Appendix E
Floodway Notice

HRGreen®

5619 DTC Parkway | Suite 1150 | Greenwood Village, CO 80111
Main 720.602.4999 + **Fax** 844.273.1057

HRGREEN.COM

March 2023

4-Way Ranch Joint Venture LLC

PO Box 50223

Colorado Springs, CO 80949-0223

Re: Notification of establishment in 1-percent-annual-chance water-surface elevations and/or future flood hazard revisions

The Flood Insurance Rate Map (FIRM) for a community depicts the Special Flood Hazard Area (SFHA), the area that has been determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

HR Green, Inc. is applying for a Conditional Letter of Map Revision (CLOMR) from the Federal Emergency Management Agency (FEMA) on behalf of D.R. Horton to revise FIRMs 08041C0552G and 08041C0556G for El Paso County along Gieck Ranch Tributary 1 and Gieck Ranch Tributary 2. D.R. Horton is proposing to realign and create a creek corridor as part of the Grandview Reserve Development. The proposed project will result in increases in the 1% annual chance (base) water-surface elevations for a portion of Geick Ranch Tributary 1 and Geick Ranch Tributary 2.

Once the project has been completed, a Letter of Map Revision (LOMR) request should be submitted that will, in part, revise the following flood hazards along Gieck Ranch Tributary 1 and Gieck Ranch Tributary 2.

The SFHA will increase and decrease along Geick Ranch Tributary 1 and Geick Ranch Tributary 2.

This letter is to inform you of the proposed project that may affect flood elevations on your property at Stapleton Dr. This letter is also to inform you of the potential changes to the effective flood hazard information that would result after the project is completed and a LOMR request is submitted to FEMA.

Maps and detailed analysis of the floodway revision can be reviewed at the Pikes Peak Regional Building Department at 2880 International Circle, Colorado Springs, Colorado 80910. If you have any questions or concerns about the proposed project or its effect on your property, you may contact Keith Curtis, CFM, Floodplain Administrator of El Paso County at Keith@pprbd.org from {date TBD} to {date TBD} or Jeff Rice with El Paso County at JeffRice@elpasoco.com from {date TBD} to {date TBD}.

HR GREEN, INC

Greg Panza, PE
Lead Engineer

HRGreen®

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HRGREEN.COM

March 2023

JMJK Holdings LLC

3855 Ambrosia St. Ste 304

Castle Rock, CO 80109

Re: Notification of establishment in 1-percent-annual-chance water-surface elevations and/or future flood hazard revisions

The Flood Insurance Rate Map (FIRM) for a community depicts the Special Flood Hazard Area (SFHA), the area that has been determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

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Once the project has been completed, a Letter of Map Revision (LOMR) request should be submitted that will, in part, revise the following flood hazards along Gieck Ranch Tributary 1 and Gieck Ranch Tributary 2.

The SFHA will increase and decrease along Geick Ranch Tributary 1 and Geick Ranch Tributary 2.

This letter is to inform you of the proposed project that may affect flood elevations on your property at Eastonville Rd. This letter is also to inform you of the potential changes to the effective flood hazard information that would result after the project is completed and a LOMR request is submitted to FEMA.

Maps and detailed analysis of the floodway revision can be reviewed at the Pikes Peak Regional Building Department at 2880 International Circle, Colorado Springs, Colorado 80910. If you have any questions or concerns about the proposed project or its effect on your property, you may contact Keith Curtis, CFM, Floodplain Administrator of El Paso County at Keith@pprbd.org from {date TBD} to {date TBD} or Jeff Rice with El Paso County at JeffRice@elpasoco.com from {date TBD} to {date TBD}.

HR GREEN, INC

Greg Panza, PE
Lead Engineer

Appendix F
Endangered Species Act Compliance

Igel, Trevor

From: Grant Gurnee <grant@ecologicalbenefits.com>
Sent: Monday, July 25, 2022 11:32 AM
To: Panza, Gregory
Cc: Jon Dauzvardis
Subject: RE: FEMA TES comment

Importance: High

Greg –
Perhaps it is best to remind FEMA that the 2020 ESA No Effect Concurrence Request Memo did include all of the information they requested, as Section 4 clearly states that Ecos screened all potential TES in the County as that is what the USFWS IPaC Trust Resources Report provides; and , we provided an Effects Determination in Section 5.

4.0 FEDERAL LISTED SPECIES
A number of species that occur in El Paso County are listed as candidate, threatened or endangered by the USFWS (USFWS, 2018) under the ESA. Ecos compiled the Federally-listed species for the Site in Table 1 based on the Site-specific, USFWS IPaC Trust Resources Report we ran for the Project (Appendix A); and our onsite assessment. Ecos has provided our professional opinion regarding the probability that these species may occur within the Site and their probability of being impacted by the Project.

The likelihood that the Project would impact any of the species listed below is very low to none. Most are not expected occur in the Project area or on the Site; nor will they be affected by the direct or indirect effects of the project.

5.0 EFFECTS DETERMINATION
The Site is not located within any USFWS designated critical habitat or known occupied habitat for federally listed threatened or endangered species. Please refer to the IPaC database (Appendix A) and Table 1.
The Project will have **No Effect** on the following listed species:
• Listed species in Nebraska, as the Site is not located in the North Platte, South Platte or Laramie River basins.
• Greenback cutthroat trout, Mexican spotted owl and North American wolverine, as suitable habitat does not exist on the Site.
• Western prairie fringed orchid, as the Site will not alter or deplete flows to the Platte River system.
• Ute ladies'-tresses orchid is unlikely to occur as the Site is situated between 6,860 and 7,020 feet above mean sea level, which is higher than the 6,500-foot elevation limits documented for the species and recommended for conducting surveys by the USFWS.
• Preble's meadow jumping mouse: This species occurs in the County but is not known to occur on the Site due to:
  - The absence of habitat required to support the life requisites of the species;
  - Negative trapping results (i.e., Trapped – Not Found) reported by USFWS upstream and downstream of the Site on West Kiowa Creek, and east of the Site on Kiowa Creek;
  - 2.5 mile distance from the closest CPW "Potential" Occupied Habitat;

- 6.5 mile distance from the closest USFWS Critical Habitat; and
- The lack of viable habitat connection corridors from known, occupied habitat to the Site.

If the above information does not suffice, please forward FEMA this email.

No Take Statement:
Ecos hereby confirms that "Take" as defined under the Endangered Species Act will not occur to threatened and endangered species present in the county as a result of the project.

Thank you,
Grant

Grant Gurnée, P.W.S.
Owner – Restoration Ecologist – Fish & Wildlife Biologist
ecosystem services LLC

(o): 970-812-ECOS (3267)
(c): 303-746-0091
(w): www.ecologicalbenefits.com
(e): grant@ecologicalbenefits.com

Life is like a river…we all must learn to adapt to the challenges of dynamic equilibrium

ecos ecosystem services LLC

Informal Consultation Request

April 10, 2020

Mr. Drue DeBerry
Acting Colorado Field Supervisor
U.S. Fish and Wildlife Service
Colorado Ecological Services Field Office
134 Union Blvd., Suite 670
Lakewood, Colorado 80228

RE: Request for Technical Assistance Regarding the Likelihood of Take of Federally-listed Threatened and Endangered Species resulting from the proposed development of the Grandview Reserve Project in El Paso County, Colorado

Dear Mr. DeBerry:

Ecosystem Services, LLC (ecos) has prepared the enclosed habitat evaluation on behalf of 4 Site Investments to describe the physical/ecological characteristics of the Grandview Reserve site (Site) and evaluate the potential effects of the proposed development project (Project) on the Federally-listed threatened and endangered (T&E) species protected under the Endangered Species Act (ESA).

The El Paso County Environmental Division has completed its review of the Project and has requested that 4 Site Investments provide a "Clearance Letter" obtained from the U.S. Fish and Wildlife Service (USFWS) to the Planning and Community Development Department prior to project commencement "where the project will result in ground disturbing activity in habitat occupied or potentially occupied by threatened or endangered species and/or where development will occur within 300 feet of the centerline of a stream or within 300 feet of the 100 year floodplain, whichever is greater."

At this time there is no Federal action and no Federal agency is making a formal effects determination under Section 7 (a)(2) of the ESA. Therefore, ecos is requesting technical assistance from USFWS regarding 4 Site Investments' (i.e., the non-federal party) responsibilities under the ESA, and specifically the likelihood of the Project (described herein) resulting in take of listed species. If the USFWS concurs with the findings presented herein we request that you issue an informal letter of concurrence for use in the El Paso County Project review process.

1.0 SITE LOCATION and PROJECT DESCRIPTION

The Site is located in the Falcon/Peyton area of El Paso County and is bounded along the north by 4 Way Ranch Phase I, along the south by Waterbury, along the southeast by Highway 24, and along the west by Eastonville Road. There are no existing structures, roads, or other infrastructure on the Site. The Site is located approximately 4.14 miles southwest of Peyton, 4.16 miles northeast of Falcon and 4.66 miles south of Eastonville, in El Paso County, Colorado. The Site is generally located within the south ½ of Section 21, south ½ of Section 22, the north ½ of Section 27, and the north ½ of Section 28, Township 12 South, Range 64 West in El Paso County, Colorado. The center of the Site is situated at approximately Latitude 38.98541389 north, -104.55472222 east (refer to Figure 1).

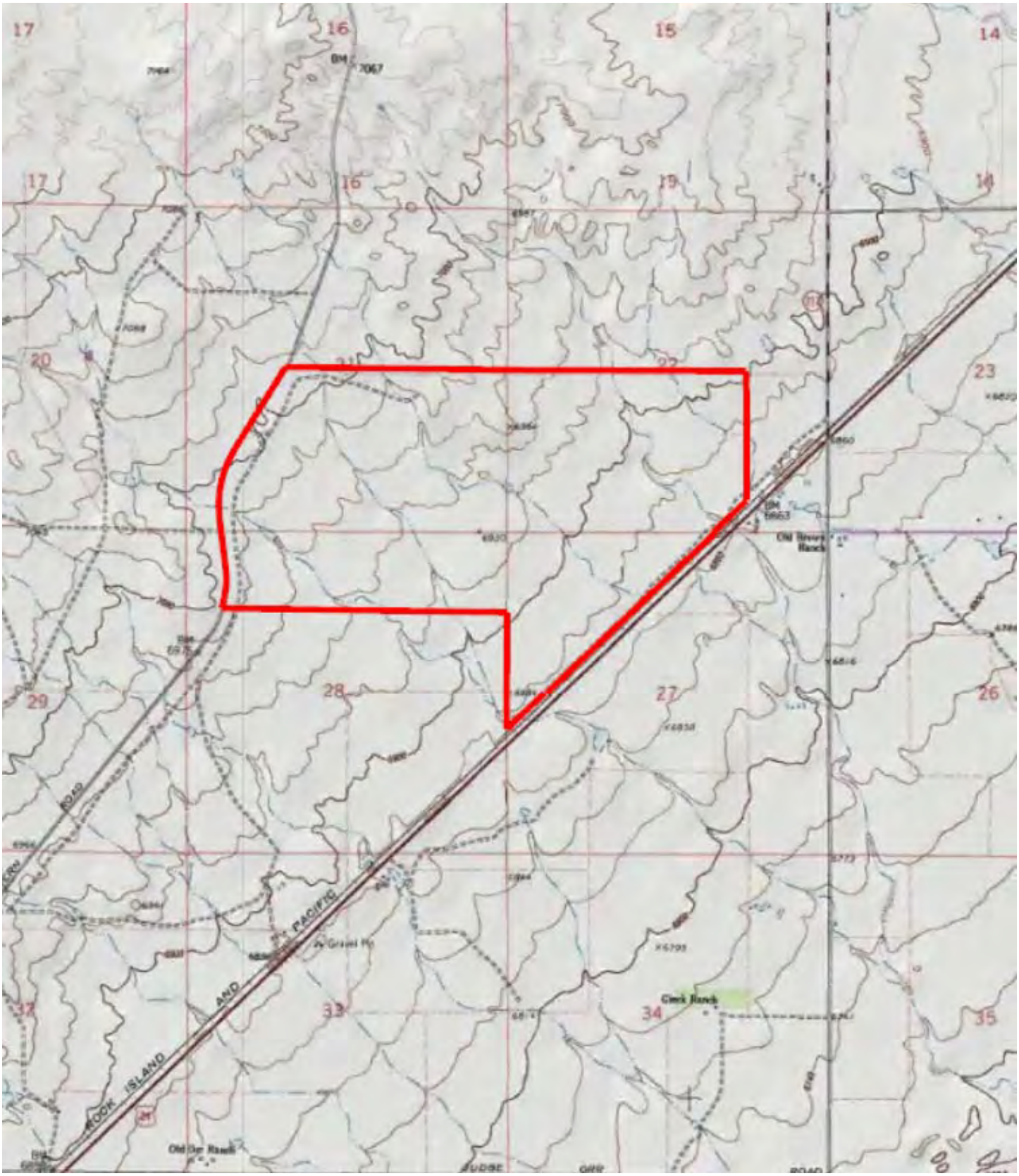
The Applicant proposes to develop the 768.2-acre Site as a mixed use residential and commercial community with the total number of units ranging from 2,496 to 3,261 as summarized below:

Table 1 – Land Use Summary

Land Use Category	Acreage	Acreage %	Density Units/Acre		Units	
			Min.	Max.	Min.	Max.
Institutions	16.9 acres	2.2%	NA	NA	NA	NA
Low Density Residential	136.4 acres	17.8%	1	2	136	272
Medium Density Residential	258.4 acres	33.6%	3	4	775	1033
Medium-High Density Residential	68.6 acres	8.9%	6	8	411	548
High Density Residential	117.4 acres	15.3%	10	12	1174	1408
Commercial	17.0 acres	2.2%	NA	NA	NA	NA
Open Space$_1$	132.5 acres	17.2%	NA	NA	NA	NA
Rex Rd. & Collector	21.0 acres	2.7%	NA	NA	NA	NA
TOTAL	**768.2 acres**	**100%**	**NA**	**NA**	**NA**	**NA**

Note 1: Open Space includes: Detention Ponds, Drainage Corridors, General Open Space & Easements and R.O.W. Buffers of Eastonville Road and Highway 24

Please refer to Figure 2.



USGS 7.5 min. Quad: Falcon
Latitude: 38.985713°N
Longitude: -104.552854°W
Section 21, 22, 27 & 28, Township 12 South, Range 64 West

EL PASO COUNTY
FALCON REGIONAL PARK

REX RD.

EASTONVILLE RD.

PARCEL A
6.2 ac.
CHURCH

PARCEL B
17.7 ac.
HIGH DENSITY

PARCEL C
24.8 ac.
HIGH DENSITY

PARCEL D
23.5 ac.
HIGH DENSITY

PARCEL E
17.2 ac
HIGH DENSITY

PARCEL F
15.5 ac.
HIGH DENSITY

PARCELG
40.0 ac.
MED DENSITY

PARCEL H
32.5 ac.
HIGH DENSITY

PARCEL I
38.8 ac.
MED. DENSITY

PARCEL J
64.2 ac.
MED. DENSITY

PARCEL K
59.1 ac.
HIGH DENSITY

PARCEL L
25.8 ac.
HIGH DENSITY

PARCEL M
29.8 ac.
HIGH DENSITY

PARCEL N
41.9
HIGH DENSITY

PARCEL O
18.5 ac.
HIGH DENSITY

PARCEL P
13.5 ac.
HIGH DENSITY

PARCEL Q
15.6 ac.
MED DENSITY

PARCEL R
23.6 ac.
HIGH DENSITY

PARCEL S
54.2 ac.
LOW DENSITY

PARCEL T
27.9 ac.
LOW DENSITY

PARCEL U
6.7 ac.
LOW DENSITY

ELEMENTARY
SCHOOL
10.7 ac.

COMMUNITY
PARK
5.9 ac.

