moist
Rammer Type:	Mechanical
Specific Gravity:	2.7
Gs Determination:	Estimated

Remarks

N/A

Test Results	
Maximum Dry Density:	112.0 pcf
Optimum Moisture Content:	16.2 %
Liquid Limit:	N/A
Plastic Limit:	N/A
Plasticity Index:	N/A
Classification:	N/A
Retained on 3/4" (%)	N/A
Retained on 3/8" (%)	N/A
Retained on No.4 (%)	< 5



LEGEND

100% Saturation Curve:

Proctor Curve:

Corrected Proctor Curve:

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Olathe, KS 66061
TEL 913.829.0078
FAX 913.829.0258
www.olssonassociates.com

Moisture - Density Relationship

Project Information	
Project Name:	WWC DeBeque Station
Project Number:	014-0292
Client Name:	Western Water Consultants, Inc.
Project Location:	DeBeque, CO

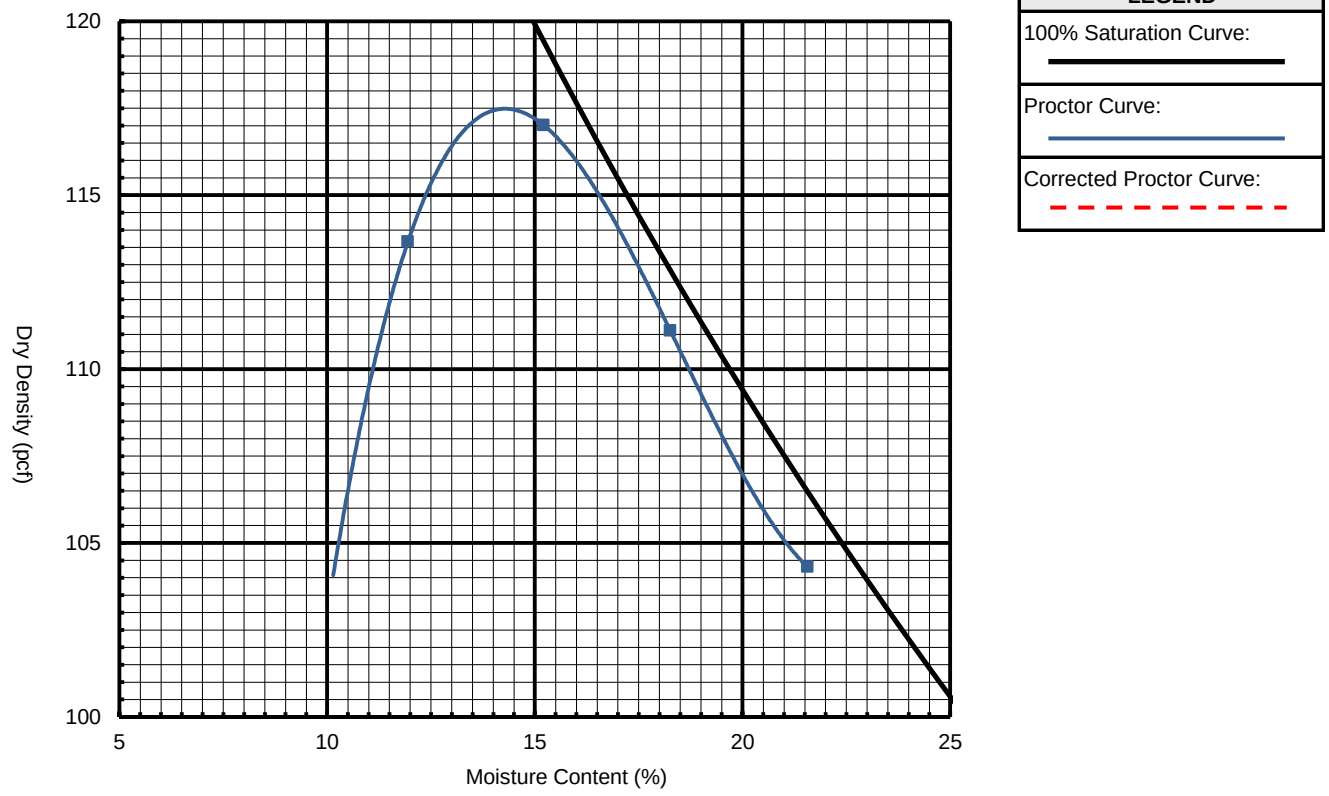
Sample Information	
Sample ID/Proctor #:	Composite Sample No.1
Sample Location:	Composite
Date Sampled:	18-Feb-14
Date Tested:	19-Mar-14
Sample Description:	B3 (SS-5), B3 (SS-9), B4 (SS-7), B5 (SS-4), B5 (SS-7), B5 (SS-8), B7 (SS-6), B7 (SS-7), B8 (SS-6)

Test Method	
Type of Test:	ASTM D-698
Method of Test:	A
Preparation Method:	Moist
Rammer Type:	Mechanical
Specific Gravity:	2.7
Gs Determination:	Estimated

Remarks

N/A

Test Results	
Maximum Dry Density:	117.5 pcf
Optimum Moisture Content:	14.3 %
Liquid Limit:	N/A
Plastic Limit:	N/A
Plasticity Index:	N/A
Classification:	N/A
Retained on 3/4" (%)	N/A
Retained on 3/8" (%)	N/A
Retained on No.4 (%)	< 5



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1802 East 123rd Street
Olathe, KS 66061
TEL 913.829.0078
FAX 913.829.0258
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Moisture - Density Relationship

Project Information	
Project Name:	WWC DeBeque Station
Project Number:	014-0292
Client Name:	Western Water Consultants, Inc.
Project Location:	DeBeque, CO

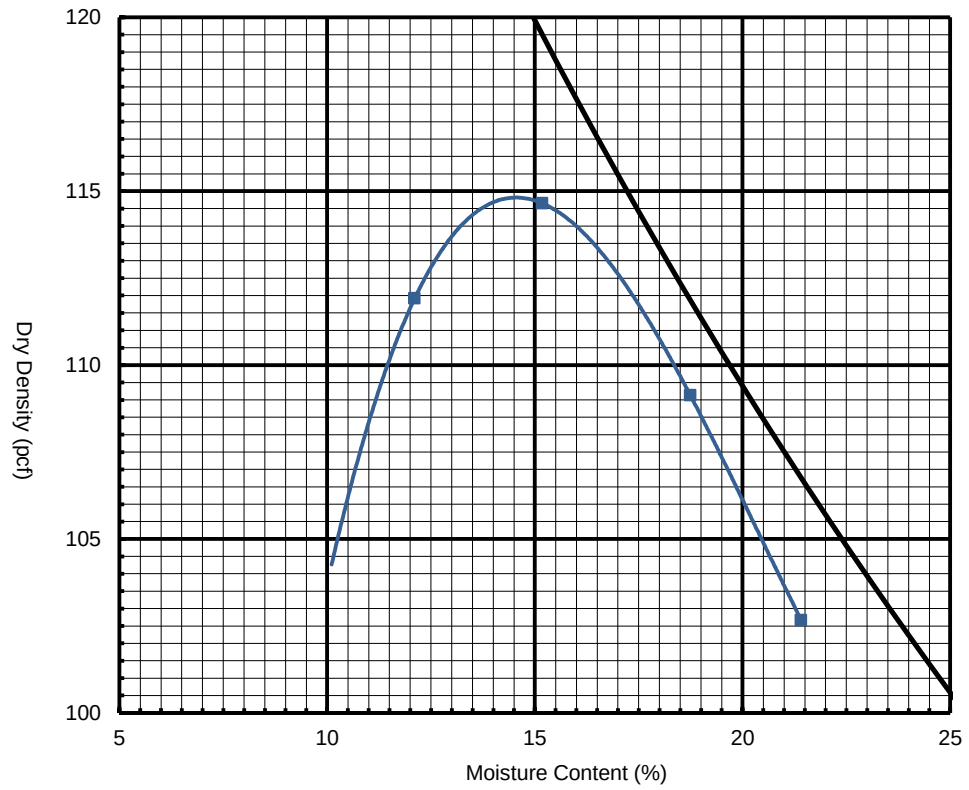
Sample Information	
Sample ID/Proctor #:	Composite Sample No.2
Sample Location:	Composite
Date Sampled:	
Date Tested:	19-Mar-14
Sample Description:	B2 (SS-1), B2 (SS-2), B2 (SS-3), B2 (SS-4), B3 (SS-1), B3 (SS-2), B4 (SS-1), B4 (SS-2), B4 (SS-3), B4 (SS-4), B5 (SS-1), B5 (SS-3), B7 (SS-1), B7 (SS-3), B7 (SS-4), B8 (SS-1), B8 (SS-2), B8 (SS-3)

Test Method	
Type of Test:	ASTM D-698
Method of Test:	A
Preparation Method:	Moist
Rammer Type:	Mechanical
Specific Gravity:	2.7
Gs Determination:	Estimated

Remarks

N/A

Test Results	
Maximum Dry Density:	114.8 pcf
Optimum Moisture Content:	14.6 %
Liquid Limit:	N/A
Plastic Limit:	N/A
Plasticity Index:	N/A
Classification:	N/A
Retained on 3/4" (%)	N/A
Retained on 3/8" (%)	N/A
Retained on No.4 (%)	< 5



LEGEND

100% Saturation Curve:

Proctor Curve:

Corrected Proctor Curve:

TRIAXIAL SHEAR TEST

Project:	Job Number:	Date:
DeBeque Station CO Monitoring Wells	014-0292	04/15/14
Sample Identification:	**Sample Description:**	
Bulk 1	Bulk #1	

INDEX TEST DATA

USCS _____ ; LL _____; PI _____ ;
%FINER (mm): 0.002 _____; 0.005_____;
0.074 (#200) _____
G_s (-#4) _____ G_s (+#4) _____
Standard: γ_d MAX. _____ w_{opt} _____
Modified: γ_d MAX. _____ w_{opt} _____

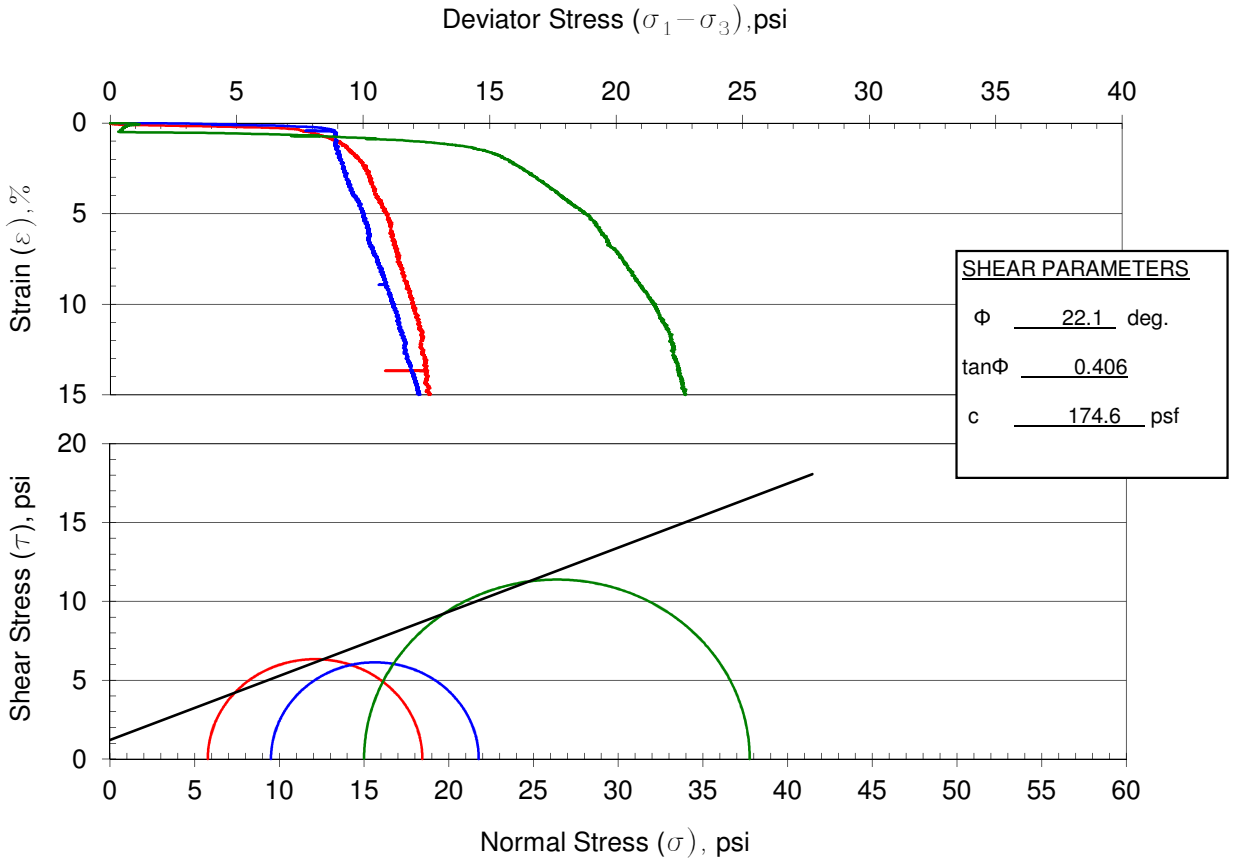
SPECIMEN DATA

HEIGHT 3.2 "; DIAMETER 1.4 "
MATERIALS TESTED PASSED____ SIEVE
METHOD OF PREPARATION:
Remolded from a bulk sample
MOLDING MOISTURE 15.50%
MOLDED AT 100% OF 107.5

TYPE OF TEST

UU	
CU	
CU'	
CD	

DRY DENSITY			MOISTURE CONTENT, %						
INITIAL pcf ☒ g/cc	CONSOL-IDATED pcf ☒ g/cc	B PARAM-ETER	START OF TEST	DEG. OF SAT. AT START OF TEST	END OF TEST	TIME OF CONSOL-IDATION (hrs.)	MINOR PRINCIPAL STRESS σ_3 (psi)	DEVIATOR STRESS $\sigma_1-\sigma_3$ (psi)	AXIAL STRAIN AT FAILURE ε (%)
108.8	107.1	0.95	15.8	75.7	24.2	72.5	5.8	12.7	14.9
107.5	107.8	0.96	15.5	73.7	22.1	26.4	9.5	12.3	15.0
107.7	104.8	0.99	14.8	70.7	20.2	20.1	15.0	22.8	14.7



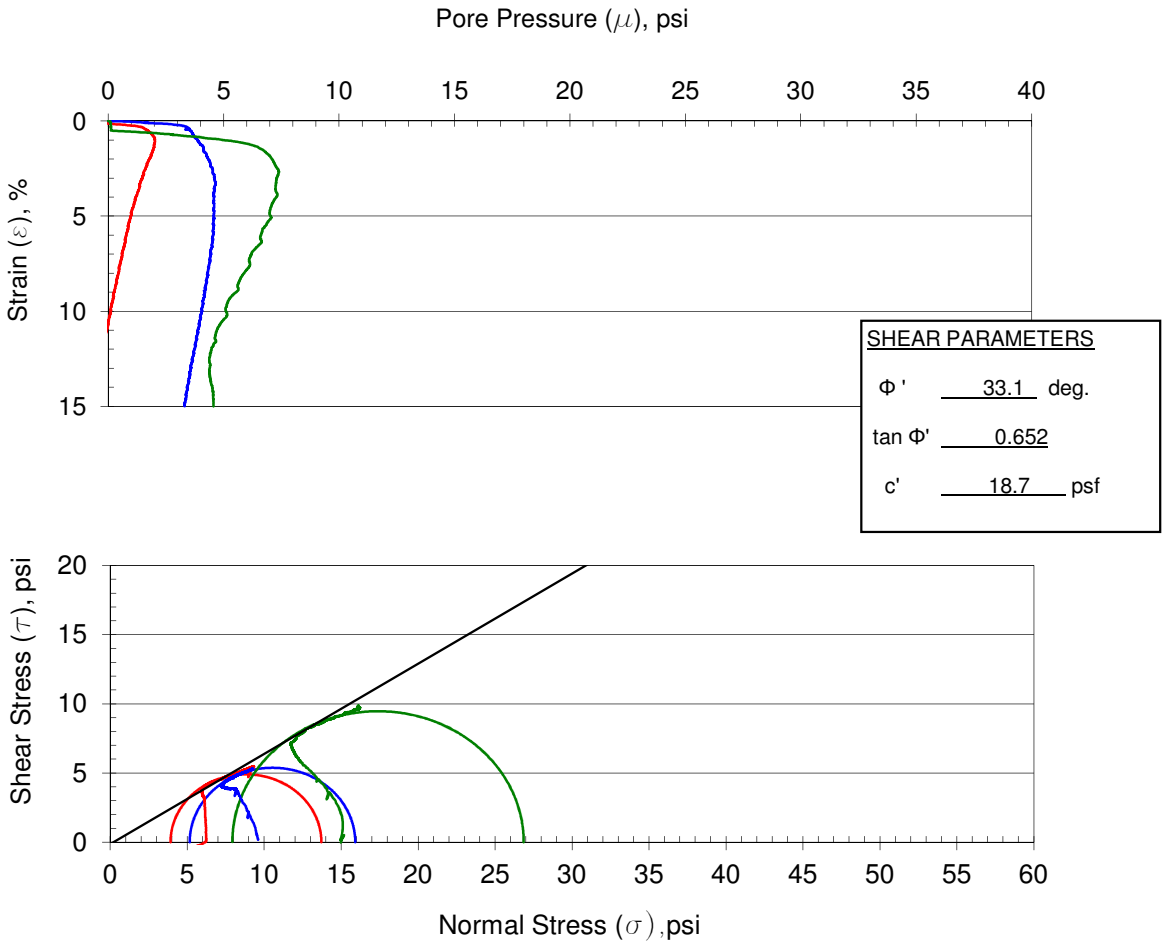
REMARKS

OLSSON ASSOCIATES

TRIAXIAL SHEAR TEST

Project:	Job Number:	Date:
DeBeque Station CO Monitoring Wells	014-0292	04/15/14
Sample Identification:	**Sample Description:**	
Bulk 1	Bulk #1	

MINOR PRINCIPAL STRESS σ_3 (psi)	PORE PRESSURE μ, (psi)	EFFECTIVE MINOR PRINCIPAL STRESS σ_3' (psi)	DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi)	FAILURE CRITERIA MAXIMUM PRINCIPAL EFFECTIVE STRESS RATIO	AXIAL STRAIN AT FAILURE ε (%)
5.8	1.9	3.9	9.8	$\left(\frac{\sigma_1'}{\sigma_3'}\right)_{max}$	1.9
9.5	4.3	5.2	10.8		8.1
15.0	7.1	7.9	18.9		5.1



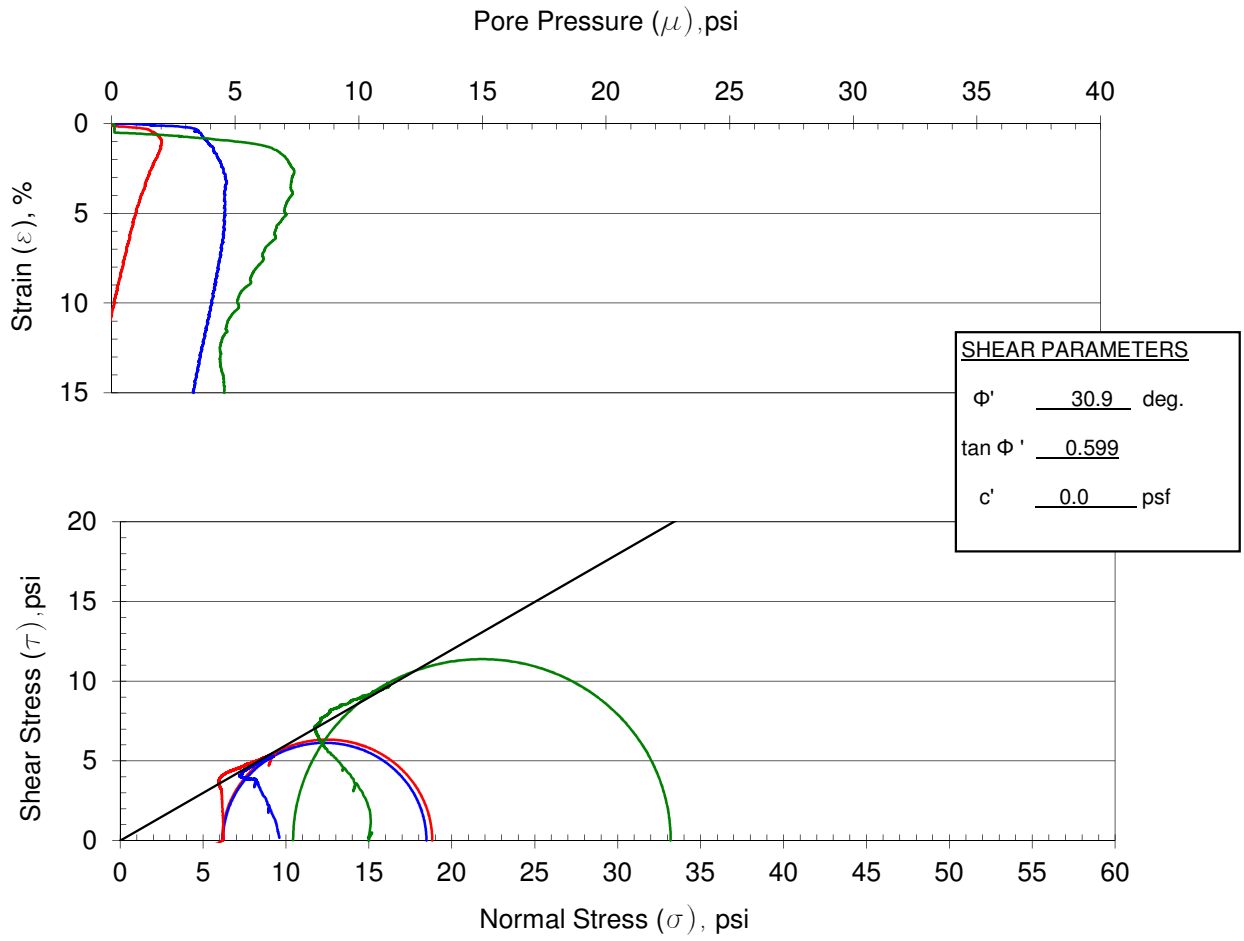
REMARKS

OLSSON ASSOCIATES

TRIAXIAL SHEAR TEST

Project:	Job Number:	Date:
DeBeque Station CO Monitoring Wells	014-0292	04/15/14
Sample Identification:	**Sample Description:**	
Bulk 1	Bulk #1	

MINOR PRINCIPAL STRESS σ_3 (psi)	PORE PRESSURE μ, (psi)	EFFECTIVE MINOR PRINCIPAL STRESS σ_3' (psi)	DEVIATOR STRESS $\sigma_1-\sigma_3$ (psi)	FAILURE CRITERIA MAXIMUM DEVIATOR STRESS	AXIAL STRAIN AT FAILURE ε (%)
5.8	-0.4	6.1	12.7	$(\sigma_1-\sigma_3)_{max}$	14.9
9.5	3.3	6.2	12.3		15.0
15.0	4.6	10.4	22.8		14.7



REMARKS

TRIAXIAL SHEAR TEST

Project:	Job Number:	Date:
DeBeque Station CO Monitoring Wells	014-0292	04/04/14
Sample Identification:	**Sample Description:**	
Bulk 4	Bulk #4	

INDEX TEST DATA

USCS _____ ; LL _____; PI _____ ;
%FINER (mm): 0.002 _____; 0.005_____;
0.074 (#200) _____
G_s (-#4) _____ G_s (+#4) _____
Standard: γ_d MAX. _____ pcf w_{opt} _____ %
Modified: γ_d MAX. _____ pcf w_{opt} _____ %

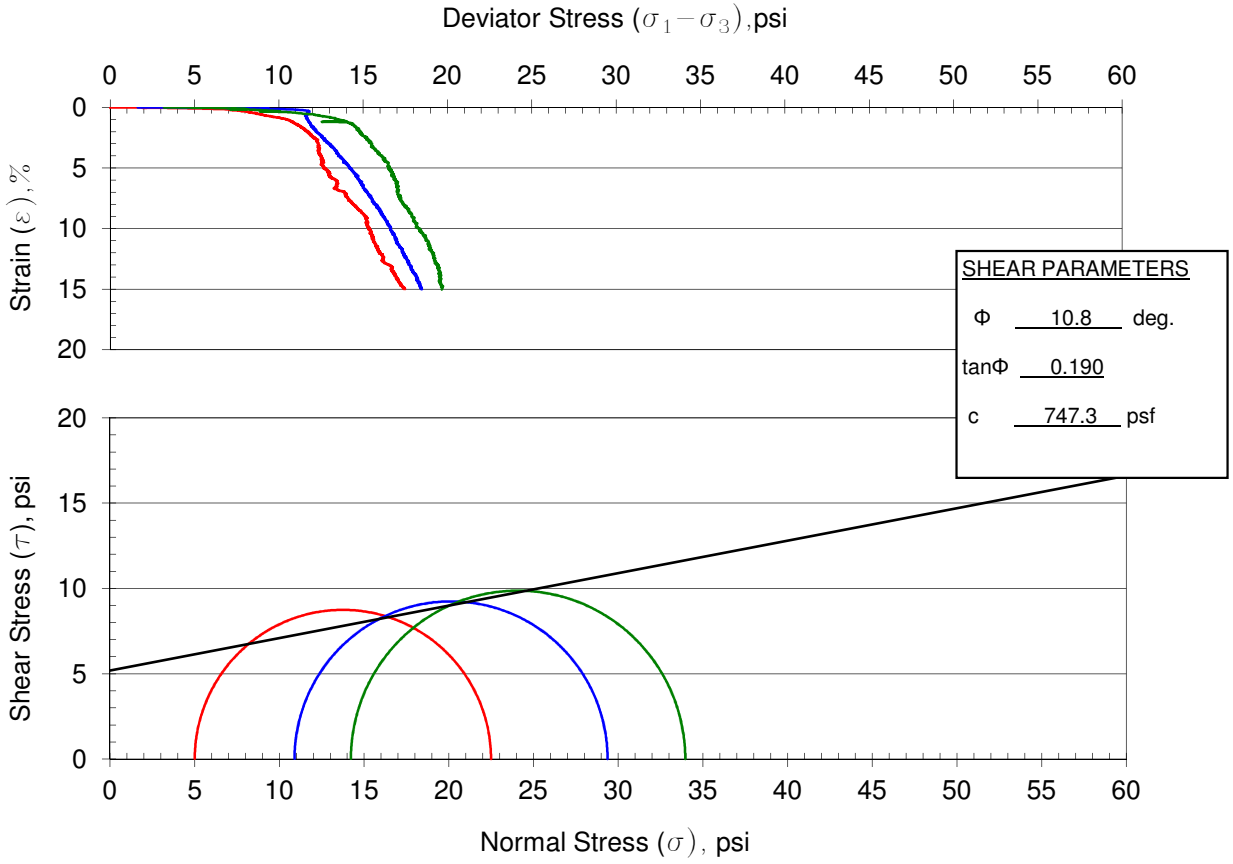
SPECIMEN DATA

HEIGHT 3.2 "; DIAMETER 1.4 "
MATERIALS TESTED PASSED____ SIEVE
METHOD OF PREPARATION:
Remolded from a bulk sample
MOLDING MOISTURE 15.50%
MOLDED AT 100% OF 107.5

TYPE OF TEST

UU	
CU	X
CU'	
CD	

DRY DENSITY		B PARAM-ETER	MOISTURE CONTENT, %			TIME OF CONSOL-IDATION (hrs.)	MINOR PRINCIPAL STRESS σ_3 (psi)	DEVIATOR STRESS $\sigma_1-\sigma_3$ (psi)	AXIAL STRAIN AT FAILURE ε (%)
INITIAL pcf ☒ g/cc	CONSOL-IDATED pcf ☒ g/cc		START OF TEST	DEG. OF SAT. AT START OF TEST	END OF TEST				
109.2	105.2	1.00	15.7	78.2	20.9	29.5	5.0	17.5	15.0
108.0	110.5	0.96	16.3	78.5	21.3	47.9	10.9	18.5	15.0
107.4	112.6	0.97	15.9	75.3	22.5	47.7	14.2	19.7	14.8



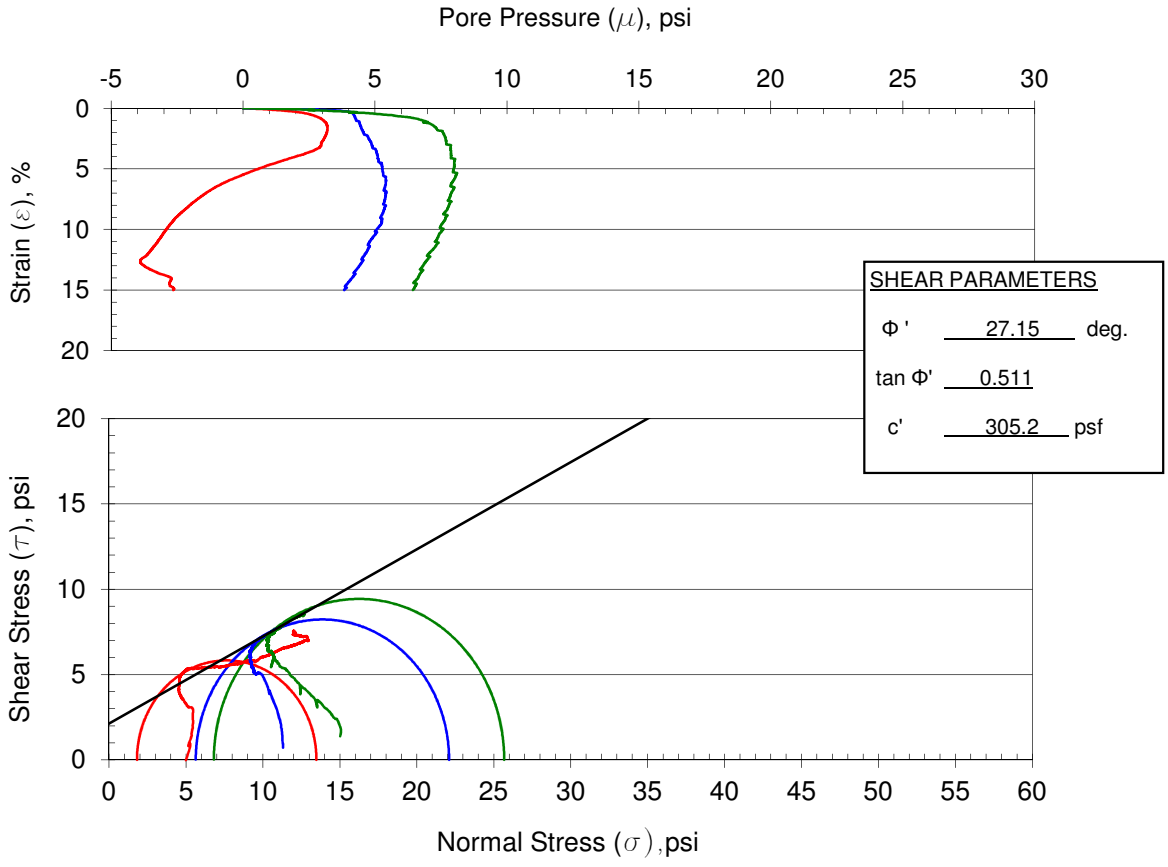
REMARKS

OLSSON ASSOCIATES

TRIAXIAL SHEAR TEST

Project:	Job Number:	Date:
DeBeque Station CO Monitoring Wells	014-0292	04/04/14
Sample Identification:	**Sample Description:**	
Bulk 4	Bulk #4	

MINOR PRINCIPAL STRESS σ_3 (psi)	PORE PRESSURE μ, (psi)	EFFECTIVE MINOR PRINCIPAL STRESS σ_3' (psi)	DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi)	FAILURE CRITERIA MAXIMUM PRINCIPAL EFFECTIVE STRESS RATIO	AXIAL STRAIN AT FAILURE ε (%)
5.0	3.2	1.8	11.7	$\left(\frac{\sigma_1'}{\sigma_3'}\right)_{max}$	1.9
10.9	5.3	5.6	16.5		9.4
14.2	7.4	6.8	18.9		11.1



