Water and Wildlife Plan

Adams County Development Standards and Regulations Section 4-11-02-03-03-03-23

CIVITAS

Crestone Peak Resources, LLC

WATER AND WILDLIFE PROTECTION PLAN

FOR

Bennett D Pad

Prepared For:

ADAMS COUNTY
COLORADO

4430 S. Adams County Pkwy.
Brighton, CO 80601
www.adcogov.org

Prepared By:

RPG RESOURCES
a System One company

1720 South Bellaire Street, Suite 400
Denver, CO 80222
www.rpgres.com

Date Prepared: December 2024

Table of Contents

1. INTRODUCTION

This Water and Wildlife Protection Plan (WWPP) was prepared by RPG Resources (RPG), on behalf of Crestone Peak Resources Operating, LLC (Civitas Resources, Inc.; hereafter Crestone), for the proposed Bennett D Pad (Site). This plan was prepared to adhere to Adams County's development standards and regulations. The WWPP serves as a framework for waters and wildlife protection and a communication tool to foster cooperative relationships between Crestone and its stakeholders. Implementation of this plan will serve to avoid or minimize environmental impacts, adverse effects to wildlife populations, their associated habitats, and respective productivity levels in anticipation of the development of Crestone oil and gas resources.

This WWPP addresses Crestone's plans to comply with all applicable operating requirements and includes a site-specific environmental site assessment. Additional measures may be implemented based on any new environmental constraints that arise or site-specific recommendations.

2. SITE DESCRIPTION

The Site boundaries are defined as the limits of disturbance (LOD) for the proposed pad and access road. The Site is located in Section 34 of Township 3 South, Range 64 West in Adams County, Colorado. It is in the Western Great Plains Range and Irrigated Region Land Resource Region (LRR) of the Central High Plains, Southern Part Major Land Resource Region (MLRA; NRCS 2006). The proposed location is a pad expansion, and the surrounding land type is rangeland.

3. WATER QUALITY MEASURES

During the drilling and pad construction phase the water supply source will be groundwater from the Rangeview Metropolitan District (39.650200, -104.659873), with a volume of 24,500 barrels. During the completions phase the water supply source will be surface water from FRICO (39.95392778, -104.74666667) with a volume of 14.85 million barrels.

Crestone is currently evaluating the feasibility to incorporate temporary produced water recycling equipment on the Bennett D Pad during completions. We are still assessing the details and full scope of the operations. The equipment will likely consist of multiple 500bbl tanks and chemical treatment which will fit within the limits of the permitted disturbance. It is possible Crestone will have to truck water to the oil and gas facility from other sites in the area. Utilizing recycled produced water will reduce the need for fresh water in completions. If Crestone determines it will pursue recycling, we will submit a minor amendment with full details of the operation to the Director for approval.

Groundwater will be sampled in accordance with the ECMC's Rule 615. Initial and periodic groundwater samples will be collected from up to four water sources within a half-mile radius of proposed site, prioritizing proximity, type, and aquifer diversity. Sampling will occur before drilling, at specific intervals after completion, and post-abandonment. Analysis will include testing for pH, dissolved gases, hydrocarbons, and various chemical constituents. Refer to the ECMC's Rule 615 for more information.

4. BMP AND SAFETY REQUIRMENTS

4.1. Environmental and Operational Safety BMP's

Crestone minimizes environmental impacts by integrating site-specific guidance into development plans and implementing additional protection measures as needed. The following Best Management Practices (BMPs) and safety measures ensure environmental protection and operational safety throughout all phases of operation:

1. During drilling, completion, and production operations, regular Auditory, Visual, and Olfactory Monitoring (AVO) inspections are performed on equipment containing hydrocarbons, fluids, or associated chemicals. AVO inspections include taking the time to look, smell and listen for leaks.
2. Operator utilizes a polyethylene liner beneath the drilling rig during drilling operations and beneath the areas where completions equipment (including pump trucks and other heavy equipment) during completion operations to ensure there is an impermeable layer between the rig and the earth. The use of this liner prevents hydrocarbons and other fluids from reaching the soil in the unlikely event a leak does occur. The liner is inspected for integrity throughout drilling operations and maintenance/repair to the liner occurs as needed.
3. Routine Spill Prevention, Control, and Countermeasure (SPCC) inspections will be conducted and documented pursuant U.S. EPA requirements. The location will be equipped with a Supervisory Control and Data Acquisition (SCADA) system that allows for remote monitoring and shut-in capabilities.
4. Operator has developed a robust Leak Detection and Repair (LDAR) program, which utilizes Forward Looking Infrared (FLIR®) cameras to identify and fix leaks. These inspections will begin during the drilling phase and continue throughout the life of the Oil & Gas Location.
5. Any spill or release reported to the ECMC shall also be reported to Adams County Local Government Department (LGD).
6. A 3-foot berm will be constructed on the western side of the pad to prevent any incidental spills from reaching the adjacent wetlands.

4.2. Wildlife BMP's

When possible, seasonal avoidance of important breeding, nesting, and winter habitats is the primary protection measure to reduce oil and gas development impacts on wildlife populations, productivity, and habitat use. Consultation with CPW and/or other wildlife agencies may be initiated to determine which other site-specific protection measures, if any, should be included in each project. Data collected during preliminary survey efforts is considered during project planning and design, and subsequent follow-up surveys and/or monitoring efforts are scheduled as needed. Protection measures are not limited to those identified in wildlife plans, and Crestone recognizes the nature of fluctuating wildlife conditions and remains adaptable to new wildlife constraints that may arise.

1. Ensure all personnel and contractors are aware of and adhere to applicable wildlife protection measures and BMPs;
2. Personnel and contractors will not harm any wildlife observed on site and will maintain recommended buffer distances related to wildlife;

3. Personnel and contractors will report any wildlife concerns, including the discovery of injured or orphaned wildlife, to on-site management and applicable EHSR personnel;
4. Consult CPW and/or other applicable agencies/personnel, upon the discovery of new wildlife constraints, as needed;
5. Use qualified third-party contractors for wildlife surveys, monitoring, and other consultation purposes; and
6. Document any wildlife-related issues or changes.

5. ENVIRONMENTAL SITE ASSESSMENT

RPG conducted a comprehensive Environmental Site Assessment (ESA) of the proposed Site and provided recommendations based on site-specific observations. RPG's considerations included, but were not limited to, resources protected under the Bald and Golden Eagle Protection Act (BGEPA), Migratory Bird Treaty Act (MBTA), Endangered Species Act, Colorado Nongame, Endangered, or Threatened Species Conservation Act, and the Clean Water Act (CWA). The ESA included a desktop review of aerial imagery, agency-mapped sensitive natural resources, and a site-specific U.S. Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) report. Following the desktop review, RPG conducted field surveys on July 31, 2024 and September 19, 2024 to assess the potential for other protected or sensitive natural resources to be impacted by operations. Detailed results of the ESA are provided in Appendix A and an Environmental Site Map is provided in Appendix B.

Note: A consultation with Colorado Parks and Wildlife (CPW) is not required, as the pad is not located within HPH. However, CPW was involved in obtaining the chemical storage waiver per ECMC Rule 1202.a.(3) due to the location's proximity to delineated wetlands. Additionally, on November 6, 2024, CPW participated in the Conceptual Review/Pre-Application meeting with Adams County, Crestone, CDPHE, and ECMC staff.

The Site is also located outside Adams County's Natural Resource Conservation Overlay.

5.1 Eagles

There is no suitable nesting habitat for bald eagles (*Haliaeetus leucocephalus*) or golden eagles (*Aquila chrysaetos*) within ½ mile of the Site, and no eagle activity was observed during the survey.

There are no CPW-mapped bald eagle winter night roost areas within ½ mile of the Site.

No further action recommended.

5.2 Burrowing Owls

No suitable burrowing owl (Athene cunicularia) habitat (i.e., prairie dog town) was identified within ¼ mile of the Site, however, burrowing owls were observed approximately 0.42 miles west of the site, further than the CPW-recommended species-specific buffer.

If construction begins between March 15 and October 31, a burrowing owl habitat survey is recommended by qualified biologists prior to construction to confirm no new habitat has been established. If new habitat is observed, burrowing owl surveys will be conducted in accordance with CPW-recommended protocol, and CPW will be consulted if owls are determined to be present.

5.3 Other Raptors

Three inactive non-eagle raptor nests were observed within ½ mile of the Site. One nest is located approximately 365 feet southwest of the Site, a second nest is located approximately 700 feet west from the Site, and a third nest is located approximately 700 feet east of the Site.

If construction begins between February 1 and July 31, additional raptor nesting surveys are recommended. If active raptor nests are observed within CPW's recommended species-specific buffers, consultation with CPW is recommended to determine appropriate mitigation measures.

5.4 Migratory Birds

No migratory bird nests or nesting activity were observed; however, suitable nesting habitat, including surface topography, vegetation, and artificial structures, is present at and immediately surrounding the Site.

If construction begins between April 1 through August 31, migratory bird nesting surveys are recommended. If MBTA-protected active nests are found, Crestone will provide work zone buffers around them while they remain active.

5.5 Threatened, Endangered, and Candidate Species

The IPaC report included six (6) federally listed threatened, endangered, or candidate species that have potential to exist within or in the immediate vicinity of the Site. These species include: piping plover (*Charadrius melodus*), whooping crane (*Grus americana*), pallid sturgeon (*Scaphirhynchus albus*), Ute ladies'-tresses (*Spiranthes diluvialis*), western prairie fringed orchid (*Platanthera praeclara*), and monarch butterfly[1] (*Danaus plexippus*). No suitable habitat for any of these species was identified at the Site.

The Colorado state-listed T&E species that have potential to occur in the same area as the Site are the burrowing owl and the Preble's meadow jumping mouse (PMJM). The burrowing owl is discussed above in Section 5.2. No suitable habitat for the PMJM was observed at the Site.

No further action is recommended.

5.6 Wetlands, Waters of the U.S., and Floodplains

There are three National Hydrography Dataset (NHD)- National Wetland Inventory (NWI)- mapped aquatic features within 500 feet of the Site, however, only two features were field verified present at the time of the survey. Feature one, an NWI-mapped wetland, is mapped within the western edge of the WPS, however, the boundaries determined in the field approximate the wetland 54-feet west of the WPS. Feature two is a stormwater pond with wetland fringe, is located approximately 150-feet west of the WPS. The pond has an ordinary high-water mark (OHWM) and fringe wetlands along the bed and bank. A drainage feature moves water downslope, from north to south, and into the pond. Feature three is an

[1] The monarch butterfly is currently a USFWS candidate species and is not yet listed as threatened or endangered. There are generally no section 7 requirements for candidate species; however, efforts to conserve this species and its associated habitats are strongly encouraged while an official federal listing determination is being considered.

NHD-mapped intermittent lake/pond and NWI-Mapped wetland and is located approximately 40-feet south of the WPS. This feature was field verified not present at the time of the survey.

No additional wetlands, water bodies, or floodplains were documented or observed within or adjacent to the Site. As a result, no impacts to any potential wetlands or waters of the U.S. are expected as a result of project activities associated with the Site.

The Site is not located within a Federal Emergency Management Agency (FEMA)-mapped 100-year floodplain.

Stormwater Best Management Practices are recommended on the western perimeter of the Site to prevent impacts to any wetlands or waters.

5.7 High Priority Habitats

The Site is not located within any CPW-mapped High Priority Habitats.

No further action is recommended.

5.8 Safety or Other Concerns

No safety issues or other concerns were identified at the Site.

No further action is recommended.

6. SUMMARY

The Bennett D Pad is not located within any High Priority Habitats.

Suitable nesting habitat for raptors and other migratory birds exists within CPW-recommended species-specific buffers. Additional wildlife surveys are recommended before construction to ensure no sensitive wildlife resources are impacted.

Groundwater will be sampled in accordance with ECMC Rule 615. Environmental impacts will be mitigated by incorporating site-specific guidance into development plans and implementing additional protection measures as needed.

Crestone and all associated contractors agree to adhere to all relevant operating requirements outlined in this WWPP. In addition to the standard operating requirements, supplementary measures and protocols may be implemented in response to specific needs identified at the Site.

PHOTOS

1. From north of Site facing south.

2. From west of Site facing east.

3. From south of Site facing north.

4. From east of Site facing west.

5. From northeast of the Site facing west.

6. From northwest of the Site facing east.

LITERATURE CITED

Adams County. 2023. Section 4-11-02-03-03-03 of the Development Standards and Regulations Manual. Updated October 17, 2023. https://adcogov.org/sites/default/files/2023-11/dsr-chapter-04.pdf. Accessed October 2024.

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Colorado Parks and Wildlife. 2020. Colorado Parks and Wildlife's (CPW) Recommendations to Avoid and Minimize Impacts to Wildlife from Land Use Development in Colorado. Colorado Department of Natural Resources.

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Colorado Parks and Wildlife. Species Profiles. https://cpw.state.co.us/learn/Pages/SpeciesProfiles.aspx. Accessed September 2024.

Department of the Interior: Fish and Wildlife Service. 2010. Endangered and Threatened Wildlife and Plants; Revised Critical Habitat for the Preble's Meadow Jumping Mouse in Colorado; Final Rule.

National Resources Conservation Service. 2006. National Coordinated Major Land Resource Area (MLRA) Version 4.2. U.S. Department of Agriculture, National Soil Survey Center.

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U.S. Fish and Wildlife Service. 2021. Featured Pollinator Monarch butterfly (*Danaus plexippus plexippus*). https://www.fws.gov/pollinators/features/Monarch_Butterfly.html. Accessed September 2024.

U.S. Fish and Wildlife Service. IPaC Information for Planning and Consultation. https://ecos.fws.gov/ipac/. Accessed September 2024.

APPENDIX A

Environmental Site Assessment Results

CIVITAS

Crestone Peak Resources, LLC

ENVIRONMENTAL SITE ASSESSMENT

RPG RESOURCES a System One company

Project Name:	Bennett D Pad	**County, State:**	Adams County, CO
Report Date:	9/19/2024	**Region:**	DJ Basin
Inspection Date:	7/31/2024, 9/19/2024, 9/24/2024	**Field Name:**	Wattenberg
Inspector Name:	Miranda Roberts	**Location:**	S34 T3S R64W
ESA Type:	Pad Expansion	**Project Lat-Long:**	39.742061, -104.534070

RAPTORS

Bald and Golden Eagle Habitat:	No	**Status:**	**CLEARED**
Bald and Golden Eagle Active Nests:	No		

No bald eagle (*Haliaeetus leucocephalus*) or golden eagle (*Aquila chrysaetos*) nests or nesting activity were observed within ½ mile of the Site during the field surveys. There is no suitable eagle nesting habitat (e.g., trees and cliffs) within ½ mile of the Site.

Bald Eagle Winter Night Roost/Communal Roost:	No	**Status:**	**CLEARED**

There are no CPW-mapped bald eagle winter night roosts / communal roosts within 1/2 mile of the Site.

***Burrowing Owls and Black-Tailed Prairie Dog Habitat:**	No	**Status:**	**TEMPORARILY CLEARED**
***Burrowing Owl nests:**	No		

No suitable burrowing owl (*Athene cunicularia*) habitat (i.e., prairie dog town) was identified within ¼ mile of the Site, however, burrowing owls were observed approximately 0.42 miles west of the site, further than the CPW-recommended species-specific buffer.

Other Raptor Habitat:	Yes	**Status:**	**TEMPORARILY CLEARED**
Other Raptor Nests:	Yes		

Three inactive non-eagle raptor nests were observed within ½ mile of the Site. One nest is located within the working pad surface, a second nest is located approximately 217 feet east of the Site, and a third nest is located approximately 283 feet east of the Site.

OTHER BIRDS

Grouse or Prairie Chicken High Priority Habitats:	No	**Status:**	**CLEARED**

The Site is not within any grouse or prairie chicken HPHs.

Non-Raptor Migratory Bird Habitat:	Yes	**Status:**	**TEMPORARILY CLEARED**
Non-Raptor Migratory Bird Nests:	No		

Suitable non-raptor nesting habitat (e.g., surface topography and vegetation) is present at and immediately surrounding the Site, however, no nests or nesting activity were observed during the field surveys.

MAMMALS

Big Game High Priority Habitats:	No	**Status:**	**CLEARED**

The Site is not located within any CPW-mapped High Priority Habitats. Not a constraint.

****** Preble's Meadow Jumping Mouse (PMJM) Habitat:**	No	**Status:**	**CLEARED**

There is no suitable PMJM habitat at the Site. Not a constraint.

Swift Fox Habitat:	No	**Status:**	**CLEARED**
Swift Fox Dens:	No		

The Site is not within CPW-mapped swift fox overall range, and no swift fox habitat was observed during the survey. Swift fox habitat is mapped approximately 0.50 miles south of the Site.

VEGETATION

****Ute ladies'-tresses orchid (ULTO):**	No	**Status:**	**CLEARED**

There is no suitable Ute ladies'-tresses orchid habitat at the Site. Not a constraint.

Colorado State Noxious Weeds - List A,B,C:	No	**Status:**	**CLEARED**

No noxious weeds were identified at the Site. Not currently a constraint.

Current Land Use:	Rangeland and O&G	**Future Land Use:**	Rangeland and O&G

CIVITAS
Crestone Peak Resources, LLC

ENVIRONMENTAL SITE ASSESSMENT

RPG RESOURCES
a System One company

AQUATIC HABITATS

Aquatic High Priority Habitats:	No	**Status:**	**CLEARED**
There are no Aquatic High Priority Habitats within 1000 feet of the Site.			
Wetlands/WOUS:	Yes	**Status:**	**CLEARED - Waiver Request Approved**

There are three National Hydrography Dataset (NHD)- National Wetland Inventory (NWI)- mapped aquatic features within 500 feet of the Site, however, only two features were field verified present at the time of the survey. Feature one, an NWI-mapped wetland, is mapped within the western edge of the WPS, however, the boundaries determined in the field approximate the wetland 54-feet west of the WPS. Feature two is a stormwater pond with wetland fringe, is located approximately 150-feet west of the WPS. The pond has an ordinary high-water mark (OHWM) and fringe wetlands along the bed and bank. A drainage feature moves water downslope, from north to south, and into the pond. Feature three is an NHD-mapped intermittent lake/pond and NWI-Mapped wetland and is located approximately 40-feet south of the WPS. This feature was field verified not present at the time of the survey.

OTHER/SAFETY

Other Issues:	No	**Status:**	**CLEARED**
None.			
Safety Issues:	No	**Status:**	**CLEARED**
None.			

FORM 2A

Is HPH Present (309.e(2)A)?	No
If NO, then Wildlife Protection Plan Needed (1201.a)?	Yes
If YES, then Wildlife Mitigation Plan Needed (1201.b)?	No
Is project in State Park or Wildlife Area (309.e(2)A)?	No
Is project in federally designated critical habitat (309.e(2)B)?	No
*****Federal or *Colorado T&E Species Present (309.e(2)B)?***	No
CPW Consultation Needed?	Yes
Vegetation removal scheduled April 1 to August 31 (1202.a(8))?	TBD
Working Pad Surface 500 to 1000' hydraulically upgradient from a HPH (1202.a(10))?	No
Density of O&G locations exceed 1 per square mile w/in HPH (1202.d)?	No
If YES, then Compensatory Mitigation Plan Needed (1203.a(1))	No

FIELD DATA COLLECTED	
Site Photos?	Yes
Reference Area Photos?	Yes
Updated Aerial Imagery Taken?	Yes
Ground Control Points?	Yes
Wetland Determination Data Form?	Yes

GENERAL COMMENTS

There is suitable non-eagle raptor and migratory bird nesting habitat present. Additional wildlife surveys are recommended prior to the start of construction to ensure no sensitive wildlife resources will be impacted.

Reviewed By: Russell Beam **Title:** Senior Environmental Manager

Signature:

APPENDIX B

Environmental Site Map

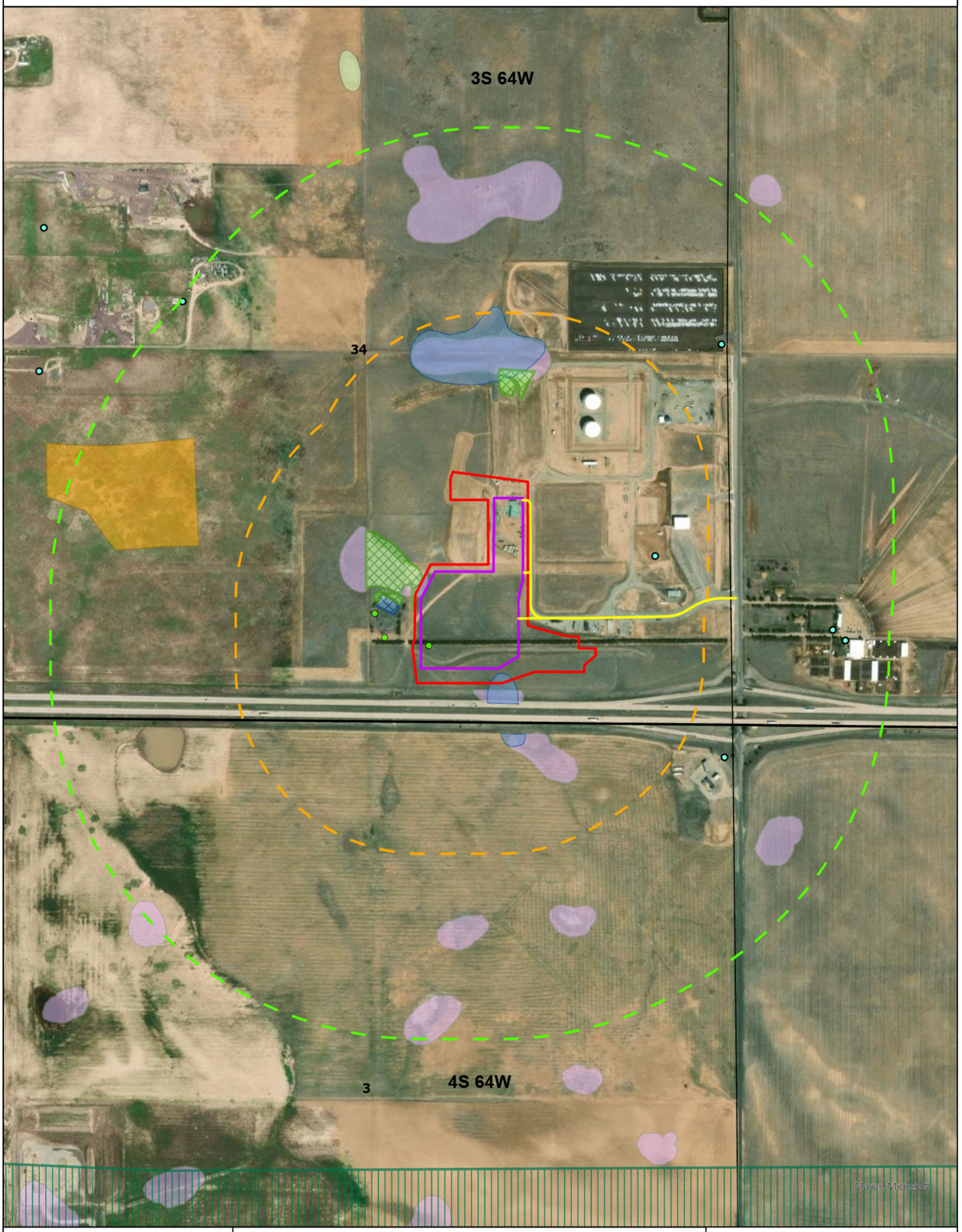
CIVITAS RESOURCES COMPANY, LLC
BENNETT D PAD
SEC34 T3S R64W 6th P.M.
ADAMS COUNTY, COLORADO

Produced for:

CIVITAS
Crestone Peak Resources, LLC

Produced by:

RPG RESOURCES
a System One company



ENVIRONMENTAL SITE MAP

- Oil & Gas Location (OGL)
- Working Pad Surface (WPS)
- Existing Access Road
- 0.25-Mile Buffer Around WPS
- 0.5-Mile Buffer Around WPS
- Inactive Non-Eagle Raptor Nest
- Pronghorn Winter Concentration Area
- HPH
- Burrowing Owl Habitat
- Delineated Wetland
- Delineated Lake/Pond
- NHD-Mapped Lake/Pond
- NWI-Mapped Freshwater Emergent Wetland
- NWI-Mapped Other Wetland
- Constructed Water Well

Projection: WGS 1984
Date: 11/18/2024
Drafted by: HJL

0 500 1,000 Feet

N

1 inch equals 650 feet

Engineering Documents

Site Plans – see Operations Plan

Haul Routes – see Transportation Plan and Written Narrative

Operations and Maintenance (O&M) plan for the existing pond – N/A

Construction Plans – N/A

Pavement Design Report – N/A

Grading Erosion and Sediment Control

Drainage study/technical drainage letter/plan

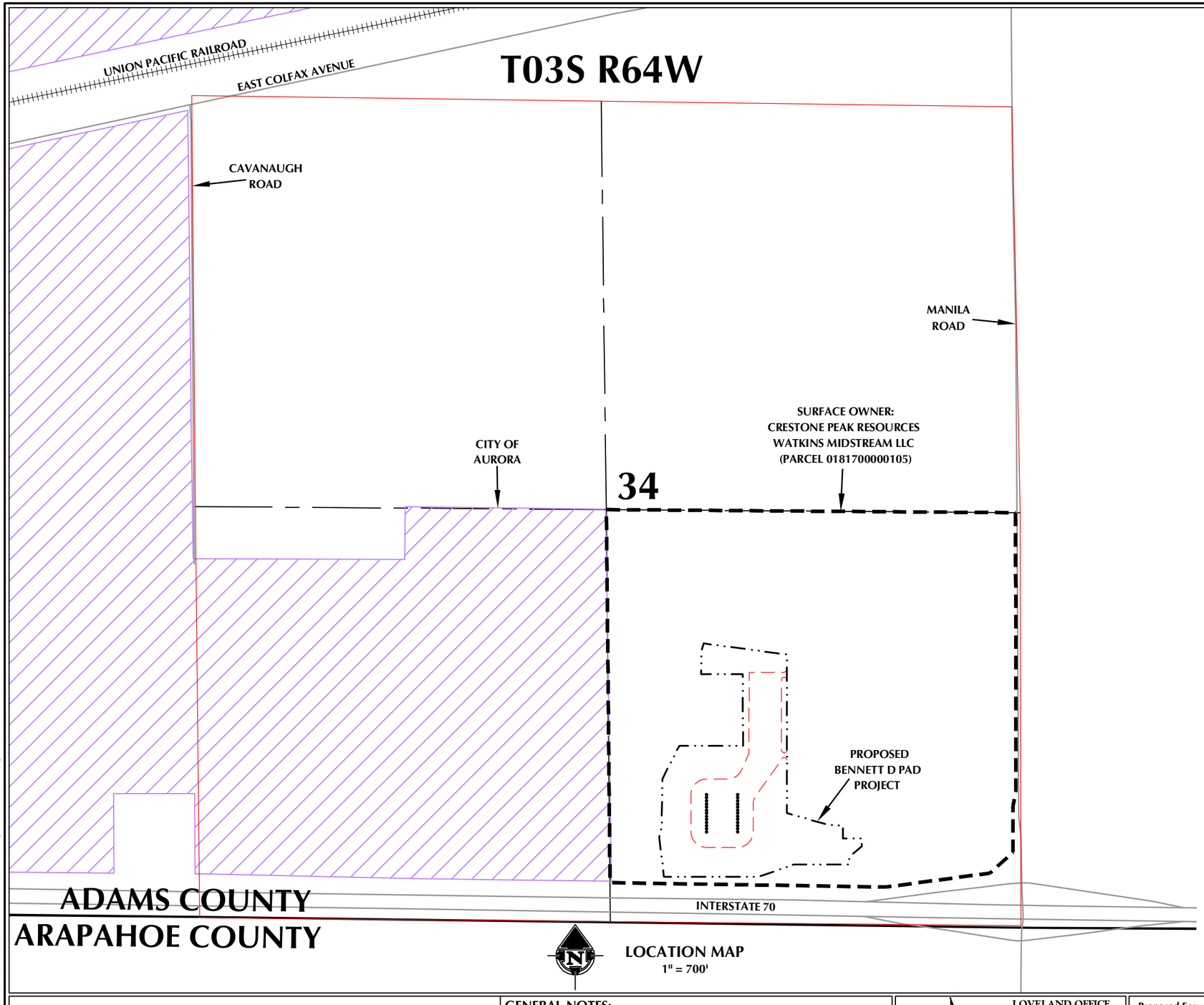
Stormwater Management Plan

Floodplain Use Permit – N/A

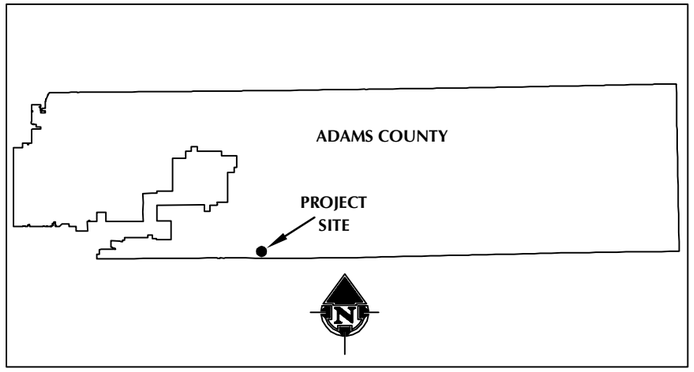
CDPHE storm water discharge permit

BENNETT D PAD
GRADING, EROSION AND SEDIMENT CONTROL PLAN

LOCATED IN SECTION 34, T3S, R64W, 6TH P.M.
ADAMS COUNTY, COLORADO



LOCATION MAP
1" = 700'



VICINITY MAP

PAGE INDEX

GENERAL NOTES:

1. THIS DRAINAGE AND EROSION CONTROL PLAN WAS PREPARED FOLLOWING ADAMS COUNTY DEVELOPMENT STANDARDS & REGULATIONS WITH ADDITIONAL DESIGN GUIDANCE PROVIDED BY MILE HIGH FLOOD DISTRICT.
2. DISCLAIMER: THIS PLAN REPRESENTS AN APPROXIMATE LOCATION OF SEDIMENT AND EROSION CONTROL FEATURES; EXACT LOCATION MAY VARY DEPENDING UPON EXISTING EASEMENTS, PIPELINES, FLOWLINES, AND SETBACK REQUIREMENTS.
3. ORIGINAL DOCUMENT SIZE: 11" X 17"

609 CONSULTING, LLC
LOVELAND OFFICE
6706 North Franklin Avenue
Loveland, Colorado 80538
Phone 970-776-4331
SHERIDAN OFFICE
1095 Saberton Avenue
Sheridan, Wyoming 82801
Phone 307-674-0609

Prepared For:
CIVITAS
CRESTONE PEAK RESOURCES, LLC
555 17TH STREET, SUITE 3700
DENVER, CO 80202

BENNETT D PAD
GRADING, EROSION AND SEDIMENT CONTROL PLAN
COVER SHEET

SCALE:	VARIES	PAGE:	1 OF 8
JOB NUMBER:	23-182	DATE:	10/21/24
DRAFTED BY:	KMG	REVISED:	

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GENERAL NOTES

1. ALL CONSTRUCTION PROJECTS, REGARDLESS OF THE SIZE, SHALL INSTALL, MAINTAIN AND REPAIR STORMWATER POLLUTION CONTROL MEASURES (CMS) TO EFFECTIVELY MINIMIZE EROSION, SEDIMENT TRANSPORT, AND THE RELEASE OF POLLUTANTS RELATED TO CONSTRUCTION ACTIVITY. CMS EXAMPLES INCLUDE SEDIMENT CONTROL LOGS (SCL), SILT FENCE (SF), DIKES/SWALES, SEDIMENT TRAPS (ST), INLET PROTECTION (IP), OUTLET PROTECTION (OP), CHECK DAMS (CD), SEDIMENT BASINS (SB), TEMPORARY/PERMANENT SEEDING AND MULCHING (MU), SOIL ROUGHENING, MAINTAINING EXISTING VEGETATION AND PROTECTION OF TREES. CMS MUST BE SELECTED, DESIGNED, ADEQUATELY SIZED, INSTALLED AND MAINTAINED IN ACCORDANCE WITH GOOD ENGINEERING, HYDROLOGIC AND POLLUTION CONTROL PRACTICES. CMS/BMPS INSTALLATION AND MAINTENANCE DETAILS SHALL CONFORM TO MILE HIGH FLOOD DISTRICT'S URBAN DRAINAGE FLOOD CONTROL CRITERIA MANUAL VOLUME 3, OR THE COLORADO DEPARTMENT OF TRANSPORTATION (CDOT) STANDARDS & SPECIFICATIONS (GREEN BOOK). CMS MUST FILTER, SETTLE, CONTAIN OR STRAIN POLLUTANTS FROM STORMWATER FLOWS IN ORDER TO PREVENT BYPASS OF FLOWS WITHOUT TREATMENT. CMS MUST BE APPROPRIATE TO TREAT THE RUNOFF FROM THE AMOUNT OF DISTURBED AREA, THE EXPECTED FLOW RATE, DURATION, AND FLOW CONDITIONS (I.E., SHEET OR CONCENTRATED FLOW). CMS/BMPS SHALL BE SPECIFIED IN THE SWMP (IF APPLICABLE), AND THE LOCATIONS SHOWN ON THE EC PLAN.
2. PRIOR TO CONSTRUCTION, PROJECTS DISTURBING 1 OR MORE ACRES OF LAND, OR ANY PROJECT BELONGING TO A COMMON PLAN OF DEVELOPMENT DISTURB 1 OR MORE ACRES, MUST OBTAIN:
   - A GENERAL PERMIT FOR STORMWATER DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITIES, FROM THE COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT, AND
   - AN ADAMS COUNTY STORMWATER QUALITY PERMIT WITHIN THE UNINCORPORATED ADAMS COUNTY MS4 AREA.
3. PERMITTED PROJECTS SHALL DEVELOP A STORMWATER MANAGEMENT PLAN (SWMP), AKA EROSION AND SEDIMENT CONTROL PLAN (ESCP), IN COMPLIANCE WITH CDPHE MINIMUM REQUIREMENTS. THE APPROVED SWMP, INCLUDING EROSION CONTROL (EC) PLAN (SITE MAP), SHALL BE KEPT ON SITE AND ALWAYS UPDATED. THE QUALIFIED STORMWATER MANAGER IS RESPONSIBLE FOR IMPLEMENTING THE SWMP AND CMS (AKA BMPS) DURING CONSTRUCTION.
4. PERMITTED PROJECTS SHALL PERFORM REGULAR STORMWATER INSPECTIONS EVERY 7 CALENDAR DAYS; OR EVERY 14 CALENDAR DAYS AND WITHIN 24 HOURS AFTER ANY PRECIPITATION OR SNOWMELT EVENT THAT CAUSES SURFACE EROSION. INSPECTION FREQUENCY CAN BE REDUCED FOR POST-STORM EVENT INSPECTIONS AT TEMPORARILY IDLE SITES AND FOR STORMWATER INSPECTIONS AT COMPLETED SITES WAITING FOR FINAL STABILIZATION. INSPECTION REPORTS MUST IDENTIFY ANY INCIDENTS OF NON-COMPLIANCE.
5. TRACKING OF DIRT ONTO PAVED PUBLIC OR PRIVATE PAVED ROADS IS NOT ALLOWED. THE USE OF DIRT RAMPS TO ENTER/EXIT FROM AN UNPAVED INTO A PAVED AREA IS PROHIBITED. VEHICLE TRACKING CONTROLS SHALL BE IMPLEMENTED, OTHERWISE ENTRANCE AREA MUST DRAIN THROUGH A CM TOWARDS THE PRIVATE SITE.
6. TRUCKLOADS OF FILL MATERIAL IMPORTED TO OR CUT MATERIAL EXPORTED FROM THE SITE SHALL BE PROPERLY COVERED TO PREVENT LOSS OF THE MATERIAL DURING TRANSPORTATION ON PUBLIC ROW. HAUL ROUTES MUST BE PERMITTED BY THE COUNTY. NO MATERIAL SHALL BE TRANSPORTED TO ANOTHER SITE WITHOUT APPLICABLE PERMITS.
7. CONTROL MEASURES DESIGNED FOR CONCRETE WASHOUT WASTE MUST BE IMPLEMENTED. THIS INCLUDES WASHOUT WASTE DISCHARGED TO THE GROUND AND WASHOUT WASTE FROM CONCRETE TRUCKS AND MASONRY OPERATIONS.
8. TEMPORARY CMS/BMPS SHALL BE REMOVED AFTER THE SITE HAS REACHED FINAL STABILIZATION.
9. DEWATERING OPERATIONS DISCHARGING OFF-SITE INTO ANY WATERS CONVEYANCE SYSTEMS INCLUDING WETLANDS, IRRIGATION DITCHES, CANALS, RIVERS, STREAMS OR STORM SEWER SYSTEMS, REQUIRE A STATE CONSTRUCTION DEWATERING PERMIT.
10. PERMITTED PROJECTS SHALL KEEP THE CDPHE'S STORMWATER DISCHARGE PERMIT, STORMWATER MANAGEMENT PLAN (SWMP) AND INSPECTION LOGS AVAILABLE ON-SITE THROUGHOUT THE DURATION OF THE PROJECT, AND FOR AN ADDITIONAL 3 YEARS AFTER PERMIT CLOSE-OUT.
11. PERMITTED LANDOWNER AND/OR CONTRACTOR SHALL CLOSE THE STATE AND CITY/COUNTY PERMIT ONCE FINAL STABILIZATION IS REACHED. STORMWATER INSPECTIONS SHALL CONTINUE UNTIL INACTIVATION NOTICE IS FILED WITH CDPHE.

PERFORMANCE STANDARD NOTES

1. STORMWATER RUNOFF FROM DISTURBED AREAS MUST FLOW TO AT LEAST ONE (1) CM TO MINIMIZE SEDIMENT IN THE DISCHARGE. DO NOT ALLOW SEDIMENT TO LEAVE THE SITE. THE BEST WAY TO PREVENT SEDIMENT OR POLLUTANTS FROM ENTERING THE STORM SEWER SYSTEM IS TO STABILIZE THE SITE AS QUICKLY AS POSSIBLE, PREVENTING EROSION AND STOPPING SEDIMENT RUN-OFF AT ITS SOURCE.
2. PHASE CONSTRUCTION TO MINIMIZE DISTURBED AREAS, INCLUDING DISTURBANCE OF STEEP SLOPES (I.E., THE ENTIRE PROJECT SITE SHOULD NOT BE DISTURBED IF CONSTRUCTION WILL ONLY BE OCCURRING IN ONE SECTION OF THE SITE). LIMIT SOIL EXPOSURE TO THE SHORTEST POSSIBLE PERIOD OF TIME. PROTECT NATURAL FEATURES AND EXISTING VEGETATION WHENEVER POSSIBLE. REMOVAL OF EXISTING VEGETATION SHALL BE LIMITED TO THE AREA REQUIRED FOR IMMEDIATE CONSTRUCTION OPERATIONS. MAINTAIN PRE-EXISTING VEGETATION (OR EQUIVALENT CMS) FOR AREAS WITHIN 50 HORIZONTAL FT OF RECEIVING WATERS.
3. SOIL COMPACTION MUST BE MINIMIZED FOR AREAS WHERE INFILTRATION CMS WILL OCCUR OR WHERE FINAL STABILIZATION WILL BE ACHIEVED THROUGH VEGETATIVE COVER.
4. ALL SOIL IMPORTED TO OR EXPORTED FROM THE SITE SHALL BE PROPERLY COVERED TO PREVENT THE LOSS OF MATERIAL DURING TRANSPORT.
5. DUST EMISSIONS RESULTING FROM GRADING ACTIVITIES OR WIND SHALL BE CONTROLLED.
6. INSTALL CONSTRUCTION FENCE (ORANGE) TO PROTECT WETLANDS AND OTHER SENSITIVE AREAS AND TO PREVENT ACCESS, AND TO DELINEATE THE LIMITS OF CONSTRUCTION. DO NOT USE SILT FENCE TO PROTECT WETLANDS SINCE TRENCHING MAY IMPACT THESE AREAS.
7. CMS INTENDED TO CAPTURE OVERLAND, LOW VELOCITY SHEET FLOW AT A LEVEL GRADE SHALL ONLY BE INSTALLED ALONG CONTOURS.
8. INSTALL CMS, SUCH AS CHECK DAMS, PERPENDICULAR TO THE CONCENTRATED FLOWS TO REDUCE FLOW VELOCITY.
9. STORM DRAIN INLETS WITHIN AND ADJACENT TO THE CONSTRUCTION SITE MUST BE PROTECTED. ANY PONDING OF STORMWATER AROUND INLET PROTECTION MUST NOT CAUSE EXCESSIVE FLOODING OR DAMAGE ADJACENT AREAS OR STRUCTURES.
10. INSTALL VEHICLE TRACKING CONTROL (VTC) TO ENTER/EXIT UNPAVED AREA. DO NOT USE RECYCLED CRUSHED CONCRETE OR ASPHALT MILLINGS FOR VEHICLE TRACKING PADS.
11. STRAW BALES SHALL NOT BE USED FOR PRIMARY EROSION OR SEDIMENT CONTROL (I.E., STRAW BALES MAY BE USED FOR REINFORCEMENT BEHIND ANOTHER BMP SUCH AS SILT FENCE).
12. OUTLETS SYSTEMS (SUCH AS SKIMMER OR PERFORATED RISER PIPE) SHALL BE INSTALLED TO WITHDRAW WATER FROM OR NEAR THE SURFACE LEVEL WHEN DISCHARGING FROM BASINS. WATER CANNOT DRAIN FROM THE BOTTOM OF THE POND.
13. TEMPORARY STABILIZATION MUST BE IMPLEMENTED FOR EARTH DISTURBING ACTIVITIES ON ANY PORTION OF THE SITE WHERE LAND DISTURBING ACTIVITIES HAVE PERMANENTLY OR TEMPORARILY CEASED (FOR MORE THAN 14 CALENDAR DAYS). TEMPORARY STABILIZATION METHODS EXAMPLES: TARPS, SOIL TACKIFIER, AND HYDROSEED. TEMPORARY STABILIZATION REQUIREMENT MAY EXCEED THE 14-DAY SCHEDULE WHEN EITHER THE FUNCTION OF THE SPECIFIC AREA REQUIRES IT TO REMAIN DISTURBED, OR PHYSICAL CHARACTERISTICS OF THE TERRAIN AND CLIMATE PREVENT STABILIZATION AS LONG AS THE CONSTRAINTS AND ALTERNATIVE SCHEDULE IS DOCUMENTED ON THE SWMP, AND LOCATIONS ARE IDENTIFIED ON THE EC PLAN (SITE MAP).
14. RUNOFF FROM STOCKPILE AREA MUST BE CONTROLLED. SOILS THAT WILL BE STOCKPILED FOR MORE THAN 30 DAYS SHALL BE PROTECTED FROM WIND AND WATER EROSION WITHIN 14 DAYS OF STOCKPILE CONSTRUCTION. INSTALL CMS/BMPS 5 FT AWAY FROM THE TOE OF THE STOCKPILE'S SLOPE.
15. WATER USED TO CLEAN CONCRETE TRUCKS SHALL BE DISCHARGED INTO A CONCRETE WASHOUT AREA (CWA). THE PREDEFINED CONTAINMENT AREA MUST BE IDENTIFIED WITH A SIGN AND SHALL ALLOW THE LIQUIDS TO EVAPORATE OR DRY OUT. CWA DISCHARGES THAT MAY REACH GROUNDWATER MUST FLOW THROUGH SOIL THAT HAS BUFFERING CAPACITY PRIOR TO REACHING GROUNDWATER. THE CONCRETE WASHOUT LOCATION SHALL NOT BE IN AN AREA WHERE SHALLOW GROUNDWATER MAY BE PRESENT AND WOULD RESULT IN BUFFERING CAPACITY NOT BEING ADEQUATE, SUCH AS NEAR NATURAL DRAINAGES, SPRINGS, OR WETLANDS. IN THIS CASE, A LINER UNDERNEATH IS NEEDED FOR AREAS WITH HIGH GROUNDWATER LEVELS. CWA SHALL NOT BE PLACED IN LOW AREAS, DITCHES OR ADJACENT TO STATE WATERS. PLACE CWA 50 FT AWAY FROM STATE WATERS.
16. WASTE, SUCH AS BUILDING MATERIALS, WORKERS' TRASH AND CONSTRUCTION DEBRIS, MUST BE PROPERLY MANAGED TO PREVENT STORMWATER POLLUTION.
17. INSTALL STABILIZED STAGING AREA (SSA) TO STORE MATERIALS, CONSTRUCTION TRAILERS, ETC.
18. IF CONDITIONS IN THE FIELD WARRANT ADDITIONAL CMS/BMPS TO THE ONES ORIGINALLY APPROVED ON THE SWMP OR EC PLAN (CIVIL DRAWING), THE LANDOWNER OR CONTRACTOR SHALL IMPLEMENT MEASURES DETERMINED NECESSARY, AS DIRECTED BY THE COUNTY.
19. PERMANENT CMS/BMPS FOR SLOPES, CHANNELS, DITCHES, OR DISTURBED LAND AREA SHALL BE PERFORMED IMMEDIATELY AFTER FINAL GRADING. CONSIDER THE USE EROSION CONTROL BLANKETS ON SLOPES 3:1 OR STEEPER AND AREAS WITH CONCENTRATED FLOWS SUCH AS SWALES, LONG CHANNELS AND ROADSIDE DITCHES.
20. THE DISCHARGE OF SANITARY WASTE INTO THE STORM SEWER SYSTEM IS PROHIBITED. PORTABLE TOILETS MUST BE PROVIDED, SECURED AND PLACED ON PERMEABLE SURFACES, AWAY FROM THE CURBSIDE, STORM INLETS AND/OR DRAINAGE WAYS.
21. REMOVE TEMPORARY CMS/BMPS ONCE FINAL STABILIZATION IS REACHED, UNLESS OTHERWISE AUTHORIZED.
22. FINAL STABILIZATION MUST BE IMPLEMENTED. FINAL STABILIZATION IS REACHED WHEN ALL SOIL DISTURBING ACTIVITIES HAVE BEEN COMPLETED, AND EITHER A UNIFORM VEGETATIVE COVER HAS BEEN ESTABLISHED WITH AN INDIVIDUAL PLANT DENSITY OF AT LEAST 70% OF PRE-DISTURBANCE LEVELS, OR EQUIVALENT PERMANENT ALTERNATIVE METHOD HAS BEEN IMPLEMENTED.
23. PROVIDE SPILL PREVENTION AND CONTAINMENT MEASURES FOR CONSTRUCTION MATERIALS, WASTE AND FUEL STORAGE AREAS. BULK STORAGE (55 GALLONS OR GREATER) OF PETROLEUM PRODUCTS AND LIQUID CHEMICALS MUST HAVE SECONDARY CONTAINMENT, OR EQUIVALENT PROTECTION, IN ORDER TO CONTAIN SPILLS AND TO PREVENT SPILLED MATERIAL FROM ENTERING STATE WATERS.
24. REPORT SPILLS OR RELEASES OF CHEMICAL, OIL, PETROLEUM PRODUCT, SEWAGE, ETC., WHICH MAY REACH THE STORM SEWER OR ENTER STATE WATERS WITHIN 24-HOURS FROM TIME OF DISCOVERY. GUIDANCE AVAILABLE AT HTTPS://CDPHE.COLORADO.GOV/REPORT-CONCERN-EMERGENCY STATE OF COLORADO SPILL-LINE: 1-877-518-5608. ADAMS COUNTY STORMWATER HOTLINE: SWQ@ADCOGOV.ORG; PUBLIC WORKS 720-523-6875 OR PUBLICWORKS@ADCOGOV.ORG AND ADAMS COUNTY PUBLIC HEALTH DEPARTMENT AT 303-288-6816

MAINTENANCE STANDARD NOTES

1. MAINTAIN AND REPAIR CMS ACCORDING TO APPROVED EROSION CONTROL PLAN (CIVIL DRAWING) TO ASSURE THEY CONTINUE PERFORMING AS ORIGINALLY INTENDED.
2. CMS/BMPS REQUIRING MAINTENANCE OR ADJUSTMENT SHALL BE REPAIRED IMMEDIATELY AFTER OBSERVATION OF THE FAILING BMP.
3. CMS SHALL BE CLEANED WHEN SEDIMENT LEVELS ACCUMULATE TO HALF THE DESIGN UNLESS OTHERWISE SPECIFIED.
4. SWMP AND EC PLAN SHALL BE CONTINUOUSLY UPDATED TO REFLECT NEW OR REVISED CMS/BMPS DUE TO CHANGES IN DESIGN, CONSTRUCTION, OPERATION, OR MAINTENANCE, TO ACCURATELY REFLECT THE ACTUAL FIELD CONDITIONS. A NOTATION SHALL BE MADE IN THE SWMP, INCLUDING DATE OF CHANGES IN THE FIELD, IDENTIFICATION OF THE CMS REMOVED, MODIFIED OR ADDED, AND THE LOCATIONS OF THOSE CMS. UPDATES MUST BE MADE WITHIN 72-HOURS FOLLOWING THE CHANGE.
5. MAINTAIN VEHICLE TRACKING CONTROL (VTC), IF SEDIMENT TRACKING OCCURS, CLEAN-UP IMMEDIATELY. SWEEP BY HAND OR THE USE STREET SWEEPERS (WITH VACUUM SYSTEM). FLUSHING OFF PAVED SURFACES WITH WATER IS PROHIBITED.
6. CWA MUST BE CLEANED ONCE WASTE ACCUMULATION REACHES ¾ OF THE WET STORAGE CAPACITY OF THE STRUCTURE. LEGALLY DISPOSED OF CONCRETE WASTE. DO NOT BURY ON-SITE.
7. CLEAN-UP SPILLS IMMEDIATELY AFTER DISCOVERY OR CONTAIN UNTIL APPROPRIATE CLEANUP METHODS CAN BE EMPLOYED. FOLLOW MANUFACTURER'S RECOMMENDED METHODS FOR SPILL CLEANUP, ALONG WITH PROPER DISPOSAL METHODS. RECORDS OF SPILLS, LEAKS, OR OVERFLOWS THAT RESULT IN DISCHARGE OF POLLUTANTS MUST BE DOCUMENTED AND MAINTAINED.
8. REMOVE SEDIMENT FROM STORM SEWER INFRASTRUCTURE (PONDS, STORM PIPES, OUTLETS, INLETS, ROADSIDE DITCHES, ETC.), AND RESTORE VOLUME CAPACITY UPON COMPLETION OF PROJECT OR PRIOR TO INITIAL ACCEPTANCE OF PUBLIC IMPROVEMENTS (IF APPLICABLE). DO NOT FLUSH SEDIMENT OFFSITE, CAPTURE ON-SITE AND DISPOSED OF AT AN APPROVED LOCATION.

GENERAL NOTES:

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DENVER, CO 80202

BENNETT D PAD
GRADING, EROSION AND SEDIMENT CONTROL PLAN
NOTES

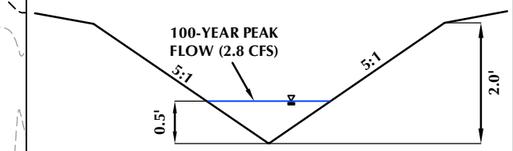
SCALE:	N/A	PAGE:	2 OF 8
JOB NUMBER:	23-182	DATE:	10/21/24
DRAFTED BY:	KMG	REVISED:	

CULVERT ID	SIZE	LENGTH (FT)	ELEVATION (FT)		GRADE
			INLET INVERT	OUTLET INVERT	
PC1	12" CMP	40	5572.5	5571.1	3.5%
PC2	12" CMP	40	5570.0	5568.8	3.0%
PC3	12" CMP	40	5566.1	5566.0	0.3%

EXISTING CULVERT
EXISTING CULVERT
EXISTING DETENTION POND
400'
EXISTING 400' X 850' MAINTENANCE EASEMENT
SURFACE OWNER: CRESTONE PEAK RESOURCES WATKINS MIDSTREAM LLC (PARCEL 0181700000105)
PROPOSED CULVERT #3 (PC3)
PERMANENT ACCESS ROAD
PERMANENT DITCH #1
PERMANENT ACCESS ROAD
EXISTING DITCH
PROPOSED CULVERT #1 (PC1)
PROPOSED CULVERT #2 (PC2)
BENNETT D PAD FACILITY
100-YEAR STORAGE ELEVATION 5564.9'
PERMANENT DITCH #2
DETENTION BASIN
SPILLWAY
DETENTION BASIN OUTLET
EXISTING TOPSOIL STOCKPILE
TOPSOIL STOCKPILE
TEMPORARY ACCESS ROAD
TEMPORARY DITCH RE-ROUTE
CUT
FILL
BENNETT D PAD WELL PAD
PROPOSED OIL AND GAS LOCATION (22.96 ACRES)
EXISTING 20' ACCESS EASEMENT
DELINEATED WETLAND
EXISTING POND
20' X 20' X 3' SEDIMENT TRAP
INTERSTATE 70
0.5% SLOPE
A
A'
B
B'
C
C'

0 100' 200'
1" = 200'
1' CONTOURS

EXISTING DITCH CROSS SECTION



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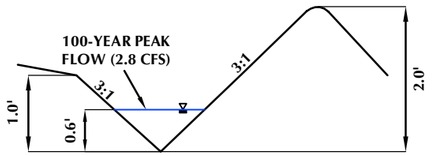

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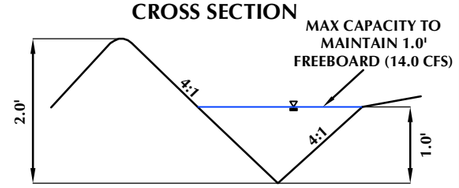
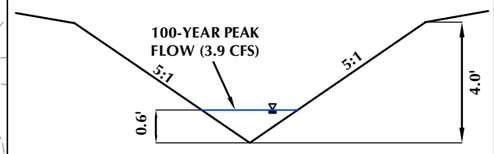


TEMPORARY DITCH RE-ROUTE CROSS SECTION



LEGEND

- EXISTING CONTOUR
- EXISTING ROAD
- EPL — EXISTING PIPELINE
- UGP — EXISTING BURIED POWERLINE
- OHP — EXISTING OVERHEAD POWERLINE
- PROPOSED OIL AND GAS LOCATION
- PROPOSED CONTOUR
- PROPOSED ACCESS ROAD/PAD
- PROPOSED WELL
- PROPERTY LINE
- PROPOSED DIVERSION DITCH
- PROPOSED BERM / OFF-SITE FLOW DEFLECTION
- PROPOSED CULVERT PROTECTION / RIPRAP
- PROPOSED SEDIMENT TRAP WITH PROTECTED OUTLET
- SP — PROPOSED SLOPE PROTECTION
- 100-YEAR STORMWATER STORAGE FOOTPRINT
- STORMWATER DRAINAGE
- EASEMENT/ROW
- EXISTING DITCH

GENERAL NOTES:

1. DISCLAIMER: THIS PLAN REPRESENTS AN APPROXIMATE LOCATION OF SEDIMENT AND EROSION CONTROL FEATURES; EXACT LOCATION MAY VARY DEPENDING UPON EXISTING EASEMENTS, PIPELINES, FLOWLINES, AND SETBACK REQUIREMENTS.
2. ELEVATIONS ARE BASED ON NAVD88 (GEOID18).
3. SLOPE PROTECTION USED FOR TEMPORARY EROSION CONTROL ON CUT/FILL SLOPES AND SOIL STOCKPILES.

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BENNETT D PAD
GRADING, EROSION AND SEDIMENT CONTROL PLAN
CONSTRUCTION PHASE SITE PLAN

SCALE:	1" = 200'	PAGE:	3 OF 8
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DRAFTED BY:	KMG	REVISED:	

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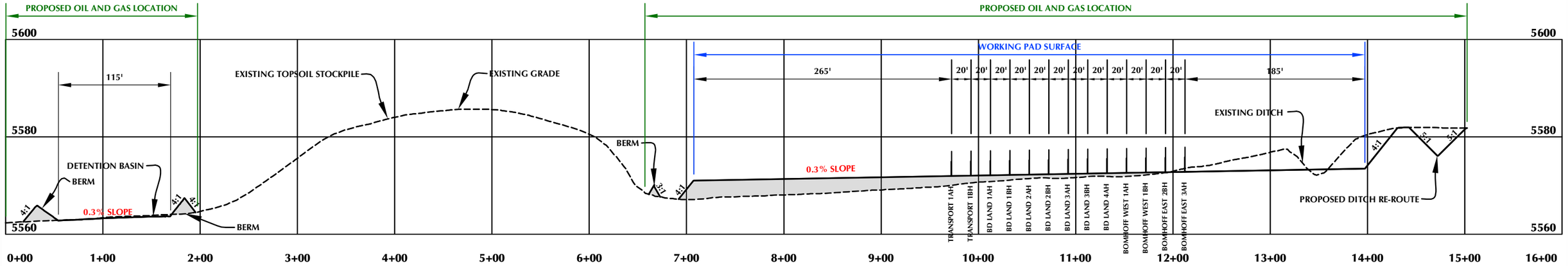
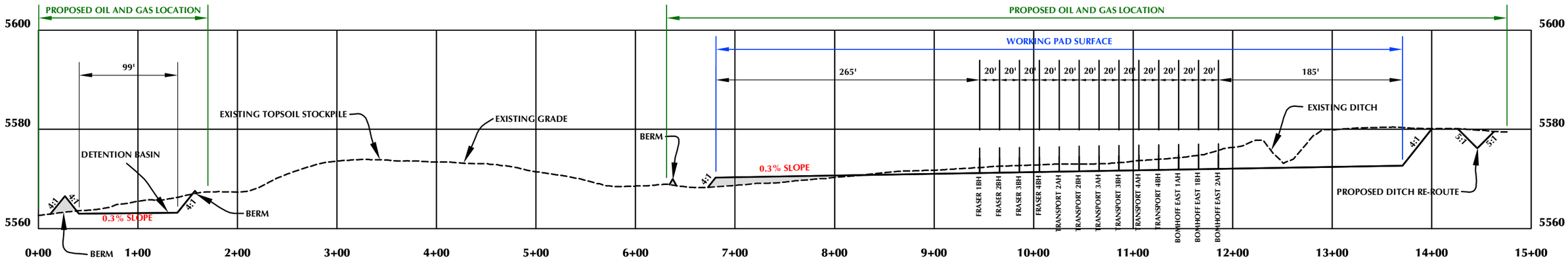
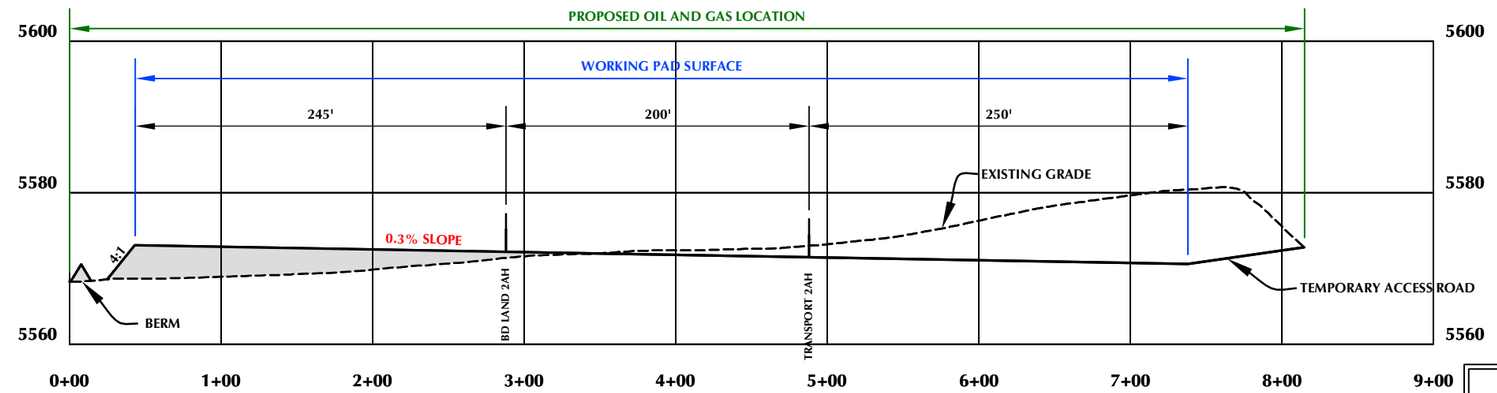


CROSS SECTION A-A'



CROSS SECTION B-B'



CROSS SECTION C-C'

HORIZONTAL 0 50' 100' 1" = 100'

VERTICAL 0 10' 20' 1" = 20'

GENERAL NOTES:

1. ELEVATIONS ARE BASED ON NAVD88 (GEOID18).

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BENNETT D PAD
GRADING, EROSION AND SEDIMENT CONTROL PLAN
CROSS SECTIONS

SCALE:	1" = 100'	PAGE:	4 OF 8
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DRAFTED BY:	KMG	REVISED:	

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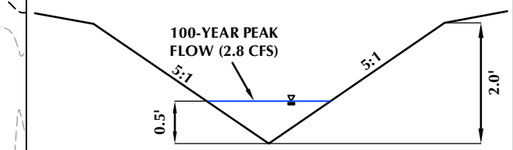
CULVERT ID	SIZE	LENGTH (FT)	ELEVATION (FT)		GRADE
			INLET INVERT	OUTLET INVERT	
PC1	12" CMP	40	5572.5	5571.1	3.5%
PC2	12" CMP	40	5570.0	5568.8	3.0%

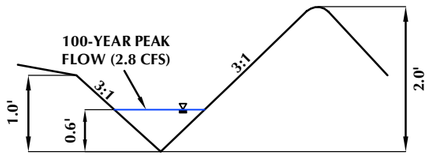
EXISTING CULVERT
EXISTING CULVERT
EXISTING DETENTION POND
400'
EXISTING 400' X 850' MAINTENANCE EASEMENT
SURFACE OWNER: CRESTONE PEAK RESOURCES WATKINS MIDSTREAM LLC (PARCEL 0181700000105)
PROPOSED CULVERT #3 (PC3)
PERMANENT ACCESS ROAD
PERMANENT DITCH #1
PERMANENT ACCESS ROAD
PROPOSED CULVERT #2 (PC2)
EXISTING DITCH
BENNETT D PAD FACILITY
100-YEAR STORAGE ELEVATION 5564.0'
0.5% SLOPE
SEEDED TOPSOIL STOCKPILE (FOR FINAL REC)
INTERSTATE 70
PERMANENT DITCH #2
EXISTING TOPSOIL STOCKPILE
DETENTION BASIN
SPILLWAY
DETENTION BASIN OUTLET
BENNETT D PAD WELL PAD
DRAINAGE SWALE
PRODUCTION PHASE OPERATIONAL AREA (7.42 ACRES)
PROPOSED OIL AND GAS LOCATION (22.96 ACRES)
EXISTING 20' ACCESS EASEMENT
DELINEATED WETLAND
EXISTING POND

0 100' 200'
1" = 200'
1' CONTOURS

EXISTING DITCH CROSS SECTION



PERMANENT DITCH #1 CROSS SECTION



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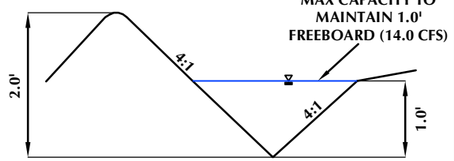
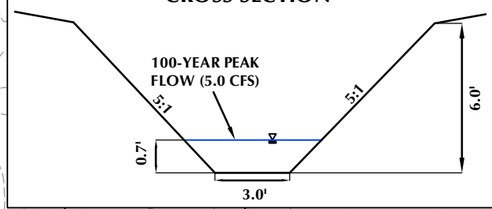


DRAINAGE SWALE CROSS SECTION



LEGEND

- EXISTING CONTOUR
- EXISTING ROAD
- EXISTING PIPELINE
- EXISTING BURIED POWERLINE
- EXISTING OVERHEAD POWERLINE
- PROPOSED OIL AND GAS LOCATION
- PROPOSED CONTOUR
- PROPOSED ACCESS ROAD/PAD
- PROPOSED WELL
- PROPERTY LINE
- PERMANENT DIVERSION DITCH
- PROPOSED BERM / OFF-SITE FLOW DEFLECTION
- PROPOSED CULVERT PROTECTION / RIPRAP
- RECLAMATION BOUNDARY
- PROPOSED PERMANENT SEEDING
- 100-YEAR STORMWATER STORAGE FOOTPRINT
- STORMWATER DRAINAGE
- EASEMENT/ROW
- EXISTING DITCH

GENERAL NOTES:

1. DISCLAIMER: THIS PLAN REPRESENTS AN APPROXIMATE LOCATION OF DRAINAGE AND EROSION CONTROL FEATURES; EXACT LOCATION MAY VARY DEPENDING UPON EXISTING EASEMENTS, PIPELINES, FLOWLINES, AND SETBACK REQUIREMENTS.
2. ELEVATIONS ARE BASED ON NAVD88 (GEOID18).
3. RECLAIMED AREA WILL BE RE-SEEDED AND RE-VEGETATED.