C-1
8.2 ac.
COMMERCIAL

C-2
8.8 ac.
COMMERCIAL

FALCON
HIGH SCHOOL

WATERBURY
PROJECT

15' BUFFER

GAS LINE ESMT

GAS LINE ESMT

OPEN SPACE

POCKET PARK

DET. POND

TRAIL (TYP)

EXISTING WETLAND AND DRAINAGEWAY

EXISTING ROCK ISLAND TRAIL

HWY 24

GRANDVIEW TRAIL CONNECTION TO EXISTING ROCK ISLAND TRAIL

Land Use Summary

LAND USE CATEGORY	ACREAGE	ACREAGE %	DU/AC	UNITS
CHURCH	6.2 ac.	0.8%	N/A	N/A
LOW DENSITY	88.8 ac.	11.6%	1.45	129
MEDIUM DENSITY	158.6 ac.	20.7%	3.10	492
HIGH DENSITY	343.4 ac.	44.9%	4.00	1374
COMMERCIAL	17.0 ac.	2.2%	N/A	N/A
SCHOOL	10.7 ac.	1.4%	N/A	N/A
OPEN SPACE	119.1 ac.	15.6%	N/A	N/A
REX & COLLECTOR	21.0 ac.	2.7%	N/A	N/A
*OPEN SPACE INCLUDES: DETENTION, DRAINAGE CORRIDORS, GENERAL OPEN SPACE AND EASEMENTS,AND R.O.W./BUFFER OF EASTONVILLE RD. & HWY 24				
Total	764.8 ac.	**100%**		**1995**

LEGEND

POCKET PARK - APPROXIMATE LOCATION

DETENTION - APPROXIMATE LOCATION

PROPOSED TRAIL

SKETCH PLAN - DRAFT 3-25-20

GRANDVIEW RESERVE

FALCON, CO

HRGreen

NORTH

0 300 600 900

SCALE: 1" = 300'

MARCH 25, 2020

2.0 METHODOLOGY

2.1 Office Assessment

Ecos performed an office assessment in which available databases, resources, literature and field guides on local flora and fauna were reviewed to gather background information on the environmental setting of the Site. We consulted several organizations, agencies, and their databases, including:

- Colorado Department of Agriculture (CDA) Noxious Weed List;
- Colorado Natural Heritage Program (CNHP);
- Colorado Oil and Gas Conservation Commission (COGCC) GIS Online;
- Colorado Parks and Wildlife (CPW);
- El Paso County Master Plan;
- El Paso County, Sub-Area Plan (provided by Client);
- Federal Emergency Management Agency (FEMA);
- Google Earth current and historic aerial imagery;
- Survey of Critical Biological Resources, El Paso County, Colorado;
- Survey of Critical Wetlands and Riparian Areas in EI Paso and Pueblo Counties, Colorado;
- U.S. Army Corps of Engineers (USACE) 1987Corps of Engineers Wetlands Delineation Manual;
- USACE 2010 Regional Supplement to the Corps of Engineers Wetlands Delineation Manual: Great Plains Region;
- U.S. Department of Agriculture (USDA) PLANTS Database;
- U.S. Fish and Wildlife Service (USFWS) Region 6;
- USFWS National Wetland Inventory (NWI);
- USFWS IPaC database search; and
- U.S. Geological Survey (USGS).

Ecos also reviewed pertinent, site-specific background data provided by 4 Site Investments and their consulting Team, including topographic base mapping, site development plans, and other data pertinent to the assessment.

2.2 Onsite Assessment

Following the collection and review of existing data and background information, ecos conducted a field assessment of the Site on October 10 and 11, 2018 to identify any potential impacts to natural resources associated with the Project. Field reconnaissance concentrated on identification of wetland habitat, waters of the U.S., wildlife habitat (including habitat suitable to support threatened and endangered wildlife) significant topographic features, noxious weeds and vegetation. Wetland habitat and waters of the U.S. boundaries, wildlife habitat, major vegetation communities, and significant weed stands were sketched on topographic and aerial base maps and located using a hand-held Global Positioning System as deemed necessary. Representative photographs were taken to assist in describing and documenting Site conditions and potential ecological impacts.

3.0 ENVIRONMENTAL SETTING

The Site is located in the Southwestern Tablelands Ecological Region (Chapman et al, 2006), which is primarily comprised of sub-humid grassland and semiarid rangeland. More specifically, the Site is located in the Foothills Grassland sub-region (26j) which contains a mix of grassland types with some small areas of isolated tallgrass prairie species that are more common much farther east. The proximity to runoff and moisture from the Front Range and the more loamy, gravelly, and deeper soils are able to support more tallgrass and midgrass species than neighboring ecoregions. Big and little bluestem, yellow indiangrass and switchgrass occur, along with foothill grassland communities. The annual precipitation of 14 to 20 inches tends to be greater than in regions farther east. Soils are loamy, gravelly, moderately deep, and mesic. Rangeland and pasture are common , with small areas of cropland. Urban and suburban development has increased in recent years, expanding out from Colorado Springs and the greater Denver area.

The Site contains no Colorado Natural Heritage Conservation Areas or Potential Conservation Areas according to the CNHP (CNHP, 2018), and no Wildlife Refuges or Hatcheries according to the USFWS IPaC Trust Resources Report (USFWS, 2016a) (refer to Appendix A).

3.1 Topography

The Site is generally characterized as gently sloping from northwest to southeast with four ephemeral drainages (prairie sloughs) present, two of which are discontinuous and two are tributary to Black Squirrel Creek offsite. Naturally undulating swales drain toward the sloughs, which contain wetlands in low areas and dry areas where alluvial deposits have formed. Site topography ranges from a high elevation of 7020 feet above mean sea level (AMSL) in the northwestern corner to a low elevation of 6860 feet above AMSL where the northeastern tributary exits the Site on the east boundary along Highway 24; for a total elevation drop of 160 feet. An ill-defined and undulating hill, which is likely an eroded remnant bluff, is present in the north-central portion of the Site. Refer to Figure 3.

3.2 Soils

Ecos utilized the U.S. Department of Agriculture, Natural Resource Conservation Service Web Soil Survey (USDA, NRCS, 2018) to determine if hydric soils are present within the Site, as this data assist in informing the presence/absence of potential wetland habitat regulated under the Clean Water Act. The soils data were also utilized to supplement the field observations of vegetation, as the USDA provides correlation of native vegetation species by soils types. Please refer to Figure 4, USDA NRCS Soil Map and Appendix A for additional USFWS wetland information.

3.3 Vegetation

The vegetation within the Site is primarily comprised of shortgrass prairie with wetland vegetation in the swales and sloughs (Figure 5). The shortgrass prairie is dominated by little bluestem (*Schizachyrium scoparium*), blue grama (*Bouteloua gracilis*), and buffalograss (*Bouteloua dactyloides*) with occasional associative grass and forb species including western wheatgrass (*Pascopyrum smithii*), yellow Indiangrass (*Sorghastrum nutans*), Canada wildrye (*Elymus canadensis*), needle and thread (*Hesperostipa comata*), switchgrass (*Panicum virgatum*), Western yarrow (*Achillea millefolium*), broom snakeweed (*Gutierrezia sarothrae*), fringed sage (*Artemisia frigida*), Prickly pear (*Opuntia* spp.), and prairie aster spp. (*Symphyotrichum* spp.). Occasional patches of snowberry (*Symphoricarpos albus*) and Wood's rose (*Rosa woodsii*) occupy the transitional areas between uplands and wetlands. A few, single plains cottonwood (*Populus deltoides*) occur along the drainages. The Site is heavily impacted by historic and ongoing grazing and there are weeds scattered throughout, including Canada thistle (*Cirsium arvense*), Scotch thistle (*Onopordum acanthium*),

Russian thistle (*Salsola kali*), common mullein (*Verbascum thapsus*), and yellow toadflax spp. (*Linaria vulgaris*). Hydrophytic vegetation (wetland vegetation) is present within the swales and sloughs (refer to Section 3.4.2).

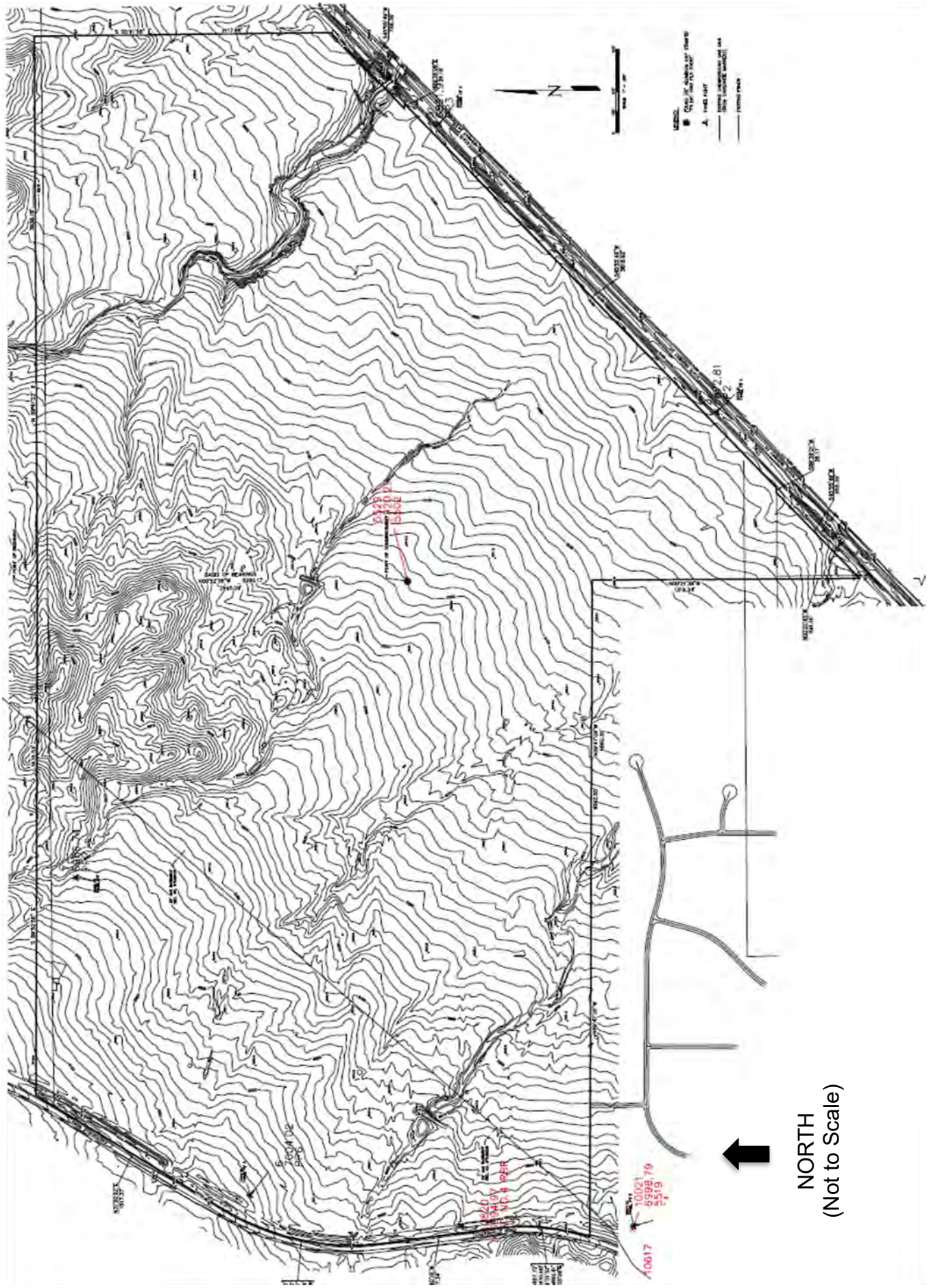
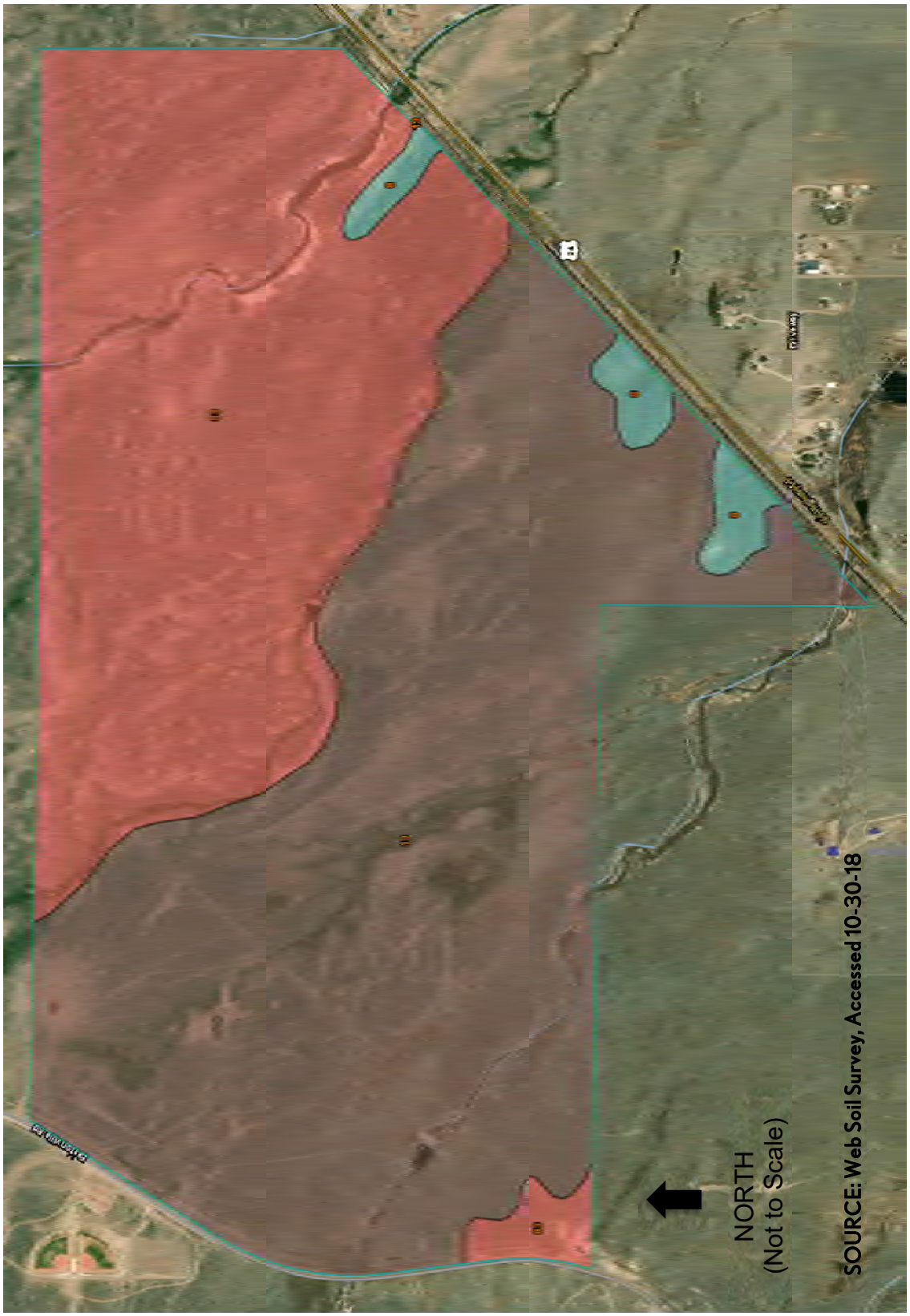


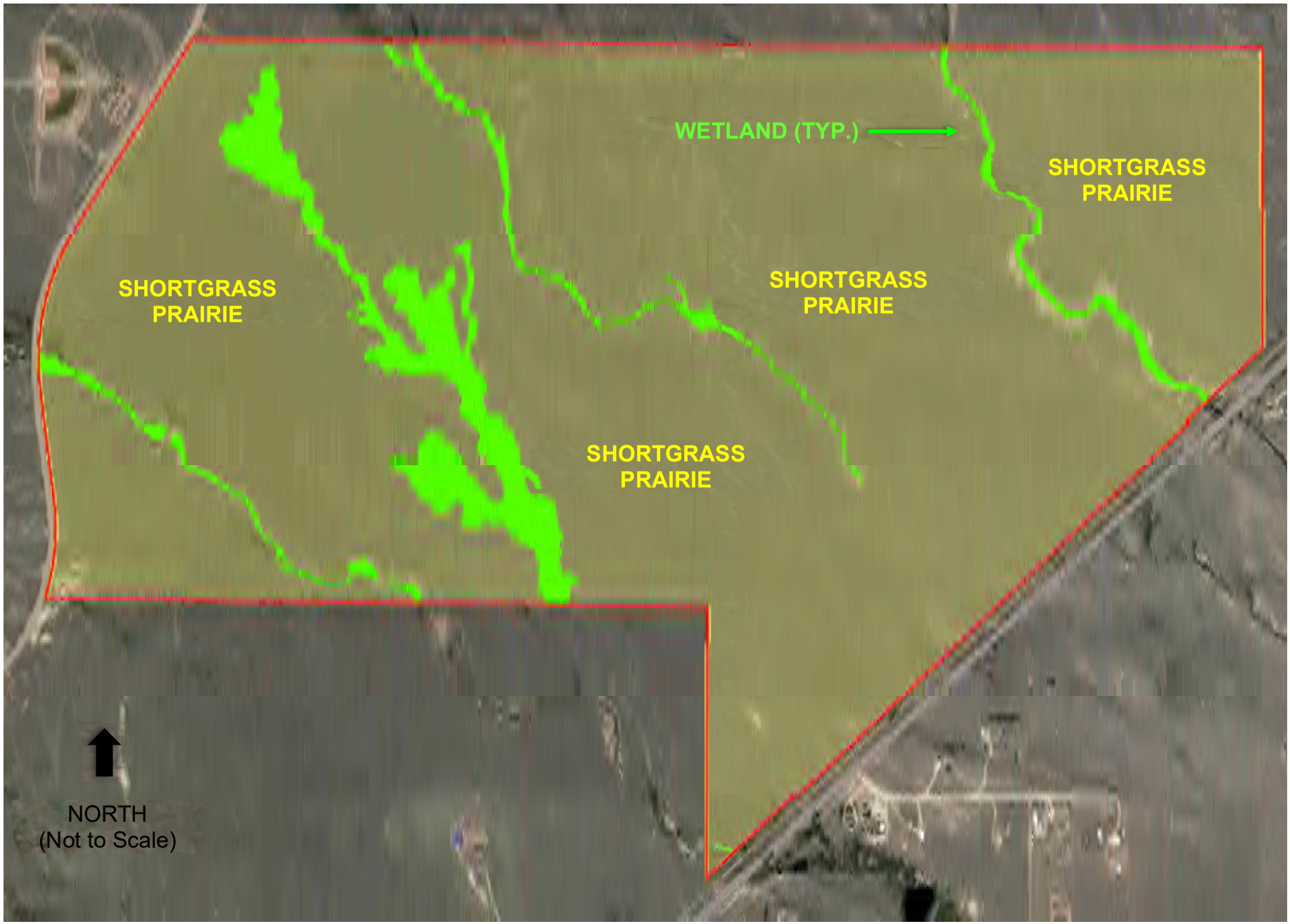
Figure 3 TOPOGRAPHIC MAP



Summary by Map Unit — El Paso County Area, Colorado (CO625)

Summary by Map Unit — El Paso County Area, Colorado (CO625)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
8	Blakeland loamy sand, 1 to 9 percent slopes	Blakeland loamy sand, 1 to 9 percent slopes	17.5	2.3%
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	Columbine gravelly sandy loam, 0 to 3 percent slopes	428.6	55.8%
83	Stapleton sandy loam, 3 to 8 percent slopes	Stapleton sandy loam, 3 to 8 percent slopes	322.2	41.9%
Totals for Area of Interest			**768.3**	**100.0%**

Figure 5



VEGETATION COMMUNITY MAP

3.4 Wetland Habitat and Waters of the U.S.

3.4.1 Methodology

Ecos utilized the National Wetland Inventory (NWI) Wetlands Mapper (USFWS 2018a); Colorado Wetland Inventory Mapping Tool (CNHP, 2018); historic and current Google Earth aerial photography; USGS 7.5-minute topographic mapping; and detailed Project topographic mapping to screen the Site for potential wetland habitat and waters of the U.S. Additionally, ecos performed a jurisdictional delineation to identify the Waters of the United States (WOUS), including wetlands.