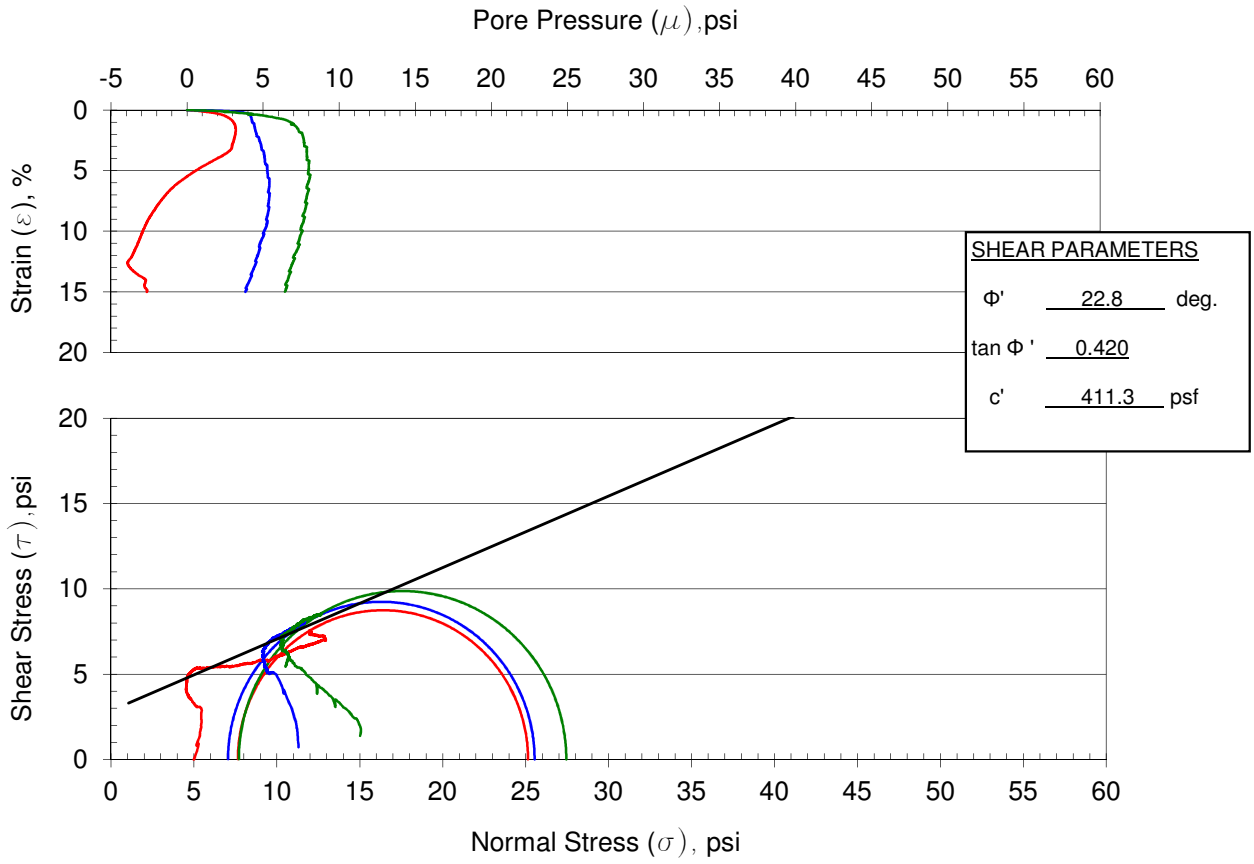
REMARKS

OLSSON ASSOCIATES

TRIAXIAL SHEAR TEST

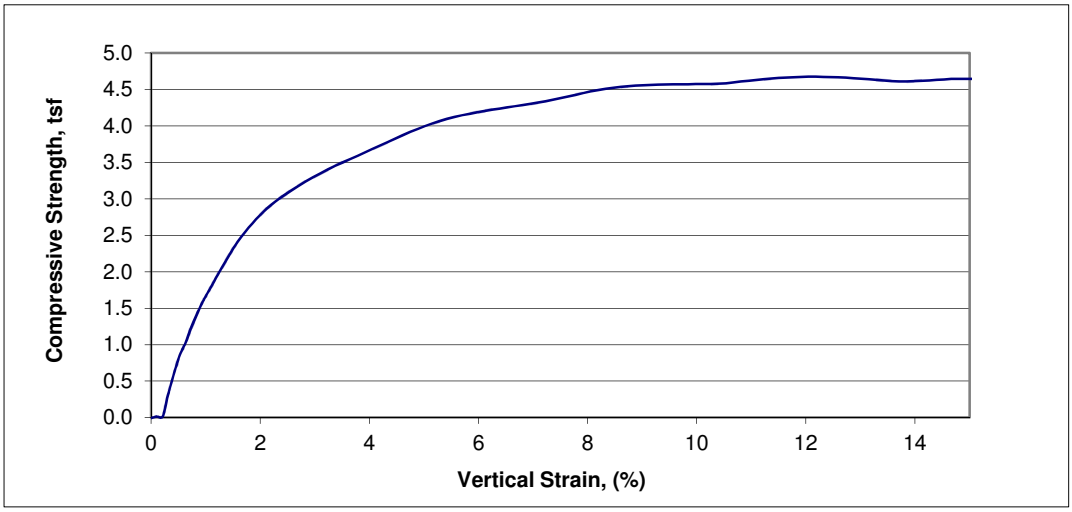
Project:	Job Number:	Date:
DeBeque Station CO Monitoring Wells	014-0292	04/04/14
Sample Identification:	**Sample Description:**	
Bulk 4	Bulk #4	

MINOR PRINCIPAL STRESS σ_3 (psi)	PORE PRESSURE μ, (psi)	EFFECTIVE MINOR PRINCIPAL STRESS σ_3' (psi)	DEVIATOR STRESS $\sigma_1-\sigma_3$ (psi)	FAILURE CRITERIA MAXIMUM DEVIATOR STRESS	AXIAL STRAIN AT FAILURE ε (%)
5.0	-2.7	7.7	17.5	$(\sigma_1-\sigma_3)_{max}$	15.0
10.9	3.8	7.1	18.5		15.0
14.2	6.5	7.7	19.7		14.8



REMARKS

Unconsolidated Undrained Triaxial Test

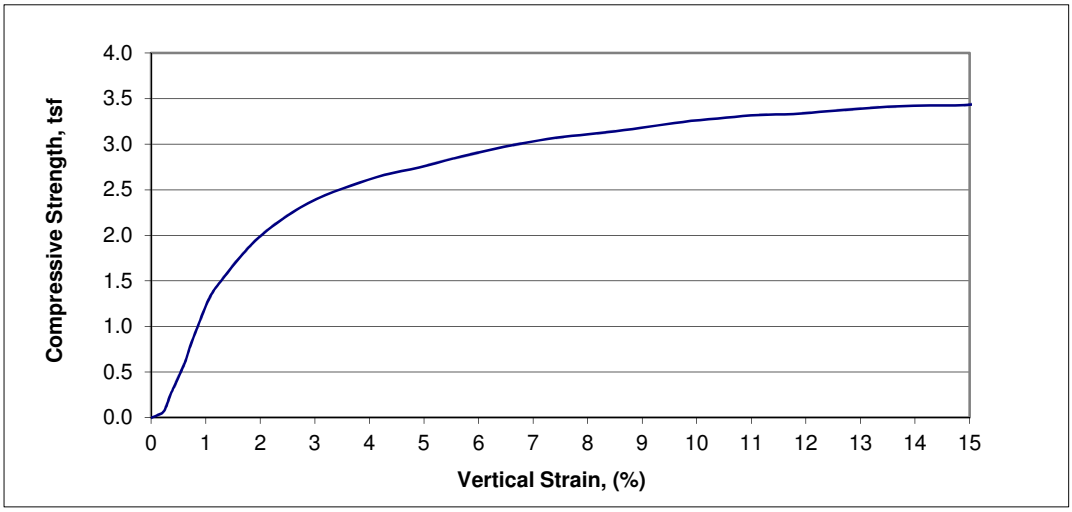


Boring		Bulk 3			
Sample		NA			
Initial	**Diameter (in)**	2.805			
	Height, (in)	5.887			
	Water Content, (%)	17.2			
	Dry Density, (pcf)	101.6			
	Saturation, (%)	70.5			
	Void Ratio	0.659			
Compressive Strength, (tsf)		4.6			
Undrained Shear Strength, (tsf)		2.3			
Time to Failure, (min)		10.9			
Strain Rate, (%/min)		1.1			
Assumed Specific Gravity		2.7			
Liquid Limit		N/A			
Plastic Limit		N/A			
Plasticity Index		N/A			
Failure Sketch		N/A			

OLSSON ASSOCIATES

Project:	KC - DeBeque, CO
Location:	DeBeque, CO
Project Number:	014-0292
Boring No:	Bulk 3
Sample Type:	Remold
Description:	NA
Remarks:	Consolidated to 12.5 psi (0.9 tsf)

Unconsolidated Undrained Triaxial Test



Boring		Bulk 5			
Sample		NA			
Initial	**Diameter (in)**	2.809			
	Height, (in)	5.885			
	Water Content, (%)	15.5			
	Dry Density, (pcf)	102.5			
	Saturation, (%)	65			
	Void Ratio	0.645			
Compressive Strength, (tsf)		3.4			
Undrained Shear Strength, (tsf)		1.7			
Time to Failure, (min)		12.4			
Strain Rate, (%/min)		1.25			
Assumed Specific Gravity		2.7			
Liquid Limit		N/A			
Plastic Limit		N/A			
Plasticity Index		N/A			
Failure Sketch		N/A			

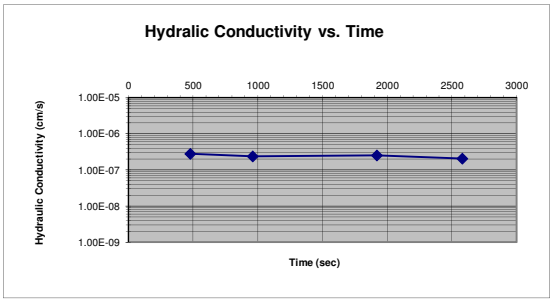
OLSSON ASSOCIATES

Project:	KC - DeBeque, CO
Location:	DeBeque, CO
Project Number:	014-0292
Boring No:	Bulk 5
Sample Type:	Remold
Description:	NA
Remarks:	Consolidated to 12.5 psi (0.9 tsf)

Revision No.	2
Revision Date	4/23/2006

Flexible Wall Permeability (ASTM D 5084-03)

Project Name	KC- DeBeque, CO			**Date**	4/24/2014
Project No.	014-0292	**Boring No.**	Bulk 2	**Sample No.**	Remold
Scale No.				**Laboratory #**	



Sample Parameters	Initial	Final
Height of Sample (cm)	7.445	7.347
Diameter of Sample (cm)	7.176	7.088
Wet density, lb/cu ft	125.749	136.246
Dry density, lb/cu ft	109.400	113.950
Water content	14.94%	19.57%
SG of solids	2.70	2.70
Saturation	74.72%	100.00%

	Test 1	Test 2	Test 3	Test 4
Cell Pressure (psi)	56.68	56.68	56.68	56.68
Lower Cap Pressure (psi)	54.10	54.10	54.10	54.10
Upper Cap Pressure (psi)	52.50	52.50	52.50	52.50
Differential Pressure (psi)	1.60	1.60	1.60	1.60
Hydraulic Gradient	15	15	15	15
Test time (sec)	480.0	480.0	960	660.0
Elapsed Time (sec)	480	960	1920	2580
Lower Cap Burette Initial Reading (mL)	27.2	28.2	29	30.7
Lower Cap Burette Final Reading (mL)	28.2	29	30.7	31.6
Upper Cap Burette Initial Reading (mL)	21.1	20.2	19.4	17.8
Upper Cap Burette Final Reading (mL)	20.2	19.4	17.8	16.9
Inflow/Outflow Ratio (0.75-1.25)	1.11	1.00	1.06	1.00
Permeability (cm/sec)	2.84E-07	2.44E-07	2.58E-07	2.11E-07
Temperature ©	20.8	21.0	21.0	21.2
Temperature Correction	0.98	0.98	0.98	0.97
Permeability, K @ 20 C (cm/sec)	2.79E-07	2.38E-07	2.52E-07	2.05E-07
Average +/- 25%	Pass	Pass	Pass	Pass

AVERAGE PERMEABILITY (cm/s) **2.44E-07**

Remarks:

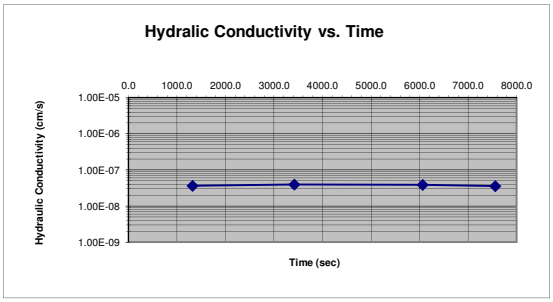
Technician:	DK
Computed By:	SJ
Checked By:	AP

OLSSON ASSOCIATES

Revision No.	2
Revision Date	4/23/2006

Flexible Wall Permeability (ASTM D 5084-03)

Project Name	KC- DeBeque, CO			**Date**	4/16/2014
Project No.	014-0292	**Boring No.**	Bulk 5	**Sample No.**	Remold
Scale No.				**Laboratory #**	



Sample Parameters	Initial	Final
Height of Sample (cm)	9.386	9.411
Diameter of Sample (cm)	7.225	7.296
Wet density, lb/cu ft	123.354	127.681
Dry density, lb/cu ft	105.725	103.545
Water content	16.67%	23.31%
SG of solids	2.70	2.70
Saturation	75.85%	100.00%

	Test 1	Test 2	Test 3	Test 4
Cell Pressure (psi)	67.03	67.03	67.03	67.03
Lower Cap Pressure (psi)	65.80	65.80	65.80	65.80
Upper Cap Pressure (psi)	62.50	62.50	62.50	62.50
Differential Pressure (psi)	3.30	3.30	3.30	3.30
Hydraulic Gradient	25	25	25	25
Test time (sec)	1320.0	2100	2640	1500
Elapsed Time (sec)	1320.0	3420	6060	7560
Lower Cap Burette Initial Reading (mL)	42.6	43.2	44.2	45.4
Lower Cap Burette Final Reading (mL)	43.2	44.2	45.4	46
Upper Cap Burette Initial Reading (mL)	18.1	17.6	16.7	15.6
Upper Cap Burette Final Reading (mL)	17.6	16.7	15.6	15
Inflow/Outflow Ratio (0.75-1.25)	1.20	1.11	1.09	1.00
Permeability (cm/sec)	3.82E-08	4.18E-08	4.07E-08	3.78E-08
Temperature ©	22.1	22.2	22.4	22.6
Temperature Correction	0.95	0.95	0.94	0.94
Permeability, K @ 20 C (cm/sec)	3.63E-08	3.97E-08	3.85E-08	3.55E-08
Average +/- 25%	Pass	Pass	Pass	Pass

AVERAGE PERMEABILITY (cm/s) **3.75E-08**

Remarks:

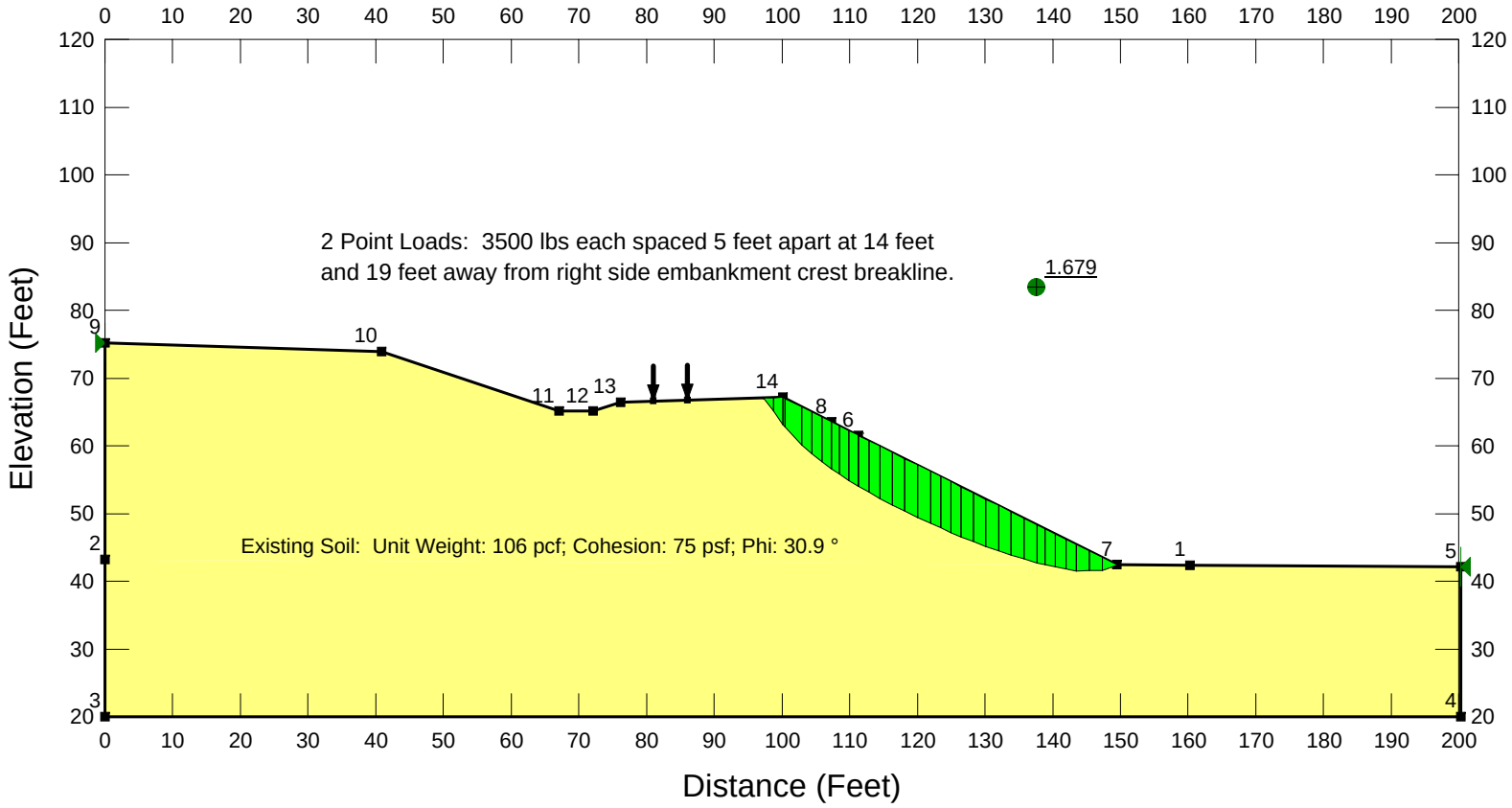
Technician:	DK
Computed By:	SJ
Checked By:	AP

OLSSON ASSOCIATES

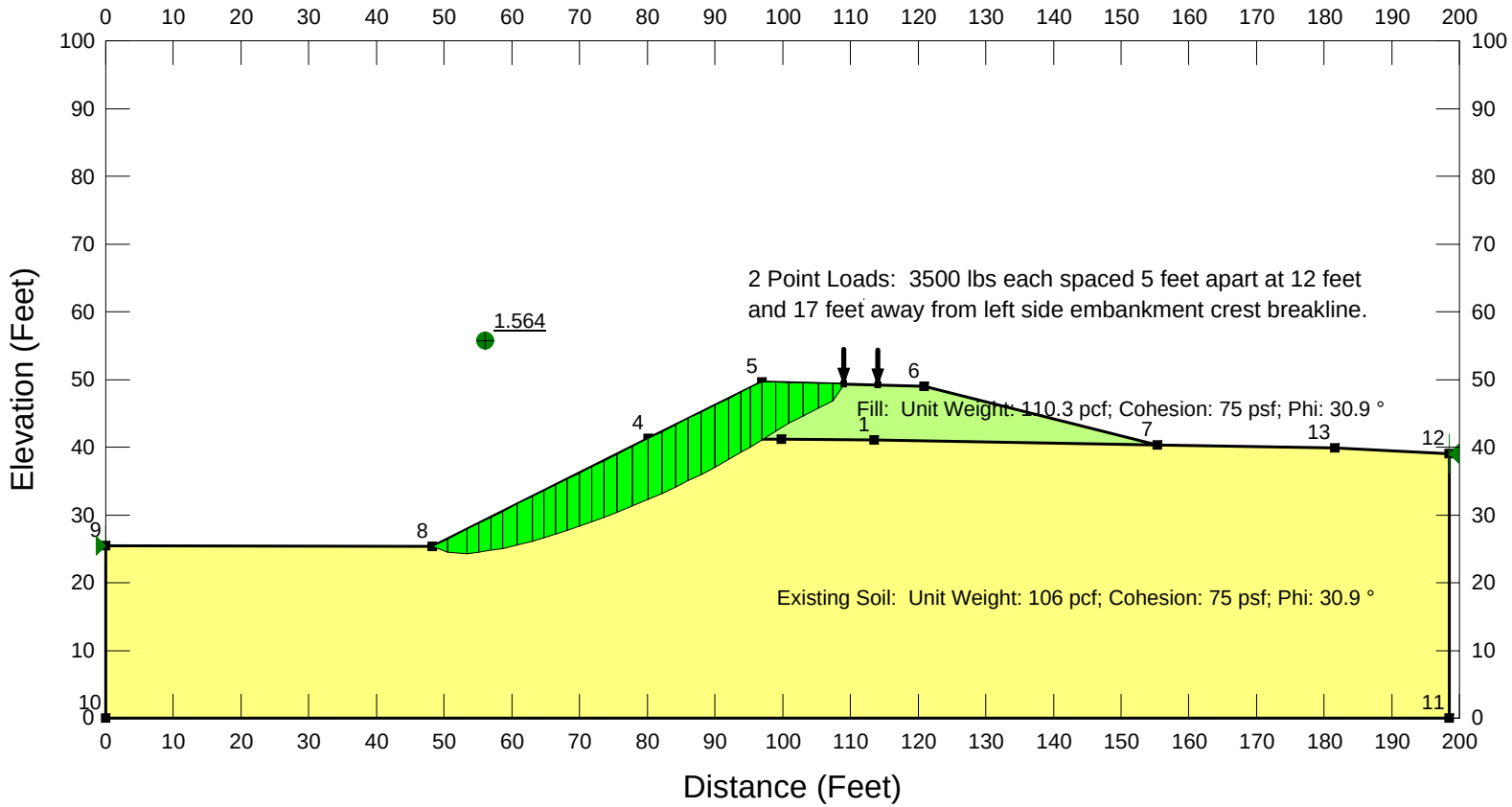
ATTACHMENT C

Geo-Slope Analysis Results

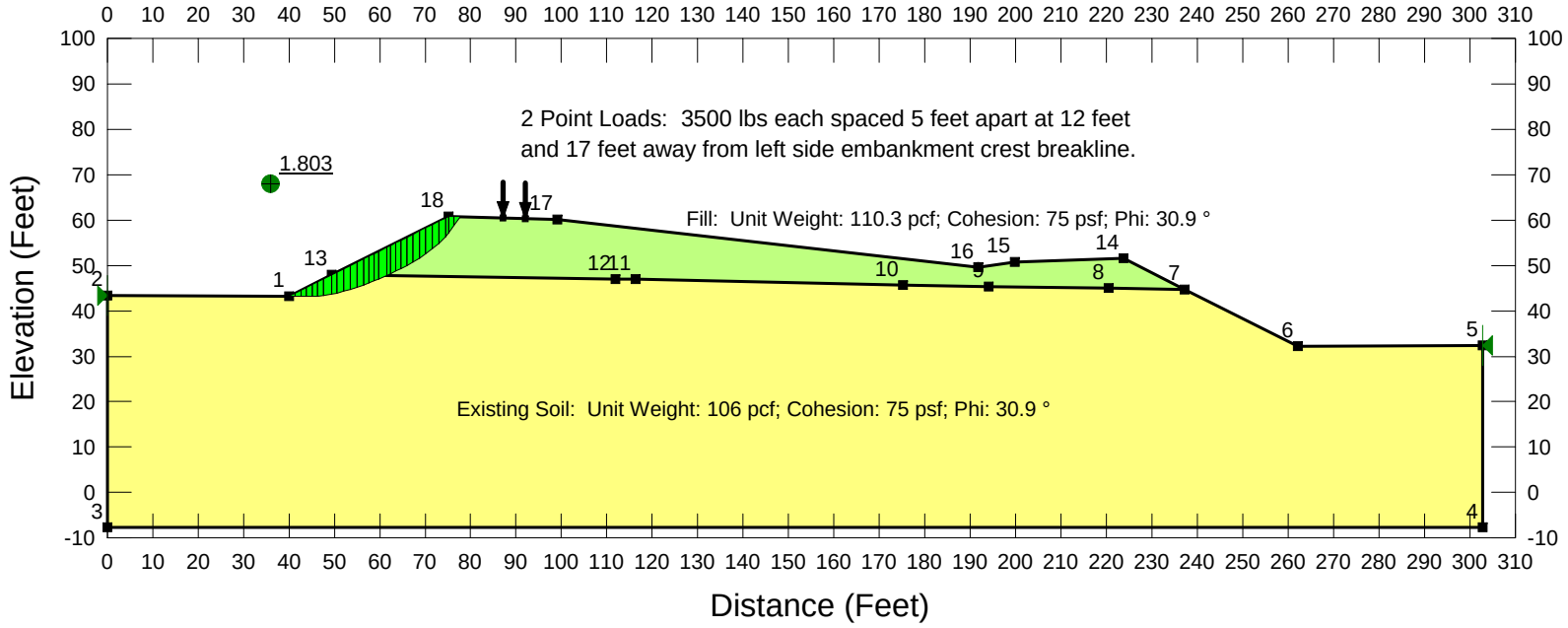
DeBeque Station - Pond 1 Analysis
Existing Soil: Unit Weight=106 pcf; c=75 psf; phi=30.9 °
Model: Mohr-Coulomb



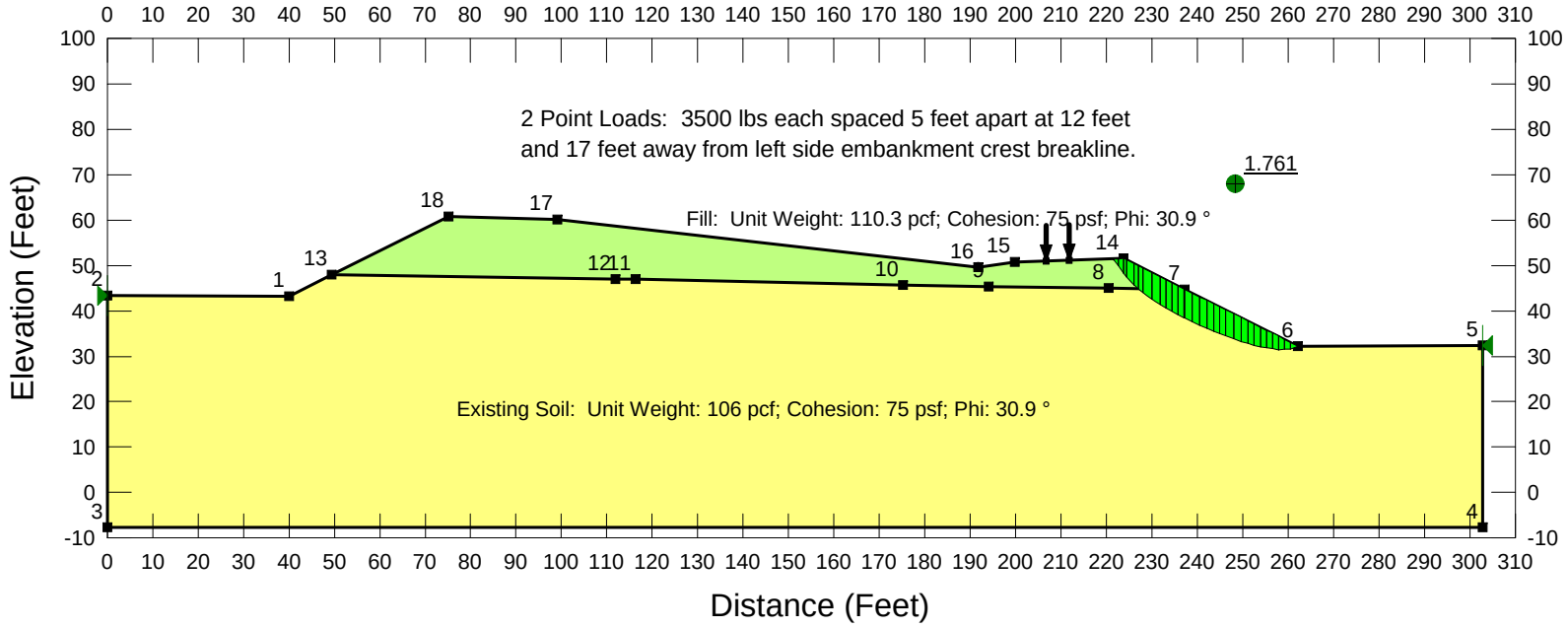
DeBeque Station - Pond 1 Analysis
Fill: Unit Weight=110.3 pcf; c=75 psf; phi=30.9 °
Existing Soil: Unit Weight=106 pcf; c=75 psf; phi=30.9 °
Model: Mohr-Coulomb



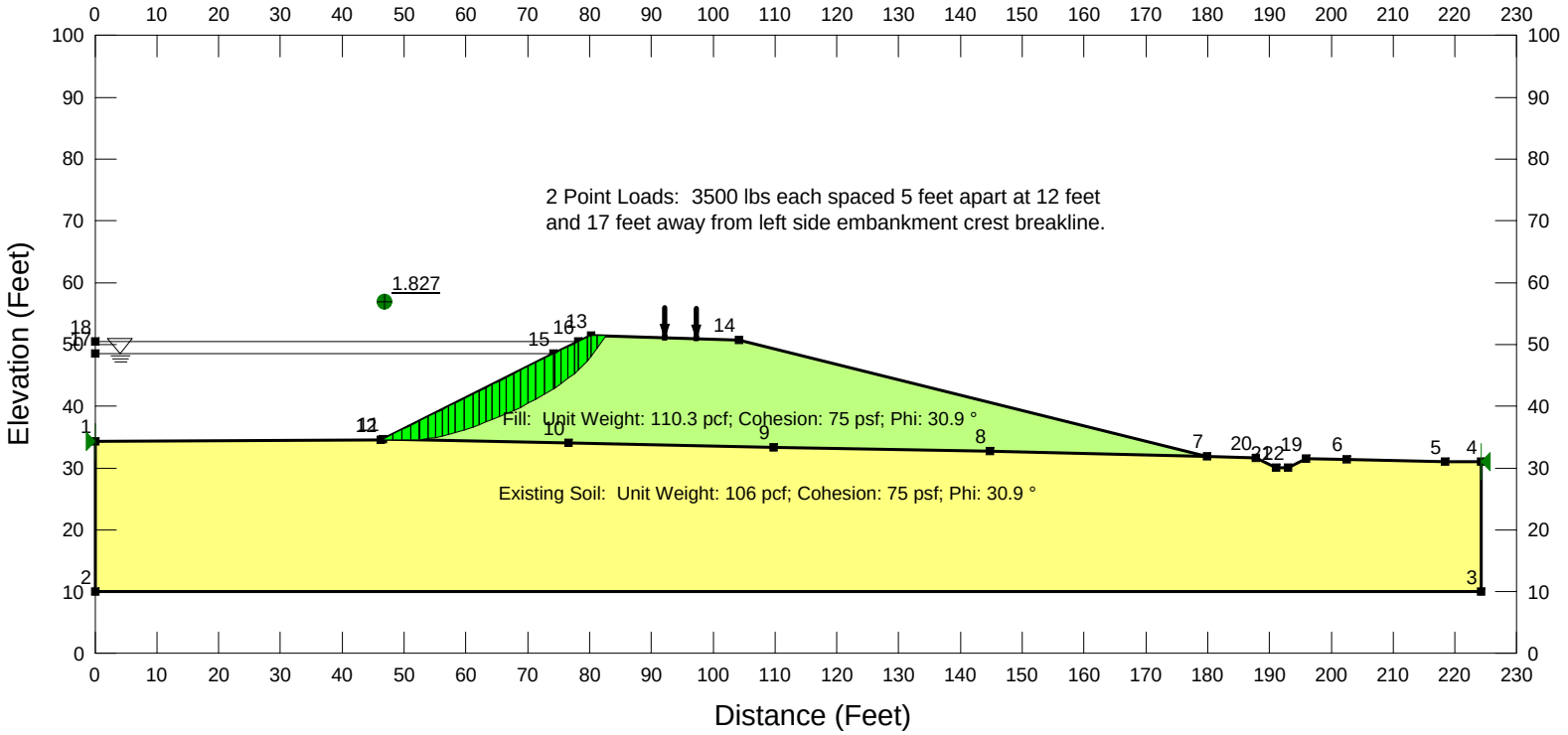
DeBeque Station - Pond 2 to Pond 3
Fill: Unit Weight=110.3 pcf; c=75 psf; phi=30.9 °
Existing Soil: Unit Weight=106 pcf; c=75 psf; phi=30.9 °
Model: Mohr-Coulomb