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BENNETT D PAD
GRADING, EROSION AND SEDIMENT CONTROL PLAN
PRODUCTION PHASE SITE PLAN

SCALE:	1" = 200'	PAGE:	5 OF 8
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DRAFTED BY:	KMG	REVISED:	

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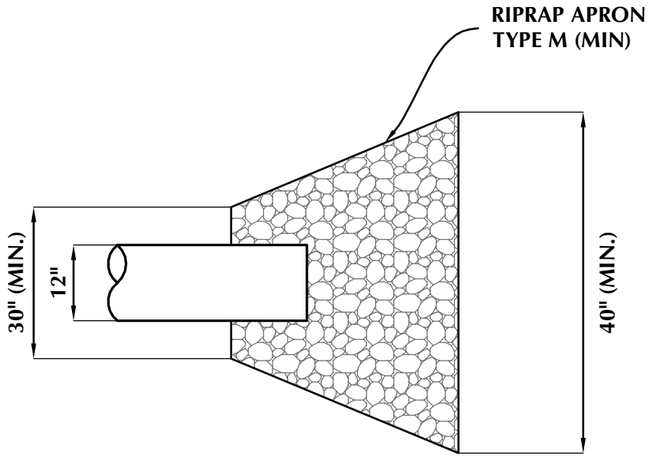
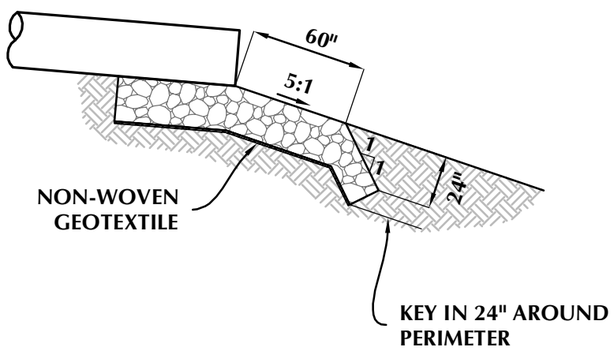
OUTLET PROTECTION

SCALE: NTS





ANTI-SEEP COLLAR

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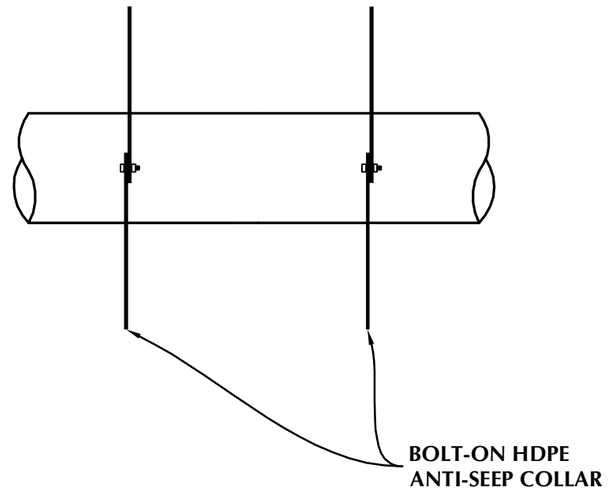

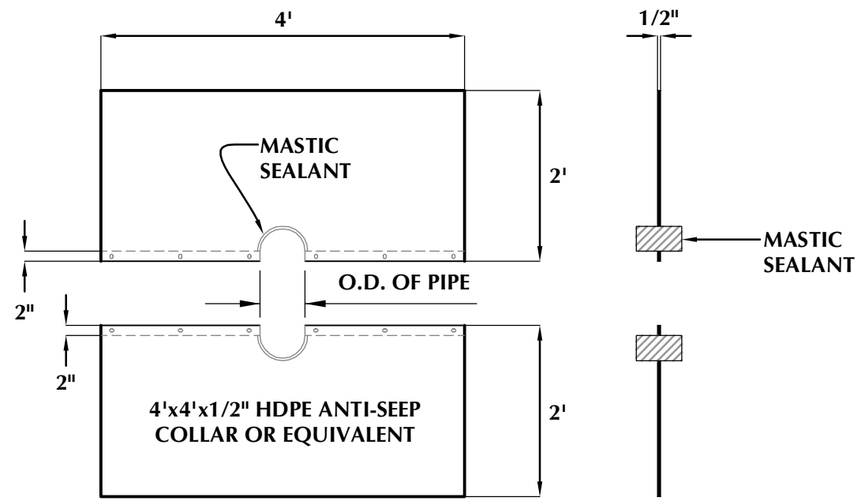

GENERAL NOTES:

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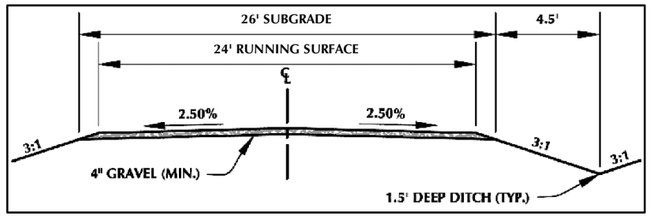
BENNETT D PAD
GRADING, EROSION AND SEDIMENT CONTROL PLAN
OUTLET DETAILS

SCALE:	VARIES	PAGE:	6 OF 8
JOB NUMBER:	23-182	DATE:	10/21/24
DRAFTED BY:	KMG	REVISED:	



CROSS-SECTION
NTS

Temporary and Permanent Seeding (TS/PS)

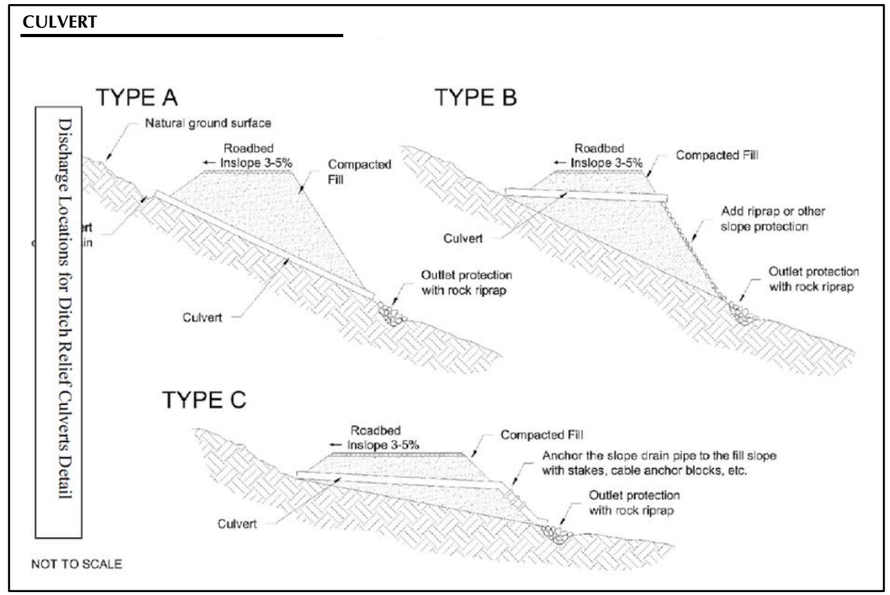
TS/PS

ADAMS COUNTY, COLORADO

SEED MIX	APPLICATION RATE (lbs/acre)
PBSI Dryland Aggressive Mix	25
(20%) Green Needlegrass, Lodorm	
(20%) Slender Wheatgrass, Native	
(20%) Western Wheatgrass, Native	
(20%) Pubescent Wheatgrass, Luna	
(20%) Intermediate Wheatgrass, Oahe/Rush	
PBSI Native Prairie Mix	15
(25%) Blue Grama	
(10%) Buffalograss	
(20%) Green Needlegrass	
(20%) Sideoats Grama	
(25%) Western Wheatgrass	
PBSI Native Sandyland Mix	15
(20%) Yellow Indiangrass	
(10%) Little Bluestem	
(10%) Indian Rice Grass	
(10%) Sideoats Grama	
(10%) Sand Lovegrass	
(10%) Prairie Sandreed	
(20%) Switchgrass	
PBSI Premium Irrig. Pasture Mix #1	25
(75%) Meadow Bromegrass, Paddock/Fleet	
(25%) Orchardgrass, Elsie/Megabite/Paiute	

Notes:
lbs/acre = pounds per acre
% = percent

CULVERT



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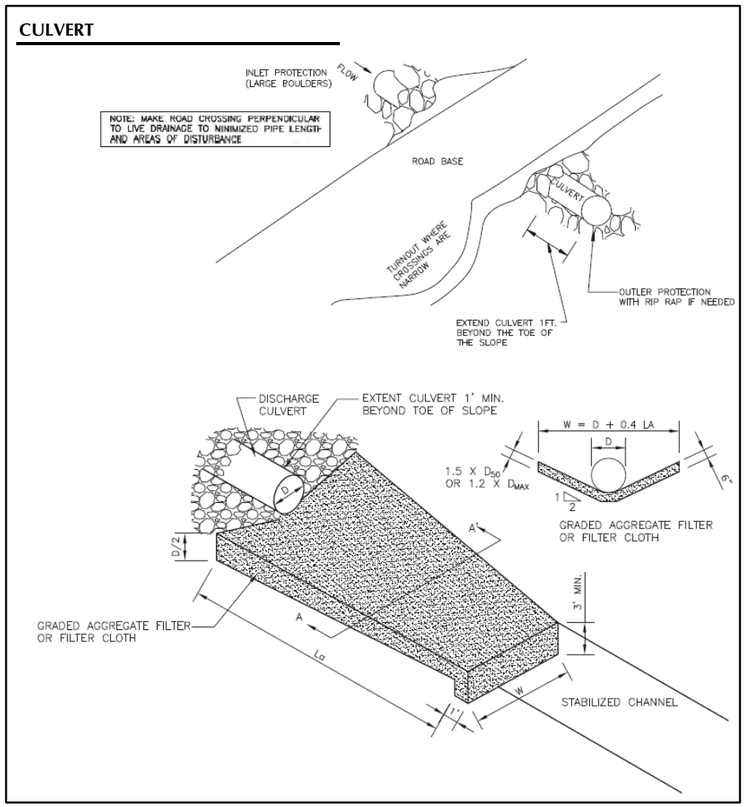
CULVERT



GENERAL NOTES:

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Prepared For:
CIVITAS
CRESTONE PEAK RESOURCES, LLC
555 17TH STREET, SUITE 3700
DENVER, CO 80202

BENNETT D PAD
GRADING, EROSION AND SEDIMENT CONTROL PLAN
BMP TYPICALS (A)

SCALE:	VARIES	PAGE:	7 OF 8
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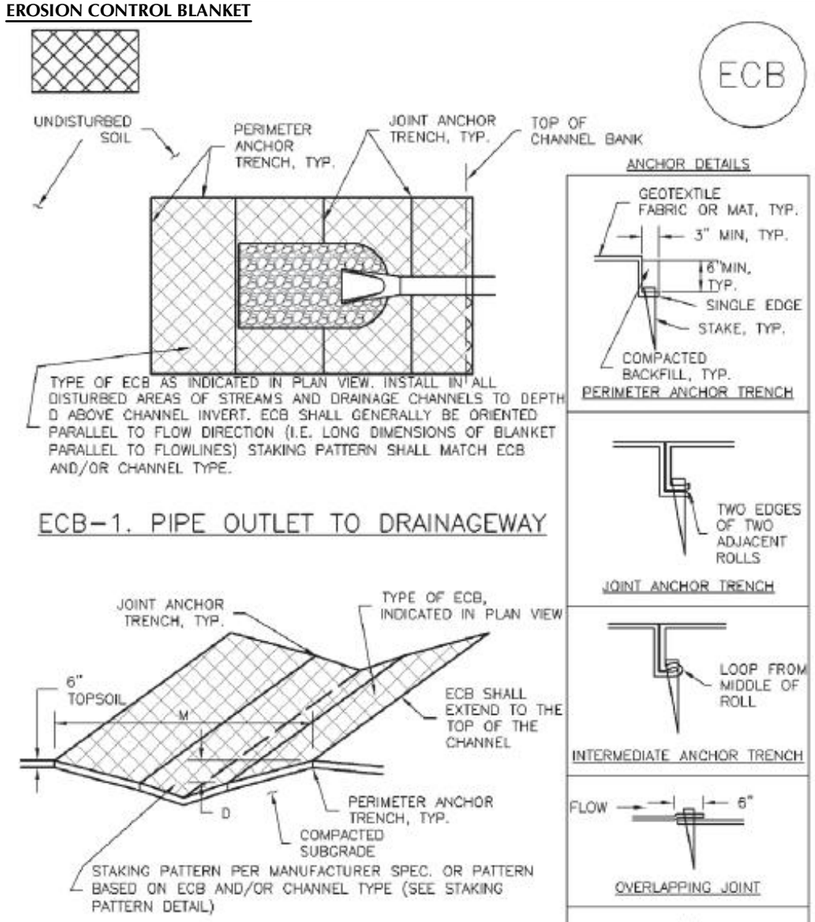
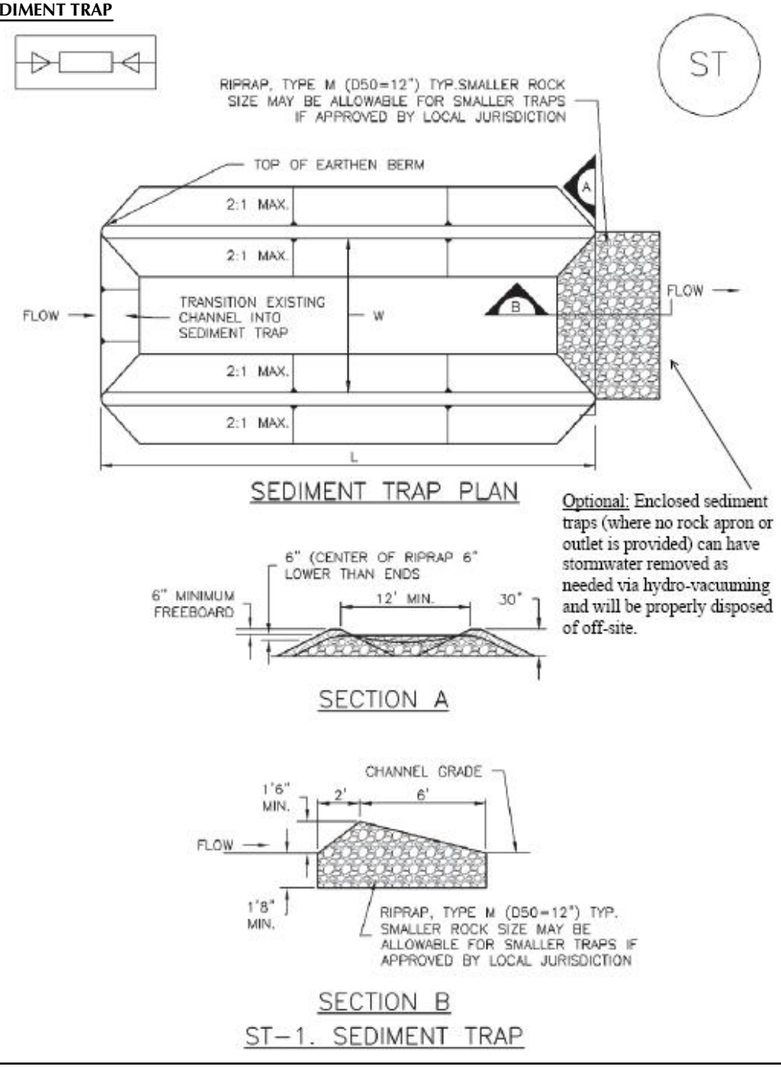
DRAFTED BY:	KMG	REVISED:	

EROSION CONTROL BLANKET



SEDIMENT TRAP



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BENNETT D PAD
GRADING, EROSION AND SEDIMENT CONTROL PLAN
BMP TYPICALS (B)

SCALE:	VARIES	PAGE:	8 OF 8
JOB NUMBER:	23-182	DATE:	10/21/24
DRAFTED BY:	KMG	REVISED:	

Preliminary Drainage Report for Bennett D Pad

Prepared for:

Crestone Peak Resources Operating LLC

A Wholly-Owned Subsidiary of Civitas Resources, Inc.

555 17th Street

Suite 3700

Denver, Colorado 80202

Submitted to:

Adams County Planning & Development Department

4430 South Adams County Parkway

1st Floor, Suite W2000

Brighton, Colorado 80601

October 2024

609 Consulting, LLC

Engineering, Surveying, Consulting & Design

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Letter of Transmittal

To: Adams County Planning & Development Department
4430 South Adams County Parkway
1st Floor, Suite W2000
Brighton, Colorado 80601

cc: Mr. Dan Harrington, Crestone Peak Resources Operating LLC
Mr. Jeff Annable, Crestone Peak Resources Operating LLC

From: Ms. Kathleen Goles, PE
609 Consulting
1095 Saberton Avenue
Sheridan, Wyoming 82801

Date: October 21, 2024

Subject: Bennett D Pad - Preliminary Drainage Report

To Adams County Planning & Development Department:

On behalf of Crestone Peak Resources Operating LLC, a wholly-owned subsidiary of Civitas Resources, Inc., we are pleased to submit the Preliminary Drainage Report for Bennett D Pad. The purpose of this report is to discuss and summarize the stormwater drainage analysis and design performed for the proposed Bennett D Pad well pad and production facility. The proposed project will be located in the southeast quarter of Section 34 of Township 3 South, Range 64 West in Adams County, Colorado.

The drainage analysis and design were prepared referencing the Adams County Development Standards & Regulations as well as the Mile High Flood District (MHFD) Urban Storm Drainage Criteria Manual. We believe the analysis and design satisfy all Adams County drainage requirements.

We greatly appreciate your time and consideration in reviewing this submittal. We look forward to your review and comments. Please contact us with any questions you may have.

Respectfully,

Kathleen M. Goles

Kathleen Goles
Registered Professional Engineer
State of Colorado No. 63868

ENGINEER CERTIFICATION OF DRAINAGE REPORT

I hereby certify that this report (plan) for the Preliminary Drainage design of Bennett D Pad was prepared by me or under my direct supervision in accordance with the provisions of Adams County Storm Drainage Design and Technical Criteria for the owners thereof. I understand that Adams County does not and will not assume liability for drainage facilities designed by others.

Date

Kathleen Goles
Registered Professional Engineer
State of Colorado No. 63868

DEVELOPER CERTIFICATION OF DRAINAGE FACILITIES

Crestone Peak Resources Operating LLC, a wholly-owned subsidiary of Civitas Resources, Inc., hereby certifies that the drainage facilities for Bennett D Pad shall be constructed according to the design presented in this report. I understand that Adams County does not and will not assume liability for the drainage facilities designed and/or certified by my engineer. I understand that Adams County reviews drainage plans pursuant to Colorado Revised Statues Title 30, Article 28; but cannot, on behalf of Bennett D Pad, guarantee that final drainage design review will absolve Crestone Peak Resources Operating LLC, a wholly-owned subsidiary of Civitas Resources, Inc., and/or their successors and/or assigns the 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.

Date

Crestone Peak Resources Operating LLC
A wholly-owned subsidiary of Civitas Resources, Inc.

Name of Developer

Authorized Signature

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APPENDICES

1.0 PROJECT DESCRIPTION AND LOCATION

Crestone Peak Resources Operating LLC is proposing the construction and development of an oil/gas well pad and production facility, Bennett D Pad, located in the southeast quarter of Section 34, Township 3 South, Range 64 West in Adams County, Colorado. Per the requirements outlined in the Adams County Development Standards & Regulations and through a direct request from Adams County, this report was prepared to discuss the analysis and design of stormwater drainage at the proposed project site. The Drainage Plan, developed in conjunction with this report, can be found in Appendix A. A Drainage Report and Drainage Plan Checklist provided by Adams County can be found in Appendix B.

1.1 Project Description

The proposed project consists of the construction and operation of the Bennett D Pad well pad and production facility containing infrastructure and operations for 26 oil/gas wells. The Energy & Carbon Management Commission (ECMC) Proposed Oil and Gas Location will have a permitted disturbance area of 22.96 acres during the construction phase which includes topsoil stripping and pad earthwork, well drilling and hydraulic fracturing, installation of permanent pipelines and facilities, and setup of temporary equipment and a modular large volume tank (MLVT) area. Construction phase grading and layout for the well pad and facility can be found in Appendix A.

Once all wells have been drilled and completed, portions of the Proposed Oil and Gas Location will be reclaimed back to existing grade and re-seeded during interim reclamation. The remaining operational area during the production phase will be approximately 7.42 acres. Production phase grading and layout for the well pad and facility can be found in Appendix A.

1.2 Project Location

Bennett D Pad is located on property owned by Crestone Peak Resources Watkins Midstream LLC (Parcel 0181700000105). The project area is approximately 0.1 miles north of Interstate 70 and 0.3 miles west of Manila Road. An existing access road running west from Manila Road will provide access to the project area. Figure 1 shows the location of Bennett D Pad.

Soils data for the project area were taken from NRCS Soil Data Viewer. The project area is comprised of Ascalon-Platner association (0 to 5 percent slopes) with a Hydrologic Soil Group (HSG) classification of Group B soils and Truckton loamy sand (3 to 9 percent slopes) with a HSG classification of Group A soils. The soils report for the project area can be found in Appendix C. Bennett D Pad will be constructed on partially developed industrial land. According to the 2019 National Land Cover Database, the project area is grassland/herbaceous.

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (Panel 08001C0960H, Effective Date: 3/5/2007), the proposed project is in an area of minimal flood hazard (Zone X) and is therefore determined to be outside the 500-year floodplain. The corresponding FIRMette displaying the flood zone classification at the project site can be found in Appendix D.

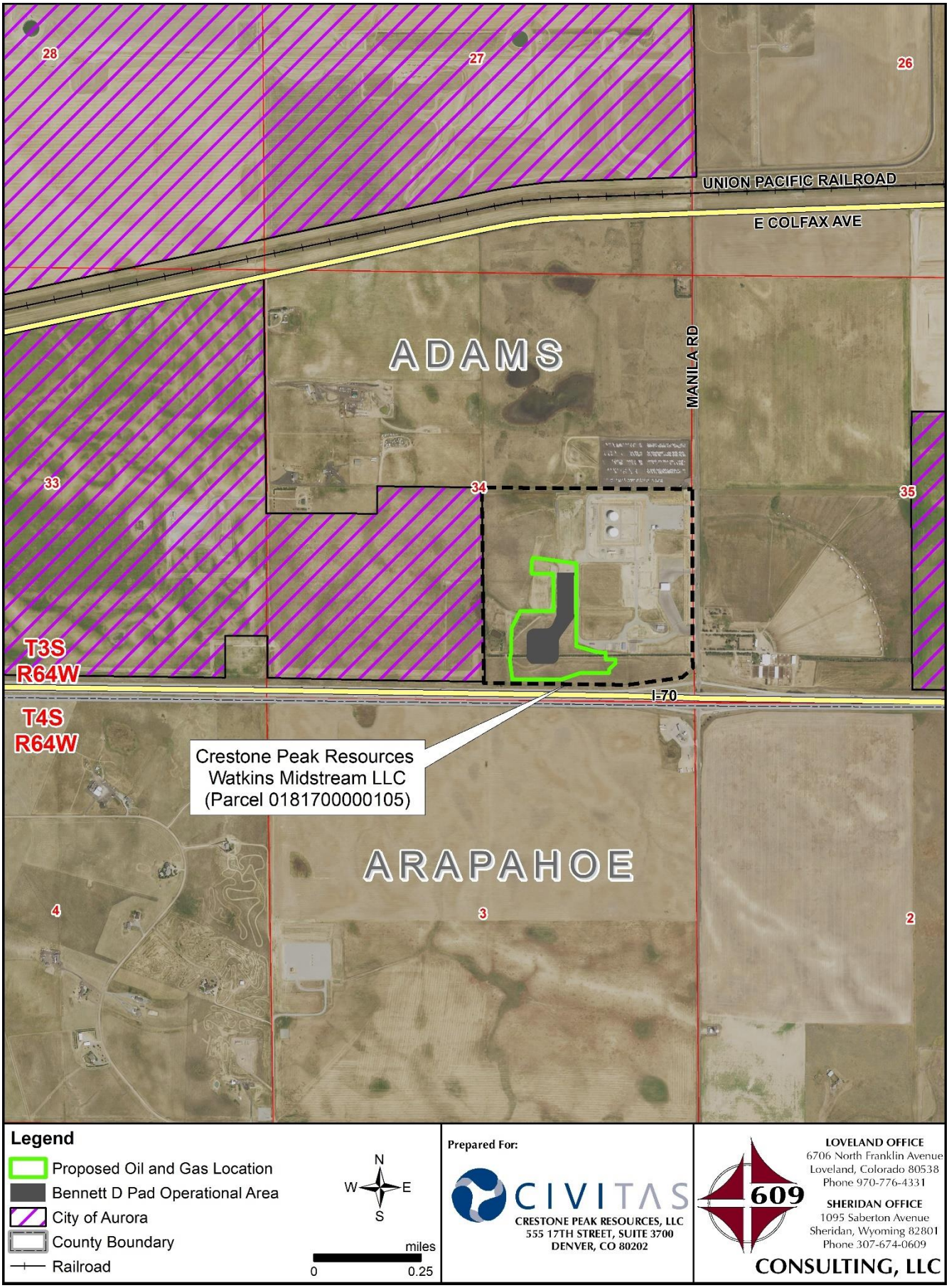

Figure 1. Project Location

1.3 Drainage Summary

Bennett D Pad lies within the *Town of Manila* Hydrologic Unit Code Level 12 (HUC 12): 101900030902. The HUC 12, approximately 47.9 square miles in area, consists of predominately agricultural lands that drain to an unnamed tributary of West Sand Creek. Currently, there has not been a master drainage plan developed for this area.

Historically, stormwater from the proposed location drains from the south to the northwest/north. A delineated wetland and existing pond are located to the west of the site while an existing detention pond is located to the north. In order to avoid outflowing towards any of these areas, stormwater will be routed to a detention basin on the north edge of the project area and the outlet will direct flow around the west side of the existing detention pond. The delineated wetland and existing ponds will not be impacted by this project.

2.0 HYDROLOGIC ANALYSIS

The following sections outline the methods used and corresponding results for the hydrologic analysis of the project site and drainage design including historic runoff, design flow, and stormwater volume.

2.1 Historic Runoff

Historic runoff, calculated assuming the site is undeveloped with a 2.0 percent imperviousness, was calculated for the proposed project site. The rational method was chosen to estimate historic peak flows. As discussed in the Mile High Flood District (MHFD) manual *Urban Storm Drainage Criteria Manual Volume I* (USDCM VI), it is acceptable to use the rational method for design storm analysis of catchments that are not complex and are 90 acres or less in size.

The MHFD spreadsheet model *Peak Runoff Prediction by the Rational Method Version 2.00* (UD-Rational) was used to calculate peak flows using the rational method. One-hour point rainfall data were obtained from the Adams County Development Standards & Regulations using the NOAA Atlas 14 Point Precipitation Frequency Estimates. One-hour point rainfall data are summarized in Table 1.

Table 1. Point Rainfall Data (NOAA Atlas 14 Point Precipitation Frequency Estimates)

Storm Event Frequency	One-Hour Point Rainfall, in
2-year	1.00
5-year	1.42
10-year	1.68
50-year	2.35
100-year	2.71

Historic peak flows were calculated for the Proposed Oil and Gas Location. Overland flow length, overland flow slope, channelized flow length, and channelized flow slope parameters were estimated using field survey, LiDAR, and imagery. HSG was derived from an area-weighted average using NRCS Soil Data Viewer. USDCM VI was referenced for the recommended conveyance factor (K). Computed Time of Concentration (T_c) was used since historic conditions have an imperviousness of less than 20 percent. Historic peak flow estimates calculated using the rational method are summarized in Table 2 and spreadsheet model inputs and results can be found in Appendix E.

Table 2. Historic Peak Flow Estimates Using the Rational Method

Storm Event Frequency	Historic Peak Flow, cfs
2-year	0.2
5-year	0.5
10-year	3.4
50-year	22.0
100-year	32.8

2.2 Design Flow

Design flows for Bennett D Pad were calculated for stormwater derived within the project disturbance area (on-site) as well as the broader drainage to and around the project area. Both the construction phase and the production phase were analyzed and used to aid in the hydraulic design.

The rational method was chosen to estimate peak flows for the proposed culverts, diversion ditches, sediment trap, drainage swale, and detention basin areas. Locations for peak flow calculations are summarized in Table 3. Outlets and drainage area delineations and their corresponding time of concentration routes during the construction phase are shown in Figure 2 and Figure 3, respectively. Outlets and drainage area delineations and their corresponding time of concentration routes during the production phase are shown in Figure 4 and Figure 5, respectively.

Table 3. Summary of Outlets and Drainage Areas

Outlet	Description	Total Drainage Area, acre	
		Construction Phase	Production Phase
ST	Sediment Trap	8.62	-
PC1	Proposed Culvert #1	1.75	-
PC2	Proposed Culvert #2	2.09	2.65
PC3	Proposed Culvert #3	2.30	2.86
DB	Detention Basin Area	17.84	10.49
DS	Drainage Swale	-	9.28

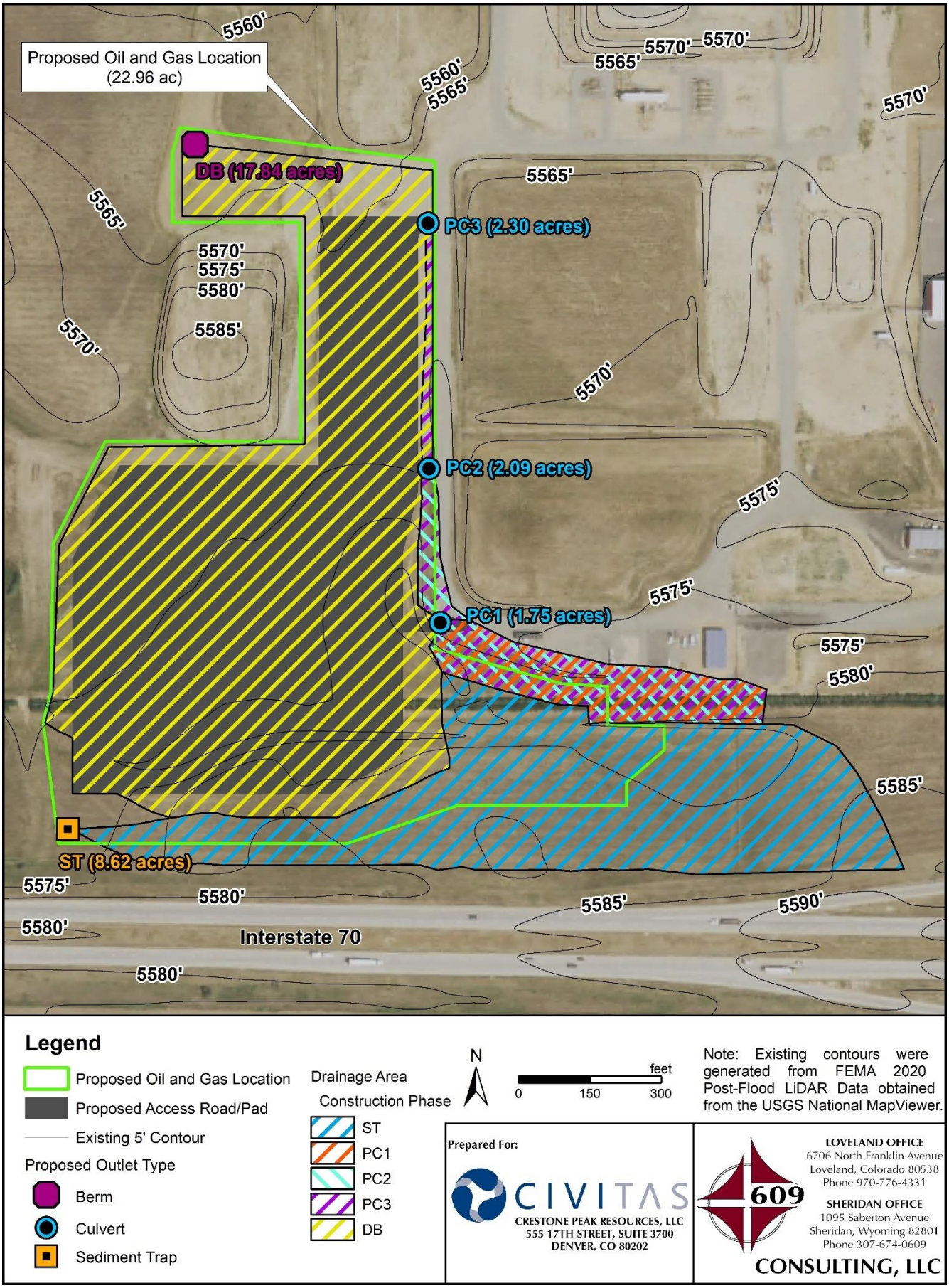

Figure 2. Construction Phase Outlets and Drainage Areas

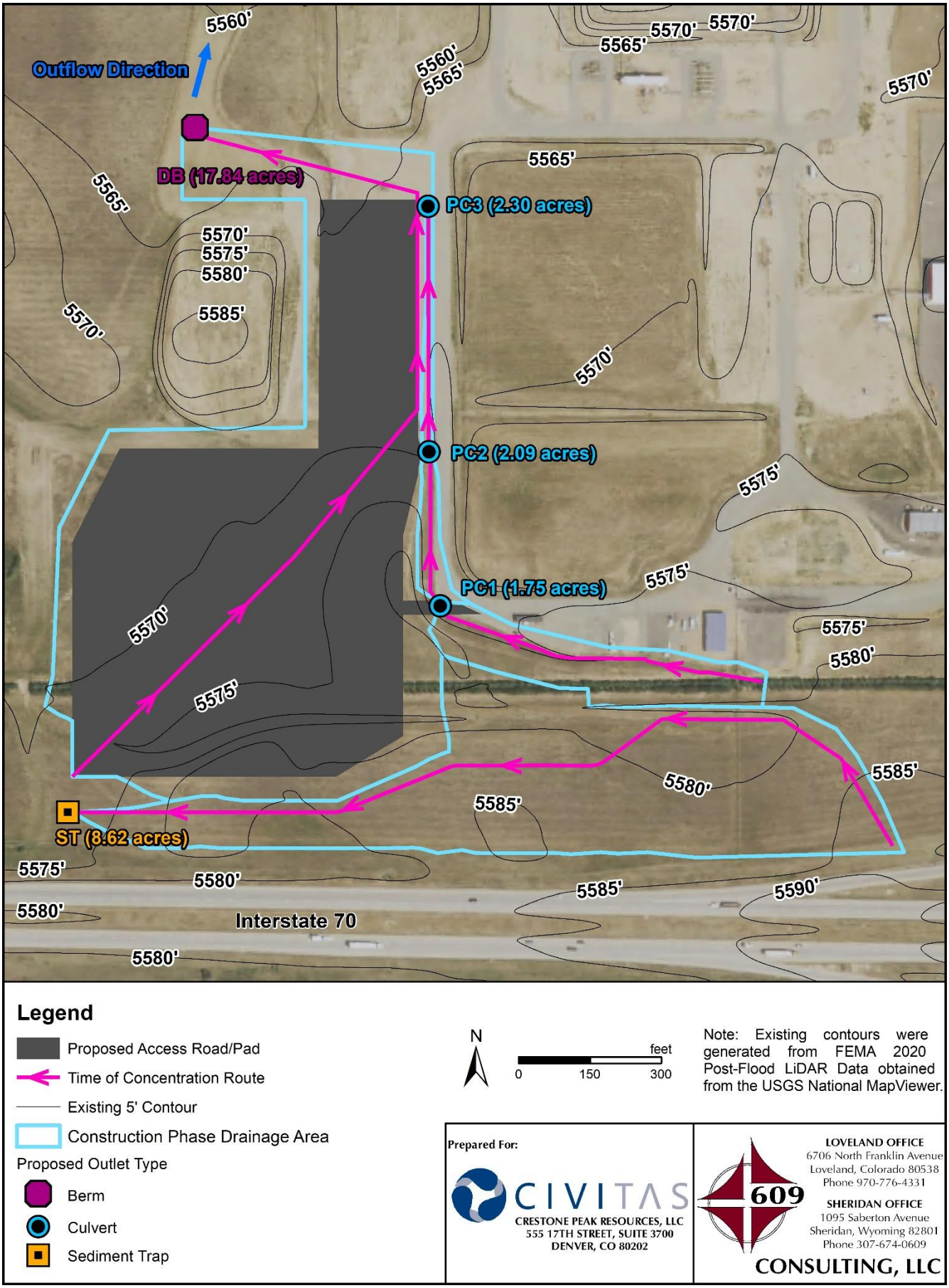

Figure 3. Construction Phase Time of Concentration Routes

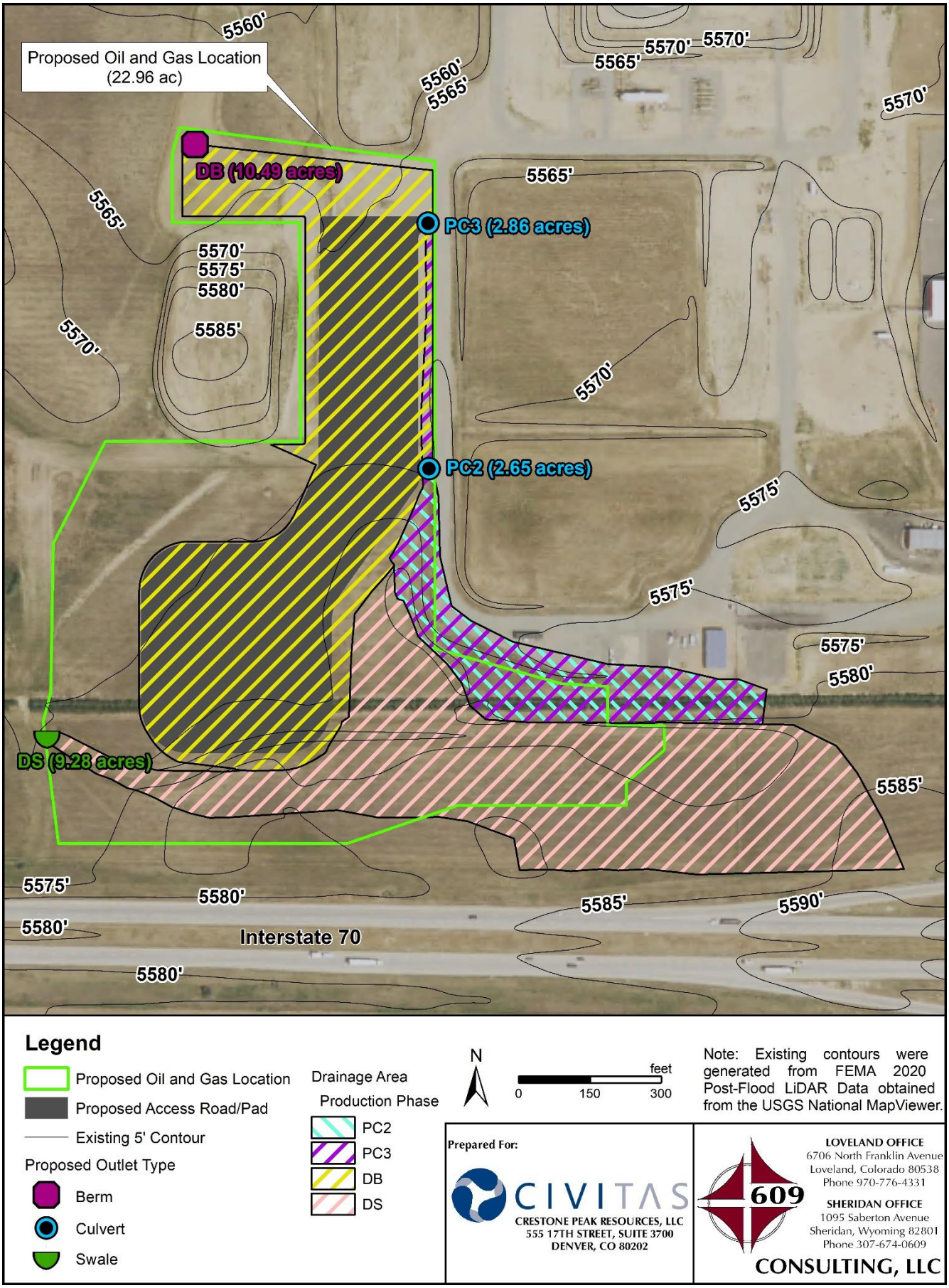

Figure 4. Production Phase Outlets and Drainage Areas

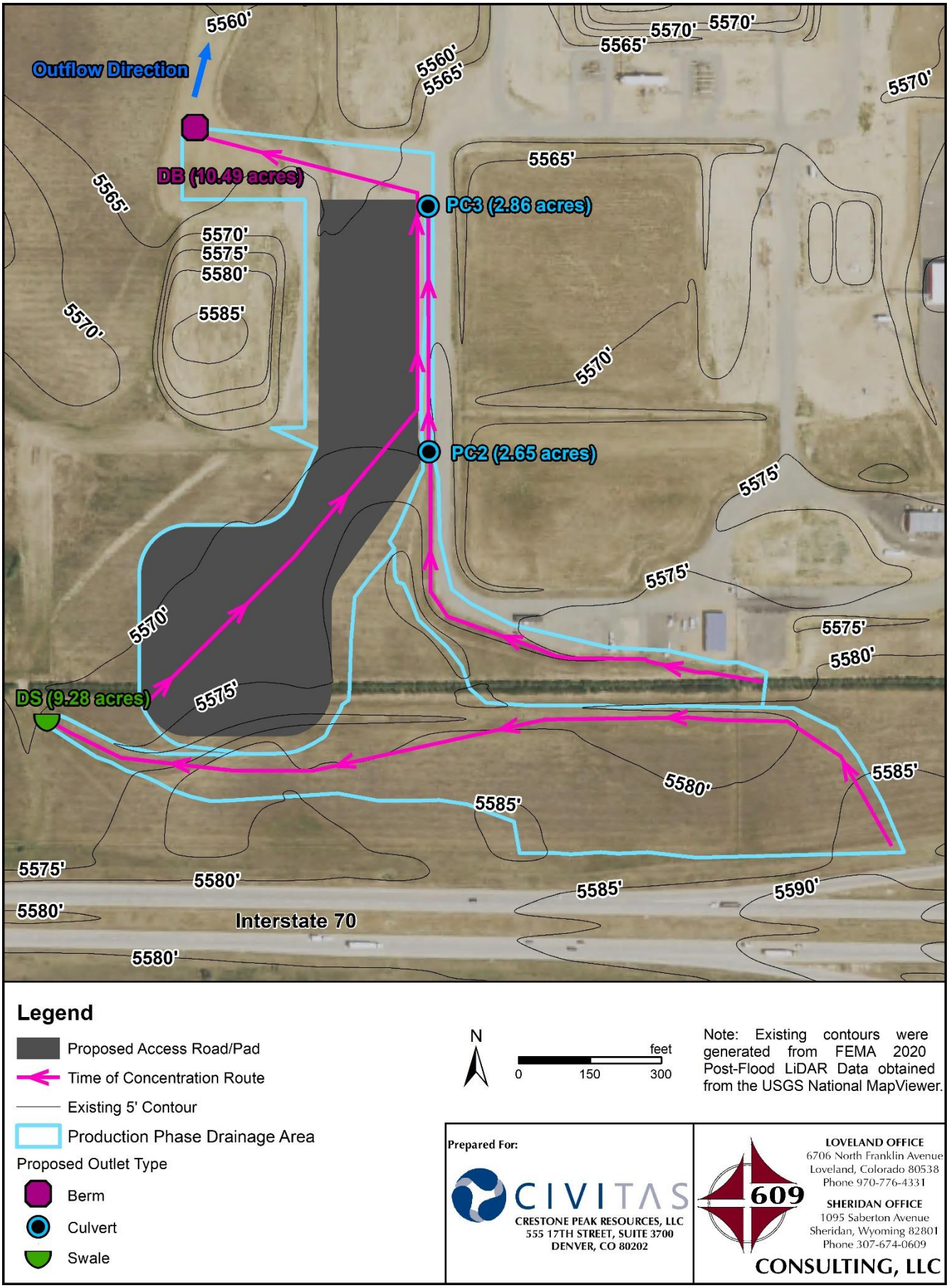

Figure 5. Production Phase Time of Concentration Routes

UD-Rational was used to calculate peak flows using the rational method. Drainages were delineated using the on-site drainage design and grading. Overland flow length, overland flow slope, channelized flow length, and channelized flow slope parameters were estimated using field survey, LiDAR data, and imagery. Computed T_c was used for outlets with imperviousness less than 20 percent. Calculations for area-weighted averages of percent imperviousness are found in Table 4. Peak flow estimates calculated using the rational method are summarized in Table 5. UD-Rational inputs and results can be found in Appendix E.

Table 4. Imperviousness Calculations

Outlet	Phase	Total Area, acre	Open (2% Imperv), acre	Gravel (40% Imperv), acre	Weighted Imperviousness	
					acre	%
ST	Construction	8.62	8.62	0.00	0.17	2.0
PC1	Construction	1.75	1.54	0.21	0.11	6.6
PC2	Construction	2.09	1.77	0.32	0.16	7.8
	Production	2.65	2.35	0.30	0.17	6.3
PC3	Construction	2.30	1.97	0.33	0.17	7.5
	Production	2.86	2.55	0.31	0.18	6.1
DB	Construction	17.84	4.52	13.32	5.42	30.4
	Production	10.49	3.09	7.40	3.02	28.8
DS	Production	9.28	9.28	0.00	0.19	2.0

Table 5. Peak Flow Estimates

Outlet	Phase	Calculated Peak Flow, cfs				
		2-year	5-year	10-year	50-year	100-year
ST	Construction	<0.1	0.1	0.3	2.0	3.9
PC1	Construction	0.1	0.1	0.3	1.2	1.8
PC2	Construction	0.1	0.2	0.4	1.4	2.2
	Production	0.1	0.2	0.4	1.9	2.8
PC3	Construction	0.1	0.2	0.4	1.4	2.2
	Production	0.1	0.2	0.4	1.8	2.8
DB	Construction	4.3	6.8	10.2	23.5	30.8
	Production	2.5	4.0	6.0	14.1	18.6
DS	Production	<0.1	0.1	0.4	3.0	5.0

2.3 Stormwater Volume

In accordance with Adams County Development Standards & Regulations requirements, stormwater falling on the project area will be detained and released at reduced flow rates. The maximum allowable release rates for the 1-hour, 5-year and 100-year storm events were determined by using *Table 9.16—Allowable Release Rates (cfs/acre)*. Using Group B soils as the dominant soil group, a release rate of 0.13 cfs/acre is acceptable during the 5-year storm event and 0.85 cfs/acre is acceptable during the 100-year storm event.

The MHFD spreadsheet model *Detention Basin Design Workbook Version 4.04* (MHFD-Detention) was used to calculate storm runoff volumes. One-hour point rainfall data for the project area (Table 1) were used within MHFD-Detention. Watershed parameters including area, length, and slope as well as imperviousness and soil type were calculated based on the site design and site characteristics. Table 6 shows storm runoff volumes (without accounting for releases) calculated for the stormwater storage area. MHFD-Detention inputs and results can be found in Appendix F.

Table 6. Calculated Storm Runoff Volumes

Outlet	Phase	Storm Runoff Volume, acre-ft						
		WQCV	EURV	2-year	5-year	10-year	50-year	100-year
DB	Construction	0.227	0.557	0.384	0.814	1.129	2.229	2.856
	Production	0.129	0.309	0.212	0.461	0.645	1.292	1.661

3.0 HYDRAULIC ANALYSIS AND DRAINAGE DESIGN

Criteria presented in the MHFD Urban Storm Drainage Criteria Manual outline the capacity, velocity, and slope requirements involved with drainage design and stormwater conveyance. The following sections describe the design recommendations for storage and conveyance during the construction phase and production phase. The recommended drainage design is shown in the Drainage Plan which can be found in Appendix A.

3.1 Stormwater Storage - Construction Phase

During the construction phase, stormwater from the well pad and facility will drain to the detention basin outlet (DB) located on the northwest corner of the detention basin. During the 5-year event, stormwater will pond to a maximum depth of 1.6 feet. During the 100-year event, stormwater will pond to a maximum depth of 3.0 feet creating a total storage of 1.844 acre-feet.

The outlet consists of two 12-inch diameter high-density polyethylene (HDPE) pipes. One pipe will have an orifice cap to control release rates and drain times for smaller events. The orifice cap will have a 1.9-inch diameter orifice at the invert of the outlet pipe, located at the bottom of the detention basin. The second pipe will be located adjacent to the first and positioned 1.0 feet above the bottom of the detention basin. The second pipe will have no orifice cap. Anti-seep collars should be used to prevent seepage through the berm and outlet slopes should be protected using geotextile fabric or riprap in order to prevent erosion along the embankment.

It will take approximately 40 hours to drain 99 percent of the water quality capture volume (WQCV) with outflow controlled by the orifice cap on the first pipe. During the 5-year and 100-year events, outflows will be controlled by the second pipe (no orifice cap). A total peak outflow of 1.3 cfs will occur during the 5-year event, which is less than the acceptable release rate of 0.13 cfs/acre during the 5-year event (0.13 cfs/acre * 17.84 acres = 2.3 cfs). A total peak outflow of 4.8 cfs will occur during the 100-year event, which is less than the acceptable release rate of 0.85 cfs/acre during the 100-year event (0.85 cfs/acre * 17.84 acres = 15.2 cfs).

An emergency spillway will be installed along the northern edge of the detention basin and will be utilized during both the construction and production phases. During the construction phase, detained stormwater will back up to the spillway during the 100-year event. The spillway was designed with a minimum crest width of 16.5 feet, 4:1 side slopes, and a crest invert elevation at 5564.9 feet (3.0 feet above the outlet invert). A berm height of 1.0 feet at the spillway will provide the required freeboard. The spillway is able to convey the developed 100-year peak flow at a depth of 0.5 feet. A concrete cutoff wall will provide scour protection at the spillway.

Stormwater storage volumes, outlet sizing, and spillway design details for the construction phase can be found in Appendix A. Supporting calculations using MHFD-Detention can be found in Appendix F.

3.2 Stormwater Storage - Production Phase

During the production phase, stormwater from the reclaimed well pad and facility will drain to the detention basin outlet (DB) located on the northwest corner of the detention basin. During the 5-year event, stormwater will pond to a maximum depth of 1.2 feet. During the 100-year event, stormwater will pond to a maximum depth of 2.1 feet creating a total storage of 0.915 acre-feet.

The outlet consists of two 12-inch diameter HDPE pipes. One pipe will have an orifice cap to control release rates and drain times for smaller events. The orifice cap will have a 1.6-inch diameter orifice at the invert of the outlet pipe, located at the bottom of the detention basin. The second pipe will be located adjacent to the first and positioned 0.7 feet above the bottom of the detention basin. The second pipe will have no orifice cap. Anti-seep collars should be used to prevent seepage through the berm and outlet slopes should be protected using geotextile fabric or riprap in order to prevent erosion along the embankment.

It will take approximately 40 hours to drain 99 percent of the WQCV with outflow controlled by the orifice cap on the first pipe. During the 5-year and 100-year events, outflows will be controlled by the second pipe (no orifice cap). A total peak outflow of 0.7 cfs will occur during the 5-year event, which is less than the acceptable release rate of 0.13 cfs/acre during the 5-year event (0.13 cfs/acre * 10.49 acres = 1.4 cfs). A total peak outflow of 3.6 cfs will occur during the 100-year event, which is less than the acceptable release rate of 0.85 cfs/acre during the 100-year event (0.85 cfs/acre * 10.49 acres = 8.9 cfs).

An emergency spillway will be installed along the northern edge of the detention basin and will be utilized during both the construction and production phases. During the production phase, detained stormwater will back up towards and nearly reach the spillway during the 100-year event. The spillway was designed with a minimum crest width of 16.5 feet, 4:1 side slopes, and a crest invert elevation at 5564.9 feet (3.0 feet above the outlet invert). A berm height of 1.0 feet at the spillway will provide the required freeboard. The spillway is able to convey the developed 100-year peak flow at a depth of 0.5 feet. A concrete cutoff wall will provide scour protection at the spillway.

Stormwater storage, outlet sizing, and spillway design details for the production phase can be found in Appendix A. Supporting calculations using MHFD-Detention can be found in Appendix F.

3.3 Culverts

Three culvert locations will be required to ensure proper on-site and off-site drainage. The MHFD spreadsheet model *Culvert Hydraulics Workbook Version 4.00* (MHFD-Culvert) was used to calculate conveyance, sizing, and performance characteristics for the recommended culvert designs. Peak flows used for culvert designs are summarized in Table 5. Culvert performance characteristics for the recommended culvert designs are summarized in Table 7. MHFD-Culvert spreadsheet calculations can be found in Appendix G.

Table 7. Culvert Performance Characteristics for Recommended Culvert Designs

Site	Recommended Culvert Design	10-year Peak Flow			Full Barrel Flow			Max Conveyance		
		Q, cfs	Vel, fps	HW/D	Q, cfs	Vel, fps	HW/D	Q, cfs	Vel, fps	HW/D
PC1	12-inch CMP	0.3	3.5	0.3	2.3	2.9	1.0	4.2	5.3	2.0
PC2	12-inch CMP	0.4	2.9	0.2	2.3	2.9	1.0	4.1	5.2	2.0
PC3	12-inch CMP	0.4	0.8	0.2	1.6	2.0	1.0	3.0	3.8	2.0

Proposed Culvert #1 (PC1) will convey off-site runoff from an existing ditch east of the project to the north under the temporary access road during the construction phase. One 12-inch corrugated metal pipe (CMP) culvert is recommended for this location. The maximum design conveyance before overtopping the access road is 4.2 cfs; therefore, the proposed culvert can adequately convey the 100-year peak flow during the construction phase (1.8 cfs).

Proposed Culvert #2 (PC2) will convey off-site runoff from an existing ditch east of the project (through PC1 during the construction phase) to the north under one of the permanent access roads during both the construction and production phases. One 12-inch CMP culvert is recommended for this location. The maximum design conveyance before overtopping the access road is 4.1 cfs; therefore, the proposed culvert can adequately convey the 100-year peak flow during the construction phase (2.2 cfs) and the 100-year peak flow during the production phase (2.8 cfs). Due to the existing site grade and the higher pipe roughness coefficient associated with CMP culverts, the 10-year peak flow velocity is below 3.0 feet per second (fps). Routine maintenance may be required to ensure sedimentation does not occur.

Proposed Culvert #3 (PC3) will convey off-site runoff from an existing diversion ditch east of the project (through PC2 during both phases) and on-site runoff from the external ditch and berm east of the facility under one of the permanent access roads during both the construction and production phases. One 12-inch CMP culvert is recommended for this location. The maximum design conveyance before overtopping the access road is 3.0 cfs; therefore, the proposed culvert can adequately convey the 100-year peak flow during the construction phase (2.2 cfs) and the 100-year peak flow during the production phase (2.8 cfs). Due to the existing site grade and the higher pipe roughness coefficient associated with CMP culverts, the 10-year peak flow velocity is below 3.0 fps. Routine maintenance may be required to ensure sedimentation does not occur.

3.4 Ditches

Diversion ditches and berms will be used to collect and direct on-site stormwater to outlets, deflect and redirect off-site runoff around the disturbance area, and store on-site stormwater. A network of existing and proposed ditches will facilitate the proposed stormwater design. Locations of ditches during the construction and production phase are shown in Figure 6 and Figure 7, respectively.

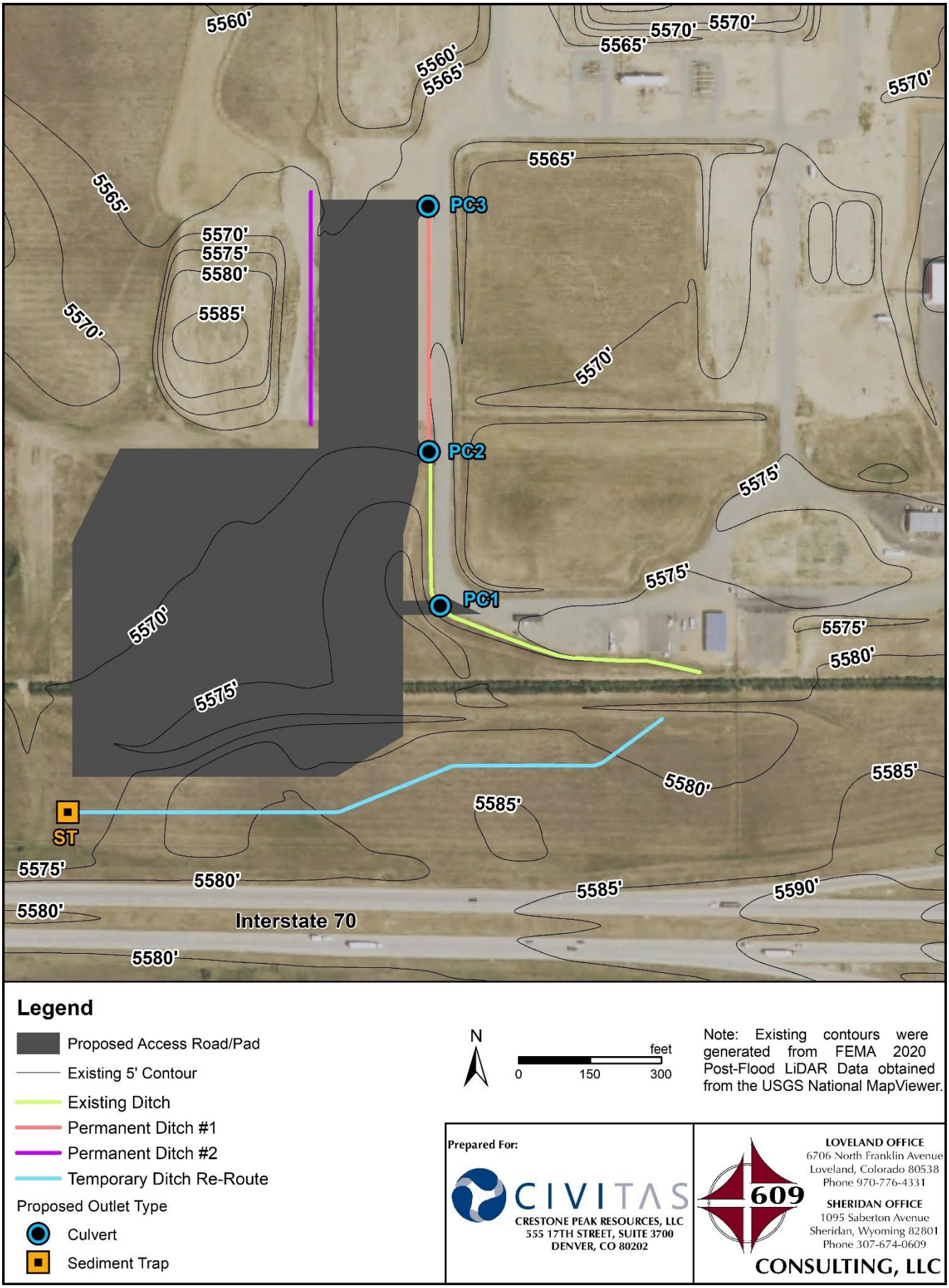

Figure 6. Construction Phase Ditch Locations

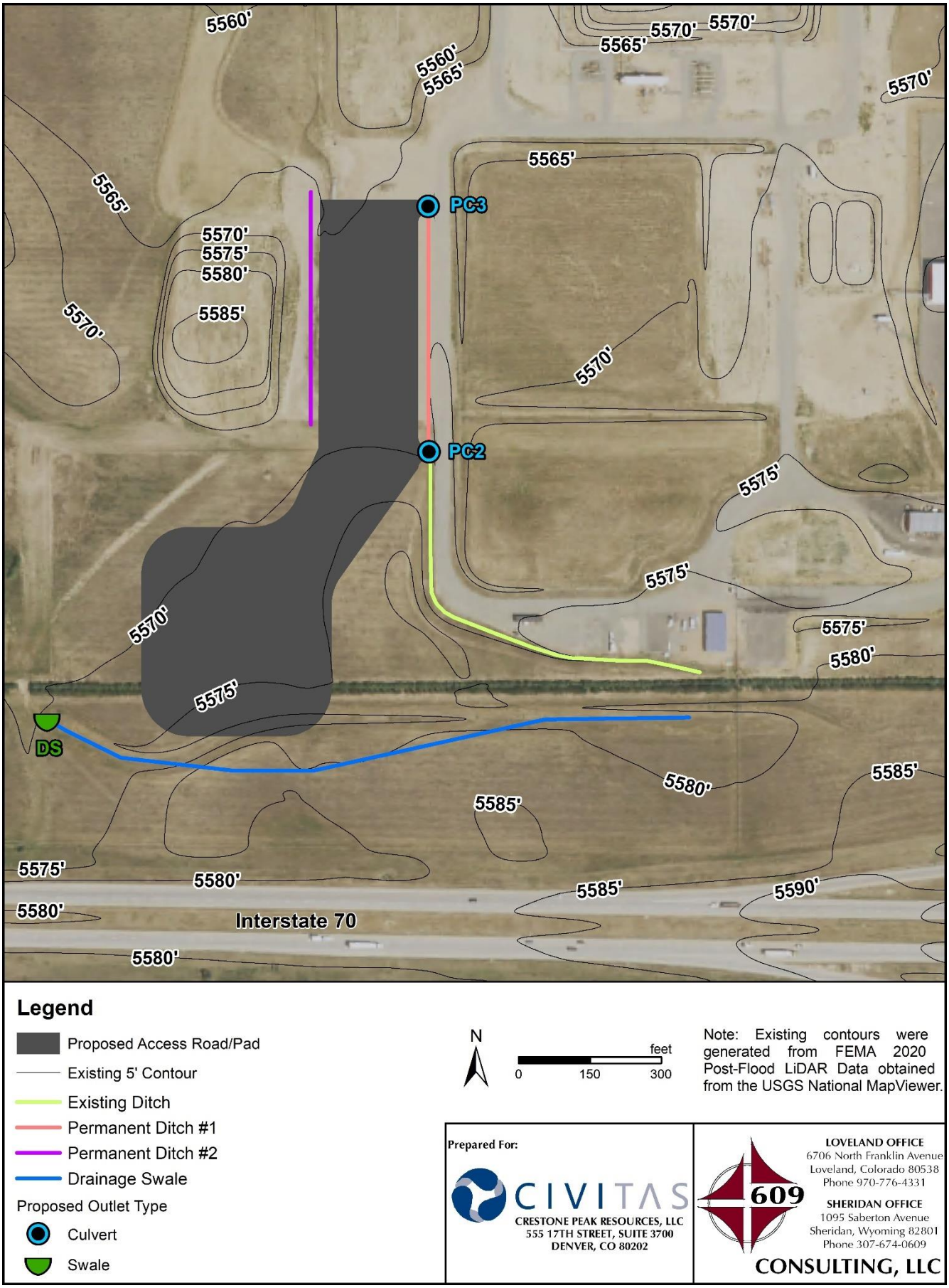

Figure 7. Production Phase Ditch Locations

Existing Ditch

During both the construction and production phases, an existing ditch will convey on-site and off-site runoff north into the proposed permanent ditch. PC1 and PC2 will convey this runoff under the access roads. The existing ditch is approximately 2.0 feet deep with an average slope of 0.7% and 5:1 side slopes. Manning's equation was used to calculate conveyance. The production phase peak flows for PC2 were used for required capacity due to these peak flows being the largest that will be conveyed through the existing ditch. The existing ditch is able to convey the production phase 100-year peak flow of PC2 (2.8 cfs) at a depth of 0.5 feet. This provides 1.5 feet of freeboard.

Permanent Ditch #1

During both the construction and production phases, a permanent ditch will be located on the east side of the facility and will convey on-site and off-site runoff from the existing ditch. This ditch will convey the runoff north under the access road (through PC3) into the detention basin. Permanent Ditch #1 is designed to be approximately 1.0 feet deep with a 1.0 feet tall berm on the outside (eastern) edge with an average slope of 0.7% and 3:1 side slopes. The production phase peak flows for PC3 were used for required capacity due to these peak flows being the largest that will be conveyed through this ditch. Permanent Ditch #1 is able to convey the production phase 100-year peak flow of PC3 (2.8 cfs) at a depth of 0.6 feet. This provides 1.4 feet of freeboard.

Permanent Ditch #2

During both the construction and production phases, a permanent ditch will be located on the west side of the facility. Minimal runoff will be routed through this ditch, and what little runoff enters the diversion ditch will be conveyed to the detention basin. Permanent Ditch #2 is designed to be 1.0 feet deep with a 1.0 feet tall berm on the outside (western) edge with an average slope of 0.7% and 4:1 side slopes. This ditch will be able to convey up to 14.0 cfs at a depth of 1.0 feet. This provides 1.0 feet of freeboard.

Temporary Ditch Re-Route

During the construction phase, an existing ditch running through the south portion of the well pad will be re-routed to flow around the well pad. It will convey off-site runoff from southeast of the project area and on-site flow from the topsoil stockpile to the west into the proposed Sediment Trap (ST). The temporary ditch re-route is designed to be approximately 4.0 feet deep with an average slope of 0.5% and 5:1 side slopes. The peak flows for ST were used for required capacity in the ditch. The ditch will be able to convey the 100-year peak flow of ST (3.9 cfs) at a depth of 0.6 feet. This provides 3.4 feet of freeboard.

Drainage Swale

During the production phase, a Drainage Swale (DS) will convey off-site runoff from southeast of the project area to the west. The swale is designed to be approximately 6.0 feet deep with a 3.0 feet wide bottom, 4:1 side slopes, and an average slope of 0.5%. The swale is able to convey the 100-year peak flow of DS (5.0 cfs) at a depth of 0.7 feet. This provides 5.3 feet of freeboard.

Manning's calculations for ditch conveyances can be found in Appendix H. Ditch cross-sections are included in Appendix A.

3.5 Sediment Trap

One sediment trap and outlet will be installed at the end of the temporary ditch re-route during the construction phase. Runoff from the topsoil stockpile will flow through the ditch and into the sediment trap. Treated stormwater will exit the sediment trap onto undisturbed ground where the natural contours will drain away from the project area. In order to provide additional capture volume and treatment, the sediment trap is designed to be oversized. A 20 feet by 20 feet by 3 feet deep sediment trap is recommended for this project. Typical sediment trap details are included with the Drainage Plan found in Appendix A.

4.0 SITE MAINTENANCE AND UPKEEP

The Crestone Peak Resources Operating LLC site monitoring program ensures site conditions stay in compliance. Sedimentation, culvert and access road condition, vegetation health, and several other safety and maintenance items are routinely monitored and evaluated to ensure the site is in workable and drainable order.

In addition to monitoring during regular operations, a formal monitoring plan has been developed for the project site. During the construction phase, the site will be inspected a minimum of every 14 calendar days as well as following rain or snowmelt events that are able to cause surface erosion. After the construction phase, areas not needed for production operations within the disturbance area will be reclaimed and site inspections will occur at a minimum of every 30 calendar days until the site is fully stabilized. Once the site is stabilized and has achieved interim reclamation standards, inspections will occur annually. More frequent, informal inspections will continue to occur during routine operations.

Routine maintenance and required repairs of access roads, culverts, ditches, berms, and outlet structures will be handled by the operations team. Cleaning and removal of sediment and debris from ditches, culverts, and outlets, as well as vegetation maintenance and specific manufacturer maintenance, will also be handled by the operations team during regular operations and maintenance checks.

5.0 CONCLUSION

The information and analysis presented in this report display the adequacy and effectiveness of the design and planning associated with the Bennett D Pad Drainage Plan. The design protects public health, safety, and general welfare and has no adverse impacts on public rights-of-way or off-site properties. Furthermore, the report demonstrates that the design adheres to Adams County Development Standards & Regulations as well as the Mile High Flood District (MHFD) Urban Storm Drainage Criteria Manual.

6.0 REFERENCES

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Web Soil Survey. Natural Resources Conservation Service. https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

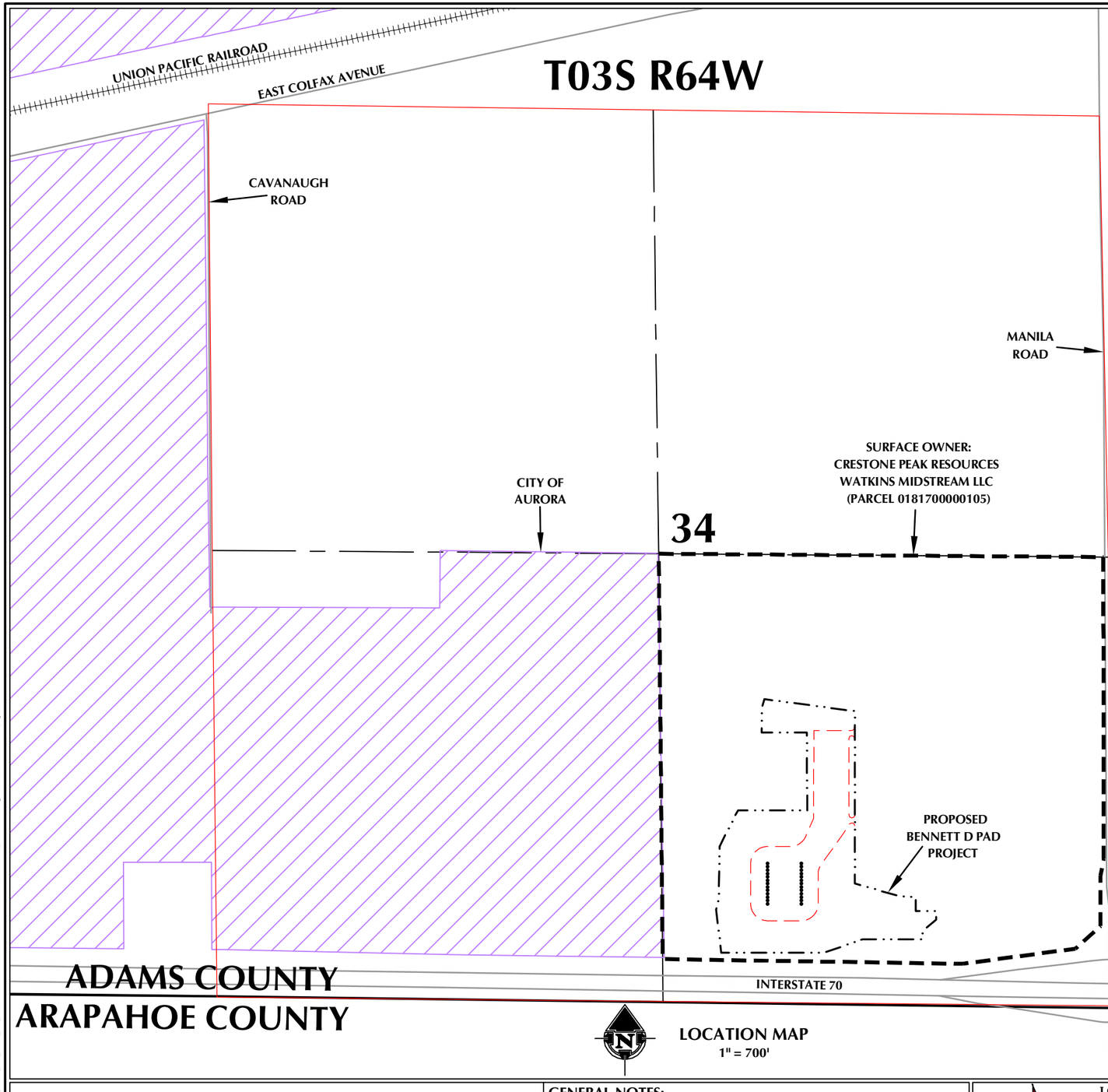
APPENDICES

Appendix A:

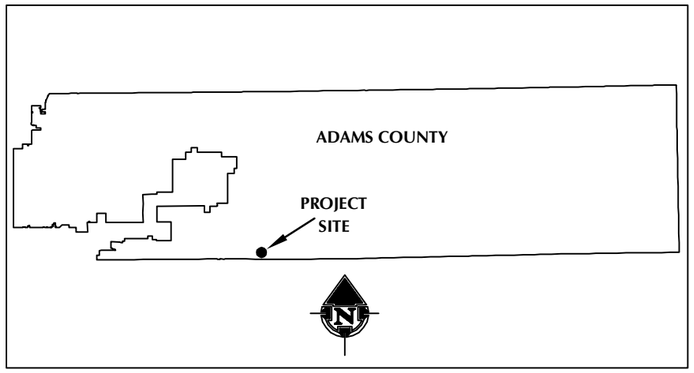
Drainage Plan

BENNETT D PAD
DRAINAGE PLAN

LOCATED IN SECTION 34, T3S, R64W, 6TH P.M.
ADAMS COUNTY, COLORADO



LOCATION MAP
1" = 700'



VICINITY MAP

PAGE INDEX

GENERAL NOTES:

1. THIS DRAINAGE AND EROSION CONTROL PLAN WAS PREPARED FOLLOWING ADAMS COUNTY DEVELOPMENT STANDARDS & REGULATIONS WITH ADDITIONAL DESIGN GUIDANCE PROVIDED BY MILE HIGH FLOOD DISTRICT.
2. DISCLAIMER: THIS PLAN REPRESENTS AN APPROXIMATE LOCATION OF DRAINAGE AND EROSION CONTROL FEATURES; EXACT LOCATION MAY VARY DEPENDING UPON EXISTING EASEMENTS, PIPELINES, FLOWLINES, AND SETBACK REQUIREMENTS.
3. ORIGINAL DOCUMENT SIZE: 11" X 17"

609 CONSULTING, LLC
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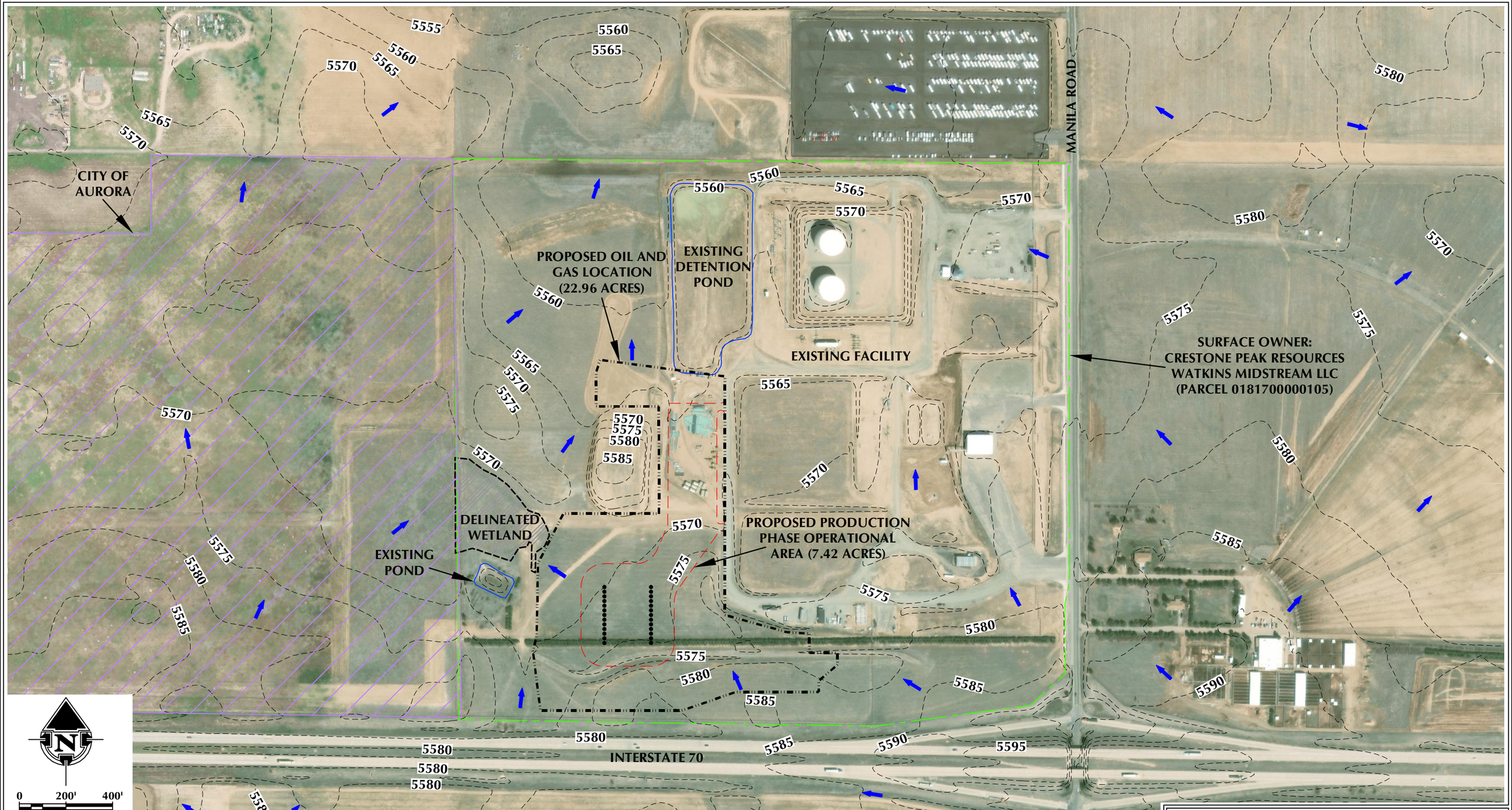
BENNETT D PAD
DRAINAGE PLAN
COVER SHEET

SCALE:	VARIES	PAGE:	1 OF 10
JOB NUMBER:	23-182	DATE:	10/21/24
DRAFTED BY:	KMG	REVISED:	

PRELIMINARY

K:\CIVIT\6 RESOURCES\2023\2023_182_SEC36_T3S_R64W_SEC_36\DRAINAGE STUDY\DWG - DRAINAGE PLAN\BENNETT D_COMBINED.dwg, 10/22/2024 2:37:14 PM, kgates



LEGEND

- EXISTING CONTOUR
- EXISTING IRRIGATION DITCH/DRAINAGEWAY
- PROPOSED OIL AND GAS LOCATION
- PROPOSED ACCESS ROAD/PAD
- STORMWATER DRAINAGE
- PROPERTY LINE

GENERAL NOTES:

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2. ELEVATIONS ARE BASED ON NAVD88 (GEOID18).