The mapping data above were proofed during the field assessment and a wetland delineation was conducted to determine the presence/absence of potential WOUS, including wetland habitat. Once a feature was verified to be present, ecos determined whether it is a jurisdictional wetland/waters under the Clean Water Act. The U.S. Army Corps of Engineers (USACE), wetland delineation methodology was employed to document the 3 field indicators (parameters) of wetland habitat (i.e., wetland hydrology, hydric soils and a predominance of hydrophytic vegetation as explained in the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory, 1987) and supplemented by the Regional Supplement to the *Corps of Engineers Wetlands Delineation Manual: Western Mountains, Valleys and Coast Region (Version 2)* (USACE, 2010). The wetland delineation was surveyed by the project team surveyor

Consistent with the NWI and Colorado Wetland Inventory Mapping Tool (Figure 6) and topographic mapping, the wetland/waters delineation revealed the presence of four drainages with the potential to support wetland habitat (Figure 7). Two of the drainages (i.e. northeast Drainage D and southwest Drainage A) were preliminarily determined to be jurisdictional (pending USACE verification) and support predominantly palustrine emergent wetland (PEMC1) habitat with minor occurrences of palustrine scrub-shrub (PSS) and palustrine forested (PFO) species along their fringes. The central Drainage C and south-central Drainage B were investigated found to be discontinuous, prairie sloughs that are non-jurisdiction, "isolated" features. Please refer to Figure 6 for a composite of the NWI and CNHP Wetland and Riparian Areas mapping, Figure 7 for the ECOS Wetland and Waters Sketch Map, and Appendix B for representative photographs.

3.4.2 Field Assessment Findings

The results of the onsite assessment for each of the four onsite drainages is summarized below, with an explanation of the field indicators (parameters) of wetland habitat/waters that were observed, and an explanation as to whether ecos preliminarily determined each feature was jurisdictional or non- jurisdictional under Section 404 of the Clean Water Act. Jurisdictional features are mapped on Figure 7.

1) <u>Jurisdictional wetland habitat and waters of the U.S</u>.
    a. <u>PEMC1 Wetland Habitat</u> – Northeast Drainage D is classified as a Palustrine Emergent, Persistent, Seasonally Flooded wetland (PEMC1). Wetland Area A is tributary to Black Squirrel Creek off of the Site to the southeast. It is dominated by Nebraska sedge, redtop, clustered field sedge, three-square bulrush, swordleaf rush, soft-stem bulrush, poverty rush, Baltic rush, and watercress. Other species were present, including water mint, sporadic patches of sandbar willow, cutleaf evening primrose, fireweed, curly dock, and water milfoil, and snowberry, wild licorice and Wood's rose along the high banks. Soil samples indicate the presence of field indicators of hydric soils (organic horizon from 0-2 inches, 10YR4/2 clay loam from 2-9 inches, 10YR4/1 clay loam from 9-14 inches, and 10YR5/1 sandy clay from 14-18+ inches). Sustaining hydrology was evident as flowing water is present within a defined channel and saturated soils are present at the surface and throughout the

floodplain, including groundwater driven side-slope seepage. This area meets all 3 parameters for jurisdictional wetland habitat.

b. PEMC1 Wetland Habitat – Southwest Drainage A is classified as a Palustrine Emergent, Persistent, Seasonally Flooded wetlands (PEMC1 Wetland Area D is tributary to Black Squirrel Creek off of the Site to the southeast. It is dominated by Nebraska sedge, clustered field sedge, swordleaf rush, redtop, poverty rush, Baltic rush, and pussytoes. Other species were present, including soft-stem bulrush, three-square bulrush, smartweed, saltgrass, foxtail barley, water mint, scouring rush, wild geranium, watercress, narrowleaf cattail, and snowberry, wild licorice and Wood's rose along the high banks. Sporadic occurrences of sandbar willow, crack willow and plains cottonwood were present. Soil samples indicate the presence of field indicators of hydric soils (10YR2/2 loamy clay from 0-6 inches, 10YR4/2 sand from 6-12 inches, 10YR4/1 sand from 12-16 inches, and 10YR4/1 clayey sand from 16-18+ inches). Sustaining hydrology from groundwater seepage was evident as saturated soil is present at or within 8-12 inches of the ground surface. These areas meet all 3 parameters for jurisdictional wetland habitat.

2) Non-Jurisdictional, Isolated Wetlands - The central Drainage C and south-central Drainage B were investigated found to be discontinuous, prairie sloughs with reaches that are upland swales; they exhibited upland "breaks" in which they did not exhibit defined bed or bank (Figure 7); and they were also found to be "isolated" as they did not connect with downstream WOUS. Patches of PEMC1 Wetland exists in these drainages that exhibits the same characteristics of other wetlands on site and meets all 3 parameters for jurisdictional wetland habitat. However, they are clearly disconnected from Black Squirrel Creek by uplands that do not exhibit a defined bed or bank. Therefore, these drainages are isolated, non-jurisdictional features and as such were not delineated.

3.4.3 Summary of Jurisdictional and Non-Jurisdictional Wetlands and Waters

Jurisdictional Habitat – Northeast Drainage D and southwest Drainage A (refer to Figure 7) are jurisdictional wetland habitat and WOUS as they are tributary to the jurisdictional habitat in Black Squirrel Creek. These natural features meet the criteria that the USACE uses to assert jurisdiction, as they are:

- Non-navigable tributaries of traditional navigable waters that are relatively permanent where the tributaries typically flow year-round or have continuous flow at least seasonally (e.g., typically three months); and
- Wetlands that directly abut such tributaries.

Non-Jurisdictional Areas – The central Drainage C and south-central Drainage B are considered non-jurisdictional. They do not meet the criteria that the Corps uses to assert jurisdiction, as they are not:

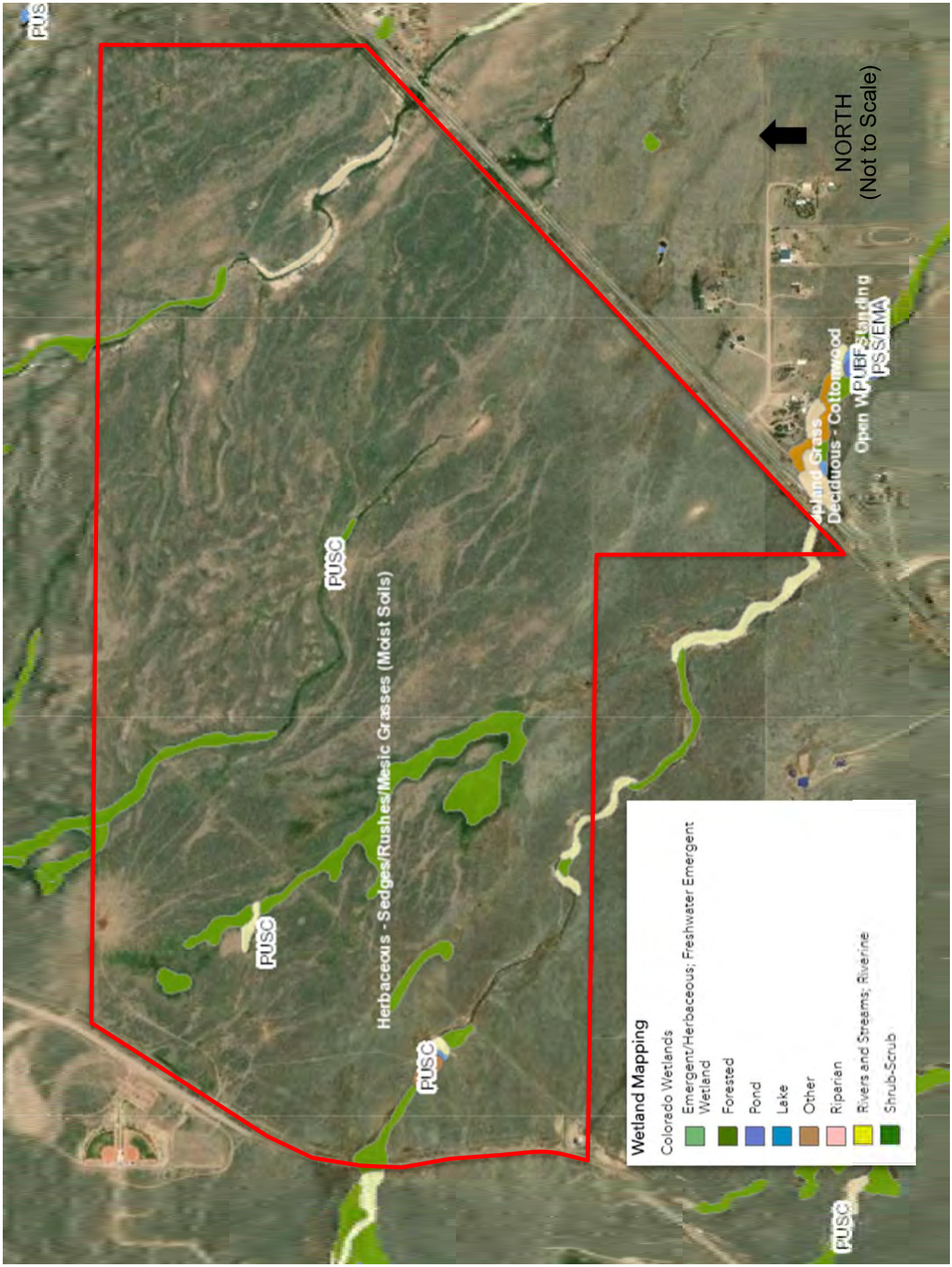
- Traditional navigable waters;
- Wetlands adjacent to traditional navigable waters;
- Non-navigable tributaries of traditional navigable waters that are relatively permanent where the tributaries typically flow year-round or have continuous flow at least seasonally (e.g., typically three months); and
- Wetlands that directly abut such tributaries.

Furthermore, Drainages B and C are not considered "tributaries", as "a tributary includes natural, man-altered, or man-made water bodies that carry flow directly or indirectly into a traditional navigable water." These drainages are ephemeral swales or erosional features (e.g., gullies, small washes characterized by low volume, infrequent, or short duration flow) over which the Corps does not assert jurisdiction.

3.4.4 Verification by the U.S. Army Corps of Engineers

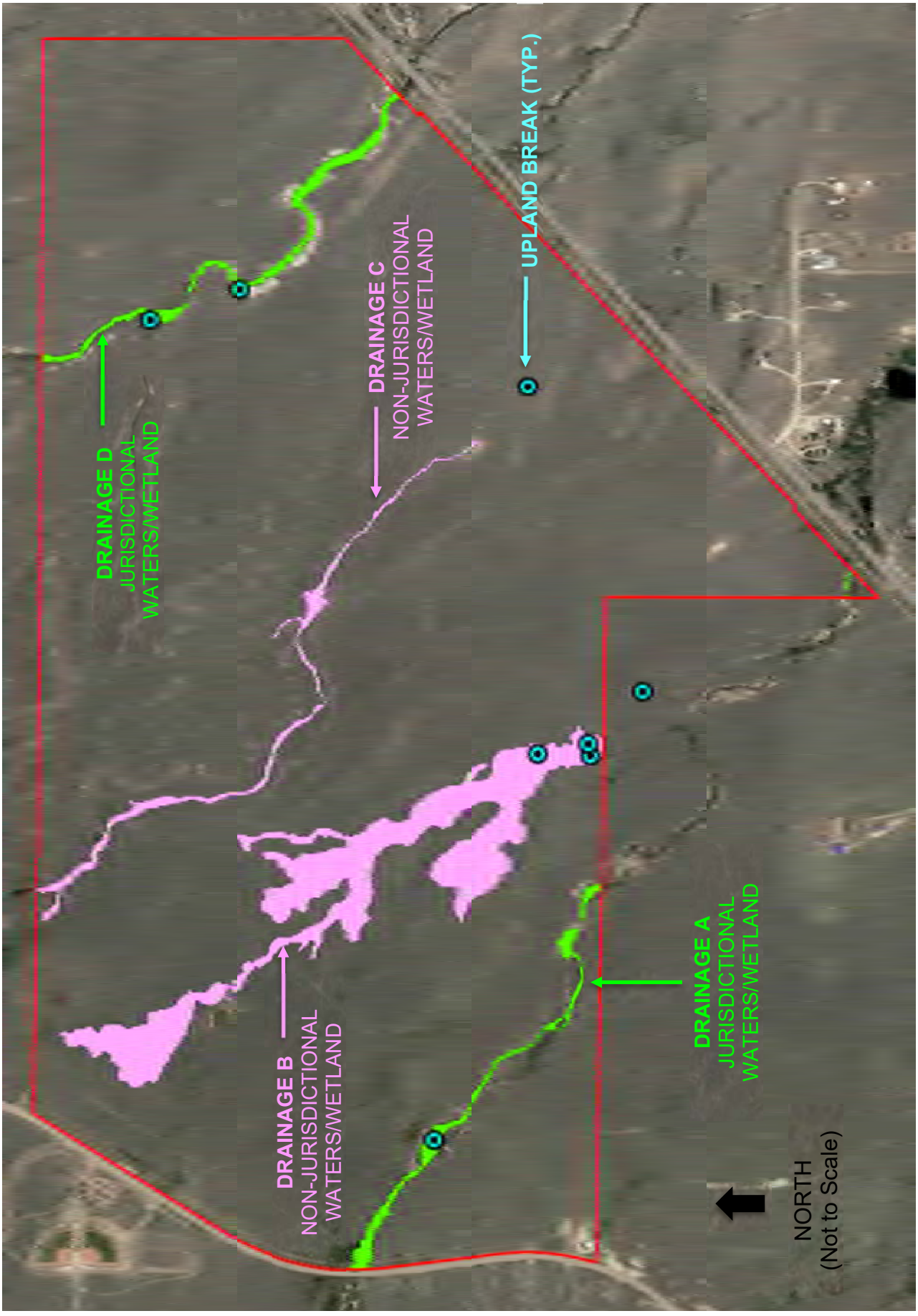
On July 5, 2019 the USACE provided an email to Ecos to confirm our findings of non-jurisdiction for Drainages B and C. Note that we did not request a jurisdictional determination of Drainages A and D as we have documented them to be jurisdictional. An excerpt of the USACE response from Tony Martinez, Regulatory Program Manager for the Albuquerque District, Southern Colorado Regulatory Branch of the USACE is copied below, and the original email is contained in Appendix C.

"Based on the information provided in the attached email and our site visit on June 21, 2019 our office concurs with your observations that central Drainage C and south-central Drainage B are isolated and are located entirely upland therefore, we conclude that No permit is required."



SOURCE: USFWS, National Wetland Inventory & CNHP, Colorado Wetland Inventory

Figure 6 NATIONAL WETLAND INVENTORY & CNHP WETLAND & RIPARIAN AREAS MAP



SOURCE: Ecosystem Services, LLC On-site Delineation, 10-11-18

Figure 7 ECOS WETLAND & WATERS SKETCH MAP

3.5 Wildlife Communities

The stated purpose and intent of the "El Paso County Development Standards" section on wildlife is to ensure that proposed development is reviewed in consideration of the impacts on wildlife and wildlife habitat, and to implement the provisions of the Master Plan (El Paso County, 2018b). Ecos has determined that the wildlife impact potential for development of the Site is expected to be low.