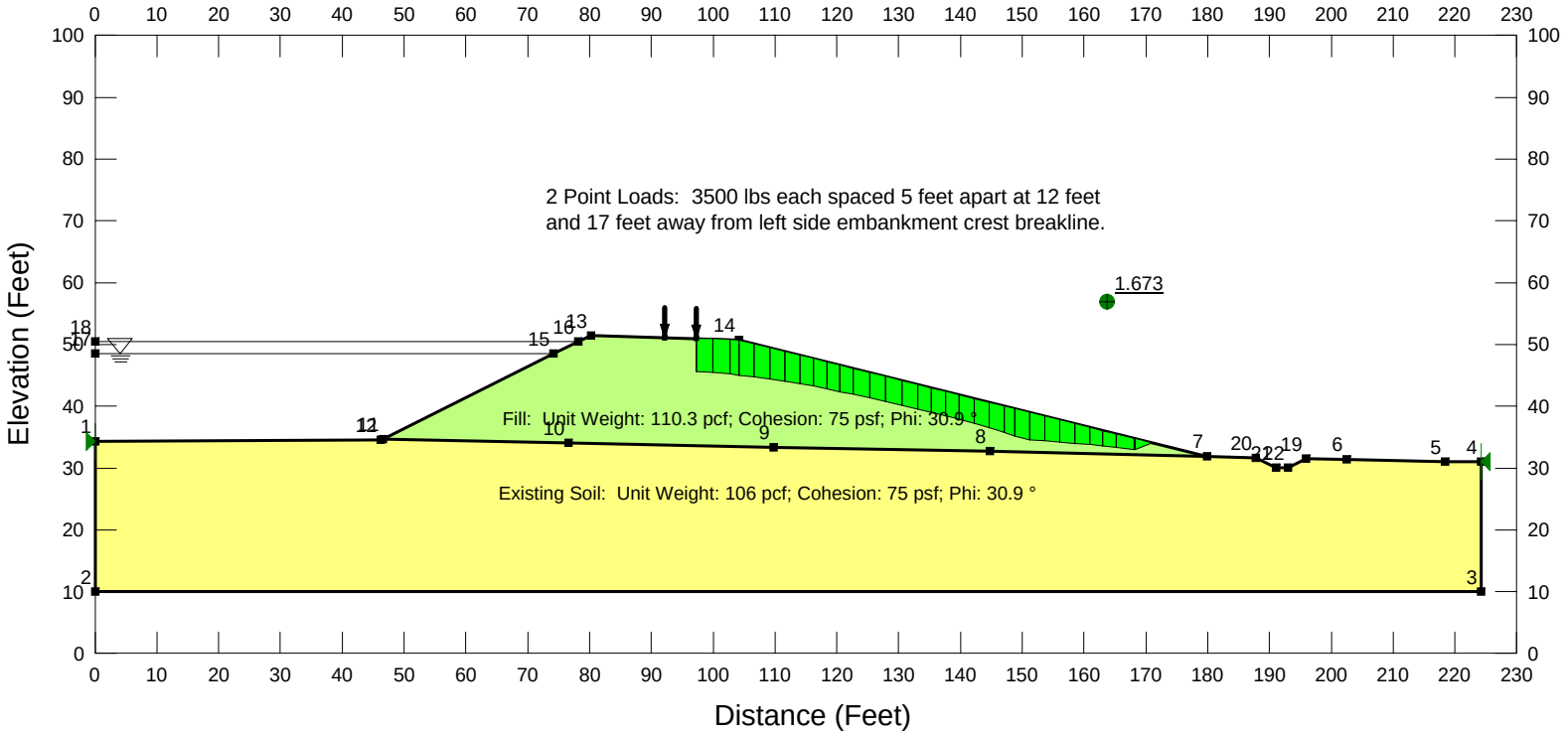
DeBeque Station - Pond 2 to Pond 3
Fill: Unit Weight=110.3 pcf; c=75 psf; phi=30.9 °
Existing Soil: Unit Weight=106 pcf; c=75 psf; phi=30.9 °
Model: Mohr-Coulomb



DeBeque Station - Pond 3
Fill: Unit Weight=110.3 pcf; c=75 psf; phi=30.9 °
Existing Soil: Unit Weight=106 pcf; c=75 psf; phi=30.9 °
Model: Mohr-Coulomb



DeBeque Station - Pond 3
Fill: Unit Weight=110.3 pcf; c=75 psf; phi=30.9 °
Existing Soil: Unit Weight=106 pcf; c=75 psf; phi=30.9 °
Model: Mohr-Coulomb



APPENDIX G-1

60-MIL HDPE LINER SPECIFICATIONS

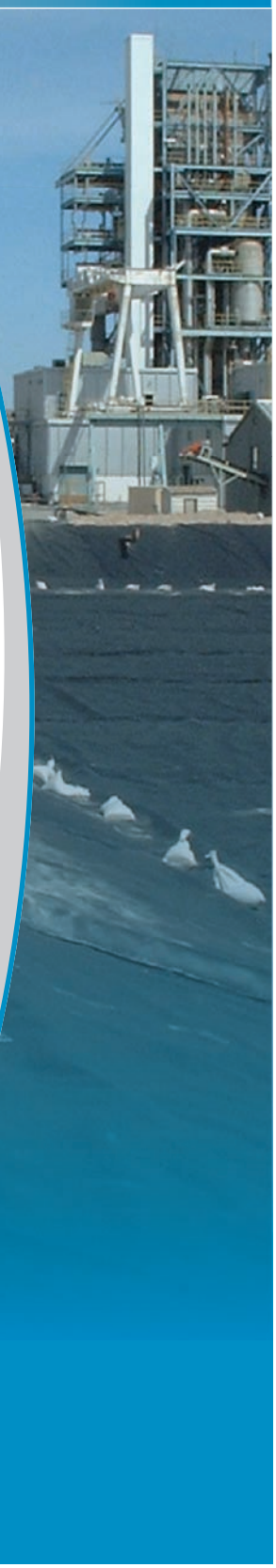
COLORADO LINING INTERNATIONAL

CO: 800.524.8672
TX: 888.546.4641
www.coloradolining.com

HDPE - HIGH DENSITY POLYETHYLENE

Polyethylene is the most commonly used liner in the industry due to its high strength, good chemical resistance, and proven track record. Polyethylene must be installed by certified technicians, but still manages to be a cost effective alternative.

Colorado Lining International is a certified installer of Polyethylene products. We maintain year roundfield crews capable of installing your next job. We want to work with you to make your job a success.



Product Features:

- Chemical Resistance
- Durable
- Cost Effective
- UV Stable
- Wide Product Range:
  - SMOOTH
  - TEXTURED
  - CONDUCTIVE
  - COLORS AVAILABLE
- Available In 20, 30, 40, 60, 80, & 100 Mils

Uses & Applications:

- Landfills
- Wastewater Treatment Plants
- Animal Waste Lagoons
- Golf Course Ponds
- Gas Collection Covers
- Pond & Lake Liners
- Irrigation Reservoirs

- ***Project Photo: Nevada Power in Las Vegas, NV***
- ***Overflow Pond Lining***
- ***43,875 SF 40 Mil HDPE***

COLORADO LINING INTERNATIONAL

HDPE

Smooth
Product Data Sheet

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness (min. ave.)	D5199	nom.	Nom.	Nom.	Nom.	Nom.	Nom.	Nom.	Per roll
• lowest individual of 10 values		-10%	-10%	-10%	-10%	-10%	-10%	-10%	
Density mg/l (min.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lb
Tensile Properties (1) (min. ave.) • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	 63 lb/in. 114 lb/in. 12% 700%	 84 lb/in. 152 lb/in. 12% 700%	 105 lb/in. 190 lb/in. 12% 700%	 126 lb/in. 228 lb/in. 12% 700%	 168 lb/in. 304 lb/in. 12% 700%	 210 lb/in. 380 lb/in. 12% 700%	 252 lb/in. 456 lb/in. 12% 700%	20,000 lb
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	54 lb	72 lb	90 lb	108 lb	144 lb	180 lb	216 lb	45,000 lb
Stress Crack Resistance (2)	D5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI-GM10
Carbon Black Content (range)	D 1603 (3)	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	20,000 lb
Carbon Black Dispersion	D 5596	note (4)	note (4)	note (4)	note (4)	note (4)	note (4)	note (4)	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) (5) (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	200,000 lb
Oven Aging at 85°C (5), (6) (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	per each formulation
UV Resistance (7) (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs (9)	GM 11 D 3895 D 5885	 N.R. (8) 50%	 N.R. (8) 50%	 N.R. (8) 50%	 N.R. (8) 50%	 N.R. (8) 50%	 N.R. (8) 50%	 N.R. (8) 50%	per each formulation

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 in.

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

APPENDIX H

CLIMATE DATA

Colorado Evaporation Stations - Western Regional Climate Center

Station Name	Time Period	January	February	March	April	May	June	July	August	September	October	November	December	Year
AKRON 4 E	1918-2005	0.00	0.00	0.00	7.30	9.29	11.43	13.26	11.16	9.09	6.16	0.00	0.00	67.69
ALAMOSA WSO AP	1948-2005	0.00	0.00	0.00	7.06	9.01	10.08	9.16	7.81	6.40	4.39	0.00	0.00	53.91
ARBOLES	1957-1963	0.00	0.00	0.00	5.41	7.95	9.56	9.78	8.61	6.52	0.00	0.00	0.00	47.83
BONNY LAKE	1949-2005	0.00	0.00	0.00	7.26	8.69	10.86	11.78	10.61	8.12	6.12	4.57	0.00	68.01
CLIMAX	1949-2005	0.00	0.00	0.00	0.00	0.00	5.36	5.32	4.44	3.41	0.00	0.00	0.00	18.53
CONEJOS 3 NNW	1948-1960	0.00	0.00	0.00	6.30	7.14	7.67	7.41	6.87	7.19	5.74	0.00	0.00	48.32
ESTES PARK	1948-1994	0.00	0.00	0.00	5.78	5.26	7.09	7.13	6.15	5.04	4.04	0.00	0.00	40.49
FORT COLLINS	1900-2005	0.00	0.00	2.50	4.52	5.42	6.32	6.92	6.07	4.74	3.07	1.48	0.00	41.04
GRAND JUNCTION WALKER	1900-2005	0.00	0.00	4.67	8.53	12.18	15.96	16.53	14.02	10.98	7.05	2.42	0.00	92.34
GRAND JUNCTION 6 ESE	1962-2005	0.00	0.00	0.00	6.60	9.29	11.77	12.01	10.24	7.48	4.65	2.09	0.00	64.13
GRAND LAKE 6 SSW	1948-2005	0.00	0.00	0.00	0.00	4.82	7.75	7.81	6.79	5.24	3.10	0.00	0.00	35.51
GREEN MOUNTAIN DAM	1948-2005	0.00	0.00	0.00	0.00	4.96	6.56	6.93	5.90	4.65	2.90	0.00	0.00	31.90
JOHN MARTIN DAM	1941-2005	0.00	0.00	6.40	8.04	9.67	11.30	12.31	10.28	7.82	5.61	2.78	0.00	74.21
LAKE GEORGE 8 SW	1948-2005	0.00	0.00	0.00	0.00	5.15	8.26	7.39	6.02	5.72	0.00	0.00	0.00	32.54
MEREDITH	1963-2005	0.00	0.00	0.00	0.00	7.69	8.26	8.34	6.96	5.25	3.21	0.00	0.00	39.71
MONTROSE 1	1948-1982	1.68	1.49	3.34	5.69	7.49	9.47	9.04	7.39	5.54	3.45	1.61	1.26	57.45
PLATORO	1949-1991	0.00	0.00	0.00	0.00	5.86	8.10	6.57	5.24	5.52	3.33	0.00	0.00	34.62
PUEBLO WSO AP	1954-2005	0.00	0.00	0.00	8.71	9.50	11.51	12.14	10.41	8.17	6.14	0.00	0.00	66.58
PUEBLO CITY RESERVOIR	1948-1971	0.00	5.13	5.86	6.85	8.81	10.09	10.60	8.85	7.43	5.30	2.99	2.71	74.62
PUEBLO RESERVOIR	1975-2005	0.00	0.00	0.00	7.18	9.34	10.87	11.58	9.92	7.90	5.88	0.00	0.00	62.67
PUEBLO 6 SSW	1971-1985	0.00	0.00	4.82	7.47	8.57	10.65	11.30	9.40	7.13	5.53	0.00	0.00	64.87
SAN LUIS LAKES 3W	1948-1955	0.00	0.00	4.50	6.07	8.51	9.88	8.49	7.77	6.57	4.53	0.00	0.00	56.32
SPRINGFIELD 7 WSW	1956-2002	0.00	0.00	0.00	7.85	9.73	11.44	12.69	11.28	8.53	6.29	4.57	0.00	72.38
SUGARLOAF RESERVOIR	1948-2005	0.00	0.00	0.00	0.00	0.00	7.03	6.15	4.97	4.15	2.93	0.00	0.00	25.23
TRINIDAD LAKE	1989-2005	0.00	0.00	0.00	6.75	9.04	10.55	9.88	8.27	7.65	6.17	3.92	2.21	64.44
TWIN LAKES RESERVOIR	1949-2005	0.00	0.00	0.00	0.00	6.93	8.65	7.92	6.79	5.33	3.96	0.00	0.00	39.58
VALLECITO DAM	1948-2005	0.00	0.00	1.91	3.82	5.29	6.22	6.09	5.31	4.39	3.04	1.60	0.00	37.67
WAGON WHEEL GAP 3 N	1948-1972	0.00	0.00	0.00	0.00	6.69	7.90	7.15	5.81	5.30	2.61	0.00	0.00	35.46
WALSH 1 W	1951-2005	0.00	0.00	0.00	0.00	10.78	12.35	12.76	11.63	9.42	6.88	0.00	0.00	63.82
WIGGINS 7 SW	1960-1971	0.00	0.00	0.00	6.82	8.50	8.42	9.97	8.09	5.87	4.22	2.23	0.00	54.12

http://www.wrcc.dri.edu/htmlfiles/westevap.final.html#COLORADO

Standard daily pan evaporation is measured using the four-foot diameter Class A evaporation pan. The pan water level reading is adjusted when precipitation is measure to obtain the actual evaporation. Most Class A pans are installed above ground, allowing effects such as radiation on the side walls and heat exchnges with the pan material. These effects tend to increase the evaporation totals. The amounts can then be adjusted by multiplying the totals b 0.70 or 0.80 to more closely estimate the evaporation from naturally existing urfaces such as a shallow lake, wet soil or other moist natural surfaces.

Many stations do not measure pan evaportation during winter months. A "0.00" total indicates no measuement is taken.

Stations marked with an asterisk (*) have estimated totals computed from meteorological measurements using a form of the Penman equation.

APPENDIX I

WATER ANALYSIS DATA

PICEANCE BASIN - CO UT

DeBeque Pipeline Project

Raw Water Pipeline (Bluestone)

Produced & Frack Water Pipeline (BHPP)

Gas Pipeline (Summit)

Electric Power Line

Tie Point to Existing

Homer Deep Unit

Winter Flats Unit

HSC Unit

Summit Compressor Station

Kobe Pump Station

Future Discharge Line (TBD)

50Ac.Ft.

30Ac.Ft.

500HP

1000HP

625HP

8S 98W

8S 97W

INTERSTATE 70

0 2,101 FEET

To: Black Hills Plateau Production
2388 Leland
Grand Junction, CO 81505

Date: April 9, 2008
No: ECA/BHP 08-02

SAMPLE IDENTIFICATION

Submitted by: Stan

Date Sampled: Mar. 15, 2008

Sample I.D.: Water, Horse Canyon Fed 15-3

Date Received: March 20, 2008

Comments: Kept 4C till tested

Date Tested: March 20-April 4, 2008

RESULTS

Parameter	Result
pH	6.436
Conductivity	122,050 umhos/cm
Resistivity	0.081 ohms/m
Specific Gravity 60/60 F	1.0610
TDS	82,770 mg/L
TSS	4,320 mg/L
Chloride	44,475 mg/L
Bicarbonate	787.4 mg/L
Carbonate	0.00 mg/L
Sulfates	1,130 mg/L
Calcium	15,840 mg/L
Magnesium	2,844 mg/L
Sodium	9,800 mg/L
Potassium	3,408 mg/L
Iron	5,240 mg/L

Results submitted by
Enviro-Chem Analytical, Inc.
Liese K. Thompson
Liese K. Thompson
Lab Director

DI WS sample. (CIRP between RLNS's (2022)

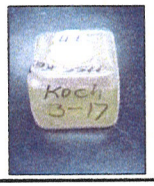
HORSESHOE CANYON - MVRD

HALLIBURTON

Water Analysis
Data Sheet
RMNWA Laboratory

Halliburton appreciates the opportunity to present this information and looks forward to being of service to you.

Company: Koch Exploration
Date Tested: April 22, 2005
For:

Date Received	28-Apr-05	22-Apr-05	22-Apr-05	31-May-83	23-Apr-80
Location	HSC 3-20	HSC 3-17	HSC 2-16	HSC #2	HSC #3
Temperature *(°F)*	74	72	72		71
pH	7.9	6.9	7.4	7.1	6.8
Chlorides *(mg/L)*:	1,700	17,800	11,300	7,952	10,684
Sulfate *(mg/L)*:	10	20	20	12	
Iron, total *(mg/L)*:	16.4	12.1	11.2	3.0	
Iron, ferrous (mg/L):	0.0	7.4	5.6		
Bicarbonates *(mg/L)*:	1,210	486	958	3,282	1,237
Carbonates *(mg/L)*:	0				
Potassium (K)- *(mg/L)*:	300			175	
Sodium (Na) - *(mg/L)*:	1,278	9,090	6,733	5,582	
Calcium (Ca) - *(mg/L)*:	40	894	252	510	332
Magnesium (Mg) - *(mg/L)*:	22	846	348	49	94
TDS - *(mg/L)*:	4,577	29,155	19,628		21,750
Resistivity - (ohm/M)	1.95	0.30	0.42	0.53	0.75
Specific Gravity	1.002	1.007	1.010	1.081	1.015
Comments, Observations:	Brown and cloudy 	Orange Tint 	Brown Sediment Throghout 		

NOTICE: This report is for information only and the content is limited to the sample described. Halliburton makes no warranties, express or implied, as to the accuracy of the contents or results. Any user of this report agrees Halliburton shall not be liable for any loss or damage, regardless of cause, resulting from the use hereof.

EXHIBIT 2
ANALYSIS OF INJECTION WATER FROM:

- **PLATEAU FIELD**
- **SHIRE GULCH FIELD**
  (INCLUDES WELLS WITHIN HORSESHOE CANYON UNIT)
- **ROBERTS CANYON FIELD**
  (INCLUDES WELLS WITHIN HORSESHOE CANYON UNIT)
- **BRONCO FLATS FIELD**
  (INCLUDES WINTER FLATS UNIT)

PLATEAU - CZ-CR

HALLIBURTON

Halliburton Energy Services
The Rockies NWA District Laboratory
Grand Junction, CO 970) 523-3692

Water Analysis Report

Contact Information

Company	Black Hills	Date Received	October 16, 2006
Reported To	Stan Lindholm	Date Tested	October 17, 2006
Reported By	Nathan Barnum	Tested By	Deba Shafiee

Sample 1 Physical Characteristics

Well Name	Nystrom	Temperature	70 °F
Location	2-18 Corcoran	pH	7.6
Specific Gravity	1.0195	Color	Yellow
Corrected SG	1.022 at 60°F	Turbidity	cloudy
TDS (calculated)	40324 ppm	Resistivity	0.285 Ω·m

Sample 1 Chemical Characteristics

Anions	Chloride	24000 mg/L	**Cations**	Total Iron	23.5 mg/L
	Sulfate	0 mg/L		Ferrous Iron	0.7 mg/L
	Bicarbonate	968 mg/L		Potassium	1386 mg/L
	Carbonate	0 mg/L		Calcium	675 mg/L
	Hydroxide	0 mg/L		Magnesium	280 mg/L
				Sodium (calculated)	13777 mg/L

PLATEAU (RLNS & DKTA)

HALLIBURTON

Halliburton Energy Services
The Rockies NWA District Laboratory
Grand Junction, CO 970) 523-3692

Water Analysis Report

Contact Information

Company	Black Hills Plateau Product	Date Received	September 25, 2007
Reported To	Stan Lindholm	Date Tested	September 25, 2007
Reported By	Ann Ekx	Tested By	Ann Ekx

Sample 1 Physical Characteristics

Well Name	Tupper		Temperature	71	°F
Location	13-13 RLNS		pH	6.63	
Specific Gravity	1.024		Color	Yellow	
Corrected SG	1.026	at 60°F	Turbidity	Cloudy	
TDS (calculated)	55785	ppm	Resistivity	0.31	Ω·m

Sample 1 Chemical Characteristics

Anions	Chloride	36000	mg/L	**Cations**	Total Iron	0.5	mg/L
	Sulfate	0	mg/L		Ferrous Iron	0.2	mg/L
	Bicarbonate	388	mg/L		Potassium	0	mg/L
	Carbonate	0	mg/L		Calcium	12880	mg/L
	Hydroxide		mg/L		Magnesium	960	mg/L
					Sodium (calculated)	6895	mg/L

Waverton 1-13 DK attached PG

Water Analysis Report (cont.)

Sample 2 Physical Characteristics

Well Name	Wolverton DKTA		Temperature	70	°F
Location	13-Jan		pH	7.9	
Specific Gravity	1.165		Color	Orange	
Corrected SG	1.167	at 60°F	Turbidity	Cloudy	
TDS (calculated)	28268	ppm	Resistivity	0.25	Ω·m

Sample 2 Chemical Characteristics

Anions	Chloride	17600	mg/L	**Cations**	Total Iron	0.0	mg/L
	Sulfate	0	mg/L		Ferrous Iron	0.0	mg/L
	Bicarbonate	324	mg/L		Potassium	106	mg/L
	Carbonate	368	mg/L		Calcium	632	mg/L
	Hydroxide		mg/L		Magnesium	160	mg/L
					Sodium (calculated)	10724	mg/L

General Comments

These samples were filtered with 40 micon paper.

HORSESHOE CANYON - DKTA

HALLIBURTON

Halliburton Energy Services
The Rockies NWA Regional Laboratory
Grand Junction, CO 970) 523-3692

Water Analysis Report

Contact Information

Company	Black Hills	Date Received	March 22, 2007
Reported To	HSC 3-20 DKTA	Date Tested	March 22, 2007
Reported By	Deba Shafiee	Tested By	Deba Shafiee

Sample Physical Characteristics

Well Name	HSC 3-20	Temperature	68 °F
Location		pH	6.7
Specific Gravity	1.02	Color	slight brown
Corrected SG	1.022 at 60°F	Turbidity	slight
TDS (calculated)	27724 ppm	Resistivity	0.325 Ω·m

Sample Chemical Characteristics

Anions	Chloride	14000	mg/L	**Cations**	Total Iron	10.9 mg/L
	Sulfate	300	mg/L		Ferrous Iron	1.2 mg/L
	Bicarbonate	600	mg/L		Potassium	11000 mg/L
	Carbonate	0	mg/L		Calcium	700 mg/L
	Hydroxide	0	mg/L		Magnesium	550 mg/L
					Sodium (calculated)	1117 mg/L

General Comments

Sample was filtered with 8mm filter prior to testing.

DEBEQUE-CRCN

Schlumberger Dowell

Dowell
9915 East 104th Avenue
Henderson, Colorado 80640
(303) 289-6350 (office)

3/6/96

LABORATORY REPORT

TO: BERNIE PAOLI, WST SALES
FROM; JACKIE VERSCHUUR, CCO LABORATORY

cc: Bill Redman, FSM Frac/Stimulation
John Grubich, CCO DIST. Mgr
Dan McKenzie, CCO Sales

(Water Smpl, + Plunger)

Prepared for: SPC
Well: ED Koch #7-9
Location: Mesa County, Colorado
Formation: Corcoran

The Dowell Commerce City laboratory received a water sample and a plunger tool that was coated with fines in the laboratory. The lab was asked to do an API water analyses and to determine if the water has a tendency to scale calcium carbonate/calcium sulfate and to determine the nature of the fines.

The fines were removed from the plunger and viewed under a power microscope and tested with dilute hydrochloric acid. There was a slight effervescence noted when exposed to the acid but the majority of the sample appears to be coal fines. The minimum sample size did not warrant enough material to perform an x-ray analysis. The observations made under the microscope suggest the material is high in sulfur by the odor emitted when tested to the acid. There appears to be some micaceous material, some white material somewhat resembling a form of calcium sulfate or other evaporite along with material that resembles coal or other forms of organic matter. The sample does not posses asphaltenes or other paraffinic material.

Sometimes it is expressed that a water is not stable. This means that certain ions are present in excess of their solubility, especially under changed conditions, and a deposit will form. The two common deposits are calcium carbonate and calcium sulfate. From the water analyses calculations can be made for these tendencies

DISSOLVED SOLIDS

CATIONS	mg/L	meq/L	Other properties	
Sodium, Na (calculated)	10,945	482	pH	7.37
Calcium, Ca	666	33	Specific Gravity	1.012
Magnesium, Mg	0	0		
ANIONS				
Chloride, Cl	18,020	505		
Sulfate, SO4	5	0.1		
Carbonate, CO3	0	0		
Bicarbonate, HC03	610	10		
TOTAL DISSOLVED SOLIDS (calc)	30,246		Iron, Fe (total)	30 mg/L

LABORATORY REPORT (cont'd)

"The Stiff-Davis" equation indicates that this water has a Stability Index of +0.84. A positive index indicates a tendency toward calcium carbonate deposition. The calculated solubility of calcium sulfate in this water is 40.3 Meq/L. Analysis indicates the water contains 33.0 Meq/L, therefore calcium sulfate deposition is not indicated.

The material coating the plunger was more formation mineralogy than scale or paraffin accumulation that had a low solubility when tested to dilute hydrochloric acid, < 25%.

Basic Pool - Tolerates 125°F — more scale @ higher Temp

WINTER FLATS

HALLIBURTON

Halliburton Energy Services
The Rockies NWA Regional Laboratory
Grand Junction, CO 970) 523-3692

Water Analysis Report

Contact Information

Company	Black Hills	Date Received	October 12, 2007
Reported To	Robert Shea	Date Tested	October 13, 2007
Reported By	C. Gauthier	Tested By	C. Gauthier

Sample Physical Characteristics

Well Name	Winter Flats 1-13-100 CMTN		Temperature	72	°F
Location	B.U. #3		pH	7	
Specific Gravity	1.019		Color	Amber	
Corrected SG	1.021	at 60°F	Turbidity	Moderate	
TDS (calculated)	25522	ppm	Resistivity	0.26	Ω·m

Sample Chemical Characteristics

Anions	Chloride	16900	mg/L	**Cations**	Total Iron	9.7	mg/L
	Sulfate	0	mg/L		Ferrous Iron	0.0	mg/L
	Bicarbonate	1000	mg/L		Potassium	108	mg/L
	Carbonate	0	mg/L		Calcium	2020	mg/L
	Hydroxide	0	mg/L		Magnesium	3340	mg/L
					Sodium (calculated)	2629	mg/L

General Comments

Scott analized the condensate: Specific gravity of the raw sample was 0.880. The seperted samples averaged 0.830.

APPENDIX J

OPERATING PLAN

DE BEQUE WATER STATION STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURES

DE BEQUE WATER STATION PUMPING PRODUCTION FROM OIL FIELDS TO WATER STORAGE FACILITIES

1.0 SCOPE

- Pumping raw and/or produced water to and from Winter Flats, Homer Deep and Horseshoe Canyon oil fields to the De Beque Water Station Ponds 1, 2 and 3, which are COGCC permanent E&P Waste management facilities.
- Water impoundment in Ponds 1, 2 and 3 will be operating under Mesa County's Commercial Conditional Use Permit (CUP) – Permit # 2014-0032.

2.0 REQUIREMENTS

- Employees and contractors shall be trained and qualified in the safe operations of water pumps and surface lines. All supervisors will have a minimum of 3 years training in SOP and waste water management.

3.0 APPLICABLE DOCUMENTS

- Black Hills Company Safety Handbook
- JSA and all applicable documents on all job actions
- Safety Data Sheet (SDS)

4.0 MATERIALS AND EQUIPMENT

- Properly sized pumps and piping in good working condition.

5.0 SAFETY AND ENVIRONMENT

- Personal Protection Equipment (PPE)
    - Hard Hat
    - Eye Protection
    - FRC Clothing
    - Steel Toe Boots
    - Ear Protection
- All newly constructed surface and sub-surface lines will be hydrostatically tested to 1.5 times the expected working pressures.
- The De Beque Water Station fencing and floating hextile cover will be inspected weekly to maintain safety for all wildlife and will meet or exceed all regulatory guidelines and standards.

- The De Beque Water Station liner and storage fluids will be inspected on a (minimum) weekly basis. All conditions will be reported and documented on "Check List" provided in Section **7.0**.
- Additional Personal Protective Equipment (PPE) as identified in SDS or in this procedure. Spill kit to be kept on location.
    - Water level will be monitored with a pressure transducer, and/or a leak detection system, tracking all fluctuation of the fluid levels. Water level monitor will be interfaced with an automated alarm system to notify staff in the event of an unexpected change in fluid levels.
    - In the event of fluids release adherence to the current ERP is mandatory.
    - On a regular basis the stored produced water will be visually inspected by a Black Hills employee. Visual data gathered will be logged weekly.
    - On an annual basis, or when deemed necessary, the De Beque Water Station Ponds 1, 2, and 3 will be drained and given a full inspection. All data will be logged.
    - The De Beque Water Station storm water plan that was approved by Mesa County is to be included in the Black Hills company SWMP and inspection schedule.
    - The De Beque Water Station Reclamation plan is included as part of this Form 28 submittal in Appendix C.

6.0 PROCEDURE

- Verify that all permanent buried and any temporary surface pipelines have been pressure tested to at least the maximum anticipated operating pressure in accordance with COGCC Rule 1101.e.(1).
- Verify that the entire length of any surface pipelines intended for use have been visually inspected to ensure integrity. Operator shall conduct daily inspections of surface pipeline routes for leaks during active transfer of fluids. Any booster pump stations, if used, shall be continuously monitored when operating.
- Notify the COGCC 48 hours prior to start of all hydraulic stimulation operations for nearby well pad locations that will use fluids from and return fluids to this pit using the Form 42 (the appropriate COGCC individuals will automatically be email notified, including the LGD for hydraulic stimulation operations).
- Inform water supervisor of intention to pump water with the following information:
    - Source of water
    - Destination of water
    - Flow rate of water
    - Total volume to be pumped or duration of pumping

- Procedures after authorization is given from the water supervisor,
    - Personnel, with a minimum of two years of experience, and supervisor with 3 years training in SOP and water management, will walk entire surface systems inspecting all fittings and valves to ensure all are in good working condition, in proper alignment for pumping and receiving water.
    - Verification will be transmitted to all parties involved with the job that pumping operations can commence.
    - All valves will be inspected to be in proper alignment before and after the job.
    - After pumping operations of produced water commence from a production pad, operators will verify that produced water is returning to the De Beque Water Station.
    - Water volumes pumped will be cross checked after completion of the job to insure all water was pumped to the destination.
    - Records of all jobs including date, location, time and quantity will be kept and reported to proper personnel.

7.0 CHECK LISTS

Black Hills Plateau Production
De Beque Water Station Facility
Weekly Operations Checklist

Date _____

Operator _____

Water Impoundment	Comments
Water Level – Visual Inspection	
Oil Sheen or Debris – Visual Inspection	
Record Meter Valves – In/Out	
Fencing & Hextile Cover – Visual Inspection	
Piping – Visual Inspection	
Notes:	

DE BEQUE WATER STATION OPERATING PLAN

DE BEQUE WATER STATION

OPERATING PLAN

Black Hills Exploration & Production
A Black Hills Corporation Enterprise

BLACK HILLS PLATEAU PRODUCTION

1515 WYNKOOP STREET, SUITE 500
DENVER CO 80202

PREPARED BY:

WWC ENGINEERING

1275 MAPLE STREET, SUITE F
HELENA, MT 59601
(406) 443-3962
www.WWCengineering.com

Innovation
Quality
Value

MARCH 2015

De Beque Water Station Operating Plan

Prepared for: Black Hills Plateau Production
ATTN: Brett Hurlbut
1515 Wynkoop Street, Suite 500
Denver, CO 80202
(303) 566-3356

Prepared by: WWC Engineering
1275 Maple Street Suite F
Helena, MT 59601
(406) 443-3962
Fax: (406) 449-0056

Principal Authors: Drew Pearson, P.E.

Reviewed by: Shawn Higley, P.E., Helena Branch Manager
Kevin Grabinski, P.E., Project Manager

Date: March 2015

TABLE OF CONTENTS

APPENDICES

DE BEQUE WATER STATION OPERATING PLAN

OVERVIEW

The De Beque Water Station will be designed for the collection of produced water from surrounding oil and gas operations along with raw water from the Colorado River. The proposed facility is located approximately 2.2 miles southwest of De Beque, Colorado in the SE ¼ of the SW ¼ of Section 29, Township 8 South, Range 97 West, 6th P.M.

The De Beque Water Station facility will consist of three lined reservoirs for the storage of produced water and raw water, a pump station, a lay down yard and an office building. Pond 1 is designated as a produced and raw water pond while Ponds 2 and 3 are designated as produced water only. This gives the operator more flexibility for water storage.

OPERATING PLAN CRITERIA

The criteria used for the operating plan for the De Beque Water Station was based on the COGCC 900 Series Rules under Section 908.B.

WATER SOURCE, TREATMENT AND FLOW RATES

Three oil fields will be the sources of produced water to be stored in proposed ponds. These fields are named Winter Flats, Homer Deep, and Horseshoe Canyon. Pipelines have been constructed to connect each field to the De Beque pump station building. Produced water will be pre-treated at each wellhead via an oil/water separator prior to pumping to the De Beque Water Station. All produced flow back water will enter the pump station building and flow through a secondary oil skimming system before being pumped to Ponds 1, 2 or 3 for storage. Any produced water that is delivered to the site via truck will also be pumped through the oil skimming system and then to the desired pond. The ponds will also store raw water that will be pumped to the facility from the Colorado River.