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BENNETT D PAD
DRAINAGE PLAN
SITE OVERVIEW

SCALE:	1" = 400'	PAGE:	2 OF 10
JOB NUMBER:	23-182	DATE:	10/21/24
DRAFTED BY:	KMG	REVISED:	

PRELIMINARY

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			INLET INVERT	OUTLET INVERT	
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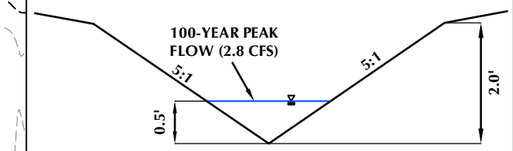
PC2	12" CMP	40	5570.0	5568.8	3.0%
PC3	12" CMP	40	5566.1	5566.0	0.3%

EXISTING CULVERT
EXISTING CULVERT
EXISTING DETENTION POND
400'
EXISTING 400' X 850' MAINTENANCE EASEMENT
SURFACE OWNER: CRESTONE PEAK RESOURCES WATKINS MIDSTREAM LLC (PARCEL 0181700000105)
PROPOSED CULVERT #3 (PC3)
PERMANENT ACCESS ROAD
PERMANENT DITCH #1
PERMANENT ACCESS ROAD
EXISTING DITCH
PROPOSED CULVERT #1 (PC1)
PROPOSED CULVERT #2 (PC2)
BENNETT D PAD FACILITY
100-YEAR STORAGE ELEVATION 5564.9'
PERMANENT DITCH #2
EXISTING TOPSOIL STOCKPILE
DETENTION BASIN
SPILLWAY
DETENTION BASIN (DB) OUTLET
CUT
FILL
BENNETT D PAD WELL PAD
TOPSOIL STOCKPILE
TEMPORARY ACCESS ROAD
TEMPORARY DITCH RE-ROUTE
INTERSTATE 70
PROPOSED OIL AND GAS LOCATION (22.96 ACRES)
EXISTING 20' ACCESS EASEMENT
20' X 20' X 3' SEDIMENT TRAP (ST)
DELINEATED WETLAND
EXISTING POND
0.5% SLOPE
0 100' 200'
1" = 200'
1' CONTOURS

EXISTING DITCH CROSS SECTION



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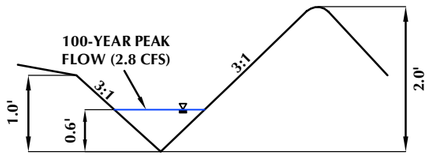

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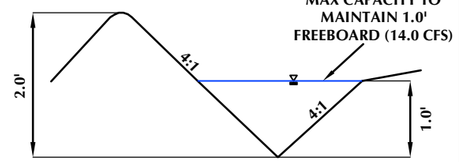

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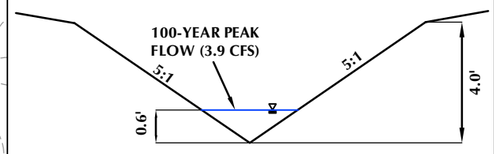

LEGEND

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- EXISTING ROAD
- EXISTING PIPELINE
- EXISTING BURIED POWERLINE
- EXISTING OVERHEAD POWERLINE
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- PROPOSED CONTOUR
- PROPOSED ACCESS ROAD/PAD
- PROPOSED WELL
- PROPERTY LINE
- PROPOSED DIVERSION DITCH
- PROPOSED BERM / OFF-SITE FLOW DEFLECTION
- PROPOSED CULVERT PROTECTION / RIPRAP
- PROPOSED SEDIMENT TRAP WITH PROTECTED OUTLET
- PROPOSED SLOPE PROTECTION
- 100-YEAR STORMWATER STORAGE FOOTPRINT
- STORMWATER DRAINAGE
- EASEMENT/ROW
- EXISTING DITCH

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2. ELEVATIONS ARE BASED ON NAVD88 (GEOID18).
3. SLOPE PROTECTION USED FOR TEMPORARY EROSION CONTROL ON CUT/FILL SLOPES AND SOIL STOCKPILES.

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BENNETT D PAD DRAINAGE PLAN

CONSTRUCTION PHASE SITE PLAN

SCALE:	1" = 200'	PAGE:	3 OF 10
JOB NUMBER:	23-182	DATE:	10/21/24
DRAFTED BY:	KMG	REVISED:	

PRELIMINARY

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PERMANENT ACCESS ROAD
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EXISTING DITCH
BENNETT D PAD FACILITY
100-YEAR STORAGE ELEVATION 5564.0'
0.5% SLOPE
PERMANENT DITCH #2
EXISTING TOPSOIL STOCKPILE
DETENTION BASIN
SPILLWAY
DETENTION BASIN (DB) OUTLET
SEEDED TOPSOIL STOCKPILE (FOR FINAL REC)
BENNETT D PAD WELL PAD
PRODUCTION PHASE OPERATIONAL AREA (7.42 ACRES)
DRAINAGE SWALE (DS)
INTERSTATE 70
PROPOSED OIL AND GAS LOCATION (22.96 ACRES)
EXISTING 20' ACCESS EASEMENT
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EXISTING POND

0 100' 200'
1" = 200'
1' CONTOURS

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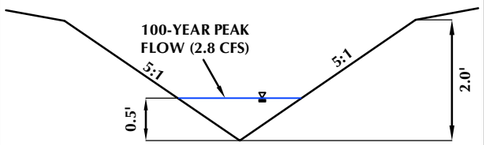

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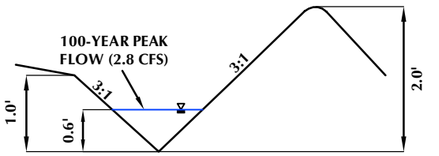

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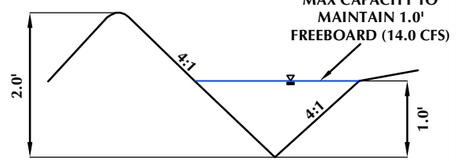

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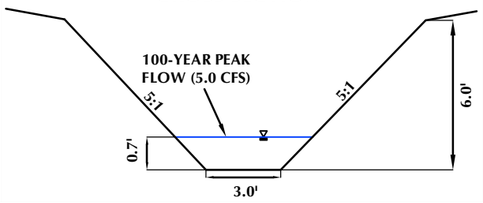

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- PROPOSED CONTOUR
- PROPOSED ACCESS ROAD/PAD
- PROPOSED WELL
- PROPERTY LINE
- PERMANENT DIVERSION DITCH
- PROPOSED BERM / OFF-SITE FLOW DEFLECTION
- PROPOSED CULVERT PROTECTION / RIPRAP
- RECLAMATION BOUNDARY
- PROPOSED PERMANENT SEEDING
- 100-YEAR STORMWATER STORAGE FOOTPRINT
- STORMWATER DRAINAGE
- EASEMENT/ROW
- EXISTING DITCH

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2. ELEVATIONS ARE BASED ON NAVD88 (GEOID18).
3. RECLAIMED AREA WILL BE RE-SEEDED AND RE-VEGETATED.

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BENNETT D PAD
DRAINAGE PLAN
PRODUCTION PHASE SITE PLAN

SCALE:	1" = 200'	PAGE:	4 OF 10
JOB NUMBER:	23-182	DATE:	10/21/24
DRAFTED BY:	KMG	REVISED:	

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DETENTION BASIN (DB) OUTLET - CONSTRUCTION PHASE

OUTLET PROFILE (PIPE 1)

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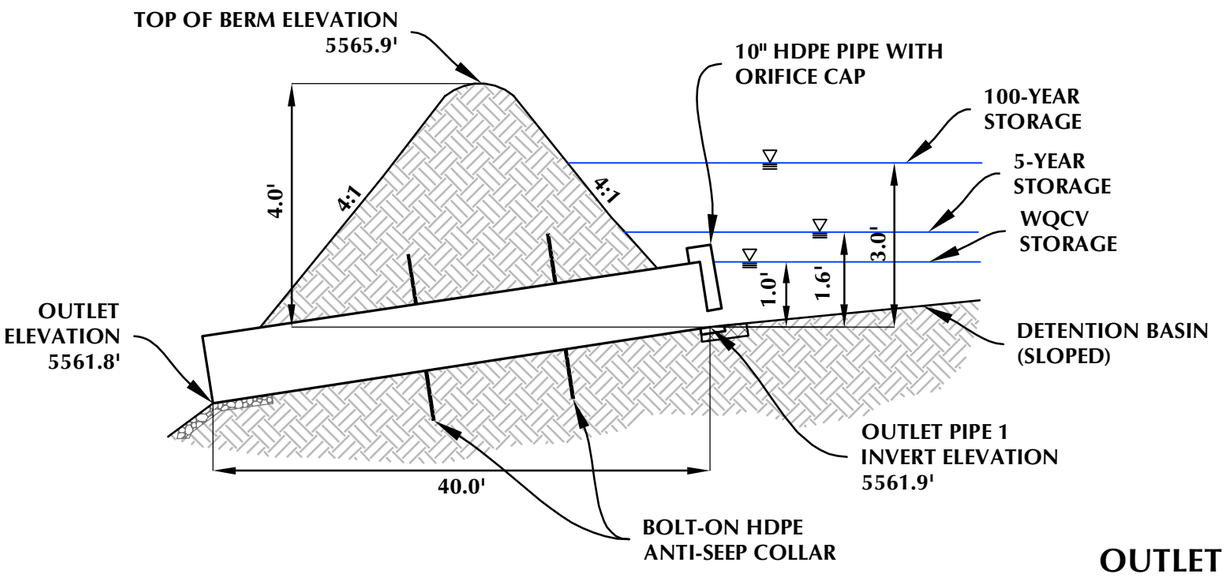

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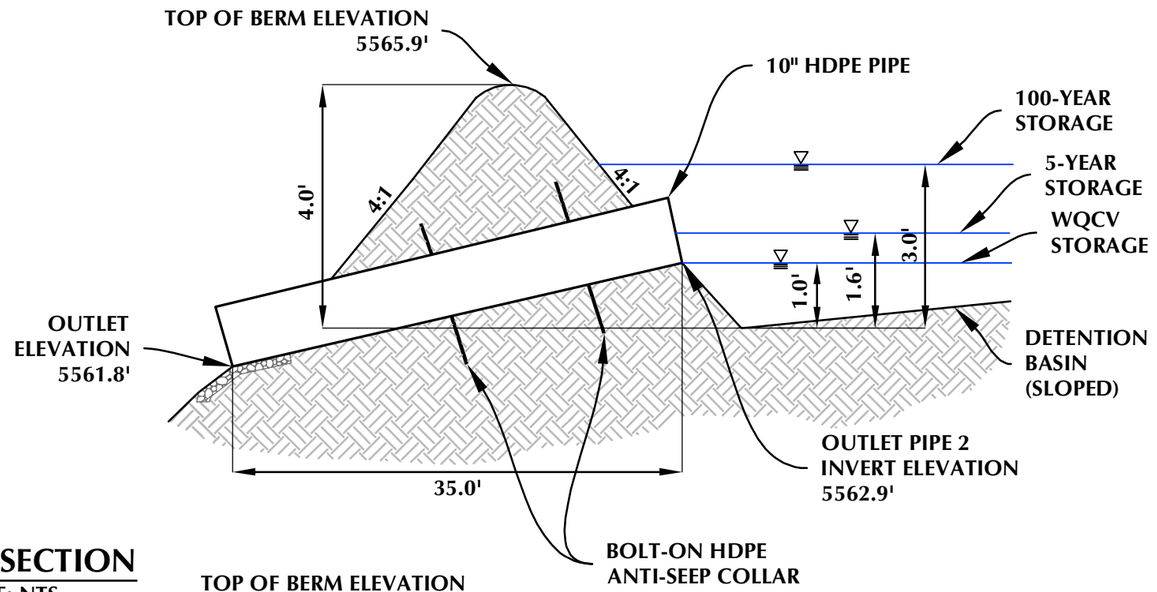

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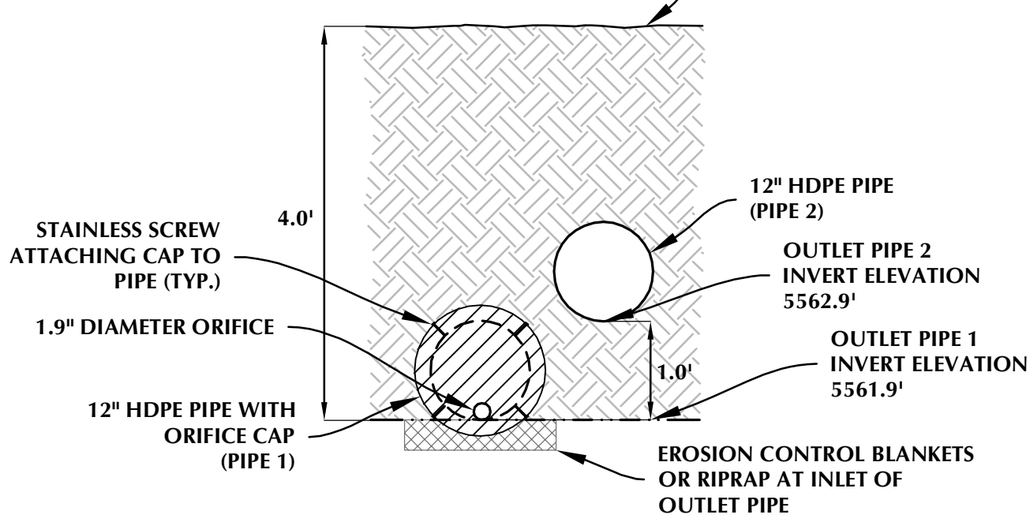

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DENVER, CO 80202

BENNETT D PAD
DRAINAGE PLAN
DETENTION BASIN OUTLET - CONSTRUCTION

SCALE:	VARIES	PAGE:	5 OF 10
JOB NUMBER:	23-182	DATE:	10/21/24
DRAFTED BY:	KMG	REVISED:	

PRELIMINARY

DETENTION BASIN (DB) OUTLET - PRODUCTION PHASE

OUTLET PROFILE (PIPE 1)

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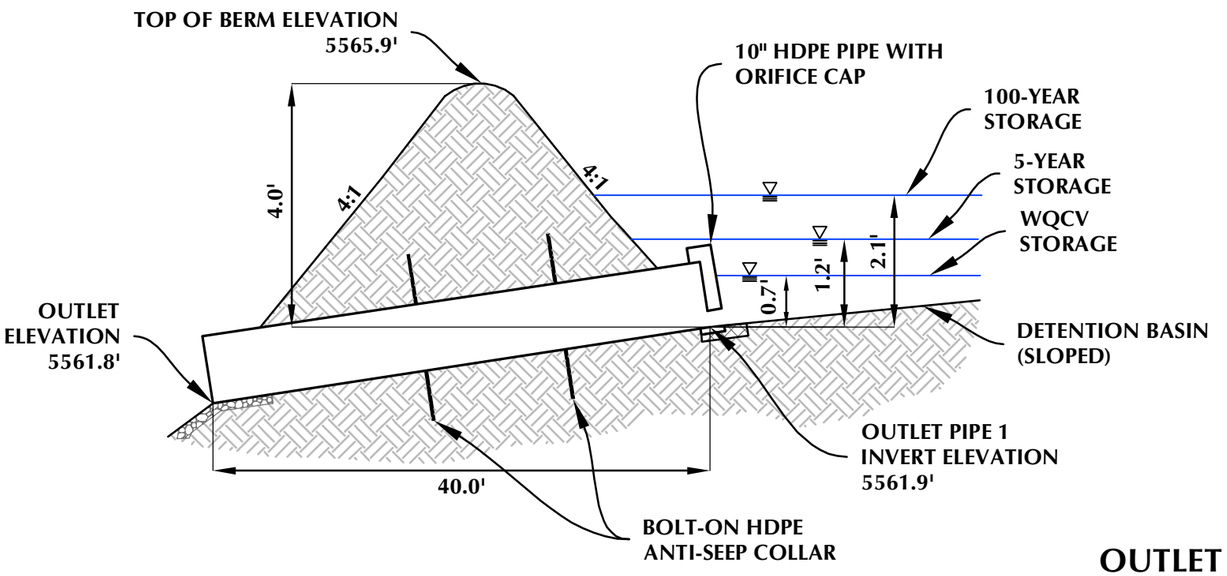

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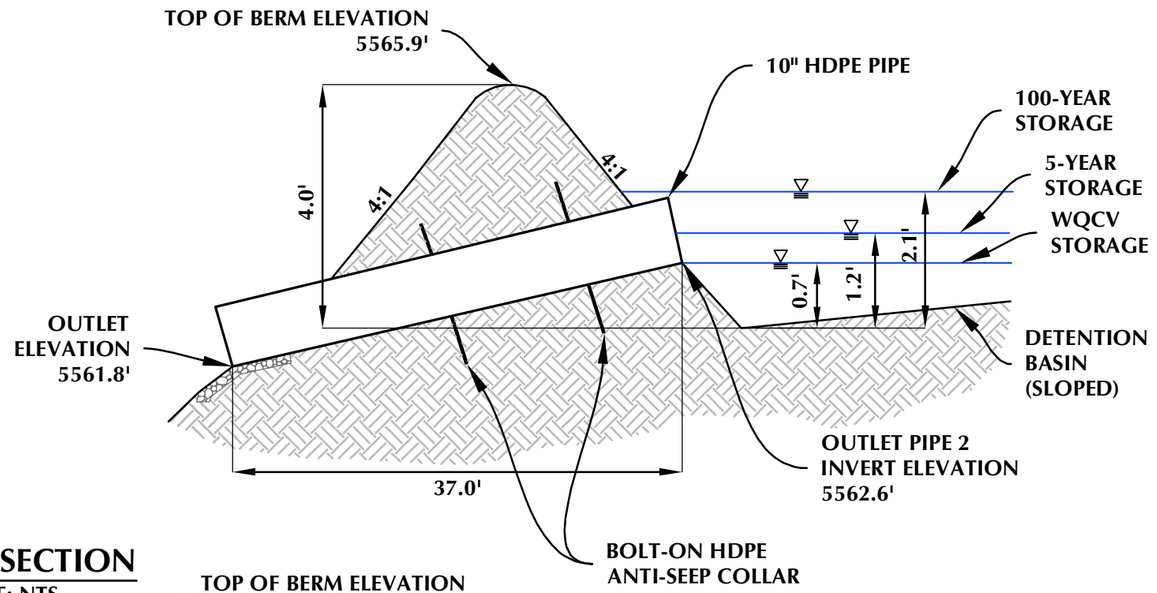

OUTLET SECTION

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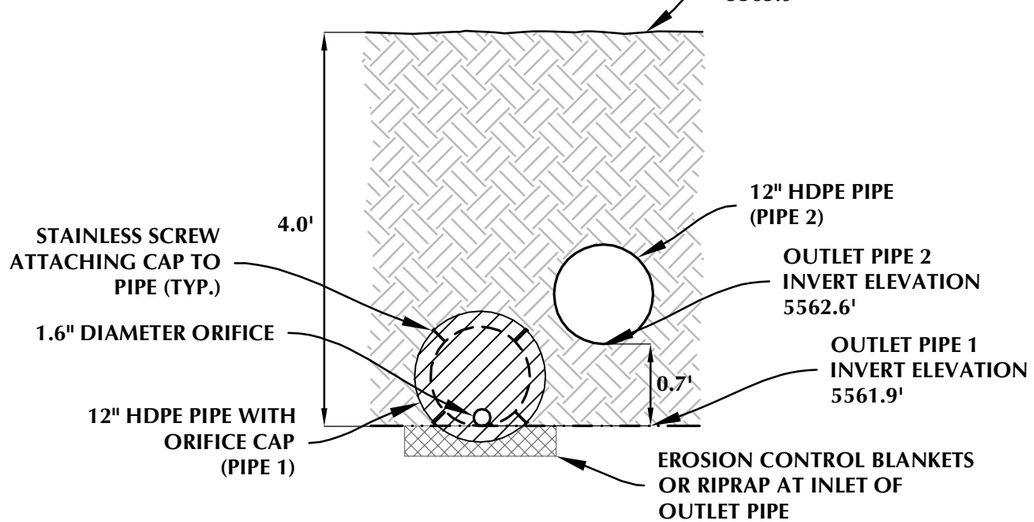

GENERAL NOTES:

1. DISCLAIMER: THIS PLAN REPRESENTS AN APPROXIMATE LOCATION OF DRAINAGE AND EROSION CONTROL FEATURES; EXACT LOCATION MAY VARY DEPENDING UPON EXISTING EASEMENTS, PIPELINES, FLOWLINES, AND SETBACK REQUIREMENTS.
2. ELEVATIONS ARE BASED ON NAVD88 (GEOID18).

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Loveland, Colorado 80538
Phone 970-776-4331

SHERIDAN OFFICE
1095 Saberton Avenue
Sheridan, Wyoming 82801
Phone 307-674-0609

Prepared For:

CIVITAS
CRESTONE PEAK RESOURCES, LLC
555 17TH STREET, SUITE 3700
DENVER, CO 80202

BENNETT D PAD
DRAINAGE PLAN
DETENTION BASIN OUTLET - PRODUCTION

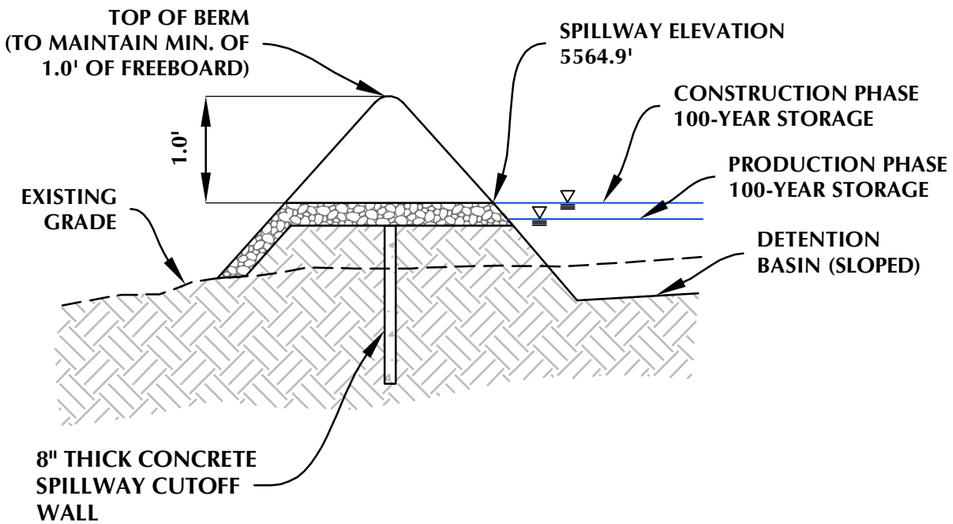
SCALE:	VARIES	PAGE:	6 OF 10
JOB NUMBER:	23-182	DATE:	10/21/24
DRAFTED BY:	KMG	REVISED:	

PRELIMINARY

DETENTION BASIN (DB) SPILLWAY - BOTH PHASES

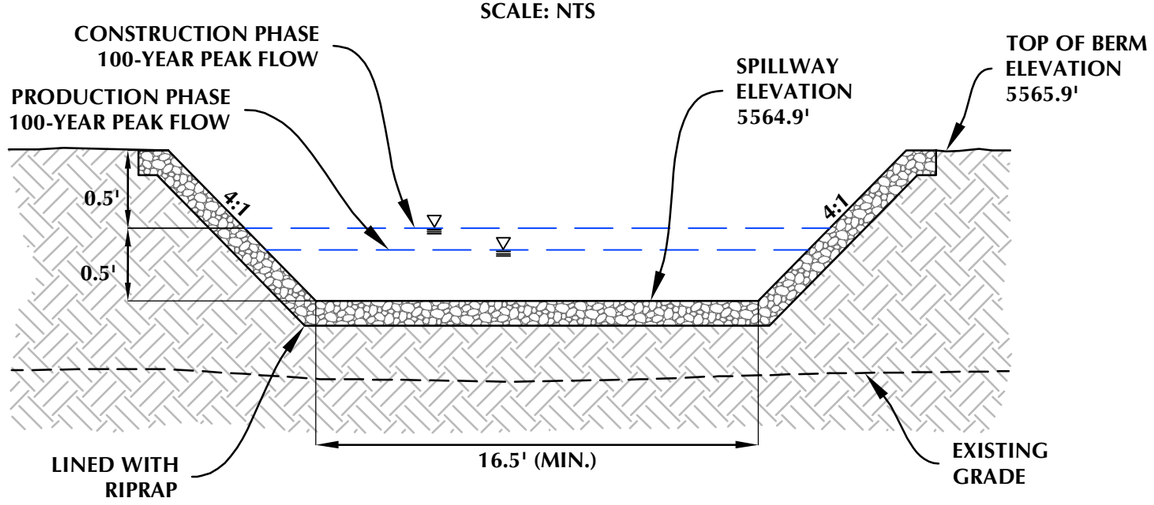
SPILLWAY PROFILE

SCALE: NTS



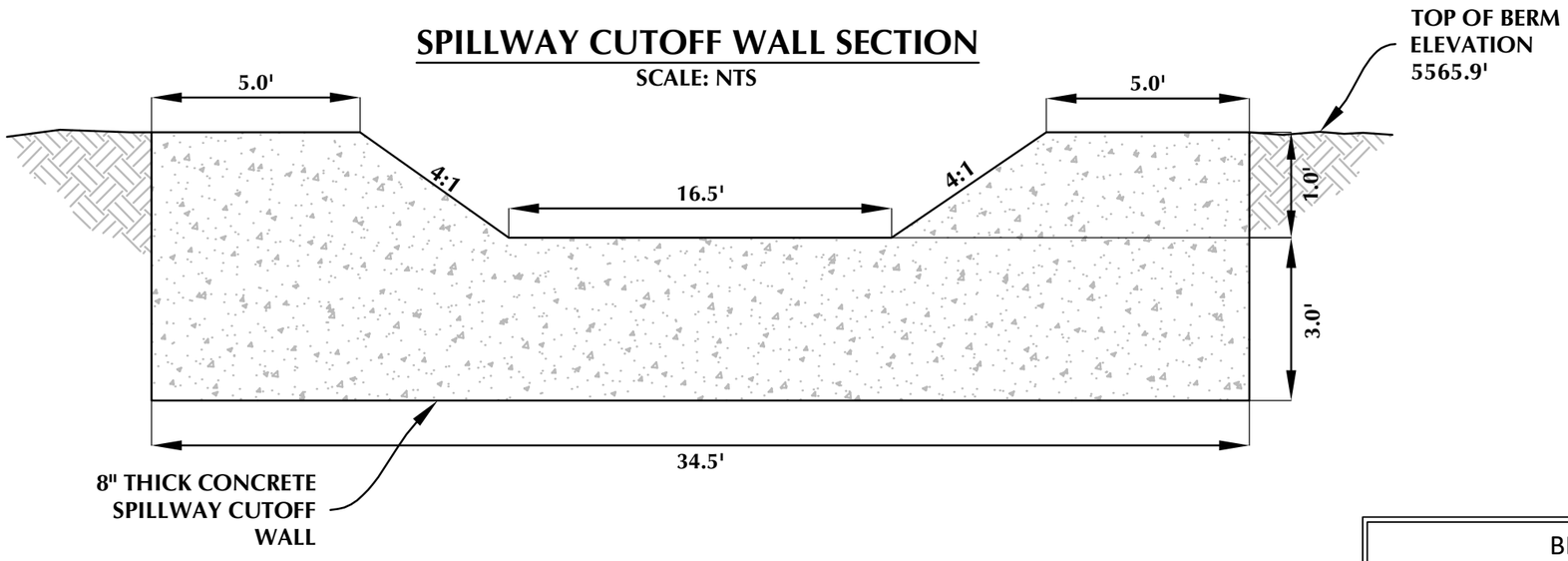
SPILLWAY SECTION

SCALE: NTS



SPILLWAY CUTOFF WALL SECTION

SCALE: NTS



GENERAL NOTES:

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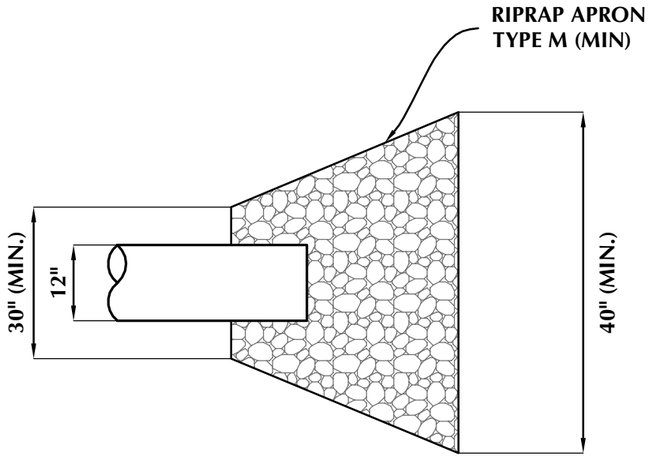
BENNETT D PAD
DRAINAGE PLAN
DETENTION BASIN SPILLWAY

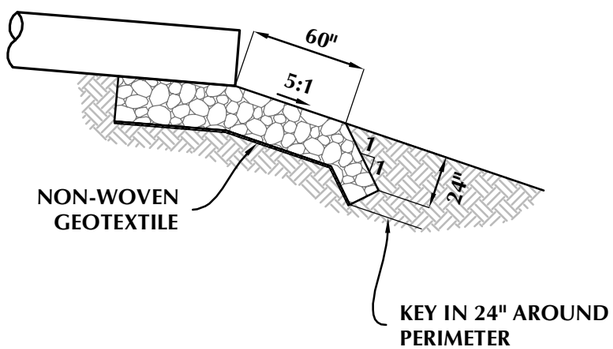
SCALE:	VARIES	PAGE:	7 OF 10
JOB NUMBER:	23-182	DATE:	10/21/24
DRAFTED BY:	KMG	REVISED:	

PRELIMINARY

OUTLET PROTECTION

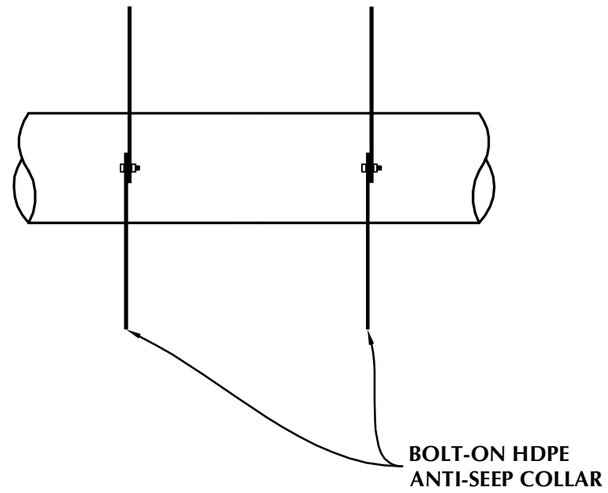
SCALE: NTS

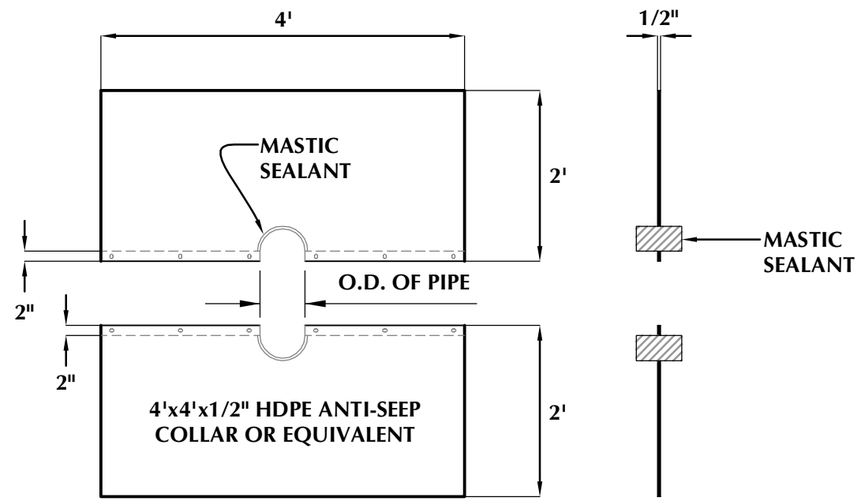




ANTI-SEEP COLLAR

SCALE: NTS





GENERAL NOTES:

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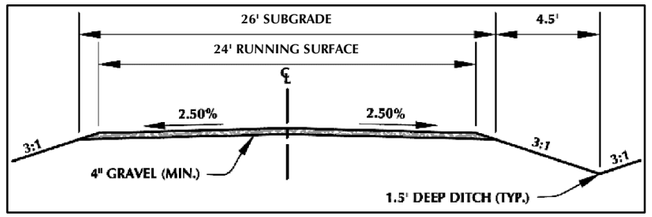
BENNETT D PAD
DRAINAGE PLAN
OUTLET DETAILS

SCALE:	VARIES	PAGE:	8 OF 10
JOB NUMBER:	23-182	DATE:	10/21/24
DRAFTED BY:	KMG	REVISED:	

PRELIMINARY



CROSS-SECTION
NTS

Temporary and Permanent Seeding (TS/PS)

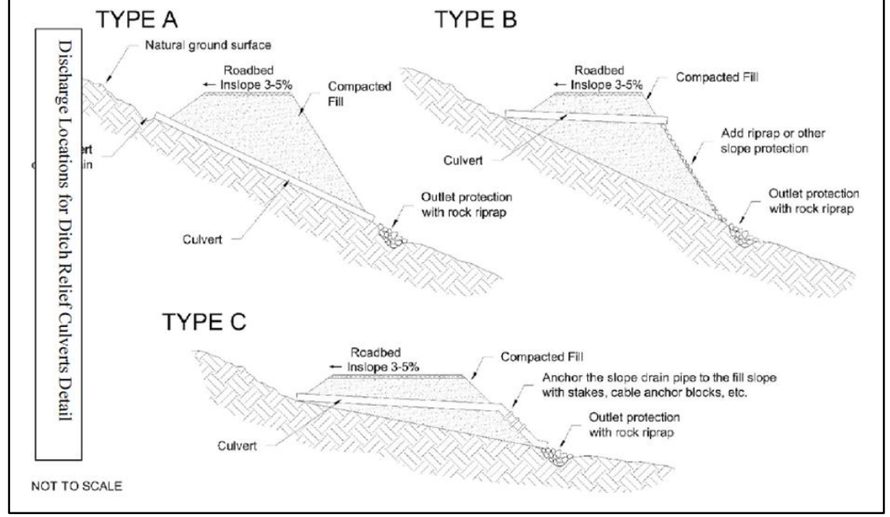
TS/PS

ADAMS COUNTY, COLORADO

SEED MIX	APPLICATION RATE (lbs/acre)
PBSI Dryland Aggressive Mix	25
(20%) Green Needlegrass, Lodorm	
(20%) Slender Wheatgrass, Native	
(20%) Western Wheatgrass, Native	
(20%) Pubescent Wheatgrass, Luna	
(20%) Intermediate Wheatgrass, Oahe/Rush	
PBSI Native Prairie Mix	15
(25%) Blue Grama	
(10%) Buffalograss	
(20%) Green Needlegrass	
(20%) Sideoats Grama	
(25%) Western Wheatgrass	
PBSI Native Sandyland Mix	15
(20%) Yellow Indiangrass	
(10%) Little Bluestem	
(10%) Indian Rice Grass	
(10%) Sideoats Grama	
(10%) Sand Lovegrass	
(10%) Prairie Sandreed	
(20%) Switchgrass	
PBSI Premium Irrig. Pasture Mix #1	25
(75%) Meadow Bromegrass, Paddock/Fleet	
(25%) Orchardgrass, Elsie/Megabite/Paiute	

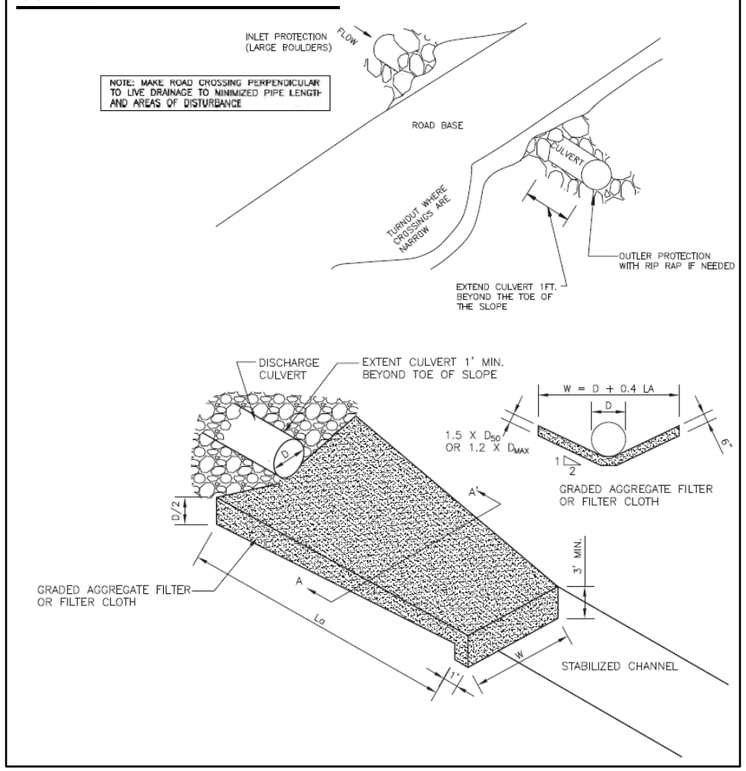
Notes:
lbs/acre = pounds per acre
% = percent

CULVERT



NOT TO SCALE

CULVERT



GENERAL NOTES:

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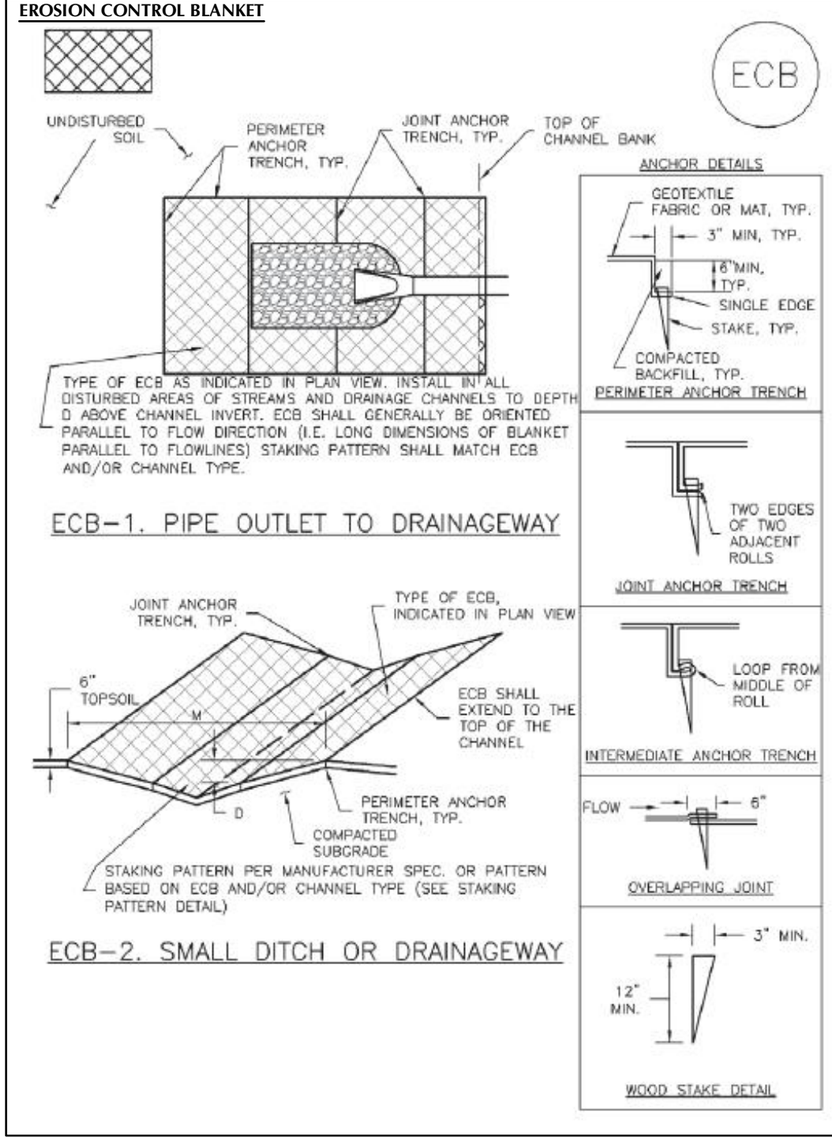
BENNETT D PAD
DRAINAGE PLAN
BMP TYPICALS (A)

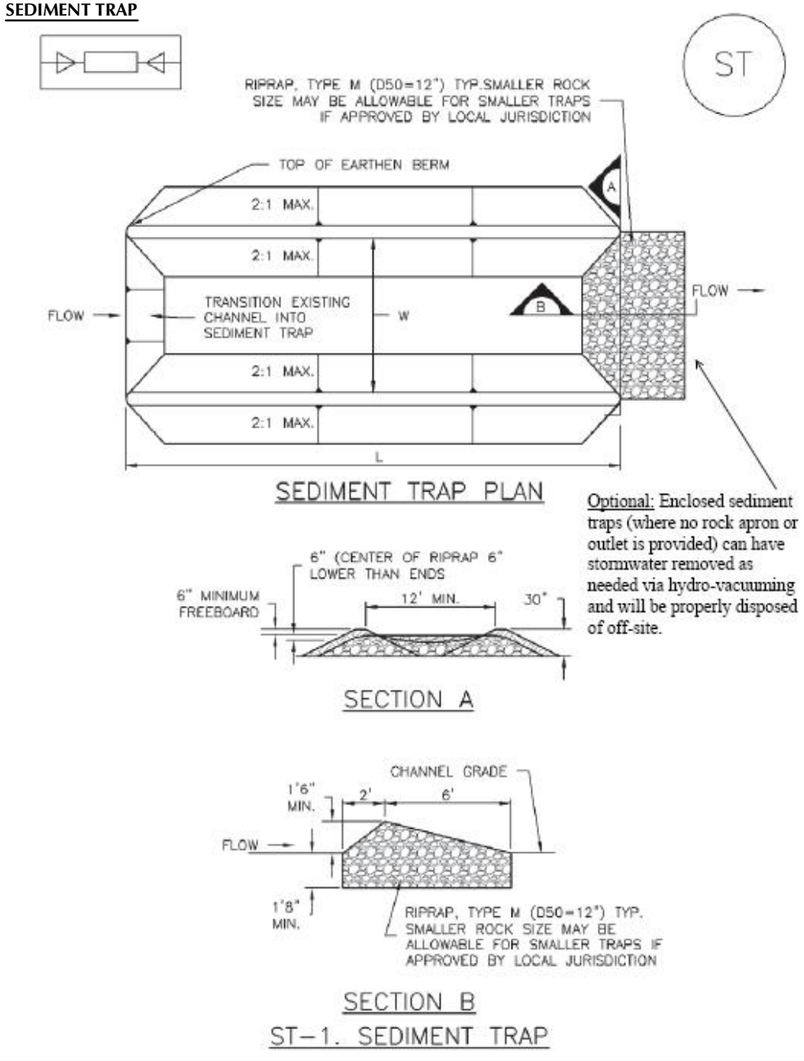
SCALE:	VARIES	PAGE:	9 OF 10
JOB NUMBER:	23-182	DATE:	10/21/24
DRAFTED BY:	KMG	REVISED:	

PRELIMINARY

EROSION CONTROL BLANKET



SEDIMENT TRAP



Optional: Enclosed sediment traps (where no rock apron or outlet is provided) can have stormwater removed as needed via hydro-vacuuming and will be properly disposed of off-site.

GENERAL NOTES:

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BENNETT D PAD
DRAINAGE PLAN
BMP TYPICALS (B)

SCALE:	VARIES	PAGE:	10 OF 10
JOB NUMBER:	23-182	DATE:	10/21/24
DRAFTED BY:	KMG	REVISED:	

PRELIMINARY

Appendix B:

Drainage Report and Drainage Plan Checklist

Level 2 – Storm Drainage Report				
Item No.	Submitted[1]	County Use Only		
		Rejected	N/A	
1.	☐	☐	☐	Signed certification statements of the Engineer and Developer.
2.	☒	☐	☐	Description of project location.
3.	☒	☐	☐	Description of pre-development site conditions.
4.	☒	☐	☐	Description of proposed development, including description of proposed developed site.
5.	☒	☐	☐	Description of proposed stormwater improvements, including conveyance, stormwater quantity control facilities, and stormwater quality control facilities.
6.	☒	☐	☐	Description of the design method utilized, names of any computer software routines utilized in the design process, and reference any design standards utilized (other than Adams County ordinances).
7.	☒	☐	☐	Preliminary hydrological and hydraulic analysis, including pre-development and post-development runoff hydrographs for the project site.
8.	☒	☐	☐	Preliminary sizing of storage facilities proposed for stormwater quantity and/or quality control.
9.	☒	☐	☐	Preliminary report addressing potential erosion and sedimentation impacts during construction, and general proposals for the mitigation of these impacts. Address erosion control during and after construction.
10.	☒	☐	☐	Vicinity Map - including Section, Township, and Range
11.	☒	☐	☐	Professional Engineer's Seal – including signature and date.
12.	☒	☐	☐	Downstream and adjacent property Drainage Impact Analysis and Mitigation Measures.
13.	☒	☐	☐	Pre-development and post-development basin maps, showing boundaries of project, any off-site contributing drainage basins, on-site drainage basins, time of concentration routes, approximate locations of all major drainage structures within the basins, and the course of stormwater originating from the subject property and extending all the way to the nearest receiving body of water (lakes, creeks, etc.). All basin maps shall be legible and at a specified scale.
14.	☒	☐	☐	Other resource material such as soils maps, isopluvial maps, nomographs, charts, figures, tables, etc.
15.	☐	☐	☐	Surface/subsurface soil test results and test locations (when retention/infiltration is proposed).
16.	☒	☐	☐	Identify all easements.
17.	☒	☐	☐	Include runoff summary table at design points.
18.	☒	☐	☐	Indicate proposed drainage improvements.
Developer's Comments (please reference the item number for each comment) 1. Stamp and signature will be added to final report. 15. Retention/infiltration is not being proposed.				
County's Comments				

[1] To be checked by the Developer. If a "submitted" box is not checked, the Applicant must explain (in comment box above) or the application may be rejected for insufficient information.

Level 2 – Storm Drainage Plan

Item No.	Submitted[1]	County Use Only		
		Rejected	N/A	
1.	X	☐	☐	Sheet Size – 24" x 36" or 11" x 17"
2.	X	☐	☐	Project Title Sheet
3.	X	☐	☐	Project Site Plan
4.	X	☐	☐	Title Block – include name and address of proposed project/development.
5.	X	☐	☐	Drawing Information • North arrow indicator • Section-Township-Range • Drawing Scale • Symbol Legend
6.	X	☐	☐	Drawing Scale – plan view must be drawn at a scale legible enough for review. Must use standard engineering scale.
7.	X	☐	☐	Topography – include contour lines at a maximum of 2' intervals with source to datum identified. Extend past the project limits as appropriate to show downstream effects.
8.	X	☐	☐	Utilities - existing and proposed, with easements identified.
9.	X	☐	☐	Site Layout – including property boundaries, dimensions, area (in square feet or acres), adjoining street names and right-of-way widths
10.	X	☐	☐	Drainage Structures - including existing and proposed structures (pipes, catch basins , channels, ponds, irrigation ditches, etc.) and impervious surfaces (parking lots, driveways, patios, buildings, etc.)
11.	X	☐	☐	Natural Features – including drainage channels, wetlands, water bodies, areas of natural vegetation, and flood plains.
12.	X	☐	☐	Proposed Conveyance Structures – including approximate plans for collection and conveyance of stormwater through the project site. As a minimum, show by flow arrows the direction of proposed stormwater flow and indicate the method for conveyance (pipe, ditch, overland flow, etc.)
13.	X	☐	☐	Preliminary Road Layouts – including existing grade and proposed finished grade.
14.	X	☐	☐	Erosion and Sedimentation Control – including location and type of erosion and sedimentation control measure proposal.
15.	X	☐	☐	General Construction Notes – include notes for clarification (see Attachment ___ for County Examples.)
16.	☐	☐	☐	Professional Engineer's Seal – including signature and date.

Developer's Comments (please reference the item number for each comment)

16. Professional Engineer's Seal will be added to final drainage plan.

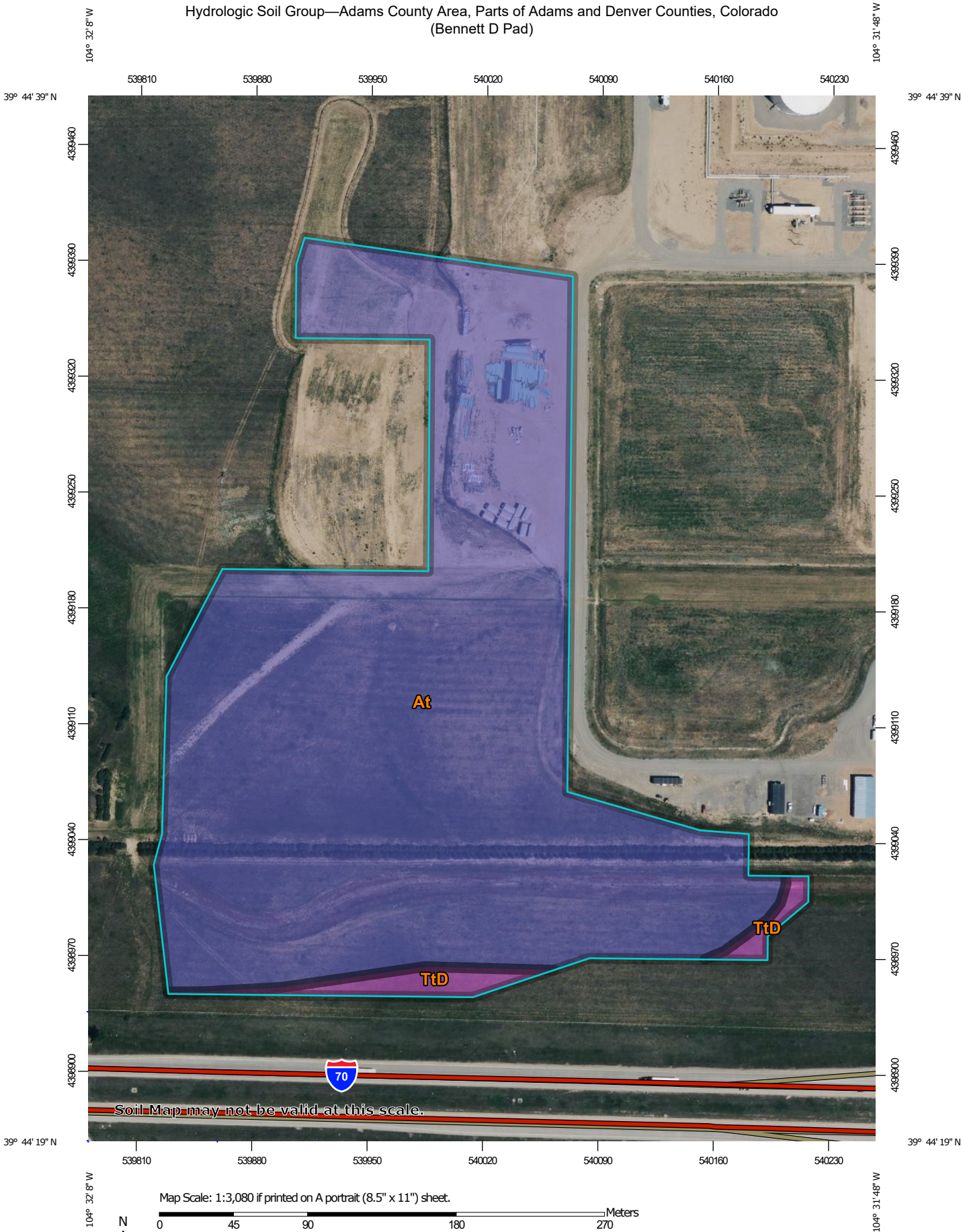
County's Comments

[1] To be checked by the Developer. If a "submitted" box is not checked, the Applicant must explain (in comment box above) or the application may be rejected for insufficient information.

Appendix C:

NRCS Web Soil Survey – Soils Report

Hydrologic Soil Group—Adams County Area, Parts of Adams and Denver Counties, Colorado
(Bennett D Pad)



Map Scale: 1:3,080 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 45 90 180 270

Feet: 0 100 200 400 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

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:
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: Adams County Area, Parts of Adams and Denver Counties, Colorado
Survey Area Data: Version 20, Aug 24, 2023

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

Date(s) aerial images were photographed: Jun 9, 2021—Jun 12, 2021

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
At	Ascalon-Platner association, 0 to 5 percent slopes	B	22.2	96.8%
TtD	Truckton loamy sand, 3 to 9 percent slopes	A	0.7	3.2%
Totals for Area of Interest			**23.0**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Appendix D:

FEMA Flood Insurance Rate Map FIRMette

National Flood Hazard Layer FIRMette

FEMA

104°32'20"W 39°44'41"N

104°31'42"W 39°44'14"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 10/14/2024 at 6:59 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Appendix E:

UD-Rational Spreadsheet Calculations

Calculation of Peak Runoff using Rational Method

Designer: KMG
Company: 609 Consulting
Date: 10/16/2024
Project: Bennett D Pad
Location: S34 T3S R64W Adams County, CO

Version 2.00 released May 2017

Cells of this color are for required user-input
Cells of this color are for optional override values
Cells of this color are for calculated results based on overrides

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S^{0.33}}$$

$$t_t = \frac{L_t}{60K_t\sqrt{S_t}} = \frac{L_t}{60V_t}$$

Computed $t_c = t_i + t_t$

Regional $t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$

$t_{minimum}$= 5 (urban)
$t_{minimum}$= 10 (non-urban)

Selected $t_c = \max\{t_{minimum}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$

Select UDFCD location for NOAA Atlas 14 Rainfall Depths from the pulldown list OR enter your own depths obtained from the NOAA website (click this link)

	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
1-hour rainfall depth, P1 (in) =	1.00	1.42	1.68		2.35	2.71	
	a	b	c				
Rainfall Intensity Equation Coefficients =	28.50	10.00	0.786				

$$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$$

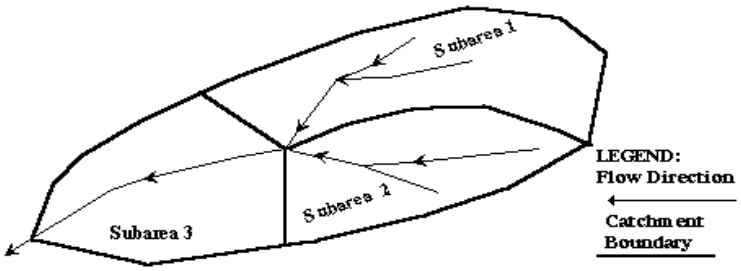
$$Q(cfs) = CIA$$

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C							Overland (Initial) Flow Time					Channelized (Travel) Flow Time						Time of Concentration			Rainfall Intensity, I (in/hr)							Peak Flow, Q (cfs)						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)	Overland Flow Time t_i (min)	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)	Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
Oil and Gas Location - Historic	22.96	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54	500			0.019	35.54	490			0.019	7	0.96	8.46	44.00	32.04	32.04	1.5	2.1	2.5		3.5	4.1		0.3	0.6	4.3		27.6	40.9	
				0.01	0.01	0.07	0.25	0.33	0.43	0.53					35.54								44.01		44.01	1.2	1.8	2.1		2.9	3.4		0.2	0.5	3.4		22.0	32.8	
ST - Construction Phase	8.62	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54	500			0.005	55.21	1400			0.005	10	0.71	33.00	88.21	61.22	61.22	1.0	1.4	1.7		2.3	2.7		0.1	0.1	1.1		6.8	10.1	
				0.01	0.01	0.03	0.08	0.13	0.22	0.35					55.43								88.43		88.43	0.8	1.1	1.3		1.8	2.1		0.0	0.1	0.3		2.0	3.9	
PC1 - Construction Phase	1.75	B	6.6	0.03	0.04	0.11	0.29	0.36	0.46	0.56	500			0.007	47.93	180			0.007	10	0.84	3.59	51.52	28.49	28.49	1.6	2.3	2.7		3.8	4.4		0.1	0.2	0.5		2.4	3.5	
				0.04	0.05	0.09	0.20	0.26	0.34	0.46					47.88								51.46		51.46	1.1	1.6	1.9		2.6	3.0		0.1	0.1	0.3		1.2	1.8	
PC2 - Construction Phase	2.09	B	7.8	0.04	0.05	0.12	0.30	0.37	0.46	0.56	500			0.007	47.53	520			0.007	10	0.84	10.36	57.89	34.94	34.94	1.4	2.0	2.4		3.4	3.9		0.1	0.2	0.6		2.6	3.7	
				0.05	0.06	0.10	0.22	0.28	0.37	0.48					47.40								57.76		57.76	1.0	1.5	1.7		2.4	2.8		0.1	0.2	0.4		1.4	2.2	
PC2 - Production Phase	2.65	B	6.3	0.03	0.04	0.11	0.29	0.36	0.46	0.56	500			0.007	48.03	520			0.007	10	0.84	10.36	58.39	35.41	35.41	1.4	2.0	2.4		3.3	3.8		0.1	0.2	0.7		3.2	4.6	
				0.04	0.04	0.09	0.23	0.29	0.38	0.49					47.93								58.28		58.28	1.0	1.5	1.7		2.4	2.8		0.1	0.2	0.4		1.9	2.8	
PC3 - Construction Phase	2.30	B	7.5	0.04	0.05	0.12	0.30	0.37	0.46	0.56	500			0.007	47.63	1035			0.007	10	0.84	20.62	68.25	45.24	45.24	1.2	1.7	2.0		2.9	3.3		0.1	0.2	0.6		2.4	3.5	
				0.05	0.05	0.10	0.23	0.29	0.37	0.49					47.52								68.14		68.14	0.9	1.3	1.6		2.2	2.5		0.1	0.2	0.4		1.4	2.2	
PC3 - Production Phase	2.86	B	6.1	0.03	0.04	0.11	0.29	0.36	0.45	0.56	500			0.007	48.10	1035			0.007	10	0.84	20.62	68.72	45.89	45.89	1.2	1.7	2.0		2.8	3.3		0.1	0.2	0.6		2.9	4.2	
				0.04	0.04	0.09	0.23	0.30	0.38	0.50					47.99								68.60		68.60	0.9	1.3	1.6		2.2	2.5		0.1	0.2	0.4		1.8	2.8	
DB - Construction Phase	17.84	B	30.4	0.21	0.23	0.30	0.44	0.50	0.57	0.65	300			0.005	34.02	1700			0.005	10	0.71	40.07	74.09	51.06	51.06	1.1	1.6	1.9		2.6	3.0		4.2	6.7	10.2		23.5	30.9	
				0.22	0.24	0.30	0.44	0.50	0.57	0.65					33.84								73.91		51.06	1.1	1.6	1.9		2.6	3.0		4.3	6.8	10.2		23.5	30.8	
DB - Production Phase	10.49	B	28.8	0.19	0.22	0.29	0.43	0.49	0.56	0.64	300			0.005	34.54	1490			0.005	10	0.71	35.12	69.66	48.05	48.05	1.2	1.7	2.0		2.8	3.2		2.4	3.9	6.0		14.1	18.6	
				0.20	0.23	0.29	0.43	0.49	0.56	0.64					34.33								69.45		48.05	1.2	1.7	2.0		2.8	3.2		2.5	4.0	6.0		14.1	18.6	
DS - Production Phase	9.28	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54	500			0.005	55.21	1440			0.005	7	0.49	48.49	103.69	62.23	62.23	1.0	1.4	1.7		2.3	2.7		0.1	0.2	1.1		7.3	10.8	
				0.01	0.01	0.04	0.14	0.20	0.29	0.41					55.36								103.85		103.85	0.7	1.0	1.2		1.6	1.9		0.0	0.1	0.4		3.0	5.0	

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: KMG
Company: 609 Consulting
Date: 10/16/2024
Project: Bennett D Pad
Location: S34 T3S R64W Adams County, CO



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Cells of this color are for optional override values
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Subcatchment Name
Oil and Gas Location - Historic

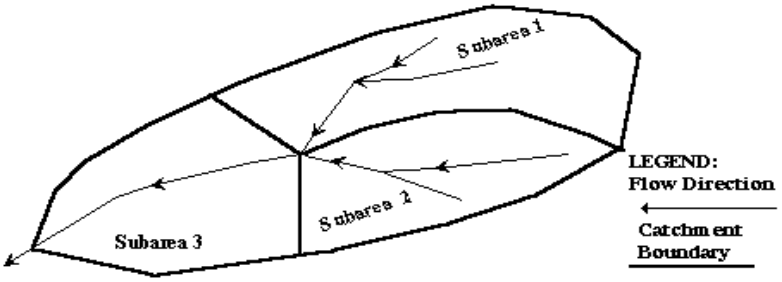
See sheet "Design Info" for imperviousness-based runoff coefficient values.

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
A	0.74	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
B	22.22	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54
Total Area (ac)	**22.96**		**Area-Weighted C**	**0.01**	**0.01**	**0.07**	**0.25**	**0.33**	**0.43**	**0.53**
			Area-Weighted Override C	**0.01**	**0.01**	**0.07**	**0.25**	**0.33**	**0.43**	**0.53**

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: KMG
Company: 609 Consulting
Date: 10/16/2024
Project: Bennett D Pad
Location: S34 T3S R64W Adams County, CO



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Subcatchment Name
ST - Construction Phase

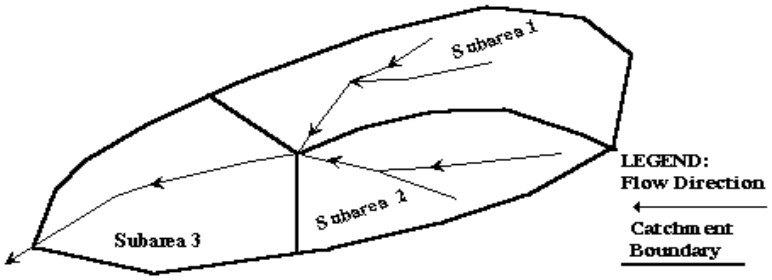
See sheet "Design Info" for imperviousness-based runoff coefficient values.

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
A	6.09	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
B	2.53	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54
Total Area (ac)	**8.62**		**Area-Weighted C**	**0.01**	**0.01**	**0.03**	**0.08**	**0.13**	**0.22**	**0.35**
			Area-Weighted Override C	**0.01**	**0.01**	**0.03**	**0.08**	**0.13**	**0.22**	**0.35**

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: KMG
Company: 609 Consulting
Date: 10/16/2024
Project: Bennett D Pad
Location: S34 T3S R64W Adams County, CO



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Subcatchment Name
PC1 - Construction Phase

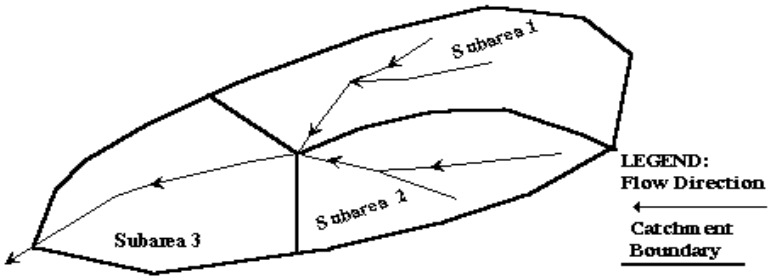
See sheet "Design Info" for imperviousness-based runoff coefficient values.

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
A	0.63	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
A	0.02	A	40.0	0.25	0.27	0.28	0.32	0.37	0.42	0.51
B	0.91	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54
B	0.19	B	40.0	0.29	0.32	0.38	0.50	0.55	0.61	0.68
Total Area (ac)	**1.75**		**Area-Weighted C**	**0.04**	**0.05**	**0.09**	**0.20**	**0.26**	**0.34**	**0.46**
			Area-Weighted Override C	**0.04**	**0.05**	**0.09**	**0.20**	**0.26**	**0.34**	**0.46**

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: KMG
Company: 609 Consulting
Date: 10/16/2024
Project: Bennett D Pad
Location: S34 T3S R64W Adams County, CO



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Subcatchment Name
PC2 - Construction Phase

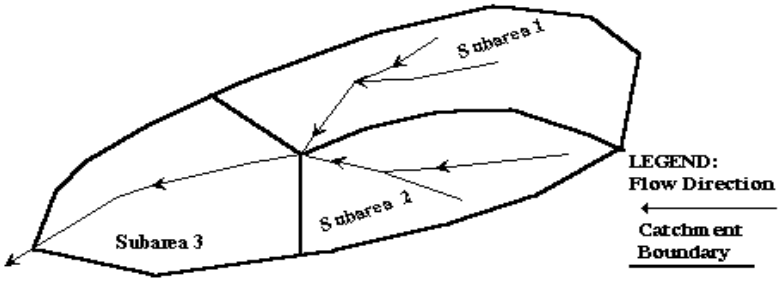
See sheet "Design Info" for imperviousness-based runoff coefficient values.

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
A	0.63	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
A	0.02	A	40.0	0.25	0.27	0.28	0.32	0.37	0.42	0.51
B	1.14	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54
B	0.30	B	40.0	0.29	0.32	0.38	0.50	0.55	0.61	0.68
Total Area (ac)	**2.09**		**Area-Weighted C**	**0.05**	**0.06**	**0.10**	**0.22**	**0.28**	**0.37**	**0.48**
			Area-Weighted Override C	**0.05**	**0.06**	**0.10**	**0.22**	**0.28**	**0.37**	**0.48**

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: KMG
Company: 609 Consulting
Date: 10/16/2024
Project: Bennett D Pad
Location: S34 T3S R64W Adams County, CO



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Subcatchment Name
PC2 - Production Phase

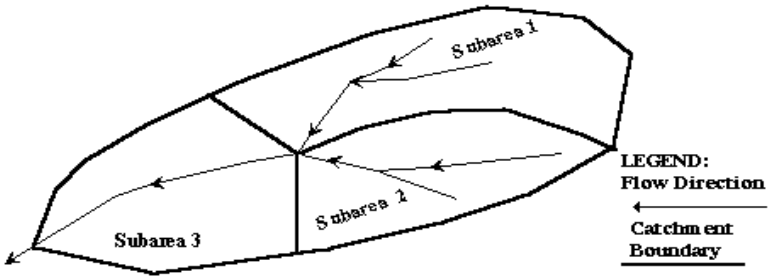
See sheet "Design Info" for imperviousness-based runoff coefficient values.