The Site currently provides poor to moderate habitat for wildlife, as illustrated in the representative photographs (Appendix B). There are two primary vegetation types on the Site, including shortgrass prairie and wetland habitat.

The project would develop most of the shortgrass prairie, however the drainages and adjacent short grass prairie would be preserved as Open Space. A noxious weed management plan will be implemented per State and County requirements to improve wildlife habitat; and a native plant re-vegetation plan for the Open Space is recommended to provide additional benefit to wildlife habitat.

The habitat preferences of the observed species are reflective of the habitat on Site. Two species of raptors were observed and appear to either be residents or frequent hunters to this Site: ferruginous hawk (*Buteo regalis*) and great horned owl (*Bubo virginianus*). Sandhill crane (*Grus canadensis*) were observed flying over during their migration, although they are not likely to utilize the Site. Prairie species such as jackrabbit (*Lepus townsendii*), pronghorn (*Antilocapra americana*), black-tailed prairie dog (*Cynomys ludovicianus*) and thirteen-lined ground squirrel (*Ictidomys tridecemlineatus*) were present. The remaining species are considered generalists and included mourning doves (*Zenaida macroura*) and American crows (*Corvus brachyrhynchos*). The Site provides very limited tree nesting habitat for raptors; however, ferruginous hawks may also use ground nests. No existing nest sites for any raptors were noted during the Site visit.

The Site provides habitat for mammals including rodents, antelope, and carnivores. The site provides foraging and breeding habitat for predators such as coyote and fox. The Site also provides habitat for reptiles but limited habitat for amphibians due to the lack of persistent standing and flowing water.

The Site contains no Wildlife Refuges or Hatcheries according to the USFWS IPaC Trust Resources Report (USFWS, 2018b) (Appendix A).

4.0 FEDERAL LISTED SPECIES

A number of species that occur in El Paso County are listed as candidate, threatened or endangered by the USFWS (USFWS, 2018) under the ESA. Ecos compiled the Federally-listed species for the Site in Table 1 based on the Site-specific, USFWS IPaC Trust Resources Report we ran for the Project (Appendix A); and our onsite assessment. Ecos has provided our professional opinion regarding the probability that these species may occur within the Site and their probability of being impacted by the Project.

The likelihood that the Project would impact any of the species listed below is very low to none. Most are not expected occur in the Project area or on the Site; nor will they be affected by the direct or indirect effects of the project.

TABLE 1 - FEDERAL LISTED SPECIES ASSESSED FOR THE PROJECT			
Species	**Status**	**Habitat Requirements and Presence**	**Probability of Impact by Project**
FISH			
Greenback cutthroat trout (*Oncorhynchus clarki stomias*)	Threatened	Cold, clear, gravely headwater streams and mountain lakes that provide an abundant food supply of insects.	None. Suitable habitat does not exist on the Site.
Pallid sturgeon (*Scaphirhynchus albus*)	Endangered	Water-related activities/use in the N. Platte, S. Platte and Laramie River Basins may affect listed species in Nebraska.	None. The proposed Project is not located in the watershed of any of the listed river basins.
REPTILES AND AMPHIBIANS			
BIRDS			
Least tern (*Sternula antillarum*)	Endangered	Water-related activities/use in the N. Platte, S. Platte and Laramie River Basins may affect listed species in Nebraska.	None. The proposed Project is not located in the watershed of any of the listed river basins.
Mexican spotted owl (*Strix occidentalis lucida*)	Threatened	Mature, old-growth forests of white pine, Douglas fir, and ponderosa pine; steep slopes and canyons with rocky cliffs. The closest USFWS designated Critical habitat is over 15 miles southwest of the Site in mountainous terrain (USFWS, 2018).	None. Suitable habitat does not exist on the Site.
Piping plover (*Charadrius melodus*)	Threatened	Water-related activities/use in the N. Platte, S. Platte and Laramie River Basins may affect listed species in Nebraska.	None. The proposed Project is not located in the watershed of any of the listed river basins.
Whooping crane (*Grus americana*)	Endangered	Water-related activities/use in the N. Platte, S. Platte and Laramie River Basins may affect listed species in Nebraska.	None. The proposed Project is not located in the watershed of any of the listed river basins.
MAMMALS			

TABLE 1 - FEDERAL LISTED SPECIES ASSESSED FOR THE PROJECT			
Species	**Status**	**Habitat Requirements and Presence**	**Probability of Impact by Project**
Preble's meadow jumping mouse (*Zapus hudsonius preblei*)	Threatened	Inhabits well-developed riparian habitat with adjacent, relatively undisturbed grassland communities, and a nearby water source. Well-developed riparian habitat includes a dense combination of grasses, forbs and shrubs; a taller shrub and tree canopy may be present. Has been found to regularly use uplands at least as far out as 100 meters beyond the 100-year floodplain.	None. Not likely to occur on Site due to: 1) the absence of habitat required to support the life requisites of the species (Figure 8 and Appendix B); 2) negative trapping results reported by USFWS adjacent to the Site (Figure 9); 3) 10.22-mile distance from closest CPW "Potential" Occupied Habitat - west/northwest of the Site in Colorado Springs (refer to Figure 8); 4) 6.5-mile distance from closest USFWS Critical Habitat - southwest of the Site along Black Squirrel Creek in Colorado Springs (refer to Figure 8); and 5) lack of habitat connection corridor from known habitat to the Site.
PLANTS			
Ute ladies'-tresses orchid (*Spiranthes diluvialis*)	Threatened	Primarily occurs along seasonally flooded river terraces, sub-irrigated or spring-fed abandoned stream channels or valleys, and lakeshores. May also occur along irrigation canals, berms, levees, irrigated meadows, excavated gravel pits, roadside borrow pits, reservoirs, and other human-modified wetlands.	Very Low. Unlikely to occur as the Site is situated between 6,860 and 7,020 feet above mean sea level, which is higher than the 6,500-foot elevation limits documented for the species and recommended for conducting surveys by the USFWS.
Western prairie fringed orchid (*Platanthera praeclara*)	Threatened	Occurs in tallgrass prairie in Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and Oklahoma. Upstream depletions to the Platte River system in Colorado and Wyoming may affect the species in Nebraska.	None. The proposed Project will not alter or deplete flows to the Platte River system.

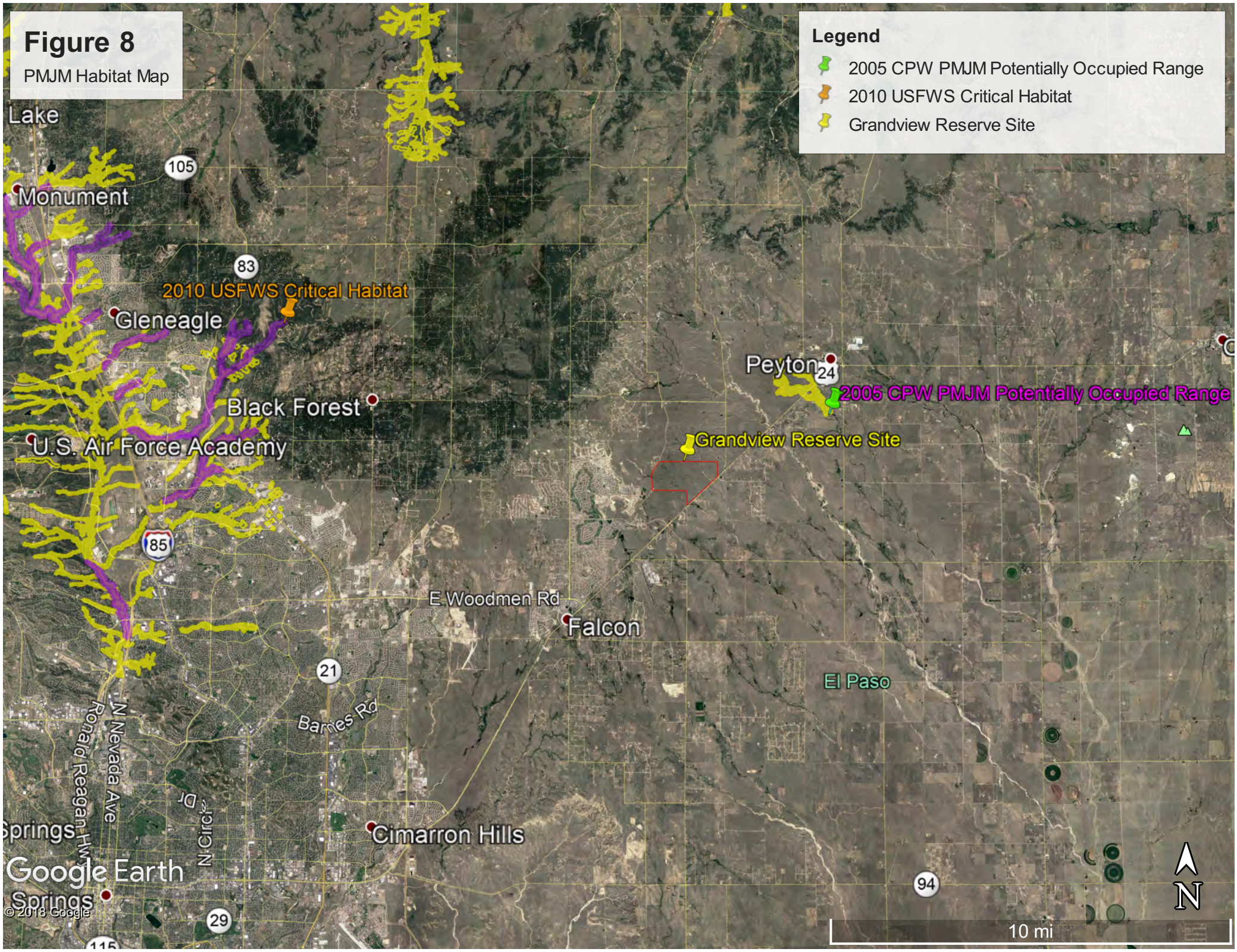


Figure 8
PMJM Habitat Map
Legend
2005 CPW PMJM Potentially Occupied Range
2010 USFWS Critical Habitat
Grandview Reserve Site
Lake
105
Monument
83
2010 USFWS Critical Habitat
Gleneagle
Peyton
24
2005 CPW PMJM Potentially Occupied Range
Black Forest
Grandview Reserve Site
U.S. Air Force Academy
85
E Woodmen Rd
Falcon
21
El Paso
Barnes Rd
N Nevada Ave
Ronald Reagan Hwy
N Circle Dr
Springs
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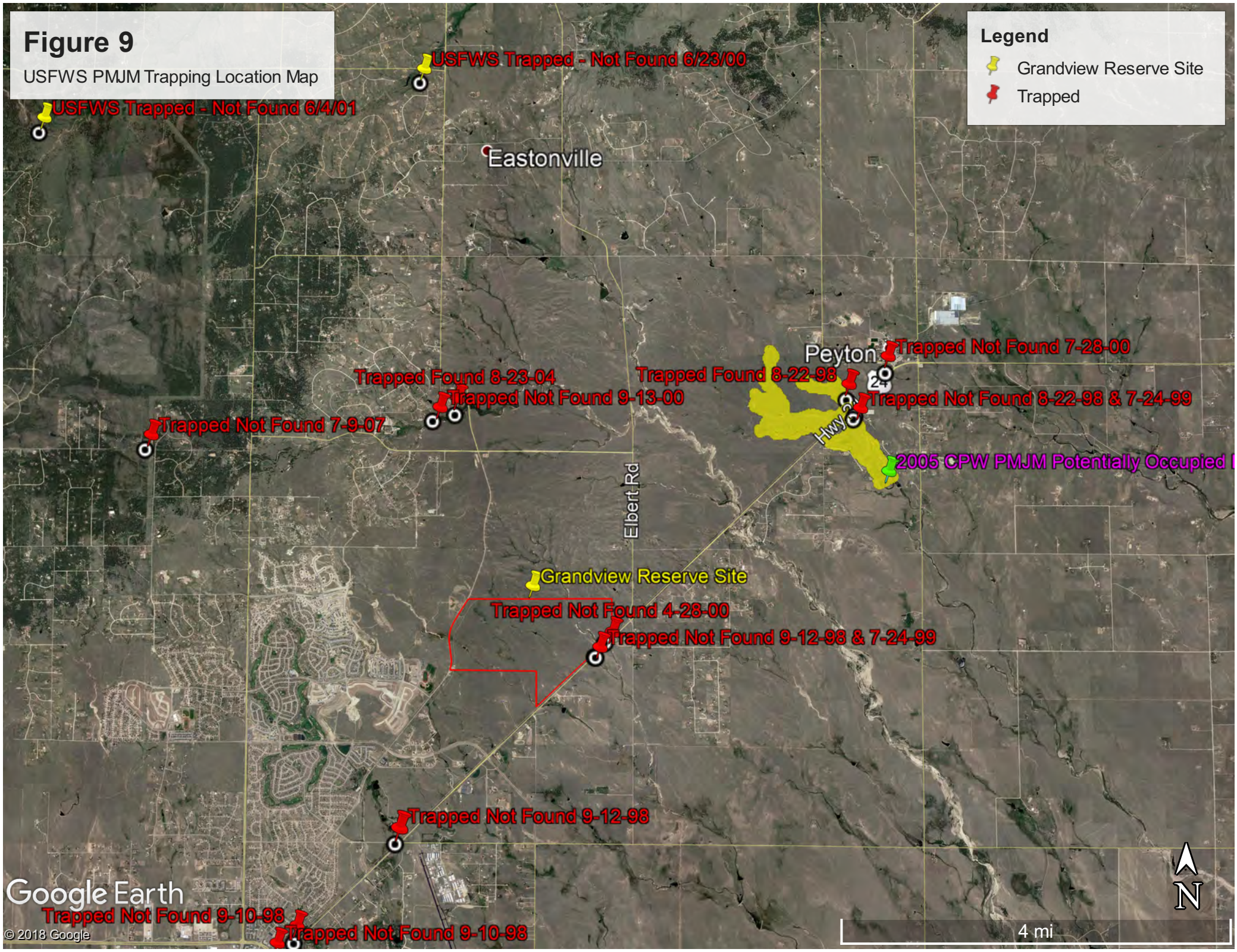
Figure 9
USFWS PMJM Trapping Location Map
Legend
Grandview Reserve Site
Trapped
USFWS Trapped - Not Found 6/23/00
USFWS Trapped - Not Found 6/4/01
Eastonville
Peyton
Trapped Not Found 7-28-00
Trapped Found 8-22-98
Trapped Found 8-23-04
Trapped Not Found 9-13-00
Trapped Not Found 8-22-98 & 7-24-99
Trapped Not Found 7-9-07
Hwy 24
2005 CPW PMJM Potentially Occupied
Elbert Rd
Grandview Reserve Site
Trapped Not Found 4-28-00
Trapped Not Found 9-12-98 & 7-24-99
Trapped Not Found 9-12-98
Google Earth
Trapped Not Found 9-10-98
Trapped Not Found 9-10-98
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5.0 EFFECTS DETERMINATION

The Site is not located within any USFWS designated critical habitat or known occupied habitat for federally listed threatened or endangered species. Please refer to the IPaC database (Appendix A) and Table 1.

The Project will have **No Effect** on the following listed species:

- Listed species in Nebraska, as the Site is not located in the North Platte, South Platte or Laramie River basins.
- Greenback cutthroat trout, Mexican spotted owl and North American wolverine, as suitable habitat does not exist on the Site.
- Western prairie fringed orchid, as the Site will not alter or deplete flows to the Platte River system.
- Ute ladies'-tresses orchid is unlikely to occur as the Site is situated between 6,860 and 7,020 feet above mean sea level, which is higher than the 6,500-foot elevation limits documented for the species and recommended for conducting surveys by the USFWS.
- Preble's meadow jumping mouse: This species occurs in the County but is not known to occur on the Site due to:
    - The absence of habitat required to support the life requisites of the species;
    - Negative trapping results (i.e., Trapped – Not Found) reported by USFWS upstream and downstream of the Site on West Kiowa Creek, and east of the Site on Kiowa Creek;
    - 2.5 mile distance from the closest CPW "Potential" Occupied Habitat;
    - 6.5 mile distance from the closest USFWS Critical Habitat; and
    - The lack of viable habitat connection corridors from known, occupied habitat to the Site.

6.0 CONSERVATION MEASURES

Species that occur in wetland and riparian habitat are expected to benefit from the proposed change in land use. All four onsite drainages will be protected via drainage easements and will also be located in Open Space. Eliminating cattle grazing from the Site would allow for more native herbaceous and woody vegetation to grow along the drainages, thus improving habitat for many wildlife species. A noxious weed management plan will be implemented per State and County requirements to improve wildlife habitat; and a native plant re-vegetation plan for the Open Space is recommended to provide additional benefit to wildlife habitat. Implementation of the stormwater management plan will further assist in protecting water quality in all drainages, provide consistent flows to non-jurisdictional/ephemeral drainages, and ameliorate development impacts on aquatic wildlife species, such as leopard frogs.