The anticipated return flow rates of the produced water at the De Beque Water Station were determined from flow back data from Well Numbers: DHS3C-19 D17998 (Well C19) and DHS3C-20 D17998 (Well C20). From 12/5/2013 to 2/26/2014, Well C19 had 79 days of return water flow. During this time, the well averaged approximately 519 bbls/day of water with a minimum of 2 bbls/day and a maximum of 3,270 bbls/day. Well C20 had 34 days of return water flow from 1/21/2014 to 2/26/2014. During this time, the well averaged 229 bbls/day of water with a minimum of 0 bbls/day and maximum of 2096 bbls/day. For the purpose of estimating the design flow back, a peak daily flow of 3,270 bbls/day will be used for a newly completed well. Tables with flow back data for Wells C19 and C20 are located in Appendix J-1 and J-2 respectively.

Oil/water ratios were estimated by comparing typical oil production values to the quantity of return water flow for each day. It was noted that the data supplied for these wells was taken at a sampling point corresponding to a flow back separator that provides the primary separation and is estimated to remove at least 90% of the hydrocarbons present in the flow back water. Based on these estimates, an average oil removal of 5.8 gallons per hour (gph) will be required with a peak removal of 15.2 gph at the De Beque Water Station.

Flow back water will flow through a secondary oil skimming system within the De Beque Water Station to remove hydrocarbons prior to being pumped to Ponds 1, 2 or 3 for storage. The oil skimming system will consist of a three part system within a cast-in-place concrete tank. The first tank chamber will contain a diffuser to reduce the velocity and kinetic energy of the produced water. An overflow weir will allow the water to flow into the second tank chamber that will provide sufficient detention time to allow the oil and water to separate. An oil skimming system will collect any hydrocarbons from the water surface and store the hydrocarbons in an underground tank located outside the building. Produced water will then flow through an undershot weir into the third tank chamber from where it will be pumped to one of three ponds for storage.

Dust and Moisture Control

The main access road into the site and to the lay down yard and pump station building will be a gravel surface that will be sprayed with magnesium chloride to provide dust suppression. The maintenance road along the pond berms will be a graveled surface. If dust becomes an issue on these roads or any other areas on-site, the raw water supplied from the Colorado River will be used for dust suppression.

Conveyance ditches will be constructed around the perimeter of the site to route storm water runoff during large rainfall events. This runoff water will be conveyed to an on-site detention pond and an existing drainage ditch.

Sampling

Three groundwater monitoring wells have been installed around the perimeter of the site with each well 100 feet deep. These wells were drilled in February of 2014 and have been monitored monthly since their installation. The groundwater level has remained greater than 100 feet since the monitoring wells were installed as no water has been detected in any well. Due to this depth of groundwater, no groundwater samples will be required for this project. If the groundwater level rises to a depth less than 100 feet then groundwater samples would then be collected.

The water in Ponds 1, 2 and 3 will be sampled on a regular basis and analyzed for the constituents listed in Table 910-1 in the COGCC regulations. Initially water samples will

be collected on a monthly basis and can be adjusted to a more or less frequent basis if conditions warrant.

Inspection and Maintenance

The facility's produced water levels and leak detection will be monitored daily by Black Hills personnel (or their operator). The pond pressure transducer will automatically report water level depth in each pond.

A leak detection system will be installed in the corner of each pond to monitor for any leaks. The leak detection system consists of a PVC pipe that is perforated at the bottom and will be placed between the primary 60-mil HDPE liner and the secondary 60-mil HDPE liner. The presence of fluid in the PVC pipe would indicate to the operator that a leak has occurred in the primary liner. If a leak is discovered the leak in the pond liner will be located and repaired.

A water level monitor will be used to ensure a minimum of two (2) feet of freeboard below the spillway is provided in each pond at all times. An additional one foot of freeboard is provided between the spillway and the minimum crest elevation. Black Hills will use a submersible pressure transducer that will be linked to a tracking system. Alarms will be set to notify operators of unscheduled fluid fluctuations and levels.

During normal operations, weekly inspections will be performed by a Black Hills operator or designated representative. During weekly inspections, the operator will perform the activities detailed in the "Weekly Checklist", included in Appendix J-3. Adherence to the criteria on the checklist will involve visual inspections of the facilities, assessment of the water levels, visual inspection for sheen on the water, recording flow meter valves, visual inspection of storm water BMPs, visual inspection of wildlife fencing and floating hextile cover, and performance of general housekeeping activities. The operator will ensure that all equipment is in proper working order and that the inspection is documented. If there are any irregularities noted during the inspection, a supervisor shall be notified (if required) and an appropriate response plan will be coordinated to resolve the irregularities.

In addition to the weekly inspections, Black Hills will conduct monthly and semi-annual inspections of the De Beque Water Station according to the criteria in the "Monthly Checklist" and "Semi-Annual Checklist" that are located in Appendix J-3. During the monthly and semi-annual inspections of the De Beque Water Station, items such as pond water sampling, leak detection piping, sampling and measuring groundwater depth in the monitoring wells, and additional equipment inspections will take place.

On an annual basis, or when deemed necessary by Black Hills, the De Beque Water Station will be drained and given a full inspection. The schedule of these inspections may be modified by the COGCC as part of the State's approval process, but otherwise the inspections will take place on a weekly, monthly and semi-annual basis. All checklists will be revised, as necessary, to reflect current operating and regulatory requirements.

EMERGENCY RESPONSE

All incidents that occur on the facility shall be reported to the facility supervisor with Black Hills. The contact information for the facility supervisor is listed below.

Brett Hurlbut
1515 Wynkoop St., Suite 500
Denver, CO 80202
(303) 566-3491 (office)
(303) 828-7816 (cell)

In the event of an emergency that requires immediate medical attention, personnel shall call 9-1-1 emergency services. The closest hospital is located in Grand Junction and is the Community Hospital. The Community Hospital is located approximately 35 miles south of the facility, and the contact information is listed below.

Grand Junction Community Hospital
2021 N. 12th St.
Grand Junction, CO 81501
(970) 242-09220

The produced water that will be pumped into Ponds 1, 2 and 3 from the producing oil wells will contain a very low percentage of hydrocarbons as it will go through a flow back separator at the well site and an additional oil skimming chamber in the pump station building. The produced water in the pond will also be mixed with raw water from the Colorado River, further reducing the hydrocarbon percentage. The low hydrocarbon content of the pond water reduces the risk of fire in the pits. In case of a fire occurring at the facility, the contact information for the De Beque Fire Protection Division is listed below.

De Beque Fire Protection Division
380 Curtis Ave.
De Beque, CO 81630
(970) 283-8632

In the event that law enforcement officials may be contacted, the Colorado State Police and De Beque Town Marshall's Office contact information is given below.

Colorado State Police
202 Centennial St.
Glenwood Springs, CO 81601
(970) 945-6198 (business hours)
(970) 824-6501 (dispatch)

De Beque Town Marshall/Police Chief's Office
381 Minter Ave.
De Beque, CO 81630
(970) 283-5475

During operational emergencies including large amounts of spilled fluids or complete embankment failure, the Mesa County Office of Emergency Management may be contacted. The contact information for this office is given below.

Mesa County Office of
Emergency Management
215 Rice Street
Grand Junction, CO 81501
Office: (970) 244-1763

In the case of a medical emergency, injury, fire, or facility operational emergency, personnel shall notify the facility supervisor immediately after contacting the appropriate emergency personnel. In the case of a fire or unauthorized release, the Colorado Oil and Gas Conservation Commission (COGCC) shall be notified. The contact information for the COGCC is given below.

Colorado Oil and Gas Conservation Commission (district office)
796 Megan Ave., Suite 201
Rifle, CO 81650
Office: (970) 625-2497

Colorado Oil and Gas Conservation Commission (main office)
1120 Lincoln St., Suite 801
Denver, CO 80203
Office: (303) 894-2100

RECORD-KEEPING

The offices of Black Hills will handle record keeping for the facility. The facility supervisor will be responsible for ensuring the accuracy and completeness of the records showing volumes of water stored in the facility. Record-keeping will be composed of the following elements: date water was transported, method of transportation (truck or pipeline), approximate volume of water, and source of water. All records will be available for the COGCC upon request.

Site Security

The site is secured with a 7 feet high industrial strength chain link fence with 3 strands of barbed wire along the top. The fence is designed to keep livestock, wildlife and unauthorized personnel from entering the site. The fence completely surrounds the facility. A 7 feet high automated gate will be installed at the site entrance adjacent to county road V 2/10. The gate will only open via an electronic card reader on the unsecured side of the gate. The gate will automatically close once the vehicle has entered the facility. Black Hills will work with Mesa County and De Beque to provide a knox box that will allow for access by emergency services. The pump station building will be locked at all times and can be accessed with a card reader. The facility will be staffed during all pumping operations.

Hours of Operation

Water may be flowing into and out of the ponds, 24 hours per day, 7 days per week. The facility will be manned as needed during normal daylight hours and will be manned at all times during pumping operations.

Noise and Odor Mitigation

Low noise levels are anticipated. The pumps that supply water for fracking operations are located within an enclosed pump station building. The building will be insulated which will help mitigate noise pollution. Odor mitigation will be accomplished by installing a floating cover on the water surface of the ponds. As the water level fluctuates, the cover will raise or lower with the water level. This cover will also deter birds from landing on the pond surface.

Final Disposition of Waste

The only anticipated waste from the facility will be typical municipal waste that will be transported to an approved landfill. Hydrocarbons removed by the oil skimming system will be transported off-site by truck and sold by Black Hills with oil produced from their wells. Small quantities of materials such as lubricants and motor oil used in the pumps will be collected on a regular basis and disposed of at a certified disposal site.

Leak Detection Actions and Annual Reporting

If inspection of the leak detection system determines fluids are accumulating as the result of a leak, the pond with the leak will be emptied. All liquids will be transferred to a separate pond or disposed of according to the appropriate local, state and federal regulations. If a breach is identified in the liner(s) it will be reported to the COGCC immediately and the appropriate action plans will be implemented. Action plans will be presented to the COGCC for review and input. Any evidence of contamination to groundwater will be reported immediately. All spills will be managed in accordance with Rule 906.

To facilitate the annual review of this facility by the COGCC, Black Hills will submit an annual 900 Series facility report summarizing operations, including the types and volumes of waste actually handled at the facility and the test results of all monitoring well samples.

Black Hills will notify the COGCC of all test results from monitoring wells within (3) months of collecting samples. Results of the monitoring program will also be included in Black Hills annual 900 Series report to the Director.

FACILITY CLOSURE

When the facility is deemed to be at the end of its useful life, it will be closed according to the appropriate local, state and federal regulatory requirements for disposal of wastes. All accumulated wastes (including sediments at the pond bottom) will be disposed of according to the regulatory requirements noted above. Methods for disposal of the accumulated wastes could include transport to a licensed facility, land farming or burial (depending upon the chemical constituents of the materials).

APPENDIX J-1

WELL C19 DATA

CAMERON

COMPANY: Blackhills | Day Lead: Wes Bybee | Phone # 307-371-9519 | DATE 02/26/14

WELL: Well C19 | Day Tech: Robert Willams | Phone # | PACKER @

FIELD: | Night Lead: Russ Rowe | Phone # 307-389-0668

Night Tech: Bryan Schmidt | Phone # 970-556-5789

FIELD REP: Michael Durham | Phone # 505 220 2865 | PERF:

WELL HEAD DATA					GAS VOLUME DATA														WATER DATA							REMARKS
					ORIFICE READINGS						21700	262855	343831				2548					35782	429,230				
TIME	CHOKE SIZE	WELLHEAD PRESS (psi)	WELLHEAD TEMP	CSG PRESS	METER RUN	DIFF	PRESS	TEMP	ORIFICE PLATE	SALES LINE PRES	SALES GAS	FLARE GAS	SCANNER 2000	SALES MMCF/D	OIL (BBLS/HR)	OIL (BBLS/DAY)	TOTAL OIL BBLS	CORIOLIS READING	WATER (BBLS/HR)	WATER (BBLS/D)	TOTAL WATER	WATER LEFT TO RECOVER	SALINITY (PPM)	SAND	PH	COMMENTS
7:00	24/64	1200	59	0	3.826	13	198	76	2.500	182	89	0	89	2136	1	24	2549	0	0	0	35782	429230				
8:00	24/64	1200	73	0	3.826	13	190	76	2.500	175	85	0	85	2040	2	48	2551	0	1	24	35783	429229				
9:00	24/64	1200	72	0	3.826	21	195	71	2.500	179	90	0	90	2160	1	24	2552	0	1	24	35784	429228				
10:00	26/64	1100	79	0	3.826	20	198	75	2.500	181	115	0	115	2760	1	24	2553	0	1	24	35785	429227				
11:00	26/64	950	82	0	3.826	23	202	74	2.500	184	86	0	86	2064	1	24	2554	0	3	72	35788	429224				
12:00	26/64	1000	94	0	3.826	24	200	73	2.500	190	108	0	108	2592	0	0	2554	0	2	48	35790	429222				
13:00	26/64	1000	85	0	3.826	20	212	73	2.500	196	121	0	121	2904	1	24	2555	0	3	72	35793	429219				
14:00	26/64	1000	82	0	3.826	19	215	73	2.500	199	81	0	81	1944	0	0	2555	0	2	48	35795	429217				
15:00	24/64	1000	77	0	3.826	20	212	74	2.500	201	95	0	95	2280	1	24	2556	0	0	0	35795	429217				
16:00	24/64	950	75	0	3.826	10	211	75	2.500	197	81	0	81	1944	0	0	2556	0	0	0	35795	429217				16:45 went to full flare because static on sales line reached 211
17:00	20/64	950	76	0	3.826	14	186	72	2.500	207	60	24	84	1440	0	0	2556	0	0	0	35795	429217				
18:00	20/64	925	75	0	3.826	14	175	74	2.500	190	0	85	85	0	0	0	2556	0	3	72	35798	429214				
19:00	20/64	900	74	0	3.826	13	156	72	2.500	151	0	85	85	0	0	0	2556	0	2	48	35800	429212				19:05 static on sales line dropped, opened sales
20:00	24/64	900	68	0	3.826	14	159	76	2.500	139	42	42	84	1008	1	24	2557	0	3	72	35803	429209				20:00 closed flare
21:00	24/64	925	81	0	3.826	26	178	77	2.500	158	102	0	102	2448	2	48	2559	0	2	48	35805	429207				
22:00	24/64	1000	78	0	3.826	22	185	76	2.500	166	103	0	103	2472	1	24	2560	0	2	48	35807	429205				
23:00	24/64	1000	70	0	3.826	21	187	77	2.500	170	106	0	106	2544	1	24	2561	0	1	24	35808	429204				
0:00	24/64	950	71	0	3.826	19	188	78	2.500	171	105	0	105	2520	1	24	2562	0	1	24	35809	429203				
1:00	24/64	925	68	0	3.826	18	191	75	2.500	174	104	0	104	2496	1	24	2563	0	0	0	35809	429203				
2:00	24/64	900	71	0	3.826	17	196	75	2.500	179	106	0	106	2544	1	24	2564	0	1	24	35810	429202				
3:00	24/64	900	71	0	3.826	16	199	75	2.500	182	102	0	102	2448	2	48	2566	0	0	0	35810	429202				
4:00	24/64	900	74	0	3.826	15	199	75	2.500	183	100	0	100	2400	2	48	2568	0	1	24	35811	429201				
5:00	24/64	900	72	0	3.826	18	204	74	2.500	186	95	0	95	2280	0	0	2568	0	0	0	35811	429201				
6:00	24/64	900	73	0	3.826	18	208	76	2.500	191	83	0	83	1992	1	24	2569	0	0	0	35811	429201				

GAS PROD (MCF/D):	2295	ACCUM PROD GAS(MCF) SCANNER 2000	346126	OIL PROD (BBLS/DAY)	21	H20 PROD (BBLS/DAY):	29			CHLORIDES (PPM):	
SALES GAS(MCF/D):	2059	ACCUM SALES GAS(MCF) TOTAL FLOW	23759	OIL RECOVERED (BBLS)	2,569	H20 RECOVERED (BBLS):	35811			H2S (PPM):	0
FLARE GAS(MCF/D):	236	ACCUM FLARE GAS(MCF)	263091	BLWTR:	429,201	H2O % Recovered:	8.34%			CO2 (%):	
SALES MMCF/D AVERAGE:	85.79										

APPENDIX J-2

WELL C20 DATA

CAMERON

COMPANY:	Blackhills	Day Lead: wes bybee	Phone # 307-371-9519
		Day Tech: robert willams	Phone # 970-217-0791
WELL:	Well C20	Night Lead: russ rowe	Phone # 303-709-1266
		Night Tech: Bryan Schmidt	Phone # 970-556-5789
FIELD:		FIELD REP: Michael Durham	Phone # 505 220 2865

DATE: 02/26/14

PACKER @:

PERF:

WELL HEAD DATA					GAS VOLUME DATA													WATER DATA								REMARKS
					ORIFICE READINGS						58332	6785	66822.75				729				6788	531131				
TIME	CHOKE SIZE	WELLHEAD PRESS (psi)	WELLHEAD TEMP	CSG PRESS	METER RUN	DIFF	PRESS	TEMP	ORIFICE PLATE	SALES LINE PRES	SALES GAS	FLARE GAS	SCANNER 2000	SALES MMCF/D	OIL (BBLS/HR)	OIL (BBLS/DAY)	TOTAL OIL BBLS	CORIOLIS READING	WATER (BBLS/HR)	WATER (BBLS/D)	TOTAL WATER	WATER LEFT TO RECOVER	SALINITY (PPM)	SAND	PH	COMMENTS
7:00	20/64	1875	74	0	3.826	17	202	56	2.500	182	89	0	89	2136	1	24	730	0	3	72	6791	531128				
8:00	20/64	1925	72	0	3.826	8	201	62	2.500	175	85	0	85	2040	3	72	733	0	1	24	6792	531127				
9:00	20/64	1900	82	0	3.826	32	197	66	2.500	179	90	0	90	2160	4	96	737	0	3	72	6795	531124				
10:00	20/64	1925	80	0	3.826	23	199	57	2.500	181	115	0	115	2760	3	72	740	0	6	144	6801	531118				
11:00	22/64	1950	83	0	3.826	23	200	59	2.500	184	86	0	86	2064	4	96	744	0	3	72	6804	531115				
12:00	22/64	1950	90	0	3.826	26	209	71	2.500	190	108	0	108	2592	0	0	744	0	0	0	6804	531115				
13:00	22/64	1950	82	0	3.826	20	212	54	2.500	196	121	0	121	2904	4	96	748	0	3	72	6807	531112				
14:00	22/64	1950	82	0	3.826	22	215	61	2.500	199	81	0	81	1944	0	0	748	0	2	48	6809	531110				
15:00	20/64	1950	81	0	3.826	20	209	62	2.500	201	95	0	95	2280	1	24	749	0	3	72	6812	531107				
16:00	18/64	1975	80	0	3.826	15	211	59	2.500	197	79.75	1.25	81	1914	0	0	749	0	3	72	6815	531104				16:45 went to full flare because static on sales line reached 211
17:00	16/64	1925	80	0	3.826	24	186	58	2.500	207	60	24	84	1440	1	24	750	0	1	24	6816	531103				
18:00	16/64	1900	79	0	3.826	20	176	60	2.500	190	0	85	85	0	1	24	751	0	1	24	6817	531102				
19:00	16/64	1875	77	0	3.826	18	161	57	2.500	151	0	85	85	0	0	0	751	0	1	24	6818	531101				19:05 static on sales line dropped, opened sales
20:00	18/64	1900	74	0	3.826	19	160	56	2.500	139	42	42	84	1008	1	24	752	0	2	48	6820	531099				20:00 closed flare
21:00	18/64	1900	77	0	3.826	25	178	61	2.500	158	100.75	1.25	102	2418	1	24	753	0	3	72	6823	531096				
22:00	18/64	1925	77	0	3.826	28	185	60	2.500	166	101.75	1.25	103	2442	2	48	755	0	2	48	6825	531094				
23:00	18/64	1925	75	0	3.826	24	186	61	2.500	170	104.75	1.25	106	2514	2	48	757	0	2	48	6827	531092				
0:00	18/64	1925	76	0	3.826	23	188	58	2.500	171	103.75	1.25	105	2490	1	24	758	0	3	72	6830	531089				
1:00	18/64	1925	76	0	3.826	24	192	60	2.500	174	102.75	1.25	104	2466	2	48	760	0	2	48	6832	531087				
2:00	18/64	1925	78	0	3.826	23	196	57	2.500	179	104.75	1.25	106	2514	2	48	762	0	3	72	6835	531084				
3:00	18/64	1925	78	0	3.826	24	200	62	2.500	182	100.75	1.25	102	2418	1	24	763	0	3	72	6838	531081				
4:00	18/64	1925	80	0	3.826	23	200	60	2.500	183	98.75	1.25	100	2370	1	24	764	0	2	48	6840	531079				
5:00	18/64	1925	80	0	3.826	24	200	61	2.500	186	95	0	95	2280	0	0	764	0	2	48	6842	531077				
6:00	18/64	1925	81	0	3.826	22	209	59	2.500	191	83	0	83	1992	1	24	765	0	1	24	6843	531076				

GAS PROD (MCF/D):	2295	ACCUM PROD GAS(MCF) SCANNER 2000	69117.75	OIL PROD (BBLS/DAY)	36	H20 PROD (BBLS/DAY):	55	CHLORIDES (PPM):	
SALES GAS(MCF/D):	2047.75	ACCUM SALES GAS(MCF) TOTAL FLOW	60379.75	OIL RECOVERED (BBLS)	765	H20 RECOVERED (BBLS):	6843	H2S (PPM):	0
FLARE GAS(MCF/D):	247.25	ACCUM FLARE GAS(MCF)	7032	BLWTR:	531,076	H2O % Recovered:	1.29%	CO2 (%):	
SALES MMCF/D AVERAGE:	85.32								

APPENDIX J-3

DE BEQUE WATER STATION
WEEKLY/MONTHLY/BI-ANNUAL
OPERATING CHECKLIST

Black Hills Plateau Production

De Beque Water Station

Weekly Operations Checklist

Date _____

Operator _____

Water Impoundment	Comments
Water Level – Visual Inspection	
Oil Sheen or Debris – Visual Inspection	
Record Flow Meter Values – In/Out	
Fencing & Hextile Cover – Visual Inspection	
Piping – Visual Inspection	

Notes:

Black Hills Plateau Production

De Beque Water Station

Monthly Operation Checklist

Date _____

Operator _____

Water Impoundment	Comments
Water Level - Visual Inspection	
Oil Sheen/Debris - Visual Inspection	
Flow Records - Meter Reading (In/Out) Record Readings	
Fencing & Hextile Cover - Visual Inspection	
Piping - Visual Inspection	
Leak Detection System – Measure & Record	
Inspect Overflow Spillway	
Notes:	

Signature: _____

Black Hills Plateau Production

De Beque Water Station

Semi-Annual Operation Checklist

Date _____

Operator _____

Water Impoundment	Comments
Water Level - Visual Inspection	
Oil Sheen/Debris - Visual Inspection	
Flow Records - Meter Reading (In/Out)	
Fencing & Hextile Cover - Visual Inspection	
Piping - Visual Inspection	
Spillway # 1 – Visual Inspection	
Operate Inlet Valve – On/Off Check	
Check Condition of Discharge Line	
Remove Discharge Pump – Check Fittings	
Inspect Power Cord from Pump to Electrical Box.	
Check Pump Intake – Clean Intake Screen	
Check Leak Detection for Liquids	
Visual Inspection of PVC Liner to Water Elevation	
Notes:	

Signature: _____

APPENDIX K

EMERGENCY RESPONSE PLAN

DE BEQUE WATER STATION EMERGENCY RESPONSE PLAN

PREPARED FOR:

Black Hills Exploration & Production
A Black Hills Corporation Enterprise

BLACK HILLS PLATEAU PRODUCTION
1515 WYNKOOP STREET, SUITE 500
DENVER CO 80202

PREPARED BY:

WWC ENGINEERING

1275 MAPLE STREET, SUITE F
HELENA, MT 59601
(406) 443-3962
www.WWCengineering.com

Innovation
Quality
Value

MARCH 2015

De Beque Water Station Emergency Response Plan

Prepared for: Black Hills Plateau Production
ATTN: Brett Hurlbut
1515 Wynkoop Street, Suite 500
Denver, CO 80202
(303) 566-3356

Prepared by: WWC Engineering
1275 Maple Street Suite F
Helena, MT 59601
(406) 443-3962
Fax: (406) 449-0056

Principal Authors: Troy Solly, E.I.

Reviewed by: Shawn Higley, P.E., Helena Branch Manager
Kevin Grabinski, P.E., Project Manager

Date: March 2015

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Emergency Response Plan

De Beque Water Station

INTRODUCTION AND SCOPE

This Emergency Response Plan (ERP) for contains procedures that personnel at the De Beque Water Station will follow in the event of fire, explosion, spills, or discharges of produced water from the containment ponds. The objective of this ERP is to minimize hazards to fresh water, public health, safety or the environment from fires, explosions or an unplanned sudden or non-sudden release of contaminants or oil field waste to soil, surface water or groundwater.

FACILITY DESCRIPTION, MAPS, AND DRAWINGS

The De Beque Water Station is designed for the collection of produced water from surrounding oil and gas operations. The proposed ponds are located approximately 2.2 miles west of De Beque, Colorado in SE ¼ of the SW ¼ of Section 29, Township 8 South, Range 97 West, 6th P.M as shown on Exhibit K1. The proposed facility is located on the south side of the V2/10 Road. There are no municipalities, schools, businesses, hospitals, churches, or institutions located within 1,000 feet of the proposed facility.

Produced water from Black Hills' surrounding oil and gas operations will be the only type of waste accepted at this facility. Prior to storage, the produced water will be separated from hydrocarbons at the well head site and also receive a secondary treatment with an oil skimmer tank located within the pump station. Exhibit K2 includes the layout of the facility along with evacuation routes leading outside of the facility boundary.

This ERP is intended to serve as an "all hazards" plan. It contains established guidelines for effectively managing these hazards and the names of organizations/agencies to be notified in the event of an emergency situation. The procedures outlined in this ERP were developed under the assumption that the local fire protection and emergency response agencies will respond to emergencies at the reported location when notified and will assist to the extent of their respective capabilities.

PLAN AVAILABILITY

This plan will be provided to the following agencies: Colorado Oil and Gas Conservation Commission (COGCC), De Beque Marshal Department, Mesa County Sheriff's Office,

and the De Beque Fire Protection District. In addition, this plan will be available within the pump house and office building within the De Beque Water Station, and the Black Hills office located in Denver, CO.

EMERGENCY PLAN

RESPONSIBILITIES OF PERSONNEL

1) Facility Supervisor – The facility supervisor will serve as the incident commander (IC) for the facility. The IC is responsible for the training of operators working at the facility, contractors at the facility, and visitors to the facility on implementing this Contingency Plan for Emergencies. In the event of a fire, explosion, release, or other emergency situation that threatens the health or safety of on-site personnel, the IC will direct evacuations and will contact or designate facility personnel to contact emergency services. Evacuation notices will be made to all on-site personnel via voice or radio communication. If emergency services are contacted, the IC will provide responders with information regarding the characteristic of the emergency and any on-site resources that are available.
2) Facility Operators – The facility operators will perform various operations within this Contingency Plan for Emergencies including assisting with the evacuation of contractors and visitors to safe briefing areas and keeping the facility supervisor informed on evacuation and emergency mitigation procedures.
3) Contractors and Visitors – Contractors and visitors to the facility will be familiar with the procedures contained within this Contingency Plan for Emergencies. Contractors and visitors will follow the facility supervisor's and facility operators' instructions during an emergency situation.

GENERAL NOTES

A T-Card System will be located at the office building located at the south side of the facility to account for all persons on site. The T-Card system will have an "In-Facility" and "Out-of-Facility" T-Card slot. Each person entering the facility will fill out a T-Card with his/her name and cell phone number and place it in the corresponding slot to provide a quick means of on-site accountability. After completing a T-Card, each person entering the facility will obtain a handheld radio that shall be maintained on his/her person at all times while within the proposed facility.

Standard fire alarms will be located within the pump house within the De Beque Water Station. The fire alarms will be used to notify facility personnel to the presence of a fire via flashing white light and audible alarm that produces 1 to 2 beeps per second.

Notification of a fire alarm will also be sent via SCADA system to the facility office building. Facility personnel will use visual inspection to determine the presence of any fire outside of the pump houses and will notify all other personnel via voice or radio communication.

The following steps describe actions that will be taken by facility personnel in the event of a fire, explosion, release to soil, release to surface water, and release to groundwater. The majority of these steps will be performed concurrently. It must be noted that the Incident Commander (IC) may amend any of these procedures as seen fit during an emergency to protect fresh water, public health, safety, and the environment.

FIRE

Emergency Notification:

- Fire alarms will provide on-site and remote (via SCADA system) notification of the presence of fire within a facility pump house or office building. Additionally, facility personnel will use visual inspection to determine the presence of any fire outside of the pump houses and will notify all other personnel via voice or radio communication.
- Facility operators will attempt to extinguish an incipient stage fire using fire extinguishers located in each of the pump houses at the facility. If the fire is unable to be quickly contained via fire extinguishers or other available means, the Incident Commander (IC) will instruct facility operators to contact local emergency responders. Facility personnel shall assist emergency first responders in any way deemed necessary.

Evacuation Procedures:

- If deemed necessary, personnel, visitors, and contractors on site will evacuate to a designated safe briefing area (SBA). Concurrently, personnel at the facility office building will review the T-Card system in order to account for all personnel, visitors, and contractors on site. In the event that personnel, visitors, and contractors have evacuated to a SBA, they will be contacted via handheld radio to ensure safe evacuation.

Source Elimination and Containment:

- Valves on the produced water inlet lines shall be shut off to stop the flow of water into the pump station and ponds until the threat of fire has been mitigated. During this time, personnel within the facility office building will remotely monitor (via SCADA system) the pipe network and valve locations to ensure that leaks,

pressure buildup, or rupturing of the valves and pipes does not occur after all inlet valves have been shut off.

- If the fire creates an imminent danger of a release of produced water into the environment, the submersible pumps located at the affective pond(s) (if operable) will be used to evacuate the water from the facility to an adjacent pond(s) if storage space is available.
- If the pumps are inoperable, backup pumps and/or vacuum trucks may be brought in to evacuate water from the affected ponds (if necessary). Absorbent pads and isolation rope pads shall be deployed down gradient from the facility if necessary.

Event Assessment

- The Incident Commander (IC) will designate facility personnel to perform a visual inspection of the affected area to determine the character and exact source of any released materials. This visual inspection will focus on surficial water marks or damp spots on the exterior pond berms, pump houses, pipeline alignments, and down gradient areas. Further attention will be given to the presence of any tears in the pond liner and presence of water within the pond leak detection systems. Concurrently, the IC will perform a visual inspection of the area to determine whether the fire has the ability to spread outside of the facility to assess any possible hazards to public health and safety. This inspection will include an assessment of the current wind speed, wind direction, and the presence of any materials adjacent to the facility that could act as fuel for a spreading fire.
- A review of the facility's water meter records will be performed to determine the character, exact source, and amount of released produced water. Additionally, hydrostatic testing of the pipe network may be performed. The extent of the released produced water will be determined via a visual inspection of the facility for water marks or damp spots on the exterior pond berms, pipeline alignments, and down gradient areas. Additionally, groundwater quality testing (and comparison to background water quality) of the surrounding water wells will be performed to determine the extent of the release. A subsurface investigation may be performed if needed to determine the extent of the spill. This subsurface investigation may include water quality testing and potholing (drilling shallow boreholes or digging shallow test holes) that will provide an indication of any direct or indirect hazards to fresh water, public health, safety, or the environment

that may have resulted from the release caused by fire. Indications of hazards may include the contamination of groundwater or the vadose zone.

Contingency Actions:

- 55 gallon drums may be used to store small releases of produced water (when obtaining a vacuum truck would not be necessary), contaminated materials, and any materials used in cleanup procedures. The drums would be temporarily stored at the lay down yard until transport to an approved disposal facility.
- Large releases of produced water will be cleaned up via vacuum truck and disposed of at an approved facility. Contaminated soils and all other affected materials will be temporarily stored within a roll-off container with temporary graded berms surrounding it (if haul trucks are not immediately available). The container will be located in the lay down yard. Contaminated soils and other affected materials will then be transported to and disposed of at a properly permitted disposal facility pursuant to a COGCC approved plan.

Documentation and Remediation:

- A Form 19, Spill/Release Report, will be submitted to COGCC, and COGCC approval will be obtained for a plan to cleanup and/or remediate any released produced water and contaminated materials. The IC will ensure compliance with the applicable provisions of the COGCC rules regarding notice and the submittal and approval of remediation plans and/or abatement plans.
- Approved facility personnel will resolve the cause of the fire prior to additional produced water being stored at the facility.