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
A	0.63	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
A	0.02	A	40.0	0.25	0.27	0.28	0.32	0.37	0.42	0.51
B	1.72	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54
B	0.28	B	40.0	0.29	0.32	0.38	0.50	0.55	0.61	0.68
Total Area (ac)	**2.65**		**Area-Weighted C**	**0.04**	**0.04**	**0.09**	**0.23**	**0.29**	**0.38**	**0.49**
			Area-Weighted Override C	**0.04**	**0.04**	**0.09**	**0.23**	**0.29**	**0.38**	**0.49**

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: KMG
Company: 609 Consulting
Date: 10/16/2024
Project: Bennett D Pad
Location: S34 T3S R64W Adams County, CO



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Subcatchment Name
PC3 - Construction Phase

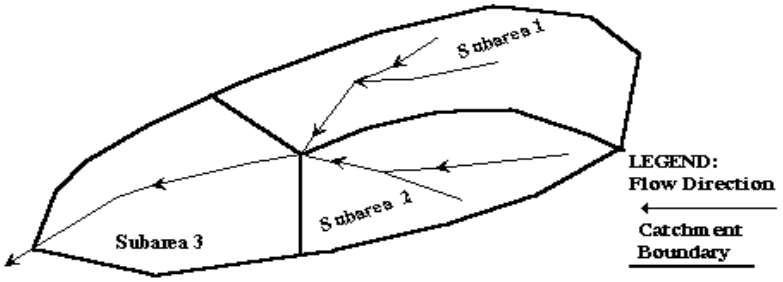
See sheet "Design Info" for imperviousness-based runoff coefficient values.

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
A	0.63	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
A	0.02	A	40.0	0.25	0.27	0.28	0.32	0.37	0.42	0.51
B	1.34	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54
B	0.31	B	40.0	0.29	0.32	0.38	0.50	0.55	0.61	0.68
Total Area (ac)	**2.30**		**Area-Weighted C**	**0.05**	**0.05**	**0.10**	**0.23**	**0.29**	**0.37**	**0.49**
			Area-Weighted Override C	**0.05**	**0.05**	**0.10**	**0.23**	**0.29**	**0.37**	**0.49**

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: KMG
Company: 609 Consulting
Date: 10/16/2024
Project: Bennett D Pad
Location: S34 T3S R64W Adams County, CO



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Subcatchment Name
PC3 - Production Phase

See sheet "Design Info" for imperviousness-based runoff coefficient values.

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
A	0.63	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
A	0.02	A	40.0	0.25	0.27	0.28	0.32	0.37	0.42	0.51
B	1.92	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54
B	0.29	B	40.0	0.29	0.32	0.38	0.50	0.55	0.61	0.68
Total Area (ac)	**2.86**		**Area-Weighted C**	**0.04**	**0.04**	**0.09**	**0.23**	**0.30**	**0.38**	**0.50**
			Area-Weighted Override C	**0.04**	**0.04**	**0.09**	**0.23**	**0.30**	**0.38**	**0.50**

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

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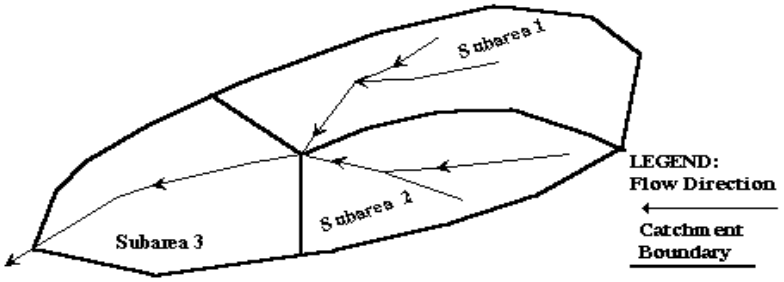
Company: 609 Consulting
Date: 10/16/2024
Project: Bennett D Pad
Location: S34 T3S R64W Adams County, CO



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Subcatchment Name
DB - Construction Phase

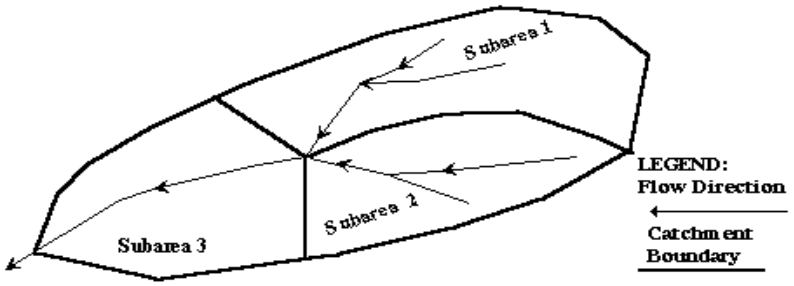
See sheet "Design Info" for imperviousness-based runoff coefficient values.

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
A	0.01	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
B	4.51	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54
B	13.32	B	40.0	0.29	0.32	0.38	0.50	0.55	0.61	0.68
Total Area (ac)	**17.84**		**Area-Weighted C**	**0.22**	**0.24**	**0.30**	**0.44**	**0.50**	**0.57**	**0.65**
			Area-Weighted Override C	**0.22**	**0.24**	**0.30**	**0.44**	**0.50**	**0.57**	**0.65**

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: KMG
Company: 609 Consulting
Date: 10/16/2024
Project: Bennett D Pad
Location: S34 T3S R64W Adams County, CO



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Subcatchment Name
DB - Production Phase

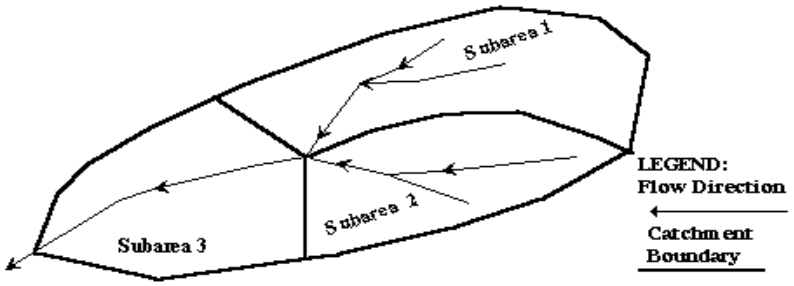
See sheet "Design Info" for imperviousness-based runoff coefficient values.

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
B	3.09	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54
B	7.40	B	40.0	0.29	0.32	0.38	0.50	0.55	0.61	0.68
Total Area (ac)	**10.49**		**Area-Weighted C**	**0.20**	**0.23**	**0.29**	**0.43**	**0.49**	**0.56**	**0.64**
			Area-Weighted Override C	**0.20**	**0.23**	**0.29**	**0.43**	**0.49**	**0.56**	**0.64**

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: KMG
Company: 609 Consulting
Date: 10/16/2024
Project: Bennett D Pad
Location: S34 T3S R64W Adams County, CO



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Subcatchment Name
DS - Production Phase

See sheet "Design Info" for imperviousness-based runoff coefficient values.

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
A	4.41	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
B	4.87	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54
Total Area (ac)	**9.28**		**Area-Weighted C**	**0.01**	**0.01**	**0.04**	**0.14**	**0.20**	**0.29**	**0.41**
			Area-Weighted Override C	**0.01**	**0.01**	**0.04**	**0.14**	**0.20**	**0.29**	**0.41**

Appendix F:

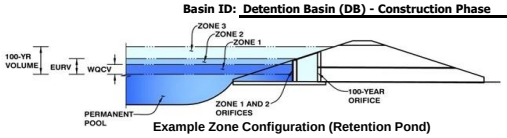
MHFD-Detention Spreadsheet Calculations

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: **Bennett D Pad**

Basin ID: **Detention Basin (DB) - Construction Phase**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	17.84	acres
Watershed Length =	2,000	ft
Watershed Length to Centroid =	1,060	ft
Watershed Slope =	0.005	ft/ft
Watershed Imperviousness =	30.40%	percent
Percentage Hydrologic Soil Group A =	0.06%	percent
Percentage Hydrologic Soil Group B =	99.94%	percent
Percentage Hydrologic Soil Groups C/D =	0.00%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.227	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.557	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1 in.) =	0.384	acre-feet	1.00	inches
5-yr Runoff Volume (P1 = 1.42 in.) =	0.814	acre-feet	1.42	inches
10-yr Runoff Volume (P1 = 1.68 in.) =	1.129	acre-feet	1.68	inches
25-yr Runoff Volume (P1 = 1.69 in.) =	1.273	acre-feet		inches
50-yr Runoff Volume (P1 = 2.35 in.) =	2.229	acre-feet	2.35	inches
100-yr Runoff Volume (P1 = 2.71 in.) =	2.856	acre-feet	2.71	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	3.511	acre-feet		inches
Approximate 2-yr Detention Volume =	0.335	acre-feet		
Approximate 5-yr Detention Volume =	0.540	acre-feet		
Approximate 10-yr Detention Volume =	0.796	acre-feet		
Approximate 25-yr Detention Volume =	0.812	acre-feet		
Approximate 50-yr Detention Volume =	1.057	acre-feet		
Approximate 100-yr Detention Volume =	1.285	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.227	acre-feet
Zone 2 Volume (100-year - Zone 1) =	1.058	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	1.285	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

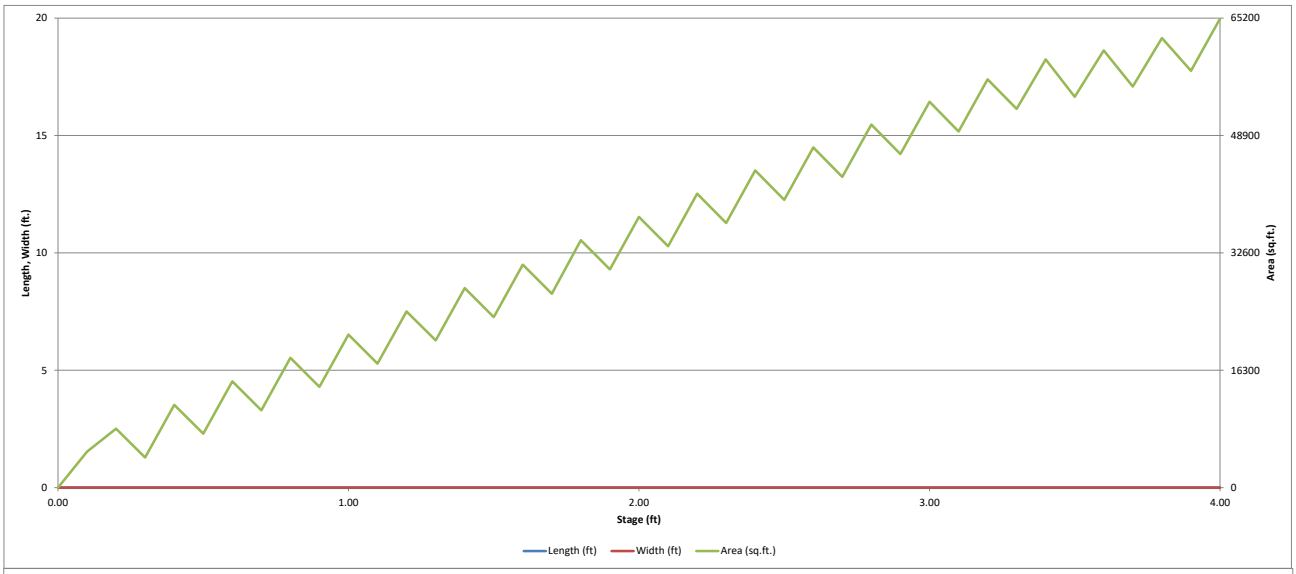
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

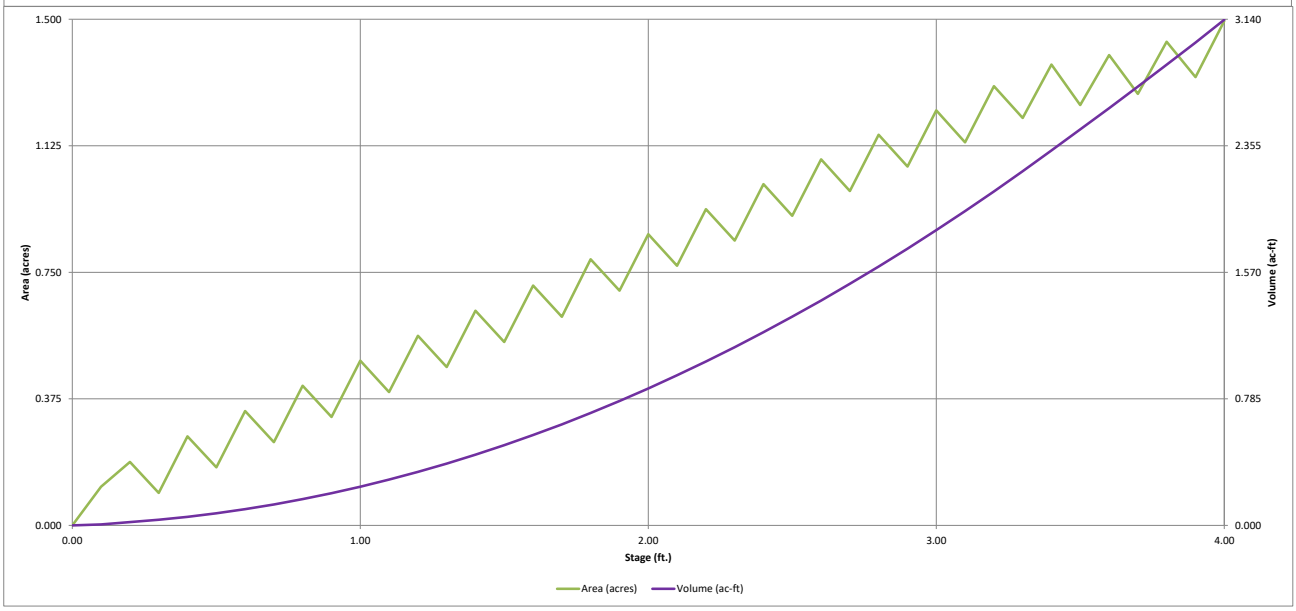
Depth Increment = 0.10 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	0	0.000		
	--	0.10	--	--	--	5,000	0.115	249	0.006
	--	0.20	--	--	--	8,188	0.188	908	0.021
	--	0.30	--	--	--	4,200	0.096	1,527	0.035
	--	0.40	--	--	--	11,490	0.264	2,312	0.053
	--	0.50	--	--	--	7,488	0.172	3,260	0.075
	--	0.60	--	--	--	14,764	0.339	4,373	0.100
	--	0.70	--	--	--	10,752	0.247	5,648	0.130
	--	0.80	--	--	--	18,024	0.414	7,087	0.163
	--	0.90	--	--	--	13,996	0.321	8,688	0.199
	--	1.00	--	--	--	21,254	0.488	10,450	0.240
	--	1.10	--	--	--	17,220	0.395	12,374	0.284
	--	1.20	--	--	--	24,474	0.562	14,459	0.332
	--	1.30	--	--	--	20,444	0.469	16,705	0.383
	--	1.40	--	--	--	27,714	0.636	19,112	0.439
	--	1.50	--	--	--	23,684	0.544	21,682	0.498
	--	1.60	--	--	--	30,960	0.711	24,414	0.560
	--	1.70	--	--	--	26,936	0.618	27,309	0.627
	--	1.80	--	--	--	34,362	0.789	30,374	0.697
	--	1.90	--	--	--	30,304	0.696	33,607	0.772
	--	2.00	--	--	--	37,588	0.863	37,002	0.849
	--	2.10	--	--	--	33,526	0.770	40,557	0.931
	--	2.20	--	--	--	40,824	0.937	44,275	1.016
	--	2.30	--	--	--	36,762	0.844	48,154	1.105
	--	2.40	--	--	--	44,048	1.011	52,195	1.198
	--	2.50	--	--	--	39,972	0.918	56,396	1.295
	--	2.60	--	--	--	47,248	1.085	60,757	1.395
	--	2.70	--	--	--	43,158	0.991	65,277	1.499
	--	2.80	--	--	--	50,424	1.158	69,956	1.606
	--	2.90	--	--	--	46,320	1.063	74,793	1.717
	--	3.00	--	--	--	53,578	1.230	79,788	1.832
	--	3.10	--	--	--	49,456	1.135	84,940	1.950
	--	3.20	--	--	--	56,704	1.302	90,248	2.072
	--	3.30	--	--	--	52,592	1.207	95,712	2.197
	--	3.40	--	--	--	59,480	1.365	101,316	2.326
	--	3.50	--	--	--	54,266	1.246	107,003	2.456
	--	3.60	--	--	--	60,706	1.394	112,752	2.588
	--	3.70	--	--	--	55,700	1.279	118,572	2.722
	--	3.80	--	--	--	62,440	1.433	124,479	2.858
	--	3.90	--	--	--	57,878	1.329	130,495	2.996
	--	4.00	--	--	--	65,118	1.495	136,645	3.137

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)



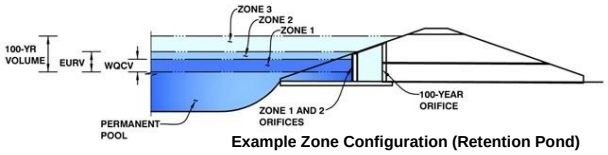


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Bennett D Pad**

Basin ID: **Detention Basin (DB) - Construction Phase**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.98	0.227	Orifice Plate
Zone 2 (100-year)	2.49	1.058	Circular Orifice
Zone 3			
Total (all zones)		1.285	

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

Underdrain Orifice Invert Depth = N/A ft (distance below the filtration media surface)

Underdrain Orifice Diameter = N/A inches

Calculated Parameters for Underdrain

Underdrain Orifice Area = N/A ft^2

Underdrain Orifice Centroid = N/A feet

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

Invert of Lowest Orifice = 0.00 ft (relative to basin bottom at Stage = 0 ft)

Depth at top of Zone using Orifice Plate = 1.00 ft (relative to basin bottom at Stage = 0 ft)

Orifice Plate: Orifice Vertical Spacing = N/A inches

Orifice Plate: Orifice Area per Row = N/A inches

Calculated Parameters for Plate

WQ Orifice Area per Row = N/A ft^2

Elliptical Half-Width = N/A feet

Elliptical Slot Centroid = N/A feet

Elliptical Slot Area = N/A ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.0							
Orifice Area (sq. inches)	2.9							

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	1.0		ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	3.0		ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	12.0		inches

Calculated Parameters for Vertical Orifice

	Zone 2 Circular	Not Selected	
Vertical Orifice Area =	0.79		ft^2
Vertical Orifice Centroid =	0.50		feet

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

	Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =			feet
Overflow Weir Grate Slope =			H:V
Horiz. Length of Weir Sides =			feet
Overflow Grate Type =			
Debris Clogging % =			%

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Overflow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

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

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Not Selected	Not Selected	
Outlet Orifice Area =			ft^2
Outlet Orifice Centroid =			feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage= 3.0 ft (relative to basin bottom at Stage = 0 ft)

Spillway Crest Length = 16.5 feet

Spillway End Slopes = 4.0 H:V

Freeboard above Max Water Surface = 0.5 feet

Calculated Parameters for Spillway

Spillway Design Flow Depth= 0.5 feet

Stage at Top of Freeboard = 4.0 feet

Basin Area at Top of Freeboard = 1.5 acres

Basin Volume at Top of Freeboard = 3.1 acre-ft

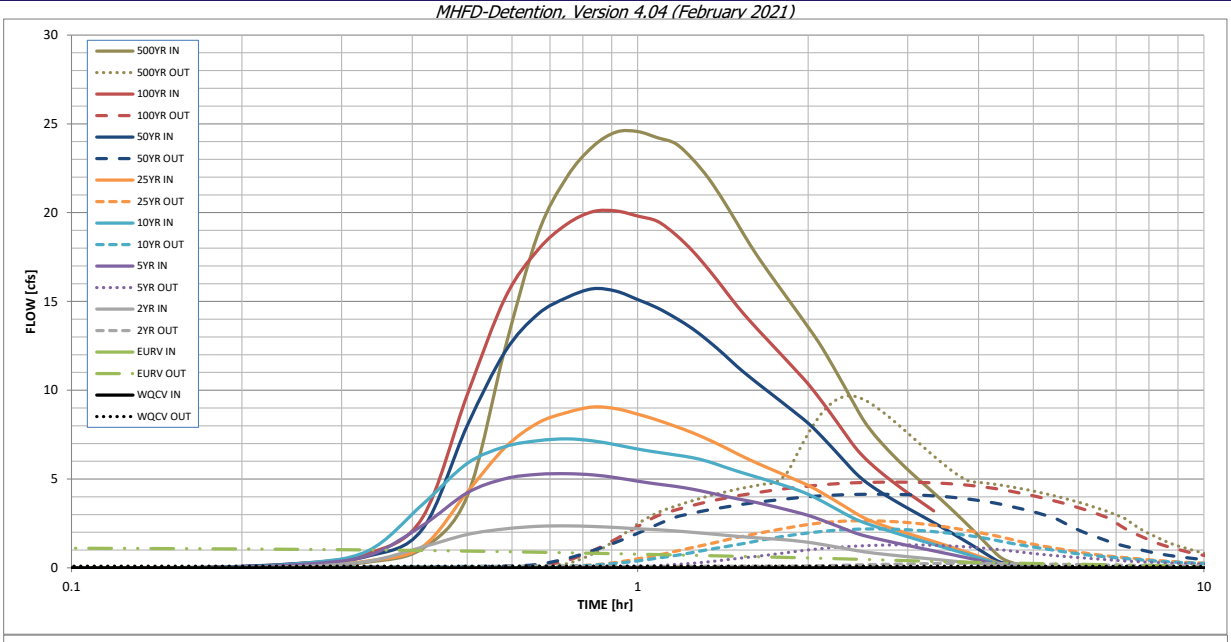
Routed Hydrograph Results

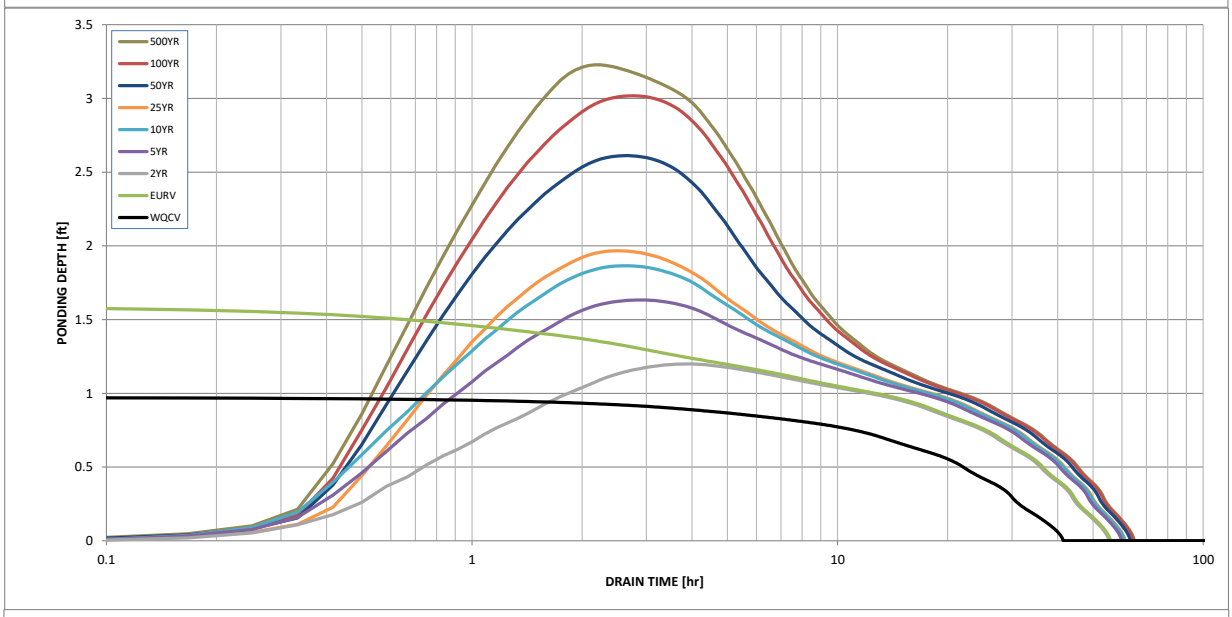
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

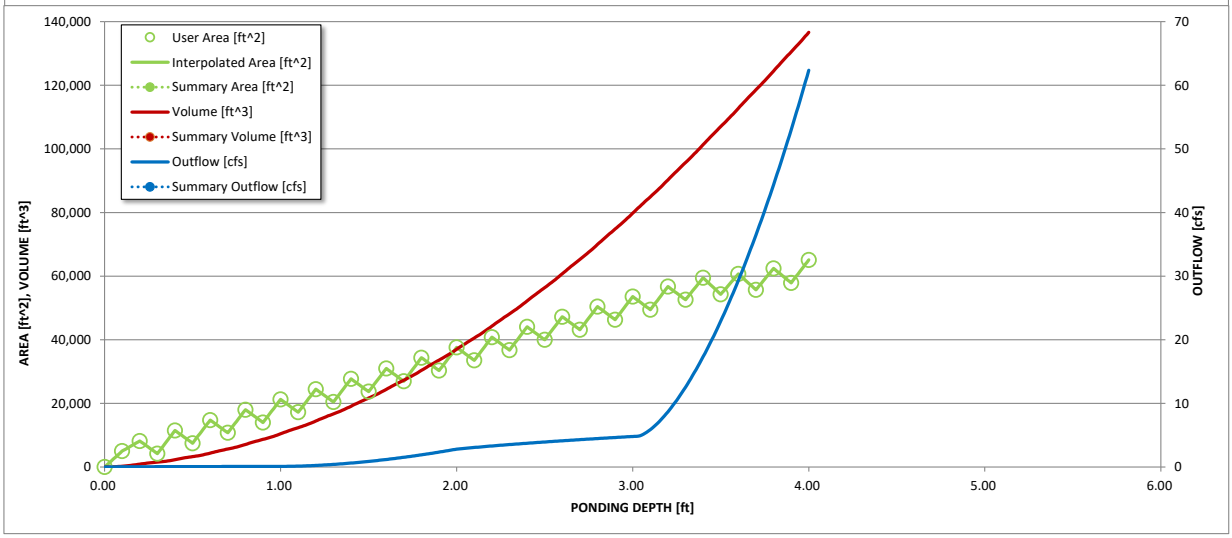
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.00	1.42	1.68	1.69	2.35	2.71	3.14
CUHP Runoff Volume (acre-ft) =	0.227	0.557	0.384	0.814	1.129	1.273	2.229	2.856	3.511
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.384	0.814	1.129	1.273	2.229	2.856	3.511
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	2.1	3.5	5.1	10.3	14.1	17.7
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A		2.3				15.2	
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.13	0.20	0.29	0.58	0.85	0.99
Peak Inflow Q (cfs) =	N/A	N/A	2.4	5.3	7.3	9.1	15.7	20.1	24.6
Peak Outflow Q (cfs) =	0.1	1.1	0.3	1.3	2.2	2.7	4.1	4.8	9.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.6	0.5	0.4	0.3	0.5
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	49	50	51	50	49	45	43	40
Time to Drain 99% of Inflow Volume (hours) =	**40**	53	53	56	56	56	55	55	53
Maximum Ponding Depth (ft) =	1.0	1.6	1.2	1.6	1.9	2.0	2.6	3.0	3.2
Area at Maximum Ponding Depth (acres) =	0.45	0.71	0.55	0.68	0.73	0.80	1.08	1.22	1.28
Maximum Volume Stored (acre-ft) =	0.230	0.560	0.326	0.581	0.743	0.816	1.406	1.844	2.098

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







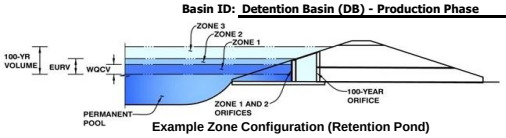
S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: **Bennett D Pad**

Basin ID: **Detention Basin (DB) - Production Phase**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	10.49	acres
Watershed Length =	1,790	ft
Watershed Length to Centroid =	850	ft
Watershed Slope =	0.005	ft/ft
Watershed Imperviousness =	28.80%	percent
Percentage Hydrologic Soil Group A =	0.00%	percent
Percentage Hydrologic Soil Group B =	100.00%	percent
Percentage Hydrologic Soil Groups C/D =	0.00%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.129	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.309	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1 in.) =	0.212	acre-feet	1.00	inches
5-yr Runoff Volume (P1 = 1.42 in.) =	0.461	acre-feet	1.42	inches
10-yr Runoff Volume (P1 = 1.68 in.) =	0.645	acre-feet	1.68	inches
25-yr Runoff Volume (P1 = 1.69 in.) =	0.731	acre-feet		inches
50-yr Runoff Volume (P1 = 2.35 in.) =	1.292	acre-feet	2.35	inches
100-yr Runoff Volume (P1 = 2.71 in.) =	1.661	acre-feet	2.71	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	2.045	acre-feet		inches
Approximate 2-yr Detention Volume =	0.185	acre-feet		
Approximate 5-yr Detention Volume =	0.299	acre-feet		
Approximate 10-yr Detention Volume =	0.447	acre-feet		
Approximate 25-yr Detention Volume =	0.459	acre-feet		
Approximate 50-yr Detention Volume =	0.598	acre-feet		
Approximate 100-yr Detention Volume =	0.731	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.129	acre-feet
Zone 2 Volume (100-year - Zone 1) =	0.602	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.731	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = 0.10 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	0	0.000		
	--	0.10	--	--	--	5,000	0.115	249	0.006
	--	0.20	--	--	--	8,188	0.188	908	0.021
	--	0.30	--	--	--	4,200	0.096	1,527	0.035
	--	0.40	--	--	--	11,490	0.264	2,312	0.053
	--	0.50	--	--	--	7,488	0.172	3,260	0.075
	--	0.60	--	--	--	14,764	0.339	4,373	0.100
	--	0.70	--	--	--	10,752	0.247	5,648	0.130
	--	0.80	--	--	--	18,024	0.414	7,087	0.163
	--	0.90	--	--	--	13,996	0.321	8,688	0.199
	--	1.00	--	--	--	21,254	0.488	10,450	0.240
	--	1.10	--	--	--	17,220	0.395	12,374	0.284
	--	1.20	--	--	--	24,474	0.562	14,459	0.332
	--	1.30	--	--	--	20,444	0.469	16,705	0.383
	--	1.40	--	--	--	27,714	0.636	19,112	0.439
	--	1.50	--	--	--	23,684	0.544	21,682	0.498
	--	1.60	--	--	--	30,960	0.711	24,414	0.560
	--	1.70	--	--	--	26,936	0.618	27,309	0.627
	--	1.80	--	--	--	34,362	0.789	30,374	0.697
	--	1.90	--	--	--	30,304	0.696	33,607	0.772
	--	2.00	--	--	--	37,588	0.863	37,002	0.849
	--	2.10	--	--	--	33,526	0.770	40,557	0.931
	--	2.20	--	--	--	40,824	0.937	44,275	1.016
	--	2.30	--	--	--	36,762	0.844	48,154	1.105
	--	2.40	--	--	--	44,048	1.011	52,195	1.198
	--	2.50	--	--	--	39,972	0.918	56,396	1.295
	--	2.60	--	--	--	47,248	1.085	60,757	1.395
	--	2.70	--	--	--	43,158	0.991	65,277	1.499
	--	2.80	--	--	--	50,424	1.158	69,956	1.606
	--	2.90	--	--	--	46,320	1.063	74,793	1.717
	--	3.00	--	--	--	53,578	1.230	79,788	1.832
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	--	3.20	--	--	--	56,704	1.302	90,248	2.072
	--	3.30	--	--	--	52,592	1.207	95,712	2.197
	--	3.40	--	--	--	59,480	1.365	101,316	2.326
	--	3.50	--	--	--	54,266	1.246	107,003	2.456
	--	3.60	--	--	--	60,706	1.394	112,752	2.588
	--	3.70	--	--	--	55,700	1.279	118,572	2.722
	--	3.80	--	--	--	62,440	1.433	124,479	2.858
	--	3.90	--	--	--	57,878	1.329	130,495	2.996
	--	4.00	--	--	--	65,118	1.495	136,645	3.137

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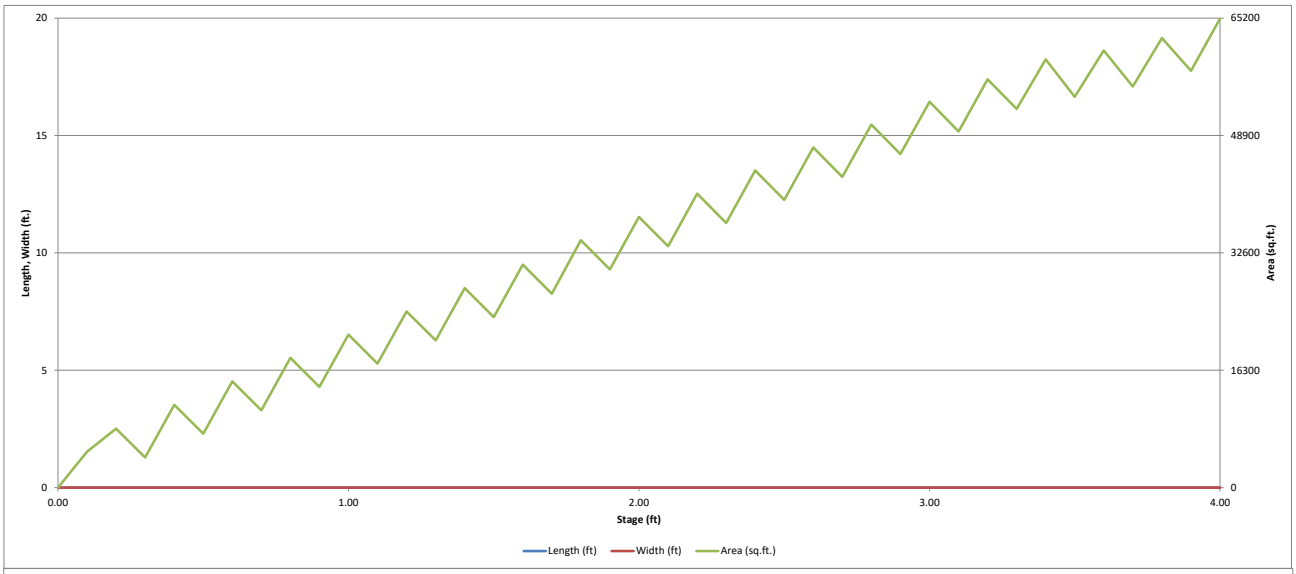
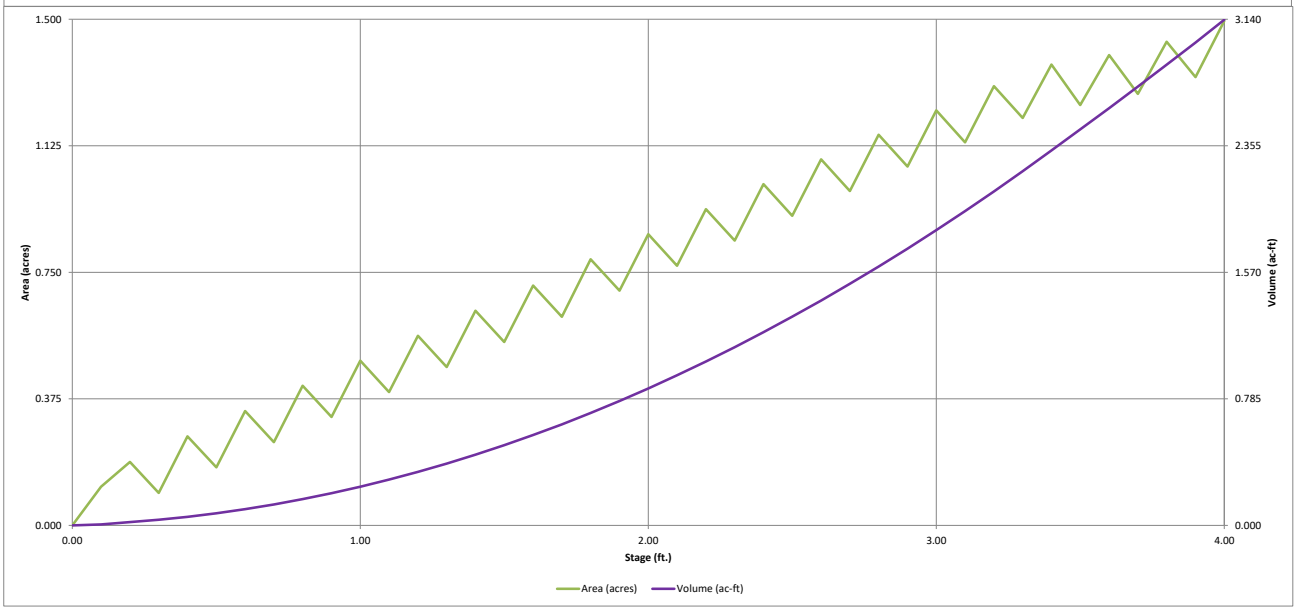
MHFD-Detention, Version 4.04 (February 2021)



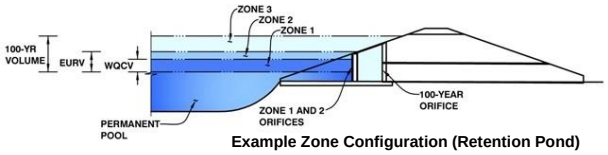


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Bennett D Pad**

Basin ID: **Detention Basin (DB) - Production Phase**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.70	0.129	Orifice Plate
Zone 2 (100-year)	1.85	0.602	Circular Orifice
Zone 3			
Total (all zones)		0.731	

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

Underdrain Orifice Invert Depth = N/A ft (distance below the filtration media surface)

Underdrain Orifice Diameter = N/A inches

Calculated Parameters for Underdrain

Underdrain Orifice Area = N/A ft^2

Underdrain Orifice Centroid = N/A feet

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

Invert of Lowest Orifice = 0.0 ft (relative to basin bottom at Stage = 0 ft)

Depth at top of Zone using Orifice Plate = 0.7 ft (relative to basin bottom at Stage = 0 ft)

Orifice Plate: Orifice Vertical Spacing = N/A inches

Orifice Plate: Orifice Area per Row = N/A inches

Calculated Parameters for Plate

WQ Orifice Area per Row = N/A ft^2

Elliptical Half-Width = N/A feet

Elliptical Slot Centroid = N/A feet

Elliptical Slot Area = N/A ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.0							
Orifice Area (sq. inches)	2.0							

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	0.7		ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	2.1		ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	12.0		inches

Calculated Parameters for Vertical Orifice

	Zone 2 Circular	Not Selected	
Vertical Orifice Area =	0.79		ft^2
Vertical Orifice Centroid =	0.50		feet

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

	Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =			feet
Overflow Weir Grate Slope =			H:V
Horiz. Length of Weir Sides =			feet
Overflow Grate Type =			
Debris Clogging % =			%

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Overflow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

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

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Not Selected	Not Selected	
Outlet Orifice Area =			ft^2
Outlet Orifice Centroid =			feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage= 3.0 ft (relative to basin bottom at Stage = 0 ft)

Spillway Crest Length = 16.5 feet

Spillway End Slopes = 4.0 H:V

Freeboard above Max Water Surface = 0.5 feet

Calculated Parameters for Spillway

Spillway Design Flow Depth= 0.5 feet

Stage at Top of Freeboard = 4.0 feet

Basin Area at Top of Freeboard = 1.5 acres

Basin Volume at Top of Freeboard = 3.1 acre-ft

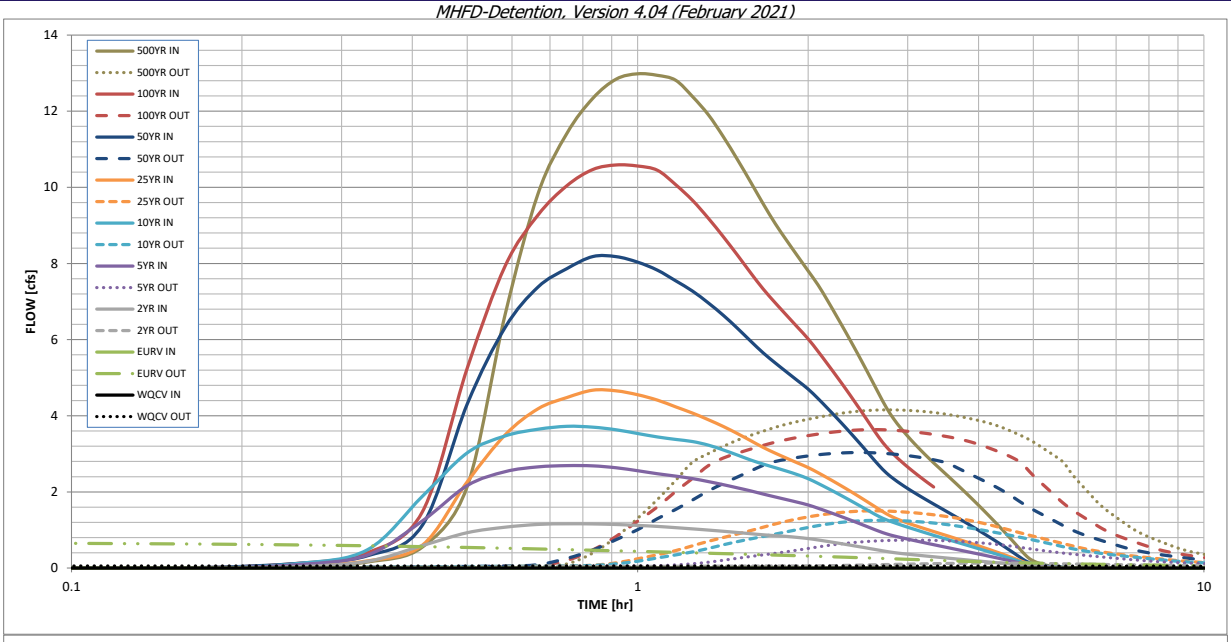
Routed Hydrograph Results

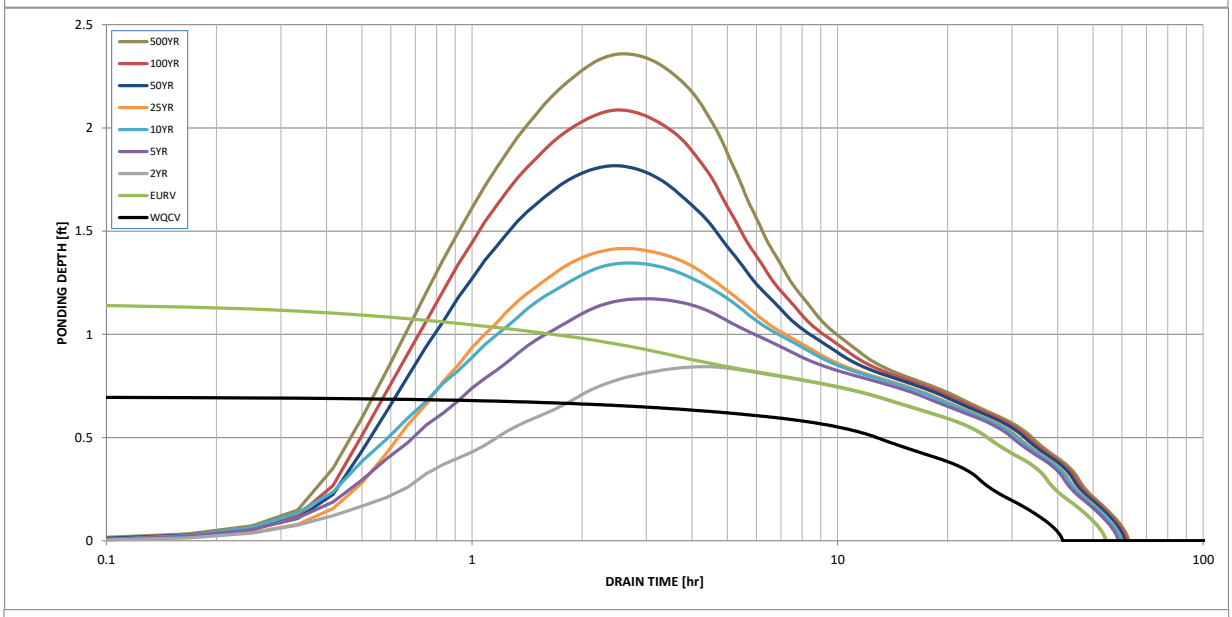
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

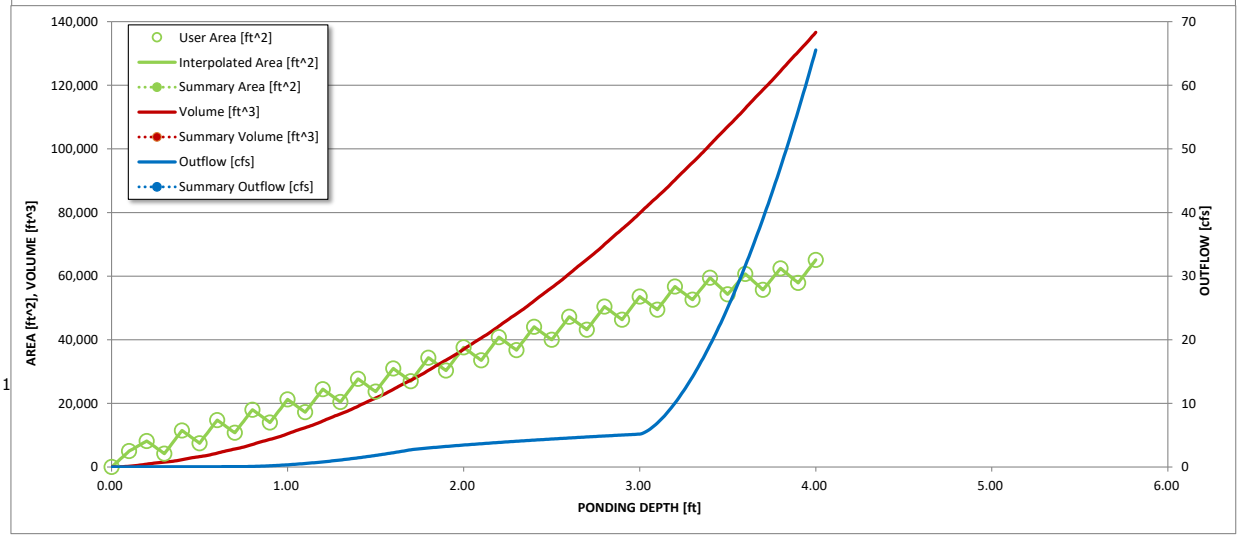
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.00	1.42	1.68	1.69	2.35	2.71	3.14
CUHP Runoff Volume (acre-ft) =	0.129	0.309	0.212	0.461	0.645	0.731	1.292	1.661	2.045
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.211	0.461	0.645	0.731	1.291	1.661	2.045
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	1.1	1.9	2.8	5.6	7.8	9.8
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A		1.4				8.9	
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.13	0.18	0.27	0.54	0.85	0.93
Peak Inflow Q (cfs) =	N/A	N/A	1.2	2.7	3.7	4.7	8.2	10.6	13.0
Peak Outflow Q (cfs) =	0.1	0.7	0.1	0.7	1.3	1.5	3.0	3.6	4.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.5	0.7	0.5	0.5	0.4	0.4
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	48	49	50	49	48	43	40	38
Time to Drain 99% of Inflow Volume (hours) =	**40**	52	52	55	55	55	53	52	51
Maximum Ponding Depth (ft) =	0.7	1.2	0.8	1.2	1.3	1.4	1.8	2.1	2.4
Area at Maximum Ponding Depth (acres) =	0.25	0.50	0.38	0.51	0.54	0.63	0.78	0.79	0.93
Maximum Volume Stored (acre-ft) =	0.130	0.311	0.179	0.316	0.404	0.445	0.705	0.915	1.150

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







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

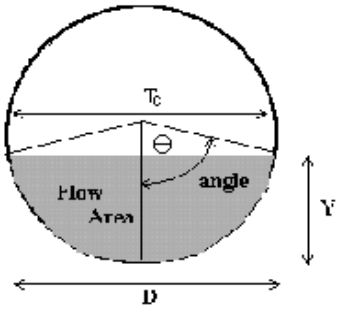
Appendix G:

MHFD-Culvert Spreadsheet Calculations

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Bennett D Pad
Pipe ID: Proposed Culvert #1 (PC1)



Design Information (Input)			
Pipe Invert Slope	So =	0.0350	ft/ft
Pipe Manning's n-value	n =	0.0240	*
Pipe Diameter	D =	12.00	inches
Design discharge	Q =	0.3	cfs

Full-Flow Capacity (Calculated)			
Full-flow area	Af =	0.79	sq ft
Full-flow wetted perimeter	Pf =	3.14	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	3.62	cfs

Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.13	radians
Flow area	An =	0.19	sq ft
Top width	Tn =	0.90	ft
Wetted perimeter	Pn =	1.13	ft
Flow depth	Yn =	**0.29**	ft
Flow velocity	Vn =	**3.49**	fps
Discharge	Qn =	0.65	cfs
Percent of Full Flow	Flow =	17.9%	of full flow
Normal Depth Froude Number	Fr_n =	1.36	supercritical

Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	0.99	radians
Critical flow area	Ac =	0.13	sq ft
Critical top width	Tc =	0.84	ft
Critical flow depth	Yc =	0.23	ft
Critical flow velocity	Vc =	2.26	fps
Critical Depth Froude Number	Fr_c =	1.00	

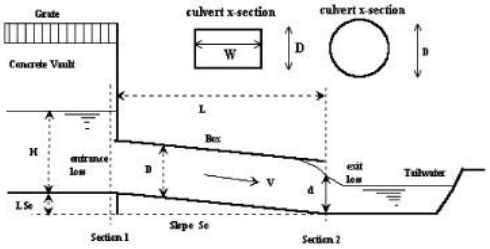
*** Unexpected value for Manning's n**

CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Bennett D Pad

ID: Proposed Culvert #1 (PC1)



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	12	inches	**Very Small Culvert**
	Inlet Edge Type (Choose from pull-down list)		Square Edge Projecting		**D >= 15 inches expected**
OR:					
Box Culvert:	Barrel Height (Rise) in Feet	H (Rise) =		ft	
	Barrel Width (Span) in Feet	W (Span) =		ft	
	Inlet Edge Type (Choose from pull-down list)				
	Number of Barrels	# Barrels =	1		
	Inlet Elevation at Culvert Invert	Elev IN =	5572.5	ft	
	Outlet Elevation **OR** Slope	Elev OUT =	5571.1	ft	
	Culvert Length	L =	40	ft	
	Manning's Roughness	n =	0.024		**For concrete, typically <= 0.016**
	Bend Loss Coefficient	K_b =	0		
	Exit Loss Coefficient	K_x =	1		

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.20
Friction Loss Coefficient	K_f =	4.24
Sum of All Loss Coefficients	K_s =	5.44
Minimum Energy Condition Coefficient	KE_{low} =	-0.1166
Orifice Inlet Condition Coefficient	C_d =	0.60

Calculations of Culvert Capacity (output): **Backwater calculations required to obtain Outlet Control Flowrate when HWo < 0.75 * Culvert Rise**

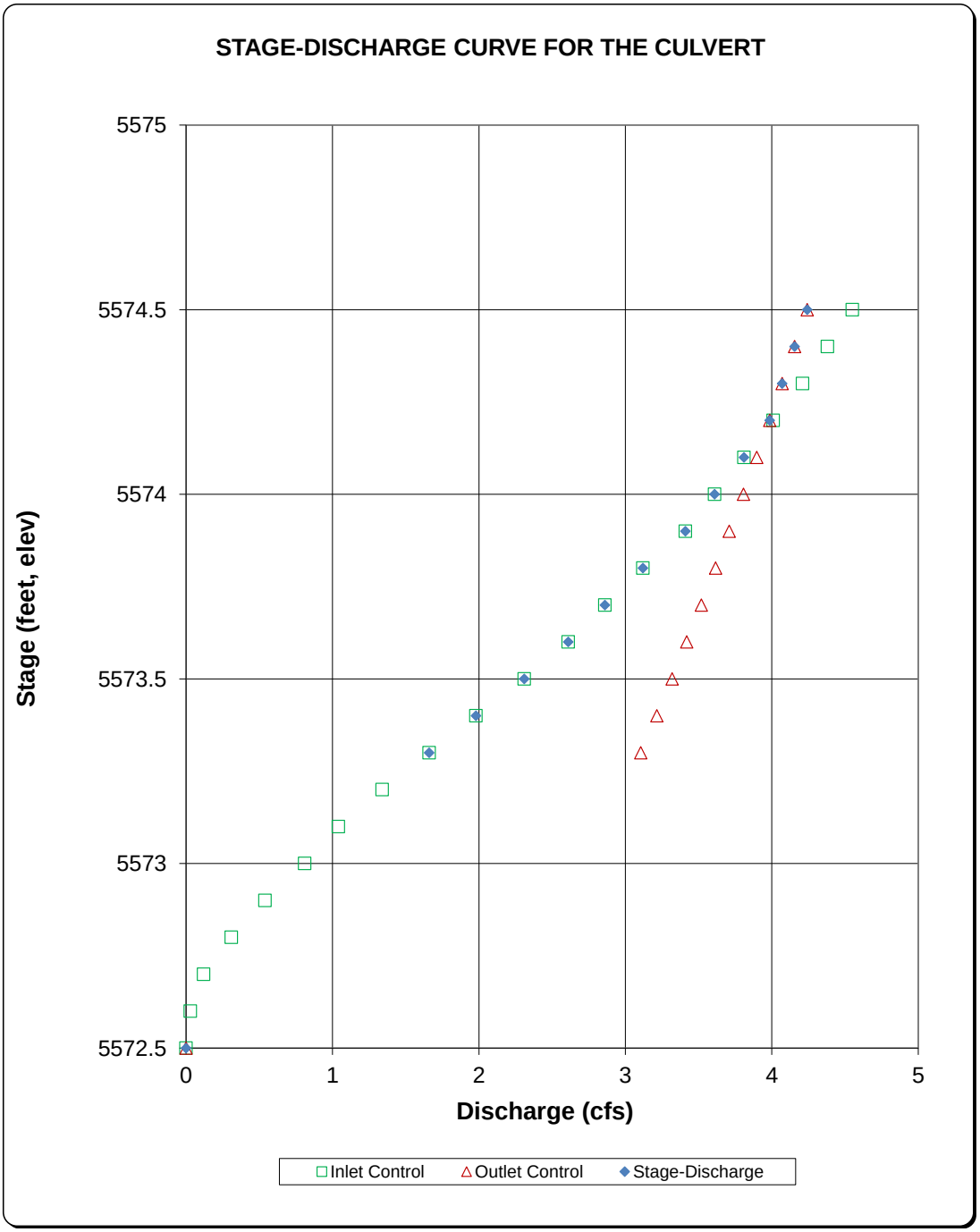
Headwater Surface Elevation (ft)	Tailwater Surface Elevation (ft)	Inlet Control Equation Used	Inlet Control Flowrate (cfs)	Outlet Control Flowrate (cfs)	Controlling Culvert Flowrate (cfs)	Flow Control Used
5572.50		No Flow (WS < inlet)	0.00	0.00	**0.00**	N/A
5572.60		Min. Energy. Eqn.	0.03	#N/A	#N/A	#N/A
5572.70		Min. Energy. Eqn.	0.12	#N/A	#N/A	#N/A
5572.80		Min. Energy. Eqn.	0.31	#N/A	#N/A	#N/A
5572.90		Min. Energy. Eqn.	0.54	#N/A	#N/A	#N/A
5573.00		Min. Energy. Eqn.	0.81	#N/A	#N/A	#N/A
5573.10		Regression Eqn.	1.04	#N/A	#N/A	#N/A
5573.20		Regression Eqn.	1.34	#N/A	#N/A	#N/A
5573.30		Regression Eqn.	1.66	3.11	**1.66**	INLET
5573.40		Regression Eqn.	1.98	3.22	**1.98**	INLET
5573.50		Regression Eqn.	2.31	3.32	**2.31**	INLET
5573.60		Regression Eqn.	2.61	3.42	**2.61**	INLET
5573.70		Regression Eqn.	2.86	3.52	**2.86**	INLET
5573.80		Regression Eqn.	3.12	3.62	**3.12**	INLET
5573.90		Regression Eqn.	3.41	3.71	**3.41**	INLET
5574.00		Regression Eqn.	3.61	3.81	**3.61**	INLET
5574.10		Regression Eqn.	3.81	3.90	**3.81**	INLET
5574.20		Regression Eqn.	4.01	3.99	**3.99**	OUTLET
5574.30		Regression Eqn.	4.21	4.07	**4.07**	OUTLET
5574.40		Regression Eqn.	4.38	4.16	**4.16**	OUTLET
5574.50		Regression Eqn.	4.55	4.24	**4.24**	OUTLET

CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **Bennett D Pad**

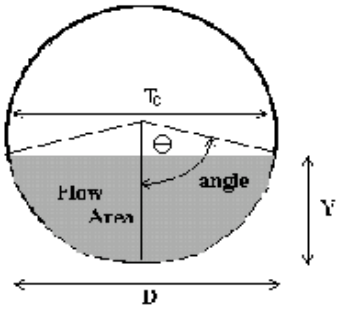
ID: **Proposed Culvert #1 (PC1)**



CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Bennett D Pad
Pipe ID: Proposed Culvert #2 (PC2)



Design Information (Input)			
Pipe Invert Slope	So =	0.0300	ft/ft
Pipe Manning's n-value	n =	0.0240	*
Pipe Diameter	D =	12.00	inches
Design discharge	Q =	0.4	cfs

Full-Flow Capacity (Calculated)			
Full-flow area	Af =	0.79	sq ft
Full-flow wetted perimeter	Pf =	3.14	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	3.35	cfs

Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.01	radians
Flow area	An =	0.14	sq ft
Top width	Tn =	0.85	ft
Wetted perimeter	Pn =	1.01	ft
Flow depth	Yn =	**0.23**	ft
Flow velocity	Vn =	**2.87**	fps
Discharge	Qn =	0.40	cfs
Percent of Full Flow	Flow =	11.9%	of full flow
Normal Depth Froude Number	Fr_n =	1.25	supercritical

Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.07	radians
Critical flow area	Ac =	0.16	sq ft
Critical top width	Tc =	0.88	ft
Critical flow depth	Yc =	0.26	ft
Critical flow velocity	Vc =	2.45	fps
Critical Depth Froude Number	Fr_c =	1.00	

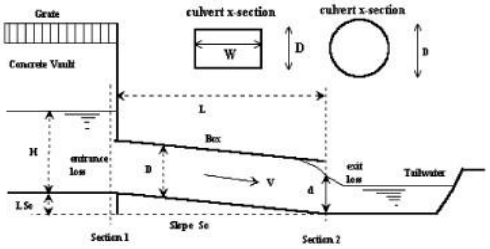
*** Unexpected value for Manning's n**

CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Bennett D Pad

ID: Proposed Culvert #2 (PC2)



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	12	inches	**Very Small Culvert**
	Inlet Edge Type (Choose from pull-down list)		Square Edge Projecting		**D >= 15 inches expected**
OR:					
Box Culvert:	Barrel Height (Rise) in Feet	H (Rise) =		ft	
	Barrel Width (Span) in Feet	W (Span) =		ft	
	Inlet Edge Type (Choose from pull-down list)				
	Number of Barrels	# Barrels =	1		
	Inlet Elevation at Culvert Invert	Elev IN =	5570.0	ft	
	Outlet Elevation **OR** Slope	Elev OUT =	5568.8	ft	
	Culvert Length	L =	40	ft	
	Manning's Roughness	n =	0.024		**For concrete, typically <= 0.016**
	Bend Loss Coefficient	K_b =	0		
	Exit Loss Coefficient	K_x =	1		

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.20
Friction Loss Coefficient	K_f =	4.24
Sum of All Loss Coefficients	K_s =	5.44
Minimum Energy Condition Coefficient	KE_{low} =	0.0125
Orifice Inlet Condition Coefficient	C_d =	0.60

Calculations of Culvert Capacity (output): **Backwater calculations required to obtain Outlet Control Flowrate when HWo < 0.75 * Culvert Rise**

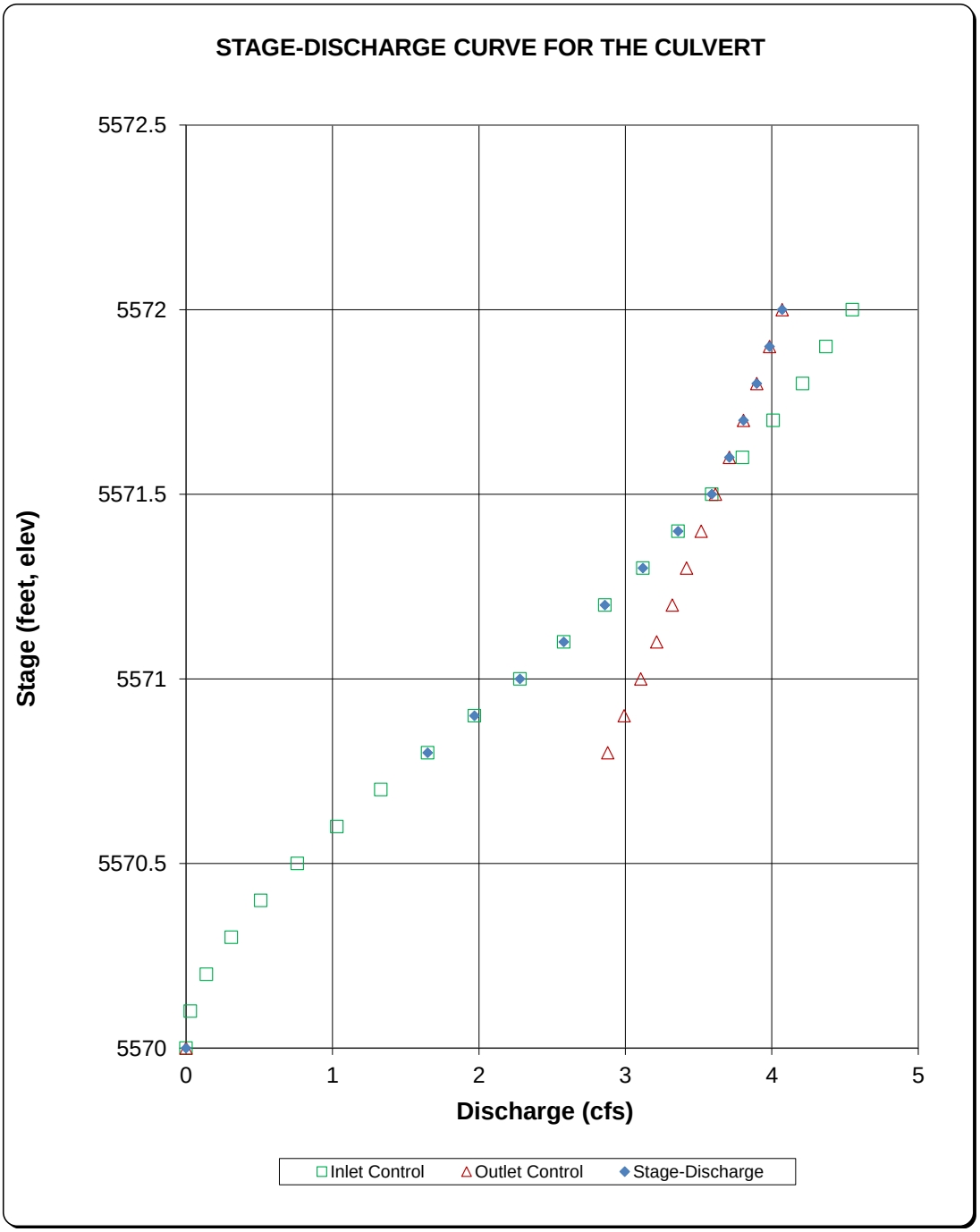
Headwater Surface Elevation (ft)	Tailwater Surface Elevation (ft)	Inlet Control Equation Used	Inlet Control Flowrate (cfs)	Outlet Control Flowrate (cfs)	Controlling Culvert Flowrate (cfs)	Flow Control Used
5570.00		No Flow (WS < inlet)	0.00	0.00	**0.00**	N/A
5570.10		Min. Energy. Eqn.	0.03	#N/A	#N/A	#N/A
5570.20		Min. Energy. Eqn.	0.14	#N/A	#N/A	#N/A
5570.30		Min. Energy. Eqn.	0.31	#N/A	#N/A	#N/A
5570.40		Min. Energy. Eqn.	0.51	#N/A	#N/A	#N/A
5570.50		Min. Energy. Eqn.	0.76	#N/A	#N/A	#N/A
5570.60		Regression Eqn.	1.03	#N/A	#N/A	#N/A
5570.70		Regression Eqn.	1.33	#N/A	#N/A	#N/A
5570.80		Regression Eqn.	1.65	2.88	**1.65**	INLET
5570.90		Regression Eqn.	1.97	2.99	**1.97**	INLET
5571.00		Regression Eqn.	2.28	3.11	**2.28**	INLET
5571.10		Regression Eqn.	2.58	3.21	**2.58**	INLET
5571.20		Regression Eqn.	2.86	3.32	**2.86**	INLET
5571.30		Regression Eqn.	3.12	3.42	**3.12**	INLET
5571.40		Regression Eqn.	3.36	3.52	**3.36**	INLET
5571.50		Regression Eqn.	3.59	3.62	**3.59**	INLET
5571.60		Regression Eqn.	3.80	3.71	**3.71**	OUTLET
5571.70		Regression Eqn.	4.01	3.81	**3.81**	OUTLET
5571.80		Regression Eqn.	4.21	3.90	**3.90**	OUTLET
5571.90		Regression Eqn.	4.37	3.98	**3.98**	OUTLET
5572.00		Regression Eqn.	4.55	4.07	**4.07**	OUTLET

CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **Bennett D Pad**

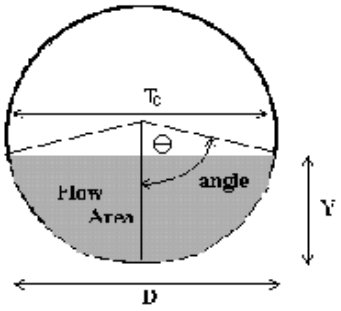
ID: **Proposed Culvert #2 (PC2)**



CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Bennett D Pad
Pipe ID: Proposed Culvert #3 (PC3)



Design Information (Input)			
Pipe Invert Slope	So =	0.0025	ft/ft
Pipe Manning's n-value	n =	0.0240	*
Pipe Diameter	D =	12.00	inches
Design discharge	Q =	0.4	cfs

Full-Flow Capacity (Calculated)			
Full-flow area	Af =	0.79	sq ft
Full-flow wetted perimeter	Pf =	3.14	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	0.97	cfs

Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.01	radians
Flow area	An =	0.14	sq ft
Top width	Tn =	0.85	ft
Wetted perimeter	Pn =	1.01	ft
Flow depth	Yn =	**0.23**	ft
Flow velocity	Vn =	**0.83**	fps
Discharge	Qn =	0.12	cfs
Percent of Full Flow	Flow =	11.9%	of full flow
Normal Depth Froude Number	Fr_n =	0.36	subcritical

Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.07	radians
Critical flow area	Ac =	0.16	sq ft
Critical top width	Tc =	0.88	ft
Critical flow depth	Yc =	0.26	ft
Critical flow velocity	Vc =	2.45	fps
Critical Depth Froude Number	Fr_c =	1.00	

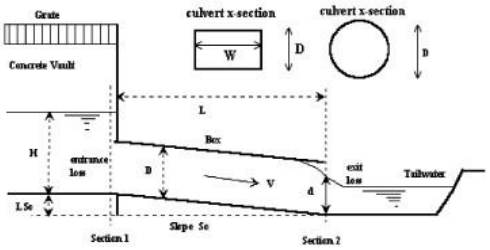
*** Unexpected value for Manning's n**

CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Bennett D Pad

ID: Proposed Culvert #3 (PC3)



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	12	inches	**Very Small Culvert**
	Inlet Edge Type (Choose from pull-down list)		Square Edge Projecting		**D >= 15 inches expected**
OR:					
Box Culvert:	Barrel Height (Rise) in Feet	H (Rise) =		ft	
	Barrel Width (Span) in Feet	W (Span) =		ft	
	Inlet Edge Type (Choose from pull-down list)				
	Number of Barrels	# Barrels =	1		
	Inlet Elevation at Culvert Invert	Elev IN =	5566.1	ft	
	Outlet Elevation **OR** Slope	Elev OUT =	5566.0	ft	
	Culvert Length	L =	40	ft	
	Manning's Roughness	n =	0.024		**For concrete, typically <= 0.016**
	Bend Loss Coefficient	K_b =	0		
	Exit Loss Coefficient	K_x =	1		

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.20
Friction Loss Coefficient	K_f =	4.24
Sum of All Loss Coefficients	K_s =	5.44
Minimum Energy Condition Coefficient	KE_{low} =	0.1237
Orifice Inlet Condition Coefficient	C_d =	0.60

Calculations of Culvert Capacity (output): **Backwater calculations required to obtain Outlet Control Flowrate when HWo < 0.75 * Culvert Rise**