The following, additional recommendations are intended to reduce potential impacts to wildlife:

1. Limit the use of herbicides, pesticides, and fertilizers as they can negatively impact aquatic wildlife species.
2. Minimize the installation of fencing. When fencing is needed, use wildlife friendly fences or include specific wildlife crossings along fence lines. Pronghorn are of particular concern because they do not jump over fences and can be injured by barbed-wire fences.
3. Road crossings over the Creek should be designed to enable wildlife underpass and allow use the Creek as a movement corridor to reduce collisions with vehicles.
4. Dogs should be kept in fenced pens and be leashed when on walks. At least one designated off-leash area for dogs should be provided, as this will increase compliance with leash rules in other areas.
5. Cats should not be allowed outdoors because they kill birds and native rodents.

7.0 CONCURRENCE REQUEST

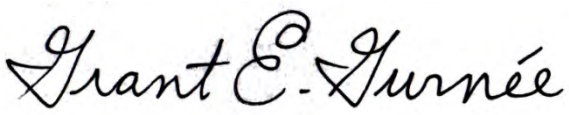
Ecos requests informal concurrence from the USFWS with our No Effects Determination based on the information presented herein. The Project and its direct and indirect environmental effects don't occur in any designated critical habitat. The majority of the ESA-listed species don't occur in the Project area and are absent from all areas where the Project will have direct or indirect environmental effects. Preble's meadow jumping mouse and Ute ladies'-tresses orchid occur in the County but are not known to occur in the Project area and areas where the Project will have direct or indirect environmental effects.

Thank you for your assistance with this project. Please feel free to call ecos (970) 812-3267 if you have any questions.

Sincerely,

Ecosystem Services, LLC

Jon Dauzvardis, P.W.S.
Owner - Restoration Ecologist



Grant E. Gurnée, P.W.S.
Owner - Restoration Ecologist

Cc: Peter Martz, 4 Site Investments

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ecos ecosystem services LLC

Informal Consultation Request

April 10, 2020

Mr. Drue DeBerry
Acting Colorado Field Supervisor
U.S. Fish and Wildlife Service
Colorado Ecological Services Field Office
134 Union Blvd., Suite 670
Lakewood, Colorado 80228

RE: Request for Technical Assistance Regarding the Likelihood of Take of Federally-listed Threatened and Endangered Species resulting from the proposed development of the Grandview Reserve Project in El Paso County, Colorado

Dear Mr. DeBerry:

Ecosystem Services, LLC (ecos) has prepared the enclosed habitat evaluation on behalf of 4 Site Investments to describe the physical/ecological characteristics of the Grandview Reserve site (Site) and evaluate the potential effects of the proposed development project (Project) on the Federally-listed threatened and endangered (T&E) species protected under the Endangered Species Act (ESA).

The El Paso County Environmental Division has completed its review of the Project and has requested that 4 Site Investments provide a "Clearance Letter" obtained from the U.S. Fish and Wildlife Service (USFWS) to the Planning and Community Development Department prior to project commencement "where the project will result in ground disturbing activity in habitat occupied or potentially occupied by threatened or endangered species and/or where development will occur within 300 feet of the centerline of a stream or within 300 feet of the 100 year floodplain, whichever is greater."

At this time there is no Federal action and no Federal agency is making a formal effects determination under Section 7 (a)(2) of the ESA. Therefore, ecos is requesting technical assistance from USFWS regarding 4 Site Investments' (i.e., the non-federal party) responsibilities under the ESA, and specifically the likelihood of the Project (described herein) resulting in take of listed species. If the USFWS concurs with the findings presented herein we request that you issue an informal letter of concurrence for use in the El Paso County Project review process.

1.0 SITE LOCATION and PROJECT DESCRIPTION

The Site is located in the Falcon/Peyton area of El Paso County and is bounded along the north by 4 Way Ranch Phase I, along the south by Waterbury, along the southeast by Highway 24, and along the west by Eastonville Road. There are no existing structures, roads, or other infrastructure on the Site. The Site is located approximately 4.14 miles southwest of Peyton, 4.16 miles northeast of Falcon and 4.66 miles south of Eastonville, in El Paso County, Colorado. The Site is generally located within the south ½ of Section 21, south ½ of Section 22, the north ½ of Section 27, and the north ½ of Section 28, Township 12 South, Range 64 West in El Paso County, Colorado. The center of the Site is situated at approximately Latitude 38.98541389 north, -104.55472222 east (refer to Figure 1).

Technical Assistance
Tracking Number: 2019-TA-0460

U.S. FISH AND WILDLIFE SERVICE

(•) NO CONCERNS

( ) CONCUR NOT LIKELY TO ADVERSELY AFFECT

( ) NO COMMENT

04/29/2020

Liisa Schmoele DATE

Colorado Assistant Field Supervisor

Remarks: Ute ladies'-tresses orchid and Preble's mouse are not likely to occupy the project site. Project is still consistent with the section 7 conclusions from 2019.

Appendix G
MT – 2 Checklist

MT-2 REVISION REQUEST SUBMITTAL CHECKLIST

PART A: GENERAL REQUIREMENTS

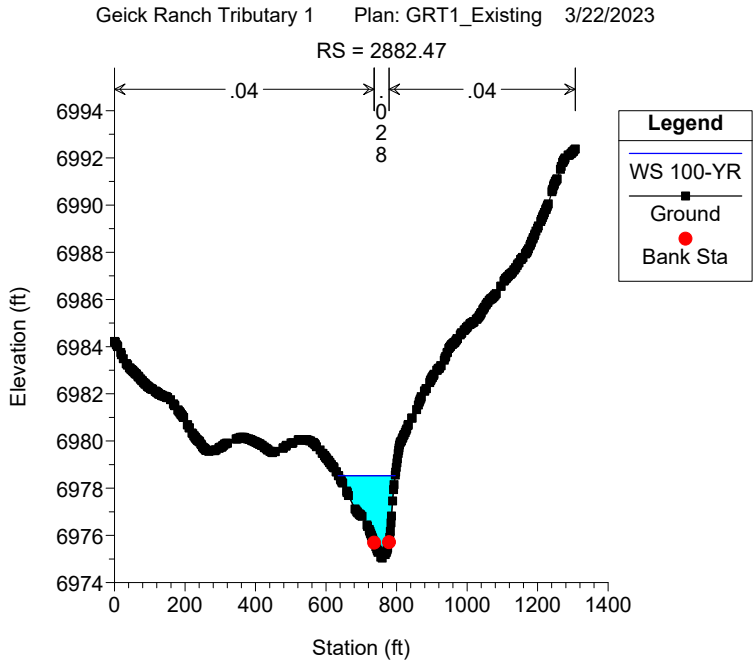
ELEMENTS	Yes	N/A
NARRATIVE: Please provide a written description about the purpose of the request and the scope of the proposed/as-built project and the methodology used to analyze the project effects.	X	
MT-2 APPLICATION FORMS: Please provide completed forms applicable to your request. Ensure that MT-2 Form 1 was signed by the requester, certifying engineer, and each community affected by the revision.	X	
HYDROLOGIC ANALYSIS: If applicable, please provide a FEMA acceptable hydrologic analysis in digital format, drainage area map and associated backup information (e.g., calculations used to determine lag time, CN and loss values as well as landuse and soil maps). FEMA-acceptable models can be accessed at www.fema.gov/national-flood-insurance-program-flood-hazard-mapping/numerical-models-meeting-minimum-requirements.		X
HYDRAULIC ANALYSIS: Please provide a FEMA acceptable hydraulic analysis in digital format. FEMA-acceptable models can be accessed at www.fema.gov/national-flood-insurance-program-flood-hazard-mapping/numerical-models-meeting-minimum-requirements.	X	
CERTIFIED TOPOGRAPHIC WORK MAP: Please provide a certified topographic work map that meets the mapping requirements outlined in MT-2 Form 2. If available, please provide digital Computer-Aided Design (CAD) or Geographic Information System (GIS) data that is spatially referenced.	X	
ANNOTATED FIRM: Please submit a revised FIRM, at the scale of the effective FIRM, which shows the revised boundary delineation of the base floodplain, 0.2-percent-annual-chance floodplain, and regulatory floodway and how it ties into the boundary delineation shown on the effective FIRM at the downstream and upstream ends of the revised reach.	X	
REVIEW FEE PAYMENT: Please include the appropriate review fee payment. The current fee schedule is available on the FEMA Web site at https://www.fema.gov/flood-map-related-fees.		X
MEET 65.10 REQUIREMENT: If the request intends to show that a berm/levee/flood wall provides flood protection, please submit all of the data requirements outlined in Section 65.10 of the NFIP regulations.		X
OPERATION AND MAINTENANCE PLAN: If the request involves a berm, levee, flood wall, dam, and/or detention basin project, please submit an officially adopted maintenance and operation plan.		X
PROPOSED/AS-BUILT PLANS: If applicable, please submit proposed/as-built plans, certified by a registered Professional Engineer, for all the project elements.	X	
FLOODWAY NOTICE: If the revision result in changing or establishing floodway boundaries, please provide floodway public notice or a statement by your community that it has notified all affected property owners, in compliance with NFIP regulation Subparagraph 65.7(b)(1).	X	
PROPERTY OWNER NOTIFICATION: If the revision result in any widening/shifting/establishing of the base floodplain and/or any BFE increases/establishing BFEs, please provide copy of the individual legal notices sent to all the property owners affected by any increases in the flood hazard information.	X	

PART B: CLOMR SPECIFIC REQUIREMENTS

Endangered Species Act COMPLIANCE: Please submit documentation of compliance with the ESA Requirements. To learn more about ESA Compliance, please see the MT-2 Instructions manual.	X	
65.12 REGULATORY REQUIREMENTS: If the Base (1-percent-annual-chance) Flood Elevation (BFE) increases greater than 0.00 foot as a result of encroachment within a floodway or 1.0 foot within Zone AE that has no floodway/Zone A, between the pre-project (existing) conditions and the proposed conditions as a result of the proposed project. Please submit a). Certification that no structures are affected by the increased BFE; b). Documentation of individual legal notice to all affected property owners, explaining the impact of the proposed action on their property; and c). An evaluation of alternatives that would not result in an increase in BFE.		X

Note: Applicants are encouraged to submit their revision request using the Online LOMC tool. To learn more about the Online LOMC tool, visit the FEMA website at www.fema.gov/online-lomc.