EXPLOSION

Emergency Notification:

- Fire alarms will provide on-site and remote (via SCADA system) notification of an explosion or resulting fire within the facility pump house or office building. Additionally, facility personnel will use visual inspection to determine the presence of any fire caused by the explosion outside of the pump house and will notify all other personnel via voice or radio communication.
- Facility operators will attempt to extinguish any incipient stage fires caused by the explosion using fire extinguishers located in the pump house at the facility. If the fire is unable to be quickly contained via fire extinguishers or other available means, the Incident Commander (IC) will instruct facility operators to contact

local emergency responders. Facility personnel shall assist emergency first responders in any way deemed necessary.

Evacuation Procedures:

- If deemed necessary, personnel, visitors, and contractors on site will evacuate to a designated safe briefing area (SBA). Concurrently, personnel at the facility office building will review the T-Card system in order to account for all personnel, visitors, and contractors on site. In the event that personnel, visitors, and contractors have evacuated to a SBA, they will be contacted via handheld radio to ensure safe evacuation.

Source Elimination and Containment:

- Valves on the produced water inlet lines shall be shut off to stop the flow of water into the pump station and ponds until the threat of explosion has been mitigated. During this time, personnel within the facility office building will remotely monitor (via SCADA system) the pipe network and valve locations to ensure that leaks, pressure buildup, or rupturing of the valves and pipes does not occur after all inlet valves have been shut off.
- If the explosion creates an imminent danger of a release of produced water into the environment, the submersible pumps located at the affected pond(s) (if operable) will be used to evacuate the water from the facility to an adjacent pond(s) if storage space is available.
- If the pumps are inoperable, backup pumps and/or vacuum trucks may be brought in to evacuate water from the affected ponds (if necessary). In addition, grading and diversion channels and/or retention ponds may be constructed down gradient from the facility using a backhoe to retain any possible released water. Absorbent pads and isolation rope pads shall be deployed down gradient from the facility if necessary.

Event Assessment:

- The Incident Commander (IC) will designate facility personnel to perform a visual inspection of the affected area to determine the character and exact source of any released materials. This visual inspection will focus on surficial water marks or damp spots on the exterior pond berms, pump houses, pipeline alignments, and down gradient areas. Further attention will be given to the presence of any tears in the pond liner and presence of water within the pond leak detection systems. Concurrently, the IC will perform a visual inspection of the area to determine any risks of further explosions to assess any possible hazards to

public health and safety. This inspection will include an assessment of the current wind speed, wind direction, and the presence of any materials adjacent to the facility that could provide an explosion hazard.

- A review of the facility's water meter records will be performed to determine the character, exact source, and amount of released produced water. Additionally, hydrostatic testing of the pipe network may be performed. The extent of the released produced water will be determined via a visual inspection of the facility for water marks or damp spots on the exterior pond berms, pipeline alignments, and down gradient areas. Additionally, groundwater quality testing (and comparison to background water quality) of the surrounding water wells will be performed to determine the extent of the release. A subsurface investigation may be performed if needed to determine the extent of the spill. This subsurface investigation may include water quality testing and potholing (drilling shallow boreholes or digging shallow test holes) that will provide an indication of any direct or indirect hazards to fresh water, public health, safety, or the environment that may have resulted from the release caused by explosion. Indications of hazards may include the contamination of groundwater or the vadose zone.

Contingency Actions:

- 55 gallon drums may be used to store small releases of produced water (when obtaining a vacuum truck would not be necessary), contaminated materials, and any materials used in cleanup procedures. The drums would be temporarily stored at the lay down yard until transport to an approved disposal facility.
- Large releases of produced water will be cleaned up via vacuum truck and disposed of at an approved facility. Contaminated soils and all other affected materials will be temporarily stored within a roll-off container with temporary graded berms surrounding it (if haul trucks are not immediately available). The container will be located in the lay down yard. Contaminated soils and other affected materials will then be transported to and disposed of at a properly permitted disposal facility pursuant to a COGCC approved plan.

Documentation and Remediation:

- A Form 19, Spill/Release Report, will be submitted to COGCC, and COGCC approval will be obtained for a plan to cleanup and/or remediate any released produced water and contaminated materials. The IC will ensure compliance with the applicable provisions of the COGCC rules regarding notice and the submittal and approval of remediation plans and/or abatement plans.

- Approved facility personnel will resolve the cause of the explosion prior to additional produced water being stored at the facility.

RELEASE TO SOIL

Emergency Notification:

- If evidence of a release to soil is discovered, facility personnel and personnel within the facility office building will be alerted to the discovery via voice and/or handheld radio communications.

Evacuation Procedures:

- Not applicable.

Source Elimination and Containment:

- Valves on the produced water inlet lines shall be shut off to stop the flow of water into the pump station and ponds until the threat of release has been mitigated. During this time, personnel within the facility office building will remotely monitor (via SCADA system) the pipe network and valve locations to ensure that leaks, pressure buildup, or rupturing of the valves and pipes does not occur after all inlet valves have been shut off.
- If required to prevent the further release of produced water, the Incident Commander will instruct facility operators to evacuate water from the facility to an adjacent pond(s) if storage space is available using submersible pumps located at each pond.

  If the pumps are inoperable, backup pumps and/or vacuum trucks may be brought in to evacuate water from the affected ponds (if necessary).

Event Assessment:

- A release of produced water to the soil will initially be determined via a visual inspection of the facility or during routine monitoring of the permanent groundwater monitoring well. Any surficial water marks or damp spots on the exterior pond berms, pump houses, pipeline alignments, or down gradient areas may be evidence of a release to the surrounding soil. Additional evidence may be a tear in the pond liner, presence of water within the leak detection systems, visual inspection of pond levels, or a review of the facility's water meter records.
- The Incident Commander (IC) will designate facility personnel to perform a visual inspection of the affected area to determine the character and exact source of any released materials. This visual inspection will focus on surficial water marks

or damp spots on the exterior pond berms, pump houses, pipeline alignments, and down gradient areas. Further attention will be given to the presence of any tears in the pond liner and presence of water within the pond leak detection systems.

- A review of the facility's water meter records will be performed to determine the character, exact source, and amount of released produced water. Additionally, hydrostatic testing of the pipe network may be performed. The extent of the released produced water will be determined via a visual inspection of the facility for water marks or damp spots on the exterior pond berms, pipeline alignments, and down gradient areas as well as potholing to determine the depth of contamination. Additionally, groundwater quality testing (and comparison to background water quality) of the surrounding water wells will be performed to determine the extent of the release. A subsurface investigation may be performed if needed to determine the extent of the spill. This subsurface investigation may include water quality testing of the monitoring well and potholing (drilling shallow boreholes or digging shallow test holes) that will provide an indication of any direct or indirect hazards to fresh water, public health, safety, or the environment that may have resulted from the release. Indications of hazards may include the contamination of groundwater or the vadose zone.

Contingency Actions:

- 55 gallon drums may be used to store small releases of produced water (when obtaining a vacuum truck would not be necessary), contaminated materials, and any materials used in cleanup procedures. The drums would be temporarily stored at the lay down yard until transport to an COGCC approved disposal facility.
- Large releases of produced water will be cleaned up via vacuum truck and disposed of at an approved facility. Contaminated soils and all other affected materials will be temporarily stored within a roll-off container with temporary graded berms surrounding it (if haul trucks are not immediately available). The container will be located in the lay down yard. Contaminated soils and other affected materials will then be transported to and disposed of at a properly permitted disposal facility pursuant to a COGCC approved plan.

Documentation and Remediation:

- A Form 19, Spill/Release Report, will be submitted to COGCC, and COGCC approval will be obtained for a plan to cleanup and/or remediate any released

produced water and contaminated materials. The IC will ensure compliance with the applicable provisions of the COGCC rules regarding notice and the submittal and approval of remediation plans and/or abatement plans.

- Approved facility personnel will resolve the cause of the release prior to additional produced water being stored at the facility.

RELEASE TO SURFACE WATER

Emergency Notification:

- If evidence of a release to surface water is discovered, facility personnel and personnel within the facility office building will be alerted to the discovery via voice and/or handheld radio communications.

Evacuation Procedures:

- Not applicable.

Source Elimination and Containment:

- Valves on the produced water inlet lines shall be shut off to stop the flow of water into the pump station and ponds until the threat of release has been mitigated. During this time, personnel within the facility office building will remotely monitor (via SCADA system) the pipe network and valve locations to ensure that leaks, pressure buildup, or rupturing of the valves and pipes does not occur after all inlet valves have been shut off.
- If required to prevent the further release of produced water, the Incident Commander will instruct facility operators to evacuate water from the facility to an adjacent pond(s) if storage space is available using submersible pumps located at each pond.
- If the pumps are inoperable, backup pumps and/or vacuum trucks may be brought in to evacuate water from the affected ponds (if necessary). Additionally, grading/diversion channels and/or retention ponds may be constructed down gradient from the facility using a backhoe to retain any possible released water. Absorbent pads and isolation rope pads shall be deployed down gradient from the facility if necessary.

Event Assessment:

- A release of produced water to surface water will initially be determined via a visual inspection of the facility. Any damage or erosion of the pond berms, slope failures, damage to the pump house or above ground piping, and the visual

presence of produced water on the ground surface may indicate a release to surface water.

- The Incident Commander (IC) will designate facility personnel to perform a visual inspection of the affected area to determine the character and exact source of any released materials This visual inspection will focus on surficial water marks or damp spots on the exterior pond berms, pump house, pipeline alignments, and down gradient areas. Further attention will be given to the presence of any tears in the pond liner and presence of water within the pond leak detection systems. Concurrently, the IC will perform a visual inspection of the down gradient areas for the presence of personnel, visitors, contractors, and the public to determine any hazards to public health and safety that may be caused by the surface release.
- A review of the facility's water meter records will be performed to determine the character, exact source, and amount of released produced water. Additionally, hydrostatic testing of the pipe network may be performed. The extent of the released produced water will be determined via a visual inspection of the facility for water marks or damp spots on the exterior pond berms, pipeline alignments, and down gradient areas as well as potholing to determine the depth of contamination. Additionally, groundwater quality testing (and comparison to background water quality) of the surrounding water wells will be performed to determine the extent of the release. A subsurface investigation may be performed if needed to determine the extent of the spill. This subsurface investigation may include water quality testing and potholing (drilling shallow boreholes or digging shallow test holes) that will provide an indication of any direct or indirect hazards to fresh water, public health, safety, or the environment that may have resulted from the release. Indications of hazards may include the contamination of groundwater or the vadose zone.

Contingency Actions:

- 55 gallon drums may be used to store small releases of produced water (when obtaining a vacuum truck would not be necessary), contaminated materials, and any materials used in cleanup procedures. The drums would be temporarily stored at the lay down yard until transport to an approved disposal facility.
- Large releases of produced water will be cleaned up via vacuum truck and disposed of at an approved facility. Contaminated soils and all other affected materials will be temporarily stored within a roll-off container with temporary graded berms surrounding it (if haul trucks are not immediately available). The

container will be located in the lay down yard. Contaminated soils and other affected materials will then be transported to and disposed of at a properly permitted disposal facility pursuant to a COGCC approved plan.

Documentation and Remediation:

- A Form 19, Spill/Release Report, will be submitted to COGCC, and COGCC approval will be obtained for a plan to cleanup and/or remediate any released produced water and contaminated materials. The IC will ensure compliance with the applicable provisions of the COGCC rules regarding notice and the submittal and approval of remediation plans and/or abatement plans.
- Approved facility personnel will resolve the cause of the release prior to additional produced water being stored at the facility.

RELEASE TO GROUNDWATER

Emergency Notification:

- If evidence of a release to groundwater is discovered, facility personnel and personnel within the facility office building will be alerted to the discovery via voice and/or handheld radio communications.

Evacuation Procedures:

- Not applicable.

Source Elimination and Containment:

- Valves on the produced water inlet lines shall be shut off to stop the flow of water into the pump station and ponds until the threat of release has been mitigated. During this time, personnel within the facility office building will remotely monitor (via SCADA system) the pipe network and valve locations to ensure that leaks, pressure buildup, or rupturing of the valves and pipes does not occur after all inlet valves have been shut off.
- If required to prevent the further release of produced water, the Incident Commander will instruct facility operators to evacuate water from the facility to an adjacent pond(s) if storage space is available using submersible pumps located at each pond.
- If the pumps are inoperable, backup pumps and/or vacuum trucks may be brought in to evacuate water from the affected ponds (if necessary).

Event Assessment:

- A release of produced water to groundwater will initially be determined via a visual inspection of the facility or during routine monitoring of the permanent groundwater monitoring well. Any surficial water marks or damp spots on the exterior pond berms, pump houses, pipeline alignments, or down gradient areas may be evidence of a release to the surrounding soil. Additional evidence may be a tear in the pond liner, presence of water within the leak detection systems, visual inspection of pond levels, or a review of the facility's water meter records.
- The Incident Commander (IC) will designate facility personnel to perform a visual inspection of the affected area to determine the character and exact source of any released materials. This visual inspection will focus on surficial water marks or damp spots on the exterior pond berms, pump house, pipeline alignments, and down gradient areas. Further attention will be given to the presence of any tears in the pond liner and presence of water within the pond leak detection systems.
- A review of the facility's water meter records will be performed to determine the character, exact source, and amount of released produced water. Additionally, hydrostatic testing of the pipe network may be performed. The extent of the released produced water will be determined via a visual inspection of the facility for water marks or damp spots on the exterior pond berms, pipeline alignments, and down gradient areas as well as potholing to determine the depth of contamination. Additionally, groundwater quality testing (and comparison to background water quality) of the surrounding water wells will be performed to determine the extent of the release. A subsurface investigation may be performed if needed to determine the extent of the spill. This subsurface investigation may include water quality testing and potholing (drilling shallow boreholes or digging shallow test holes) that will provide an indication of any direct or indirect hazards to fresh water, public health, safety, or the environment that may have resulted from the release. Indications of hazards may include the contamination of groundwater or the vadose zone.

Contingency Actions:

- If it is determined that a release to groundwater occurred, groundwater quality mitigation efforts will be examined and performed if feasible pursuant to COGCC rules and a COGCC approved plan.
- Due to liner integrity failure, contaminated soils will be mitigated during liner repair pursuant to COGCC rules and in accordance with a COGCC approved plan.

Documentation and Remediation:

- A Form 19, Spill/Release Report, will be submitted to COGCC, and COGCC approval will be obtained for a plan to cleanup and/or remediate any released produced water and contaminated materials. The IC will ensure compliance with the applicable provisions of the COGCC rules regarding notice and the submittal and approval of remediation plans and/or abatement plans.
- Approved facility personnel will resolve the cause of the release prior to additional produced water being stored at the facility.

INCOMPATIBLE RELEASED MATERIAL

Emergency Notification:

- If the presence of any released material (other than the produced water stored within the facility) is detected within the facility, facility personnel and personnel within the facility office building will be alerted to the discovery via voice and/or handheld radio communications. An example of released material within the facility may include fluid leaking out of a vehicle that has been on-site.

Evacuation Procedures:

- Not applicable.

Source Elimination and Containment:

- Absorbent pads and/or temporarily graded isolation will be used to isolate the released material from the produced water to prevent mixing from occurring.
- If the source is visually identifiable (i.e. a truck visibly leaking fluid), the source will be immediately removed from the facility to prevent the further release of material.
- If the released material has spilled into a particular pond, valves on the inlet and outlet pipes for that pond will be shut to isolate the released material and/or mixture from the produced water in the other ponds. During this time, personnel within the facility office building will remotely monitor (via SCADA system) the pipe network and valve locations to ensure that leaks, pressure buildup, or rupturing of the valves and pipes does not occur after the valves have been shut off.

Event Assessment:

- Facility personnel will perform a visual inspection of the area to determine the source of the released material. This inspection would include determining

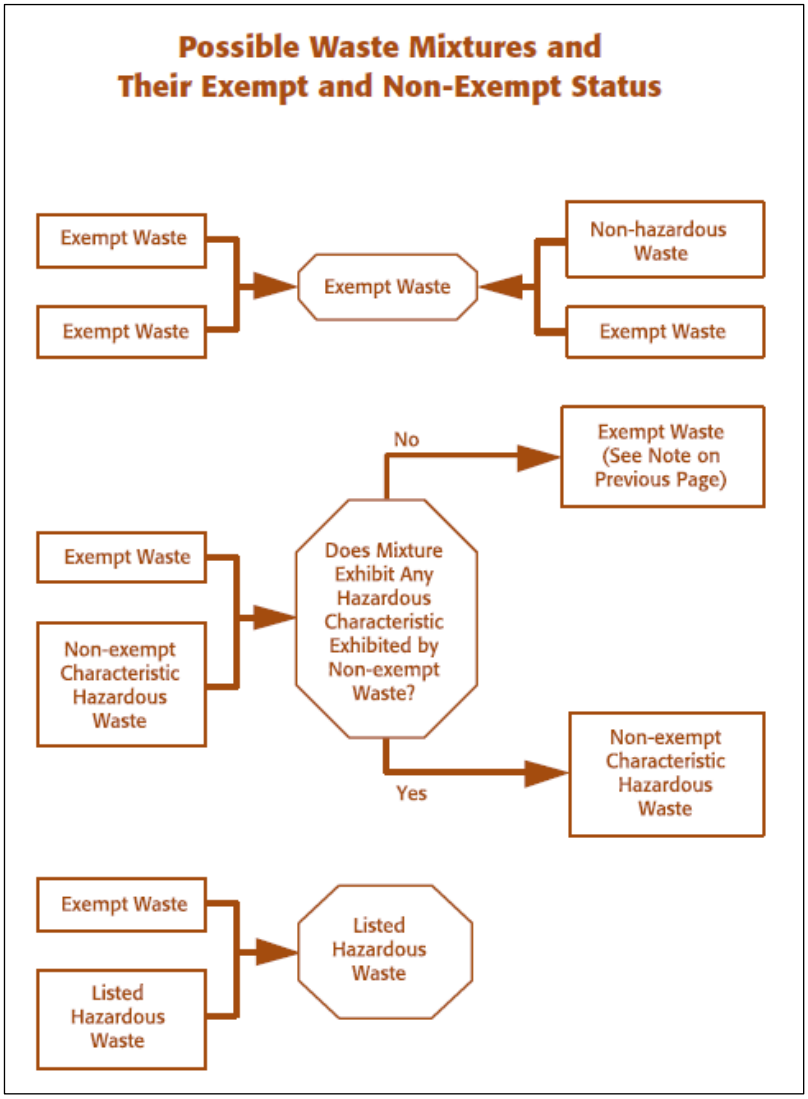
whether any vehicles were recently on-site that may have caused the release of material. Facility personnel will also review the T-Card system at the facility office building to determine the person(s) that were recently on-site that may have created the presence of released material at the facility.

- The released material may be classified as exempt or non-exempt from regulations under Subtitle C of the Resource Conservation and Recovery Act (RCRA). If mixing of the released material with the stored produced water has occurred (or the released material has spilled into a particular pond), the following mixing rules flow chart taken from the United States Environmental Protection Agency (EPA) 530-K-01-004 publication will be used as a guide to determine the mixtures exempt or non-exempt status. A full copy of this publication is located in Appendix K-1 of this plan and will provide further assistance to facility personnel in the determination of exempt and non-exempt wastes. If the nature of the released material or mixture is unknown, characteristic testing of the material or mixture will be performed to determine its ignitability, corrosivity, reactivity, and toxicity. This testing will assist in the determination of the released material or mixture's exempt or non-exempt status.

Contingency Actions:

- The additional released material and/or mixture will be cleaned up with absorbent pads or vacuum truck. The released material and/or mixture will be placed in 55 gallon drums (that do not contain produced water) and labeled to differentiate between drums containing only produced water. The drums would be temporarily stored at the lay down yard until disposed of per RCRA Subtitle C (for non-exempt characteristic hazardous waste and listed hazardous waste) or RCRA Subtitle D and OCD approval (for exempt waste). Details for this determination of waste mixture status are given in the previously listed flow chart.
- If the released material has spilled into a particular pond, the released material and produced water mixture within the pond will undergo characteristic testing, and the status of the mixture will be determined to be exempt waste, non-exempt characteristic hazardous waste, or listed hazardous waste. If non-exempt characteristic hazardous waste or listed hazardous waste, the released material mixture will be evacuated via vacuum truck (that is authorized to haul hazardous waste) and disposed of per RCRA Subtitle C (for non-exempt characteristic hazardous waste and listed hazardous waste). If the mixture has been determined to be exempt, it may be reused for future oil and gas exploration operations (similar to the produced water that is stored at the facility). Additionally, the exempt mixture may also be disposed of per RCRA Subtitle D

and OCD. Details for this determination of waste mixture status are given in the flow chart.



(Taken from Page 17 of EPA 530-k-01-004)

Documentation and Remediation:

- A Form 19, Spill/Release Report, will be submitted to COGCC, and COGCC approval will be obtained for a plan to cleanup and/or remediate any released produced water, other released materials, and contaminated materials. The IC

will ensure compliance with the applicable provisions of the COGCC rules regarding notice and the submittal and approval of remediation plans and/or abatement plans.

TELEPHONE NUMBERS

1) **Emergency Services**

In the event of an emergency that requires immediate medical attention, personnel shall call 9-1-1 emergency services. The nearest physician is located at the Grand River Medical Center in Rifle, CO. The Grand River Medical Center is located approximately 32 miles east of the facility, while St. Mary's Hospital in Grand Junction, CO is approximately 42 miles west of the facility. The contact information for the hospitals is listed below. A list of emergency contacts that can be posted in at the facility is provided in Appendix K-2.

AGENCY	TELEPHONE NUMBER	ADDRESS
Health Services		
Grand River Medical Center	(970) 625-1510	501 Airport Rd Rifle, CO 81650
St. Mary's Hospital	(970) 244-2273	2635 N 7th St Grand Junction, CO 81501

In the event that law enforcement officials may be contacted, the De Beque Marshal's Office and Mesa County Sheriff's Office contact information is given below.

AGENCY	TELEPHONE NUMBER	ADDRESS
Police Departments		
Mesa County Sheriff's Office	(970) 244-3500	215 Rice St, Grand Junction, CO 81503
De Beque Marshal's Office	(970) 242-6707	381 Minter Avenue De Beque, CO 81630

In case of a fire or explosion occurring at the facility, the contact information for the De Beque Fire Protection District is listed below.

AGENCY	TELEPHONE NUMBER	ADDRESS
Fire Department		
De Beque Fire Protection District	(970) 984-3412	380 Curtis Avenue De Beque, CO 81630

2) Government Agencies

AGENCY	TELEPHONE NUMBER	ADDRESS
COGCC Environmental Release/Incident Report Hotline	(877) 518- 5608	120 Lincoln Street #801 Denver, CO 80203
Colorado Department of Public Health & Environment	(877) 518-5608 (24 hr. hotline)	4300 E Cherry Creek S Dr Denver, CO 80246

3) Black Hills Internal Call List

NAME	TITLE	OFFICE NUMBER	CELL NUMBER	EMAIL
Gary Stripling *(Primary Contact)*	Production Superintendent	(970) 257-0727	(505) 486-0314	Gary.Stripling@blackhillscorp.com
Brett Hurlbut	Facility Engineer	(303) 566-3356		Brett.Hurlbut@blackhillscorp.com

SAFETY EQUIPMENT AND SUPPLIES AVAILABLE

1) Hydrogen Sulfide Monitors:

Equipment	Amount	Location	Description	Capabilities
Individual H_2S monitors	8-12	Stored at facility office building. Must be worn by facility personnel, visitors and contractors at all times while within the facility.	Calibrated on a monthly basis with documentation maintained for each calibration. Water and dust resistant.	Pre-programmed to provide separate alarms for H_2S concentration of 10 ppm (2 audible beeps per second and 1 vibration per second) and H_2S concentration of 20 ppm (3 audible beeps per second and 1 vibration per second).

2) Road Block/ Visual Awareness and Accountability Equipment:

Equipment	Amount	Location	Description	Capabilities
T-Card System	1	Facility office building	Multi-colored T-Cards that can be placed on a board containing both an “In Facility” and “Out of Facility” slots.	Each person entering the facility must fill out a T-Card with name and cell phone number. T-Cards must be placed in the corresponding slot to provide on-site accountability.
Handheld Radios	8-12	Facility office building	Multi-channel, water resistant, handheld radio	Provides means of communication for all on-site personnel, contractors, and visitors
Reflective Traffic Control Vests	4	Facility office building	Yellow or orange mesh vests, Reflective	Provides high visibility protection for facility personnel at road block locations.
Stop Sign Paddles	4	Facility office building	2-sided handheld “Stop” sign, Red with white letters, Reflective, Minimum 18” octagonal dimension	Provides “Stop” instructions to anyone at road block locations.

3) **First Aid Equipment:**

Equipment	Amount	Location	Description	Capabilities
First Aid Kit	2	One (1) located in the pump house, One (1) located at the facility office building	Plastic Case, White Color, Wall Mounted	Contains adhesive bandages, burn treatments, eye treatments, pain relief medicines for a minimum of 10 people

4) **Fire Fighting/Evacuation Notification Equipment:**

Equipment	Amount	Location	Description	Capabilities
Fire Extinguisher	4 on-site & 1 in each company vehicle	Two (2) located in the pump house; Two (2) located in the office building; One (1) located in each on-site company vehicle.	Red Epoxy Cylinder, rechargeable, High corrosion and impact resistant, Minimum 10 lb. cylinder for pump houses, Minimum 2.5 lb. cylinder for vehicles	Effective on Class A, B, and C fires. Capable of smothering wood, plastic, liquid, and electrical fires.
Fire Alarm	2	One (1) located in the pump house; One (1) located in the office building.	Wall or ceiling mounted, Provides flashing white light and audible alarm that produces 1 to 2 beeps per second	Detects the presence fire within the pump houses. Provides on-site notification via flashing lights and audible alarm. Provides notification to the facility office building via SCADA system

5) **Release Cleanup Equipment:**

Equipment	Amount	Location	Description	Capabilities
Absorbent Pads	10 minimum at the pump house	Located within the pump house	Minimum dimensions of 2’ x 3’	Quickly absorbs oil, coolants, produced water, solvents, water, acids, bases
Absorbent Rope Pads	10 minimum at the pump house	Located within the pump house	Minimum dimensions of 8’ x 3”	Quickly absorbs oil, coolants, produced water, solvents, water, acids, bases

EXPECTED CONTAMINANTS AND CONTAMINATED MEDIA

Produced water is the main waste stream that will be stored at the proposed facility. Any hydrocarbons skimmed from the produced water will be stored in below ground tanks until it is transported from the facility. Expected contaminated media that would be affected by a release of produced water will be soil, surface water, and groundwater.

NOTIFICATION

ON-SITE NOTIFICATION

Fire alarms will provide on-site and remote (via SCADA system) notification of a fire or explosion within the pump house. Notification of on-site personnel, contractors, and visitors to the presence of any emergency situation will occur via voice or handheld radio communication. Additionally, appropriate agencies will be contacted by phone (cell phone or permanent phone at facility office building) if their assistance is needed.

COLORADO OIL AND GAS CONSERVATION COMMISSION NOTIFICATION

The COGCC shall be notified in the event of any release of produced water or spills. The COGCC's approval must be gained prior to site cleanup, remediation, and disposal of any released material and material contaminated by the release or spill. The Incident Commander shall comply with the reporting requirements of Rule 906.b. The Incident Commander shall report a release that exceeds twenty (20) barrels by providing verbal notification within 24 hours after discovery to the COGCC. Spills/releases of any size which impact or threaten to impact any surface water supply area shall be reported to the Director and to the Environmental Release/Incident Report Hotline (1-877-518-5608). Spills and releases that impact or threaten a surface water intake shall be verbally reported to the emergency contact for that facility immediately after discovery. Chemical spills and releases shall be reported in accordance with applicable state and federal laws, including the Emergency Planning and Community Right-to-Know Act; the Comprehensive Environmental Response, Compensation, and Liability Act; the Oil Pollution Act; and the Clean Water Act, as applicable.

A copy of the COGCC Form 19, Spill/Release Report, is provided in Appendix K-3. Black Hills internal documentation reports and guidelines are provided in Appendix K-4.

TRAINING AND DRILLS

RESPONSIBILITIES AND DUTIES OF ESSENTIAL PERSONNEL

All personnel involved in the implementation of this plan will be trained on their responsibilities during annual on-site or classroom training meetings. All facility personnel, contractors, and visitors must participate in a facility orientation containing this plan's procedures prior to entering the facility.

ON-SITE OR CLASSROOM DRILLS

Black Hills will conduct on-site or classroom training meetings regarding personnel responsibilities and procedures regarding this plan. These meetings will take place on a yearly basis at a minimum. These meetings will include drills that simulate a situation in which a fire, explosion, or release is detected and will describe the responsibilities of all personnel.

TRAINING AND ATTENDANCE DOCUMENTATION

On-site and classroom training meetings will be documented. This documentation will include attendance sheets and a description of the training and activities that were conducted.

BRIEFING OF PUBLIC OFFICIALS ON PLANS

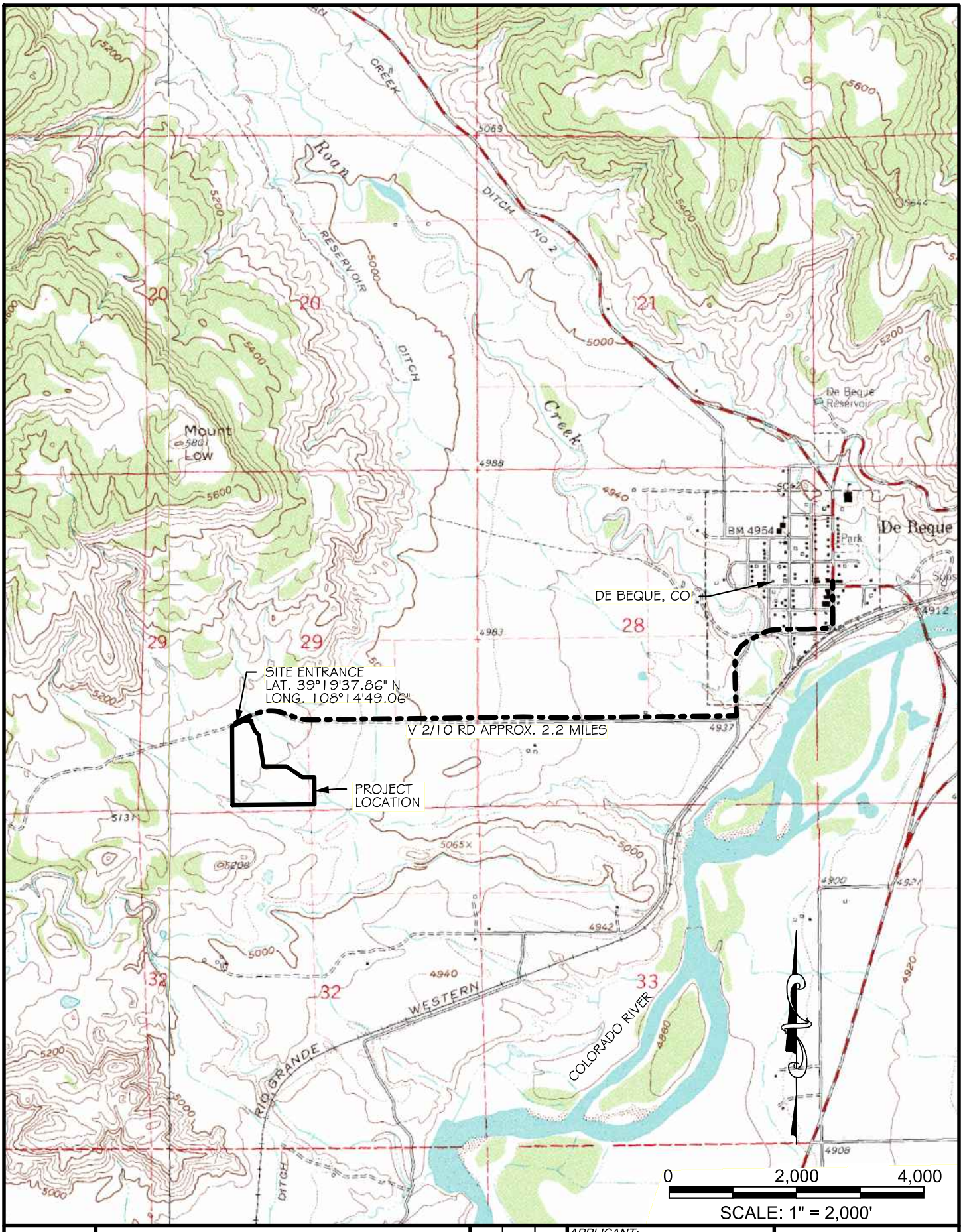
Local law enforcement officials, health officials, and other first responders listed in this plan will be invited to attend the annual on-site or classroom training meetings regarding the contents of this plan. These officials will be notified on the contents of this plan.

PLAN AMENDMENTS

This Contingency Plan for Emergencies shall be amended within five working days whenever: the facility permit is revised or modified; the plan fails in an emergency; the facility changes design, construction, operation, maintenance or other circumstances in a way that increases the potential for fires, explosions or releases of oil field waste constituents that could threaten fresh water, public health, safety or the environment or change the response necessary in an emergency; the list of emergency contacts or their contact information changes; or the list of emergency equipment changes.