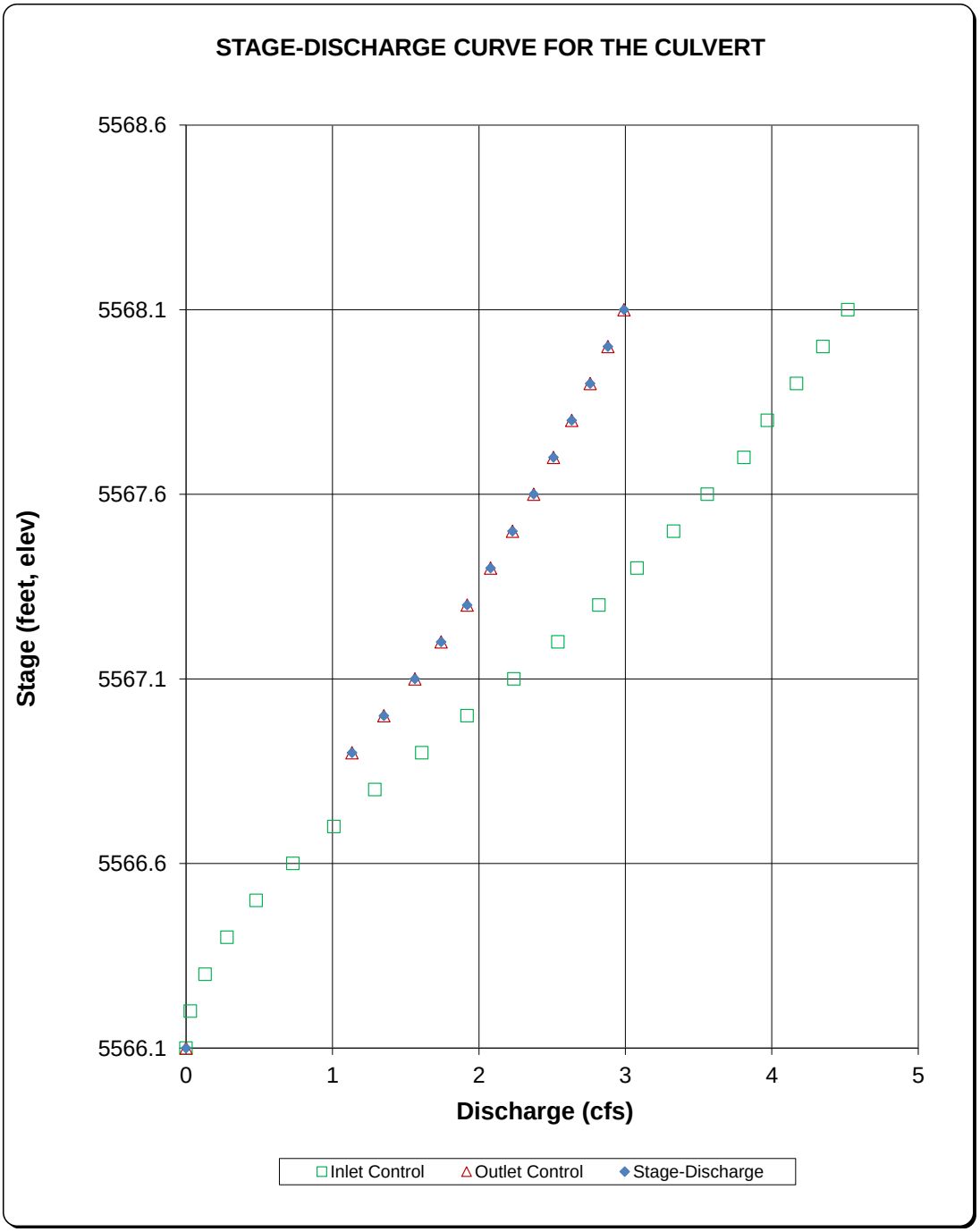
Headwater Surface Elevation (ft)	Tailwater Surface Elevation (ft)	Inlet Control Equation Used	Inlet Control Flowrate (cfs)	Outlet Control Flowrate (cfs)	Controlling Culvert Flowrate (cfs)	Flow Control Used
5566.10		No Flow (WS < inlet)	0.00	0.00	**0.00**	N/A
5566.20		Min. Energy. Eqn.	0.03	#N/A	#N/A	#N/A
5566.30		Min. Energy. Eqn.	0.13	#N/A	#N/A	#N/A
5566.40		Min. Energy. Eqn.	0.28	#N/A	#N/A	#N/A
5566.50		Min. Energy. Eqn.	0.48	#N/A	#N/A	#N/A
5566.60		Min. Energy. Eqn.	0.73	#N/A	#N/A	#N/A
5566.70		Regression Eqn.	1.01	#N/A	#N/A	#N/A
5566.80		Regression Eqn.	1.29	#N/A	#N/A	#N/A
5566.90		Regression Eqn.	1.61	1.13	**1.13**	OUTLET
5567.00		Regression Eqn.	1.92	1.35	**1.35**	OUTLET
5567.10		Regression Eqn.	2.24	1.56	**1.56**	OUTLET
5567.20		Regression Eqn.	2.54	1.74	**1.74**	OUTLET
5567.30		Regression Eqn.	2.82	1.92	**1.92**	OUTLET
5567.40		Regression Eqn.	3.08	2.08	**2.08**	OUTLET
5567.50		Regression Eqn.	3.33	2.23	**2.23**	OUTLET
5567.60		Regression Eqn.	3.56	2.37	**2.37**	OUTLET
5567.70		Regression Eqn.	3.81	2.51	**2.51**	OUTLET
5567.80		Regression Eqn.	3.97	2.63	**2.63**	OUTLET
5567.90		Regression Eqn.	4.17	2.76	**2.76**	OUTLET
5568.00		Regression Eqn.	4.35	2.88	**2.88**	OUTLET
5568.10		Regression Eqn.	4.52	2.99	**2.99**	OUTLET

CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **Bennett D Pad**

ID: **Proposed Culvert #3 (PC3)**



Appendix H:

Conveyance Calculations for Diversion Ditch Design

Existing Ditch Design

Estimated Capacity of Existing Ditch

10-year Storm Event			Required Capacity:	0.4 cfs
Depth =	0.2	ft		
Bottom Width=	0.0	ft		
Side Slope (H:V)=	5			
n=	0.022		$Q = \frac{1.49}{n} AR^{2/3} S^{1/2}$	
A=	0.29	ft^2		
P=	2.45	ft		
Minimum S=	0.007	ft/ft		
			Calculated Q=	0.4 cfs
			Calculated V=	1.4 fps

100-year Storm Event			Required Capacity:	2.8 cfs
Depth =	0.5	ft		
Bottom Width=	0.0	ft		
Side Slope (H:V)=	5			
n=	0.022		$Q = \frac{1.49}{n} AR^{2/3} S^{1/2}$	
A=	1.25	ft^2		
P=	5.10	ft		
Minimum S=	0.007	ft/ft		
			Calculated Q=	2.8 cfs
			Calculated V=	2.2 fps

Permanent Ditch #1 Design

Estimated Capacity of Permanent Ditch #1

10-year Storm Event			Required Capacity:	0.4 cfs
Depth =	0.3	ft		
Bottom Width=	0.0	ft		
Side Slope (H:V)=	3			
n=	0.022		$Q = \frac{1.49}{n} AR^{2/3} S^{1/2}$	
A=	0.27	ft^2		
P=	1.90	ft		
Minimum S=	0.007	ft/ft		
			Calculated Q=	0.4 cfs
			Calculated V=	1.5 fps

100-year Storm Event			Required Capacity:	2.8 cfs
Depth =	0.6	ft		
Bottom Width=	0.0	ft		
Side Slope (H:V)=	3			
n=	0.022		$Q = \frac{1.49}{n} AR^{2/3} S^{1/2}$	
A=	1.12	ft^2		
P=	3.86	ft		
Minimum S=	0.007	ft/ft		
			Calculated Q=	2.8 cfs
			Calculated V=	2.5 fps

Permanent Ditch #2 Design

Estimated Capacity of Permanent Ditch #2

Depth =	1.0	ft
Bottom Width=	0.0	ft
Side Slope (H:V)=	4	
n=	0.022	
A=	4.00	ft^2
P=	8.25	ft
Minimum S=	0.007	ft/ft

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

Calculated Q=	14.0	cfs
Calculated V=	3.5	fps

Temporary Ditch Re-Route Design

Estimated Capacity of Temporary Ditch Re-Route

10-year Storm Event			Required Capacity:	0.3 cfs
Depth =	0.2	ft		
Bottom Width=	0.0	ft		
Side Slope (H:V)=	5			
n=	0.022		$Q = \frac{1.49}{n} AR^{2/3} S^{1/2}$	
A=	0.24	ft^2		
P=	2.24	ft		
Minimum S=	0.005	ft/ft		
			Calculated Q=	0.3 cfs
			Calculated V=	1.1 fps

100-year Storm Event			Required Capacity:	3.9 cfs
Depth =	0.6	ft		
Bottom Width=	0.0	ft		
Side Slope (H:V)=	5			
n=	0.022		$Q = \frac{1.49}{n} AR^{2/3} S^{1/2}$	
A=	1.83	ft^2		
P=	6.17	ft		
Minimum S=	0.005	ft/ft		
			Calculated Q=	3.9 cfs
			Calculated V=	2.1 fps

Drainage Swale Design

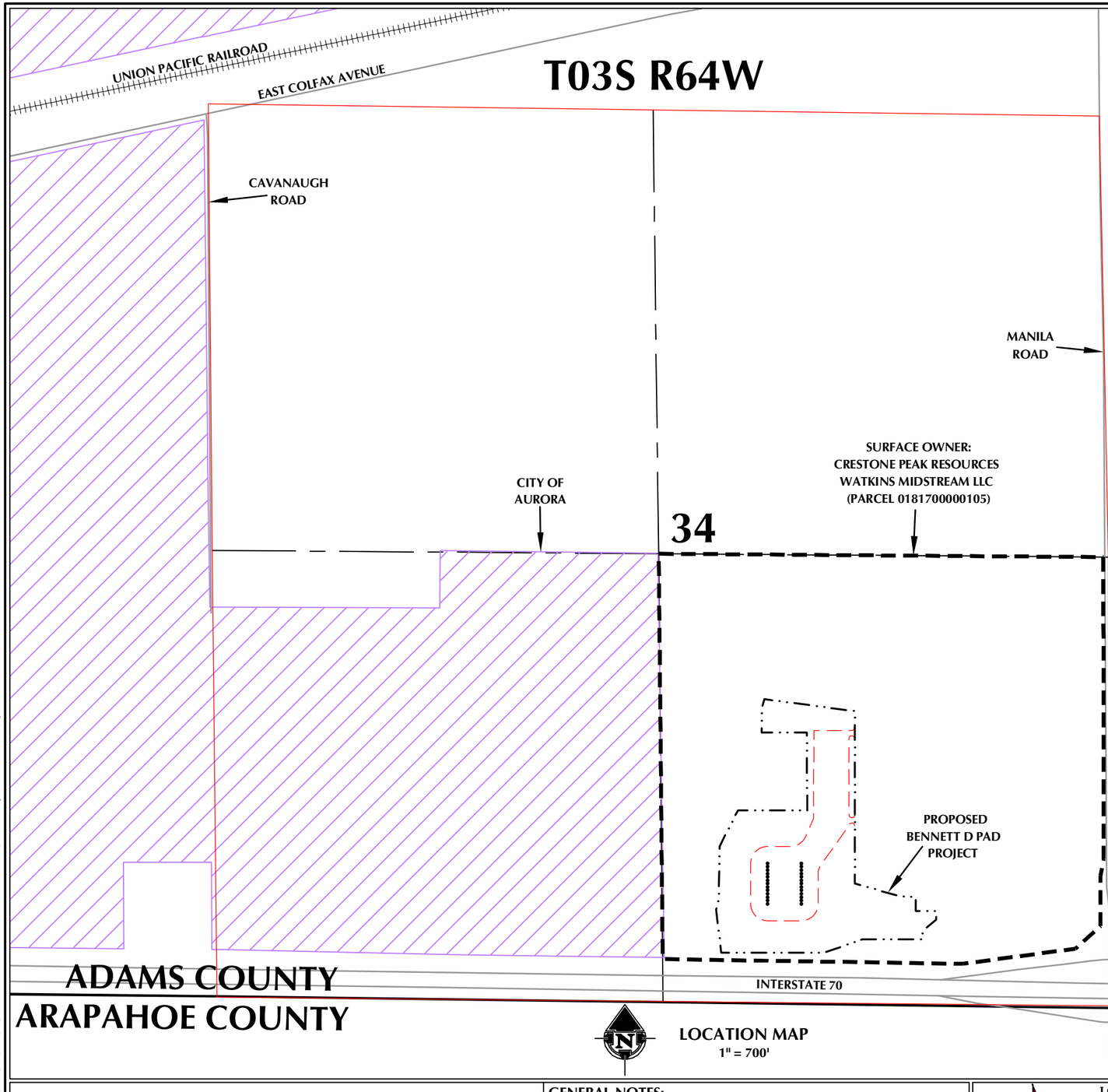
Estimated Capacity of Drainage Swale

10-year Storm Event			Required Capacity:	0.4 cfs
Depth =	0.2	ft		
Bottom Width=	3.0	ft		
Side Slope (H:V)=	4			
n=	0.05		$Q = \frac{1.49}{n} AR^{2/3} S^{1/2}$	
A=	0.71	ft^2		
P=	4.57	ft		
Minimum S=	0.005	ft/ft		
			Calculated Q=	0.4 cfs
			Calculated V=	0.6 fps

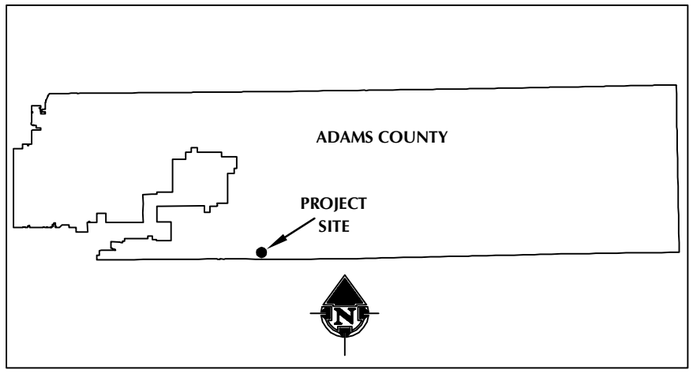
100-year Storm Event			Required Capacity:	5.0 cfs
Depth =	0.7	ft		
Bottom Width=	3.0	ft		
Side Slope (H:V)=	4			
n=	0.05		$Q = \frac{1.49}{n} AR^{2/3} S^{1/2}$	
A=	3.97	ft^2		
P=	8.69	ft		
Minimum S=	0.005	ft/ft		
			Calculated Q=	5.0 cfs
			Calculated V=	1.3 fps

BENNETT D PAD
DRAINAGE PLAN

LOCATED IN SECTION 34, T3S, R64W, 6TH P.M.
ADAMS COUNTY, COLORADO



LOCATION MAP
1" = 700'



VICINITY MAP

PAGE INDEX

GENERAL NOTES:

1. THIS DRAINAGE AND EROSION CONTROL PLAN WAS PREPARED FOLLOWING ADAMS COUNTY DEVELOPMENT STANDARDS & REGULATIONS WITH ADDITIONAL DESIGN GUIDANCE PROVIDED BY MILE HIGH FLOOD DISTRICT.
2. DISCLAIMER: THIS PLAN REPRESENTS AN APPROXIMATE LOCATION OF DRAINAGE AND EROSION CONTROL FEATURES; EXACT LOCATION MAY VARY DEPENDING UPON EXISTING EASEMENTS, PIPELINES, FLOWLINES, AND SETBACK REQUIREMENTS.
3. ORIGINAL DOCUMENT SIZE: 11" X 17"

609 CONSULTING, LLC
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SHERIDAN OFFICE
1095 Saberton Avenue
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Phone 307-674-0609

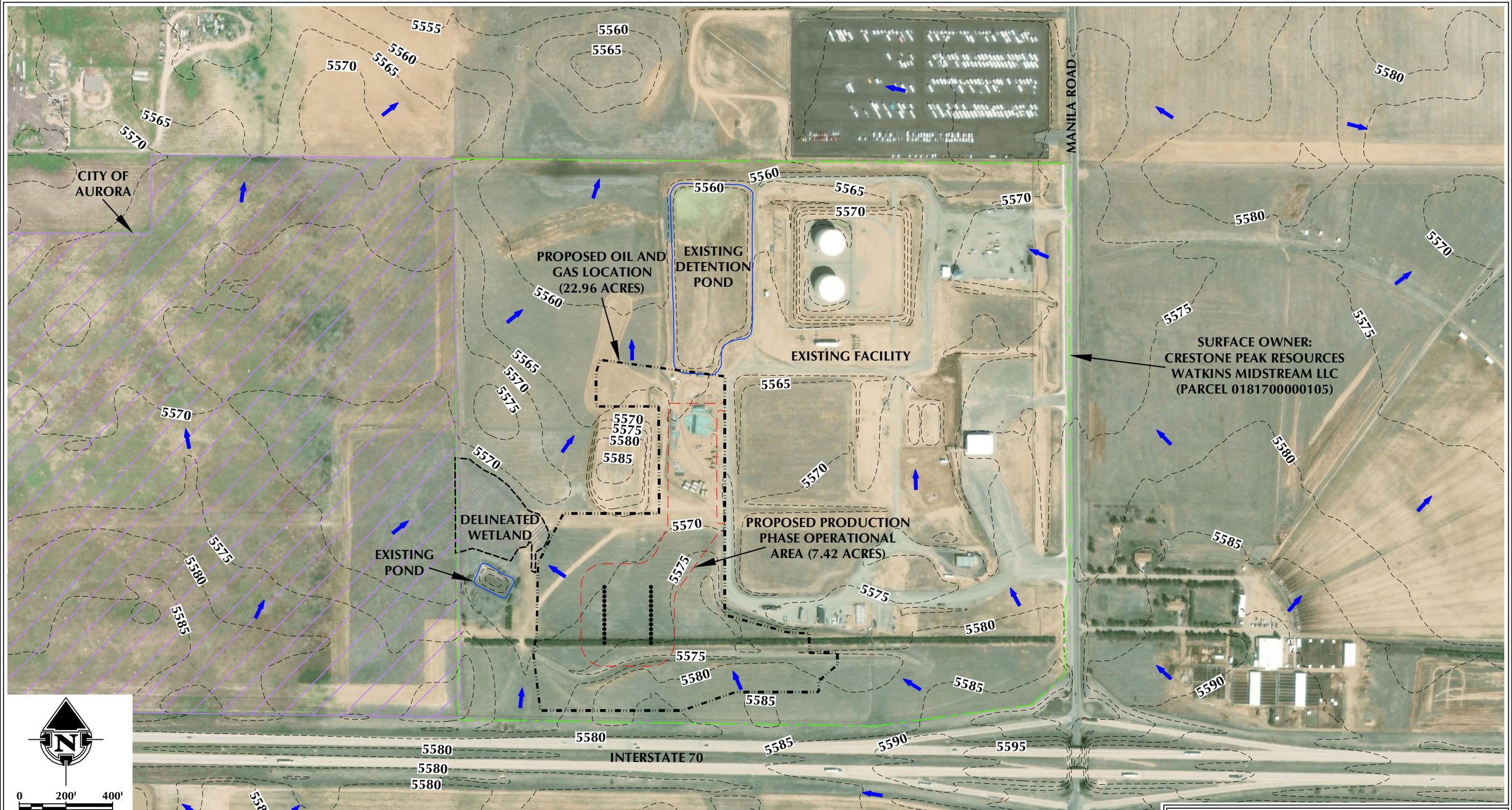
Prepared For:
CIVITAS
CRESTONE PEAK RESOURCES, LLC
555 17TH STREET, SUITE 3700
DENVER, CO 80202

BENNETT D PAD
DRAINAGE PLAN
COVER SHEET

SCALE:	VARIES	PAGE:	1 OF 10
JOB NUMBER:	23-182	DATE:	10/21/24
DRAFTED BY:	KMG	REVISED:	

PRELIMINARY

K:\CIVIT\6 RESOURCES\2023\2023_182_SEC36_T3S_R64W_SEC_36\DRAINAGE STUDY\DWG - DRAINAGE PLAN\BENNETT D_COMBINED.dwg, 10/22/2024 2:37:14 PM, kgates



LEGEND

- EXISTING CONTOUR
- EXISTING IRRIGATION DITCH/DRAINAGEWAY
- PROPOSED OIL AND GAS LOCATION
- PROPOSED ACCESS ROAD/PAD
- STORMWATER DRAINAGE
- PROPERTY LINE

GENERAL NOTES:

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2. ELEVATIONS ARE BASED ON NAVD88 (GEOID18).

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555 17TH STREET, SUITE 3700
DENVER, CO 80202

BENNETT D PAD
DRAINAGE PLAN
SITE OVERVIEW

SCALE:	1" = 400'	PAGE:	2 OF 10
JOB NUMBER:	23-182	DATE:	10/21/24
DRAFTED BY:	KMG	REVISED:	

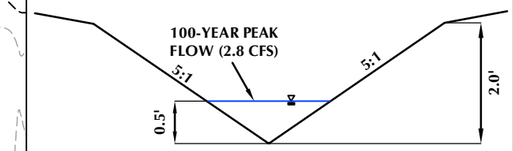
PRELIMINARY

K:\CIVITAS RESOURCES\2023\2023_182_SOC36_T3S_R64W_SEC_36\DRAINAGE STUDY\DWG - DRAINAGE PLAN\BENNETT D_COMBINED.dwg, 10/19/2024 3:04:35 PM, kgates

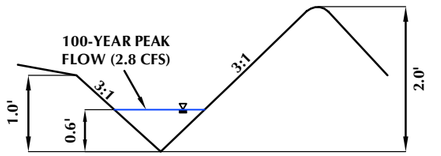
CULVERT ID	SIZE	LENGTH (FT)	ELEVATION (FT)		GRADE
			INLET INVERT	OUTLET INVERT	
PC1	12" CMP	40	5572.5	5571.1	3.5%
PC2	12" CMP	40	5570.0	5568.8	3.0%
PC3	12" CMP	40	5566.1	5566.0	0.3%

EXISTING CULVERT
EXISTING CULVERT
EXISTING DETENTION POND
400'
EXISTING 400' X 850' MAINTENANCE EASEMENT
SURFACE OWNER: CRESTONE PEAK RESOURCES WATKINS MIDSTREAM LLC (PARCEL 0181700000105)
PROPOSED CULVERT #3 (PC3)
PERMANENT ACCESS ROAD
PERMANENT DITCH #1
PERMANENT ACCESS ROAD
EXISTING DITCH
PROPOSED CULVERT #1 (PC1)
PROPOSED CULVERT #2 (PC2)
BENNETT D PAD FACILITY
100-YEAR STORAGE ELEVATION 5564.9'
PERMANENT DITCH #2
EXISTING TOPSOIL STOCKPILE
DETENTION BASIN
SPILLWAY
DETENTION BASIN (DB) OUTLET
CUT
FILL
BENNETT D PAD WELL PAD
TOPSOIL STOCKPILE
TEMPORARY ACCESS ROAD
TEMPORARY DITCH RE-ROUTE
INTERSTATE 70
PROPOSED OIL AND GAS LOCATION (22.96 ACRES)
EXISTING 20' ACCESS EASEMENT
20' X 20' X 3' SEDIMENT TRAP (ST)
DELINEATED WETLAND
EXISTING POND
0.5% SLOPE
0 100' 200'
1" = 200'
1' CONTOURS

EXISTING DITCH CROSS SECTION



PERMANENT DITCH #1 CROSS SECTION



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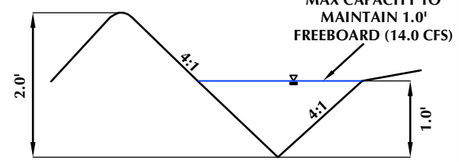
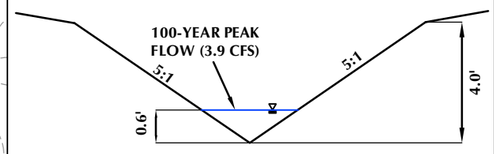


TEMPORARY DITCH RE-ROUTE CROSS SECTION



LEGEND

- EXISTING CONTOUR
- EXISTING ROAD
- EXISTING PIPELINE
- EXISTING BURIED POWERLINE
- EXISTING OVERHEAD POWERLINE
- PROPOSED OIL AND GAS LOCATION
- PROPOSED CONTOUR
- PROPOSED ACCESS ROAD/PAD
- PROPOSED WELL
- PROPERTY LINE
- PROPOSED DIVERSION DITCH
- PROPOSED BERM / OFF-SITE FLOW DEFLECTION
- PROPOSED CULVERT PROTECTION / RIPRAP
- PROPOSED SEDIMENT TRAP WITH PROTECTED OUTLET
- PROPOSED SLOPE PROTECTION
- 100-YEAR STORMWATER STORAGE FOOTPRINT
- STORMWATER DRAINAGE
- EASEMENT/ROW
- EXISTING DITCH

GENERAL NOTES:

1. DISCLAIMER: THIS PLAN REPRESENTS AN APPROXIMATE LOCATION OF DRAINAGE AND EROSION CONTROL FEATURES; EXACT LOCATION MAY VARY DEPENDING UPON EXISTING EASEMENTS, PIPELINES, FLOWLINES, AND SETBACK REQUIREMENTS.
2. ELEVATIONS ARE BASED ON NAVD88 (GEOID18).
3. SLOPE PROTECTION USED FOR TEMPORARY EROSION CONTROL ON CUT/FILL SLOPES AND SOIL STOCKPILES.

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BENNETT D PAD DRAINAGE PLAN

CONSTRUCTION PHASE SITE PLAN

SCALE:	1" = 200'	PAGE:	3 OF 10
JOB NUMBER:	23-182	DATE:	10/21/24
DRAFTED BY:	KMG	REVISED:	

PRELIMINARY

K:\CIVIL\76 RESOURCES\2023\2023_182_SOC36_T3S_R64W_SEC_36\DRAINAGE STUDY\DWG - DRAINAGE PLAN\BENNETT D_COMBINE D.dwg, 10/22/2024 2:43:35 PM, kgoles

CULVERT ID	SIZE	LENGTH (FT)	ELEVATION (FT)		GRADE
			INLET INVERT	OUTLET INVERT	
PC2	12" CMP	40	5570.0	5568.8	3.0%
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EXISTING CULVERT
EXISTING CULVERT
EXISTING DETENTION POND
400'
EXISTING 400' X 850' MAINTENANCE EASEMENT
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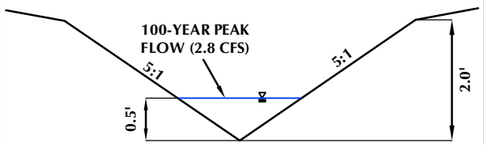
PERMANENT DITCH #1
PERMANENT ACCESS ROAD
PROPOSED CULVERT #2 (PC2)
EXISTING DITCH
BENNETT D PAD FACILITY
100-YEAR STORAGE ELEVATION 5564.0'
0.5% SLOPE
PERMANENT DITCH #2
EXISTING TOPSOIL STOCKPILE
DETENTION BASIN
SPILLWAY
DETENTION BASIN (DB) OUTLET
SEEDED TOPSOIL STOCKPILE (FOR FINAL REC)
BENNETT D PAD WELL PAD
PRODUCTION PHASE OPERATIONAL AREA (7.42 ACRES)
DRAINAGE SWALE (DS)
INTERSTATE 70
PROPOSED OIL AND GAS LOCATION (22.96 ACRES)
EXISTING 20' ACCESS EASEMENT
DELINEATED WETLAND
EXISTING POND

0 100' 200'
1" = 200'
1' CONTOURS

EXISTING DITCH CROSS SECTION



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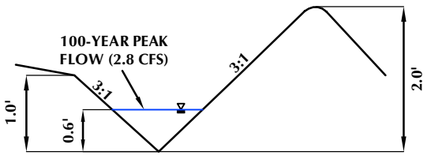

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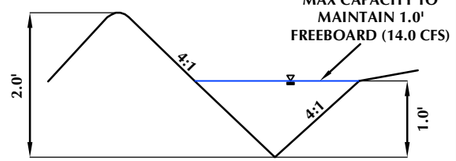
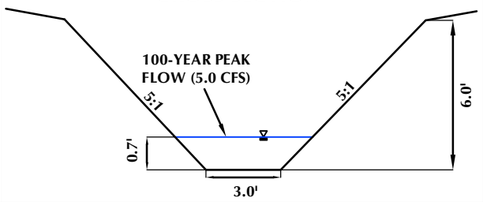


DRAINAGE SWALE CROSS SECTION



LEGEND

- EXISTING CONTOUR
- EXISTING ROAD
- EXISTING PIPELINE
- EXISTING BURIED POWERLINE
- EXISTING OVERHEAD POWERLINE
- PROPOSED OIL AND GAS LOCATION
- PROPOSED CONTOUR
- PROPOSED ACCESS ROAD/PAD
- PROPOSED WELL
- PROPERTY LINE
- PERMANENT DIVERSION DITCH
- PROPOSED BERM / OFF-SITE FLOW DEFLECTION
- PROPOSED CULVERT PROTECTION / RIPRAP
- RECLAMATION BOUNDARY
- PROPOSED PERMANENT SEEDING
- 100-YEAR STORMWATER STORAGE FOOTPRINT
- STORMWATER DRAINAGE
- EASEMENT/ROW
- EXISTING DITCH

GENERAL NOTES:

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2. ELEVATIONS ARE BASED ON NAVD88 (GEOID18).
3. RECLAIMED AREA WILL BE RE-SEEDED AND RE-VEGETATED.

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DENVER, CO 80202

BENNETT D PAD
DRAINAGE PLAN
PRODUCTION PHASE SITE PLAN

SCALE:	1" = 200'	PAGE:	4 OF 10
JOB NUMBER:	23-182	DATE:	10/21/24
DRAFTED BY:	KMG	REVISED:	

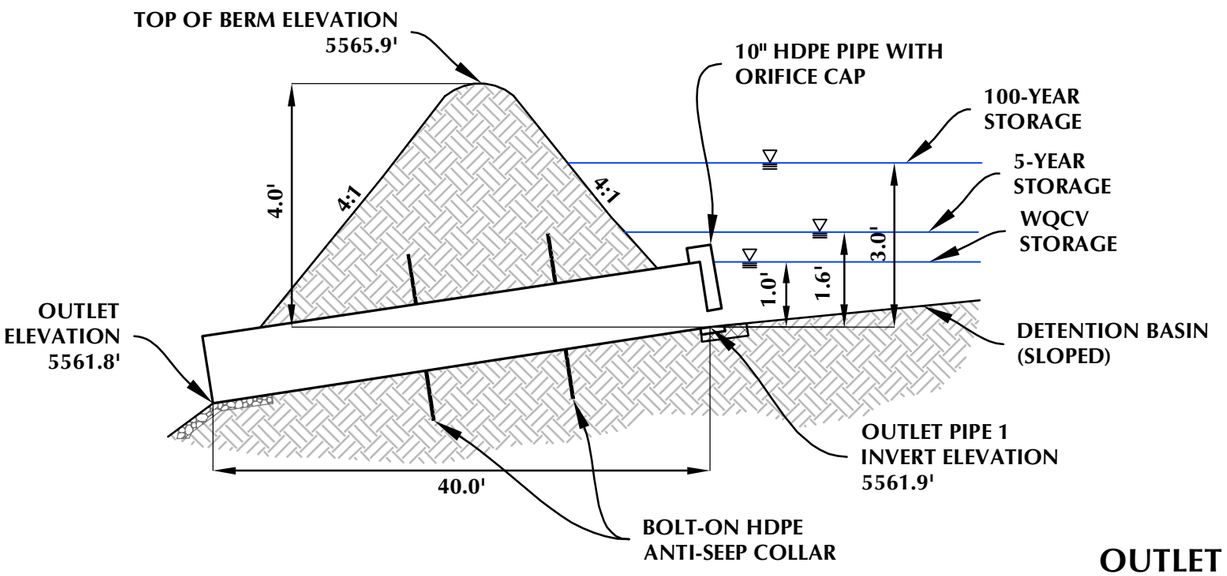
PRELIMINARY

K:\CIVIL\76 RESOURCES\2023\2023_182_SOC36_T3S_R64W_SEC_36\DRAINAGE STUDY\DWG - DRAINAGE PLAN\BENNETT D_COMBINE.dwg, 10/22/2024 2:45:34 PM, tgoles

DETENTION BASIN (DB) OUTLET - CONSTRUCTION PHASE

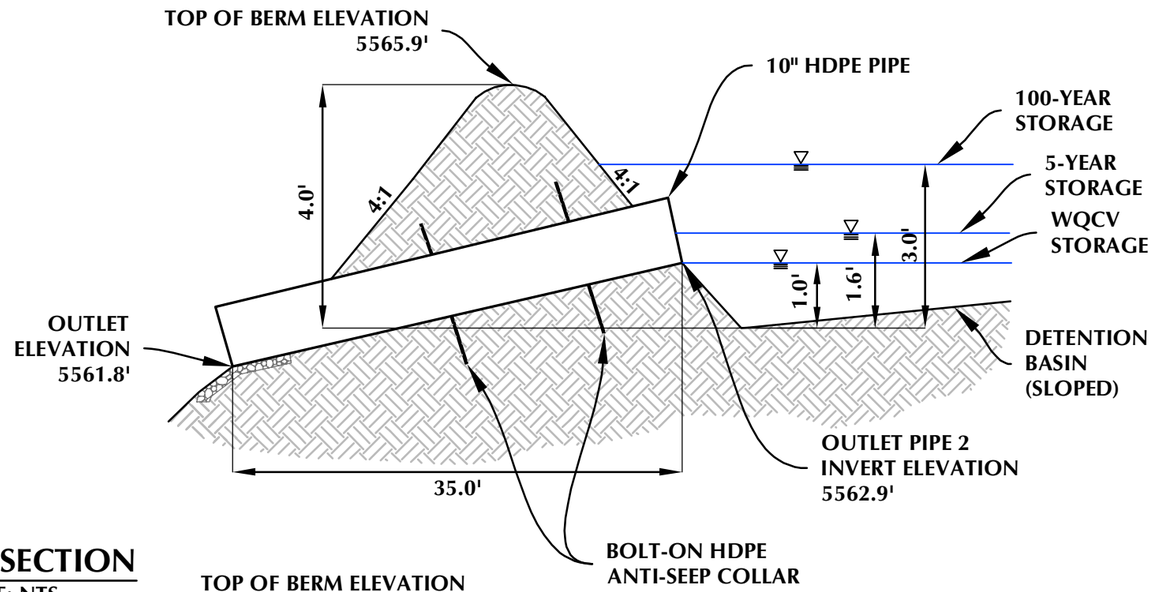
OUTLET PROFILE (PIPE 1)

SCALE: NTS



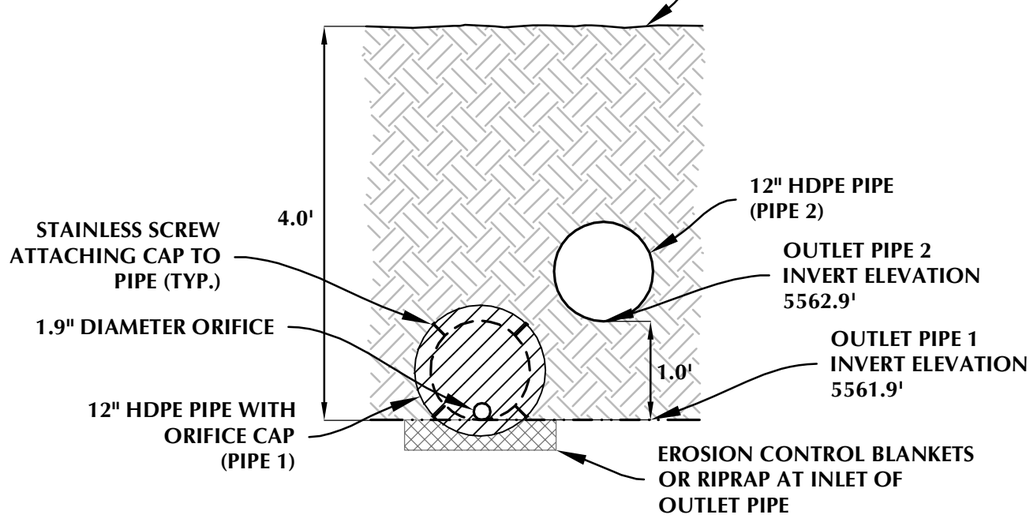
OUTLET PROFILE (PIPE 2)

SCALE: NTS



OUTLET SECTION

SCALE: NTS



GENERAL NOTES:

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2. ELEVATIONS ARE BASED ON NAVD88 (GEOID18).

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BENNETT D PAD
DRAINAGE PLAN
DETENTION BASIN OUTLET - CONSTRUCTION

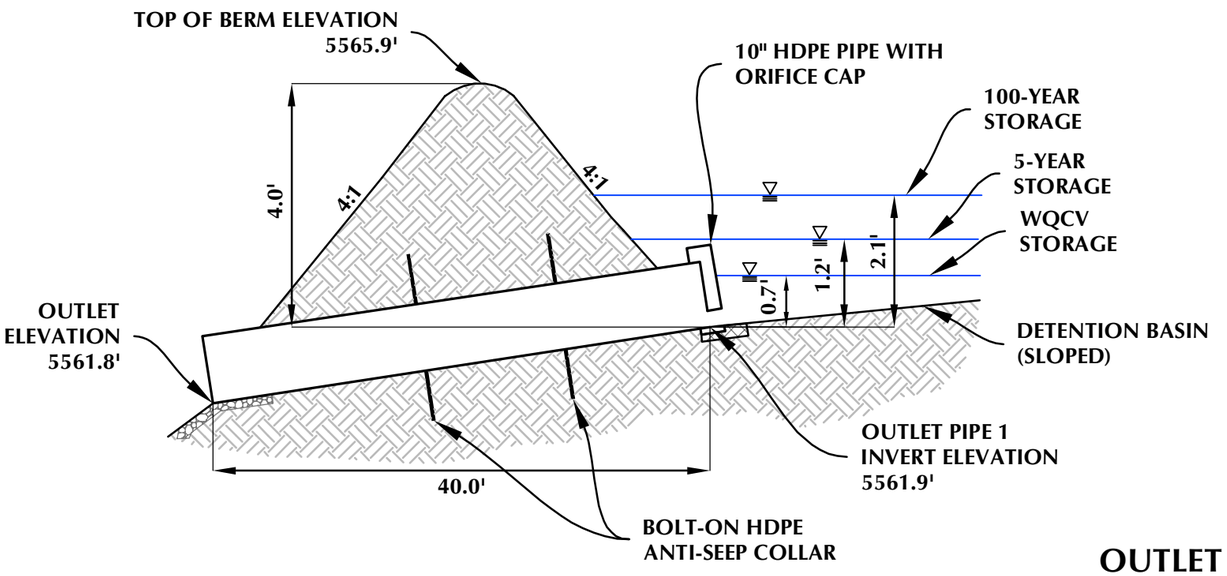
SCALE:	VARIES	PAGE:	5 OF 10
JOB NUMBER:	23-182	DATE:	10/21/24
DRAFTED BY:	KMG	REVISED:	

PRELIMINARY

DETENTION BASIN (DB) OUTLET - PRODUCTION PHASE

OUTLET PROFILE (PIPE 1)

SCALE: NTS



OUTLET PROFILE (PIPE 2)

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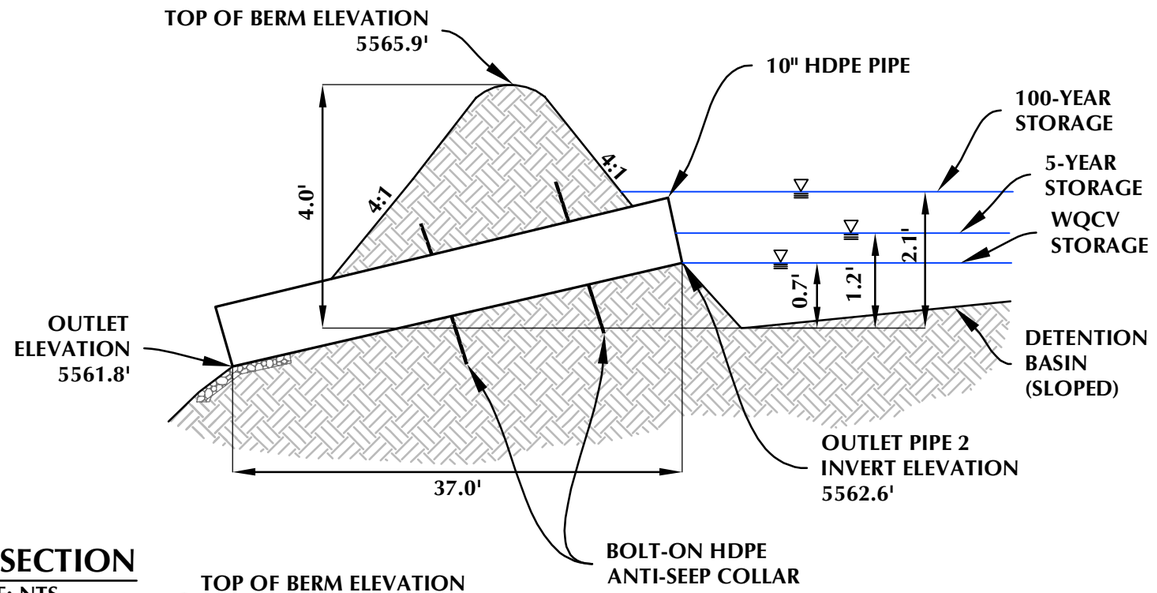

OUTLET SECTION

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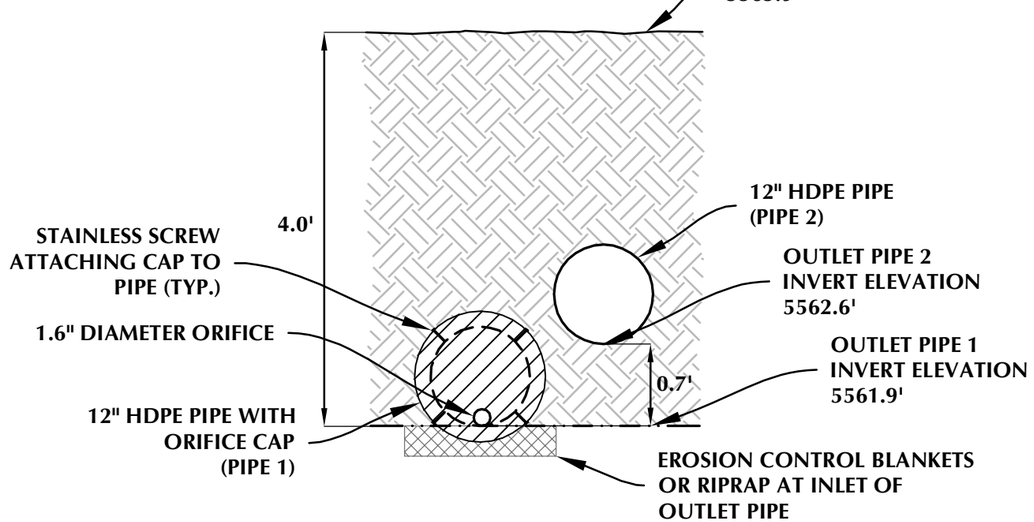

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BENNETT D PAD
DRAINAGE PLAN
DETENTION BASIN OUTLET - PRODUCTION

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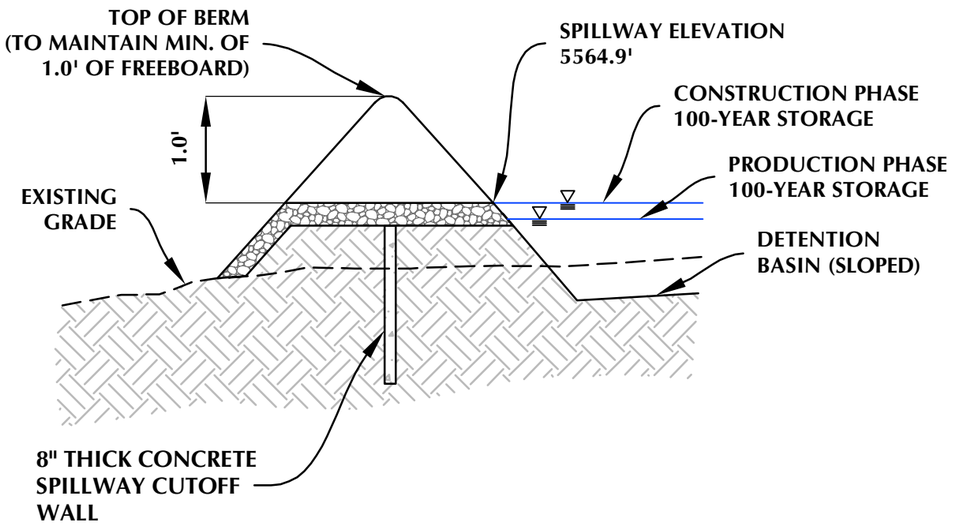
DRAFTED BY:	KMG	REVISED:	

PRELIMINARY

DETENTION BASIN (DB) SPILLWAY - BOTH PHASES

SPILLWAY PROFILE

SCALE: NTS



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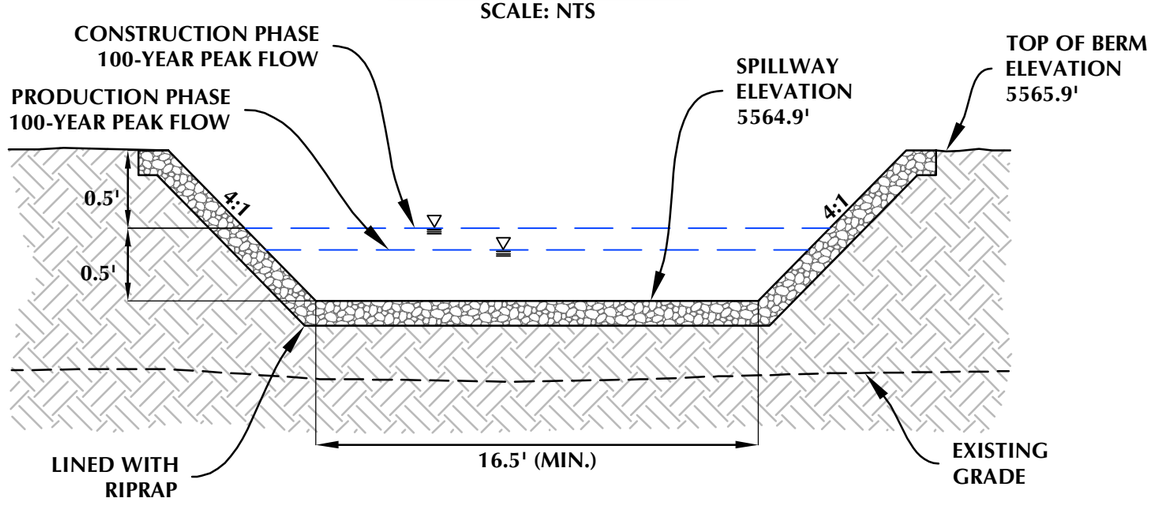

SPILLWAY CUTOFF WALL SECTION

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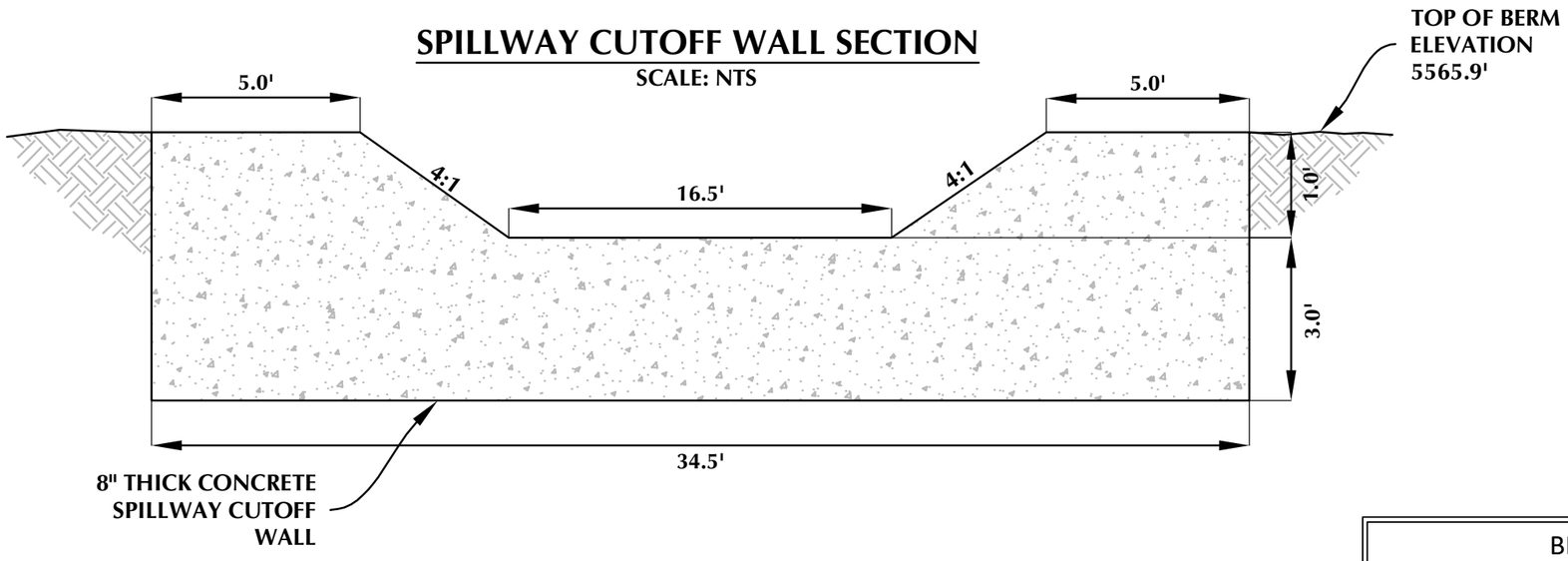

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BENNETT D PAD
DRAINAGE PLAN
DETENTION BASIN SPILLWAY

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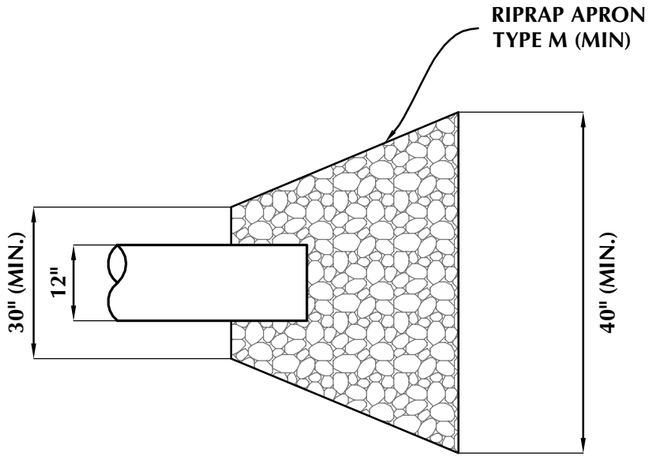
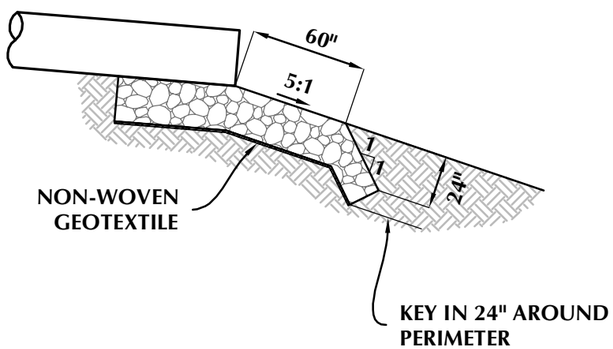
DRAFTED BY:	KMG	REVISED:	

PRELIMINARY

OUTLET PROTECTION

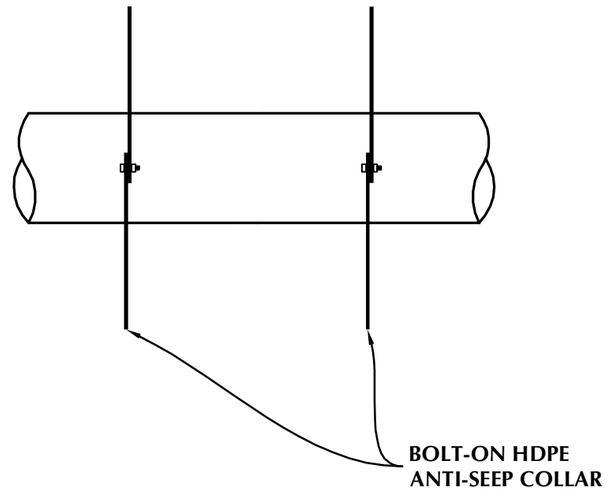
SCALE: NTS

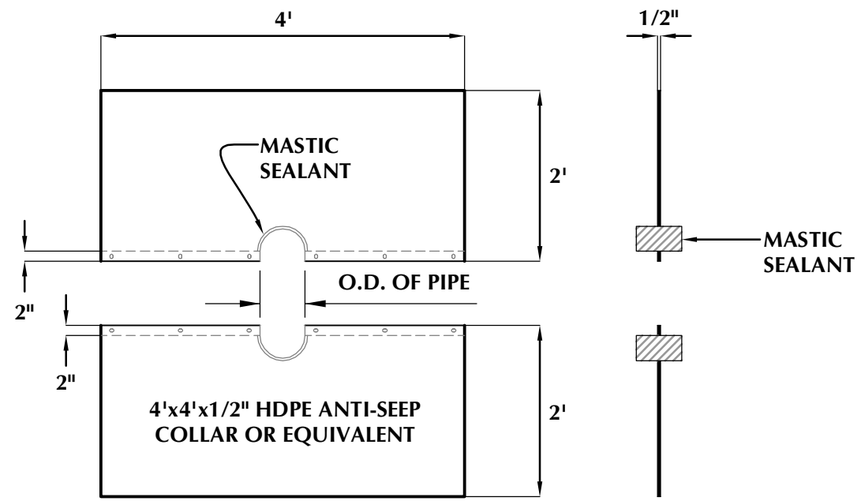




ANTI-SEEP COLLAR

SCALE: NTS





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BENNETT D PAD
DRAINAGE PLAN
OUTLET DETAILS

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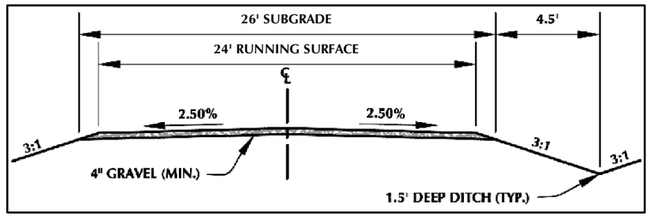
PRELIMINARY



CROSS-SECTION
NTS

Temporary and Permanent Seeding (TS/PS)

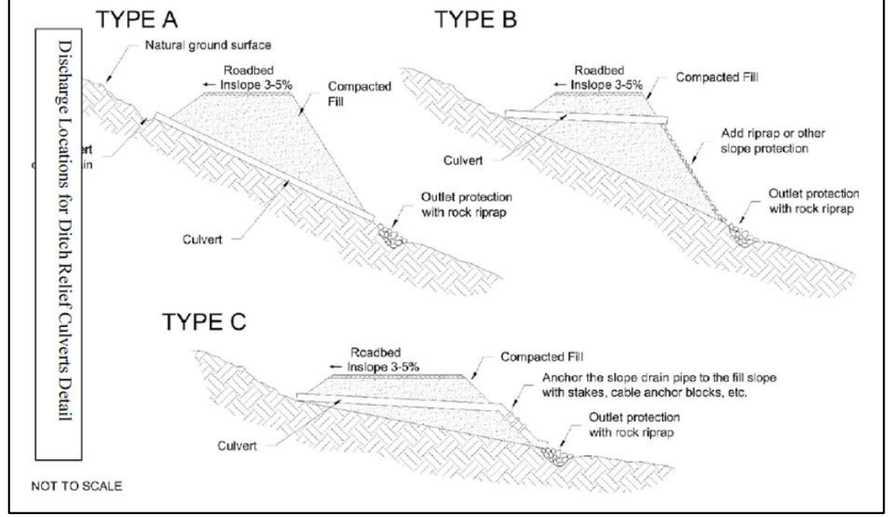
TS/PS

ADAMS COUNTY, COLORADO

SEED MIX	APPLICATION RATE (lbs/acre)
PBSI Dryland Aggressive Mix	25
(20%) Green Needlegrass, Lodorm	
(20%) Slender Wheatgrass, Native	
(20%) Western Wheatgrass, Native	
(20%) Pubescent Wheatgrass, Luna	
(20%) Intermediate Wheatgrass, Oahe/Rush	
PBSI Native Prairie Mix	15
(25%) Blue Grama	
(10%) Buffalograss	
(20%) Green Needlegrass	
(20%) Sideoats Grama	
(25%) Western Wheatgrass	
PBSI Native Sandyland Mix	15
(20%) Yellow Indiangrass	
(10%) Little Bluestem	
(10%) Indian Rice Grass	
(10%) Sideoats Grama	
(10%) Sand Lovegrass	
(10%) Prairie Sandreed	
(20%) Switchgrass	
PBSI Premium Irrig. Pasture Mix #1	25
(75%) Meadow Bromegrass, Paddock/Fleet	
(25%) Orchardgrass, Elsie/Megabite/Paiute	

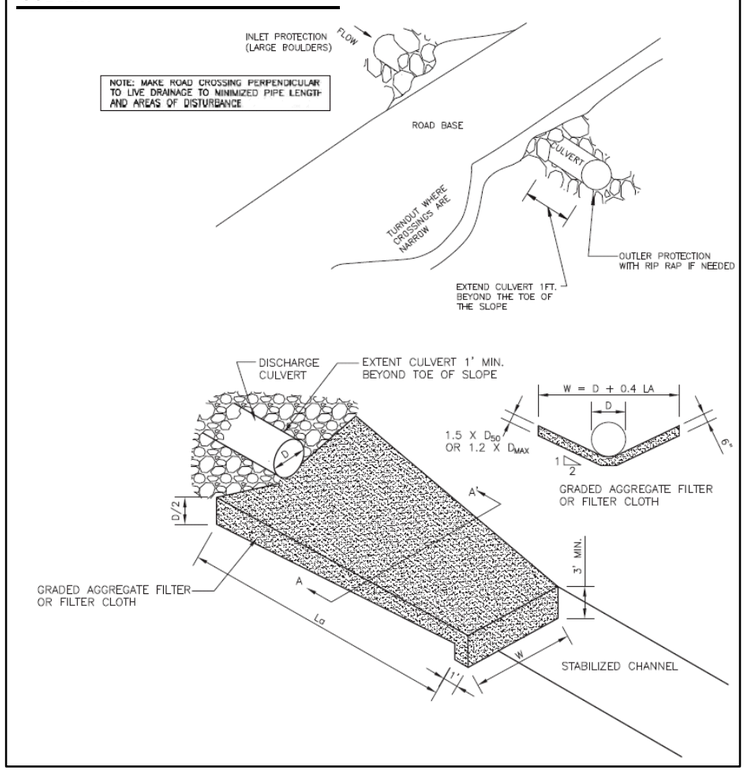
Notes:
lbs/acre = pounds per acre
% = percent

CULVERT



NOT TO SCALE

CULVERT



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BENNETT D PAD
DRAINAGE PLAN
BMP TYPICALS (A)

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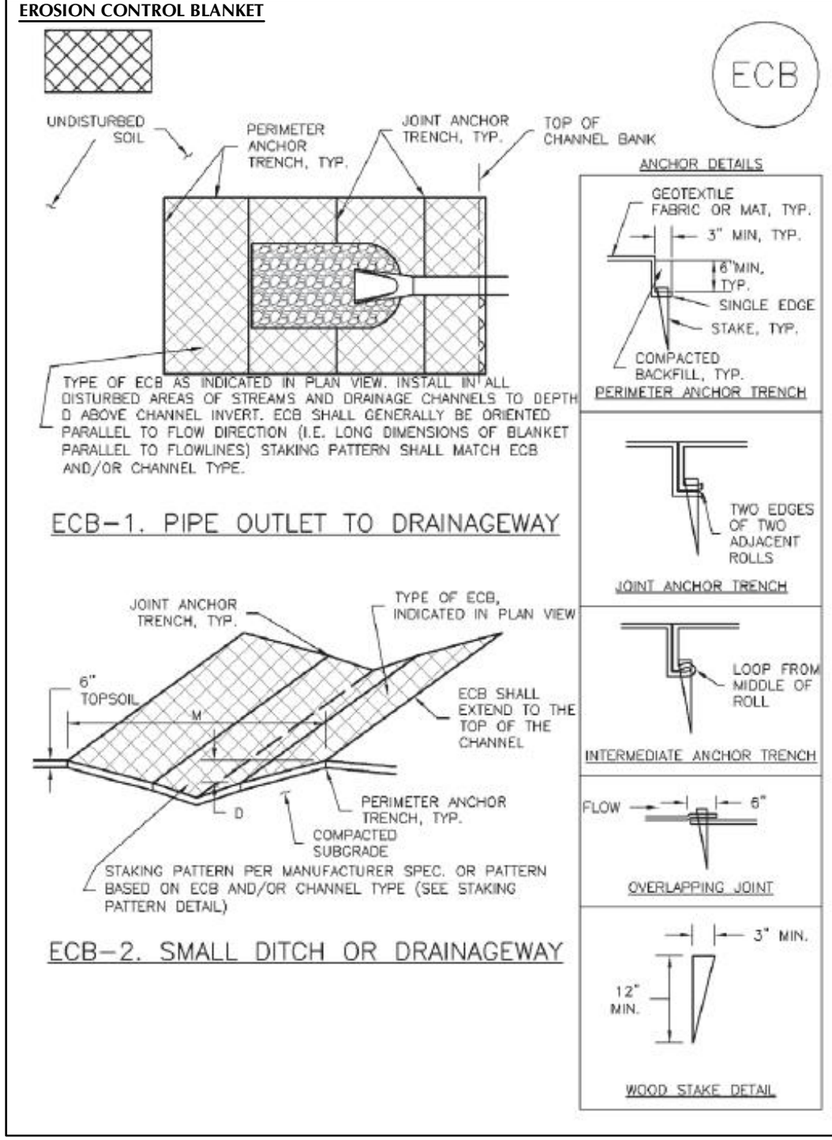
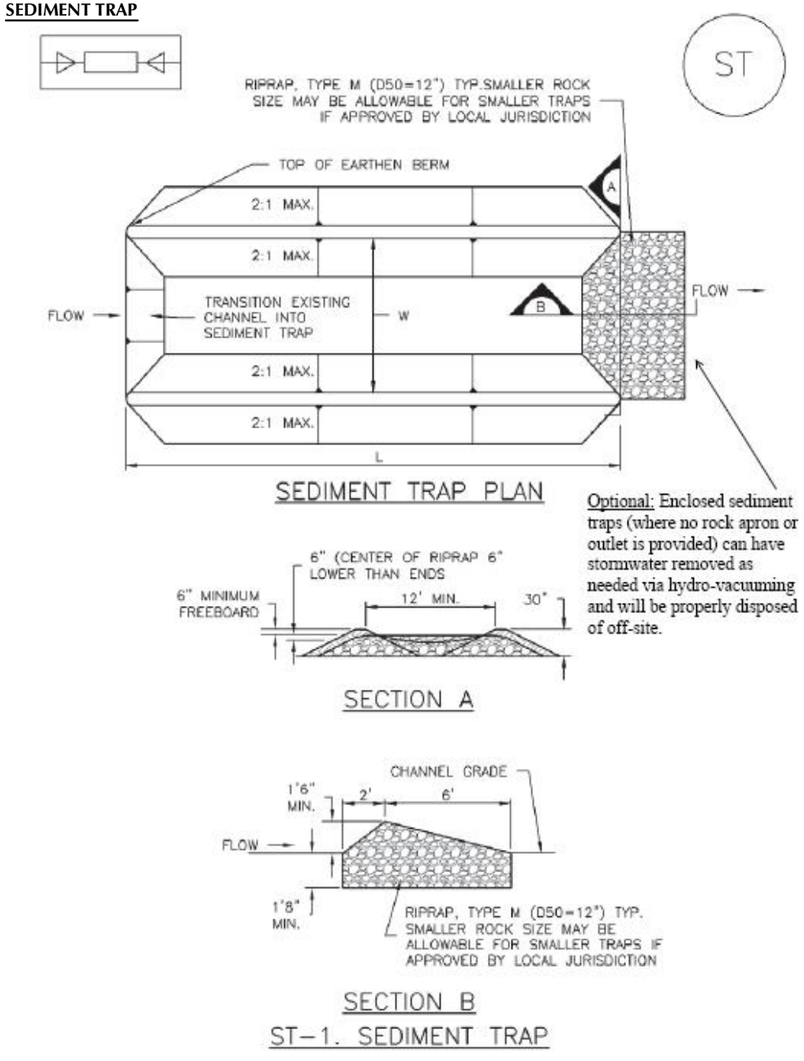
PRELIMINARY

EROSION CONTROL BLANKET



SEDIMENT TRAP



Optional: Enclosed sediment traps (where no rock apron or outlet is provided) can have stormwater removed as needed via hydro-vacuuming and will be properly disposed of off-site.

GENERAL NOTES:

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BENNETT D PAD
DRAINAGE PLAN
BMP TYPICALS (B)

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PRELIMINARY

Stormwater Management Plan For Bennett D Pad

Prepared for:

Crestone Peak Resources Operating LLC

A Wholly-Owned Subsidiary of Civitas Resources, Inc.

555 17th Street

Suite 3700

Denver, Colorado 80202

October 2024

609 Consulting, LLC

Engineering, Surveying, Consulting & Design

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APPENDICES

1.0 INTRODUCTION

This Stormwater Management Plan (SWMP) is being prepared for the Bennett D Pad project on behalf of Crestone Peak Resources Operating LLC, a wholly-owned subsidiary of Civitas Resources, Inc. The project consists of the construction and development of an oil/gas well pad and production facility located in the southeast quarter of Section 34, Township 3 South, Range 64 West in Adams County, Colorado.

The purpose of this report is to develop a site specific SWMP using Stormwater Best Management Practices (BMPs) to control stormwater runoff in a manner that minimizes erosion, transport of sediment offsite, and site degradation. This SWMP shall comply with the Energy & Carbon Management Commission (ECMC) Rule 1002.f and Rule 304.c.(15) and will accompany Form 2A.

This report will discuss the stormwater impacts that may occur during the different development phases (Construction and Production) of the project and will detail the various stormwater BMPs that will be used to minimize erosion, transport of sediment offsite, and site degradation. This SWMP is intended to be a living document which should be updated routinely as site conditions change.

2.0 PROJECT DESCRIPTION AND LOCATION

2.1 Project Description

The proposed project consists of the construction and operation of the Bennett D Pad well pad and production facility containing infrastructure and operations for 26 oil/gas wells. The ECMC Proposed Oil and Gas Location will have a permitted disturbance area of 22.96 acres during the construction phase which includes topsoil stripping and pad earthwork, well drilling and hydraulic fracturing, installation of permanent pipelines and facilities, and setup of temporary equipment and a modular large volume tank (MLVT) area.

Once all wells have been drilled and completed, portions of the Proposed Oil and Gas Location will be reclaimed back to existing grade and re-seeded during interim reclamation. The remaining un-reclaimed area during the production phase will be approximately 7.42 acres.

2.2 Project Location

Bennett D Pad is located on property owned by Crestone Peak Resources Watkins Midstream LLC (Parcel 0181700000105). The project area is approximately 0.1 miles north of Interstate 70 and 0.3 miles west of Manila Road. An existing access road running west from Manila Road will provide access to the project area. Bennett D Pad will be constructed on partially developed industrial land. According to the 2019 National Land Cover Database, the project area is grassland/herbaceous. A map of the proposed Bennett D Pad can be found in Appendix A.

Historically, stormwater from the proposed location drains from the south to the northwest/north. A delineated wetland and existing pond are located to the west of the site while an existing detention pond is located to the north. In order to avoid outflowing towards any of these areas, stormwater will be routed to a detention basin on the north edge of the project area and the outlet will direct flow around the west side of the existing detention pond. The delineated wetland and existing ponds will not be impacted by this project.

Soils data for the project area were taken from NRCS Soil Data Viewer. The project area is comprised of Ascalon-Platner association (0 to 5 percent slopes) soils and Truckton loamy sand (3 to 9 percent slopes). The Ascalon-Platner association has a Hydrologic Soil Group (HSG) classification of Group B with a K soil erosion factor of 0.17, which consists of soils having a moderate infiltration rate and a low runoff potential. The Truckton loamy sand has a HSG classification of Group A soils with a K soil erosion factor of 0.17, which consists of soils having a high infiltration rate and a low runoff potential. The K soil erosion factor is an index ranging from 0.02 to 0.64, which quantifies the relative susceptibility of the soil to sheet and rill erosion. The following table is a summary of K soil erosion factors with typical soil descriptions.

Table 1. Summary of K Soil Erosion Factors with Typical Soil Descriptions

K Factor	Types of Soil	Susceptibility to Erosion
0.02 to 0.25	Sands, Clays, Sandy Clays	Low
0.25 to 0.40	Loams, Sandy Loams, Sandy Silts	Moderate
0.40 to 0.64	Silts	High

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (Panel 08001C0960H, Effective Date: 3/5/2007), the proposed project is in an area of minimal flood hazard (Zone X) and is therefore determined to be outside the 500-year floodplain. The corresponding FIRMette displaying the flood zone classification at the project site can be found in Appendix B.

2.3 Proposed Development

The proposed project consists of the construction of the Bennett D Pad well pad, production facility, and access roads. The project will have two phases: a construction phase and a production phase. The construction phase well pad will have a larger disturbance area to facilitate drilling and completions operations. The production phase well pad will have a smaller disturbance area to facilitate gathering and production operations.