Appendix H
Existing Condition Cross Sections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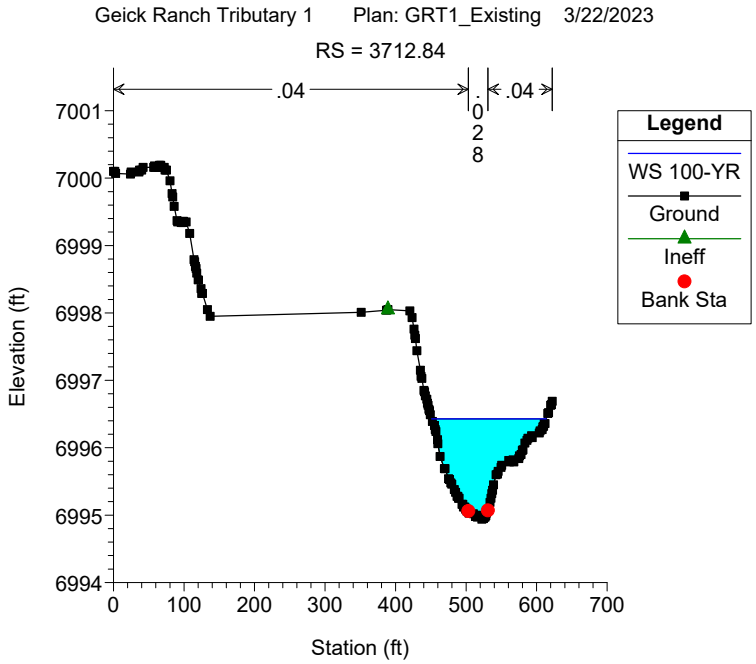
Ground
Bank Sta
Elevation (ft)
Station (ft)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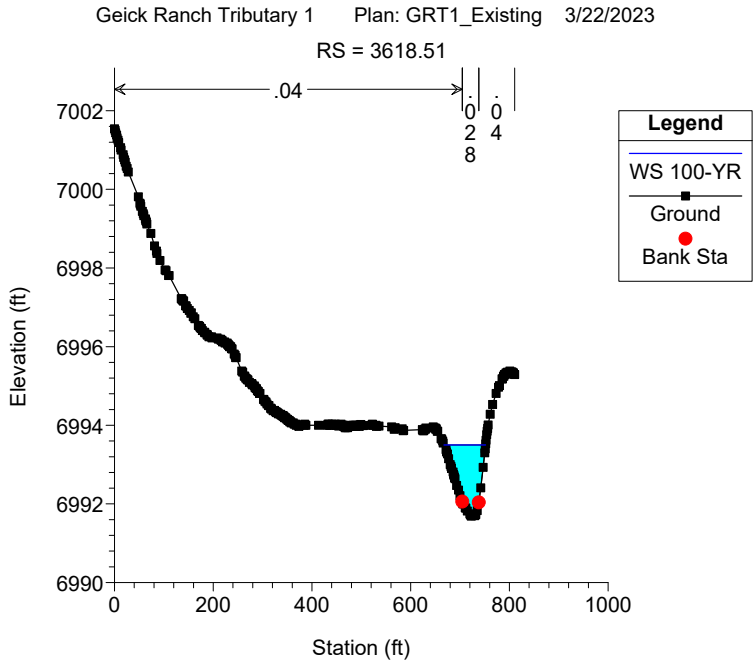
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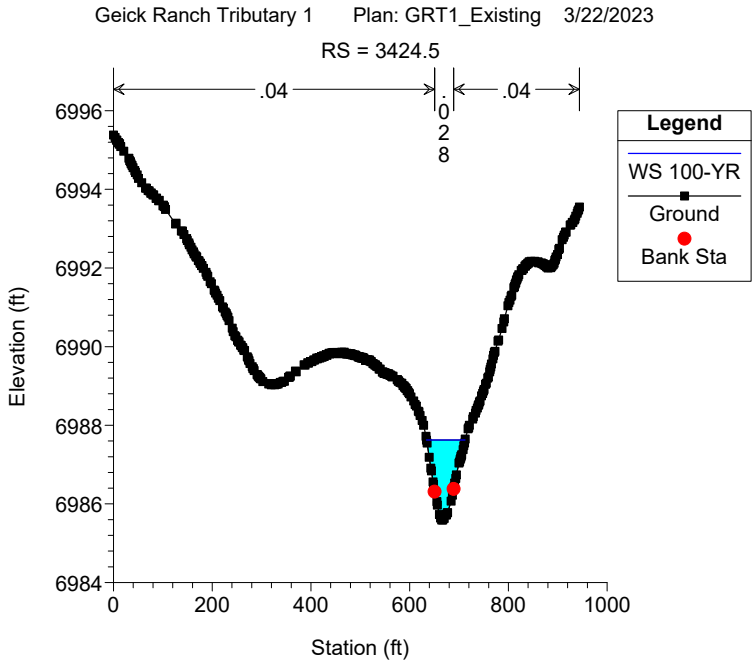
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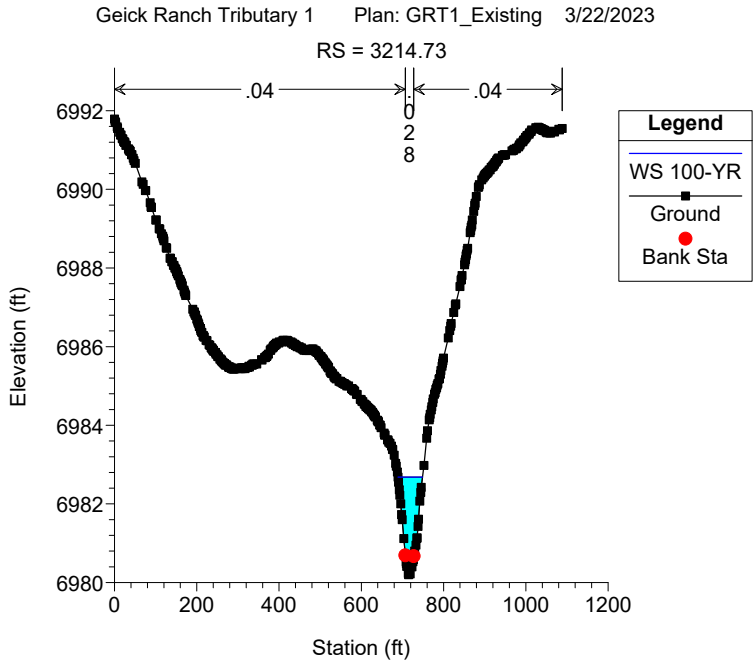
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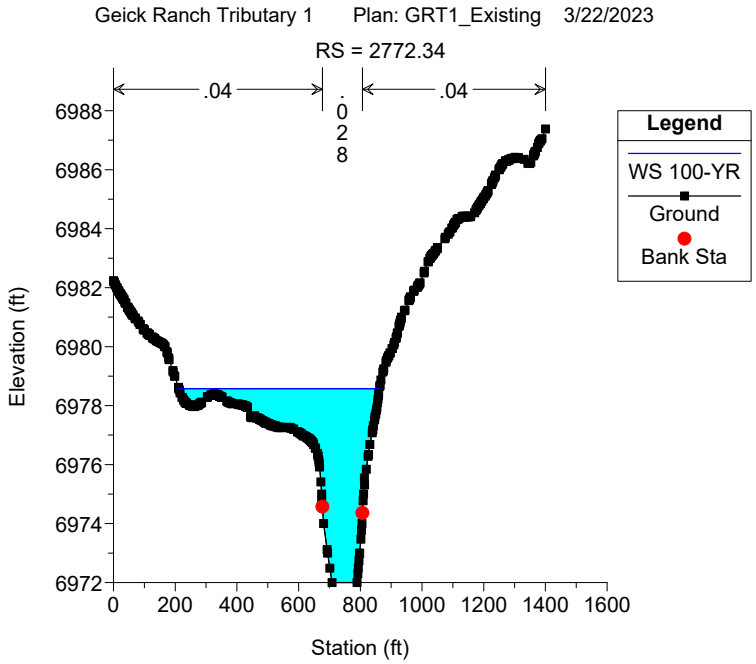
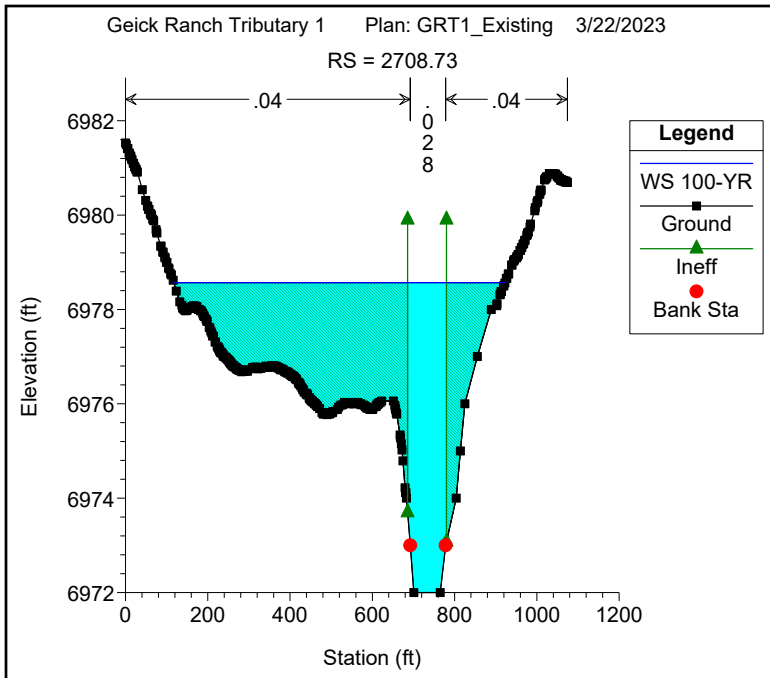
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Existing 3/22/2023
RS = 2772.34
.04
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Existing 3/22/2023
RS = 2708.73
.04
.028
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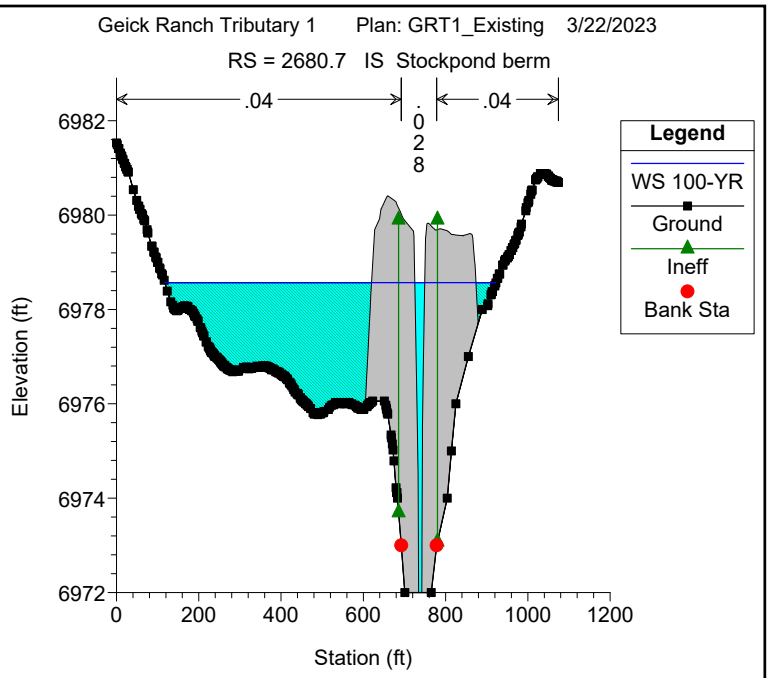
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Existing 3/22/2023
RS = 2680.7 IS Stockpond berm
.04
.028
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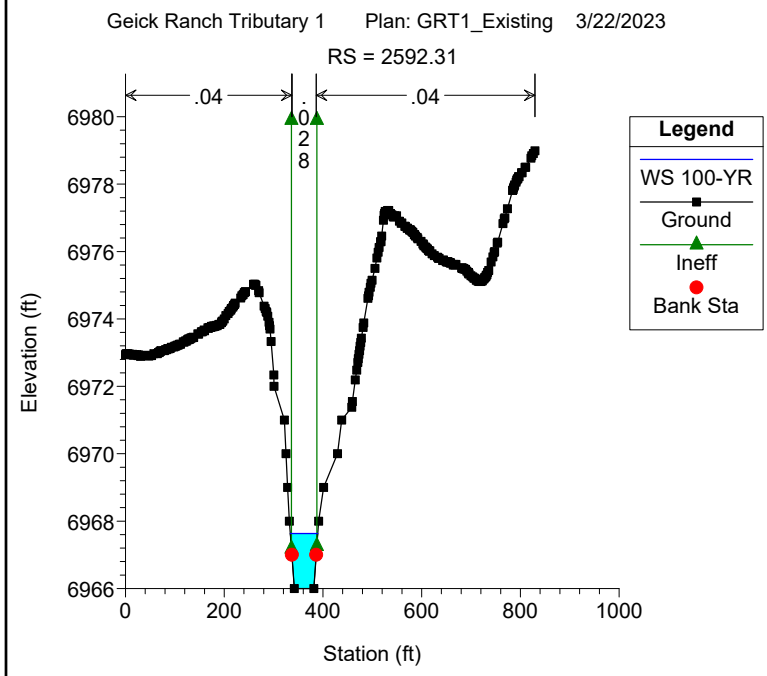
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Existing 3/22/2023
RS = 2592.31
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.028
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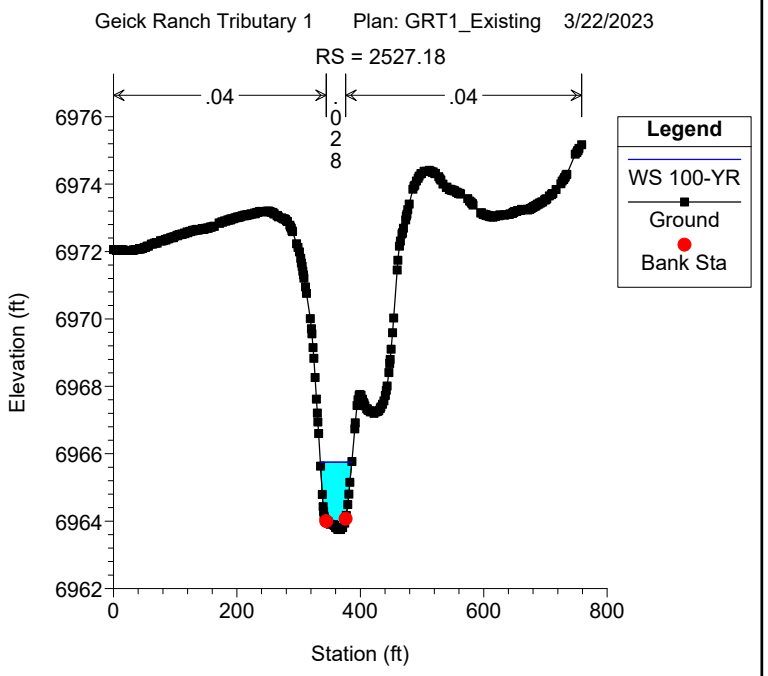
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Existing 3/22/2023
RS = 2527.18
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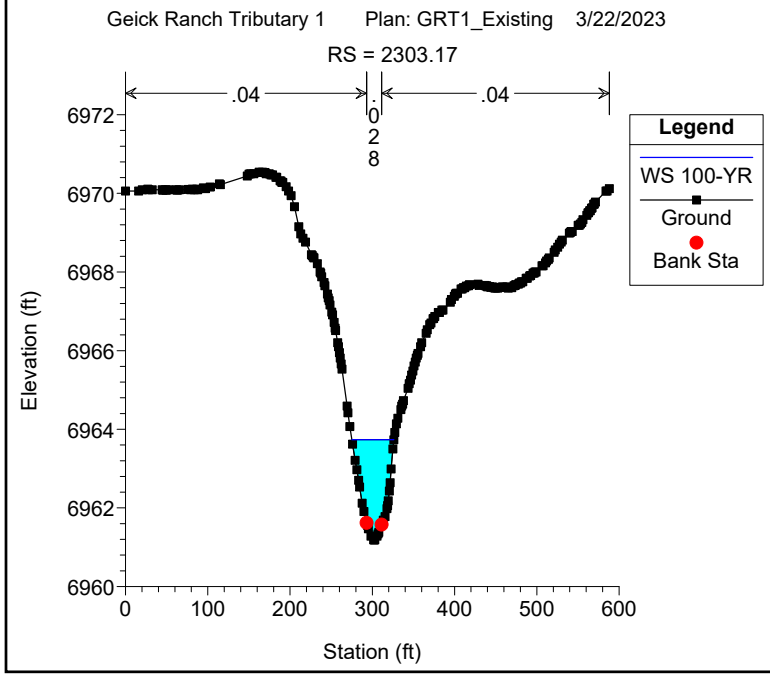
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Existing 3/22/2023
RS = 2303.17
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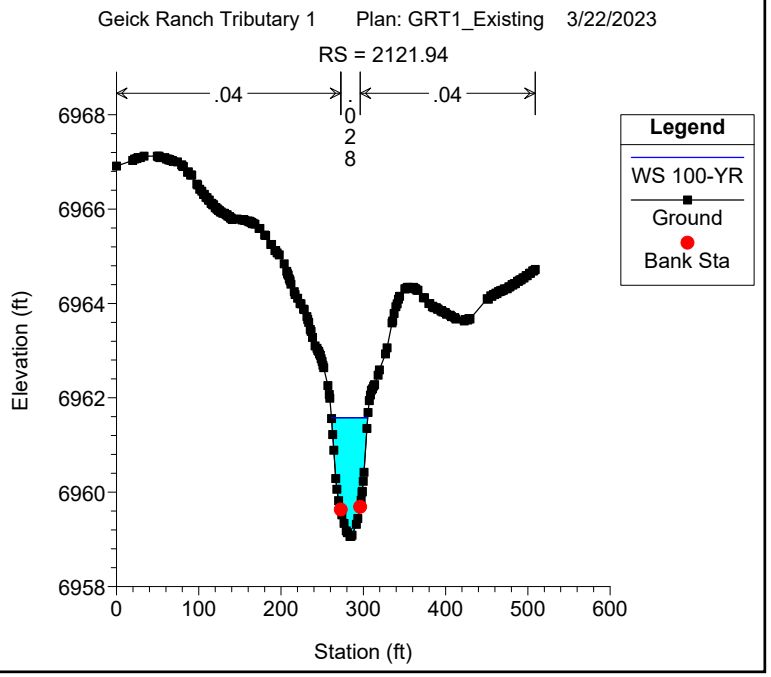
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Existing 3/22/2023
RS = 2121.94
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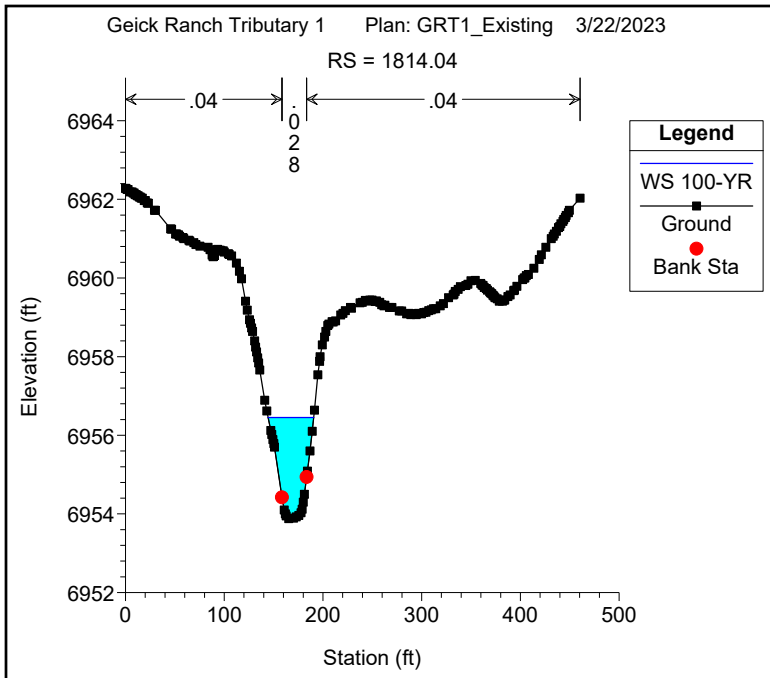
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Existing 3/22/2023
RS = 1814.04