Additionally, the Incident Commander may amend this plan during an emergency as necessary to protect fresh water, public health, safety, and the environment.

EXHIBITS



ERP EXHIBIT
K-1

DE BEQUE WATER STATION
SECTION 29, T8S, R97W 6TH P.M.

EMERGENCY RESPONSE MAP

DSGN	DATE	CKD
TAS	2/15/15	STH
REV	DATE	CKD

JOB # 2013-134

APPLICANT:

Black Hills Exploration & Production
A Black Hills Corporation Enterprise
1515 WYNKOOP ST., SUITE 500
DENVER, CO 80202
(303) 566-3356

WWC ENGINEERING
1275 MAPLE STREET, SUITE F
HELENA, MT 59601
(406) 443-3962

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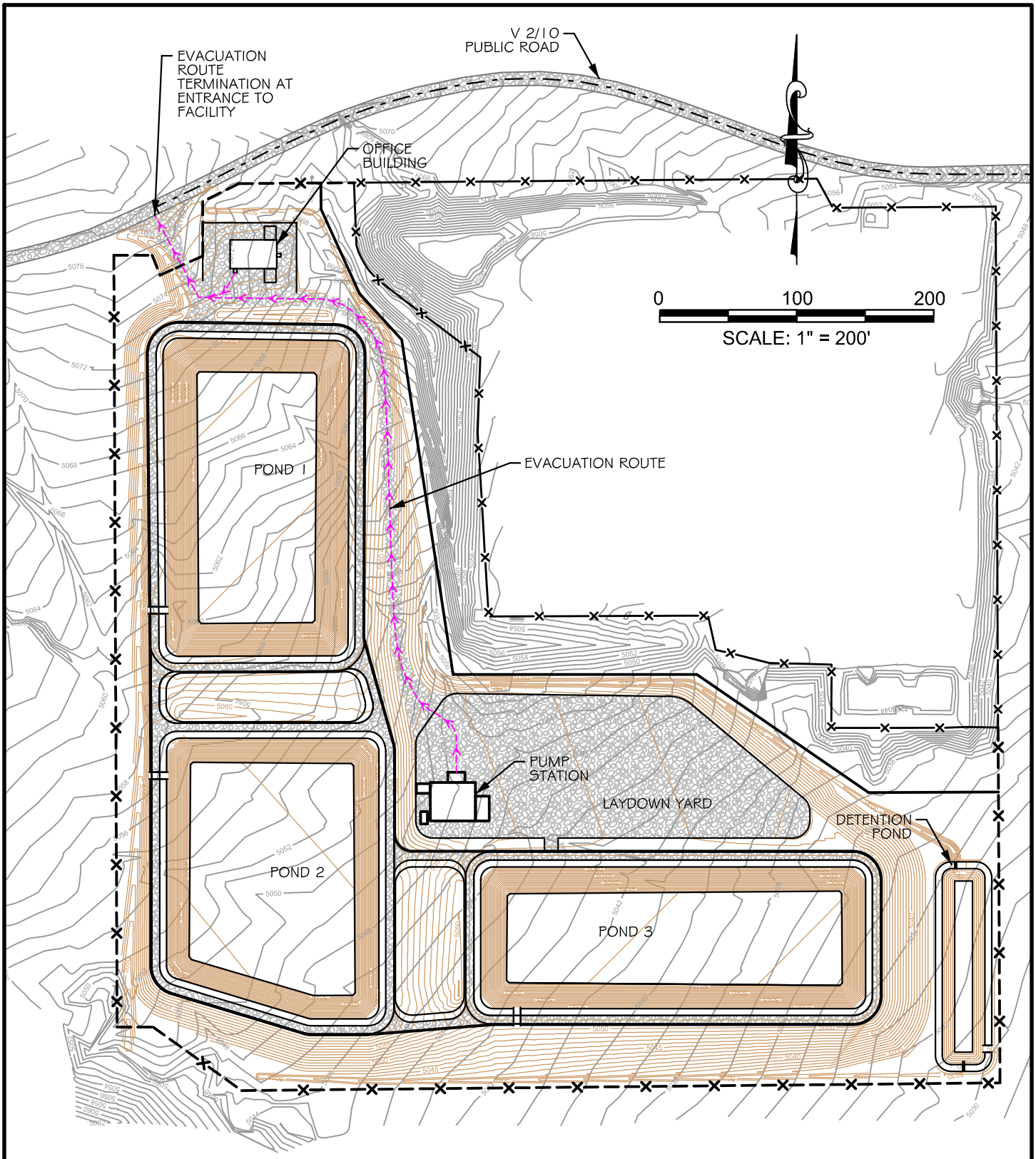

ERP
EXHIBIT

K-2

DE BEQUE WATER STATION
SECTION 29, T8S, R97W 6TH P.M.

EMERGENCY ACTION SITE PLAN

DSGN	DATE	CKD
TAS	2/18/15	STH
REV	DATE	CKD

JOB # 2013-134

APPLICANT:

Black Hills Exploration & Production
A Black Hills Corporation Enterprise

1515 WYNKOOP ST., SUITE 500
DENVER, CO 80202
(303) 566-3356

WWC ENGINEERING

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APPENDIX K-1

EPA 530-K-01-004 PUBLICATION

United States
Environmental Protection
Agency

Exemption of Oil and Gas Exploration and Production Wastes from Federal Hazardous Waste Regulations

Printed on paper that contains at least 30 percent postconsumer fiber.

Cover photo: Oil Production, Bakersfield, California

Introduction

This publication provides an understanding of the exemption of certain oil and gas exploration and production (E&P) wastes from regulation as hazardous wastes under Subtitle C of the Resource Conservation and Recovery Act (RCRA).

The information contained in this booklet is intended to furnish the reader with:

- A basic background on the E&P exemption.
- Basic rules for determining the exempt or non-exempt status of wastes.
- Examples of exempt and non-exempt wastes.
- Status of E&P waste mixtures.
- Clarifications of several misunderstandings about the exemption.

- Answers to frequently asked questions.
- Recommendations for sensible waste management.
- Additional sources of information.

The American Petroleum Institute (API) estimated that 149 million barrels of drilling wastes, 17.9 billion barrels of produced water and 20.6 million barrels of other associated wastes were generated in 1995 from exploration and production (E&P) operations.

Once generated, managing these wastes in a manner that protects human health and the environment is essential for limiting operators' legal and financial liabilities and also makes good business sense. Operators must also determine if the waste is subject to hazardous waste regulations. At times this determination is misunderstood and can lead to improper waste management decisions.

Drilling waste volumes are directly related to the level of drilling activity. API data show that the total footage drilled for all oil and gas wells dropped from 315.4 million feet in 1985 to 118 million feet in 1995, a decrease of 60 percent. A corresponding drop in the volume of drilling waste, from 361 million barrels in 1985, to 149 million barrels in 1995, was estimated.

On the other hand, as hydrocarbons from producing wells deplete, produced water volumes typically increase. API has estimated that the average volume of produced water increased from 6 barrels of water per barrel of oil in 1985, to 7.5 barrels of water per barrel of oil in 1995.

Prudent waste management decisions, even for nonhazardous wastes, should be based on the inherent nature of the waste. Not all waste management options are appropriate for every waste. Operators also should be familiar with state and federal regulations governing the management of hazardous and nonhazardous wastes.

The preferred option for preventing pollution is to avoid generating wastes whenever possible (source reduction). Examples include process modifications to reduce waste volumes and materials substitution to reduce toxicity.

Understanding the procedures for determining the exempt or nonexempt status of a waste is a valuable tool, especially for operators who choose to develop voluntary waste management plans. When these procedures are used in conjunction with a knowledge of the nature of the waste, the operator will be better prepared to develop site-specific waste management plans and to manage E&P wastes in a manner that protects human health and the environment.

Scope of the Exemption

In December 1978, EPA proposed hazardous waste management standards that included reduced requirements for several types of large volume wastes. Generally, EPA believed these large volume "special wastes" are lower in toxicity than other wastes being regulated as hazardous waste under RCRA. Subsequently, Congress exempted these wastes from the RCRA Subtitle C hazardous waste regulations pending a study and regulatory determination by EPA. In 1988, EPA issued a regulatory determination stating that control of E&P wastes under RCRA Subtitle C regulations is not warranted. Hence, E&P wastes have remained exempt from Subtitle C regulations. The RCRA Subtitle C exemption, however, did not preclude these wastes from control under state regulations, under the less stringent RCRA Subtitle D solid waste regulations, or under other federal regulations. In addition, although they are relieved from regulation as hazardous wastes, the exemption does not mean these wastes could not present a hazard to human health and the environment if improperly managed.

Among the wastes covered by the 1978 proposal were "gas and oil drilling muds and oil production brines." The oil and gas exemption was expanded in the 1980 legislative amendments to RCRA to include "drilling fluids, produced water, and other wastes associated with the exploration, development, or production of crude oil or natural gas. . . ." (Geothermal energy wastes were also exempted but are not addressed by this publication.)

According to the legislative history, the term "other wastes associated" specifically includes waste materials intrinsically derived from primary field operations associated with the exploration, development, or production of crude oil and natural gas. The phrase "intrinsically derived from the primary field operations" is intended to distinguish exploration, development, and production operations from transportation and manufacturing operations.

With respect to crude oil, primary field operations include activities occurring at or near the wellhead and before the point where the oil is transferred from an individual field facility or a centrally located facility to a carrier for transport to a refinery or a refiner.

With respect to natural gas, primary field operations are those activities occurring at or near the wellhead or at the gas plant, but before the point where the gas is transferred from an individual field facility, a centrally located facility, or a gas plant to a carrier for transport to market. Examples of carriers include trucks, interstate pipelines, and some intrastate pipelines.

Primary field operations include exploration, development, and the primary, secondary, and tertiary production of oil or gas. Crude oil processing, such as water separation, de-emulsifying, degassing, and storage at tank batteries associated with a specific well or wells, are examples of primary field operations. Furthermore, because natural gas often requires processing to remove water and other impurities prior to entering the sales line, gas plants are considered to be part of production operations regardless of their location with respect to the wellhead.

In general, the exempt status of an E&P waste depends on how the material was used or generated as waste, not necessarily whether the material is hazardous or toxic. For example, some exempt E&P wastes might be harmful to human health and the environment, and many non-exempt wastes might not be as harmful. The following simple rule of thumb can be used to determine if an E&P waste is exempt or non-exempt from RCRA Subtitle C regulations:

- Has the waste come from down-hole, i.e., was it brought to the surface during oil and gas E&P operations?
- Has the waste otherwise been generated by contact with the oil and gas production stream during the removal of produced water or other contaminants from the product?

If the answer to either question is yes, then the waste is likely considered exempt from RCRA Subtitle C regulations. It is important to remember that *all* E&P wastes require proper management to ensure protection of human health and the environment.

Exempt and Non-Exempt Wastes

In its 1988 regulatory determination, EPA published the following lists of wastes that were determined to be either exempt or non-exempt. These lists are provided as examples of wastes regarded as exempt and non-exempt and should not be considered to be comprehensive. The exempt waste list applies only to those wastes generated by E&P operations. Similar wastes generated by activities other than E&P operations are not covered by the exemption.

Exempt E&P Wastes

- Produced water
- Drilling fluids
- Drill cuttings
- Rigwash
- Drilling fluids and cuttings from offshore operations disposed of onshore
- Geothermal production fluids
- Hydrogen sulfide abatement wastes from geothermal energy production
- Well completion, treatment, and stimulation fluids
- Basic sediment, water, and other tank bottoms from storage facilities that hold product and exempt waste
- Accumulated materials such as hydrocarbons, solids, sands, and emulsion from production separators, fluid treating vessels, and production impoundments
- Pit sludges and contaminated bottoms from storage or disposal of exempt wastes
- Gas plant dehydration wastes, including glycol-based compounds, glycol filters, and filter media, backwash, and molecular sieves
- Workover wastes
- Cooling tower blowdown
- Gas plant sweetening wastes for sulfur removal, including amines, amine filters, amine filter media, backwash, precipitated amine sludge, iron sponge, and hydrogen sulfide scrubber liquid and sludge
- Spent filters, filter media, and backwash (assuming the filter itself is not hazardous and the residue in it is from an exempt waste stream)
- Pipe scale, hydrocarbon solids, hydrates, and other deposits removed from piping and equipment prior to transportation
- Produced sand
- Packing fluids
- Hydrocarbon-bearing soil
- Pigging wastes from gathering lines
- Wastes from subsurface gas storage and retrieval, except for the non-exempt wastes listed on page 11
- Constituents removed from produced water before it is injected or otherwise disposed of
- Liquid hydrocarbons removed from the production stream but not from oil refining

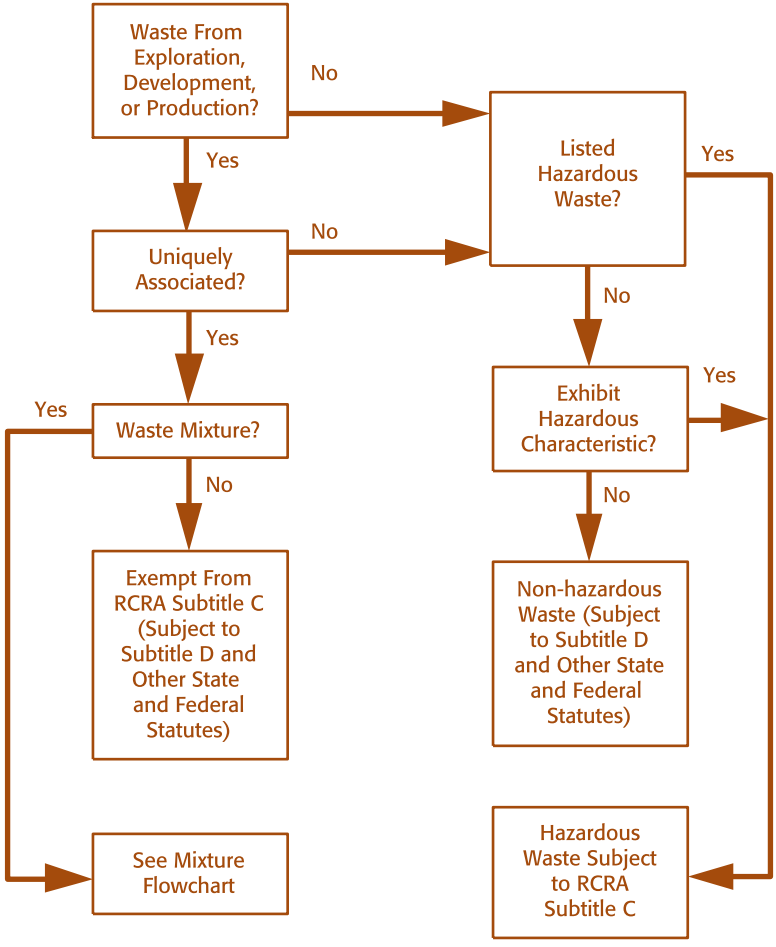
- Gases from the production stream, such as hydrogen sulfide and carbon dioxide, and volatilized hydrocarbons
- Materials ejected from a producing well during blowdown
- Waste crude oil from primary field operations
- Light organics volatilized from exempt wastes in reserve pits, impoundments, or production equipment

Non-Exempt Wastes

- Unused fracturing fluids or acids
- Gas plant cooling tower cleaning wastes
- Painting wastes
- Waste solvents
- Oil and gas service company wastes such as empty drums, drum rinsate, sandblast media, painting wastes, spent solvents, spilled chemicals, and waste acids
- Vacuum truck and drum rinsate from trucks and drums transporting or containing non-exempt waste
- Refinery wastes
- Liquid and solid wastes generated by crude oil and tank bottom reclaimers [1]
- Used equipment lubricating oils
- Waste compressor oil, filters, and blowdown
- Used hydraulic fluids
- Waste in transportation pipeline related pits
- Caustic or acid cleaners
- Boiler cleaning wastes
- Boiler refractory bricks
- Boiler scrubber fluids, sludges, and ash
- Incinerator ash
- Laboratory wastes
- Sanitary wastes
- Pesticide wastes
- Radioactive tracer wastes
- Drums, insulation, and miscellaneous solids

[1] Although non-E&P wastes generated from crude oil and tank bottom reclamation operations (e.g., waste equipment cleaning solvent) are non-exempt, residuals derived from exempt wastes (e.g., produced water separated from tank bottoms) are exempt. For a further discussion, see the Federal Register notice, Clarification of the Regulatory Determination for Waste from the Exploration, Development, and Production of Crude Oil, Natural Gas and Geothermal Energy, March 22, 1993, Federal Register Volume 58, Pages 15284 to 15287.

Exempt/Non-Exempt Wastes



Mixing Wastes

Mixing wastes, particularly exempt and non-exempt wastes, creates additional considerations. Determining whether a mixture is an exempt or non-exempt waste requires an understanding of the nature of the wastes prior to mixing and, in some instances, might require a chemical analysis of the mixture. Whenever possible, avoid mixing non-exempt wastes with exempt wastes. If the non-exempt waste is a listed or characteristic hazardous waste, the resulting mixture might become a non-exempt waste and require management under RCRA Subtitle C regulation. Furthermore, mixing a characteristic hazardous waste with a non-hazardous or exempt waste for the purpose of rendering the hazardous waste non-hazardous or less hazardous might be considered a treatment process subject to appropriate RCRA Subtitle C hazardous waste regulation and permitting requirements.

NOTE: In a policy letter dated September 25, 1997, EPA clarified that a mixture is exempt if it contains exempt oil and gas exploration and production (E&P) waste mixed with non-hazardous, non-exempt waste. Mixing exempt E&P waste with non-exempt characteristic hazardous waste, however, for the purpose of rendering the mixture non-hazardous or less hazardous, could be considered hazardous waste treatment or impermissible dilution.

Below are some basic guidelines for determining if a mixture is an exempt or non-exempt waste under the present mixture rule.

- **A mixture of an exempt waste with another exempt waste remains exempt.**

  Example: A mixture of stimulation fluid that returns from a well with produced water results in an exempt waste.

- **Mixing a non-hazardous waste (exempt or non-exempt) with an exempt waste results in a mixture that is also exempt.**

  Example: If non-hazardous wash water from rinsing road dirt off equipment or vehicles is mixed with the contents of a reserve pit containing only exempt drilling waste, the wastes in the pit remain exempt regardless of the characteristics of the waste mixture in the pit.

- **If, after mixing a non-exempt characteristic hazardous waste with an exempt waste, the resulting mixture exhibits any of the same hazardous characteristics as the hazardous waste (ignitability, corrosivity, reactivity, or toxicity), the mixture is a non-exempt hazardous waste.**

  Example: If, after mixing non-exempt caustic soda (NaOH) that exhibits the hazardous characteristic of corrosivity in a pit containing exempt waste, the mixture also exhibits the hazardous characteristic of corrosivity as determined from pH or steel corrosion tests, then the entire mixture becomes a non-exempt hazardous waste.

  Example: If, after mixing a non-exempt solvent containing benzene with an exempt waste also containing benzene,

the mixture exhibits the hazardous characteristic for benzene, then the entire mixture becomes a non-exempt hazardous waste.

- **If, after mixing a non-exempt characteristic hazardous waste with an exempt waste, the resulting mixture does not exhibit any of the same characteristics as the hazardous waste, the mixture is exempt. Even if the mixture exhibits some other characteristic of a hazardous waste, it is still exempt.**

  Example: If, after mixing non-exempt hydrochloric acid (HCl) that only exhibits the corrosive characteristic with an exempt waste, the mixture does not exhibit the hazardous characteristic of corrosivity but does exhibit some other hazardous characteristic such as toxicity, then the mixture is exempt.

  Example: If, after mixing a non-exempt waste exhibiting the hazardous characteristic for lead with an exempt waste exhibiting the characteristic for benzene, the mixture exhibits the characteristic for benzene but not for lead, then the mixture is exempt.

- **Generally, if a listed hazardous waste[2] is mixed with an exempt waste, regardless of the proportions, the mixture is a non-exempt hazardous waste.**

  Example: If any amount of leaded tank bottoms from the petroleum refining industry (listed as waste code K052) is mixed with an exempt tank bottom waste, the mixture is considered a hazardous waste and is therefore non-exempt.

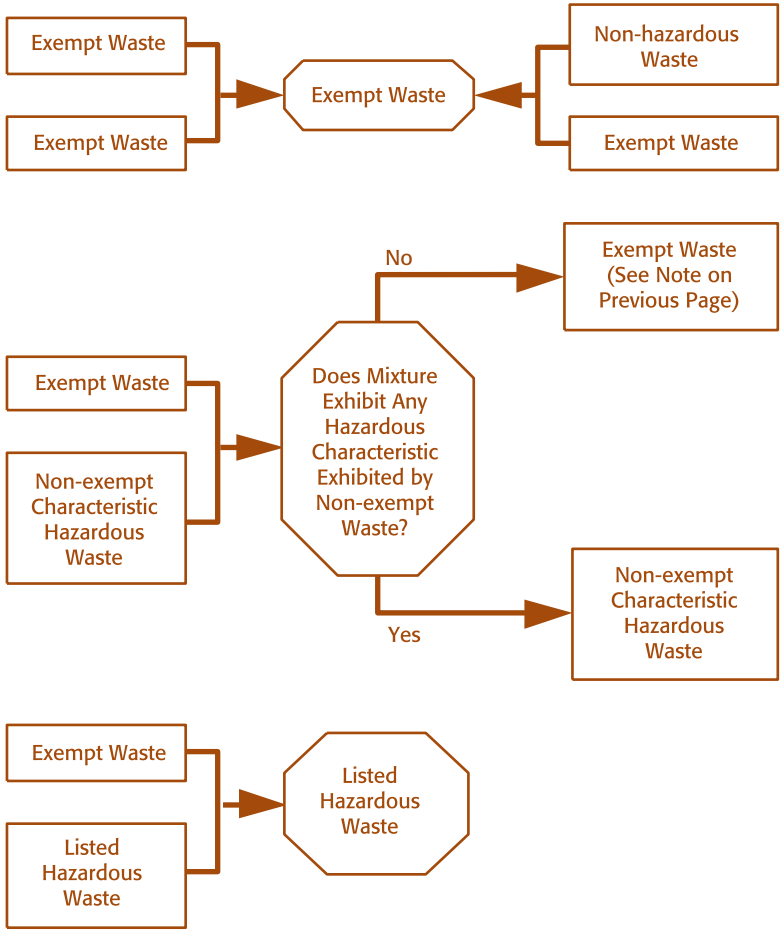
2 Listed hazardous wastes are those wastes listed as hazardous in the Code of Federal Regulations under Subpart D of 40 CFR Part 261.

It is also important to emphasize that a mixture of an exempt waste with a listed hazardous waste generally becomes a non-exempt hazardous waste regardless of the relative volumes or concentrations of the wastes. However, if the listed hazardous waste was listed solely for one or more of the characteristics of ignitability, corrosivity, or reactivity, then a mixture of this waste with an exempt waste would only become non-exempt if the mixture exhibits the characteristic for which the hazardous waste was listed (i.e., if the mixture is ignitable, corrosive, or reactive).

Similarly, if a mixture of an exempt waste with a non-exempt characteristic hazardous waste exhibits any of the same hazardous waste characteristics as the hazardous waste, or if it exhibits a characteristic that would not have been exhibited by the exempt waste alone, the mixture becomes a non-exempt hazardous waste regardless of the relative volumes or concentrations of the wastes. In other words, for any of these scenarios, the wastes could become non-exempt even if only one barrel of hazardous waste were mixed with 10,000 barrels of exempt waste.

NOTE: The act of mixing a hazardous waste with an exempt waste may be subject to RCRA regulations affecting hazardous waste treatment, including the need for a permit (unless the unit or process is otherwise exempt). Moreover, the waste may still be subject to the 40 CFR 268 Land Disposal Restrictions (LDR) regulations (as applicable), including the prohibition of dilution as a substitute for adequate treatment.

Possible Waste Mixtures and Their Exempt and Non-Exempt Status



Common Misunderstandings

An incomplete understanding of the hazardous waste regulations can result in misinterpretations of the regulatory status of various wastes. The following are common misunderstandings that arise with the RCRA Subtitle C exemption and hazardous waste determinations.

Misunderstanding: All wastes located at E&P sites are exempt.

Fact: All wastes located at E&P sites are not necessarily exempt. To be considered an exempt waste, the waste must have been generated from a material or process uniquely associated with the exploration, development, and production of crude oil and natural gas. For example, a solvent used to clean surface equipment or machinery is not exempt because it is not uniquely associated with exploration, development, or production operations. Conversely, if the same solvent were used in a well, it would be exempt because it was generated through a procedure that is uniquely associated with production operations.

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Misunderstanding: All service company wastes are exempt.

Fact: Not all service company wastes are exempt. As with all oilfield wastes, only those wastes generated from a material or process uniquely associated with the exploration and pro-

duction of oil and gas are considered exempt. The previous example of solvents used for cleaning equipment and machinery would also apply in this case—the solvent is not an exempt waste.

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Misunderstanding: Unused products are exempt.

Fact: Unused products, if disposed of, are not exempt, regardless of their intended use, because they have not been used and therefore are not uniquely associated with the exploration or production of oil and gas. When unused products become waste (e.g., they are disposed of), they are subject to RCRA Subtitle C hazardous waste regulations if they are listed or exhibit a hazardous characteristic.

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Misunderstanding: All exempt wastes are harmless to human health and the environment.

Fact: Certain exempt wastes, while excluded from RCRA Subtitle C hazardous wastes control, might still be harmful to human health and the environment if not properly managed. The exemption relieves wastes that are uniquely associated with the exploration and production of oil and gas from regulation as hazardous wastes under RCRA Subtitle C but does not indicate the hazard potential of the exempt waste. Additionally, some of these wastes might still be subject to state hazardous or non-hazardous waste regulations or other federal regulations (e.g., hazardous materials transportation regulations and National Pollutants Discharge Elimination System (NPDES) or state discharge regulations) unless specifically excluded from regulation under those laws.

Misunderstanding: Any mixture of a non-exempt hazardous waste with an exempt waste becomes an exempt waste.

Fact: Not all mixtures of a non-exempt hazardous waste with an exempt waste become exempt wastes. Generally, a mixture of a listed hazardous waste with an exempt waste becomes a non-exempt hazardous waste.

Also, a mixture of a hazardous waste that exhibits one of the characteristics of a hazardous waste (ignitability, corrosivity, reactivity, or toxicity) with an exempt waste, becomes a non-exempt characteristic hazardous waste if the mixture exhibits one of the same hazardous characteristics as the original hazardous waste. Conversely, if the mixture does not exhibit one of the same hazardous characteristics of the hazardous waste, the mixture becomes a non-hazardous exempt waste. Remember, mixing a non-exempt hazardous waste with an exempt waste for the purpose of rendering the hazardous waste non-hazardous or less hazardous may be considered a treatment process and must be conducted in accordance with applicable RCRA Subtitle C regulations.

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Misunderstanding: A waste exempt from RCRA Subtitle C regulation is also exempt from state and other federal waste management regulations.

Fact: The exemption applies only to the federal requirements of RCRA Subtitle C. A waste that is exempt from RCRA Subtitle C regulation might be subject to more stringent or broader state hazardous and non-hazardous waste regulations and other state and federal program regulations. For example, oil and gas exploration and production wastes are subject to regulation under the Clean Air Act (CAA), Clean Water Act (CWA), Safe Drinking Water Act (SDWA), and Oil Pollution Act of 1990 (OPA).

Frequently Asked Questions

EPA receives calls on a regular basis requesting answers to questions related to the E&P exemption. The most common questions and answers are listed below.

Q: Are RCRA-exempt wastes also exempt under other federal laws?

A: Not necessarily. Unless specifically excluded from regulation under other federal laws, RCRA-exempt wastes might still be subject to regulation under authorities other than RCRA.

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Q: What is the benefit of the RCRA exemption if the operator is still liable for cleanups under RCRA?

A: Although the operator might still be liable for cleanup actions under RCRA for wastes that pose an imminent and substantial endangerment to human health and the environment, the RCRA exemption does allow the operator to choose a waste management and disposal option that is less stringent and possibly less costly than those required under RCRA Subtitle C. The operator,

however, should make every effort to choose the proper management and disposal procedures for a particular waste to avoid the need for later cleanup action.

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Q: When is a waste considered "uniquely associated with" exploration and production operations?

A: A waste is "uniquely associated with" exploration and production operations if it is generated from a material or procedure that is necessary to locate and produce crude oil or natural gas. Also, a waste is "uniquely associated with" exploration and production operations if it is generated from a material or procedure that only occurs during the exploration and production of crude oil or natural gas. A simple rule of thumb for identifying "uniquely associated wastes" is whether the waste came from downhole or otherwise was generated in contact with the oil or gas production stream for the purpose of removing water or other contaminants from the well or the product.

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Q: Are wastes generated from a transportation pipeline considered exempt wastes under RCRA Subtitle C?

A: No. The RCRA Subtitle C exemption only applies to wastes generated from the exploration, development, and production (i.e., primary field operations) of crude oil or natural gas. Hence, wastes generated from the transportation of crude oil or natural gas are not RCRA-exempt.

Q: Do exempt wastes lose their exempt status if they undergo custody transfer and are transported offsite for disposal?

A: No. Custody transfer is used to define the endpoint of production operations for crude oil and applies only to the change in ownership of the product (e.g., crude oil). Exempt wastes maintain their exempt status even if they undergo custody transfer and are transported off-site for disposal or treatment.

Q: Are all wastes generated at facilities that treat or reclaim exempt wastes also exempt?

A: No. The exemption applies only to those wastes derived from exempt wastes, not to additional wastes generated by the treatment or reclamation of exempt wastes. For example, if a treatment facility uses an acid in the treatment of an exempt waste, any waste derived from the exempt waste being treated is also exempt but the spent acid is not.

Q: When does transportation begin?

A: For crude oil, transportation begins at the point of custody transfer of the oil or, in the absence of custody transfer, after the endpoint of production separation and dehydration. Storage of crude oil in stock tanks at production facilities is considered part of the production separation process, not transportation, and is

included in the exemption. For natural gas, transportation begins at the point where the gas leaves the facility after production separation and dehydration at the gas plant. Natural gas pipelines between the gas well and the gas plant are considered to be part of the production process, rather than transportation, and wastes that are uniquely associated with production that are generated along such a pipeline are exempt.

EPA periodically issues interpretive letters regarding the oil and gas exemption. One such letter was in response to a request for clarification of the exempt or non-exempt status of wastes generated at natural gas compressor stations. In some regions, such as the Appalachian states, natural gas might not require sweetening or extensive dehydration. Therefore, the gas generally does not go to a gas plant but is carried from the wellhead to a main transmission line and, in some cases, directly to the customer. Compressor stations are located as needed along the pipelines that run between the wellhead and the main transmission line or the customer to maintain pressure in the lines. The Agency has taken the position that these compressor stations (in the absence of gas plants, and handling only local production) should be treated the same as gas plants, and that wastes generated by these compressor stations are exempt. On the other hand, compressor stations located along main gas transmission lines are considered to be part of the transportation process, and any wastes generated by these compressor stations are non-exempt.

Sensible Waste Management

Sensible waste management begins with "good housekeeping." Prudent operators design E&P facilities and processes to minimize potential environmental threats and legal liabilities. EPA promotes sensible waste management practices through a number of joint efforts with organizations such as API, individual states, and the Interstate Oil and Gas Compact Commission (IOGCC). The following waste management suggestions have been compiled from publications produced by these organizations as well as from literature available from industry trade associations, trade journals, and EPA.

Suggested E&P Waste Management Practices

- Size reserve pits properly to avoid overflows.
- Use closed loop mud systems when practical, particularly with oil-based muds.
- Review material safety data sheets (MSDSs) of materials used, and select less toxic alternatives when possible.
- Minimize waste generation, such as by designing systems with the smallest volumes possible (e.g., drilling mud systems).
- Reduce the amount of excess fluids entering reserve and production pits.
- Keep non-exempt wastes out of reserve or production pits.
- Design the drilling pad to contain stormwater and rig-wash.
- Recycle and reuse oil-based muds and high density brines when practical.
- Perform routine equipment inspections and maintenance to prevent leaks or emissions.
- Reclaim oily debris and tank bottoms when practical.
- Minimize the volume of materials stored at facilities.
- Construct adequate berms around materials and waste storage areas to contain spills.
- Perform routine inspections of materials and waste storage areas to locate damaged or leaking containers.
- Train personnel to use sensible waste management practices.

Sources of Information

Resource Conservation and Recovery Act (RCRA)

RCRA regulates hazardous waste generators, hazardous waste transporters, and hazardous waste treatment, storage, and disposal facilities (TSDFs). RCRA encourages environmentally sound methods for managing commercial and industrial waste, as well as household and municipal waste.

RCRA Resources:

- 40 CFR Parts 260 to 279
- RCRA Call Center: 800 424-9346 or Washington, DC Area Local 703 412-9810 or TDD 800 553-7672 or TDD Washington, DC Area Local 703 412-3323 Fax: 703 308-8686
- Internet access: <www.epa.gov/epaoswer/other/oil/index.htm>

Clean Water Act (CWA)

The Water Pollution Control Act, commonly known as the Clean Water Act (CWA), is the Federal program designed to restore and maintain the integrity of the nation's surface waters. CWA controls direct discharges to surface waters (e.g., through a pipe) from industrial processes or stormwater systems associated with an industrial activity. It also regulates indirect discharges, or discharges to publicly owned treatment works (POTWs) through a public sewer system, by requiring industrial facilities to pretreat their waste before discharging to a public sewer.