During the construction phase, the Proposed Oil and Gas Location will have a permitted disturbance area of 22.96 acres which includes topsoil stripping and pad earthwork, well drilling and hydraulic fracturing, installation of permanent pipelines and facilities, and setup of temporary equipment and a MLVT area. Once all wells have been drilled and completed, portions of the Proposed Oil and Gas Location will be reclaimed back to existing grade and re-seeded during interim reclamation. The remaining operational area during the production phase will be approximately 7.42 acres.

It is anticipated that heavy construction equipment will construct the access road and working pad surface of this project. Construction of the access road and working pad surface during both phases will consist of:

- Clearing and grubbing of existing vegetation
- Stripping and stockpiling of overlying topsoil
- Grading the working pad area, stormwater diversion ditches, berms, and sediment control structures
- Installing stormwater detention structures
- Installing construction BMPs
- Installing stormwater BMPs

Topsoil piles and excess spoils piles (if any) will be separated and protected from erosion, offsite sediment transport, and degradation. Further site development will consist of:

- Mobilization/demobilization of construction equipment
- Drilling, development, and completion of oil/gas wells
- Installing production facility equipment, utilities, and pipelines

Site development may vary depending on the site-specific conditions.

2.4 Site Specific Construction Requirements

Prior to commencement of any ground disturbance activity, perimeter BMPs will be installed to protect downstream lands from sediment pollution. Once the work area is secure, the access road and well pad will be stripped of topsoil to a depth consistent with the grading plan. Topsoil will be stockpiled separately, then the site will be graded, redistributing material across the site between cut and fill areas to achieve pad finish grade elevations. During this process, fill areas will be properly compacted to ensure working pad surface integrity and proper stabilization. Construction water may be used to assist with compaction as well as minimize dust. All excess material, if any, will be separated and stockpiled. The contractor will place gravel road base on both the pad surface and access road to a compacted depth as shown on the grading plan to provide additional stabilization. All disturbed soil stockpiles and cut/fill slopes will receive slope protection as temporary erosion control during the construction phase. Once all wells have been drilled and completed, portions of the Proposed Oil and Gas Location will be reclaimed back to existing grade and stabilized with drill seed and mulch and any additional stormwater BMPs will be installed.

3.0 DISTURBANCE REDUCTION & RECLAMATION

3.1 Disturbance Reduction and Interim Reclamation

Once all drilling and completion activities are complete, the working pad surface size will be reduced to minimize the site disturbance during the production phase. A sufficient amount of working pad surface must remain to ensure a safe working environment for continued oil and gas production operations. All areas needed for ongoing operations will be stabilized for the long-term life of the well pad. All unused portions of the project area will be reclaimed as described below, and in accordance with the interim reclamation plan.

3.2 Reclamation

Developed areas to be reclaimed will be stripped of topsoil, cross-ripped to 18" (compaction alleviation), and graded to pre-disturbed conditions. Surface treatment will consist of reapplying the topsoil, seeding, and mulching. Reclaimed areas will be restored to as nearly as practicable to the site's original condition. The reclaimed areas will be monitored until final stabilization is achieved. All reclamation shall be completed within three (3) months on crop land and twelve (12) months on non-crop land.

The operator will seed using a seed mix specified by the surface owner. Seeding will be applied at the optimum seeding methodology. A typical seed mix and application rates can be found in Appendix C.

Successful reclamation of the well site and access road will be considered completed when:

1. All construction activities are complete.
2. All working pad surface areas are stabilized from compaction and erosion for the remainder of the project.
3. All seeded and mulched areas have achieved a desirable vegetation density when:
    i. On Crop Land: Reclamation has been performed as per Rules 1003 & 1004 and observation by the Director over two (2) growing seasons has indicated no significant unrestored subsidence.
    ii. On Non-Crop Land: Reclamation has been performed as per Rules 1003 & 1004 and disturbed areas have been either built on, compacted, paced, or otherwise stabilized in such a way as to minimize erosion to the extent practicable, or a uniform vegetative cover has been established that reflects the pre-development or reference area forbs, shrubs, and grasses with a total plant cover of at least eighty percent (80%) of pre-development or reference area levels, excluding noxious weeks, as determined by the Director through visual appraisal.
4. Disturbances resulting from flow line installations shall be deemed adequately reclaimed when the disturbed area is reasonably capable of supporting the pre-development land use.
5. A final reclamation inspection has been completed by the Director, or a representative appointed by the Director, there are no outstanding compliance issues relating to commission rules, regulations, orders, permit conditions or the act, and the Director has notified the operator that final reclamation has been approved. A Sundry Notice Form 4 will be submitted by the operator when final stabilization has been achieved when. The sundry notice will describe the final reclamation procedures and mitigation measures and any changes in the landowner's designated final land use (if applicable).

3.3 Abandonment

Once the operator has made the decision to no longer operate production operations on a well, it will be plugged and abandoned (P&A). All equipment associated with the well will be removed from the location. If the well pad and access road is no longer needed, it will be reclaimed and recontoured to its pre-disturbed conditions and/or in accordance with the surface owner's requirements.

4.0 SWMP REQUIREMENTS

Crestone Peak Resources Operating LLC has a field-wide master SWMP that covers their construction activities within this area. Also, construction activities within this area are covered under and governed by the CDPS General Permit for Discharges Associated with Construction Activity (Permit No. COR401104). The CDPS General Permit can be found in Appendix D.

Stormwater BMPs will be employed in accordance with good engineering, hydrologic, and pollution control practices in order to prevent pollution in stormwater discharges associated with the development of the Bennett D Pad project. All personnel, including applicable contractors, shall comply with the contents of this SWMP.

All information and conditions represented this SWMP are estimated and intended as a preliminary plan. As stated previously, this SWMP is intended to be a living document which should be updated routinely as site conditions change. Actual placement of BMP's may vary based on actual conditions encountered at the site.

4.1 Qualified Stormwater Management Plan Manager

The Qualified SWMP Manager (QSM) has the authority to dedicate the financial and human resources needed to install & implement SWMP control measures, conduct inspections, keep records, report incidents, and make repairs and/or changes in design. The following person has been assigned as the QSM.

Mr. Bryan Mickiewicz, Director EHS
650 Southgate Drive
Windsor, CO 80550
Office: (303) 294-7814
Cell: (720) 539-9978

4.2 State-wide SWMP Requirements

Site inspections must be conducted in accordance with the following requirements. The required inspection schedules are a minimum frequency and do not affect the permittee's responsibility to implement control measures in effective operating condition as prescribed in the SWMP. Proper maintenance of control measures may require more frequent inspections. Site inspections shall start within 7 calendar days of the commencement of construction activities on site.

The person(s) inspecting the site may be on the permittee's staff or a third-party contractor hired to conduct stormwater inspections under the direction of the permittee(s). The permittee is responsible for ensuring that the inspector is a qualified stormwater manager.

4.2.1 Site Inspections Frequency

Permittees must conduct site inspections at least once every seven (7) calendar days for sites that discharge to a water body designated as an "Outstanding Water" by the Water Quality Control Commission. Otherwise, permittees must conduct site inspections in accordance with the following minimum frequencies:

a. At least one inspection every seven (7) calendar days; or
b. At least one inspection every fourteen (14) calendar days, if post-storm event inspections are conducted within 24 hours after the end of any precipitation or snowmelt event that causes surface erosion. Post-storm inspections may be used to fulfill the 14-day routine inspection requirement.
c. When site conditions make the schedule required in this section impractical, the permittee may petition the Division to grant an alternate inspection schedule. The alternative inspection schedule may not be implemented prior to written approval by the Division and incorporation into the SWMP.

4.2.2 Reduced Inspection Frequency

The permittee may perform site inspections at the following reduced frequencies when one of the following conditions exist:

1. Post-Storm Inspections at Temporarily Idle Sites
   For permittees choosing to combine 14-day inspections and post-storm-event-inspections, if no construction activities will occur following a storm event, post-storm event inspections must be conducted prior to recommencing construction activities, but no later than 72 hours following the storm event. The delay of any post-storm event inspection must be documented in the inspection record. Routine inspections must still be conducted at least every 14 calendar days.

2. Inspections at Completed Sites/Areas
   When the site, or portions of a site, are awaiting establishment of a vegetative ground cover and final stabilization, the permittee must conduct a thorough inspection of the stormwater management system at least once every 30 days. Post-storm event inspections are not required under this schedule. This reduced inspection schedule is allowed if all of the following criteria are met:

   a. All construction activities resulting in ground disturbance are complete
   b. All activities required for final stabilization, in accordance with the SWMP, have been completed, with the exception of the application of seed that has not occurred due to seasonal conditions or the necessity for additional seed application to augment previous efforts
   c. The SWMP has been amended to locate those areas to be inspected in accordance with the reduced schedule allowed for in this paragraph

4.2.3 Inspections Exclusions

Inspections are not required for sites that meet the following conditions:

1. Construction activities are temporarily halted; or,
2. Snow cover exists over the entire site for an extended period of time and there is no snowmelt (only applies to the routine 7-day, 14-day and monthly inspections, as well as the post-storm-event inspections)

When the permittee has an inspection exclusion, the following information must be documented in accordance with permit requirements:

1. Dates when construction activities began & ended; or,
2. Dates when snow cover existed and date when snow melt began

4.3 SWMP Inspection Scope

When conducting a SWMP site inspection:

1. Visually verify whether all implemented control measures are in effective operational condition and are working as designed in their specifications to minimize pollutant discharges
2. Determine if there are new potential sources of pollutants
3. Assess the adequacy of control measures at the site to identify areas requiring new or modified control measures to minimize pollutant discharges
4. Identify all areas of non–compliance with the permit requirements and, if necessary, implement corrective action(s)

The following areas, if applicable, must be inspected for evidence of, or the potential for, pollutants leaving the construction site boundaries, entering the stormwater drainage system or discharging to state waters:

1. All disturbed areas
2. Ditches, berms, and any areas with stormwater mitigation
3. Site perimeter
4. Spill containment areas
5. Topsoil & material stockpiles
6. All locations where stormwater has the potential to discharge offsite
7. Locations where vehicles enter/exit the working pad surface

The permittee must keep a record of all SWMP inspections conducted for each permitted site. Inspection reports must identify any incidents of non-compliance with the terms and conditions of this permit. Inspection records must be retained and signed in accordance with the SWMP. At a minimum, the inspection report must include:

1. Facility Name
2. Inspector's name, title, and company
3. Date of inspection
4. Weather conditions at the time of inspection
5. Phase of construction at the time of inspection
6. Estimated acreage of disturbance at the time of inspection
7. Location(s) and identification of discharges of sediment or other pollutants from the site
8. Location(s) and identification of control measures needing maintenance
9. Location(s) and identification of inadequate control measures
10. Location(s) and identification of additional control measures needed that were not in place at the time of inspection
11. Location of discharges of sediment or other pollutants from the site
12. Description of inspection frequency and any deviations from the minimum inspection schedule

This would include documentation of division approval for an alternate inspection schedule. Location and description of corrective action(s) that have been taken, or where a report does not identify any incidents requiring corrective action, the report shall contain a statement.

5.0 SITE-SPECIFIC SWMP REQUIREMENTS

The following are the site-specific SWMP BMPs. Included with each BMP is its description, applicability, limitations, and location. More information on each site-specific stormwater BMP can be found in Appendix E.

5.1 Berm

Description

A berm is a mound of compacted soil. The top is at a specified width and the side slopes are at a specified slope. Berms may be constructed from either excavated topsoil or subsoil. Berms may be used to collect and direct on-site stormwater to sediment traps and outlets, store on-site stormwater, and deflect/redirect off-site runoff around the disturbance area.

Applicability

Berms help contain and divert runoff. Berms may be used for the upslope of cut or fill slopes to contain or divert surface water. Usually, berms will surround the perimeter of the working pad surface or spill containment area.

Limitations

Berms must be regularly maintained sometimes several times a year depending on site conditions. Berms will erode if they not properly maintained, compacted, and/or stabilized with vegetation or road base. Berms will fail if it is constructed with hydro-sensitive material. Berms which are downstream to surface drainage will require a ditch or additional protection to prevent erosion. Drive-over berms installed through a pad entrance will require a larger width and increased maintenance to remain effective. Depending on the berm material, stabilization such as erosion control blankets, road base, or liners may be needed.

Location

Two ditches and berms will be constructed along part of the perimeter of the Bennett D Pad project site to ensure that runoff remains on-site and is diverted to the sediment trap and detention basin area.

5.2 Ditch

Description

A ditch consists of a sub-grade drainage channel. The bottom is at a specified width and the side slopes are at a specified slope. Ditches will have a specified channel slope and discharge to the sediment trap or the detention basin area. Typically, ditches are constructed with an earthen channel. The purpose of a ditch is to collect and divert surface water. Typically, ditches will collect and divert off-site surface water around the perimeter of the well site, and, collect and divert on-site surface water from the bottom of cut and fill slopes to sediment control devices.

Applicability

Ditches help to collect and divert runoff. On-site ditches will be placed around the perimeter of the pad and soil stockpiles to divert on-site and off-site surface water to the sediment trap or detention basin area. Diversion ditches and berms will be used to collect and direct on-site stormwater to outlets, deflect and redirect off-site runoff around the disturbance area, and store on-site stormwater.

Limitations

Ditches must be regularly maintained sometimes several times a year depending on site conditions. Ditches may erode and fill in if they not properly maintained, compacted, and/or stabilized with vegetation or road base. Ditches will fail if they are not properly sloped or not deep enough to contain the diverted runoff. Ditches that cross roads must have a stabilized low water crossing or culvert. Ditches concentrate flows and increase runoff velocities. Ditches must be released into an appropriate outlet structure or they can become a source of erosion. Ditch outlet structures must release into downstream historical drainages. Ditches with steep slopes and increased velocities will require check dams and stabilization such as erosion control blankets, road base, or liners.

Location

Two permanent ditches will be constructed on the west and east sides of the facility to ensure that runoff remains on-site and is diverted to the detention basin area. A temporary ditch re-route will direct off-site runoff and on-site runoff from the topsoil stockpile to the sediment trap and outlet. Treated stormwater will exit the sediment trap onto undisturbed ground where the natural contours will drain away from the project area. Ditches shall have a minimum slope of 0.5%, 12" depth minimum, and 2:1 slope.

5.3 Culvert

Description

A culvert is a structure that channels water through an obstacle, with a sole purpose to allow water to drain. It allows normal drainage to flow under a travel way and to drain inside road ditches.

Applicability

Culverts are installed to periodically relieve the ditch line flow by piping water to the opposite side of the obstacle where the flow can be dispersed away from the roadway.

Limitations

Culverts must be regularly inspected and maintained, especially during construction activities. Without proper maintenance, culverts with high water velocities may result in soil erosion. Culverts with the minimum diameter will help with drainage and ditch relief to prevent failure from debris and blockages.

Location

Three culvert locations will be required to ensure proper on-site and off-site drainage. Three 12-inch corrugated metal pipe (CMP) culverts will convey on-site and off-site runoff from east of the project site to the north under the temporary access road and each of the permanent access roads during both the construction and production phases.

5.4 Sediment Trap

Description

A sediment trap consists of a sub-grade excavation that captures and detains runoff, storing sediment and releasing runoff. Sediment traps are designed to capture drainage from disturbed areas and allow sediment to settle prior to being discharged. In order to provide additional capture volume and treatment, sediment traps are designed to be oversized when possible.

Applicability

Sediment traps help prevent the transport of sediment offsite during construction activities and slope stabilization periods. Sediment traps are used as outlet structures for on-site drainage ditches.

Limitations

Sediment traps must be regularly inspected and maintained, especially during construction activities. Sediment traps may fail by being filled in if they not properly maintained. Sediment traps could also erode if they are not properly compacted and the outlet is not properly stabilized.

Location

One 20 feet by 20 feet by 3 feet deep sediment trap will be installed at the end of the temporary ditch re-route during the construction phase. The sediment trap will be reclaimed during the production phase.

5.5 Stormwater Detention Basin

Description

Stormwater detention basins capture runoff in a large area allowing sediment to settle prior to flows being released. By detaining on-site stormwater, flows are released more slowly than without the control structure. During both the construction and production phase, an engineered stormwater detention basin area will hold stormwater from the required 100-year storm event and control release rates through an outlet pipe and emergency spillway. As an additional erosion and sediment control measure, the outlet pipe will discharge to a riprap pad surrounded with straw wattles to slow the velocity and minimize sediment before outflows are released off site.

Applicability

The stormwater detention area is designed to be site-specific and are appropriate for detaining stormwater from the project area.

Limitations

Stormwater detention basins only provide peak flow reduction and do little to control stormwater volume. Stormwater detention basins have limited water quality treatment capacity.

Location

During the construction phase, stormwater from the well pad and production facility will drain to the stormwater detention basin located north of the facility. The outlet, utilized during both the construction and production phase, will consist of two 12-inch diameter high-density polyethylene (HDPE) pipes. One will have an orifice cap to control release rates and one will have no orifice cap. Anti-seep collars should be used to prevent seepage through the berm and outlet slopes should be protected using geotextile fabric or riprap in order to prevent erosion along the embankment.

5.6 Riprap Apron

Description

Riprap aprons are runoff energy dissipation devices usually constructed from rip-rap at the end of culverts and pipe outlets. Riprap aprons are specified by rip-rap gradations, length, and width. The purpose of riprap aprons is to reduce the stormwater runoff velocities from ditches and culverts and spread out the runoff as it is released.

Applicability
Riprap aprons are used at the end of ditches and culverts. Riprap aprons help to reduce areas susceptible to erosion.

Limitations
Riprap aprons must be regularly maintained especially during construction activities. Riprap aprons are not sediment traps and if allowed to silt in they may become a source of erosion. Riprap aprons may fail if they are undersized or not property placed.

Location
This site will have riprap aprons located at the inlet and outlet of each culvert and the pipe outlet for the stormwater detention basin.

5.7 Sediment Control Logs

Description
Sediment control logs are a manufactured tubular sediment collection device sometimes referred as "straw wattles." Sediment control logs are at a specified diameter and must be installed according to the manufacturer's recommendations and specifications. The purpose of the sediment control logs is to capture sediment preventing it from leaving the site while releasing the stormwater runoff.

Applicability
Sediment control logs help prevent the transport of sediment offsite during the slope stabilization and revegetation periods. Sediment control logs are often placed along contour lines in short repeating intervals perpendicular to cut/fill slopes. Sediment control logs are also commonly used at the bottom of material stockpiles. Sediment control logs cannot be used as runoff diversion devices. Sediment control logs may be used as ditch check dams and storm drain inlet control devices.

Limitations
Sediment control logs must be regularly maintained especially during construction activities and slope stabilization periods. Sediment control logs have a limited sediment capture zone area and multiple lines will be needed for longer slopes. Sediment control logs must be placed in a trench which could cause slope damage while doing maintenance using heavy machinery. Sediment control logs may be difficult to install on rocky slopes.

Location
Straw wattles may be placed around the perimeter of stockpiles during both the construction and production phase to further control erosion and minimize sediment transport.

5.8 Seeding and Mulching

Description

Seeding and mulching assumes the preparation of a seedbed with topsoil, selection of an appropriate native seed mixture, proper planting techniques, and protection mulching of the seeded area. The purpose of seeding and mulching is to stabilize slopes and prevent erosion control and sediment transport from the site. Seeding also absorbs the impact of raindrops, reduces the velocity of runoff, reduces runoff volumes by increasing water permeation into the soil, binds soil with roots, protects soil from wind, improves wildlife habitat, and enhances natural beauty.

Applicability

Seeding and mulching is used for slope stabilization and erosion control on all disturbed slopes, berms, ditches, and material stockpiles during construction following interim reclamation efforts. Operator will seed with a mix specified by the surface owner. Seeding will be applied at the optimum seeding methodology. Typical seed mix and application rates can be found in Appendix C.

Limitations

Without proper seedbed preparation and seed mix, seeding and mulching will fail. Seeding and mulching takes time to develop and slopes will need to be protected and regularly maintained. Noxious weeds transported onsite may become a site nuisance and a hazard to private property and may try to establish themselves in seedbed areas.

Location

Permanent seeding will be applied to all topsoil stockpiles and reclaimed areas during the production phase.

6.0 SITE MAINTENANCE AND UPKEEP

The Crestone Peak Resources Operating LLC site monitoring program ensures site conditions stay in compliance. Sedimentation, culvert and access road condition, vegetation health, and several other safety and maintenance items are routinely monitored and evaluated to ensure the site is in workable and drainable order.

Routine maintenance and required repairs of access roads, culverts, ditches, berms, and outlet structures will be handled by the operations team. Cleaning and removal of sediment and debris from ditches, culverts, and outlets, as well as vegetation maintenance and specific manufacturer maintenance, will also be handled by the operations team during regular operations and maintenance checks.

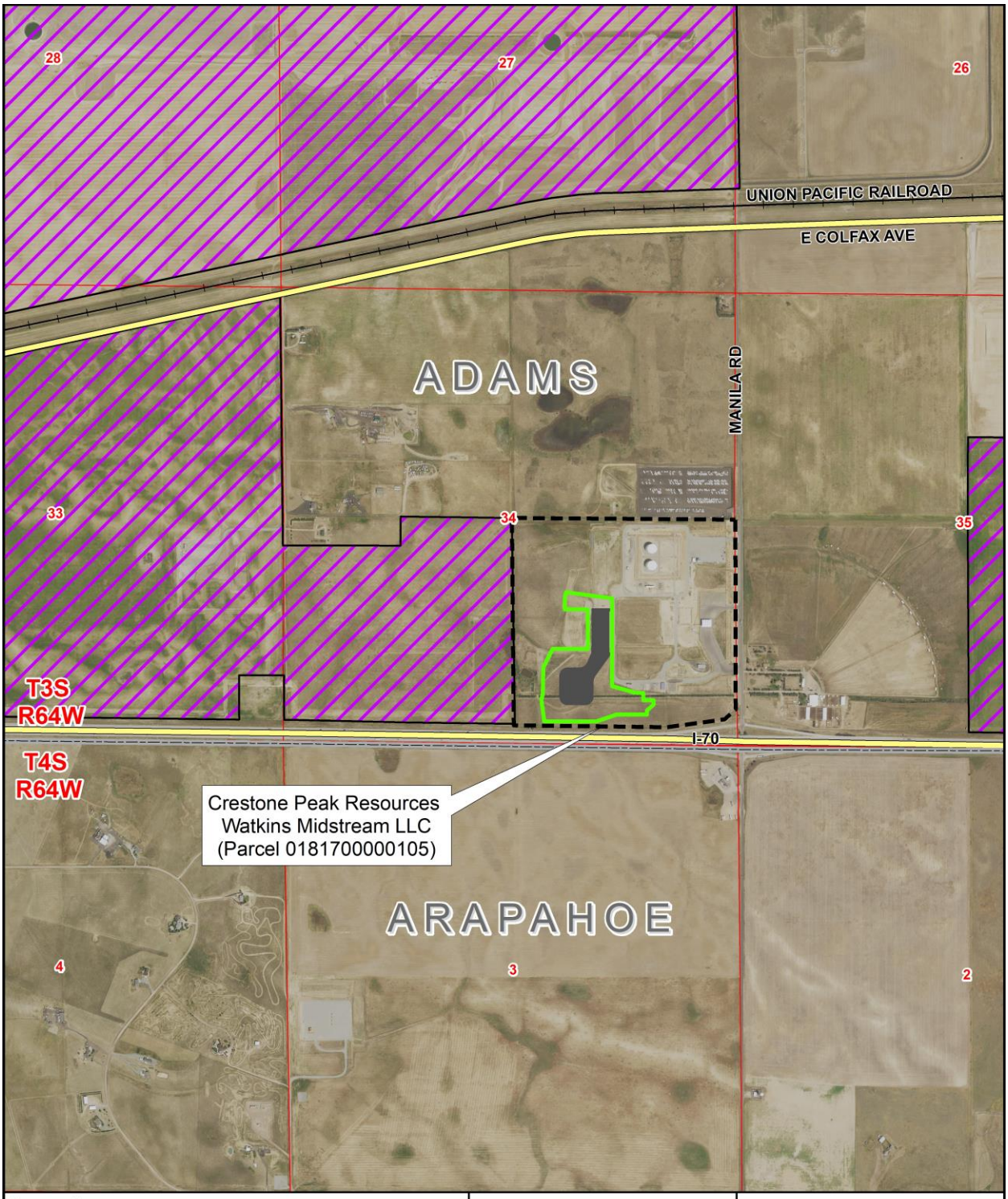
7.0 CONCLUSION

The information and analysis presented in this SWMP display the adequacy and effectiveness of the design and planning associated with the Bennett D Pad. The design protects public health, safety, and general welfare and has no adverse impacts on public rights-of-way or off-site properties.

APPENDICES

Appendix A:

Project Location



Legend

- Proposed Oil and Gas Location
- Bennett D Pad Operational Area
- City of Aurora
- County Boundary
- Railroad

N
W E
S

0 0.25 miles

Prepared For:

CIVITAS

CRESTONE PEAK RESOURCES, LLC
555 17TH STREET, SUITE 3700
DENVER, CO 80202

609 CONSULTING, LLC

LOVELAND OFFICE
6706 North Franklin Avenue
Loveland, Colorado 80538
Phone 970-776-4331

SHERIDAN OFFICE
1095 Saberton Avenue
Sheridan, Wyoming 82801
Phone 307-674-0609

Appendix B:

FEMA Flood Insurance Rate Map FIRMette

National Flood Hazard Layer FIRMette

FEMA

104°32'20"W 39°44'41"N

104°31'42"W 39°44'14"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 10/14/2024 at 6:59 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Appendix C:

Seed Mix

Table 4
Seed Mix and Application Rates

ADAMS COUNTY, COLORADO

SEED MIX	APPLICATION RATE (lbs/acre)
PBSI Dryland Aggressive Mix	**25**
(20%) Green Needlegrass, Lodorm	
(20%) Slender Wheatgrass, Native	
(20%) Western Wheatgrass, Native	
(20%) Pubescent Wheatgrass, Luna	
(20%) Intermediate Wheatgrass, Oahe/Rush	
PBSI Native Prairie Mix	**15**
(25%) Blue Grama	
(10%) Buffalograss	
(20%) Green Needlegrass	
(20%) Sideoats Grama	
(25%) Western Wheatgrass	
PBSI Native Sandyland Mix	**15**
(20%) Yellow Indiangrass	
(10%) Little Bluestem	
(10%) Indian Rice Grass	
(10%) Sideoats Grama	
(10%) Sand Lovegrass	
(10%) Prairie Sandreed	
(20%) Switchgrass	
PBSI Premium Irrig. Pasture Mix #1	**25**
(75%) Meadow Bromegrass, Paddock/Fleet	
(25%) Orchardgrass, Elsie/Megabite/Paiute	

Notes:
lbs/acre = pounds per acre
% = percent

Appendix D:

CDPS General Permit Certification

COLORADO
Department of Public Health & Environment

CERTIFICATION TO DISCHARGE
UNDER
CDPS GENERAL PERMIT COR400000
STORMWATER ASSOCIATED WITH CONSTRUCTION ACTIVITY

Certification Number: **COR401104**

This Certification to Discharge specifically authorizes:

Owner Civitas Resources
Operator Civitas Resources
to discharge stormwater from the facility identified as

COP Field Permit Arapahoe County West of Watkins

To the waters of the State of Colorado, including, but not limited to:

Box Elder Creek, Coal Creek, South Platte River

Facility Activity :	OilGas
Disturbed Acres:	2000 acres
Facility Located at:	County Line Rd and Watkins Rd Watkins 80137 Arapahoe County Latitude 39.662067 Longitude -104.624440
Specific Information (if applicable):	

Certification is issued: 5/15/2024
Certification is effective: 4/1/2024
Expiration date of general permit: 3/31/2029

This certification under the general permit requires that specific actions be performed at designated times. The certification holder is legally obligated to comply with all terms and conditions of the COR400000 permit.

This certification was approved by:
Andrew Sayers-Fay Permits Section Manager
Clean Water Program
Water Quality Control Division

Appendix E:

Site-Specific Stormwater BMPs

Berm (B)

Description

A berm is a ridge of compacted soil located at the top or base of a sloping disturbed area to contain or divert surface water runoff. Berms may be constructed from compactable soils sufficiently impermeable to retain water. Typically berms will be constructed using subsoils.

The purpose of a berm is to control runoff velocity, divert on-site surface runoff into a sediment trapping device, divert clean water away from disturbed areas, provide secondary containment, and to provide a safe slope barrier for vehicle traffic.

Applicability

Berms are usually appropriate for drainage basins smaller than five acres, but with modifications they can be capable of servicing areas as large as ten acres. With regular maintenance, the life span of earthen berms can last throughout the life of a project. Berms can used at, but are not limited to, the following applications:

- Along the outside shoulder of an in-sloped road to ensure runoff from the roadway drains inward and to protect the fill slope from continual disturbance during road blading and maintaining;
- Up slope of cut or fill slopes to divert flows away from disturbed areas;
- Down slope of cut or fill slopes to divert on-site runoff into a stabilized outlet or sediment trapping device;
- Along the outside shoulder of a road to provide vehicle safety or;
- Secondary containment around pollutant sources.

Limitations

- Berms may erode if not properly maintained, compacted, and or stabilized with vegetation. Berms which are adjacent to concentrated flows may require other means of stabilization.
- If a berm crosses a vehicle roadway or entrance, it needs to be compacted and widened to create a drive over that ensures simultaneous function of the berm and road. Wherever possible, berms should be designed to avoid crossing vehicle pathways.

Design Criteria

See figure B-1 for design criteria.

Construction Specifications

- Prior to berm construction, remove all trees, brush, stumps, and other objects in the path of the berm. Fill will typically consist of subsoil excavated during the construction of nearby roads or well pads.
- All berms shall have positive drainage to a stabilized outlet so runoff does not collect in ponds on the up-slope side of the berm, but instead flows along the berm until it reaches a stabilized outlet. Field location should be adjusted as needed. The stabilized outlet may be a well-vegetated area, a well pad detention pond, or a sediment control such as a silt fence or sediment trap where sediment can settle out of the runoff before being discharged.
- Berms should be constructed prior to commencement of major up-slope land disturbance. This will maximize the effectiveness of the structure as a stormwater control device.
- Berms used as secondary containment must be compacted and sufficiently impervious to retain liquids until the next routine inspection.

Maintenance Considerations

The frequency of inspections shall be in accordance with the Stormwater Management Plan (SWMP). Berms should be inspected for evidence of erosion or deterioration. Berms should also be maintained at or above the minimum required height. Any decrease in height due to settling or erosion, which impacts the effectiveness of the BMP, shall be repaired.

Removal

Berms should remain in place and in good condition until all up-slope disturbed areas are permanently stabilized. There is no need to remove a berm upon stabilization, provided the berm is stabilized and functioning properly.

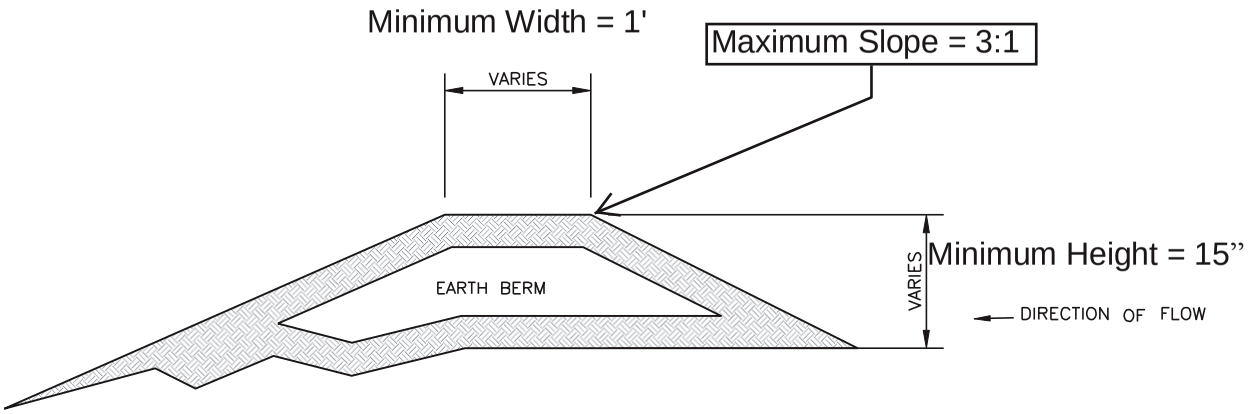
References

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control.* Washington, D.C., February, 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

New York State Department of Environmental Conservation, *New York Guidelines for Erosion and Sediment Control*. New York. August 2005.http://www.dec.ny.gov/chemical/29066.html

Urban Drainage and Flood Control District, *Volume 3 Stormwater Quality*. Denver, CO, November 2015. http://udfcd.org/volume-three

FIGURE B-1
Earth Berm



Notes:
1. Soil must be compactable and sufficiently impervious to retain/deflect stormwater.
2. Earthen Berms must be compacted to be effective.

SCALE: NOT TO SCALE

Culvert (C)

Description

Culverts are typically constructed of concrete, steel, aluminum, or plastic pipe and are used to direct stream flow or ditch water under a road or construction area.

Applicability

Culverts are ideal on roads with grades of less than 15%. For grades over 15%, it is difficult to slow down the water or remove it from road surface rapidly. On such steep grades, it is best to use frequently spaced relief culverts and drainage crossing culverts, with armored ditches (see RIPRAP [R]). Culverts may be used:

- As drainage crossing culverts in streams and gullies to allow normal drainage to flow under pathways and roads;
- As ditch relief culverts to periodically relieve the inside ditch line flow by piping water to the opposite side of the road where the flow can be dispersed away from the roadway;
- Culverts placed in natural drainages may be utilized for ditch relief.

Limitations

- Undersized culverts are susceptible to plugging and will require cleaning;
- Culverts will not filter sediment;
- Culverts are easily crushed if not properly designed/protected.

Design Criteria

Pipe size can be determined using general design criteria, such as in Table C-1, but it is ideally based upon site-specific hydrologic analysis.

Depth

The depth of culvert burial must be sufficient to ensure protection of the culvert barrel for the design life of the culvert. This requires anticipating the amount of material that may be lost to road use and erosion.

Headwalls

Use headwalls on culvert pipes as often as possible (see RETAINING WALL [RW]). The advantages of headwalls include preventing large pipes from floating out of the ground when plugged;

reducing the length of the pipe capacity; allowing debris to funnel through the pipe; retaining the backfill material; and reducing the chances of culvert failure if it is overtopped.

Construction Specifications

Drainage Crossing Culverts

- Make road crossings of natural drainages perpendicular to the drainage to minimize pipe length and area of disturbance (Figure C-1).
- Use single large pipes versus multiple smaller diameter pipes to minimize plugging potential in most channels (unless roadway elevation is critical). In very broad channels, multiple pipes are desirable to maintain the natural flow spread across the channel. All culverts should be concrete-lined corrugated metal pipe made of steel or aluminum, or properly bedded and backfilled corrugated metal or plastic pipe.
- Align culverts in the bottom and middle of the natural channel flowline so the installation causes no change in the stream alignment or stream bottom elevation. Culverts should not cause damming or pooling or increase stream velocities significantly.
- Extend the outlet of the culvert at least one foot beyond the toe of the slope to prevent erosion of the fill material. Alternatively, use retaining walls (headwalls) to hold back the fill slope when applicable.
- It may be necessary to install rip rap, erosion control blanketing, or a combination of both or other energy-dissipater device at the outlet end of the culvert to reduce soil erosion or to trap sediment (see CULVERT PROTECTION [CP]).
- It may be desirable to construct pull offs/turnouts for vehicles on one or both sides of narrow culvert crossings. This will help avoid culvert crushing as well as disturbance to roadside ditches and berms.

Ditch Relief Culverts (See Figure C-2 for installation details).

- Ditch relief culverts can provide better flow when skewed 0 to 30 degrees perpendicular to the road.
- The culvert gradient should be at least 2% greater than the approach ditch gradient. This improves the flow hydraulics and reduces siltation and debris from plugging the culvert inlet.
- Discharge the culvert at the natural ground level where possible (see Figure C-3, type A), on firm, non-erosive soil or in rocky or bushy areas. If discharging on fill slopes, and armor outlets with riprap or logging slash (see Figure C-3, type B), or use down-drain structures (see Figure C-3, type C and SLOPE DRAIN [SD]).
- Extend the inlet of the culvert at least one foot beyond the flowline of the roadside ditch.
- Extend the outlet of the culvert at least one foot beyond the toe slopes to prevent erosion of the fill material.
- It may be necessary to install riprap or other energy-dissipater devices at the outlet end of the culvert to prevent soil erosion or to trap sediment (see CULVERT PROTECTION [CP]).
- Spacing of culverts is dependent on the road gradient, soil types, and runoff characteristics according to the table below.
- It may be desirable to construct pull offs/turnouts for vehicle on one or both sides of narrow culvert crossings. This will help avoid culvert crushing as well as disturbance to roadside ditches and berms.

Soil Type	Road Grade		
	3-4%	5-8%	9-12%
Highly Corrosive Granitic or Sandy	240'	180'	140'
Intermediate Erosive Clay or Load	310'	260'	200'
Low Erosive Shale or Gravel	400'	325'	250'

Backfill and Compaction

- Firmly compact well-graded fill material (soil or road base) around culverts, particularly around the bottom half, using placement in layers to achieve a uniform density. Use slightly plastic sandy gravel with fines. Avoid the use of fine sand and silt rich soils for bedding material because of their susceptibility to piping. Pay particular attention to culvert bedding and compaction around the haunches of the pipe. Do not allow the compaction to move or raise the pipe. In large fills, allow for settlement.
- Cover the top of the metal and plastic culvert pipes with fill to a depth of at least one foot to prevent crushing by heavy trucks. Use a minimum cover of 2 feet of fill over concrete pipe. For maximum allowable fill height, **follow the manufacturer's recommendations.**
- Mound fill materials over the top of culvert pipes so the road is slightly raised at the culvert locations to help prevent erosion and water from ponding over culvert crossings. This practice, as well as placing large boulders around the culvert outlets, will also help to prevent culverts from being crushed.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). If any damage to culvert or inlet/outlet protection is noted or if there is any evidence of scour, repairs should be made immediately. Any debris that may be blocking the culvert inlet or outlet should be removed.

References

Horizon Environmental Services, Inc, *Guidance Document Reasonable and Prudent practices for Stabilization (RAPPS) of Oil and Gas Construction Sites.* April 2004.

Keller, Gordon and James Sherar, *Low-Volume Roads Engineering, Best Management Practices Field Guide.* United States Department of Agriculture (USDA), Forest Service, US Agency of International Development (USAID), 2003. http://www.blm.gov/bmp/field%20guide.htm

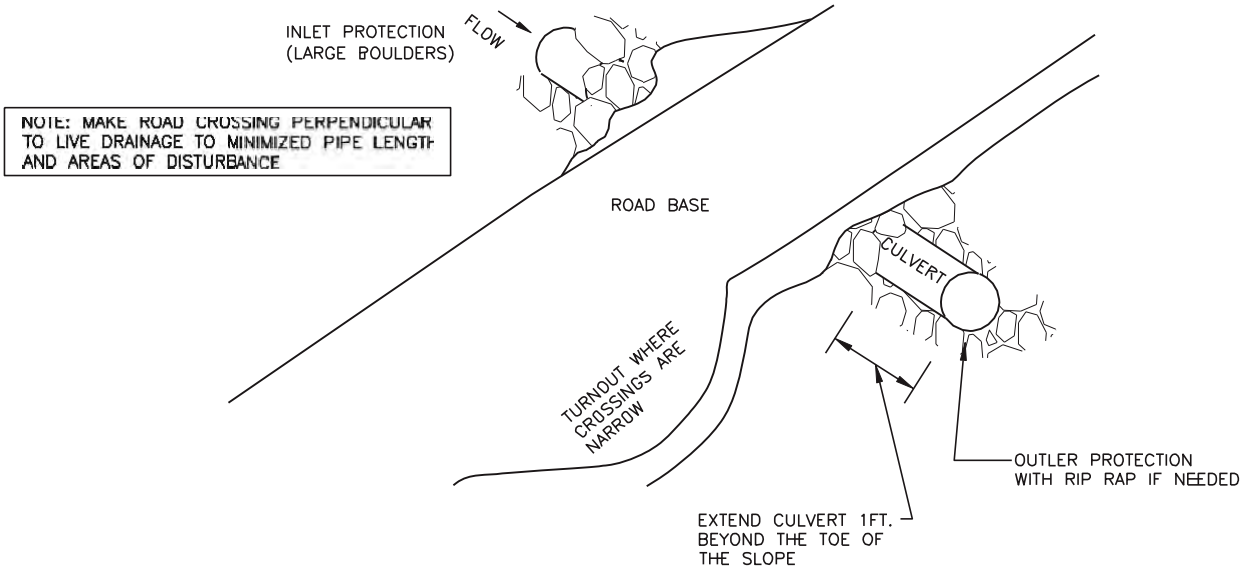
United States Department of the Interior, Bureau of Land Management (BLM), *Surface Operating Standards for Oil and Gas Exploration and Development "Gold Book"*. Fourth Edition, 2007. http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/best_management_practices/gold_book.h tml

TABLE C-1
Culvert Sizing

Drainage Area (acres)	Size of Drainage Structure (diameter and area)			
	Steep Slopes (Light Vegetation) C=0.7		Gentle Slopes (Heavy Vegetation) C=0.2	
	Round Pipe (in)	Area (sq. ft)	Round Pipe (in)	Area (sq. ft)
0-10	30"	4.9	18"	1.8
10-20	42"	9.6	24"	3.1
20-35	48"	12.6	30"	4.9
35-75	72"	28.3	42"	9.6
75-125	84"	38.5	48"	12.6
125-200	96"	50.3	60"	19.6

Note: Minimum culvert sizes are general construction practices. Engineered designs may provide other sized culverts as applicable to site-specific installation. Details will be noted in the SWMP diagram and site-specific documentation.

FIGURE C-1
Drainage Crossing Culvert Alignment & Overflow Dip



SCALE: NOT TO SCALE

FIGURE C-2

Ditch Relief Culvert Installation

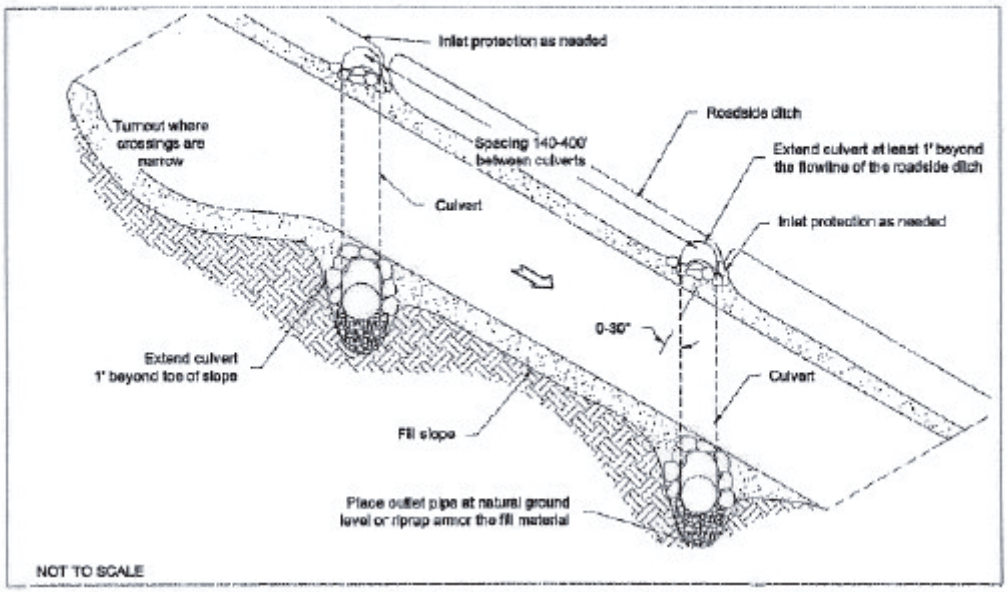
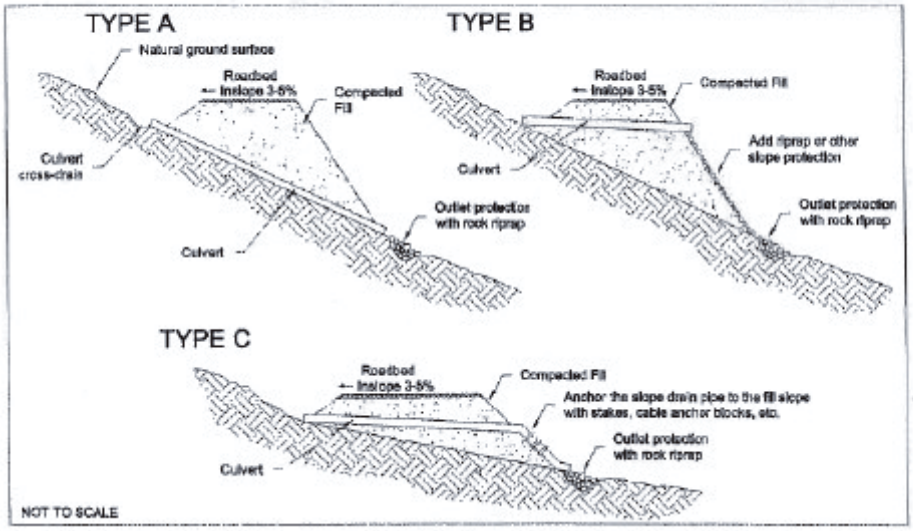


FIGURE C-3

Culvert Installation Options



Culvert Protection (CP)

Description

Culvert protection may be required at the inlet (upstream side) of the culvert and/or the outlet (downstream side) of the culvert. Protection helps to reduce erosion from culverts with concentrated, high velocity flows.

Culvert inlet protection involves placing boulders, riprap, gabions, rock retaining walls, slash, and/or any other protection at the inlet pipes. Riprap, or other energy-dissipating devices, will reduce the velocity of stormwater flows and thereby prevent erosion and help protect the inlet structure.

Culvert outlet protection involves placing structurally lined aprons or other appropriate energy-dissipating devices, such as large boulders or plunge pools, at the outlets of the pipes. Lined aprons or other appropriate energy-dissipating devices will reduce the velocity of stormwater flows and thereby prevent scour at stormwater outlets, protect the outlet structure, and minimize potential for erosion downstream.

Applicability

Riprap inlet protection should be used where velocities and energies at the inlets of culverts are sufficient to erode the inlet structure. Riprap may also be used to help channel the stormwater into the inlet of the culvert.

Culvert outlet protection should be used where discharge velocities and energies at the outlets of the culverts or channels are sufficient to erode the next downstream reach.

Limitations

Rock aprons at the culvert outlets should not be placed on slopes steeper than 10 %. Runoff from pipe outlets at the top of cut/fills or on slopes steeper than 10% should be routed using slope drains or riprap chutes to a rock apron at the toe of the slope. Otherwise, the flow will re- concentrate and gain velocity as the flow leaves the apron.

Design Criteria

See Figure CP-2 and Table CP-1 for design criteria.

Culvert Inlet Protection

Riprap, gabions, or rock retaining walls at culvert inlets shall be designed according to RIPRAP (R) or RETAINING WALL (RW).

Culvert Outlet Protection

Gabions or rock retaining walls at culvert outlets shall be designed according to RETAINING WALL (RW). Riprap aprons at culvert outlets shall be designed as follows:

Tail-water depth: The depth of tail-water immediately below the pipe outlet must be determined for the design capacity of the pipe. If the tail-water depth is less than half the diameter of the outlet pipe, and the receiving stream is wide enough to accept divergence of the flow, it shall be classified as a minimum tail-water condition. If the tail-water depth is greater than half the pipe diameter and the receiving stream will continue to confine the flow, it shall be classified as a maximum tail-water condition. Pipes out-letting onto flat areas with no defined channel may be assumed to have a minimum tail-water condition.

Riprap apron size and D50 size: The apron length (LA) and the D50 size of the riprap will be determined using Table CP-1 according to the design flow and weather there is a minimum or maximum tail-water condition. The apron width (W) shall then be determined as (W=d+0.4LA) where d is the diameter of the culvert. If the pipe discharges directly into a well-defined channel, the apron shall extend across the channel bottom and up the channel banks to an elevation one foot above the maximum tail-water depth or to the top of the bank, whichever is less. The upstream end of the apron, adjacent to the pipe, shall have a width of two times the diameter of the outlet pipe.

Riprap materials: The outlet protection may be done using rock riprap or grouted riprap. Riprap shall be composed of a well-graded mixture of stone size such that 50% of the pieces, by weight, shall be larger than the D50 size determined from Table CP-1. A well-graded mixture, as used herein, is defined as a mixture composed primarily of larger stone sizes, but with a sufficient mixture of other sizes to fill the smaller voids between the stones. The diameter of the largest stone size in such a mixture shall be 1.5 times the D50 size. All grout for grouted riprap must be 1-part Portland cement for every 3-parts sand, mixed thoroughly with water.

Filter: If a filter cloth or gravel is used, it should be designed according to RIPRAP (R).

Apron thickness: The minimum thickness of the riprap layer shall be 1.5 times the maximum stone diameter for a D50 of 15 inches or less and 1.2 times the maximum stone size for a D50 greater than 15 inches.

Riprap stone quality: Stone for riprap shall consist of field stone or rough un-hewn angular stone. The stone shall be hard and angular and of a quality that will not disintegrate with exposure to water or weathering. The specific gravity of the individual stone shall be at least 2.5. Site rock or site boulders may be used providing it has a density of at least 150 pounds per cubic foot and does not have any exposed steel or reinforcing bars

Construction Specifications

Culvert Inlet Protection

- Riprap, gabions, or rock retaining walls at culvert inlets shall be constructed in accordance to RIPRAP (R) or RETAINING WALL (RW).
- After installation of a culvert, examine the stream channel for the amount of debris, logs, and brushy vegetation present. In channels with large amounts of debris, consider using oversized pipes.
- Boulders should be dry-stacked around the culvert inlet and up the slope to the edge of the road.

Culvert Outlet Protection

Gabions or rock retaining walls at culvert outlets shall be designed according to RETAINING WALL (RW). Riprap aprons at culvert outlets shall be constructed according to CP-2 and the following:

- Prepare the sub-grade for the riprap to the required lines and grades. Any fill required in the sub-grade shall be compacted to a density of approximately that of the surrounding undisturbed material.
- If a pipe discharges into a well-defined channel, the channel's side slopes may not be steeper than 2:1.
- Construct the apron to the design length and width with no slope (Figure CP-2). The invert elevations must be equal at the receiving channel and the apron's downstream end. No over-fall at the end of the apron is allowed. The elevation of the downstream culvert outlet and of the apron shall be equal to the elevation of the receiving channel or adjacent ground. The outlet protection apron shall be located so there are no bends in the horizontal alignment.
- Line the apron with riprap, grouted riprap, or concrete. Riprap should be the appropriate size thickness and design. See RIPRAP (R) for the placement of riprap.
- If a culvert outlet discharges at the top of cut/fills or on slopes steeper than 10%, one of the following options is suggested:
    1. Transition the culvert to a slope drain according to SLOPE DRAIN (SD). The slope drain shall convey stormwater to the bottom of the slope where the riprap apron, as designed above, shall prevent erosion at the slope drain outlet.
    2. Line the slope below the culvert outlet with a riprap channel to convey stormwater to the bottom of the slope where a riprap apron, as designed above, shall prevent erosion at the bottom of the slope. The riprap channel shall be designed according to the table in the RIPRAP (R) construction specification based on depth of flow and slope. The riprap channel shall dip into the slope such that all water is contained within the channel, flows to the riprap outlet apron at the base of the slope, and does not spill over the sides onto unprotected soil.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). Inspect for debris at the entrance to culverts and within culverts. Inspect riprap at culvert inlets for damage and dislodged stones. The maintenance needs are usually very low for properly installed riprap aprons at culvert outlets. However, inspect for evidence of scour beneath riprap at outlet aprons or for dislodged stones. Anything found to reduce the effectiveness of the culvert or culvert outlet protection should be repaired immediately.

References

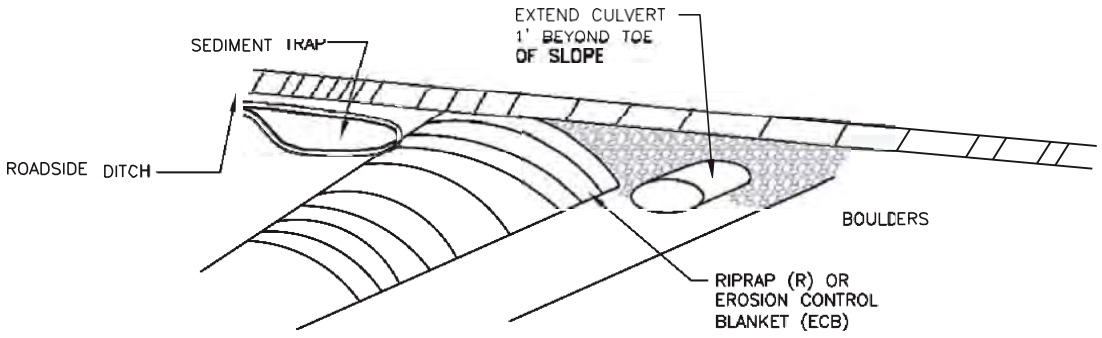
Keller, Gordon and James Sherar, *Low-Volume Roads Engineering, Best Management Practices Field Guide.* United States Department of Agriculture (USDA), Forest Service, US Agency of International Development (USAID), 2003. http://www.blm.gov/bmp/field%20guide.htm

New York State Department of Environmental Conservation, *New York Guidelines for Erosion and Sediment Control*. New York. August 2005. http://www.dec.ny.gov/chemical/29066.html

TABLE CP-1
Outlet Protection Design

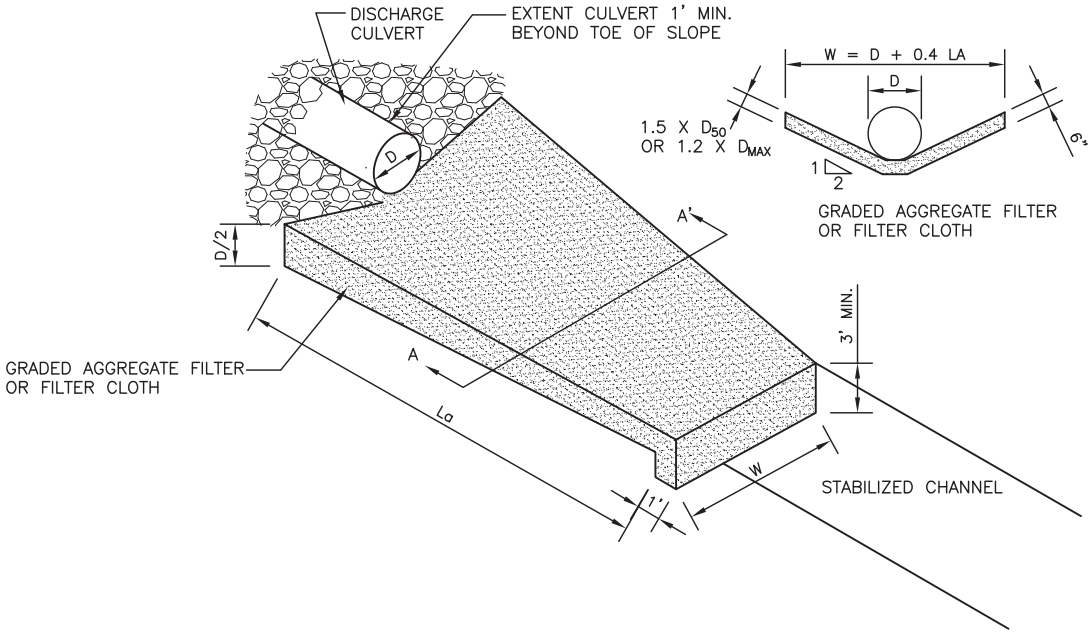
Riprap Aprons for Low Tailwater (downstream flow depth <0.5 X pipe diameter)																
Culvert Diameter	Lowest Value			Intermediate values to interpolate from									Highest value			
	Q	L_A	D_{50}	Q	L_A	D_{50}	Q	L_A	D_{50}	Q	L_A	D_{50}	Q	L_A	D_{50}	
	Cfs	Ft	In	Cfs	Ft	In	Cfs	Ft	In	Cfs	Ft	In	Cfs	Ft	In	
12"	4	7	2.5	6	10	3.5	9	131	6	12	16	7	14	17	8.5	
15"	6.5	8	3	10	12	5	15	16	7	20	18	10	25	20	12	
18"	10	9	3.5	15	14	5.5	20	17	7	30	22	11	40	25	14	
21"	15	11	4	25	18	7	35	22	10	45	26	13	60	29	18	
24"	21	13	5	35	20	8.5	50	26	12	65	30	16	80	33	19	
27"	27	14	5.5	50	24	9.5	70	29	14	90	34	18	110	37	22	
30"	36	16	6	60	25	9.5	90	33	15.5	120	38	20	140	41	24	
36"	56	20	7	100	32	13	140	40	18	180	45	23	220	50	28	
42"	82	22	8.5	120	32	12	160	39	17	200	45	20	260	52	26	
48"	120	26	10	170	37	14	220	46	19	270	54	23	320	64	37	
Riprap Aprons for High Tailwater (downstream flow depth <0.5 X pipe diameter)																
Culvert Diameter	Lowest Value			Intermediate values to interpolate from									Highest value			
	Q	L_A	D_{50}	Q	L_A	D_{50}	Q	L_A	D_{50}	Q	L_A	D_{50}	Q	L_A	D_{50}	
	Cfs	Ft	In	Cfs	Ft	In	Cfs	Ft	In	Cfs	Ft	In	Cfs	Ft	In	
12"	4	8	2	6	18	2.5	9	28	4.5	12	36	7	14	40	8	
15"	7	8	2	10	20	2.5	15	34	5	20	42	7.5	25	50	10	
18"	10	8	2	15	22	3	20	34	5	30	50	9	40	60	11	
21"	15	8	2	25	32	4.5	35	48	7	45	58	11	60	72	14	
24"	20	8	2	35	36	5	50	55	8.5	65	68	12	80	80	15	
27"	27	10	2	50	41	6	70	58	10	90	70	14	110	82	17	
30"	36	11	2	60	42	6	90	64	11	120	80	15	140	90	18	
36"	56	18	2.5	100	60	7	140	85	13	180	104	18	220	120	23	
42"	82	15	2.5	120	50	60	160	75	10	200	96	14	260	120	19	
48"	120	20	2.5	170	58	7	220	85	12	270	105	16	320	120	20	

FIGURE CP-1
Typical Inlet Protection



SCALE: NOT TO SCALE

FIGURE CP-2
Typical Outlet Protection



Ditch and Berm (DB)

Description

A ditch and berm (also known as Earthen Dike and Drainage Swale) is a drainage with a parabolic or V-shaped cross-section and a supporting ridge on the lower side that is constructed across the slope. The purpose of a ditch and berm is to prevent off-site stormwater runoff (runon) from entering a disturbed area, to prevent sediment laden storm runoff from leaving the construction site or disturbed area, to prevent flows from eroding slopes, and to direct sediment laden flows to a trapping device.

Applicability

Ditch and berms can be designed for temporary or permanent use. Regardless of timeframe, a ditch and berm should be sufficiently constructed throughout to minimize the potential for failure. Ditch and berms may be used for, but are not limited to:

- The up slope of cut or fill slopes to convey or divert flows away from disturbed areas;
- The down slope of cut or fill slopes to divert on-site runoff to a stabilized outlet or sediment trapping device;
- At the outer edge of a location to ensure that runoff remains on the pad and is diverted to a designated water collection system, such as a sediment trap, pond, etc. (if applicable);
- Where runoff from higher areas has potential for causing erosions, or interfering with, or preventing the establishment of vegetation on lower areas;
- Where the length of slopes need to be reduced so soil loss will be kept to a minimum;
- At the perimeter of a site or disturbed area.

Limitations

- The area around the ditch and berm that is disturbed by its construction must be stabilized (with vegetation or other erosion control) so it is not subject to similar erosion as the steep slope the channel is built to protect. Overburden needs to be sufficiently compacted upon initial ditch construction.
- To alleviate erosion capability, ditch and berms must be directed into a stabilized outlet or well-vegetated area or to sediment trapping devices, where erosion sediment can be settled out of the runoff before being discharged into surface waters.
- Temporary ditch and berms should be designed to avoid crossing vehicle pathways. If a ditch needs to cross a vehicle pathway a culvert and or similar BMPs must be utilized.
- Ditch and berms should be used with caution on soils subject to slippage.

Design Criteria

See Figures ED-1, DS-1, DS-2, DS-3, DS-4 and/or DS-5 for design criteria and installation details.

Construction Specifications

- All trees, brush, stumps, obstructions, and other objectionable material shall be removed and disposed of so as not to interfere with the proper functioning of the ditch and berm. Ideally the ditch will be cut in a location that avoids obstructions and or objects as to avoid additional disturbance.
- All ditch and berms shall have uninterrupted positive grade to an outlet.
- All ditch and berms shall be parabolic or V-shaped if possible.
- The ditch and berm shall be excavated or shaped to line, grade, and cross section as required to meet the specific criteria, depending on ditch design (see ED/DS Diagram).
- All ditch and berms must be cut to a minimum depth of 15 inches from the top of the ditch to the bottom center.
- The side slopes must be 3:1 to ensure ease of maintenance, minimize erosion, and allow the ditch to adequately disperse flow.
- All ditch and berms must have a minimum width of 7.5 feet from ridge to ridge.
- In the event of an excavated ditch and berm, all overburden needs to be sufficiently compacted along the ditch edge.
- Rills shall be compacted as needed to prevent unusual settlement that would interfere with the proper functioning of the ditch and berm.
- All earth that is removed and not needed in the construction process shall be spread or disposed of on the well pad side so it will not interfere with the functioning of the ditch and berm.
- Stabilization BMPs shall be incorporated into all ditch and berms immediately after the ridge and channel are constructed in order to minimize erosion, degradation, and sediment deposition from the ditch. Permanent ditch and berms must be seeded or hydro seeded and mulched or covered with erosion control blanketing according to SEEDING (S) and MULCHING (M) or EROSION CONTROL BLANKET (ECB) along with any disturbed areas that drain into the ditch and berm.
- Diverted runoff from a disturbed area shall be conveyed to a sediment trapping device.
- Diverted runoff from an undisturbed area shall outlet to a sediment trapping device or into an undisturbed stabilized area at non-erosive velocities. Vegetative outlets shall be installed before ditch and berm construction, if needed, to ensure establishment of vegetative cover in the outlet channel.

Location

Ditch and berms are usually located above or below cut or fill slopes. Exact ditch and berm location shall be determined by considering outlet conditions, topography, land use, soil type, length of slope, and the development layout. Where possible on shallow slopes, a vegetative buffer strip should be left between the edge of the cut or fill slope and the ditch and berm. See VEGETATIVE BUFFER (VB).

For clay vegetated channels. Ditch and berms are usually not applicable below high sediment producing areas unless structural measures, designed to prevent damaging accumulations of sediment in the channels, are installed with or before the ditch and berm.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). Channels should be cleared of sediment and repairs made when necessary. Maintain ditch and berm capacity, ridge height, especially if high-sediment yielding areas are in the drainage area above the ditch and berm. Redistribute the sediment as necessary to maintain the capacity of the ditch and berm.

Removal

Temporary ditch and berms shall remain in place only until the disturbed areas are re-graded and prepared for permanent stabilization. Permanent ditch and berms shall remain in place until final reclamation (abandonment).

References

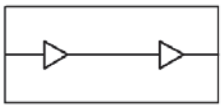
United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February, 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

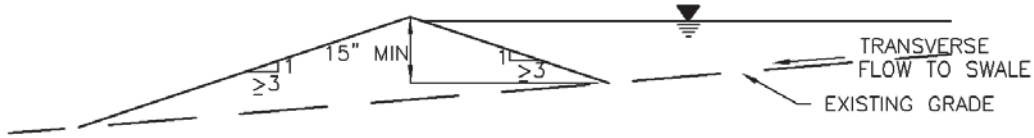
New York State Department of Environmental Conservation, *New York Guidelines for Erosion and Sediment Control*. New York. August 2005. http://www.dec.ny.gov/chemical/29066.html

United States Department of Agriculture (USDA), Natural Resources Conservation Services (NRCS), *Field Office Technical Guide.* 2002. http://www.nrcs.usda.gov/technical/efotg/

Urban Drainage and Flood Control District, *Volume 3 Stormwater Quality*. Denver, CO, November 2015. http://udfcd.org/volume-three

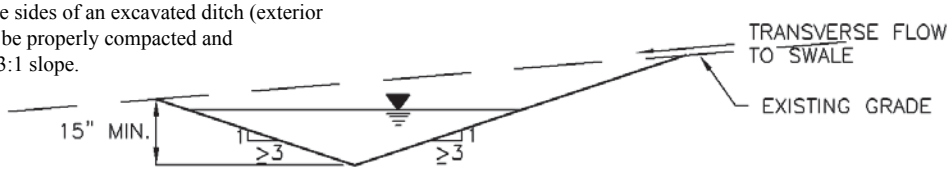
Earth Dikes and Drainage Swales (ED/DS)





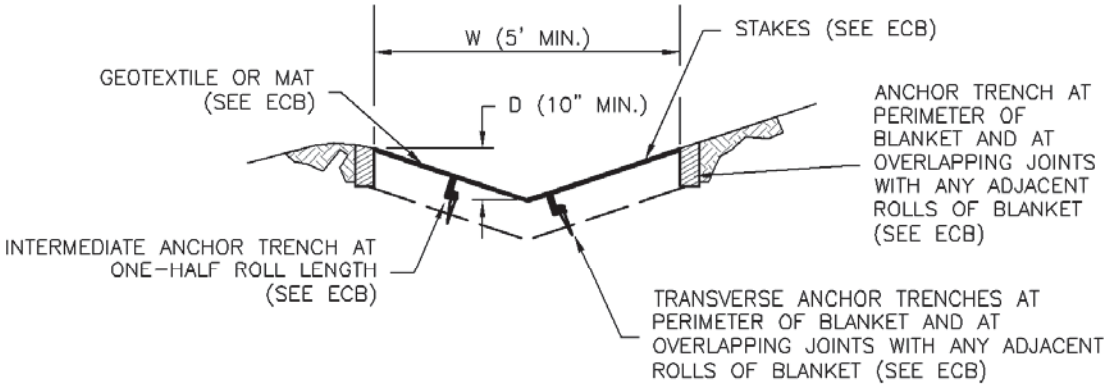
ED–1. COMPACTED UNLINED EARTH DIKE FORMED BY BERM

Optional: An interior berm is optional if all overburden generated during the constuction phase is removed and properly stored on location. All overburden that remains along the sides of an excavated ditch (exterior & interior) must be properly compacted and constructed at a 3:1 slope.



DS–1. COMPACTED UNLINED EXCAVATED SWALE

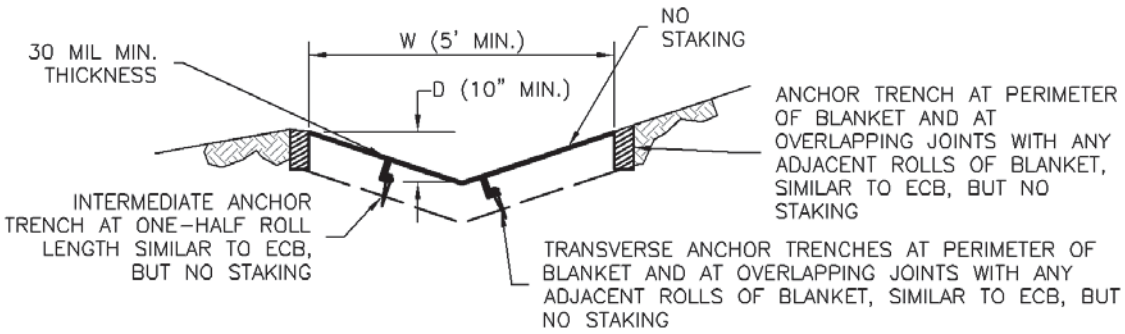
DS–2. COMPACTED UNLINED SWALE FORMED BY CUT AND FILL



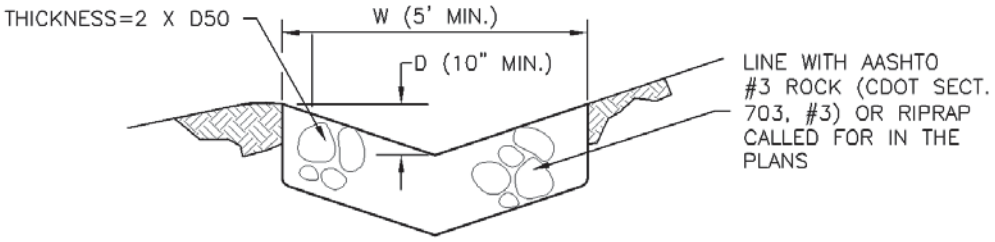
DS–3. ECB LINED SWALE (CUT AND FILL OR BERM)

Note: Excavated or fill material used to create a ditch and berm must be compacted.
Note: Locations with site-specific engineered ditch and berm desgins will be followed in lieu of this standard design and will be documented in the site-specific SWMP diagram and/or applicable documentation.

Earth Dikes and Drainage Swales (ED/DS)



DS-4. SYNTHETIC LINED SWALE



DS-5. RIPRAP LINED SWALE

EARTH DIKE AND DRAINAGE SWALE INSTALLATION NOTES

1. SEE SITE PLAN FOR:
   - LOCATION OF DIVERSION SWALE
   - TYPE OF SWALE (UNLINED, COMPACTED AND/OR LINED).
   - LENGTH OF EACH SWALE.
   - DEPTH, D, AND WIDTH, W DIMENSIONS.
   - FOR ECB/TRM LINED DITCH, SEE ECB DETAIL.
   - FOR RIPRAP LINED DITCH, SIZE OF RIPRAP, D50.