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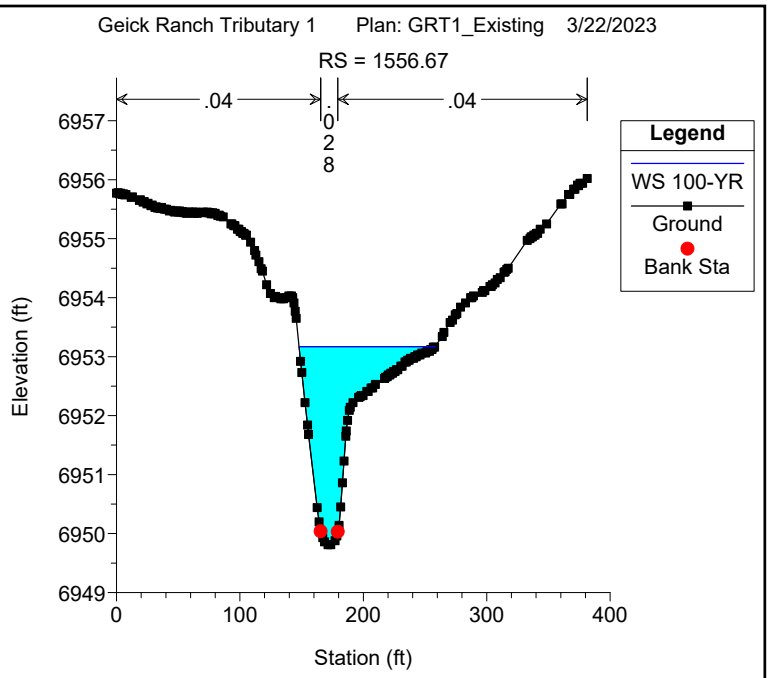
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Existing 3/22/2023
RS = 1556.67
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.028
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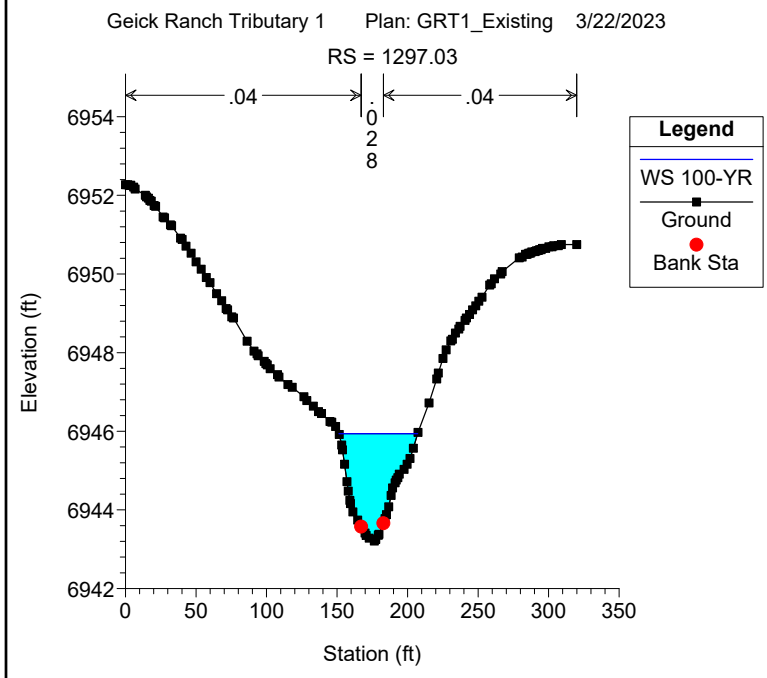
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Existing 3/22/2023
RS = 1297.03
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.028
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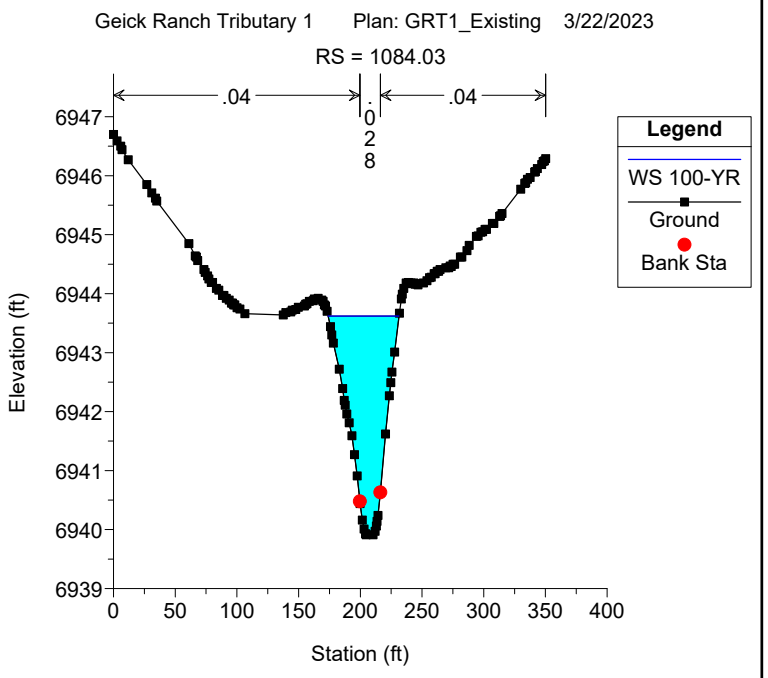
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Existing 3/22/2023
RS = 1084.03
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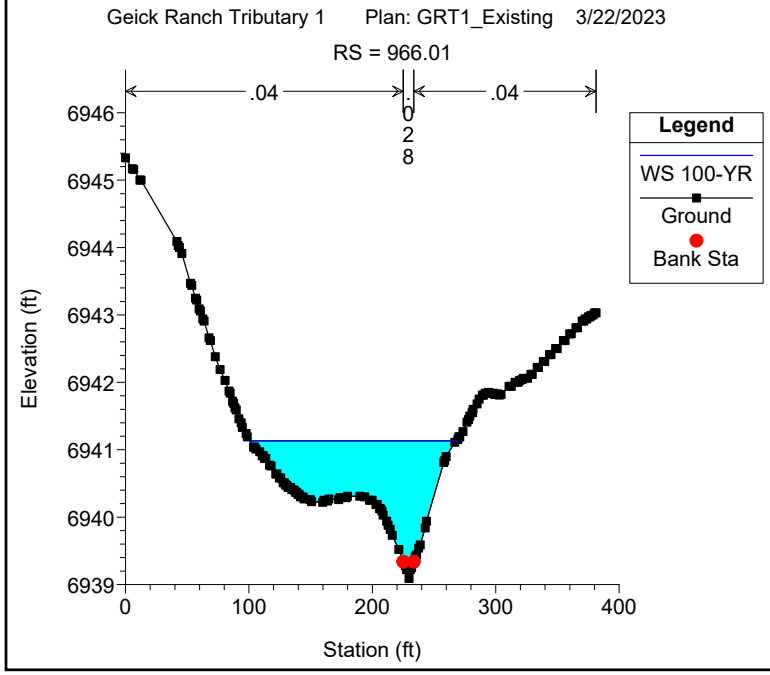
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Existing 3/22/2023
RS = 966.01
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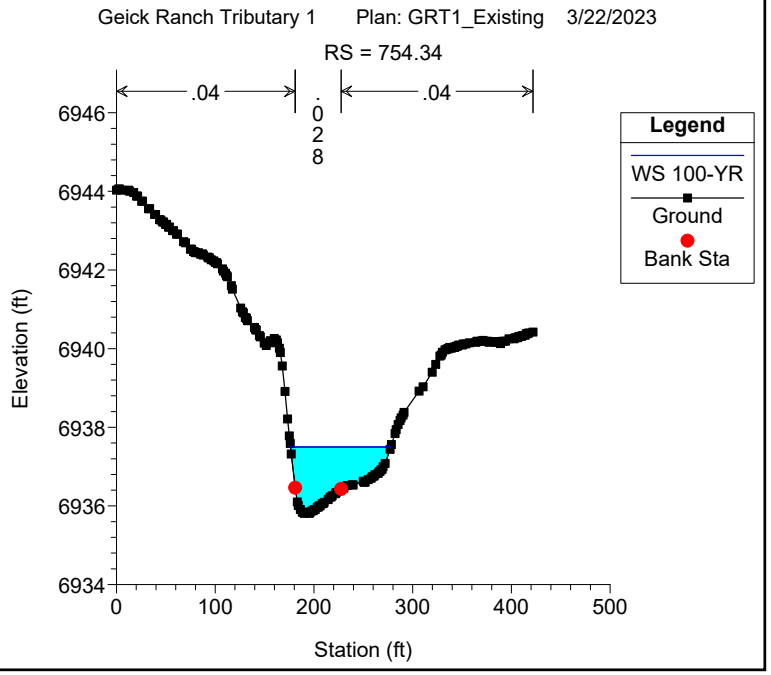
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Existing 3/22/2023
RS = 754.34
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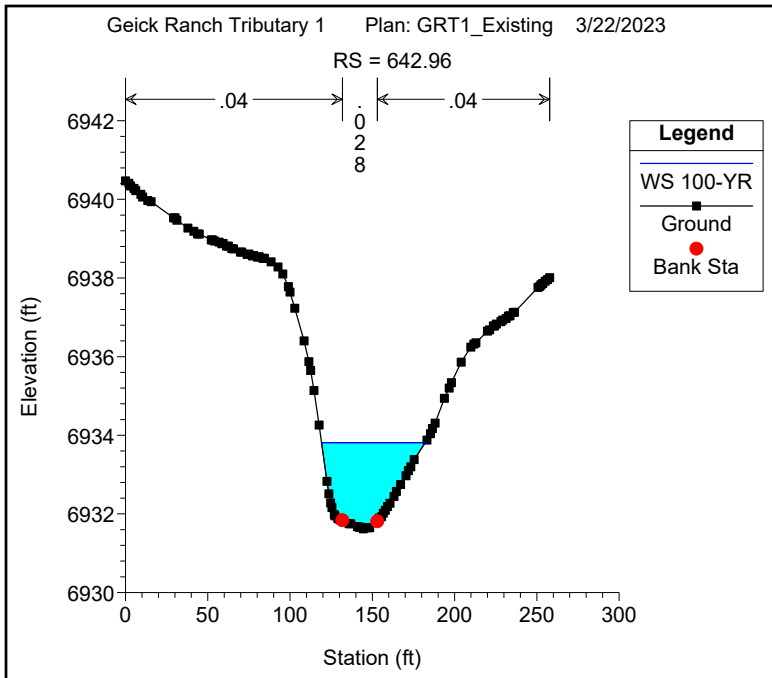
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Existing 3/22/2023
RS = 642.96
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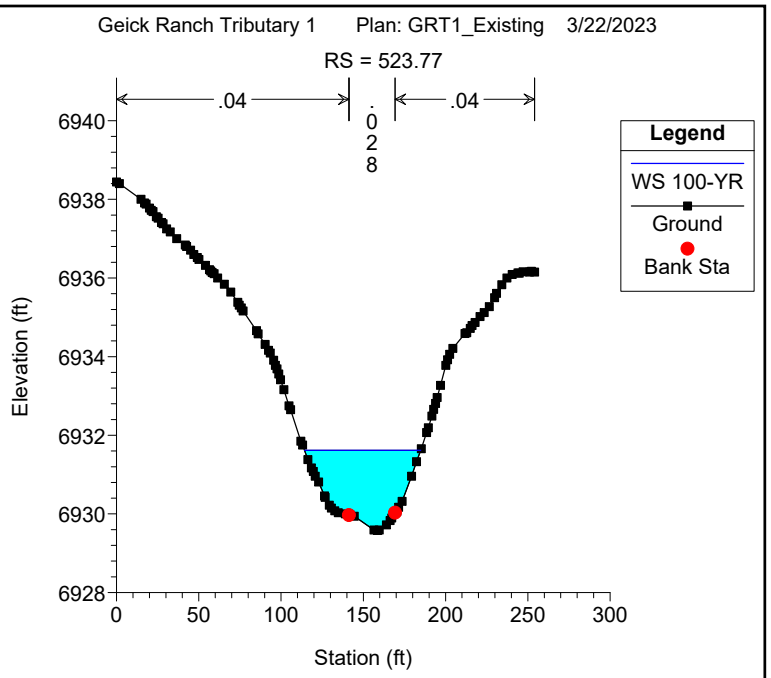
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Existing 3/22/2023
RS = 523.77
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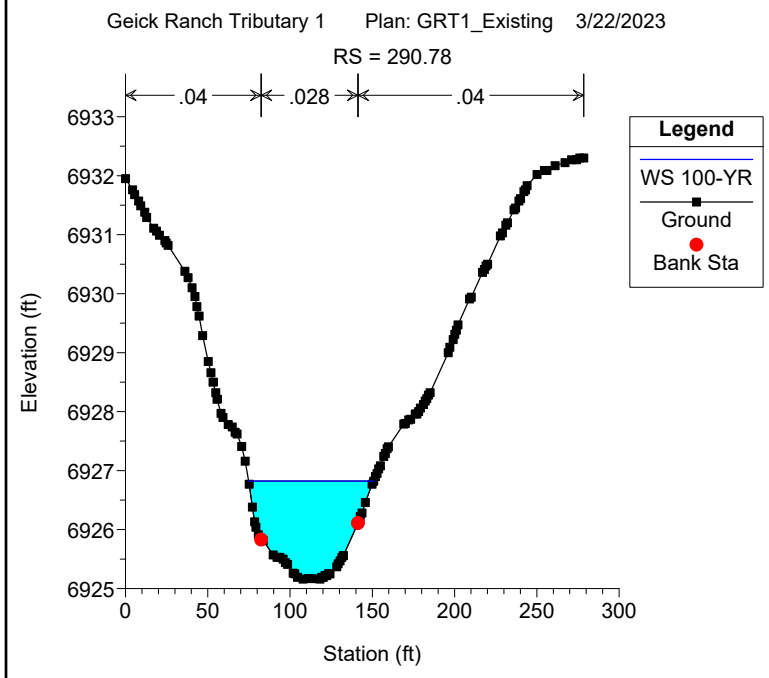
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Existing 3/22/2023
RS = 290.78
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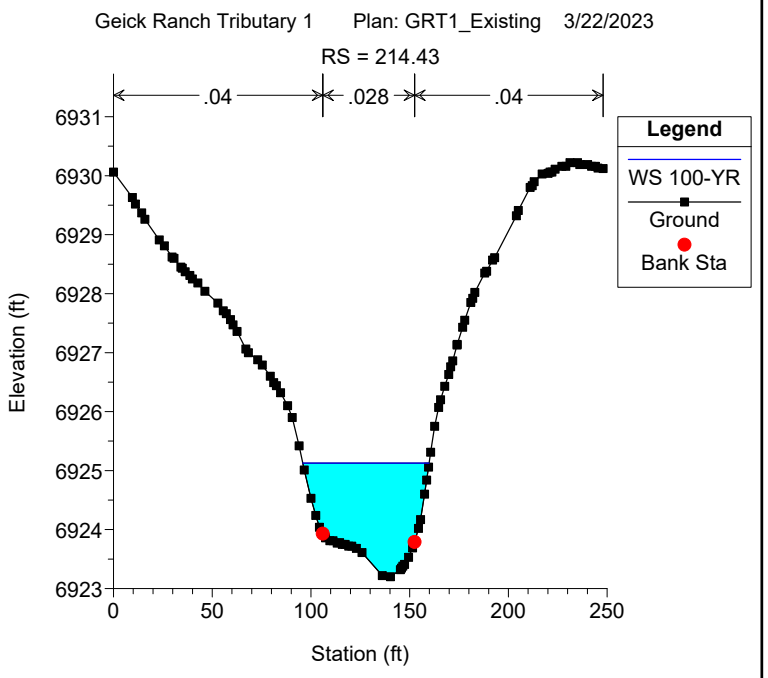
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Existing 3/22/2023
RS = 214.43
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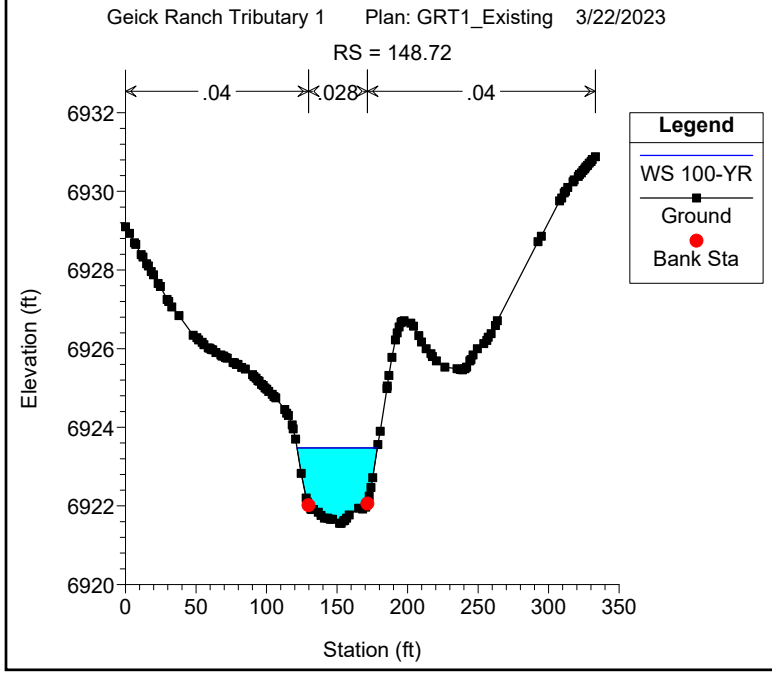
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Existing 3/22/2023
RS = 148.72
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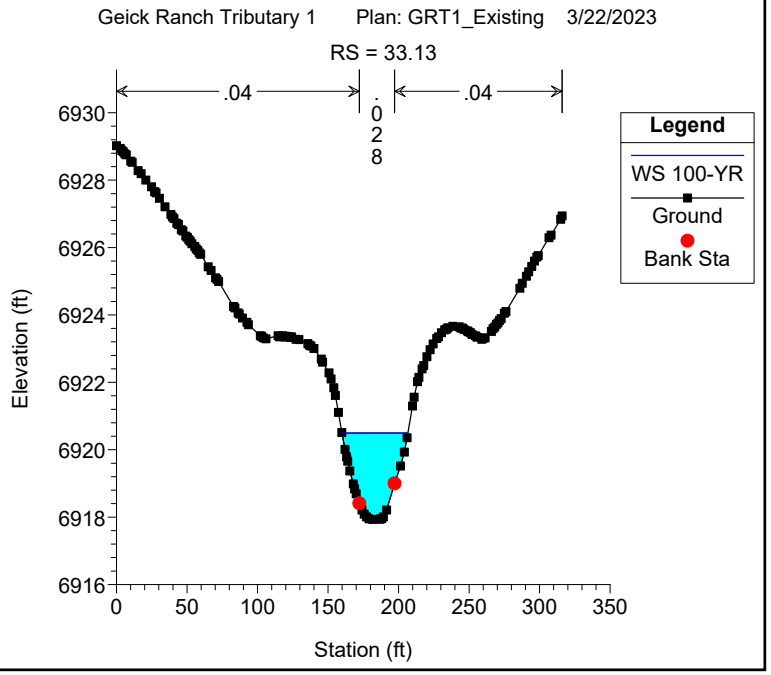