CWA Resources:

- 40 CFR Parts 100-129 and 400-503
- EPA Office of Water: 202 260-5700
- State water authority, regional EPA office, and local POTW
- Internet access: <www.epa.gov/ow/>

Oil Pollution Prevention (Spill Prevention, Control and Countermeasures Regulations)

Spill prevention, control and countermeasures (SPCC) regulations promulgated pursuant to the CWA are designed to protect our nation's waters from oil pollution caused by oil spills that could reach the navigable waters of the United States or adjoining shorelines. The regulations apply to non-transportation-related facilities with a specific aboveground or underground oil storage capacity that, due to its location, can be reasonably expected to discharge oil into the navigable waters of the United States.

SPCC Regulations Resources:

- 40 CFR Part 112
- RCRA Call Center: 800 424-9346
- Internet Access: <www.epa.gov/oilspill/index.htm>

Discharge of Oil

The section of the CWA regulations commonly known as the “sheen rule” provides the framework for determining whether a facility or vessel responsible for an oil spill must report the spill to the federal government. These rules require oil spills that may be “harmful to the public health or welfare” to be reported to the National Response Center. Usually, oil spills that cause a sheen or discoloration on the surface of a body of water, violate applicable water quality standards, and cause a sludge or emulsion to be deposited beneath the surface of the water or on adjoining shorelines, must be reported.

Discharge of Oil Regulations Resources:

- 40 CFR Part 110
- RCRA Call Center: 800 424-9346
- Internet Access: <www.epa.gov/oilspill/index.htm>
- Reporting discharges to the National Response Center: 800 424-8802.

Oil Pollution Act (OPA)

OPA of 1990 amended the CWA, and provided new requirements for contingency planning by government and industry under the National Oil and

Hazardous Substances Pollution Contingency Plan. OPA also increased penalties for regulatory noncompliance, broadened the response and enforcement authorities of the federal government, and preserved state authority to establish laws governing oil spill prevention and response.

OPA Resources:

- Internet Access: <www.epa.gov/oilspill/index.htm>

Safe Drinking Water Act (SDWA)

SDWA mandates that EPA establish regulations to protect human health from contaminants present in drinking water. Under the authority of the SDWA, EPA developed national drinking water standards and created a joint federal/state system to ensure compliance with these standards. EPA also regulates underground injection of liquid wastes through the Underground Injection Control (UIC) program under the SDWA. The UIC program regulates five classes of injection wells to protect underground sources of drinking water.

SDWA Resources:

- 40 CFR Parts 141-143 (SDWA); 40 CFR Parts 144-148 (UIC)
- SDWA Hotline: 800 426-4791
- State oil and gas regulatory authority.
- Internet Access: <www.epa.gov/ogwdw>

Clean Air Act (CAA)

CAA regulates air pollution. It includes national emission standards for new stationary sources within particular industrial categories. It also includes the National Emission Standards for Hazardous Air Pollutants (NESHAPs), which are designated to control the emissions of particular hazardous air pollutants (HAPS). NESHAPs specific to oil and gas production were promulgated in 1999.

The CAA includes a Risk Management Program. This program requires stationary sources with more than a threshold quantity of a regulated substance (designated in the regulations) to develop and implement a risk management program (RMP). The RMP must include a hazard assessment, a prevention program, and an emergency response program.

CAA Resources:

- 40 CFR Parts 50-99
- Control Technology Center, Office of Air Quality, Planning and Standards (OAQPS), EPA, General Information: 919 541-0800; Publications: 919 541-2777
- RCRA Call Center (CAA §112(r) questions): 800 424-9346
- Internet Access: <www.epa.gov/oar/oaq_caa.html>
- Oil and Gas Production NESHAPs Rule: <www.epa.gov/ttn/uatw/oilgas/oilgaspg.html>

The Emergency Planning and Community Right-to-Know Act (EPCRA)

EPCRA was designed to improve community access to information about potential chemical hazards and to facilitate the development of chemical emergency response plans by State and local governments. EPCRA regulations establish four types of reporting obligations for facilities that store or manage certain chemicals above specified quantities.

EPCRA Resources:

- 40 CFR Parts 350-372
- RCRA Call Center: 800 424-9346
- Internet Access: <www.epa.gov/opptintr/tri/> and <www.epa.gov/swercepp>

Comprehensive Environmental Response Compensation, and Liability Act (CERCLA or Superfund)

Superfund authorizes EPA to respond to releases, or threatened releases, of hazardous substances that might endanger public health, welfare, or the environment. It also grants EPA the authority to force parties responsible for environmental contamination to clean it up or to reimburse response costs incurred by EPA. CERCLA also contains hazardous substance release reporting regulations that require facilities to report to the National Response Center (NRC) any release of a hazardous substance that exceeds the specified quantity for that substance.

CERCLA Resources:

- 40 CFR Parts 300-399
- RCRA Call Center: 800 424-9346

- Internet Access: <www.epa.gov/superfund>

Toxic Substances Control Act (TSCA)

TSCA allows EPA to collect data on chemicals to evaluate, assess, mitigate, and control risks that might be posed by their manufacture, processing, and use. Facilities are required to report information as necessary to allow EPA to develop and maintain this inventory.

TSCA Resources:

- 40 CFR Parts 702-799
- TSCA Hotline: 202 554-1404
- Internet Access: <www.epa.gov/internet/opptsfrs/home/opptsim.htm>

Other EPA Information Resources

Office of Solid Waste
Industrial and Extractive Wastes Branch
1200 Pennsylvania Avenue, NW.
Mail Code 5306W
Washington, DC 20460

RCRA Call Center: 800 424-9346 or
Washington, DC Area Local 703 412-9810 or
TDD 800 553-7672 or TDD Washington, DC
Area Local 703 412-3323 Fax: 703 308-8686
Internet access: <www.epa.gov/epaoswer/hotline>

The RCRA Call Center is a publicly accessible service that provides up-to-date information on several EPA programs. Please note that the Center cannot provide regulatory interpretations. It also processes requests for relevant publications and information resources.

Office of Emergency and Remedial Response, Oil Spill Program
1200 Pennsylvania Avenue, NW.
Washington, DC 20460
Oil Spill Program Information Line: 800 424-9346
Internet access: <www.epa.gov/oilspill/>

The Office of Emergency and Remedial Response (OERR) manages the Superfund and Oil Spill programs.

National Response Team

c/o U.S. EPA
1200 Pennsylvania Avenue, NW.
Washington, DC 20460
Telephone: 800 424-8802
Fax: 202 260-0154
Internet access: <www.nrt.org>

The National Response Team and the Regional Response Teams are the federal component of the National Response System (NRS), the federal government's coordinated mechanism for emergency response to discharges of oil and releases of chemicals. The NRT is chaired by the U.S. EPA with the United States Coast Guard serving as Vice Chair. The National Response Center (800 424-8802) is the sole federal point of contact for reporting oil and chemical spills.

Other Federal Agencies

U.S. Department of Interior

U.S. Bureau of Land Management
Fluid Minerals Group
1849 C Street, Room 406-LS
Washington, DC 20240
Telephone: 202 452-5125
Fax: 202 452-5124
Internet access: <www.blm.gov/nhp/300/wo310/>

The Bureau of Land Management's (BLM's) management of fluid minerals includes overseeing the production and conservation of oil and gas, geothermal energy, and helium. BLM is responsible for leasing oil and gas resources on all federally owned lands, including those lands managed by other federal agencies. This includes about 564 million acres of federal minerals estate, or about 28 percent of all lands within the United States. Additionally, BLM is responsible for the review and approval of all permits and licenses to explore, develop, and produce oil and gas and geothermal resources on both Federal and Indian lands.

U.S. Fish and Wildlife Service
Division of Environmental Quality
4401 North Fairfax Drive, Suite 322
Arlington, VA 22203
Telephone: 703 358-2148
Internet access: <contaminants.fws.gov>

The U.S. Fish and Wildlife Service is the main federal agency dedicated to protecting wildlife and their habitat from pollution's harmful effects. Specialists in the Environmental Contaminants Program focus on detecting toxic chemicals; addressing their effects; preventing harm to fish, wildlife and their habitats; and removing toxic chemicals and restoring habitat when prevention is not possible. These specialists are experts on oil and chemical spills, pesticides, water quality, hazardous materials disposal and other aspects of pollution biology.

U.S. Department of Energy

Office of Natural Gas & Petroleum Technology,
Office of Fossil Energy
1000 Independence Ave. SW. - Forrestal Building
Washington, DC 20585
Telephone: 202 586-6503
Fax: 202 586-5145
Internet access: <www.fe.doe.gov/programs_oilgas.html>

The Department of Energy's (DOE's) Office of Natural Gas and Petroleum Technology is responsible for the gas and oil exploration and production program, natural gas storage and delivery, downstream petroleum processing, and environmental and regulatory analysis programs for oil and natural gas operations, and natural gas import/export authorizations.

Other Information Resources

American Petroleum Institute

1220 L Street, NW.
Washington, DC 20005
Telephone: 202 682-8000
Internet access: <www.api.org>

The American Petroleum Institute (API) is the national trade association representing over 400 companies involved in oil and gas exploration, production, transportation, refining, and marketing. API represents its members in addressing public policy and regulatory issues. API also sponsors research, collects statistics, conducts workshops, and develops standards and recommended practices for industry equipment and operations.

Interstate Oil and Gas Compact Commission

P.O. Box 53127
Oklahoma City, OK 73152-3127
Telephone: 405 525-3556
Fax: 405 525-3592
E-mail: iogcc@iogcc.state.ok.us
Internet access: <www.iogcc.state.ok.us>

Founded by six states in 1935, the Interstate Oil and Gas Compact Commission (IOGCC) was established to control unregulated petroleum overproduction and resulting waste. "Since that time, states have established effective regulation of the oil and natural gas industry through a variety of IOGCC programs designed to gather and share information, technologies and regulatory methods."

Ground Water Protection Council

13208 N. MacArthur
Oklahoma City, OK 73142
Telephone: 405 516-4972
Fax: 405 516-4973
Internet access: <www.gwpc.org>

The Ground Water Protection Council is an organization whose members consist of state and federal ground water agencies, industry representatives, environmentalists, and concerned citizens. Since it includes state Underground Injection Control (UIC) program directors, it is the best source of data on Class II well injection issues.

National Governors' Association

Emergency Management and Oil Spill Prevention and
Response Project
Hall of States
444 North Capitol Street, NW.
Washington, DC 20001-1512
Telephone: 202 624-5300
Internet access: <www.nga.org>

The National Governors' Association's project on oil spill prevention, preparedness, and response offers states an opportunity to share their experiences and coordinate with the federal agencies involved in oil spill prevention and response. This program facilitates the exchange of information on successful state programs among state and federal emergency managers. NGA works with U.S. EPA to coordinate and promote state oil spill prevention programs by holding workshops, summarizing successful state oil programs, and establishing ongoing workgroups to discuss oil spill topics.

Publications

Title: "Report to Congress: Management of Wastes from the Exploration, Development, and Production of Crude Oil, Natural Gas, and Geothermal Energy," U.S. EPA, December 1987, NTIS Publication No. PB 88-146212.

Available from: National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161, 703 487-4650.

◆ ◆ ◆

Title: "Regulatory Determination for Oil and Gas and Geothermal Exploration, Development, and Production Wastes," July 6, 1988, Federal Register Volume 53, Pages 25446 to 25459.

Available from: RCRA Call Center, Washington, DC, 800 424-9346

Internet access: <www.epa.gov/epaoswer/other/oil/index.htm>

◆ ◆ ◆

Title: "Clarification of the Regulatory Determination for Wastes from the Exploration, Development, and Production of Crude Oil, Natural Gas and Geothermal Energy," March 22, 1993, Federal Register Volume 58, Pages 15284 to 15287.

Available from: RCRA Call Center, Washington, DC, 800 424-9346

Internet access: <www.epa.gov/epaoswer/other/oil/index.htm>

◆ ◆ ◆

Title: Associated Wastes Reports: "Crude Oil Tank Bottoms and Oily Debris," "Completion and Workover Wastes," "Dehydration and Sweetening Wastes."

Available from: EPA Office of Solid Waste

Internet access: <www.epa.gov/epaoswer/other/oil/execrep.htm>

◆ ◆ ◆

Title: "Profile of the Oil and Gas Extraction Industry"

Available from: EPA Office of Enforcement and Compliance Assurance

Internet access: <es.epa.gov/oeca/sector/index.html#oilgasex>

◆ ◆ ◆

Title: "Environmental Guidance Document: Waste Management in Exploration and Production Operations," API Bulletin E5, Second Edition, February 1997.

Available from: American Petroleum Institute, c/o Global Engineering Documents, 15 Inverness Way E., Englewood, CO 80112, 800 854-7179

Internet access: <www.api.org/cat>

◆ ◆ ◆

Title: "Guidelines for Commercial Exploration and Production Waste Management Facilities," (Order Number G0004), March 2001.

Available from: American Petroleum Institute, c/o Global Engineering Documents, 15 Inverness Way E., Englewood, CO 80112, 800 854-7179

Internet access: <www.api.org/ehs/CommFac>

Title: "Environmental Engineering for Exploration and Production Activities," Monograph Volume 18.

Available from: Society of Petroleum Engineers, P.O. Box 833836, Richardson, TX 75083-3836, 972 952-9393

E-mail: books@spe.org

Internet access: <www.spe.org>

Title: "Suggested Procedure for Development of Spill Prevention Control and Countermeasure Plans," API Bulletin D16, Second Edition, August 1, 1989.

Available from: American Petroleum Institute, c/o Global Engineering Documents, 15 Inverness Way E., Englewood, CO 80112, 800 854-7179

Internet access: <www.api.org/cat>

Title: "Onshore Oil and Gas Production Practices for Protection of the Environment," API Recommended Practice 51, Third Edition, February 2001.

Available from: American Petroleum Institute, c/o Global Engineering Documents, 15 Inverness Way E., Englewood, CO 80112, 800 854-7179

Internet access: <www.api.org/cat>

Title: "Revised Guidelines for Waste Minimization in Oil and Gas Exploration and Production."

Available from: Interstate Oil and Gas Compact Commission, P.O. Box 53127, Oklahoma City, OK 73152-3127, 405 525-3556

Internet access: <www.iogcc.state.ok.us>

United States
Environmental Protection Agency
Office of Solid Waste (5305W)
Washington, DC 20460

Official Business
Penalty for Private Use $300
EPA530-K-01-004
October 2002
www.epa.gov/osw

APPENDIX K-2

EMERGENCY CONTACTS

APPENDIX K-2 – EMERGENCY CONTACTS

NAME OF FACILITY: De Beque Water Station **Issue Date: 3/2015**

Latitude: 39°19'37.86"N **Longitude: 108°14'49.06"**

NAME OF COMPANY OR AGENCY	PHONE NO.
Any Emergency	911
St. Mary's Air Life City: Grand Junction State: Colorado	1-800-322-4923
St. Mary's Hospital City: Grand Junction State: Colorado	(970) 244-2273
Grand River Medical Center City: Rifle State: Colorado	(970) 625-1510
Mesa County Sheriff City: Grand Junction State: Colorado	(970) 244-3500 (970) 242-6707 Dispatch
State Highway Patrol City: Fruita State: Colorado	(970) 248-7277
De Beque Marshal Department City: De Beque State: Colorado	(970) 283-5146 (970) 242-6707 Dispatch
Colorado State Patrol HAZMAT Service City: Parachute State: Colorado	(970) 248-7283
De Beque Fire Protection District City: De Beque State: Colorado	(970) 984-3412
Colorado State Patrol Dispatch County: Garfield State: Colorado	(970) 824-6501
Colorado Division of Wildlife City: Grand Junction State: Colorado	(970) 255-6100
Emergency Operations City: Glenwood Springs State: Colorado	(970)-945-0453
Other Agencies or Contacts (Customers, people living near the facility, etc.)	
City: State:	
City: State:	
City: State:	
City: State:	

APPENDIX K-3

FORM 19 CO COGCC
SPILL/RELEASE REPORT FORM

FORM
19
Rev 6/99

Click here to reset form

State of Colorado
Oil and Gas Conservation Commission

1120 Lincoln Street, Suite 801, Denver, Colorado 80203 (303)894-2100 Fax:(303)894-2109

FOR OGCC USE ONLY

Spill report taken by:

FACILITY ID:

SPILL/RELEASE REPORT

This form is to be submitted by the party responsible for the oil and gas spill or release. Any spill or release which may impact waters of the State must be reported as soon as practicable; any spill over 20 bbls must be reported within 24 hours and all spills over five bbls must be reported within ten days. Submit a Site Investigation and Remediation Workplan (Form 27) when requested by the Director.

OPERATOR INFORMATION

Name of Operator: _____ OGCC Operator No: _____

Address: _____

City: _____ State: _____ Zip: _____

Contact Person: _____

Phone Numbers

No: ___ _____

Fax: _____

E-Mail:_____

DESCRIPTION OF SPILL OR RELEASE

Date of Incident: _____ Facility Name & No.: _____

Type of Facility (well, tank battery, flow line, pit): _____

Well Name and Number: _____

API Number: _____

County: _____

QtrQtr: _____ Section: _____

Township: _____ Range: _____

Meridian: _____

Specify volume spilled and recovered (in bbls) for the following materials:

Oil spilled: _____ Oil recov'd: _____ Water spilled: _____ Water recov'd: _____ Other spilled: _____ Other recov'd:_____

Ground Water impacted? ☐ Yes ☐ No Surface Water impacted? ☐ Yes ☐ No

Contained within berm? ☐ Yes ☐ No Area and vertical extent of spill: _____x_____

Current land use: _____ Weather conditions: _____

Soil/geology description: _____

IF LESS THAN A MILE, report distance **IN FEET** to nearest.... Surface water: _____ wetlands: _____ buildings: _____

Livestock: _____ water wells: _____ Depth to shallowest ground water: _____

Cause of spill (e.g., equipment failure, human error, etc.): _____ Detailed description of the spill/release incident:

CORRECTIVE ACTION

Describe immediate response (how stopped, contained and recovered):

Describe any emergency pits constructed:

How was the extent of contamination determined:

Further remediation activities proposed (attach separate sheet if needed):

Describe measures taken to prevent problem from reoccurring:

OTHER NOTIFICATIONS

List the parties and agencies notified (County, BLM, EPA, DOT, Local Emergency Planning Coordinator or other).

Date	Agency	Contact	Phone	Response

Spill/Release Tracking No: _____

APPENDIX K-4

BLACK HILLS GUIDANCE AND REPORT DOCUMENTS

(Colorado)

Oil & Produced Water Release Report

Initial Report (Subject to change as information is gathered) Supplemental Report # Final Report

Date of Spill	
Time of Spill	
Field	
Lease	
County	
State	

Reason for Supplement			
Section	Township		Range
Landowner			
Landowner Notified	Yes ☐	No ☐	Not Required

	Spilled	Recovered		Type of Surface Affected (Check all that apply)
Volume of Oil	Bbls	Bbls		☐ Land/Habitat
Volume of Water	Bbls	Bbls		☐ Inside Dike/Berm
Size of Spill	Length (ft)	Width (ft)	Depth (ft)	☐ Water
				☐ Dry Drainage

If Release is 1 bbl or more (regardless of containment) Notify:	Person Contacted	Time	Date
OGCC (303)894-2100			
OGCC Tracking No.			
CO Dept. of Public Health & Env. (877) 518-5608			
If Oil Enters <u>Any</u> Surface Water, in addition to the above, Notify:			
NRC w/in 2 hours 1-800-424-8802			

When Reporting to agencies include:
A. Date and time of spill
B. Identity of material spilled
C. Quantity spilled
D. Location/source
E. Cause of Spill
F. Hazards/Injuries
G. Correction action
H. Black Hills name and number

(Colorado)

Oil & Produced Water Release Report

Description of Spill

General Spill Location

- ☐ Production Well
- ☐ Injection Well
- ☐ Tank Battery
- ☐ Treatment Facility
- ☐ Water Treatment Plant
- ☐ Drilling/Workover Rig
- ☐ Other

Type of Material

(Check all that apply)

- ☐ Aluminum, Bronze/Brass
- ☐ Fiberglass
- ☐ Steel
- ☐ Plastic/PVC
- ☐ Stainless Steel
- ☐ Other
- ☐ Internally Coated
- ☐ Externally Coated

Estimated Age

Size

Specific Spill Location

- ☐ Tubing/Casing
- ☐ Wellhead
- ☐ Stuffing Box
- ☐ Flowline
- ☐ Truck line/Gathering Line
- ☐ Facility Piping/Connections
- ☐ Vessel #
- ☐ Tank #
- ☐ Pump
- ☐ Injection/Disposal Line
- ☐ Other

Weather Conditions

- ☐ Dry ☐ Windy
- ☐ Rain ☐ Snow

Has it rained in the last 48 hours?

- ☐ Yes ☐ No

Is precipitation Expected before clean up can occur?

- ☐ Yes ☐ No

Root Cause of Spill

(Check all that apply)

- ☐ Freezing
- ☐ Lightning
- ☐ Earthquake
- ☐ Fire
- ☐ Other Natural Forces
- ☐ Power Failure
- ☐ External Damage
- ☐ Livestock
- ☐ Vandalism
- ☐ Contractor Error
- ☐ Worn Equipment
- ☐ Internal Corrosion
- ☐ External Corrosion
- ☐ Plugging
- ☐ Malfunction
- ☐ Defective Material
- ☐ Alarm Failure

- ☐ Procedure-Related
- ☐ Design
- ☐ Training

Write in costs if know, otherwise check best estimate

Repairs	$		Clean-up	$		Oil Loss	$
$0-$99			$0-$99			$0-$99	
$100-$499			$100-$499			$100-$499	
$500-$999			$500-$999			$500-$999	
$1000-$2999			$1000-$2999			$1000-$2999	
$3000-$4999			$3000-$4999			$3000-$4999	
$5000-$9999			$5000-$9999			$5000-$9999	
More than $10,000			More than $10,000			More than $10,000	

General Comments:

(Colorado)

Oil & Produced Water Release Report

What was the cause of the spill?	
What corrective measures have been taken to prevent future spills?	
What has been done, or will be done to remediate the spill area?	
Where is recovered material being stored?	
How and where is recovered material being disposed?	
Estimated size and depth of spill area.	
Other comments	

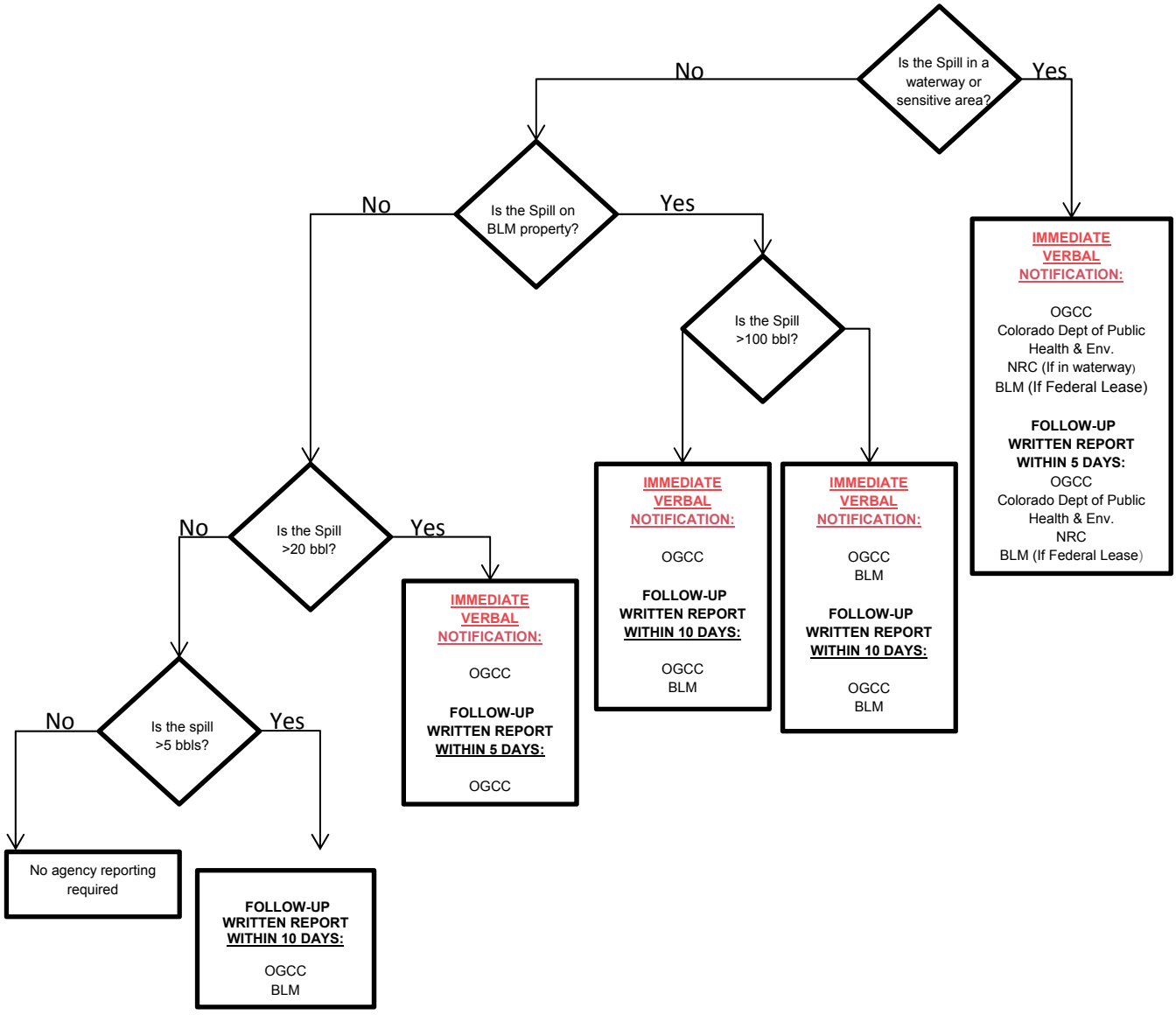
Reported by	Title	Date
Supervisor	Title	Phone

Call Production Superintendent as soon as practicable after discovery of spill at (970) 257-0727 or cell #(505) 486-0314.
Complete form and Email completed spill report to Production Superintendent within 24 hours of the incident at Gary.Stripling@blackhillscorp.com

Black Hills Exploration and Production

Oil and Produced Water Release Reporting Flowchart

DeBeque, Colorado



Reporting Requirements:

Spills greater than 20 bbl, any spill to a sensitive area or waterway must be reported immediately, but no later than 24 hours after discovery.

Follow-up reports must be filed with OGCC, Colorado Dept. of Public Health and Environment and NRC (if spill was to a waterway) and BLM (if federal lease). Follow-up reports to OGCC must be filed on OGCC Form 19.

Agency Contact Phone Numbers:

Oil and Gas Conservation Commission (OGCC)	(303) 894-2100 or (888) 235-1101
Colorado Dept. of Public Health and Environment	(877) 518-5608
National Response Center (NRC)	(800) 424-8802
Bureau of Land Management (BLM)	(970) 244-3000

CONTRACTOR GENERAL LIABILITY INCIDENT REPORT
Black Hills Exploration and Production

Use this form to report all Contractor incidents. Non-injury motor vehicle incidents should be reported on Motor Vehicle Report Form.

Reporting Person	Phone
Employer	Asset/Field
Nearest Town/City	Lease/Facility
State	Zip Code

Injured Person's Employer Information	
Employer	Phone
Address	City
State	Zip

Incident Information	
Injured Person	Date of Incident
Address	Time of Incident
City/State	Location of Incident
Zip Code	Work Activity
Phone	Black Hills Supervisor

Incident Type (Check all that apply)		**Contractor Type**
☐ Property Damage	☐ Motor Vehicle	☐ Drilling/Well Servicing
☐ First Aid	☐ Serious Potential (Near Miss)	☐ Transportation
☐ Medical Treatment	☐ Earthquake/Landslide	☐ Construction/Maint.
☐ Lost Time	☐ Occupational Illness	☐ Electrical
☐ Fire		☐ Other

Medical Information

Seen by Physician ☐ Yes ☐ No Ambulance/EMT ☐ Yes ☐ No

Physician/Hospital

Physician Phone No.

Comments

CONTRACTOR GENERAL LIABILITY INCIDENT REPORT
Black Hills Exploration and Production

Use this form to report all Contractor incidents. Non-injury motor vehicle incidents should be reported on Motor Vehicle Report Form.

Witnesses

Witness	Address	Phone #
1.		
2.		
3.		

Responding Agencies

Agency	Name of Agency Official	Phone #
1.		
2.		
3.		

Injury Description

Describe in detail the incident.
Attach additional pages and/or
documentation as necessary.

Basic cause of the incident.
Attach additional information if
Necessary.

Describe corrective action(s) taken
to prevent recurrence. Attach
additional information if necessary.

Form Prepared by	Supervisor
Title	
Signature	Date

Within 24 hours, Email completed form to the Production Superintendent,
Gary Stripling at Gary.Stripling@blackhillscorp.com.

APPENDIX L

MESA COUNTY PERMITS AND ZONING

11/13/2014
Date

PERMIT TO BUILD

MESA COUNTY BUILDING DEPARTMENT
BUILDING INSPECTION DIVISION

$ 319,667.04
Value

BEMZ
PERMIT TYPE

14-02641
PERMIT NUMBER

PERMIT CITY: _____ MOBILE HOME TAX ID NO. _____

OWNER: BLACK HILLS PLATEAU PRODUCTION TAX SCHEDULE NO. 2445-293-00-225

PROJECT ADDRESS: 4325 V 2/10 RD

CONTRACTOR: KUERSTEN CONST ADDRESS: _____

PHONE: _____ LICENSE NO. _____

DESCRIPTION OF WORK: 56 X 66 PUMP STATION BUILDING

REQUIRED DOCUMENTS:

RADON SURVEY: _____ SEWER: _____ SEPTIC PERMIT: _____ SEPTIC CLEARANCE: _____

FIRE DEPARTMENT CLEARANCE: _____ FOOD HANDLING: _____ PLANNING: _____

OCCUPANCY: _____

SPECIAL CONDITIONS: _____

ELECT CONT: MARK BRIELS ELCT LICENSE NUMBER: _____ VALUE: _____

PLUMB CONT: THOMPSON PLBG LICENSE NUMBER: _____ VALUE: _____

MECH CONT: RIDGERUNNER HVAC LICENSE NUMBER: _____ VALUE: _____

MESA COUNTY USE TAX

EXEMPT_____ MONTHLY ___ ON COMPLETION ___
EXEMPTION NUMBER _____
I hereby acknowledge the USE TAX filing status noted above and agree to abide by the provisions and regulations of the COUNTY SALES AND USE TAX RESOLUTION TAX MCM-81-199. I understan that I am responsible for maintaining adequate accounting records that are subject to audit for 3 years to substantiate my use tax return.

_____

CITY OF GRAND JUNCTION USE TAX

1. USE TAX UPON PURCHASES OF ALL MATERIALS WHICH THE GRANI JUNCTION SALES TAX HAS NOT BEEN PAID. You may summarize by supplier on USE TAX FORM directly on the FINANCE DIRECTOR'S OFFICE
2. PAYMENT OF TAX DIRECTLY TO SUPPLIER. I hereby certify that all materials used in the above construction will be purchased within the city limits and the Sales Tax paid directly to the supplier. All purchase records and invoices will be retained for 3 years. I certify that the statements made herein are true and correct to the best of my knowledge.

X _____

I hereby acknowledge that the above information is correct to the best of my knowledge, and I agree to comply with all city or county ordinances regulating building construction.

_____
CONTRACTOR/OWNER SIGNATURE

TJC
_____
BUILDING DEPARTMENT SIGNATURE

PERMIT FEE $694.00

11/13/2014
Date

PERMIT TO BUILD

MESA COUNTY BUILDING DEPARTMENT
BUILDING INSPECTION DIVISION

$ 453,247.20
Value

BEMPZS
PERMIT TYPE

14-02640
PERMIT NUMBER

PERMIT CITY: _____ MOBILE HOME TAX ID NO. _____

OWNER: BLACK HILLS PLATEAU PRODUCTION TAX SCHEDULE NO. 2445-293-00-225

PROJECT ADDRESS: 4325 V 2/10 RD

CONTRACTOR: KUERSTEN CONST ADDRESS: _____

PHONE: _____ LICENSE NO. _____ , _____

DESCRIPTION OF WORK: 42 X 68 OFFICE BUILDING

REQUIRED DOCUMENTS:

RADON SURVEY: _____ SEWER: _____ SEPTIC PERMIT: _____ SEPTIC CLEARANCE: _____

FIRE DEPARTMENT CLEARANCE: _____ FOOD HANDLING: _____ PLANNING: _____

OCCUPANCY: _____

SPECIAL CONDITIONS: _____

ELECT CONT: MARK BRIELS ELECT LICENSE NUMBER: _____ VALUE: _____

PLUMB CONT: THOMPSON LICENSE NUMBER: _____ VALUE: _____

MECH CONT: RIDGE RUNNERS LICENSE NUMBER: _____ VALUE: _____

MESA COUNTY USE TAX

EXEMPT_____ MONTHLY ____ ON COMPLETION ____
EXEMPTION NUMBER _____
I hereby acknowledge the USE TAX filing status noted above and agree to abide by the provisions and regulations of the COUNTY SALES AND USE TAX RESOLUTION TAX MCM-81-199. I understan that I am responsible for maintaining adequate accounting records that are subject to audit for 3 years to substantiate my use tax return.