2. SEE DRAINAGE PLANS FOR DETAILS OF PERMANENT CONVEYANCE FACILITIES AND/OR DIVERSION SWALES EXCEEDING 2-YEAR FLOW RATE OR 10 CFS.

3. EARTH DIKES AND SWALES INDICATED ON SWMP PLAN SHALL BE INSTALLED PRIOR TO LAND-DISTURBING ACTIVITIES IN PROXIMITY.

4. EMBANKMENT IS TO BE COMPACTED TO 90% OF MAXIMUM DENSITY AND WITHIN 2% OF OPTIMUM MOISTURE CONTENT ACCORDING TO ASTM D698.

5. SWALES ARE TO DRAIN TO A SEDIMENT CONTROL BMP.

6. FOR LINED DITCHES, INSTALLATION OF ECB/TRM SHALL CONFORM TO THE REQUIREMENTS OF THE ECB DETAIL.

7. WHEN CONSTRUCTION TRAFFIC MUST CROSS A DIVERSION SWALE, INSTALL A TEMPORARY CULVERT WITH A MINIMUM DIAMETER OF 12 INCHES.

Note: Excavated or fill material used to create a ditch and berm (dike/swale) must be compacted.

Earth Dikes and Drainage Swales (ED/DS)

EARTH DIKE AND DRAINAGE SWALE MAINTENANCE NOTES

1. INSPECT BMPs ACCORDING TO THE APPLICABLE SWMP SCHEDULE AND MAINTAIN THEM IN EFFECTIVE OPERATING CONDITION. MAINTENANCE OF BMPs SHOULD BE PROACTIVE, NOT REACTIVE. INSPECT BMPs AS SOON AS POSSIBLE (AND ALWAYS WITHIN 24 HOURS) FOLLOWING A STORM THAT CAUSES SURFACE EROSION, AND PERFORM NECESSARY MAINTENANCE.

2. FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN BMPs IN EFFECTIVE OPERATING CONDITION. INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.

3. WHERE BMPs HAVE FAILED, REPAIR OR REPLACEMENT SHOULD BE INITIATED UPON DISCOVERY OF THE FAILURE.

4. SWALES SHALL REMAIN IN PLACE UNTIL THE END OF CONSTRUCTION; IF APPROVED BY LOCAL JURISDICTION, SWALES MAY BE LEFT IN PLACE.

5. WHEN A SWALE IS REMOVED, THE DISTURBED AREA SHALL BE COVERED WITH TOPSOIL, SEEDED AND MULCHED OR OTHERWISE STABILIZED IN A MANNER APPROVED BY LOCAL JURISDICTION.

(DETAIL ADAPTED FROIIA DOUGLAS COUNTY, COLORADO ANO THE CITY OF COLORADO SPRINGS, COLORADO, NOT AVAILABLE IN AUTOCAD)

Land Grading (LG)

Description

Grading involves reshaping the ground surface to planned grades. Grading provides more suitable topography for well pads and pipelines and helps to control runoff, soil erosion, and sediment during and after construction in these areas. Land grading includes the following.

- Proper cut and fill techniques to ensure roads and well pads remain stable over time.
- Road crowning or sloping to properly route stormwater off of the roadway.
- Surfacing of roads or well pads with gravel to avoid mud, rutting, and large quantities of sediment that will wash away during storms.

Applicability

- The construction and maintenance of any road or well pad, but particularly those located on steep topography or easily erodible soils.
- Surface gravel areas with "soft" soils sections, steep grades, highly erosive soils, or where all-weather access is needed. Gravel may be used as "fill" material in ruts or as a full structural section over the entire road or well pad.

Limitations

- Improper cut and fill slopes that disrupt natural stormwater patterns might lead to poor drainage, high runoff velocities, and increased peak flows during storm events.
- Rutting and wash boarding may develop if surface gravel is not designed properly or if road or well pad is not sloped properly.
- Flat-blading to maintain the roadway must be done properly to avoid changes in gravel thickness, road slope, and road grade.

Design Criteria

Land grading should be based upon well pad and pipeline layouts that fit and utilize existing topography and desirable natural surroundings to avoid extreme grade modifications. Clearing and grading should only occur at those areas necessary for well pad activity and equipment traffic. Maintaining undisturbed temporary or permanent buffer zones in the grading operation

provides a low cost sediment control measure that will help reduce runoff and off-site sedimentation.

Slope Failures

Landslides and failed cuts and fills can be a major source of sediment. Slope failures can close the roads or require major repairs and can greatly increase maintenance costs. Slope failures or landslides typically occur where a slope is overly steep, where fill material is not compacted, or where cuts in natural soils encounter groundwater or zones of weak material. Good road location can often avoid landslide areas and reduce slope failures. When failure does occur, the slide area should be stabilized by removing the slide material, flattening the slope, adding drainage, or using structures as discussed below. Designs are typically site specific and may require input from geotechnical engineers and engineering geologists. Failures that occur typically impact operations and can be costly to repair. Failures near streams and channel crossings have an added risk of impact to water quality.

Road Slope (See Figure LG-1 for details).

All roads should be designed with one of the following three slope types:

1. Out-sloped roads minimize the concentration of water and minimize road width by avoiding the need for an inside ditch, but may require roadway surface and fill slope stabilization. Out-sloped roads with clay rich, slippery road surface materials often require surface stabilization with gravel or limited use during rainy periods to assure traffic safety. Roads with over 10% to 12% grades and on steep hill slope areas, out- sloped roads are difficult to drain and can feel unsafe.
2. In-sloped roads are the best method to control surface water. However, in-sloped roads also concentrate water and require a system of ditches and turnouts or cross draining culverts.
3. Crowned roads are appropriate for higher standard, two lane roads on gentle grades. They may or may not require roadside ditches, turnouts, and/or cross drains. It is difficult to create and maintain a crown on a narrow road, so generally in-sloped or out-sloped road drainage is more effective.

Construction Specifications

Cut and Fill Slopes

- All areas to be disturbed (both cut and fill) shall be cleared, grubbed, and stripped of topsoil to remove trees, vegetation, roots, or other objectionable material.
- Fill material shall be free of brush, logs, stumps, roots, or other objectionable material that would interfere with, or prevent construction or satisfactory fills. This material can be set aside and later used at the toe of fill slopes as filter berms.
- Table LG-1 presents a range of commonly used cut and fill slope ratios appropriate for the soil and rock types described. Vertical cut slopes should not be used unless the cut is in rock or very well-cemented soil. Ideally, both cut and fill slopes should be constructed with a 2:1 or flatter slope to promote growth of vegetation, but cut slopes in dense, sterile soils or rocky material are often difficult to vegetate. All cut & fill slopes will be constructed according to the engineered diagrams when applicable.

- All fills shall be compacted as required to reduce erosion, slippage, settlement, subsidence, or other related problems.
- Topsoil required for the establishment of vegetation shall be stockpiled in the amount necessary to complete finished grading of all exposed areas.

Road Slope (See Figure LG-1).

- Compact soil or road base material to direct runoff.
- If crowning a road, runoff is directed to both sides of the road requiring two roadside ditches, unless runoff will drain directly to well-stabilized areas.
- If using an in-slope design, runoff will be directed toward the hillside and requires a roadside ditch with periodic turnouts or cross drain culvert installation.
- If using an out-slope design, ensure a moderate road slope with dense vegetative cover.

Surface Gravel

- Ideally, aggregate surfacing material is (1) hard, durable, and crushed or screened to a minus 2-inch size; (2) well graded to achieve maximum density; (3) contains 5-15% clayey binder to prevent raveling; and (4) has a plasticity index of 2 to 10.
- Gravel thickness should be at least twice the diameter of the largest stone with a minimum thickness of 4 inches. Gravel thickness can be reduced with the use of geotextile or geo-grid sub-grade reinforcement when gravel is placed over very weak soils. Also, geotextile layers are useful over soft soils to separate the gravel from the soil, keep it uncontaminated, and extend the useful life of the gravel.
- Compact the aggregate during construction and maintenance to achieve a dense, smooth surface and thus reduce the amount of water that can soak into the road or well pad.
- "Spot" stabilize local wet areas and soft areas with 4 to 6 inches of coarse rocky material, add more as needed.
- Blend coarse aggregate and fine clay-rich soil (when available) with 5% to 15% fines for binder to produce a desirable composite roadway material that is coarse yet well graded.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). Inspect cut and fill slopes for rills or other indications of erosion. Maintain all crowns, out slopes, in slopes, and surface gravel.

References

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

Horizon Environmental Services, Inc, *Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites.* April 2004.

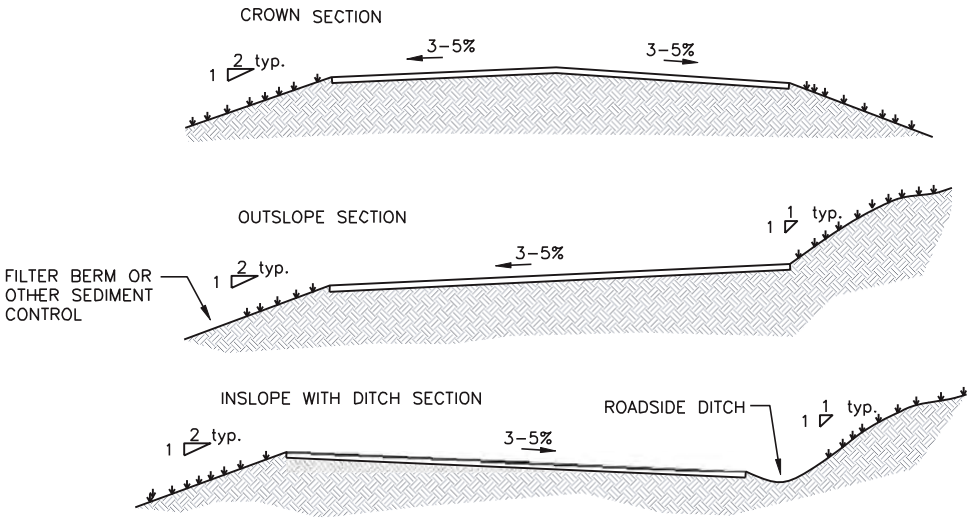
Keller, Gordon and James Sherar, *Low-Volume Roads Engineering, Best Management Practices Field Guide.* United States Department of Agriculture (USDA), Forest Service, US Agency of International Development (USAID), 2003. http://www.blm.gov/bmp/field%20guide.htm

New York State Department of Environmental Conservation, *New York Guidelines for Erosion and Sediment Control*. New York. August 2005. http://www.dec.ny.gov/chemical/29066.html

TABLE LG-1
Stable Slope Ratios for Various Conditions

Soil/Rock Condition	Slope Ratio (Hor:Vert)
Most rock	1/4: 1 to 1/2: 1
Very well cemented soils	1/4: 1 to 1/2: 1
Most in-place soils	3/4: 1 to 1: 1
Very fractured rock	1: 1 to 1 1/2: 1
Loose coarse granular soils	1 1/2: 1
Heavy clay soils	2: 1 to 3: 1
Soft clay rich zones or wet seepage areas	2: 1 to 3: 1
Fills of most soils	1 1/2: 1 to 2: 1
Fills of hard, angular rock	1 1/3: 1
Low cuts and fills (<10 ft high)	2: 1 or flatter (for revegetation)

FIGURE LG-1
Typical Road Surface Drainage Options



SCALE: NOT TO SCALE

Mulching (M)

Description

Mulching is a temporary erosion control practice in which materials such as grass, hay, wood chips, wood fibers, straw, or gravel are placed on exposed or recently planted soil surfaces. Mulching stabilizes soils by minimizing rainfall impact and reduces stormwater runoff velocity. When used in combination with seeding or planting, mulching can aid plant growth by holding seeds, fertilizers, and topsoil in place, preventing birds from eating seeds, retaining moisture, and insulating plant roots against extreme temperatures.

Mulch matting is materials such as jute or other wood fibers that are formed into sheets and are more stable than loose mulch. Jute and other wood fibers, plastic, paper, or cotton can be used individually or combined into mats to hold mulch to the ground. Netting can be used to stabilize soils while plants are growing, although netting does not retain moisture or insulate against extreme temperatures. Mulch binders consist of asphalt or synthetic materials that are sometimes used instead of netting to bind loose mulch.

Applicability

Mulching is often used after (or in combination with) seeding to help aid in the establishment of vegetation. Hydraulic application of mulch is often used in steep areas (up to 1:1) where regular mulching is difficult because of environmental constraints. Mulch matting, with net or anchoring to hold it in place, can also be used on steep slopes or in critical areas such as waterways. Mulch can last for one to two years and is most effective when used on an area less than two acres in size.

Limitations

- Mulching, matting, and netting might delay seed germination because the cover changes soil surface temperatures.
- The mulches are subject to erosion and may be washed away in a large storm.
- Maintenance is necessary to ensure that mulches provide effective erosion control.

Design Criteria

See Table M-1 and M-2 for mulch materials and application rate details.

Construction Specifications

Site Preparation

- Prior to mulching, install the necessary temporary or permanent erosion control practices and drainage system within or adjacent to the area to be mulched.
- Slope, grade, and smooth the side to fit the needs of the selected mulch products.
- Remove all undesirable stones and other debris to meet the needs of the anticipated land use and maintenance required.

Mulching and Anchoring

- Select the appropriate mulch and application rate that will best meet the need and availability of material. When possible, organic mulches should be used for erosion control and plant establishment. See Table M-1 for suggested materials and application rates. Other materials include hydraulic mulch products with 100% post-consumer paper content and yard trimming composts. All materials should be free of seed.
- Apply mulch after soil amendments and planting is accomplished or simultaneously if hydro-seeding is used. See Table M-1 for installation guidelines.
- Use a mulch crimper to apply and anchor mulch. A crimper should have approximately 6-inch cleats with perpendicular, dull, disc blades. If a crimper is unavailable the Contractor shall apply the mulch and anchor it to the soil using one of the methods described in Table M-2. The mulch should be anchored the same day as the mulch application. Materials that are heavy enough to stay in place (for example, bark or wood chips on flat slopes) do not need anchoring. Mulches may or may not require a binder, netting, or tacking. Mulch binders should be applied at rates recommended by the manufacturer. Effective use of netting and matting material requires firm, continuous contact between the materials and the soil.

Hydraulic Mulching

- For steep slopes or other areas where hydraulic application of mulch is desired, a high-quality type of hydraulic matrix known as a Bonded Fiber Matrix (BFM) may be used. A BFM refers to a continuous layer of elongated wood fiber strands that are held together by a water-resistant bonding agent to form a water-absorbing crust.
- A typical construction specification for wood fiber mulch (hydro-mulch) is as follows: Biodegradable green-dyed wood-cellulose-fiber mulch, which is nontoxic, free of plant growth- or germination-inhibitors, with maximum moisture content of 15% and a pH range of 4.5 to 6.5.
- A typical construction specification for weed-free-straw non-asphaltic tackifier is as follows: Organic derivative vegetative gum tackifier recommended by fiber-mulch manufacturer for a slurry application, which is nontoxic and free of plant growth-or germination-inhibitor.

- Hydraulic application of BFM must be done when no rainfall is expected, preferably within a 24-hour time period. Mix BFM in a hydraulic application machine (such as a hydro-seeder or a mulch blower) and then apply to the slope as a liquid slurry. The slurry must be constantly agitated to keep the proper application rate and achieve uniform effective coverage. The minimum application rate shall be 2,000 pounds per acre with a typical application rate between 3,000 and 4,000 pounds per acre.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). Areas should be identified where mulch has loosened or been removed. Such areas should be re-seeded (if necessary) and the mulch cover replaced. If washout, breakage, or erosion occurs, surfaces should be repaired, re-seeded, and re-mulched, and new netting should be installed. Inspections should be continued until vegetation is firmly established.

Removal

Anchor netting and any other artificial mulch material should be removed when protection is no longer needed and then disposed of in a landfill.

References

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control*. Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

Horizon Environmental Services, Inc, *Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites.* April 2004

New York State Department of Environmental Conservation, *New York Guidelines for Erosion and Sediment Control*. New York. August 2005. http://www.dec.ny.gov/chemical/29066.html

United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), *Field Office Technical Guide.* 2002. http://www.nrcs.usda.gov/technical/efotg/

Table M-1
Typical Mulching Materials and Application Rates

Material	Rate per Acre	Requirements	Notes
Organic Mulches			
Straw	1-2 tons	Dry, unchopped, unweathered; certified weed free	Spread by hand or machine; must be tacked or tied down
Wood fiber or wood cellulose	1/2 - 1 ton		Use with hydroseeder, may be used to tack straw. Do not use in hot dry weather.
Wood Chips	5 - 6 tons	Air dry. Add fertilizer N. 12 lb/ton	Apply with blower, chip handler, or by hand. Not for fine turf areas.
Bark	35 yd^3	Air dry, shredded, or hammermilled, or chips.	Apply with mulch blower, chip handler, or by hand. Do not use asphalt tack.
Nets and Mats			
Jute net	Cover area	Heavy, uniform; woven of single jute yarn. Used with organic mulch	Withstands water flow
Excelsior (wood fiber) mat	Cover area		

Table M-2
Mulch Anchoring Guide

Anchoring Method or Material	Kind of Mulch to be Anchored	How to Apply
1. Mulch netting	Hay or straw	Staple the light-weight paper, jute, wood fiber, or plastic nettings to soil surface according to manuracturer's recommendations. Should be biodegradable. Most products are not suitable for foot traffic.
2. Wood cellulose fiber	Hay or straw	Apply hydroseeder immediately after mulching. Use 500 lbs. Wood fiber per acre. Some products contain an adheisive material, possibly advantageous.
3. Mulch anchoring tool/Crimper	Hay or straw	Apply mulch and pull a mulch anchoring tool (blunt, straight discs) over mulch as near to the contour as possible. Mulch material should be "tucked" into soil surface about 3".
4. Chemical	Hay or straw	Apply Terra Tack AR 120lbs./ac. In 480 gal. of water (#156/sec.) or Aerospray 70 (60gal./ac.) according to manufacturer's instructions. Avoid application during rain. A 24-hour curing period and a soil temperatire higher than 45 deg. Ferhenheit are required.

Riprap (R)

Description

Riprap is a permanent, erosion resistant layer made of stones or boulders. It is intended to stabilize areas subject to erosion and protect against scour of the soil caused by concentrated, high velocity flows.

Applicability

Riprap can be used for areas subject to erosion or weathering, particularly where conditions prohibit the establishment of re-vegetation or where flow velocities exceed 5 feet per second.

Riprap can be used in, but is not limited to:

- Cut and fill slopes;
- Channel side slopes and/or bottoms;
- Inlets and outlets to culverts, slope drains, and sediment traps; and
- Roadside ditches.

Limitations

Riprap is limited by steepness of slope, because slopes that are greater than 1.5:1 have potential riprap loss due to erosion and sliding. When working within flowing streams, measures should be taken to prevent excessive turbidity and erosion during construction. Bypassing base flows or temporarily blocking base flows are two possible methods.

Design Criteria

Gradation

A well-graded mixture of rock sizes should be used instead of one uniform size (with the exception of dry stacking boulders). Fifty percent by weight should be larger than the specified design size. The diameter of the largest stone size in such a mixture should be 1.5 times the D50 size with smaller sizes graded down to one inch. When dry stacking up a slope, boulders may be uniform in size or may get gradually smaller as the boulders are placed up the slope.

Quality

Riprap must be durable so freeze/thaw cycles do not decompose it in a short time. They should be angular and not subject to breaking down when exposed to water or weathering.

Size

The sizes of stones used for riprap protection are determined by the purpose and specific site conditions:

- **Slope Stabilization:** Riprap stone for slope stabilization not subject to flowing water should be sized for the proposed grade. The gradient of the slope to be stabilized should be less than the natural angle of the repose of the stone selected. Angles of the repose of riprap stones may be estimated using Figure R-1. Riprap used for surface stabilization of slopes does not add significant resistance to sliding or slope failure and should not be considered a retaining wall. Slopes approaching 1.5:1 may require special stability analysis. The inherent ability of the soil must be satisfactory before riprap is used for surface stabilization.
- **Outlet Protection.** Design criteria for sizing stone and determining dimensions of riprap aprons are presented in CULVERT PROTECTION (CP).
- **Stream Bank Protection.** If the shear stress is estimated, riprap stone for stream bank protection can be selected from the gradations in Table R-1, below. The shear stress can be estimated from the depth of flow and the channel slope (see note for Table R-1). The riprap should extend 2 feet below the channel bottom and be keyed into the bank both at the upstream end and downstream end of the proposed work or reach.

Filter Material

Filter material is sometimes used between riprap and the underlying soil surface to prevent soil from moving through the riprap. Filter cloth material or a layer of sand and/or gravel is usually used for the filter.

The design of a sand/gravel filter blanket is based on the ratio of particle size in the overlying filter material to that of the base material in accordance with the criteria below. Multiple layers (each a minimum of 6-inches thick) may be designed to affect a proper filter if necessary. A sand/gravel filter blanket should have the following relationship for a stable design.

The design of a synthetic filter fabric, which may be used with or in place of gravel filters, is as follows:

- Filter fabric covering a base containing 50 percent or less by weight of fine particles (#200 sieve size).
- Total open area of filter fabric should not exceed 36%.
- Filter fabric covering other soils.
- Equivalent opening size (EOS) is no larger than 0.21 mm (#70 sieve size).
- Total open area of filter fabric should not exceed 10%.
- *EOS- Equivalent opening size compared to a U.S. standard sieve size.

No filter fabric should have less than 4% open area or an EOS less than U.S. Standard Sieve #100 (0.15 mm). The permeability of the fabric must be greater than that of the soil. The fabric may be

made of woven or non-woven monofilament yarns and should meet the following minimum requirements:

- Thickness 20-60 mils
- Grab strength 90-120 lbs
- Conform to ASTM D-1682 or ASTM D-177

Construction Specifications

See Figure R-2 for riprap slope stabilization and stream bank protection. See Figure R-3 for dry stacking boulders. See SEDIMENT TRAP (ST) for a detail of a riprap lined channel leading into a sediment trap. For culvert outlet protection, construct according to CULVERT PROTECTION (CP).

Sub-Grade Preparation

Prepare the sub-grade for riprap to the required lines and grades. Compact any fill required in the sub-grade to a density approximating that of the undisturbed material or overfill depressions with riprap. Remove brush, trees, stumps, and other objectionable material. Cut the sub-grade sufficiently deep so the finished grade of the riprap will be at the elevation of the surrounding area. Channels should be excavated sufficiently to allow placement of the riprap in a manner such that the finished inside dimensions and grade of the riprap meet design specifications.

Sand/Gravel Filter Basket

If using a granular filter, spread filter stone in a uniform layer to the specified depth. Where more than one layer of filter material is used, spread the layers with minimal mixing.

Synthetic Filter Fabric

If using a filter fabric, place the cloth directly on the prepared foundation. Where large stones are to be placed, a 4-inch layer of fine sand or gravel is recommended to protect the filter cloth. Filter fabric is not recommended as a filter on slopes steeper than 2:1.

Stone Placement

Place riprap so it forms a dense, well-graded mass of stone with a minimum of voids. The desired distribution of stones throughout the mass may be obtained by selective loading at the quarry and controlled dumping during the final placement. Place riprap through chutes or other methods that cause segregation of stone sizes. If a filter is used, be careful not to lodge the underlying base filter or damage the filter cloth when placing the stones. If damage occurs, remove the riprap and repair the filter.

The toe of the riprap should be keyed into a stable foundation at its base as shown in Figure R-2 if required for slope stabilization and stream bank protection. The finished slope should be free of pockets of small stones or clusters of large stones. Hand placing may be necessary to achieve proper distribution of stone sizes to produce a relatively smooth, uniform surface. The finished grade of the riprap should blend with the surrounding area.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). If riprap has been damaged or dislodged, repairs should be made to prevent a progressive failure. If repairs are needed repeatedly at one location, the site should be evaluated to determine if the original design conditions have changed. Channel obstructions such as trees and sediment bars can change flow patterns and cause erosive forces that may damage riprap. Control of weed and brush growth may be needed in some locations.

Removal

Riprap is generally not removed. If it is anticipated that riprap shall be removed from a location, removal generally occurs during pullback/reduction methods.

References

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control*. Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

New York State Department of Environmental Conservation, *New York Guidelines for Erosion and Sediment Control*. New York. August 2005. http://www.dec.ny.gov/chemical/29066.html

TABLE R-1
Riprap Gradations

Unit shear stress (lb/ft^2)	D_{50}	d_{max}	Minimum blanket thickness (inches)
0.67	2	4	6
2	6	9	14
3	9	14	20
4	12	18	27
5	15	22	32
6	18	27	32
7.8	21	32	38
8	24	36	43

Unit shear stress calculated as T=y*d*s where:

T=shear stress in lb/ft^2

y=unit weight of water, 62.4 lb/ft^2

d=flow depth in ft

s=channel gradient in ft/ft

FIGURE R-1
Angles of Repose of Riprap Stones

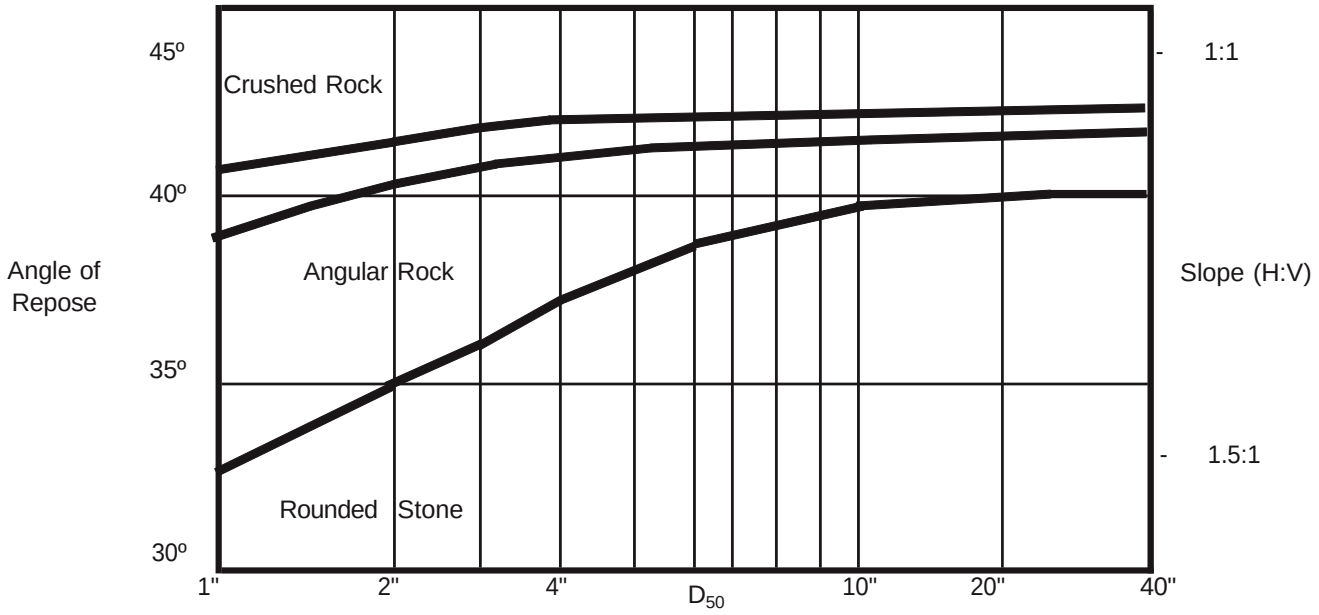


Figure R-2
Typical Riprap Slope Protection
Detail

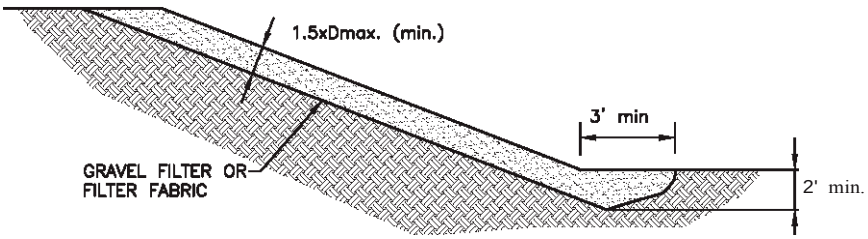
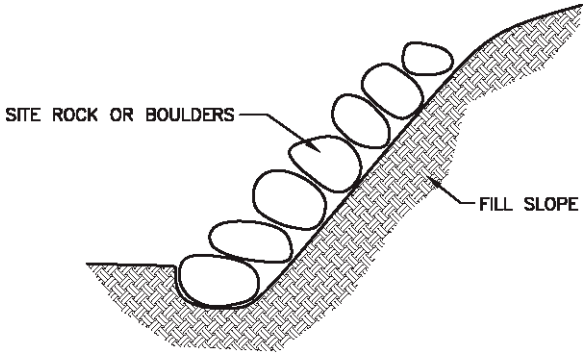


Figure R-3
Typical Boulder Drystack
Detail



SCALE: NOT TO SCALE

Sediment Basin (SB)

Description

Sediment basins can be used to temporarily pond and capture eroded or disturbed soil transported in stormwater runoff. Sediment basins are designed to capture runoff in a large pool or pond and allow sediment to settle from runoff prior to discharge from a location. The pool is dewatered through a single riser and drainage hole leading to a suitable outlet on the downstream side of the embankment or through the gravel of a rock dam. The water is released more slowly than it would be without the control structure. Many sediment basins are constructed in a location where it will remain after post-construction to serve as a permanent means of sediment settling.

Applicability

Sediment ponds are usually used for drainage areas greater than 2 acres. They can be temporary or permanent. Sediment ponds designed to be used for up to 3 years are usually described as temporary. Those designed for longer service are considered permanent. Temporary sediment basins can be converted into permanent stormwater runoff management ponds, but they must meet all regulatory requirements for wet ponds.

Limitations

Do not use a sediment pond with an earthen embankment or a rock dam in an area of continuously running water (live streams). Do not use a sediment pond in an area where failure of the earthen or rock dam will result in loss of life or damage to homes or other buildings. Do not use sediment basins in areas where failure will prevent the use of public roads or utilities.

Design Criteria

Investigate potential sites for sediment ponds during the initial site evaluation. Construct the ponds before any grading takes place in the drainage area. Ponds should take into account basin storage volume, geometry, dam embankment, and inflow structure (See Table SB-1). For permanent structures, a qualified professional engineer experienced in designing dams should complete the basin design.

Construction Specification

A sediment pond is constructed by excavation or by erecting an earthen embankment across a low area or drainage swale. Some sediment ponds are designed to drain completely during dry periods. Others are constructed so a shallow pool of water remains between storm events. See Diagram SD and Table SB for installation details.

Maintenance Considerations

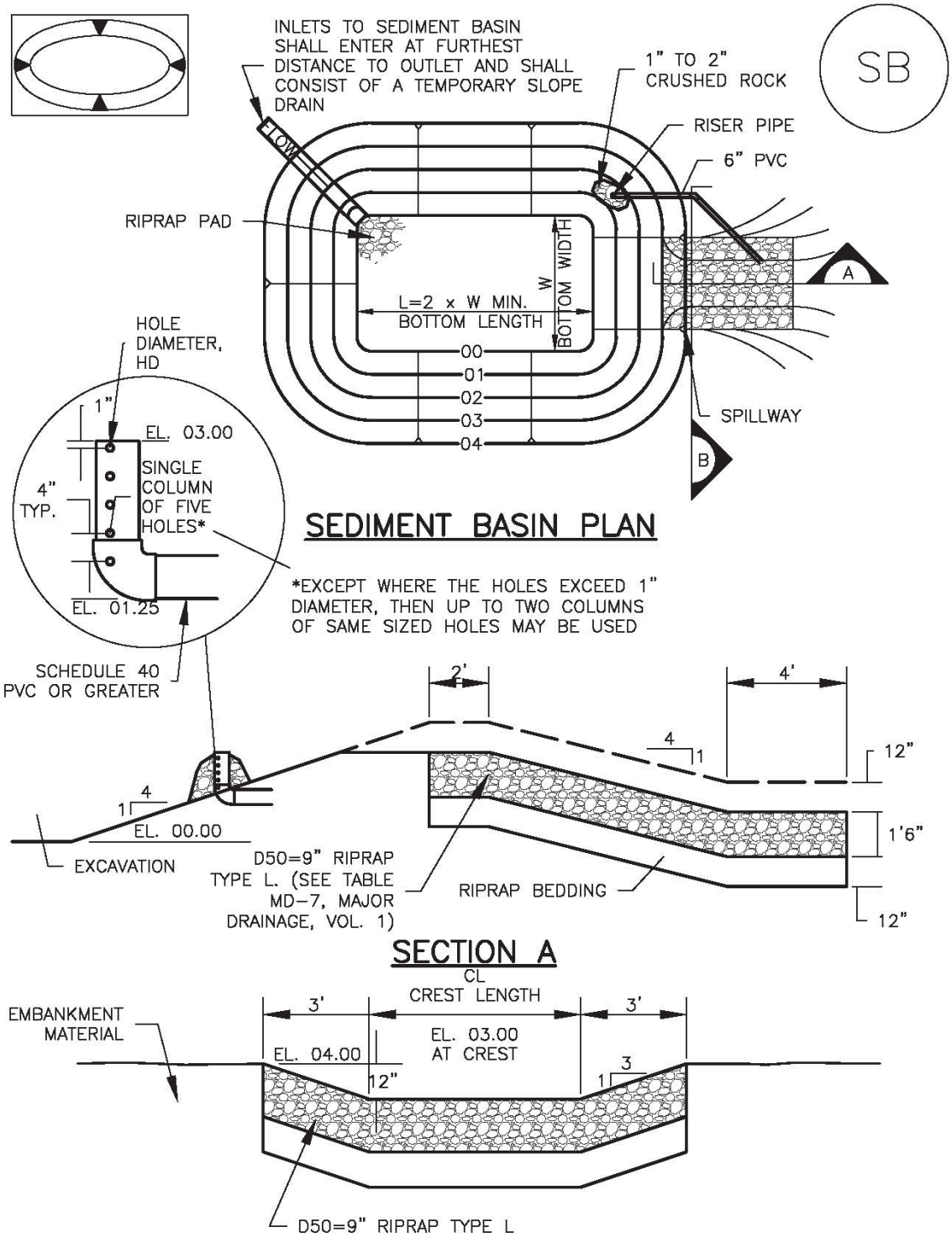
The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP) to ensure proper drainage from the collection pool and determine the need for structural repairs. Replace material eroded from earthen embankments or stones moved from rock dams immediately. Locate sediment basins in an area that is easily accessible to maintenance crews for removal of accumulated sediment. Remove sediment from the basin when the storage capacity has reached approximately 50%. Remove trash and debris from around dewatering devices promptly after rainfall events.

References

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control*. Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

Urban Drainage and Flood Control District, *Volume 3 Stormwater Quality*. Denver, CO, November 2015. http://udfcd.org/volume-three

Sediment Basin (SB)



Note: Excavated or fill material used to create a sediment basin must be compacted.

Sediment Basin (SB)

TABLE SB–1. SIZING INFORMATION FOR STANDARD SEDIMENT BASIN			
Upstream Drainage Area (rounded to nearest acre), (ac)	Basin Bottom Width (W), (ft)	Spillway Crest Length (CL), (ft)	Hole Diameter (HD), (in)
1	12 ½	2	9/32
2	21	3	13/16
3	28	5	½
4	33 ½	6	9/16
5	38 ½	8	21/32
6	43	9	21/32
7	47 ¼	11	25/32
8	51	12	27/32
9	55	13	7/8
10	58 ¼	15	15/16
11	61	16	31/32
12	64	18	1
13	67 ½	19	1 1/16
14	70 ½	21	1 1/8
15	73 ¼	22	1 3/16

SEDIMENT BASIN INSTALLATION NOTES

1. SEE PLAN VIEW FOR:
   - –LOCATION OF SEDIMENT BASIN.
   - –TYPE OF BASIN (STANDARD BASIN OR NONSTANDARD BASIN).
   - –FOR STANDARD BASIN, BOTTOM WIDTH W, CREST LENGTH CL, AND HOLE DIAMETER, HD.
   - –FOR NONSTANDARD BASIN, SEE CONSTRUCTION DRAWINGS FOR DESIGN OF BASIN INCLUDING RISER HEIGHT H, NUMBER OF COLUMNS N, HOLE DIAMETER HD AND PIPE DIAMETER D.

2. FOR STANDARD BASIN, BOTTOM DIMENSION MAY BE MODIFIED AS LONG AS BOTTOM AREA IS NOT REDUCED.

3. SEDIMENT BASINS SHALL BE INSTALLED PRIOR TO ANY OTHER LAND–DISTURBING ACTIVITY THAT RELIES ON ON BASINS AS AS A STORMWATER CONTROL.

4. EMBANKMENT MATERIAL SHALL CONSIST OF SOIL FREE OF DEBRIS, ORGANIC MATERIAL, AND ROCKS OR CONCRETE GREATER THAN 3 INCHES AND SHALL HAVE A MINIMUM OF 15 PERCENT BY WEIGHT PASSING THE NO. 200 SIEVE.

5. EMBANKMENT MATERIAL SHALL BE COMPACTED TO AT LEAST 95 PERCENT OF MAXIMUM DENSITY IN ACCORDANCE WITH ASTM D698.

6. PIPE SCH 40 OR GREATER SHALL BE USED.

7. THE DETAILS SHOWN ON THESE SHEETS PERTAIN TO STANDARD SEDIMENT BASIN(S) FOR DRAINAGE AREAS LESS THAN 15 ACRES. SEE CONSTRUCTION DRAWINGS FOR EMBANKMENT, STORAGE VOLUME, SPILLWAY, OUTLET, AND OUTLET PROTECTION DETAILS FOR ANY SEDIMENT BASIN(S) THAT HAVE BEEN INDIVIDUALLY DESIGNED FOR DRAINAGE AREAS LARGER THAN 15 ACRES.

Sediment Basin (SB)

SEDIMENT BASIN MAINTENANCE NOTES

1. INSPECT BMPs IN ACCORDANCE WITH THE APPLICABLE SWMP FREQUENCY, AND MAINTAIN THEM IN EFFECTIVE OPERATING CONDITION. MAINTENANCE OF BMPs SHOULD BE PROACTIVE, NOT REACTIVE. INSPECT BMPs AS SOON AS POSSIBLE (AND ALWAYS WITHIN 24 HOURS) FOLLOWING A STORM THAT CAUSES SURFACE EROSION, AND PERFORM NECESSARY MAINTENANCE.

2. FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN BMPs IN EFFECTIVE OPERATING CONDITION. INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.

3. WHERE BMPs HAVE FAILED, REPAIR OR REPLACEMENT SHOULD BE INITIATED UPON DISCOVERY OF THE FAILURE.

4. SEDIMENT ACCUMULATED IN BASIN SHALL BE REMOVED AS NEEDED TO MAINTAIN BMP EFFECTIVENESS, TYPICALLY WHEN SEDIMENT DEPTH REACHES ONE FOOT (I.E.. TWO FEET BELOW THE SPILLWAY CREST).

5. SEDIMENT BASINS ARE TO REMAIN IN PLACE UNTIL THE UPSTREAM DISTURBED AREA IS STABILIZED AND GRASS COVER IS ACCEPTED BY THE LOCAL JURISDICTION.

6. WHEN SEDIMENT BASINS ARE REMOVED, ALL DISTURBED AREAS SHALL BE COVERED WITH TOPSOIL, SEEDED AND MULCHED OR OTHERWISE STABILIZED.

(DETAILS ADAPTED FROM DOUGLAS COUNTY, COLORADO)

NOTE: MANY JURISDICTIONS HAVE BMP DETAILS THAT VARY FROM UDFCD STANDARD DETAILS. CONSULT WITH LOCAL JURISDICTIONS AS TO WHICH DETAIL SHOULD BE USED WHEN DIFFERENCES ARE NOTED.

Sediment Trap (ST)

Description

Sediment traps are traps formed by excavation of an area or by placing an earthen embankment across a low area or drainage swale. Sediment traps are designed to capture drainage from disturbed areas and allow settling of sediment prior to discharge from a location.

Applicability

Sediment traps are generally temporary control measures used at the outlets of stormwater diversion structures, channels, slope drains, construction site entrance wash racks, or any other runoff conveyance that discharges waters containing erosion sediment and debris. Sediment traps should be used for drainage areas of five acres or less. Sediment traps shall remain in place until the upstream disturbed area is stabilized. Traps may be located in a series to accommodate larger drainage areas and allow for backup control in case one trap fails.

Limitations

- Regular maintenance is needed to remove sediment. Traps should be located near roads or where accessible to remove sediment.
- Although sediment traps allow eroded soils to settle, due to the short detention periods for stormwater, traps typically do not remove fine particles such as silts and clays.
- Water may remain in sediment traps for extended periods causing mosquitoes and other insects to gather. Locate the trap in a sunny spot if possible.
- Never construct a sediment trap on a live flow stream or in wetlands.

Design Criteria

Traps should be located at points of discharge from disturbed areas. The location will be determined by the natural terrain, drainage pattern of the runoff, and the accessibility for maintenance. Sediment traps should not be located in areas where their failure due to stormwater runoff excess can lead to further erosive damage of the landscape. Alternative diversion pathways should be designed to accommodate these potential overflows. Sediment trap locations should also allow for easy maintenance access for the periodic removal of accumulated sediment.

Construction Specifications

See Figure ST for installation details.

- Sediment traps, along with other perimeter controls, shall be installed before any land disturbance takes place in the drainage area.
- Traps should be located above the floodplain, where possible. If there are space constraints, several small sediment traps may be constructed in series.
- Area under embankment shall be cleared, grubbed, and stripped of any vegetation and root mat. The pool area shall be cleared.
- The fill material for the embankment shall be free of roots and other woody vegetation as well as over-sized stones, rocks, organic material, or other objectionable material.
- The sediment trap must have a minimum depth of 2.5 feet from the bottom of the trap to the top of the earthen berm. The sediment trap must also have a minimum width of 12 feet measured from berm-to-berm. Sizes vary on a site-specific basis.
- The sides of the sediment trap must be 2:1 to minimize erosion and ensure sufficient pooling of stormwater runoff.
- The berm of the sediment trap must be compacted or similar BMPs implemented.
- Stabilization of the embankment should be performed as soon as possible after construction of the sediment trap. This includes sufficient compaction, slope grade, or similar stabilization BMPs.
- The top of the earthen berm shall be, at minimum, 6 inches higher than the center of the outlet. The spillway must consist of Type M riprap (D50) 12 inches in size, at minimum, and extend 8 feet beyond the outlet. Smaller rock may be allowable for smaller traps if approved by local jurisdiction. Alternatives to a Type M riprap spill way include, but are not limited to, the combination of an erosion control blanket and wattles, a series of wattles, and/or Silt Soxx on properly compacted spillways.
- Sediment traps may be used in conjunction with the perimeter ditch in order to slow down the velocity of the water moving through the ditch and provide the sediment an intermediate location whereby it can fall/settle out of the water. In this instance, the trap(s) is/are placed in-line with the perimeter ditch with an outlet/spillway directing water either offsite (perpendicular to the ditch), or to continue on into the ditch downgradient of the sediment trap.
- In the event that an outlet is not constructed (enclosed design), sediment traps may be cleaned via hydro-vacuuming as needed and stortmwater will be properly disposed of off-site as described in the SWMP.
- Seeding of sediment trap embankments can be conducted if the life expectancy of a trap exceeds 12 months (1 year).

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). The primary maintenance consideration for temporary sediment traps is the removal of accumulated sediment from the basin to ensure the continued effectiveness of the sediment trap. Sediments should be removed when the trap reaches approximately 50% sediment capacity. Inspectors should also ensure that the trap is draining properly (if applicable) and check the structure for damage from erosion.

Removal

The structure shall be removed and the area stabilized when the drainage area has been properly stabilized.

References

Colorado Department of Transportation (CDOT), *Erosion Control and Stormwater Quality Guide.* 2002. http://www.coloradodot.info/programs/environmental/water-quality/documents/erosion-storm-quality

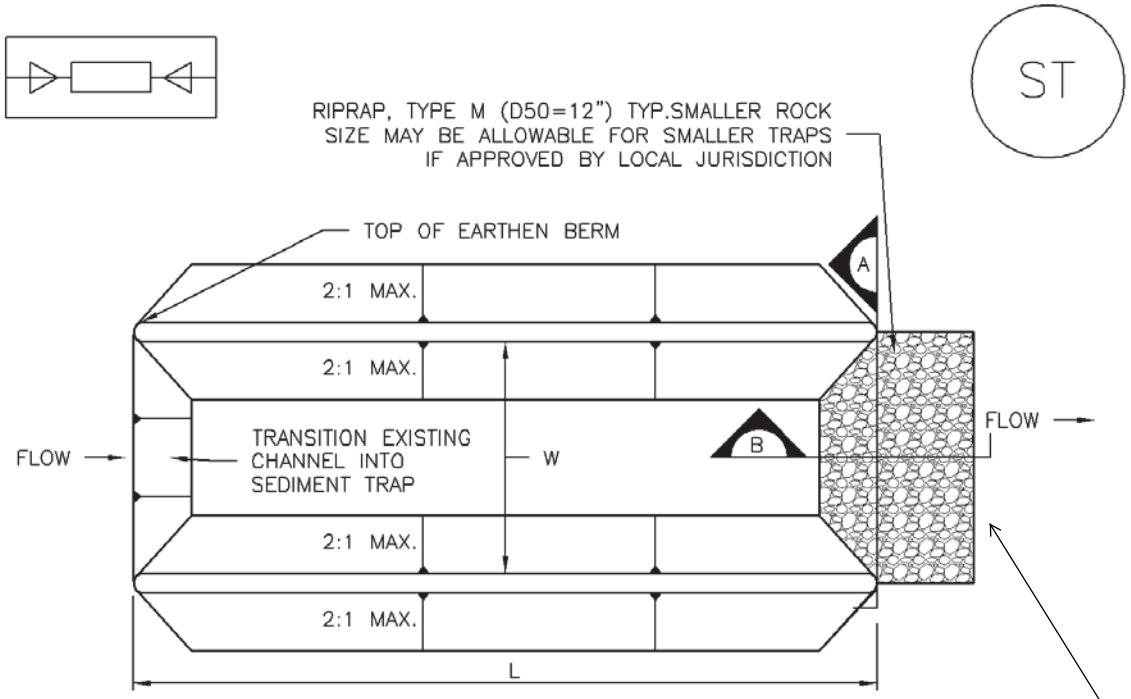
Colorado Department of Transportation (CDOT), *Erosion Control and Stormwater Quality Field Guide.* 2011. https://www.codot.gov/programs/environmental/water-quality/documents/CDOT%20Pocket%20Guide%20122211.pdf

Fank and Pat Pfister. *Stormwater - Sediment Trap.* 2011. http://forum.sws.org/eve/forums/a/tpc/f/2756008642/m/6897034506

Horizon Environmental Services, Inc, *Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites.* April 2004

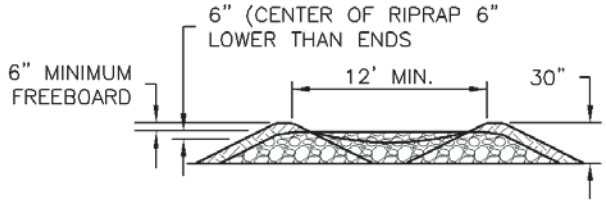
Urban Drainage and Flood Control District, *Volume 3 Stormwater Quality*. Denver, CO, November 2015. http://udfcd.org/volume-three

Sediment Trap (ST)

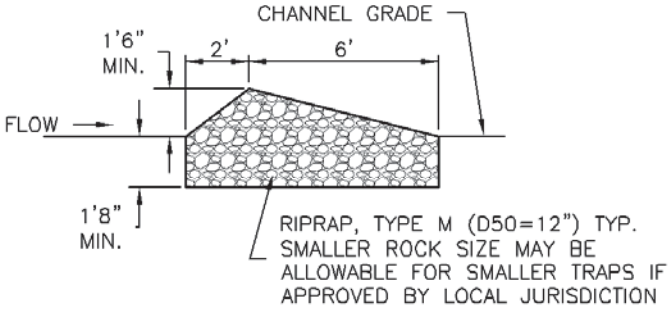


SEDIMENT TRAP PLAN

Optional: Enclosed sediment traps (where no rock apron or outlet is provided) can have stormwater removed as needed via hydro-vacuuming and will be properly disposed of off-site.



SECTION A

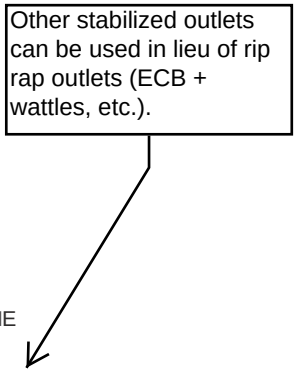


SECTION B

ST–1. SEDIMENT TRAP

Note: Excavated or fill material used to create a sediment trap must be compacted.
Note: Locations with site-specific engineeried sediment trap desgins will be followed in lieu of this standard design and will be documented in the site-specific SWMP diagram and/or applicable documentation.

Sediment Trap (ST)



SEDIMENT TRAP INSTALLATION NOTES

1. SEE PLAN VIEW FOR:
   -LOCATION, LENGTH AND WIDTH OF SEDIMENT TRAP.

2. ONLY USE FOR DRAINAGE AREAS LESS THAN 5 ACRES.

3. SEDIMENT TRAPS SHALL BE INSTALLED PRIOR *TO* ANY UPGRADIENI LAND-DISTURBING ACTIVITIES.

4. SEDIMENT TRAP BERM SHALL BE CONSTRUCTED FROM MATERIAL FROM EXCAVATION. THE BERM SHALL BE COMPACTED.

5. SEDIMENT TRAP OUTLET *TO* BE CONSTRUCTED OF RIPRAP, TYPE M (050=12") TYP.SMALLER ROCK SIZE MAY BE ALLOWABLE FOR SMALLER TRAPS IF APPROVED BY LOCAL JURISDICTION.

6. THE TOP OF THE EARTHEN BERM SHALL BE A MINIMUM OF 6" HIGHER THAN THE TOP OF THE RIPRAP OUTLET STRUCTURE.

7. THE ENDS OF THE RIPRAP OUTLET STRUCTURE SHALL BE A MINIMUM OF 6" HIGHER THAN THE CENTER OF THE OUTLET STRUCTURE.

SEDIMENT TRAP MAINTENANCE NOTES

1. INSPECT BMPs IN ACCORDANCE WITH THE APPLICABLE SWMP FREQUENCY, AND MAINTAIN THEM IN EFFECTIVE OPERATING CONDITION. MAINTENANCE OF BMPs SHOULD BE PROACTIVE, NOT REACTIVE. INSPECT BMPs AS SOON AS POSSIBLE FOLLOWING A STORM THA CAUSES SURFACE EROSION, AND PERFORM NECESSARY MAINTENANCE.

2. FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN BMPs IN EFFECTIVE OPERATING CONDITION INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.

J. WHERE BMPs HAVE FAILED, REPAIR OR REPLACEMENT SHOULD BE INITPTEO UPON DISCOVERY OF THE FAILURE.

4. REMOVE SEDIMENT ACCUMULATED IN TRAP AS NEEDED TO MAINTAIN THE FUNCTIONALITY OF THE BMP, TYPICALLY WHEN THE SEDIMENT DEPTH REACHES)2 THE HEIGHT OF THE RIPRAP OUTLET.

5. SEDIMENT TRAPS SHALL REMAIN IN PLACE UNTIL THE UPSTREAM DISTURBED AREA IS STABILIZED.

6. WHEN SEDIMENT TRAPS ARE REMOVED. THE DISTURBED AREA SHALL BE COVERED WITH TOPSOIL, SEEDED AND MULCHED OR OTHERWISE STABILIZED.

(DETAILS ADAPTED FRDM DOUGLAS COUNTY, COLORIIDO, NOT AVAILABLE N AUTOCAO)

Seeding (S)

Description

Seeding involves planting seed to establish a vegetative cover in disturbed areas that will be inactive for an extended period. Seeding establishes vegetation that reduces erosion and sediment displacement by stabilizing disturbed areas in a manner that is economical, adaptable to site conditions, and allows selection of the most appropriate plant material.

Seeding also:

- Absorbs the impact of raindrops;
- Reduces the velocity of runoff;
- Reduces runoff volumes by increasing water permeation into the soil;
- Binds soil with roots;
- Protects soil from wind;
- Improves wildlife habitat; and
- Enhances natural beauty.

Applicability

Seeding is most effective on slopes no steeper than 2:1. Seeding may be used as a permanent control or a temporary control in areas where exposed soil surfaces are not to be re-graded for periods longer than 30 days. Such areas include denuded areas, soil stockpiles, berms, temporary road banks, etc.

Limitations

The effectiveness of seeding can be limited by:

- High erosion potential during establishment.
- The need for stable soil temperature and soil moisture content during germination and early growth.
- The need to re-seed areas that fail to establish.
- Limited seeding times depending on the season.

Proper seedbed preparation and the use of quality seed are important in this practice. Failure to carefully follow sound agronomic recommendations will often result in an inadequate stand of vegetation that provides little or no erosion control.

Seeding does not immediately stabilize soils. Prior to seeding, install necessary erosion and sediment control practices such as diversions, straw bales, and basins until vegetation is established.

Design Criteria

Successful plant establishment can be maximized with proper planning; consideration of soil characteristics; selection of plant materials that are suitable for the site; adequate seedbed preparation, liming, and fertilization; timely planting; and regular maintenance.

When to Seed

Areas to be stabilized with vegetation must be seeded or planted one to four months after grading is completed unless temporary stabilization measures are in place. Temporary stabilization measures should be installed through "no growth" periods during winter months until the weather can support seed growth.

Seed Mix

Climate, soils, and topography are major factors that dictate the suitability of plants for a particular site. Vegetation that has adapted to the site, has strong roots, and provides good ground cover should be used. Although a native seed mix is best, some grasses such as Vetiver have been used extensively worldwide because of their strong deep roots, adaptability, and non- invasive properties.

Construction Specifications

- Seeding does not immediately stabilize soils. Temporary erosion and sediment control measures should be in place to prevent off-site transport of sediments from disturbed areas until vegetation is established.
- Vegetation should not be established on slopes that are unsuitable due to inappropriate soil texture, poor internal structure or internal drainage, volume of overland flow, or excessive steepness, until measures have been taken to correct these problems.
- If the area has been recently loosened or disturbed, no further roughening is required. When the area is compacted, crusted, or hardened, the soil surface shall be loosened by disking, raking, harrowing, or other acceptable means to ensure good water infiltration and root penetration (see SOIL ROUGHENING [SR]).
- The soil on a disturbed site may need to be modified to provide an optimum environment for seed germination and seedling growth. To maintain a good stand of vegetation, the soil must meet certain minimum requirements as a growth medium. If any of the below criteria cannot be met then topsoil shall be applied. The existing soil must have these characteristics:
    1. Enough fine-grained material to maintain adequate moisture and nutrient supply.

2. Sufficient depth of soil to provide an adequate root zone. The depth to rock or impermeable layers such as hard-pans shall be 12 inches or more, except on slopes steeper than 2:1 where the addition of soil is not feasible.
3. A favorable pH range for plant growth. If the soil is so acidic that a pH range of 6.0 to 7.0 cannot be attained by addition of pH-modifying materials, then the soil is considered an unsuitable environment for plant roots and further soil modification would be required.
4. Freedom from toxic amounts of materials harmful to plant growth.
5. Freedom from excessive quantities of roots, branches, large stones and clods of earth, or trash of any kind. Clods and stones may be left on slopes steeper than 3:1 if they do not significantly impede good seed-soil contact.

- Add fertilizer and/or lime, if necessary. Lime and fertilizer may be incorporated into the top 2 to 4 inches of the soil if possible. The addition of lime is equally as important as applying fertilizer. Lime will modify the pH and supply calcium and magnesium. Its effect on pH makes other nutrients more available to the plant.
- The appropriate seed shall be evenly applied with a broadcast seeder, drill, cultipacker or hydro-seeder. Seeding depth should be \1 to Yz inch.
- If necessary, apply mulch according to MULCHING (M). The mulch will hold moisture and modify temperature extremes and prevent erosion while seedlings are growing.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). Vegetation is considered established when a density of at least 70% of pre-disturbance levels has been reached throughout the area. Seeded areas should be inspected for failure and any necessary repairs and re-seeding should be made prior to the next growing season.

References

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control*. Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

Horizon Environmental Services, Inc, *Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites.* April 2004.

Keller, Gordon and James Sherar, *Low-Volume Roads Engineering, Best Management Practices Field Guide.* United States Department of Agriculture (USDA), Forest Service, US Agency of International Development (USAID), 2003. http://www.blm.gov/bmp/field%20guide.html

Soil Roughening (SR)

Description

Soil (surface) roughening is an erosion control practice that involves tracking, scarifying, imprinting, or tilling a disturbed area to provide temporary stabilization of disturbed areas. Surface roughening creates variations in the soil surface that help to minimize wind and water erosion. Depending on the technique used, surface roughening may also help establish conditions favorable to establishment of vegetation.

Applicability

Soil roughening is most effective for areas of one acre or less, or in conjunction with other sediment controls on larger locations, and works well for the following applications:

- Any slope, but particularly fill slopes greater than 3:1;
- Areas with highly erodible soils; and
- Soils that are frequently disturbed

Limitations

- Soil roughening is not appropriate for rocky slopes.
- Soil compaction might occur when roughening with tracked machinery.
- Soil roughening is of limited effectiveness in anything more than a gentle or shallow depth rain.
- If roughening is washed away in a heavy storm, the surface will have to be re-roughened.

Design Criteria

The selection for the appropriate method of soil roughening depends on the type of slope. Steepness, mowing requirements, and/or a cut or fill slope operation are all factors considered in choosing a roughening method. See Figure SR-1 and Figure SR-2 for design criteria and installation details.

Construction Specifications

- To slow erosion, roughening should be done as soon as possible after grading activities have ceased (temporarily or permanently) in an area.
- All cut and fill slopes should be roughened whenever possible.

- Do not blade or scrape the final fill slope face.
- Excessive compacting of the soil surface should be avoided during roughening, and areas should be seeded as soon as possible after roughening is completed.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). Roughening might need to be repeated after storm events.

References

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control*. Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

Horizon Environmental Services, Inc, *Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites.* April 2004.

New York State Department of Environmental Conservation, *New York Guidelines for Erosion and Sediment Control*. New York. August 2005. http://www.dec.ny.gov/chemical/29066.html

FIGURE SR-1
Corrugation/Grooving

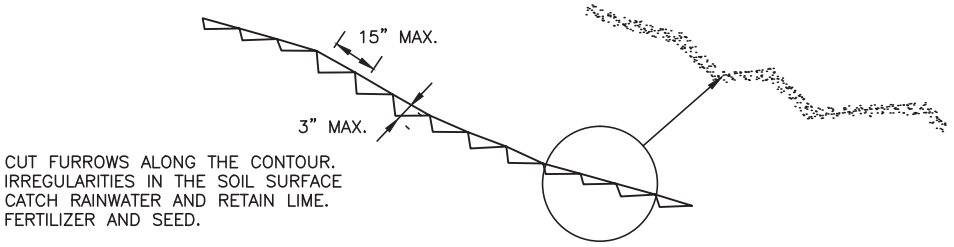
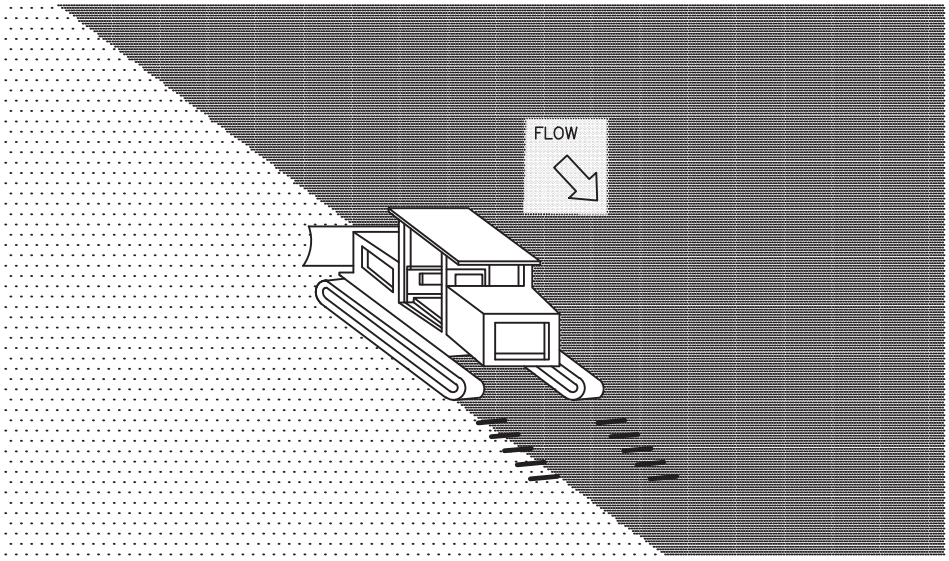


FIGURE SR-2
Tracking



SCALE: NOT TO SCALE

Tracking Pad (TP)

Description

A stabilized construction entrance (i.e., tracking pad) is a pad of gravel where construction traffic leaves a site. The purpose of a stabilized access to a site is to minimize the amount of tracked mud that leaves a site. As a vehicle drives over the gravel tracking pad, mud and sediment are removed from the vehicle's wheels and off-site transport of soil is reduced. The gravel tracking pad also reduces erosion and rutting in the soil beneath the stabilized structure. The filter fabric separates the gravel from the soil below, preventing the gravel from being ground into the soil. The fabric also reduces the amount of rutting caused by vehicle tires by spreading the vehicle's weight over a larger soil area than just the width of the tire. Tracking pads are generally used in conjunction with stabilization material such as surface armor, road base, etc.

Applicability

Typically, stabilized construction accesses are installed at locations where construction traffic leaves or enters an existing paved road. However, the applicability of the site access stabilization should be extended to any roadway or entrance where vehicles will enter or leave the site.

Limitations

- Although stabilizing construction access is a good way to help reduce the amount of sediment leaving a site, some soil may still be deposited from vehicle tires onto paved surfaces. To further reduce the chance of these sediments polluting stormwater runoff, sweeping of the paved area adjacent to the stabilized site access is recommended.
- Site traps or other secondary sediment controls may be needed to capture sediment that accumulates at the pad and may run off during storm events.

Design Criteria

Construct all tracking pads on a level surface. Where feasible, grade the tracking control towards the construction site in order to reduce off-site runoff. There are several different types of stabilized tracking pads including:

1. **Aggregate Vehicle Tracking Control:** This type of tracking pad consists of a coarse-aggregate surfaced pad underlain by a geotextile to minimize compaction of tracking material. This tracking pad can be effective at removing sediment from vehicle tires when properly maintained and refreshed.

2. **Aggregate Vehicle Tracking Control with Was Rock:** This type of tracking pad may consists of a coarse-aggregate surface similar to VTC-1, with the addition of a sediment trapping device, and the optional installation of a geotextile. A concrete or steel rack is utilized for shaking and washing purposes and to dispose of sediment and/or sediment laden water in a designated location (if applicable). This is the most common vehicle tracking control and when properly maintained can be effective at removing sediment from vehicle tires.
3. **Vehicle Tracking Control with Construction Mat:** This type of tracking pad may be appropriate for locations with a small access and low traffic volume over vegetated areas. Although this application does not typically remove sediment from vehicles, it helps protect existing vegetation and provides a stabilized entrance.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). Stabilization of site accesses should be maintained until the remainder of the construction site has been fully stabilized. Stone and gravel might need to be periodically added to each stabilized construction site access to keep the access effective. Soil that is tracked off site should be swept up immediately and properly disposed of.

References

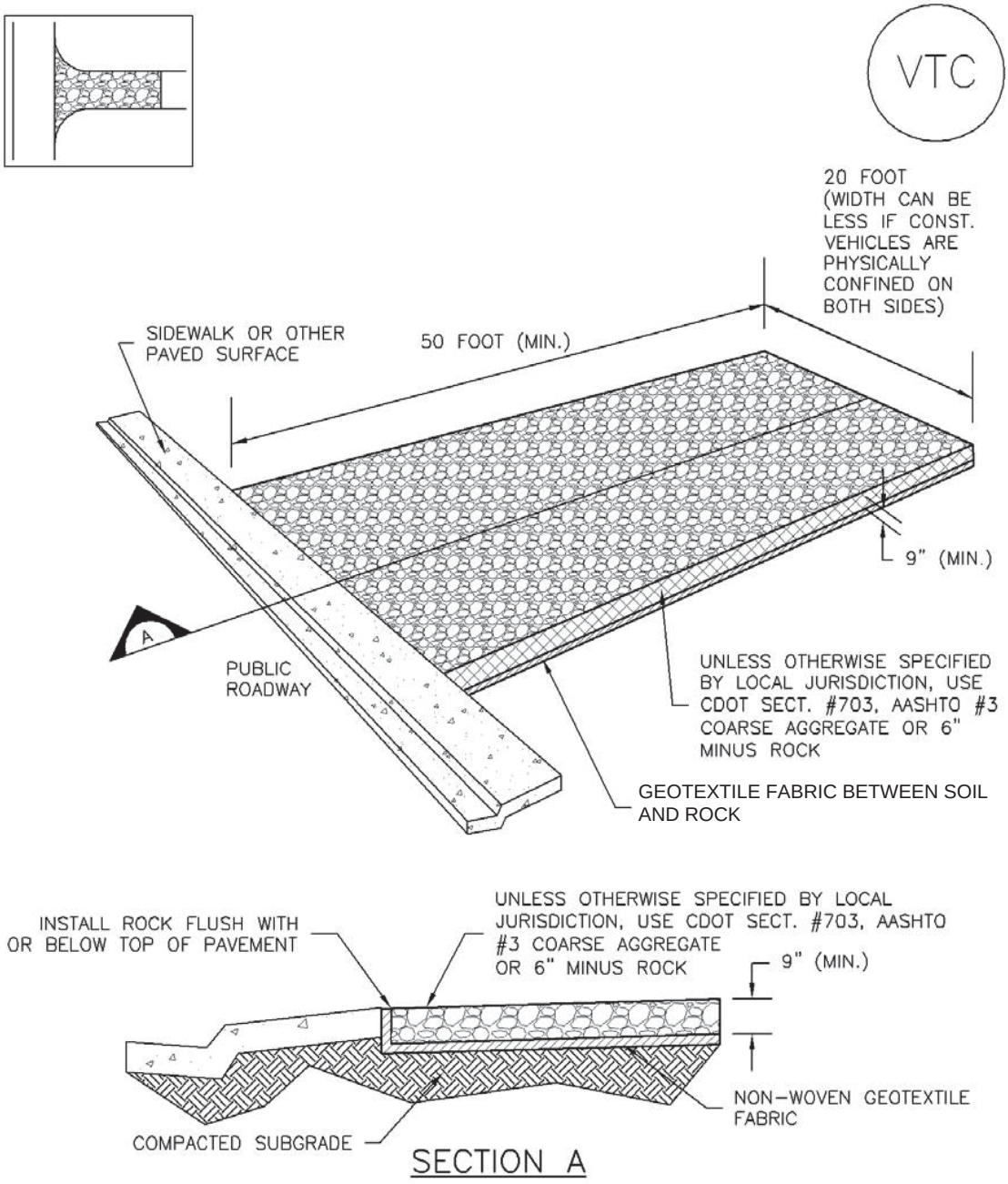
Colorado Department of Transportation (CDOT), *Erosion Control and Stormwater Quality Guide*. 2002. http://www.coloradodot.info/programs/environmental/water- quality/documents/erosion-storm-quality

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control*. Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

Horizon Environmental Services, Inc, *Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites.* April 2004.

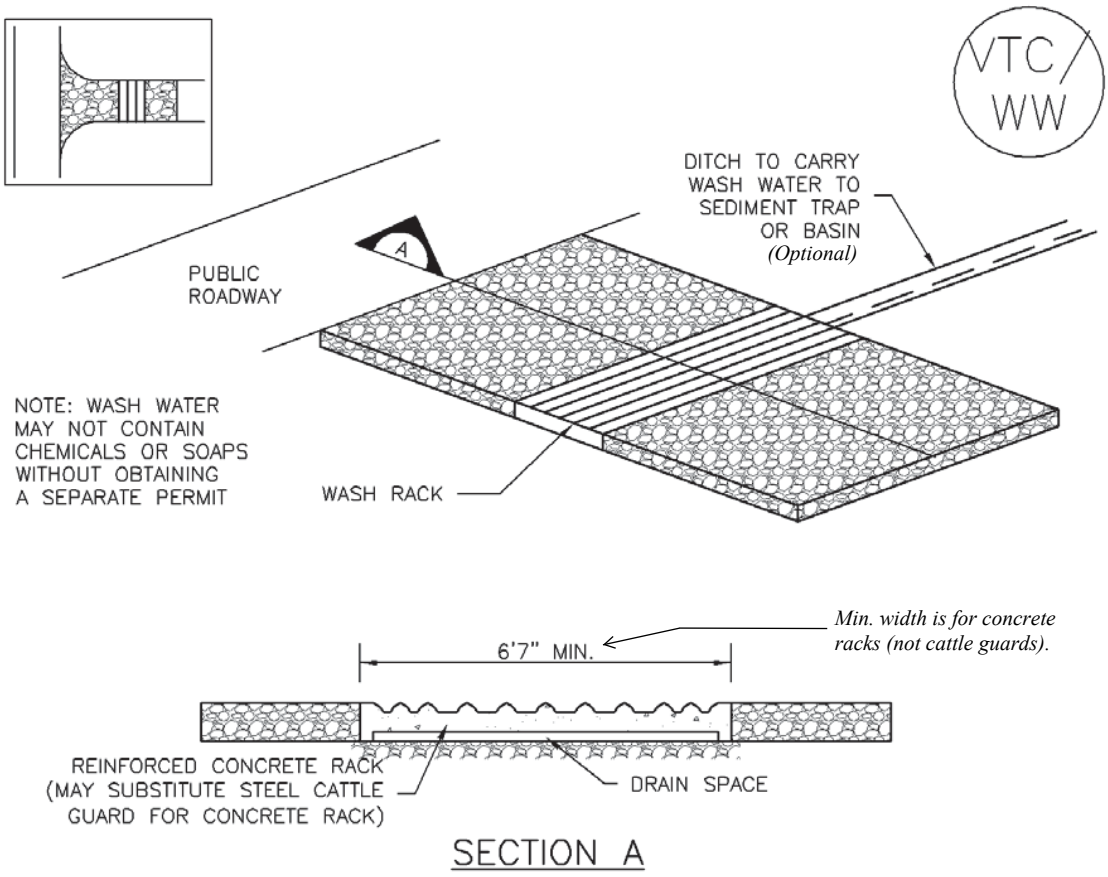
Urban Drainage and Flood Control District, *Volume 3 Stormwater Quality*. Denver, CO, November 2015. http://udfcd.org/volume-three

Vehicle Tracking Control (VTC)



VTC-1. AGGREGATE VEHICLE TRACKING CONTROL

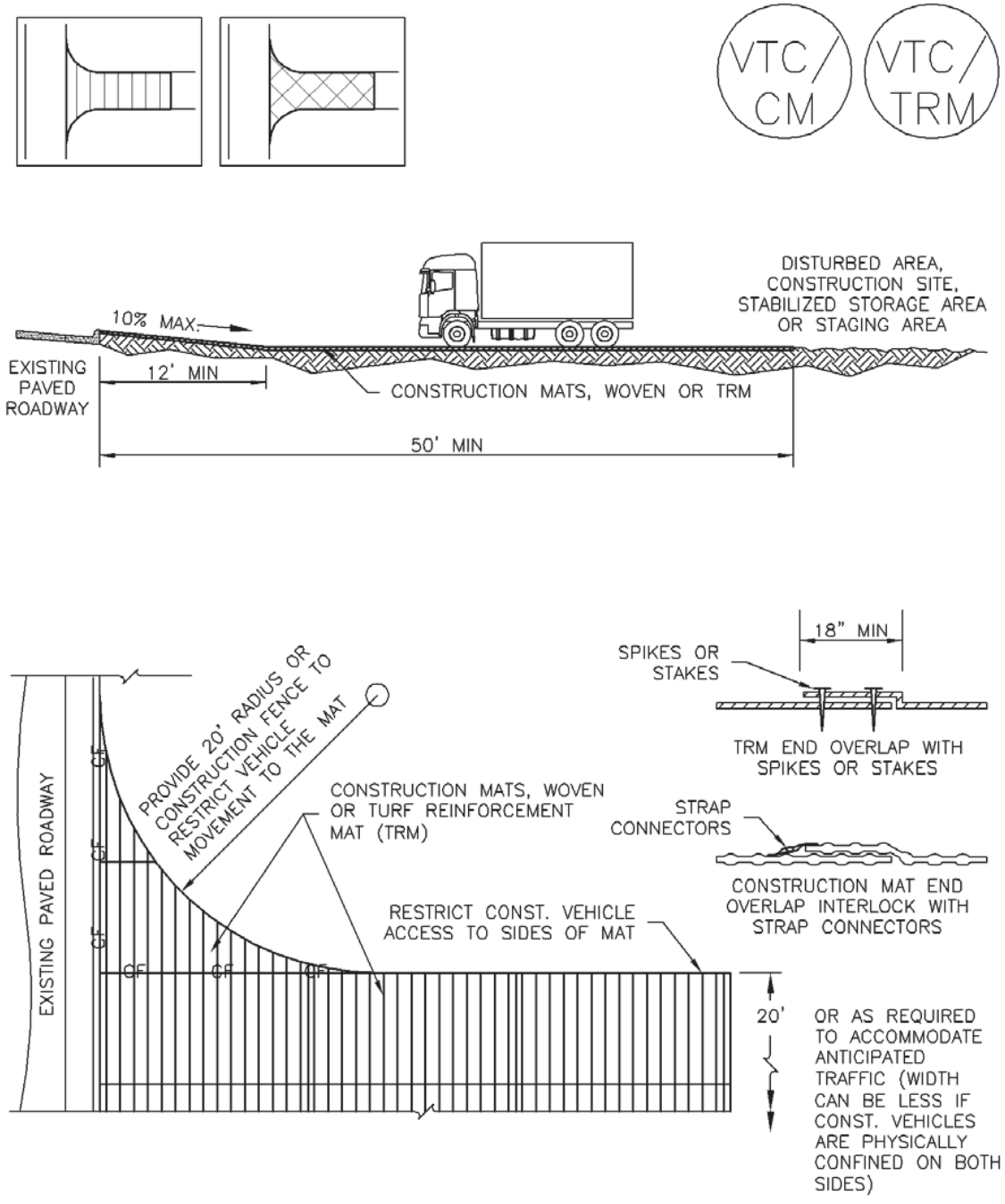
Vehicle Tracking Control (VTC)



VTC–2. AGGREGATE VEHICLE TRACKING CONTROL WITH WASH RACK

Note: Locations which use a steel cattle guard for tracking control purposes do no require the use of a ditch and sediment trap combination to control sediment and/or stormwater. All cattle guards will be inspected in accordance with the SWMP and cleaned out once 50% capacity is reached.
Note: Cattle guards may be used in series if additional tracking control is required.

Vehicle Tracking Control (VTC)



VTC–3. VEHICLE TRACKING CONTROL W/ CONSTRUCTION MAT OR TURF REINFORCEMENT MAT (TRM)

Vehicle Tracking Control (VTC)

STABILIZED CONSTRUCTION ENTRANCE/EXIT INSTALLATION NOTES

1. SEE PLAN VIEW FOR
   -LOCATION OF CONSTRUCTION ENTRANCE(S)/EXIT(S).
   -TYPE OF CONSTRUCTION ENTRANCE(S)/EXITS(S) (WITH/WITHOUT WHEEL WASH, CONSTRUCTION MAT OR TRM).

2. CONSTRUCTION MAT OR TRM STABILIZED CONSTRUCTION ENTRANCES ARE ONLY TO BE USED ON SHORT DURATION PROJECTS (TYPICALLY RANGING FROM A WEEK TO A MONTH) WHERE THERE WILL BE LIMITED VEHICULAR ACCESS.

3. A STABILIZED CONSTRUCTION ENTRANCE/EXIT SHALL BE LOCATED AT ALL ACCESS POINTS WHERE VEHICLES ACCESS THE CONSTRUCTION SITE FROM PAVED RIGHT-OF-WAYS.

4. STABILIZED CONSTRUCTION ENTRANCE/EXIT SHALL BE INSTALLED PRIOR TO ANY LAND DISTURBING ACTIVITIES.

5. A NON-WOVEN GEOTEXTILE FABRIC SHALL BE PLACED UNDER THE STABILIZED CONSTRUCTION ENTRANCE/EXIT PRIOR TO THE PLACEMENT OF ROCK.

6. UNLESS OTHERWISE SPECIFIED BY LOCAL JURISDICTION, ROCK SHALL CONSIST OF DOT SECT. #703, AASHTO #3 COARSE AGGREGATE OR 6" (MINUS) ROCK.

STABILIZED CONSTRUCTION ENTRANCE/EXIT MAINTENANCE NOTES

1. INSPECT BMPs IN ACCORDANCE WITH THE APPLICABLE SWMP FREQUENCY, AND MAINTEN THEM IN EFFECTIVE OPERATING CONDITION. MAINTENANCE OF BMPs SHOULD BE PROACTIVE, NOT REACTIVE. INSPECT BMPs AS SOON AS POSSIBLE FOLLOWING A STORM THAT CAUSES SURFACE EROSION, AND PERFORM NECESSARY MAINTENANCE.

2. FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN BMPs IN EFFECTIVE OPERATING CONDITION. INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.

3. WHERE BMPs HAVE FAILED, REPAIR OR REPLACEMENT SHOULD BE INITIATED UPON DISCOVERY OF THE FAILURE.

4. ROCK SHALL BE REAPPLIED OR REGRADED AS NECESSARY TO THE STABILIZED ENTRANCE/EXIT TO MAINTAIN A CONSISTENT DEPTH.

5. SEDIMENT TRACKED ONTO PAVED ROADS IS TO BE REMOVED THROUGHOUT THE DAY AND AT THE END OF THE DAY BY SHOVELING OR SWEEPING. SEDIMENT MAY NOT BE WASHED DOWN STORM SEWER DRAINS.

NOTE: MANY JURISDICTIONS HAVE BMP DETAILS THAT VARY FROM UDFCD STANDARD DETAILS. CONSULT WITH LOCAL JURISDICTIONS AS TO WHICH DETAIL SHOULD BE USED WHEN DIFFERENCES ARE NOTED.

(DETAILS ADAPTED FROM CITY OF BROOMFIELD, COLORADO, NOT AVAILABLE IN AUTOCAD)

Wattles (W)

Description

A wattle (also called a Sediment Control Log) consists of straw, flax, or other similar synthetic materials bound into a tight tubular roll. When wattles are placed at the toe and on the face of slopes, they intercept runoff, reduce its flow velocity, release the runoff as sheet flow, and provide removal of sediment from the runoff. By interrupting the length of a slope, wattles can also reduce erosion.

Applicability

Wattles may be a suitable BMP choice:

- Along the top, face, and at the grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow;
- At the end of a downward slope where it transitions to a steeper slope;
- Along the perimeter of a project;
- At the overflow location of sediment traps;
- As check dams in unlined ditches; and/or
- Around temporary stockpiles.

Limitations

- Wattles are not effective unless trenched and staked properly.
- The maximum allowable drainage area per 100 lineal feet of wattles installed along the contour is approximately 0.25 acres with a disturbed slope length of up to 150 feet and a slope gradient no steeper than 3:1. Longer and steeper slopes require additional measures (i.e. larger diameter wattles, stacked wattles, etc.).
- Difficult to move once saturated.
- If not properly staked and trenched in, wattles could be transported in high flows.
- Wattles have a very limited sediment capture zone.
- Wattles should not be used on slopes subject to creep, slumping, or landslide.
- Wattles should not be used where periodic road or surface maintenance activities are expected.

- If wattles are installed in an area that experiences concentrated flow, "J-hook" installation may be appropriate to force runoff to pond and evaporate or infiltrate multiple areas rather than concentrate and cause erosive conditions parallel to the BMP.

Design Criteria

See Figures SCL-1, SCL-2, and SCL-3 for design criteria.

Construction Specifications

Wattles should be either prefabricated rolls or rolled tubes of erosion control blankets. A minimum diameter of 9" is required for prefabricated rolls. If using erosion control blankets, roll the length of erosion control blanket into a tube with a minimum of 8 inches in diameter and bind the roll at each end and every 4 feet along the length of the roll with jute-type twine.

Locate wattles on a level contour and spaced as follows:

- Slope inclination of 4:1 or flatter: Fiber rolls should be placed at a maximum interval of 20 feet.
- Slope inclination between 4:1 and 2:1: Fiber rolls should be placed at a maximum of 15 feet.
- Slope inclination 2:1 or greater: Fiber rolls should be placed at a maximum interval of 10 feet.
- Turn the ends of the wattles upslope to prevent runoff from going around the roll.
- Stake the wattles into a trench with a depth of 1/3 the wattle diameter and a trench width equal to the diameter of the wattle.
- Drive stakes at the end of each wattle and space 4 feet maximum on center.
- If more than one wattle is placed in a row, the rolls should be overlapped, not abutted.
- Cross stake the ends of the wattles and throughout as necessary to minimize the potential of a wattle to be lifted and/or removed from location.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). Repair or replace split, torn, unraveling, or slumping rolls. If the wattle is used as a sediment capture device, or as an erosion control device to maintain sheet flows, sediment that accumulates must be periodically removed in order to maintain wattle effectiveness. Sediment should be removed when sediment accumulation reaches half the distance between the top of the wattle and the adjacent ground surface.

Removal

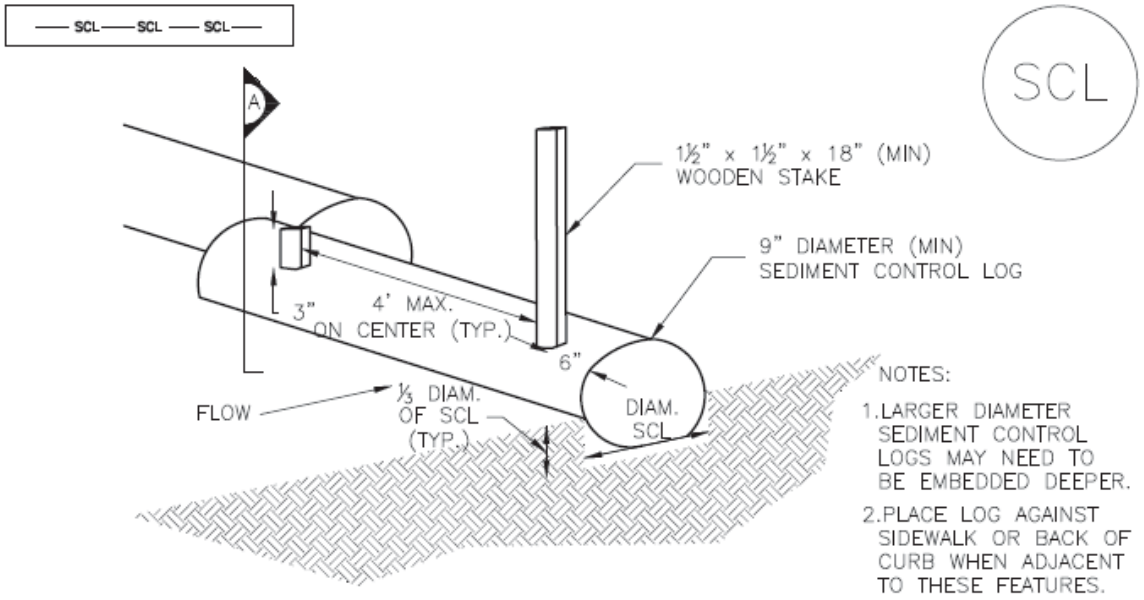
Wattles are typically left in place until final stabilization. If wattles are removed, collect and dispose of sediment accumulation, and fill and compact holes, trenches, depressions, or any other ground disturbance to blend with adjacent ground.

References

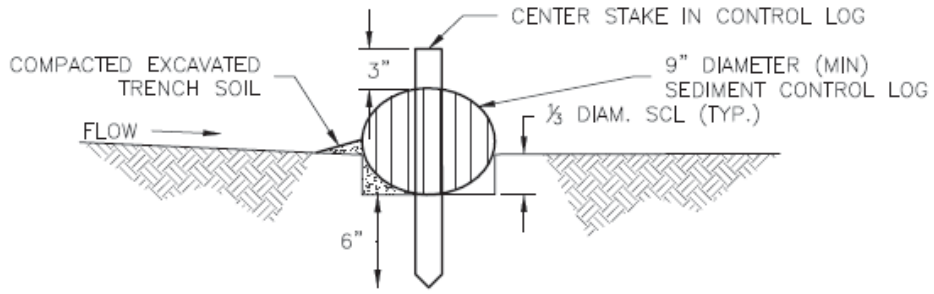
California Stormwater Quality Association (CASQA). 2003. Stormwater Best Management *Practice Handbook: Construction.* https://www.casqa.org/store/products/tabid/154/p-167-construction-handbookportal-initial-subscription.aspx

Urban Drainage and Flood Control District, *Volume 3 Stormwater Quality*. Denver, CO, November 2015. http://udfcd.org/volume-three

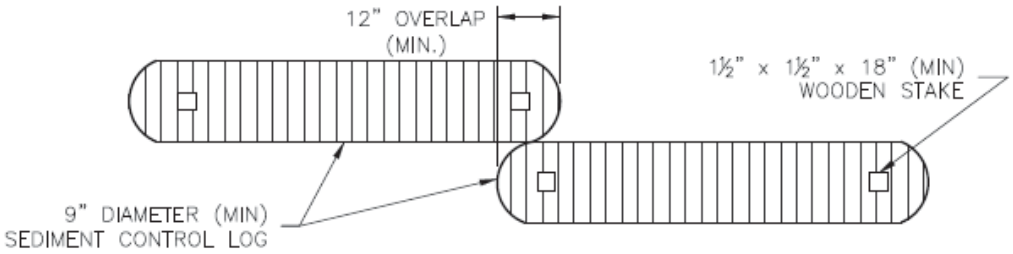
Sediment Control Log (SCL)



TRENCHED SEDIMENT CONTROL LOG



SECTION Ⓐ
TRENCHED SEDIMENT CONTROL LOG

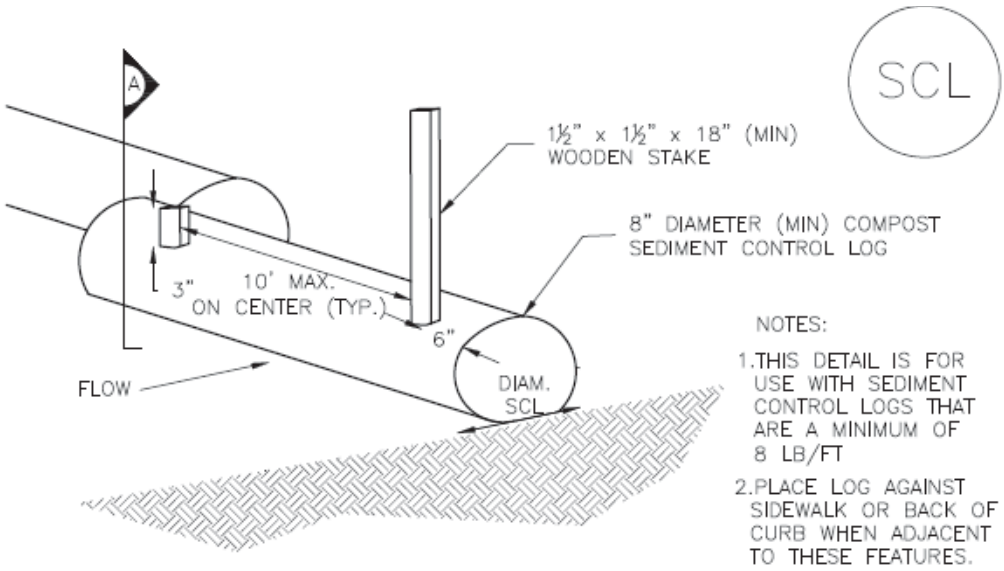


LOG JOINTS

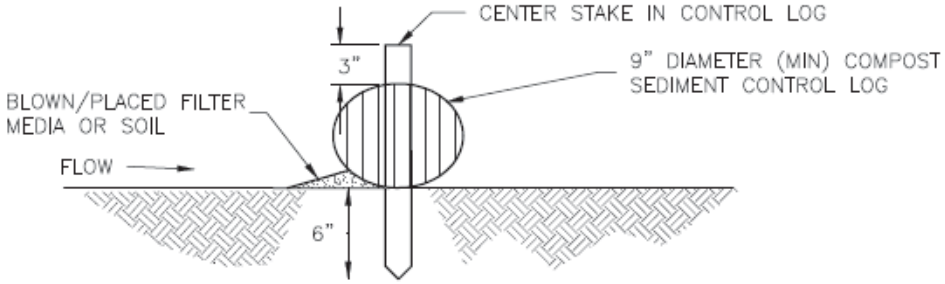
SCL–1. TRENCHED SEDIMENT CONTROL LOG

Note: Wattles may be cross-staked at the ends and throughout to prevent lifting of wattles off stakes.

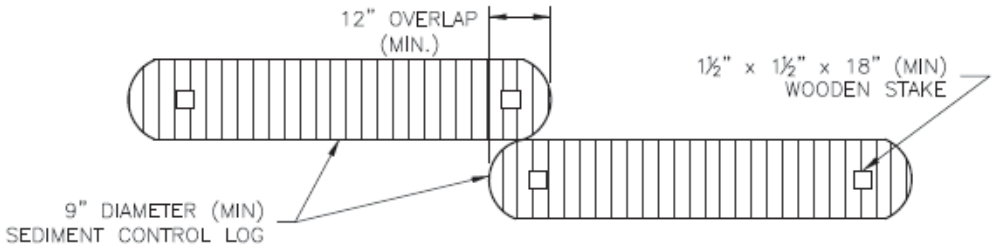
Sediment Control Log (SCL)



COMPOST SEDIMENT CONTROL LOG (WEIGHTED)



SECTION (A)
COMPOST SEDIMENT CONTROL LOG

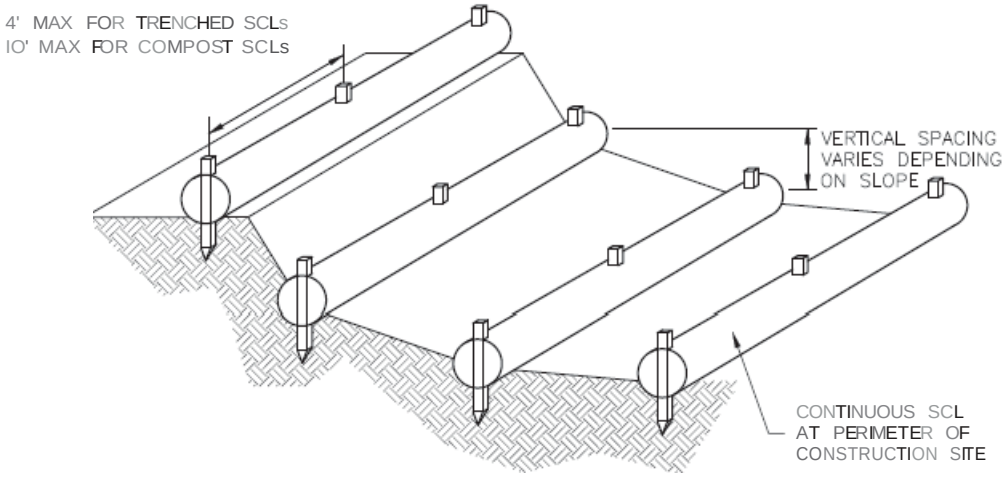


LOG JOINTS

SCL–2. COMPOST SEDIMENT CONTROL LOG (WEIGHTED)

Note: Wattles may be cross-staked at the ends and throughout to prevent lifting of wattles off stakes.

Sediment Control Log (SCL)



SCL-3. SEDIMENT CONTROL LOGS TO CONTROL SLOPE LENGTH

Sediment Control Log (SCL)

SEDIMENT CONTROL LOG INSTALLATION NOTES

1. SEE PLAN VIEW FOR LOCATION AND LENGTH OF SEDIMENT CONTROL LOGS.

2. SEDIMENT CONTROL LOGS THAT ACT AS A PERIMETER CONTROL SHALL BE INSTALLED PRIOR TO ANY UPGRADIENT LAND-DISTURBING ACTIVITIES.

3. SEDIMENT CONTROL LOGS SHALL CONSIST OF STRAW, COMPOST, EXCELSIOR OR COCONUT FIBER, AND SHALL BE FREE OF ANY NOXIOUS WEED SEEDS OR DEFECTS INCLUDING RIPS, HOLES AND OBVIOUS WEAR.

4. SEDIMENT CONTROL LOGS MAY BE USED AS SMALL CHECK DAMS IN DITCHES AND SWALES. HOWEVER, THEY SHOULD NOT BE USED IN PERENNIAL STREAMS.

5. IT IS RECOMMENDED THAT SEDIMENT CONTROL LOGS BE TRENCHED INTO THE GROUND TO A DEPTH OF APPROXIMATELY Y.i OF THE DIAMETER OF THE LOG. IF TRENCHING TO THIS DEPTH IS NOT FEASIBLE AND/OR DESIRABLE (SHORT TERM INSTALLATION WITH DESIRE NOT TO DAMAGE LANDSCAPE) A LESSER TRENCHING DEPTH MAY BE ACCEPTABLE WITH MORE ROBUST STAKING. COMPOST LOGS THAT ARE 8 LB/FT *DO* NOT NEED TO BE TRENCHED.

6. THE UPHILL SIDE OF THE SEDIMENT CONTROL LOG SHALL BE BACKFILLED WITH SOIL OR FILTER MATERIAL THAT IS FREE OF ROCKS AND DEBRIS. THE SOIL SHALL BE TIGHTLY COMPACTED INTO THE SHAPE OF A RIGHT TRIANGLE USING A SHOVEL OR WEIGHTED LAWN ROLLER OR BLOWN IN PLACE.

7. FOLLOW MANUFACTURERS' GUIDANCE FOR STAKING. IF MANUFACTURERS' INSTRUCTIONS DO NOT SPECIFY SPACING, STAKES SHALL BE PLACED ON 4' CENTERS AND EMBEDDED A MINIMUM OF 6" INTO THE GROUND. 3" OF THE STAKE SHALL PROTRUDE FROM THE TOP OF THE LOG. STAKES THAT ARE BROKEN PRIOR TO INSTALLATION SHALL BE REPLACED. COMPOST LOGS SHOULD BE STAKED 1O' ON CENTER.

SEDIMENT CONTROL LOG MAINTENANCE NOTES

1. INSPECT BMPs ACCORDING TO THE APPLICABLE SWMP FREQUENCY, AND MAINTAIN THEM IN EFFECTIVE OPERATING CONDITION. MAINTENANCE OF BMPs SHOULD BE PROACTIVE, NOT REACTIVE. INSPECT BMPs AS SOON AS POSSIBLE (AND ALWAYS WITHIN 24 HOURS) FOLLOWING A STORM THAT CAUSES SURFACE EROSION, AND PERFORM NECESSARY MAINTENANCE.

2. FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN BMPs IN EFFECTIVE OPERATING CONDITION. INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.

3. WHERE BMPs HAVE FAILED, REPAIR OR REPLACEMENT SHOULD BE INITIATED UPON DISCOVERY OF THE FAILURE.

4. SEDIMENT ACCUMULATED UPSTREAM OF SEDIMENT CONTROL LOG SHALL BE REMOVED AS NEEDED TO MAINTAIN FUNCTIONALITY OF THE BMP, TYPICALLY WHEN DEPTH OF ACCUMULATED SEDIMENTS IS APPROXIMATELY OF THE HEIGHT OF THE SEDIMENT CONTROL LOG.

5. SEDIMENT CONTROL LOG SHALL BE REMOVED AT THE END OF CONSTRUCTION. COMPOST FROM COMPOST LOGS MAY BE LEFT IN PLACE AS LONG AS BAGS ARE REMOVED AND THE AREA SEEDED. IF DISTURBED AREAS EXIST AFTER REMOVAL, THEY SHALL BE COVERED WITH TOP SOIL, SEEDED AND MULCHED OR OTHERWISE STABILIZED IN A MANNER APPROVED BY THE LOCAL JURISDICTION.

(DETAILS ADAPTED FROM *TOWN* OF PARKER, COLORADO, JEFFERSON COUNTY, COLORADO, DOUGLAS COUNTY, COLORADO, AND CITY Of AURORA. COLORADO, NOT AVALABLE IN AVTOCAD)

NOTE: MANY JURISDICTIONS HAVE BMP DETAILS THAT VARY FROM UDFCD STANDARD DETAILS. CONSULT WITH LOCAL JURISDICTIONS AS TO WHICH DETAIL SHOULD BE USED WHEN DIFFERENCES ARE NOTED.

COLORADO
Department of Public Health & Environment

CERTIFICATION TO DISCHARGE
UNDER
CDPS GENERAL PERMIT COR400000
STORMWATER ASSOCIATED WITH CONSTRUCTION ACTIVITY

Certification Number: **COR401104**

This Certification to Discharge specifically authorizes:

Owner Civitas Resources
Operator Civitas Resources
to discharge stormwater from the facility identified as

COP Field Permit Arapahoe County West of Watkins

To the waters of the State of Colorado, including, but not limited to:

Box Elder Creek, Coal Creek, South Platte River

Facility Activity :	OilGas
Disturbed Acres:	2000 acres
Facility Located at:	County Line Rd and Watkins Rd Watkins 80137 Arapahoe County Latitude 39.662067 Longitude -104.624440
Specific Information (if applicable):	

Certification is issued: 5/15/2024
Certification is effective: 4/1/2024
Expiration date of general permit: 3/31/2029

This certification under the general permit requires that specific actions be performed at designated times. The certification holder is legally obligated to comply with all terms and conditions of the COR400000 permit.

This certification was approved by:
Andrew Sayers-Fay Permits Section Manager
Clean Water Program
Water Quality Control Division

Surface Owner Documentation

Applicant is surface owner – deed enclosed

Electronically Recorded RECEPTION#: 2022000032417,
4/12/2022 at 10:13 AM, 1 OF 8,
REC: $48.00 DocStamp: $0.00
TD Pgs: 0 Josh Zygielbaum, Adams County, CO.

SPECIAL WARRANTY DEED

This Special Warranty Deed (this "***Deed***"), effective as of March 1, 2022, at 12:01 a.m., Mountain Standard Time (the "***Effective Time***"), is from DJ South Infield Gathering, LLC, a Colorado limited liability company (the "***Grantor***"), to Crestone Peak Resources Watkins Midstream LLC, a Delaware limited liability company ("***Grantee***"). Capitalized terms used but not defined in the body of this Assignment shall have the meanings set forth in that certain Asset Purchase Agreement, dated March 29, 2022, by and between Grantor and Grantee (the "***APA***").

For $10.00 and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged by Grantor, Grantor hereby conveys to Grantee, and its successors and assigns, all of Grantor's right, title and interest in and to all of the real property being in the County of Adams, State of Colorado, further described on Exhibit A hereto, together with all and singular the hereditaments and appurtenances thereto belonging, or in anywise appertaining thereto, (the "***Land***").

TO HAVE AND TO HOLD unto Grantee and its successors and assigns forever, but excepting and reserving to Grantor, however, all other assets and properties of Grantor not specifically described as Land, and further excepting and reserving unto Grantor and its successors and assigns the Excluded Assets, as definited in the APA.

Grantor hereby warrants title to the land, free and clear of all Encumbrances except Permitted Encumbrances, against claims by, through and under Grantor, but not otherwise.

Except as explicitly set forth herein, this Deed is made without warranty of any kind, whether express, implied or statutory; however, Grantor gives and grants to Grantee, its successors and assigns, to the extent so transferable, full power and right of substitution and subrogation in and to all covenants and warranties by others heretofore given or made with respect to the Land or any part thereof.

THE PARTIES AGREE THAT, TO THE EXTENT REQUIRED BY APPLICABLE LAW TO BE OPERATIVE, THE FOLLOWING DISCLAIMERS ARE "CONSPICUOUS" DISCLAIMERS FOR THE PURPOSES OF ANY APPLICABLE LAW, RULE OR ORDER.

(a) NO REPRESENTATIONS AND WARRANTIES. ***EXCEPT AS EXPLICITLY SET FORTH HEREIN,*** GRANTOR EXPRESSLY DISCLAIMS ANY AND ALL REPRESENTATIONS AND WARRANTIES, INCLUDING WITHOUT LIMITATION, ANY WARRANTIES OR REPRESENTATIONS, WHETHER EXPRESS, IMPLIED, STATUTORY OR OTHERWISE, RELATING TO: (I) TITLE TO THE LAND; (II) THE CONDITION, QUANTITY, QUALITY, CONFORMITY TO MODELS OR SAMPLES, FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR NON-INFRINGEMENT OF THE LAND; (III) THE ACCURACY OR COMPLETENESS OF ANY DATA, REPORTS, RECORDS, PROJECTIONS, INFORMATION OR MATERIALS FURNISHED OR MADE AVAILABLE TO OR OTHERWISE OBTAINED BY GRANTEE; (IV) THE ENVIRONMENTAL CONDITION OF THE LAND, BOTH SURFACE AND SUBSURFACE; OR (V) ANY OTHER MATTERS CONTAINED IN ANY MATERIALS FURNISHED OR MADE AVAILABLE TO OR OTHERWISE OBTAINED BY GRANTEE OR ITS AGENTS AND REPRESENTATIVES.

(b) INSPECTION. GRANTEE HAS INSPECTED, OR WAIVED ITS RIGHT TO INSPECT, THE LAND FOR ALL PURPOSES, AND SATISFIED ITSELF AS TO ITS PHYSICAL AND ENVIRONMENTAL CONDITION, BOTH SURFACE AND SUBSURFACE, INCLUDING CONDITIONS SPECIFICALLY RELATING TO THE PRESENCE, RELEASE OR DISPOSAL OF HAZARDOUS MATERIALS, SOLID WASTES, ASBESTOS, OTHER MAN-MADE FIBERS, AND NATURALLY OCCURRING RADIOACTIVE MATERIALS. GRANTEE IS RELYING SOLELY UPON ITS OWN INSPECTION OF THE LAND.

(c) "AS IS, WHERE IS". GRANTEE IS ACQUIRING THE LAND IN AN "AS IS, WHERE IS" CONDITION, AND SHALL ASSUME ALL RISKS AND LIABILITIES THAT THE LAND MAY CONTAIN HAZARDOUS MATERIALS OR OTHER WASTE, TOXIC, HAZARDOUS, EXTREMELY HAZARDOUS OR OTHER MATERIALS OR SUBSTANCES, OR OTHER ADVERSE PHYSICAL CONDITIONS, INCLUDING WITHOUT LIMITATION, THE PRESENCE OF UNKNOWN ABANDONED OIL AND GAS WELLS, WATER WELLS, SUMPS, PITS, PIPELINES OR OTHER WASTE OR SPILL. ALL RESPONSIBILITY AND LIABILITY RELATING TO ALL SUCH CONDITIONS, WHETHER KNOWN OR UNKNOWN, FIXED OR CONTINGENT, ARE ASSUMED BY GRANTEE, REGARDLESS OF WHEN THE LIABILITY OR RESPONSIBILITY AROSE.

1. Exhibits. Exhibit A attached to this Deed are incorporated herein and made a part hereof for all purposes, provided, that such incorporation shall not be deemed to ratify or create any rights in favor of any third party.

2. Successors and Assigns. This Deed shall inure to the benefit of and be binding upon the parties hereto, and their respective successors, legal representatives and assigns.

3. Headings. The headings in this Deed are inserted for convenience only and shall not control or affect the meaning or construction of any of the provisions hereof.

4. Further Actions. Grantee and Grantor covenant and agree to take all such further actions and to execute, acknowledge and deliver all such further documents that are necessary or useful in carrying out the purposes of this Deed.

5. Invalidity. If any term, provision, covenant or restriction of this Deed is held by a court of competent jurisdiction to be invalid, void or unenforceable, the remainder of the terms, provisions, covenants and restrictions of this Deed shall continue in full force and effect and shall in no way be affected, impaired or invalidated unless such an interpretation would materially alter the rights and privileges of any party hereto or materially alter the terms of the transactions contemplated hereby.

6. Governing Law; Venue; Jury Trial Waiver.

(a) THIS DEED AND THE LEGAL RELATIONS BETWEEN THE PARTIES SHALL BE GOVERNED BY AND CONSTRUED IN ACCORDANCE WITH THE LAWS OF THE STATE OF COLORADO, EXCLUDING ANY CHOICE OF LAW RULES WHICH MAY DIRECT THE APPLICATION OF THE LAWS OF ANOTHER JURISDICTION.

(b) Each of the Parties hereby irrevocably and unconditionally submits to the exclusive jurisdiction of the State and Federal courts sitting in Denver County, in the State of Colorado and any appellate court from any thereof, with respect to any proceeding relating to this

Deed. Further, each of the Parties hereby irrevocably and unconditionally waives any objection or defense that it may have based on improper venue or forum non conveniens to the conduct of any such proceeding in any such courts. The Parties agree that either or both of them may file a copy of this paragraph with any court as written evidence of the knowing, voluntary and bargained agreement between the Parties to waive irrevocably any objections to jurisdiction, venue or to convenience of forum. Each of the Parties (on behalf of itself and its Affiliates) agrees that a final judgment in any such action or proceeding shall be conclusive and may be enforced in other jurisdictions by suit on the judgment or in any other manner provided by Law or in equity.

(c) WITH RESPECT TO ANY ACTION ARISING OUT OF OR RELATING TO THIS DEED OR THE TRANSACTIONS CONTEMPLATED HEREBY, EACH PARTY HEREBY WAIVES, TO THE FULLEST EXTENT PERMITTED BY LAW, ANY RIGHT IT MAY HAVE TO A TRIAL BY JURY.

7. Miscellaneous. This Deed together with the Exhibits and the APA contains the entire understanding and agreement of Grantor and Grantee with respect to the subject matter hereof. This Deed may be executed in any number of original counterparts, all of which constitute one and the same instrument. Whenever possible, each provision or part thereof of this Deed shall be interpreted in such manner as to be valid and effective under applicable Laws, but if any provision or part thereof of this Deed or the application of any such provision or part thereof to any Person or circumstance shall be held invalid, illegal, or unenforceable in any respect by a court of competent jurisdiction, such invalidity, illegality, or unenforceability shall not affect any other provision or part thereof.

8. APA. This Deed is subject to and delivered under the terms and conditions of the APA. If any provision of this Deed is construed to conflict with any provision of the APA, the provisions of the APA shall be deemed controlling to the extent of that conflict. The execution and delivery of this Deed by Grantor, and the execution and acceptance of this Deed by Grantee, shall not operate to release or impair any surviving rights or obligations of any Party under the APA.

[*Signature pages follow*]

Electronically Recorded RECEPTION#: 2022000032417,
4/12/2022 at 10:13 AM, 4 OF 8,
TD Pgs: 0 Josh Zygielbaum, Adams County, CO.

Dated this 28th day of March 2022, but effective as of the Effective Time.

GRANTOR

DJ SOUTH INFIELD GATHERING, LLC,
a Colorado limited liability company

By: _____
Name: Daniel C. Campbell
Title: Chief Executive Officer

ACKNOWLEDGEMENT

STATE OF COLORADO)
) ss.
COUNTY OF DENVER)

The foregoing instrument was acknowledged before me this 28 day of March 2022 by Daniel C. Campbell, Chief Executive Officer of DJ South Infield Gathering, LLC, a Colorado limited liability company, on behalf of such company.

WITNESS my hand and official seal.

My commission expires: April 17, 2023

LALENA BISHOP
NOTARY PUBLIC
STATE OF COLORADO
NOTARY ID 20154015513
MY COMMISSION EXPIRES APRIL 17, 2023

_____
Notary Public

By: _____
Name: Rogan McGillis
Title: Chief Financial Officer

ACKNOWLEDGEMENT

STATE OF COLORADO)
) ss.
COUNTY OF DENVER)

The foregoing instrument was acknowledged before me this 28 day of March 2022 by Rogan McGillis, Chief Financial Officer of DJ South Infield Gathering, LLC, a Colorado limited liability company, on behalf of such company.

WITNESS my hand and official seal.

My commission expires: April 17, 2023

LALENA BISHOP
NOTARY PUBLIC
STATE OF COLORADO
NOTARY ID 20154015513
MY COMMISSION EXPIRES APRIL 17, 2023

_____
Notary Public

Electronically Recorded RECEPTION#: 2022000032417,
4/12/2022 at 10:13 AM, 5 OF 8,
TD Pgs: 0 Josh Zygielbaum, Adams County, CO.

GRANTEE

CRESTONE PEAK RESOURCES WATKINS MIDSTREAM LLC

By: _____
Name: Cyrus Marter
Title: General Counsel

ACKNOWLEDGEMENT

STATE OF COLORADO)
) ss.
COUNTY OF DENVER)

The foregoing instrument was acknowledged before me this 28th day of February 2022, by Cyrus Marter, General Counsel of Crestone Peak Resources Watkins Midstream LLC, a Delaware limited liability company, on behalf of such company.

WITNESS my hand and official seal.

My commission expires: 9-21-2024

PAULA L. GREER
NOTARY PUBLIC
STATE OF COLORADO
NOTARY ID 19934011880
MY COMMISSION EXPIRES SEPTEMBER 21, 2024

_____
Notary Public, State of Colorado

Electronically Recorded RECEPTION#: 2022000032417,
4/12/2022 at 10:13 AM, 6 OF 8,
TD Pgs: 0 Josh Zygielbaum, Adams County, CO.

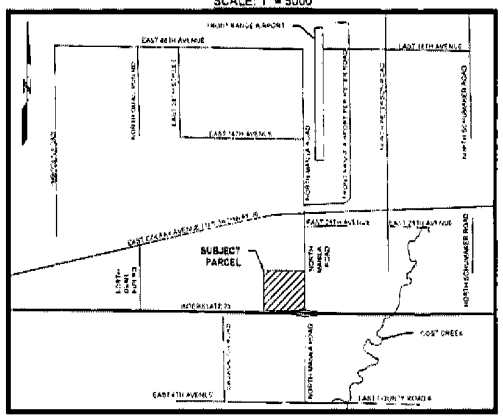
Exhibit A

[See attached]

LAND SURVEY PLAT

PART OF THE SE ¼ OF SECTION 34,TOWNSHIP 3 SOUTH, RANGE 64 WEST OF THE 6TH P.M., COUNTY OF ADAMS, STATE OF COLORADO

VICINITY MAP
SCALE: 1" = 5000'



RECORD LEGAL DESCRIPTION:

(FROM ADAMS COUNTY WARRANTY DEED REC. NO. 2019000004213)

TO BE A PART OF THAT PART OF THE SOUTHEAST ¼ OF SECTION 34, TOWNSHIP 3 SOUTH, RANGE 64 WEST OF THE 6TH PRINCIPAL MERIDIAN, COUNTY OF ADAMS, STATE OF COLORADO, MORE PARTICULARLY DESCRIBED AS FOLLOWS: COMMENCING AT THE SOUTHEAST CORNER OF SAID SECTION 34; THENCE WEST ALONG THE SOUTH LINE OF SAID SOUTHEAST ¼ OF SECTION 34, A DISTANCE OF 2648.81 FEET TO THE SOUTHWEST CORNER OF SAID SOUTHEAST ¼ OF SECTION 34; THENCE ON A DEFLECTION ANGLE TO THE RIGHT OF 88°57'08" ALONG THE WEST LINE OF SAID SOUTHEAST ¼ OF SECTION 34, A DISTANCE OF 252.99 FEET TO THE POINT OF BEGINNING; THENCE NORTH ALONG THE LAST DESCRIBED COURSE A DISTANCE OF 2401.98 FEET TO THE NORTHWEST CORNER OF SAID SOUTHEAST ¼ OF SECTION 34; THENCE ON A DEFLECTION ANGLE TO THE RIGHT OF 90°53'26" ALONG THE NORTH LINE OF THE SAID SOUTHEAST ¼ OF SECTION 34, A DISTANCE OF 2637.00 FEET TO A POINT ON THE WEST RIGHT-OF-WAY LINE OF MANILA ROAD; THENCE ON A DEFLECTION ANGLE TO THE RIGHT OF 89°30'10" ALONG THE SAID WEST RIGHT-OF-WAY LINE OF MANILA ROAD, A DISTANCE OF 1706.24 FEET; THENCE ON A DEFLECTION ANGLE TO THE RIGHT 11°16'30" ALONG THE NORTH RIGHT-OF-WAY LINE INTERSTATE 70, A DISTANCE OF 300.00 FEET; THENCE ON A DEFECTION ANGLE TO THE RIGHT OF 48°10'30" ALONG SAID NORTH RIGHT OF WAY LINE OF INTERSTATE 70, A DISTANCE OF 201.30 FEET; THENCE ON A DEFECTION ANGLE TO THE RIGHT OF 34°03'30" ALONG SAID NORTH RIGHT OF WAY LINE OF INTERSTATE 70, A DISTANCE OF 672.50 FEET; THENCE ON A DEFLECTION ANGLE TO THE RIGHT OF 98°55'58" ALONG SAID NORTH RIGHT-OF-WAY LINE OF INTERSTATE 70, A DISTANCE OF 1784.31 FEET TO THE POINT OF BEGINNING, COUNTY OF ADAMS, STATE OF COLORADO

ALSO DESCRIBED AS
(FROM ADAMS COUNTY WARRANTY DEED REC. NO. 2019000004213)

THAT PART OF THE SOUTHEAST QUARTER OF SECTION 34, TOWNSHIP 3 SOUTH, RANGE 64 WEST OF THE 6TH PRINCIPAL MERIDIAN, ADAMS COUNTY, STATE OF COLORADO BEING MORE PARTICULARLY DESCRIBED AS FOLLOWS: COMMENCING AT THE SOUTHEAST CORNER OF SAID SECTION 34; THENCE N89°39'30"W AND ALONG THE SOUTH LINE OF THE SOUTHEAST QUARTER OF SAID SECTION 34, A DISTANCE OF 2565.02 FEET TO THE SOUTH QUARTER CORNER OF SAID SECTION 34; THENCE N00°11'41"W, A DISTANCE OF 2413.18 FEET TO A POINT ON THE NORTH LINE OF SAID SOUTHEAST QUARTER; THENCE S89°34'18"E AND ALONG SAID NORTH LINE, A DISTANCE OF 2639.78 FEET TO A POINT ON THE WEST RIGHT OF WAY LINE OF MANILLA ROAD; THENCE S00°05'43"E ALONG SAID WEST RIGHT-OF-WAY LINE, A DISTANCE OF 1790.35 FEET TO A POINT ON THE NORTH RIGHT-OF-WAY LINE OF INTERSTATE 70; THENCE ALONG SAID NORTH RIGHT-OF-WAY LINE FOR THE FOLLOWING FIVE COURSES: 1) S11°12'47"W, 102.00 FEET; 2) S00°05'43"E, 300.00 FEET; 3) S46°04'47"W, 201.30 FEET; 4) S82°08'17"W, 672.50 FEET; 5) N88°55'28"W, 1756.74 FEET TO THE POINT OF BEGINNING.

SURVEYED LEGAL DESCRIPTION:

BEING A PORTION OF THE SOUTHEAST SECTION 34, TOWNSHIP 3 SOUTH, RANGE 64 WEST OF THE 6TH PRINCIPAL MERIDIAN, ADAMS COUNTY, STATE OF COLORADO BEING MORE PARTICULARLY DESCRIBED AS FOLLOWS

COMMENCING AT THE SOUTH ¼ CORNER OF SAID SECTION 34 (AS MONUMENTED BY A FOUND 3-1/4" ALUMINUM CAP "PLS 28285/ 2014"), FROM WHICH THE SOUTHEAST CORNER OF SAID SECTION 34 (AS MONUMENTED BY A 3-1/4" ALUMINUM CAP "AZTEC CONSULTANTS INC./ 2004/ PLS 38550") BEARS S89°38'36"E, A DISTANCE OF 2,662.28 FEET, FORMING THE BASIS OF BEARINGS USED IN THIS DESCRIPTION;

THENCE N00°14'47"W COINCIDENT WITH THE WEST LINE OF THE SOUTHEAST QUARTER OF SAID SECTION 34, A DISTANCE OF 250.20 FEET TO A POINT ON THE NORTH RIGHT-OF-WAY LINE OF INTERSTATE 70 AS DESCRIBED IN BOOK 746 ON PAGE 70 (REC. NO. 553054) AS RECORDED IN THE OFFICIAL ADAMS COUNTY RECORDS, SAID POINT ALSO BEING THE POINT OF BEGINNING;

THENCE N00° 14' 47"W COINCIDENT WITH THE WEST LINE OF THE SOUTHEAST QUARTER OF SAID SECTION, A DISTANCE OF 2416.51 FEET TO THE CENTER ¼ CORNER OF SAID SECTION; THENCE S89° 32' 39" E COINCIDENT WITH THE NORTH LINE OF THE SOUTHEAST QUARTER OF SAID SECTION, A DISTANCE OF 2,639.91' FEET TO A POINT ON THE WEST RIGHT-OF-WAY LINE OF MANILA ROAD; THENCE S00° 05' 01"E COINCIDENT WITH SAID WEST RIGHT-OF-WAY LINE OF MANILA ROAD, A DISTANCE OF 1790.41 FEET TO A POINT ON THE NORTH RIGHT-OF-WAY LINE OF INTERSTATE - 70; THENCE ALONG SAID NORTHERLY RIGHT-OF-WAY LINE OF INTERSTATE 70 THE FOLLOWING FIVE (5) COURSES:

1. S11° 13' 31"W, A DISTANCE OF 102.00 FEET;
2. S00° 04' 59"E, A DISTANCE OF 300.00 FEET;
3. THENCE S45° 05' 31"W, A DISTANCE OF 201.30 FEET;
4. THENCE S82° 09' 01"W, A DISTANCE OF 672.50 FEET
5. THENCE N89° 15' 26"W, A DISTANCE OF 1756.74 FEET TO THE POINT OF BEGINNING

PARCEL CONTAINS 6,314,024 SQUARE FEET OR 144.95 ACRES, MORE OR LESS

GENERAL NOTES:

1. NOTICE: ACCORDING TO COLORADO LAW, YOU MUST COMMENCE LEGAL ACTION BASED UPON ANY DEFECT IN THIS SURVEY WITHIN THREE YEARS AFTER YOU FIRST DISCOVER SUCH DEFECT. IN NO EVENT MAY ANY ACTION BASED UPON ANY DEFECT IN THIS SURVEY BE COMMENCED MORE THAN TEN YEARS FROM THE DATE OF THE CERTIFICATION SHOWN HEREON. (C.R.S. 13-80-105)
2. THIS SURVEY DOES NOT CONSTITUTE A TITLE SEARCH BY ENCOMPASS SERVICES, LLC TO DETERMINE OWNERSHIP OR EASEMENTS OF RECORD. FOR ALL INFORMATION REGARDING EASEMENTS, RIGHTS-OF-WAY, AND TITLE OF RECORD, ENCOMPASS SERVICES, LLC RELIED UPON A PUBLIC RECORDS SEARCH ONLY USING THE ADAMS COUNTY CLERK AND RECORDER ONLINE DATABASE. ENCOMPASS SERVICES, LLC HAS NOT RESEARCHED OR SHOWN ANY OTHER EASEMENTS, RIGHTS-OF-WAY, VARIANCES, AND OR AGREEMENTS OF RECORD EXCEPT AS SHOWN HEREON. ALL REFERENCES HEREON TO BOOKS, PAGES, MAPS, AND RECEPTION NUMBERS ARE PUBLIC DOCUMENTS FILED IN THE RECORDS OF ADAMS COUNTY, COLORADO.
3. THE BASIS OF BEARINGS FOR THIS SURVEY, MONUMENTED AND DESCRIBED AS SHOWN HEREON, ARE GRID BEARINGS OF NAD83(11) COLORADO STATE PLANE CENTRAL ZONE (0502) WITH ALL BEARINGS REFERENCED HEREIN RELATIVE THERETO.
4. ALL DISTANCES SHOWN HEREON ARE GROUND DISTANCES RELATIVE TO NAD83(11) COLORADO STATE PLANE CENTRAL ZONE (0502). THE COMBINED ELEVATION/ SCALE FACTOR (CSF) USED TO MODIFY DISTANCES TO GROUND IS 0.99971230.
5. THE LINEAR UNITS FOR THIS SURVEY ARE U.S. SURVEY FEET (1200/3937 METERS).
6. THE FIELDWORK FOR THIS SURVEY WAS PERFORMED AND COMPLETED IN FEBRUARY 2022.
7. THIS LAND SURVEY PLAT WAS PREPARED IN ACCORDANCE WITH C.R.S. 38-51-106.

SURVEYORS CERTIFICATE:

I, AARON J. HANDL, A REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF COLORADO DO HEREBY STATE THAT THIS LAND SURVEY PLAT AND THE SURVEY FROM WHICH IT IS BASED WAS PREPARED UNDER MY DIRECT SUPERVISION AND THAT THE INFORMATION SHOWN HEREON IS CORRECT TO THE BEST OF MY KNOWLEDGE, INFORMATION AND BELIEF AND THAT THIS SURVEY WAS COMPLETED IN ACCORDANCE WITH APPLICABLE STANDARDS OF PRACTICE. THIS IS NOT A GUARANTY OR WARRANTY, EITHER EXPRESSED OR IMPLIED.

DATE OF LAND SURVEY PLAT: 03-03-2022

AARON J. HANDL, PLS 38328
FOR AND ON BEHALF OF
ENCOMPASS SERVICES, LLC
10901 W. 120TH AVE., STE. 400
BROOMFIELD, CO 80021

COLORADO LICENSED AARON J. HANDL 38328 03-03-22 PROFESSIONAL LAND SURVEYOR

INDEXING STATEMENT:

DEPOSITED THIS _____ DAY OF _____, 20_____, AT _____, M., IN BOOK_____
OF THE COUNTY SURVEYOR'S LAND SURVEY/ RIGHT-OF-WAY SURVEYS AT
PAGE(S)_____, RECEPTION NUMBER_____

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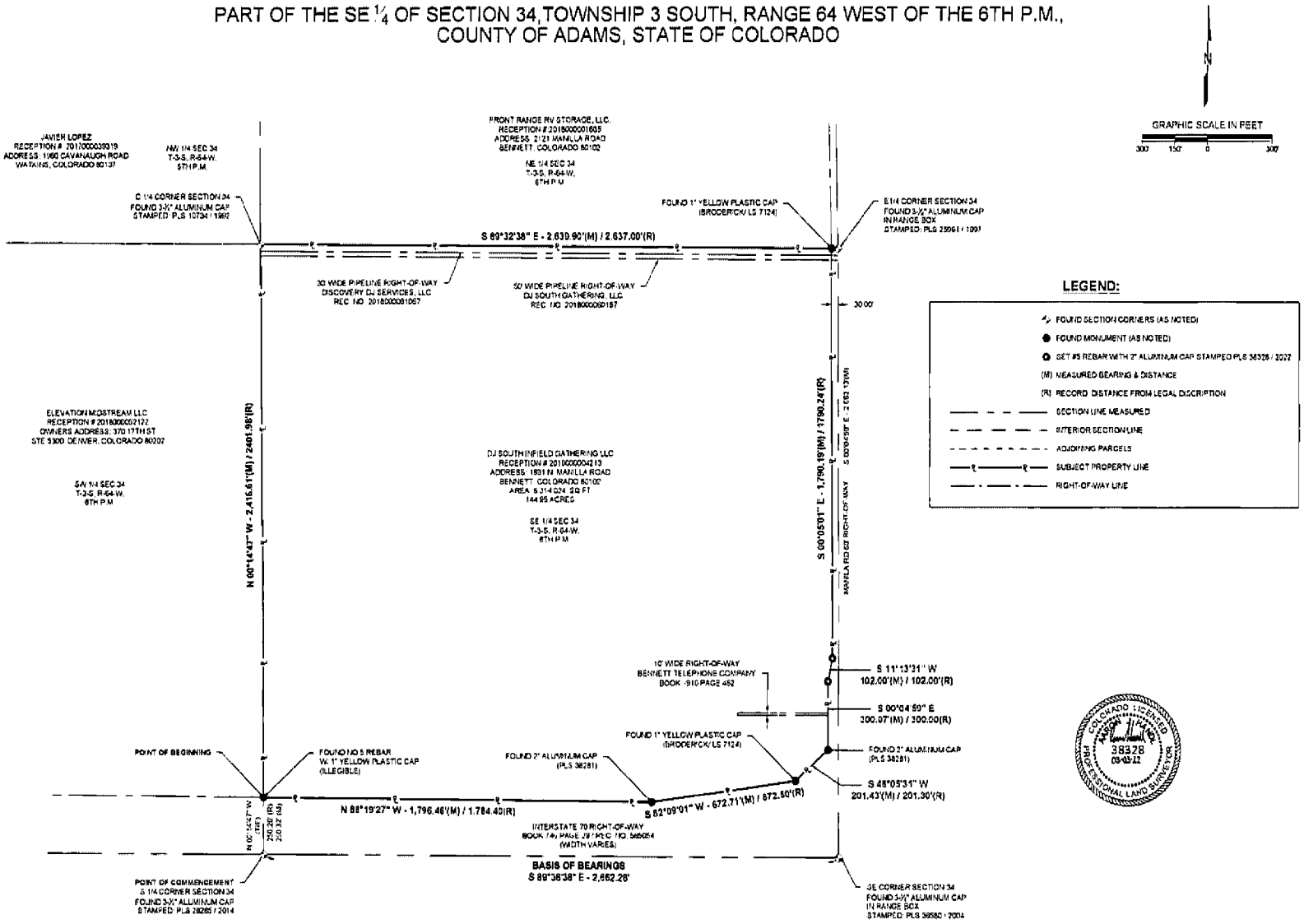
COUNTY SURVEYOR/ DEPUTY COUNTY SURVEYOR

eneompass ENCOMPASS SERVICES, LLC 10901 W. 120TH AVE., STE. 400 BROOMFIELD, CO 80021	LAND SURVEY PLAT PART OF THE SE ¼ OF SECTION 34, TOWNSHIP 3 SOUTH, RANGE 64 WEST OF THE 6TH P.M., COUNTY OF ADAMS, STATE OF COLORADO	ISSUE DATE: 02/28/2022 / PROJECT NO.: 61763 / REV. NO.: 1	SHEET NO.
		DATE: / REVISION COMMENTS: / DRWN / CHKD	
		03/03/2022 / UPDATED MONUMENT REFERENCES / RD / AH	1
			1 OF 2

LAND SURVEY PLAT

PART OF THE SE ¼ OF SECTION 34, TOWNSHIP 3 SOUTH, RANGE 64 WEST OF THE 6TH P.M.,
COUNTY OF ADAMS, STATE OF COLORADO



encompass

ENCOMPASS SERVICES, LLC
10901 W. 120TH AVE., STE. 400
BROOMFIELD, CO 80021

LAND SURVEY PLAT
PART OF THE SE ¼ OF SECTION 34,
TOWNSHIP 3 SOUTH, RANGE 64 WEST OF THE 6TH P.M.,
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ISSUE DATE: 02/28/2022	PROJECT NO.: 61763	REV. NO.: 1	SHEET NO.
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03/03/2022	UPDATED MONUMENT REFERENCES	RD / AH	2
			2 OF 2

Transportation Plan & Traffic Summary

Adams County Development Standards and Regulations Section 4-11-02-03-03-03-22

To:	John Piekara, Civitas Resources
From:	Lily Vagelatos, PE, Tetra Tech Bill Zahniser, PE, Tetra Tech
Date:	January 27, 2025
Subject:	Bennett Pad D – Narrative Traffic Memorandum

Crestone Peak Resources Operating, LLC (Crestone, operating as part of Civitas Resources, Inc.) is planning development of the Bennett D Pad located north of Interstate 70 (I-70) and west of Manila Road, in the Southeast ¼ of Section 34, Township 3 South, Range 64 West (**Figure 1**). Crestone has contracted services from Tetra Tech Inc. (Tetra Tech) to provide a narrative description of the local traffic impacts anticipated for the proposed oil and gas development. Impacts are based on a desktop review of the area, and information provided to Tetra Tech by Crestone for their development plans. A field traffic survey was not performed in support of this evaluation. A traffic count was previously performed for the oil terminal that first developed the existing access and Adams County confirmed with Crestone that a second one was not needed.

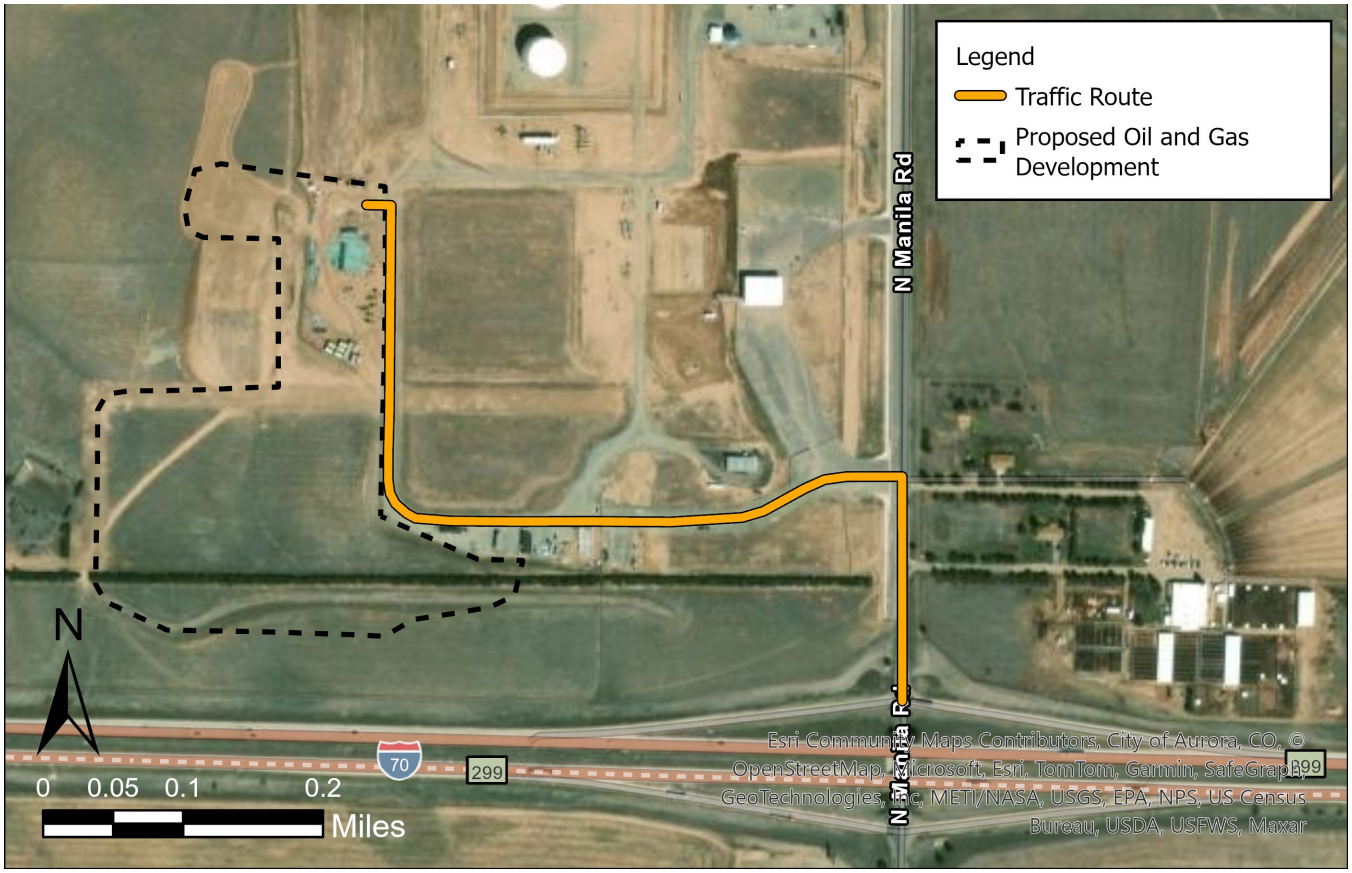

Figure 1. Site location and traffic route.

Current Conditions

The proposed location for the development is a mostly vacant portion of a privately owned land parcel in Adams County that has existing oil and gas development on the eastern portion of the property, between the proposed project and Manila Road. The main access is off Manila Road approximately 0.1 miles north of I-70 and is an industrial site access permitted by Adams County. No additional public road construction or improvements to county roads is planned as part of this development as the existing access is of sufficient quality and dimensions for the trucks and heavy equipment that will be used.

Bennett D Pad Development Plan

Crestone is in the process of permitting the drilling and completion of up twenty-six horizontal wells and the installation of related surface production equipment on one well pad that will be serviced by the existing access road. They are also planning the construction of water and product pipelines at this location to reduce the number of produced water and product trucks accessing the site. The installation of these pipelines are projected to eliminate as many as 160,000 tanker truck and facility service rig trips over the projected 30 year life of the facility. Construction, drilling and completion phases of the project are considered to be a temporary use, and do not factor into long term changes to the site access. Once completed, it is anticipated that one to two operators will access the site daily in light duty trucks to check equipment.

Crestone has provided traffic estimates and durations for each phase of the project. The duration of each phase is dependent on the number of wells drilled. The traffic data provided in **Table 1** conservatively assumes all twenty-six proposed wells are drilled and completed. All traffic for the project will access the site from I-70.

Table 1. Estimated Traffic Volumes and Durations

Phase	Duration (Days)	Truck[(1)] Trips (Total)	Average Truck Trips per Day	Light Duty Crew Traffic (Trips/Day)	PCE Trips/Day	Peak Hour PCE
Pad Construction	60	1,418	24	10	82	15
Drilling	194	4,268	24	23	95	9
Completions: • Completions • Facility Construction • Mill Out/Tubing	 • 105[(2)] • 92[(2)] • 164[(2)]	20,672	77	61	292	26
Flowback	60	40	1	5	8	4
Interim Reclamation	60	566	9	10	37	11
Production	15 – 30 years	40 (per month)	1	2	5	0

Notes:

- PCE – Passenger car equivalent, CDOT – Colorado Department of Transportation, SHAC – State Highway Access Code.

1. Crestone indicated that the majority of the truck traffic for the project will be Class 8 through 13 combo units (3 PCE), but that there may be some Class 4 through single unit trucks (2 PCE). To be conservative, all PCE calculations assume combo units for the total volumes.
2. Completion activities may be performed in parallel, and durations are not necessarily additive for this phase of the project.

Sight Distance Evaluations

Sight distance is an important measure to determine the safety of a vehicle entering a roadway. Stopping sight distance (SSD) is the minimum distance a vehicle driver needs to be able to see to have room to stop before colliding with an object in the roadway. Insufficient sight distance can adversely affect the safety or operations of a roadway or intersection. A desktop evaluation of sight distance measurements was made using Google Earth at the existing access from Manila Road. The posted traffic speed limit along Manila Road is 45 miles per hour (mph). Using the Colorado Department of Transportation (CDOT) State Highway Access Code (Colorado Department of Transportation, 2002), the design stopping distance for a 45-mph road is 400 feet. The stretch of Manila Road with the existing site access, is straight, relatively flat and there are no trees or obstructing structures. Using street view in Google Earth, the SSD of 400 feet is clear both north and south bound toward the access (**Figure 2**).

Figure 2. Sight stopping distance. Left picture 400 feet south of the existing access facing north. Right picture 400 feet north of the existing access facing south.

Another important measure of sight distance is the entering sight distance. Guidelines for measuring these distances can also be found in the State Highway Access Code. Entering sight distance is the sight distance a vehicle entering a roadway needs to safely make the movement. Section 4.3 of the State Highway Access Code provides a list of required entering sight distance values for varying types of entering vehicles. An entering sight distance of 765 feet is required for multi-unit trucks for a two-lane roadway at 45 mph, such as Manila

Road. Again, using street view in Google Earth, the entering sight distance of 765 feet is clear both east and west bound looking out from the access (**Figure 3**).

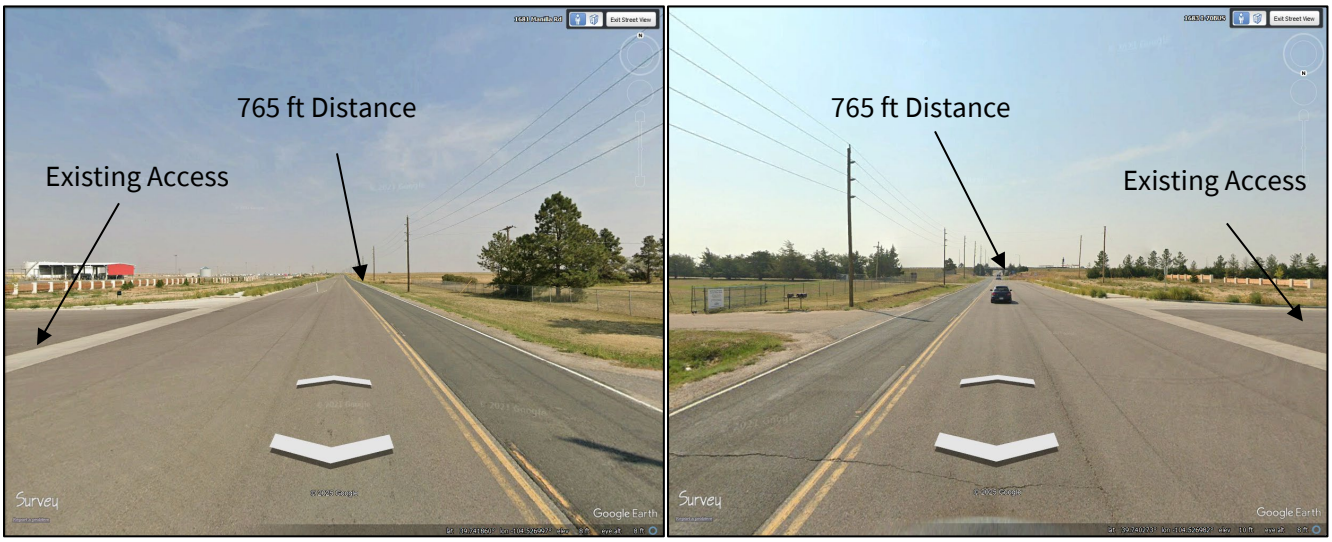

Figure 3. Entering sight distance. Left picture from the existing access facing north. Right from the existing access facing south.

Conclusions

Based on the details above, Tetra Tech anticipates that the Bennett D Pad will have a minor impact on traffic volume during the construction and development period of the project. After completion of the construction build-out phase, there should be minimal impacts to traffic along Manila Road related to the Bennett D Pad project site.

The existing access meets safety requirements for both the driving public and the development traffic. There is adequate visibility for inbound and outbound project traffic to negotiate the access and make full turn movements. Traffic throughout the construction and development phase of the project is anticipated to exceed the CDOT warrant for a left turn auxiliary deceleration lane (10 PCE per hour during the peak hour); however, due to the temporary nature of the impact (less than a year) construction of an auxiliary lane would be potentially be more disruptive to the driving public. Tetra Tech recommends a traffic control plan with additional signage during the peak periods of traffic.

Tetra Tech understands that the County may require a road maintenance agreement to help manage potential damages from the project traffic. Crestone has indicated they are amenable to such an agreement if warranted. Tetra Tech would recommend that the term of any such road maintenance agreement be focused on potential damage that may be incurred during the construction of the facility.

References

Colorado Department of Transportation. (2002). State Highway Access Code. Transportation Commission and Office of Transportation Safety.