_____

CITY OF GRAND JUNCTION USE TAX

1. USE TAX UPON PURCHASES OF ALL MATERIALS WHICH THE GRANI JUNCTION SALES TAX HAS NOT BEEN PAID. You may summarize by supplier on USE TAX FORM directly on the FINANCE DIRECTOR'S OFFICE
2. PAYMENT OF TAX DIRECTLY TO SUPPLIER. I hereby certify that all materials used in the above construction will be purchased within the city limits and the Sales Tax paid directly to the supplier. All purchase records and invoices will be retained for 3 years. I certify that the statements made herein are true and correct to the best of my knowledge.

X _____

I hereby acknowledge that the above information is correct to the best of my knowledge, and I agree to comply with all city or county ordinances regulating building construction.

_____
CONTRACTOR/OWNER SIGNATURE

_____
BUILDING DEPARTMENT SIGNATURE

PERMIT FEE $815.00

MESA COUNTY

Printed: November 13, 2014

200 S. Spruce Street, P.O. Box 20000 • GRAND JUNCTION, CO 81502
(970) 244-1631

Receipt Number: B29036

Permit Number: 14-02641

Permit Type: BEMZ

Site Address: 4325 V 2/10 RD

Applicant: KUERSTEN CONST

Owner: BLACK HILLS PLATEAU PRODUCTION

Contractor: KUERSTEN CONST

Job Description: 56 X 66 PUMP STATION BUILDING

FEES PAID

R 100.60201.32210		
BUILDING PERMIT FEE		
BUILDING PERMIT FEE	R 100.60201.32210	$759.00
11/3/2014:	R 100.60201.32210	-$65.00
Total Fees for Account R 100.60201.32210:		**$694.00**
Total Fees Paid:		**$694.00**

Date Paid: Thursday, November 13, 2014
Paid By: KUERSTEN CONST
Pay Method: CHECK 26701
Received By: TORI A BEVAN

MESA COUNTY

Printed: November 13, 2014

200 S. Spruce Street, P.O. Box 20000 • GRAND JUNCTION, CO 81502
(970) 244-1631

Receipt Number: B29037

Permit Number: 14-02640

Permit Type: BEMPZS

Site Address: 4325 V 2/10 RD

Applicant: KUERSTEN CONST

Owner: BLACK HILLS PLATEAU PRODUCTION

Contractor: KUERSTEN CONST

Job Description: 42 X 68 OFFICE BUILDING

FEES PAID

R 100.60201.32210		
BUILDING PERMIT FEE		
BUILDING PERMIT FEE	R 100.60201.32210	$880.00
11/3/2014:	R 100.60201.32210	-$65.00
Total Fees for Account R 100.60201.32210:		**$815.00**
Total Fees Paid:		**$815.00**

Date Paid: Thursday, November 13, 2014
Paid By: KUERSTEN CONST
Pay Method: CHECK 26701
Received By: TORI A BEVAN

INSPECTION CARD

11/13/14
Date

INSPECTIONS WILL NOT BE MADE UNLESS 14-02641

1. THIS PERMIT IS POSTED ON THE JOB SITE
2. THE PLANS ARE ON THE JOB SITE
3. THE JOB ADDRESS IS POSTED AND LEGIBLE FROM THE STREET

4325 V 2/10 RD
ADDRESS

KUERSTEN CONST
PRODUCTION
CONTRACTOR

BLACK HILLS PLATEAU
OWNER

DESCRIPTION OF WORK 56 X 66 PUMP STATION BUILDING

FOR INSPECTIONS CALL
970-256-1564

FOR CANCELLATIONS AFTER 7:00
CALL 970-244-1631

NOTICE: INSPECTIONS SCHEDULED BY 6:30 A.M. ON A WORKING DAY WILL BE PREFORMED THE SAME WORKING DAY

NOTICE:
EXCEPT FOR A RESIDENTAL HOMEOWNER, IT IS ILLEGAL TO PERFORM ELECTRICAL AND PLUMBING WORK EXCEPT BY THOSE LICENSED TO DO SO BY THE STATE OF COLORADO. IN THE CITY OF GRAND JUNCTION A CITY CONTRACTOR'S LICENSE IS REQUIRED, VIOLATORS WILL BE PROSECUTED.

PERMITS BECOME NULL AND VOID IF THE PROJECT IS NOT COMMENCED AND PROGRESS VERIFIED BY AN INSPECTOR EVERY 180 DAYS

NO ELECTRICAL, PLUMBING, MECHANICAL OR FRAMING SHALL BE COVERED OR CONCEALED NOR FOUNDATIONS POURED UNTIL INSPECTED AND APPROVAL IS MARKED ON THIS CARD.

BUILDING GROUP	PLUMBING GROUP	MECHANICAL GROUP	ELECTRICAL GROUP
100 FOOTER	220 UNDERGROUND	340 GAS PIPING AND TEST	460 TEMPORARY POLE
102 FOUNDATION	222 ROUGH-IN	342 BOILER/FURNACE	462 ROUGH-IN
104 SLAB	224 SEWER	343 IN FLOOR HEAT	464 TEMPORARY SERVICE
106 FRAME	226 WATER LINE	344 HOT WATER HEATER	466 UNDERGROUND
108 INSULATION		346 VENTING	470 IN SLAB ROUGH-IN
110 FIREPLACE		348 MECH DUCT/ FIRE DAMPR	472 CEILING ROUGH-IN
111 REROOF		350 GAS FIREPLACE	474 SOFFIT ROUGH-IN
112 STRUCTURAL STEEL		352 WOOD BURNING APPLIANCE	
113 FIRE WALL		354 HOOD SYSTEM	
114 MASONRY GROUT			
115 STUCCO LATH			
116 FINAL CO	232 FINAL	356 FINAL	476 FINAL
118 MANUFACTURED HOME	234 MANUFACTURED HOME	358 MANUFACTURED HOME	478 MANUFACTURED HOME
120 SET BACKS	*ZONING CODE GROUP 600 INSPECTION CODE*	360 AHU SMOKE TEST	
		COMMERCIAL FINAL BACK FLOW INSPECTION SLADE CONNELL 970-256-4101	
FOUNDATION CERTIFICATE	PLUMBING CONTRACTOR: THOMPSON PLBG	MECHANICAL CONTRACTOR: RIDGERUNNER HVAC	ELECTRICAL CONTRACTOR: MARK BRIELS ELCT
FIRE DEPT CODES GROUP 5			
REVISED 12-4-2007			

INSPECTION CARD

11/13/14
Date

INSPECTIONS WILL NOT BE MADE UNLESS 14-02640
1. THIS PERMIT IS POSTED ON THE JOB SITE
2. THE PLANS ARE ON THE JOB SITE
3. THE JOB ADDRESS IS POSTED AND LEGIBLE FROM THE STREET

4325 V 2/10 RD
ADDRESS

KUERSTEN CONST
PRODUCTION
CONTRACTOR

BLACK HILLS PLATEAU
OWNER

DESCRIPTION OF WORK 42 X 68 OFFICE BUILDING

FOR INSPECTIONS CALL
970-256-1564

FOR CANCELLATIONS AFTER 7:00
CALL 970-244-1631

NOTICE: INSPECTIONS SCHEDULED BY 6:30 A.M. ON A WORKING DAY WILL BE PREFORMED THE SAME WORKING DAY

NOTICE:
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120 SET BACKS	*ZONING CODE GROUP 600 INSPECTION CODE*	360 AHU SMOKE TEST	
		COMMERCIAL FINAL BACK FLOW INSPECTION SLADE CONNELL 970-256-4101	
FOUNDATION CERTIFICATE	PLUMBING CONTRACTOR: THOMPSON	MECHANICAL CONTRACTOR: RIDGE RUNNERS	ELECTRICAL CONTRACTOR: MARK BRIELS ELECT
FIRE DEPT CODES GROUP 5			
REVISED 12-4-2007			

Mesa County Department of Public Works
Administration-Building-Engineering-Road and Bridge
Traffic-Planning-Solid Waste Management-Fleet
200 S. Spruce Street•P.O. Box 20,000 Department 5034•Grand Junction, Co 81502
Ph (970) 254-4141 Fax (970) 683-4340

☐ Vault application
Application Number **14-138**
Permit Number **14107**

On Site Wastewater Treatment System Permit

RPE Design by: WWC Engineering
RECEIVED 10/14/2014

DATE R 10/14/2014
Tax Schedule # 2445-293-00-225

Construction Address	City	State	Zip
4325 V 2/10 Road	Debeque	CO	81630

Subdivision ____ Lot ____ Block ____ Filing ____ Parcel Size 39.28

Owners Name	Owners Address	City	State	Zip
Red Rock Gathering Company, LLC			CO	

Applicant Black Hills Plateau Production Address ____
Installer: Kuersten Const.

☑ New ☐ Modification ☐ Tank Only ☑ Year Round ☐ Public
☐ Repair ☐ Enlargement ☐ Seasonal ☐ Well ☑ Cistern ☐ Spring ☐ Surface
☐ Alteration ☐ Relocation # of Days ____ Other ____ ☐ None

Total Square Footage: 2856 Square footage of basement: ____ Garage: attached

accessory building: ____ ☐ plumbed

Single Family
☐ Frame/Manufactured
☐ Mobile Home
# of Bedrooms ____
☐ Washer
☐ Disposal
☐ Basement Plumbing

Multi-Family
of Units ____
Bedrooms per unit ____
# of Units w/Clotheswasher ____
# of Units s/Garbage Disposal ____

Commercial
Type of Business: Oil & Gas Office
Number of Clients: ____
Number of Employees: 15
# of Shifts: ____
☐ Commercial Basement Plumbing

Building sewer depth: Per PE
Type of system: Infiltrator Trenches
Tank Volume: 1,000
☑ Concrete ☐ Fiberglass/Plastic
☐ Privy ☐ Vault
☐ Observed Percolation/Site Inspection
Notes: ____

Comments

Install in strict conformance with the attached plans byWWC Engineering, with Mesa County Engineering approval stamp dated 11/4/2014. Call Mesa County Engineering/OWTS Program (254-4141) and WWC Engineering. (406-443-3962) before backfill of any component of the onsite wastewater treatment system or for questions. Allow 48 hrs notice for final inspection and maintain all MC OWTS Regulation required setbacks

This permit is issued with the understanding that the sewage disposal system will be located and constructed in accordance with Regulations of the State of Colorado and the Mesa County Health Department. THIS PERMIT IS VALID FOR 1 (ONE) YEAR and must be available to Health Department Representatives upon request during construction. NO REFUNDS WILL BE GIVEN AFTER 1 (ONE) YEAR, OF THE DATE OF PAYMENT.

Issued By	Date Issued	Permit Fee		
Robin Carns	11/4/2014	$550.00	receipt:	317894
Inspected By	Final Inspection	date renewal:	receipt:	renewal fee: $0.00

☐ Marked off in Trak It ____ As-Built Received: ____

Fax Phone Number: 406-449-0056

Fax to: MIKE BERVE

COLORADO DEPT OF PUBLIC HEALTH and ENVIRONMENT

222 S. 6th St., Rm 232, Grand Junction CO 81501-2768 Telephone: 970-248-7164

GAMMA RADIATION SURVEY - REPORT FROM RECORDS

Date:	9/24/2014	CITY 0129
Location No.:	56690	COUNTY 077
Address:	04325 V 2/10 RD	N/R
Unit or Space #		
Tax Parcel No.:	2445-293-00-225	
Owner	RED ROCKS GATHERING CO	Code (Circle one): (9) 16
Occupant	COMM/INDUS SITE	
Comment:	BPR OFFICE BLDG 42X68 AND PUMP STATION 56X66	

Survey Requested by: MIKE

Phone: 406-443-3962

Date: 9/24/2014

Type of Request: COMM BLDG

✓ **No field survey required based on record review of the vicinity of the building site. No tailings deposits were identified from available records that would affect the construction site.**

Prepared by: Kate Elsbernd

Office Correction: _____

Address Correction per: _____

MESA COUNTY DEPARTMENT OF PUBLIC WORKS
Administration - Building - Engineering – Road and Bridge
*Traffic - **Planning** - Solid Waste Management*

200 S. Spruce Street • P.O. Box 20,000 - 5022 • Grand Junction, CO 81502-5001
Ph (970) 244-1636 Fax (970) 244-1769

Commercial Site Plan Approval

Short Form

Project Address: 4325 V 2/10 RD
Parcel Number: 2445-293-00-225
Business Name/Owner: Black Hills Plateau Production LLC
Representative: Shawn Higley **Phone #:** 406-443-3962

Description of Intended Use (include number of buildings, square footage, etc.):

Construction of an office building and pump station located at 4325 V 2/10 RD. as approved in CUP 2014-0032.

FOR OFFICE USE ONLY:

Trak-It Number: TBD **Zoning:** AFT

File Name and Number: Ref. CUP 2014-0032 CUP

TIF: $ N/A ____ DIST A Date TIF Paid:_____
____ DIST B

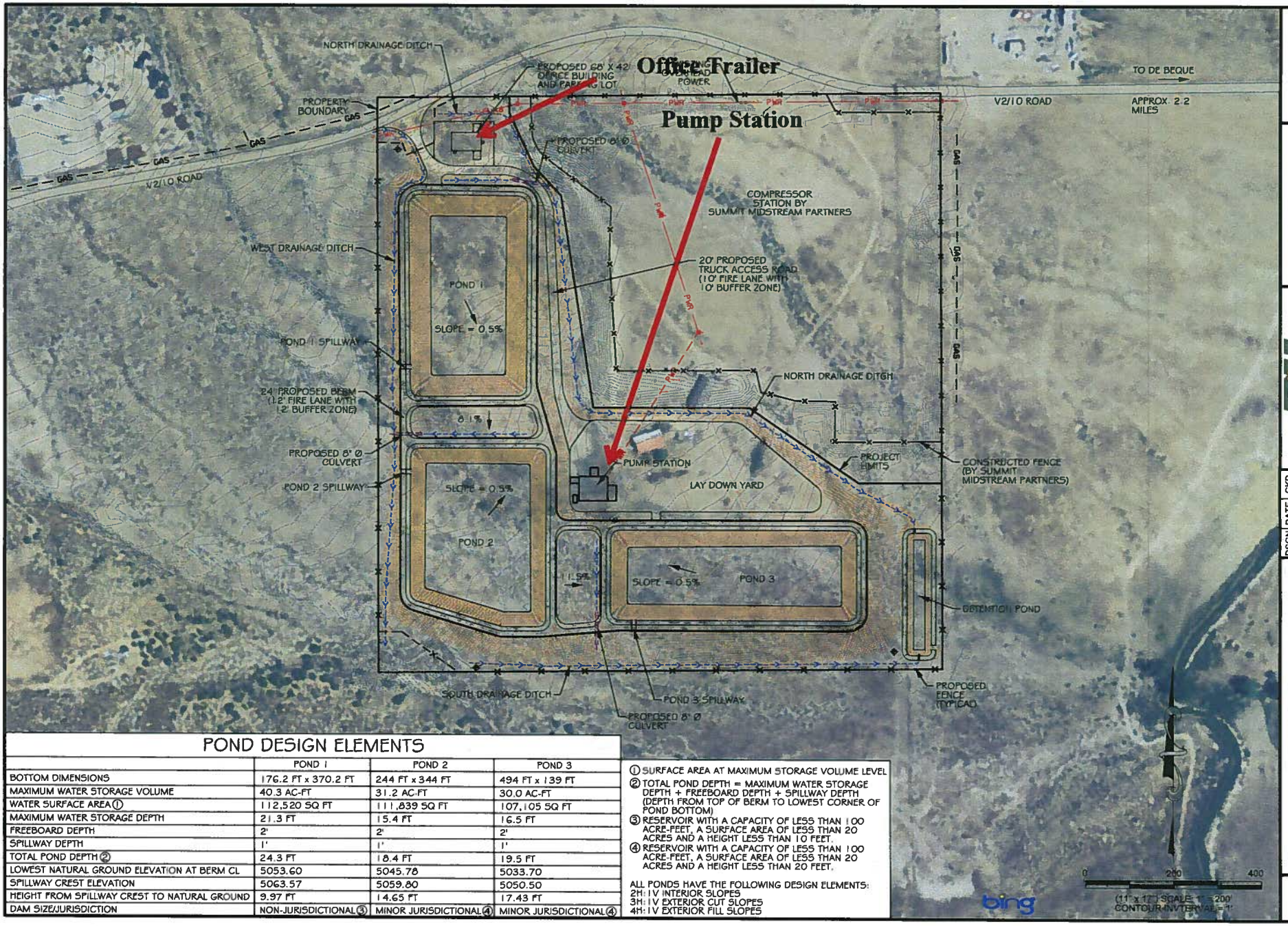
Driveway Permit Required: ____ Yes __X__ No

CDOT Permit Number: N/A

Special conditions: None

Date: 11/03/2014

Approved by: Randy Price, randy.price@mesacounty.us



POND DESIGN ELEMENTS

	POND 1	POND 2	POND 3
BOTTOM DIMENSIONS	176.2 FT x 370.2 FT	244 FT x 344 FT	494 FT x 139 FT
MAXIMUM WATER STORAGE VOLUME	40.3 AC-FT	31.2 AC-FT	30.0 AC-FT
WATER SURFACE AREA ①	112,520 SQ FT	111,839 SQ FT	107,105 SQ FT
MAXIMUM WATER STORAGE DEPTH	21.3 FT	15.4 FT	16.5 FT
FREEBOARD DEPTH	2'	2'	2'
SPILLWAY DEPTH	1'	1'	1'
TOTAL POND DEPTH ②	24.3 FT	18.4 FT	19.5 FT
LOWEST NATURAL GROUND ELEVATION AT BERM CL	5053.60	5045.78	5033.70
SPILLWAY CREST ELEVATION	5063.57	5059.80	5050.50
HEIGHT FROM SPILLWAY CREST TO NATURAL GROUND	9.97 FT	14.65 FT	17.43 FT
DAM SIZE/JURISDICTION	NON-JURISDICTIONAL ③	MINOR JURISDICTIONAL ④	MINOR JURISDICTIONAL ④

① SURFACE AREA AT MAXIMUM STORAGE VOLUME LEVEL
② TOTAL POND DEPTH = MAXIMUM WATER STORAGE DEPTH + FREEBOARD DEPTH + SPILLWAY DEPTH (DEPTH FROM TOP OF BERM TO LOWEST CORNER OF POND BOTTOM)
③ RESERVOIR WITH A CAPACITY OF LESS THAN 100 ACRE-FEET, A SURFACE AREA OF LESS THAN 20 ACRES AND A HEIGHT LESS THAN 10 FEET.
④ RESERVOIR WITH A CAPACITY OF LESS THAN 100 ACRE-FEET, A SURFACE AREA OF LESS THAN 20 ACRES AND A HEIGHT LESS THAN 20 FEET.

ALL PONDS HAVE THE FOLLOWING DESIGN ELEMENTS:
2H:1V INTERIOR SLOPES
3H:1V EXTERIOR CUT SLOPES
4H:1V EXTERIOR FILL SLOPES

WWC ENGINEERING
1275 MAPLE STREET, SUITE F
HELENA, MT 59601
(406) 443-3962

Black Hills Exploration & Production
A Black Hills Corporation Company
2350 G Road, Suite 101
Grand Junction, CO 81505

DSGN	DATE	CKD
DDP	4/25/14	STH
REV	DATE	CKD

DE BEQUE STATION

Proposed Facility Layout

EXHIBIT 1

(11" x 17" SCALE: 1" = 200' CONTOUR INTERVAL = 1')

6 PAGE DOCUMENT

RECEPTION #: 2692234, BK 5608
PG 801 06/10/2014 at 01:36:47 PM,
1 OF 6, R $0.00 S $0.00
Sheila Reiner, Mesa County, CO
CLERK AND RECORDER

BOCC 2014-147

RESOLUTION NO. _____

Planning Department No. 2014-0032 CUP

APPROVAL OF A CONDITIONAL USE PERMIT FOR BLACK HILLS DEBEQUE STATION WATER REUSE FACILITY

WHEREAS, Shawn Higley of WWC Engineering, representative for Black Hills Plateau Production, LLC, requested approval to operate a centralized oil and gas produced water reuse facility; and

WHEREAS, The Black Hills Debeque Station Water Reuse Facility will be located on a parcel of 39.3 acres in size, located at 4325 V 2/10 Rd., 1.5 miles west of DeBeque, as described on attached Exhibit "A", Legal Description and for 4325 V 2/10 Rd., DeBeque, located as shown on attached Exhibit "B", Location Map; and

WHEREAS, Black Hills Debeque Station Water Reuse Facility is proposed to be located on the same parcel that the Red Rock Gathering Company LLC, Debeque Processing Plant is located; and

WHEREAS, attached Exhibit "C" is the proposed site plan for the facility; and

WHEREAS, the staff recommendation was contained in a staff report dated April 15, 2014 (Revised May 5, 2014); and

WHEREAS, the Planning Commission recommended approval of this project by a vote of 6 to 1 at their public hearing April 24, 2014; and

WHEREAS, the public hearing before the Mesa County Board of County Commissioners was held on May 13, 2014.

NOW, THEREFORE, THE BOARD OF COUNTY COMMISSIONERS OF THE COUNTY OF MESA FINDS AS FOLLOWS:

THAT public notice requirements of Section 3.1.8 of the Mesa County Land Development Code (2000, as amended) have been met; and

THAT the application for a Conditional Use Permit for the Black Hills Debeque Station Water Reuse Facility located at 4325 V 2/10 Rd., DeBeque, can meet (with compliance with conditions) the applicable Approval Criteria for a Conditional Use Permit (Section 3.8.7) and the General Approval Criteria (Section 3.1.17) of the Mesa County Land Development Code (2000,

as amended) and the Approval Criteria of Section 5.2.22, Oil and Gas Support Services including consistency with intergovernmental agreements.

THAT this request is in accordance with the health, safety and welfare of the residents of Mesa County.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF COUNTY COMMISSIONERS IN THE COUNTY OF MESA, STATE OF COLORADO:

THAT the Conditional Use Permit for Concord Produced Water Services is approved with the following conditions:

1. Prior to the construction of the impoundments and other structures, the applicant shall submit and obtain approval of a site plan application to the Mesa County Public Works, Planning Division addressing compliance with these conditions of approval, addressing comments from review agencies and additional information as required in the site plan application checklist.
2. All applicable Federal, State, Local and County permits shall be obtained and maintained by the applicant and/or operator.
3. Compliance with the Development Standards of Chapter 7 of the Mesa County Land Development Code is continually required.
4. All review agency comments not in conflict with the conditions of approval shall be addressed.
5. The applicant shall use wildlife proof trash receptacles.
6. An emergency management plan and spill prevention and response plan shall be developed by the applicant's engineer and submitted for review and approval by the Mesa County Emergency Manager and the DeBeque Fire Department. Standard operating procedures dealing with occurrences shall be covered within the plan. Employees shall be trained in the procedures.
7. Regular maintenance of access road for emergency access and dust suppression.
8. The applicant, owner and operator shall not significantly deviate from the site plan and documents submitted with this application. Any modification or expansion of this facility, not including minor modifications as determined by the Planning Director, shall require an amendment of the Conditional Use Permit.
9. The applicant shall enter into a maintenance agreement with Mesa County as required for maintenance of 44 Rd. and V2/10th Rd with strong consideration to maintain local access.
10. Upon completion of the construction of the facility the applicant and the closest resident will evaluate the visual impacts to the nearest residence and provide additional screening

by landscaping, fencing or berming as needed to comply with Section 5.2.22B(11)of the Mesa County Land Development Code.

11. Noise levels on the site will adhere to the COGCC regulations for noise levels in residential and agricultural areas.
12. Prior to final site plan approval, the applicant shall provide a final drainage report meeting the specifications of the Development Engineering Division.
13. Full cutoff lighting with automatic shutoff will be used at this facility.
14. Conditional Use Permit approvals for support services facilities are valid for a period of three (3) years. The operator may submit a request for an extension of time before the end of the first three-year (3) period as an application for amendment.
15. Odors will be controlled through best available technology.

PASSED AND ADOPTED THIS 10th DAY OF JUNE, 2014.

John Justman, Chair
Board of Mesa County Commissioners

ATTEST:

Shelia Reiner, by Lori Peterson
Shelia Reiner
Mesa County Clerk and Recorder

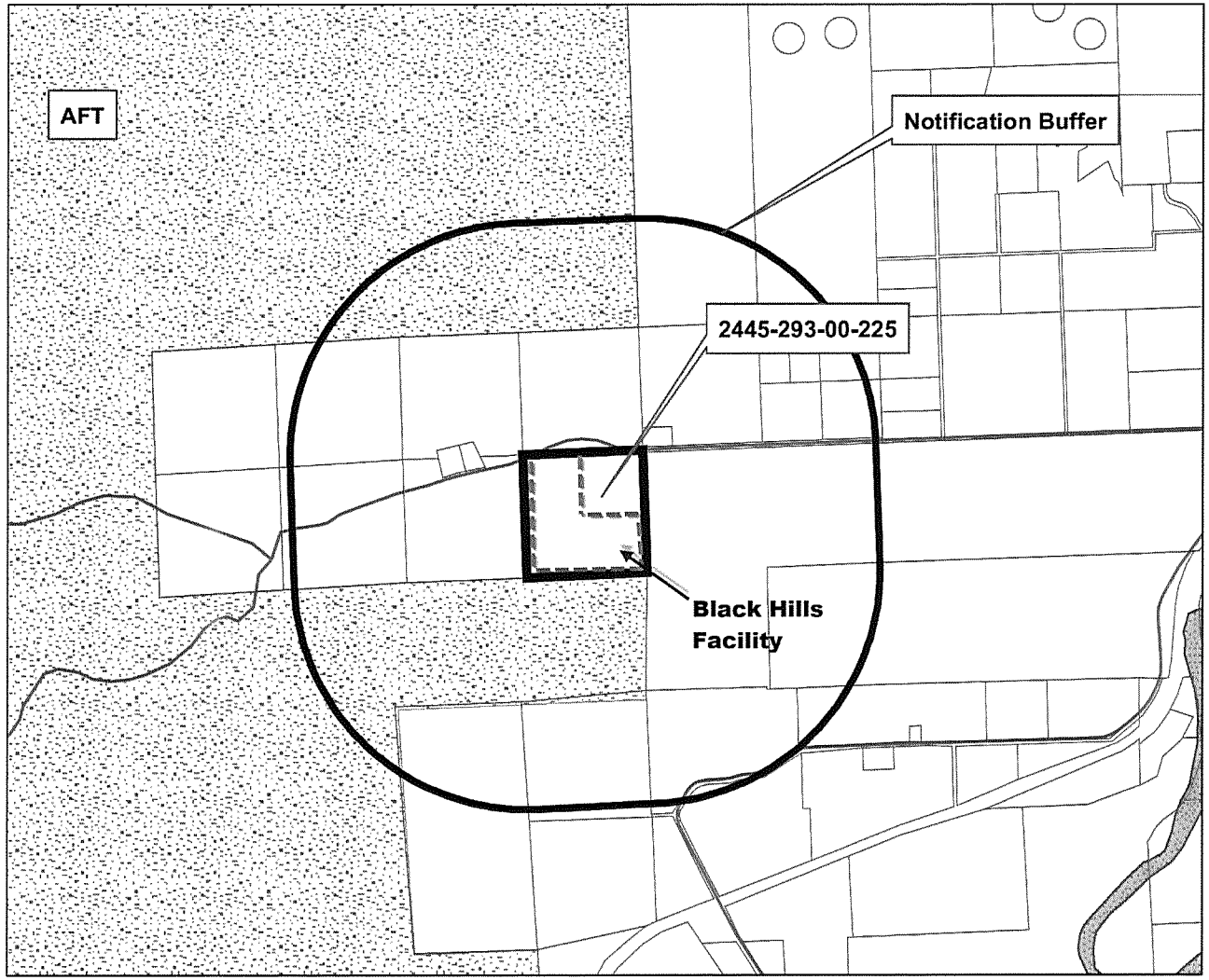
Exhibit A

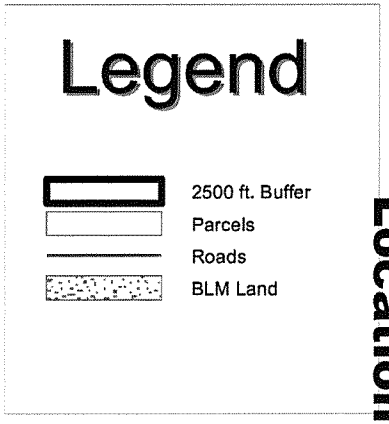
Legal Description for 4325 V 2/10 Rd, DeBeque, CO 81630

SE ¼ SW ¼ of Section 29, Township 8 South, Range 97 West of the 6th Principal Meridian, County of Mesa, State of Colorado, also known by street and number as 4325 V 2/10 Road, DeBeque, CO 81506.

Black Hills Debeque Station Water Reuse Facility
2014-0032 CUP
April 7, 2014

Zoning/Parcel Map

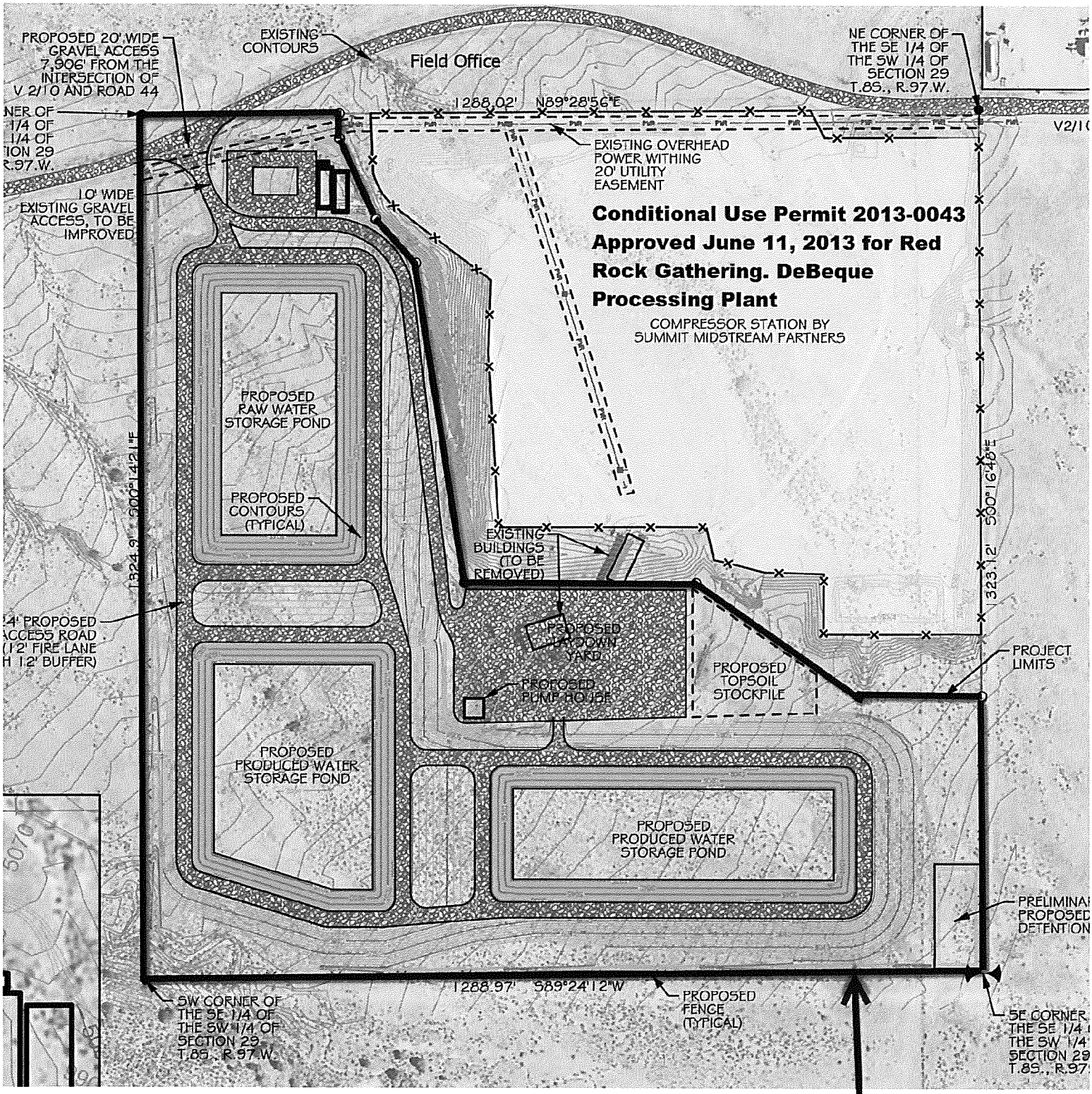




Location Map

Exhibit B

Exhibit C



Permit area for The Black Hills Debeque Station Water Reuse Facility