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Existing 3/22/2023
RS = 33.13
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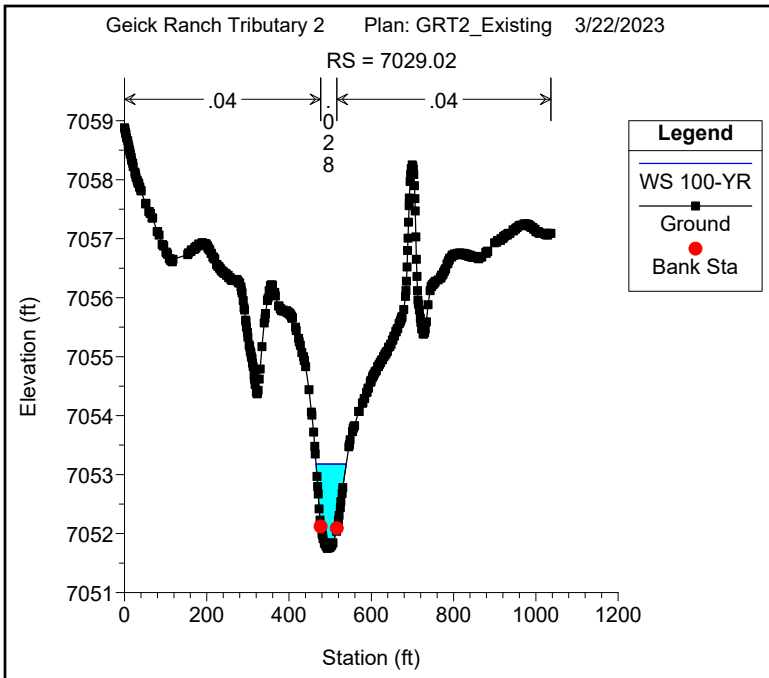
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 7029.02
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.028
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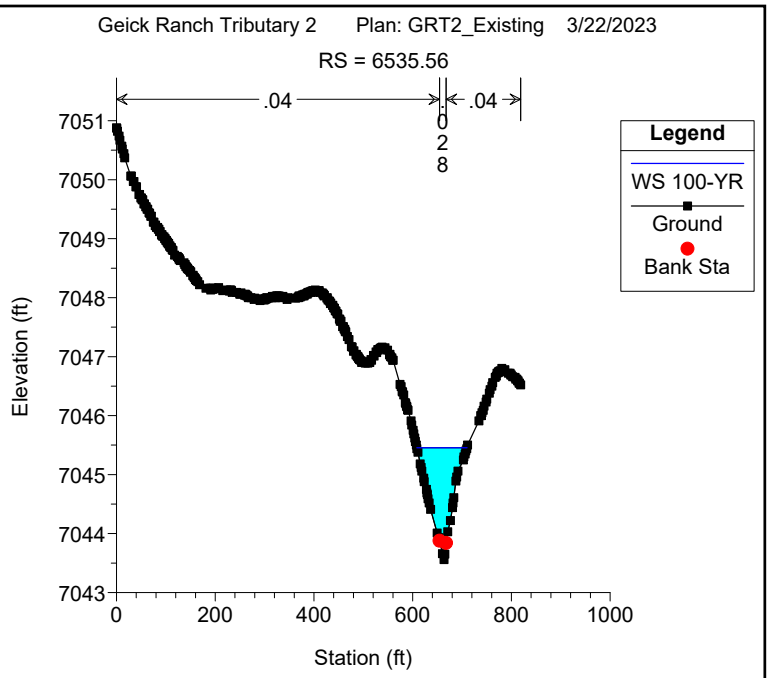
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 6535.56
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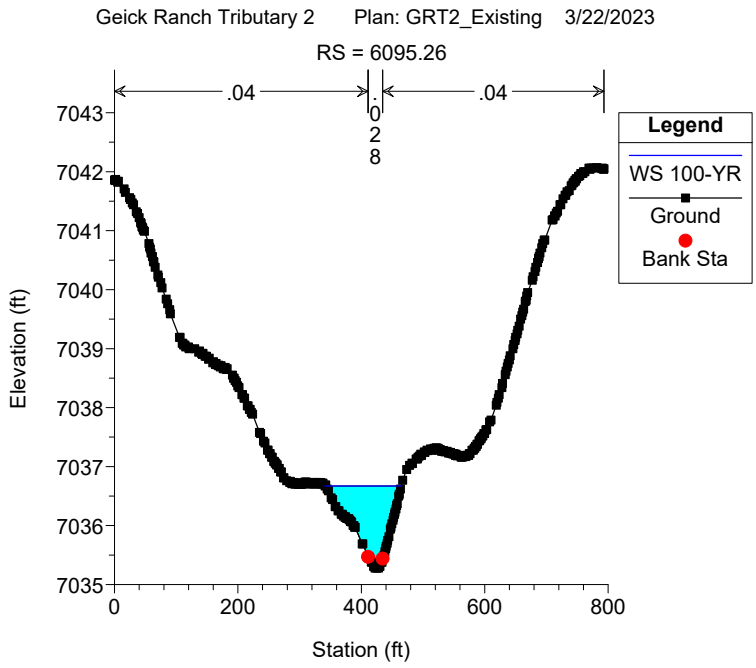
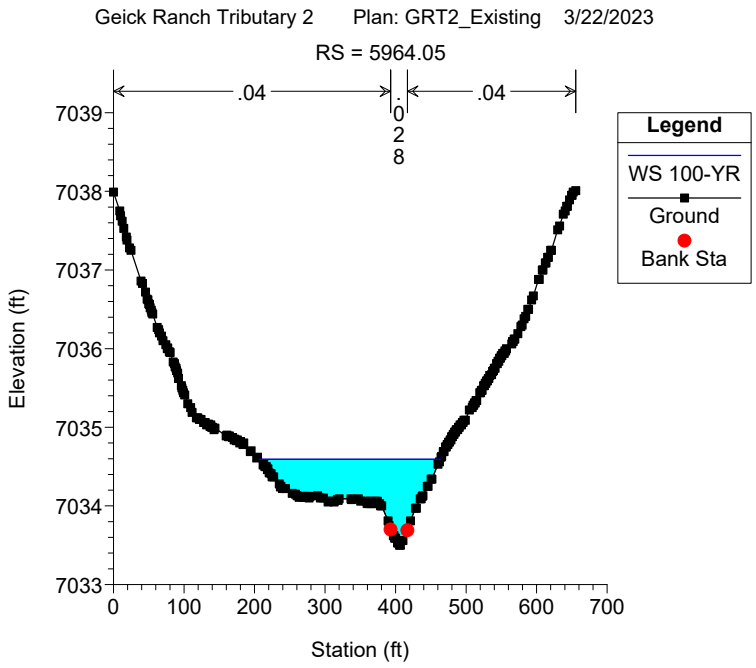
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 6095.26
.04
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 5964.05
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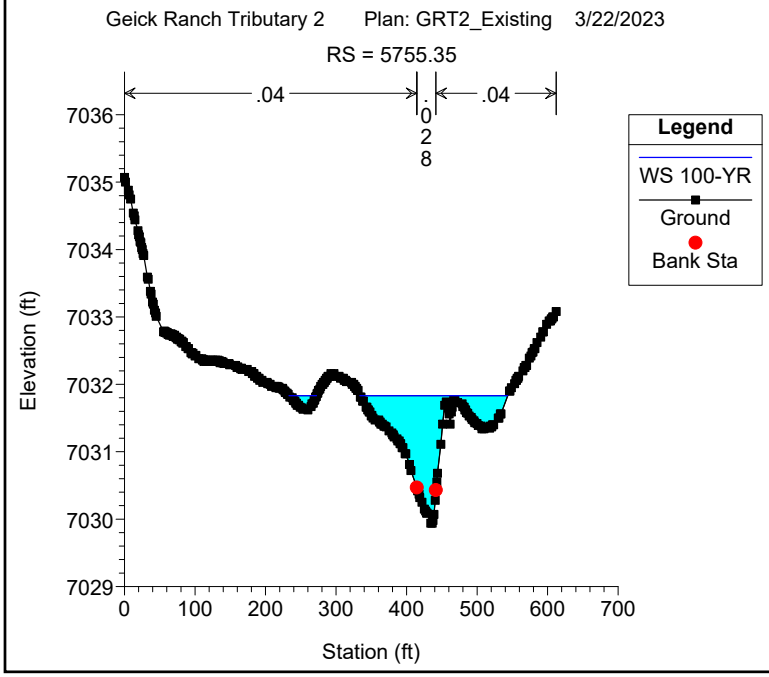
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 5755.35
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.028
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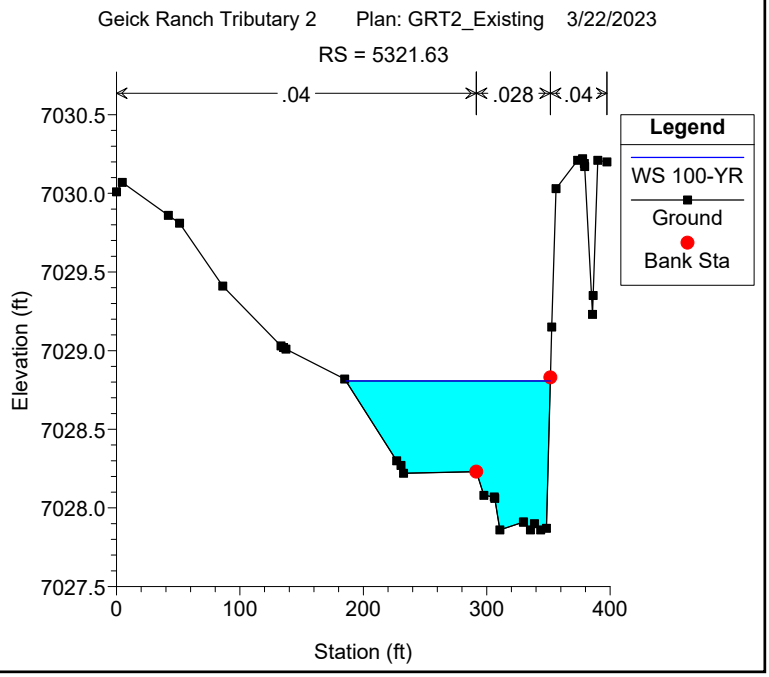
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 5321.63
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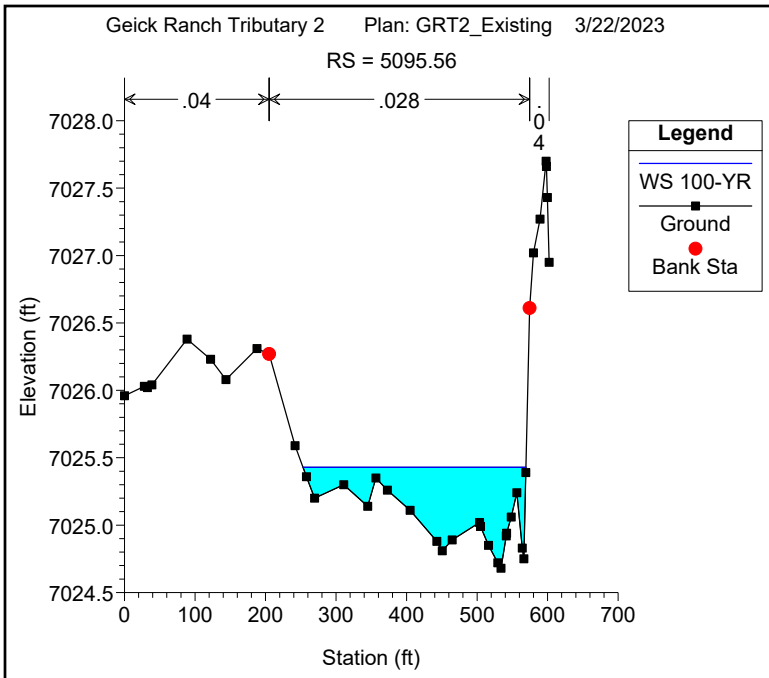
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 5095.56
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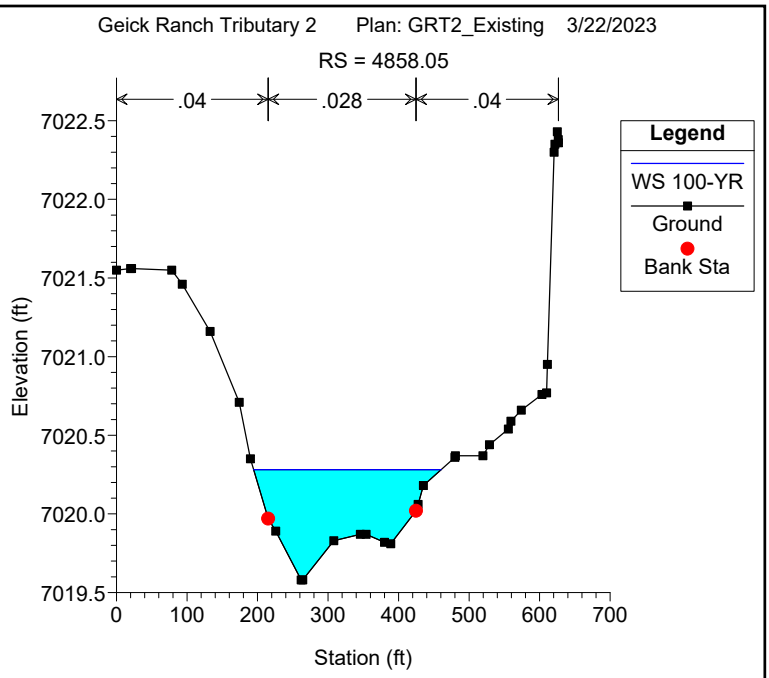
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
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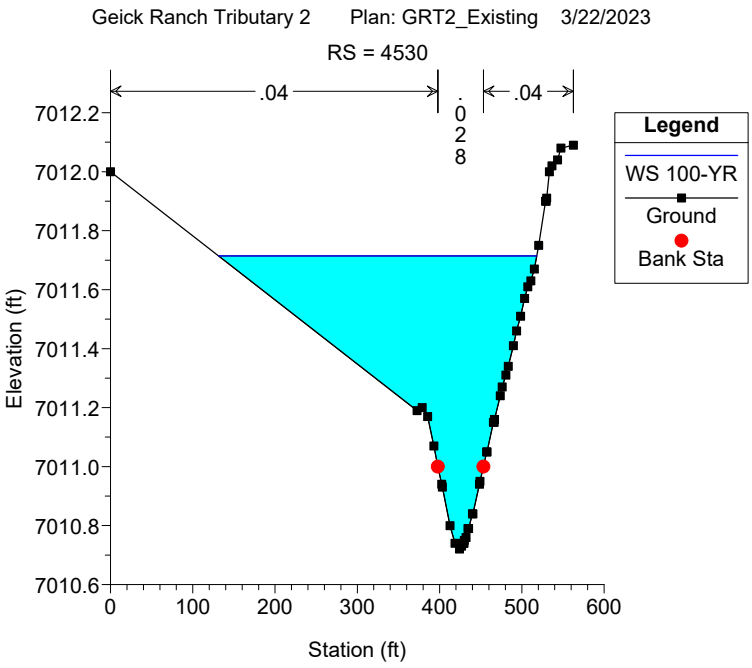
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 4530
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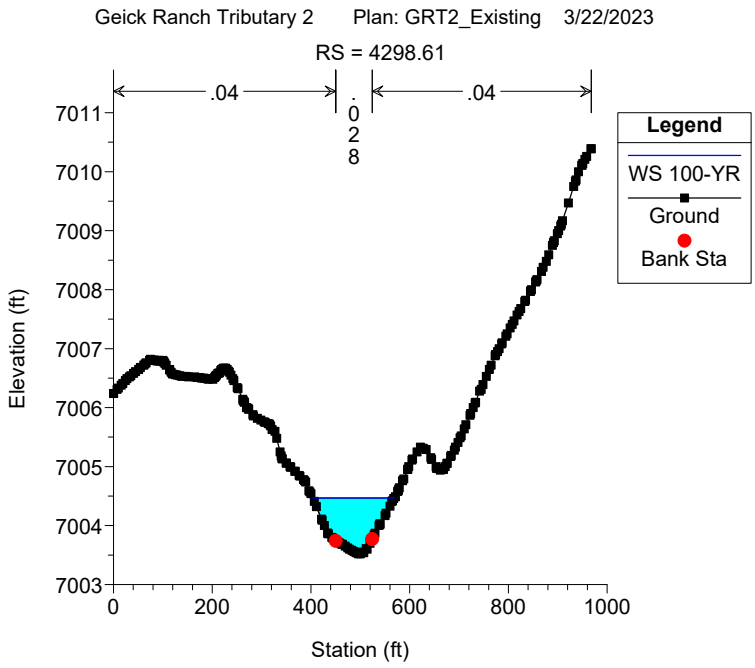
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 4298.61
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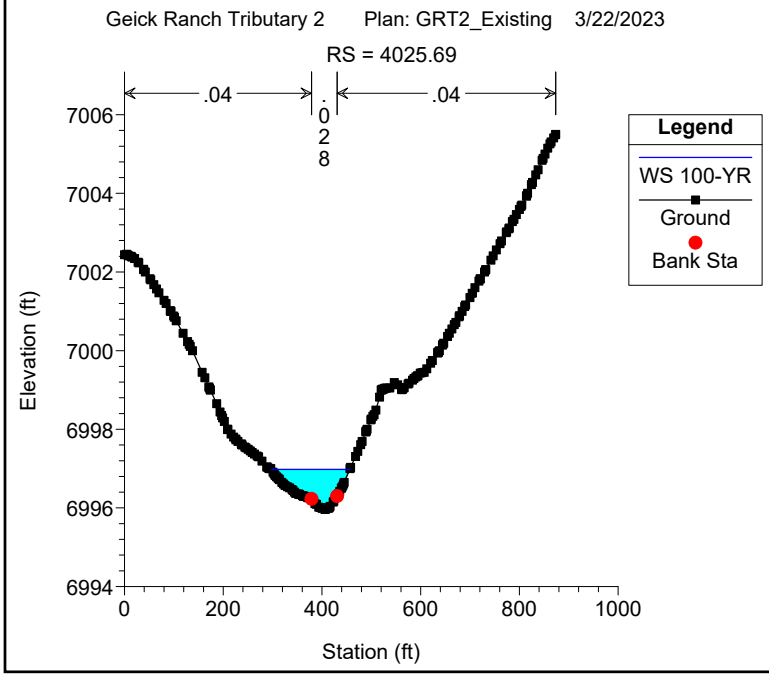
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 4025.69
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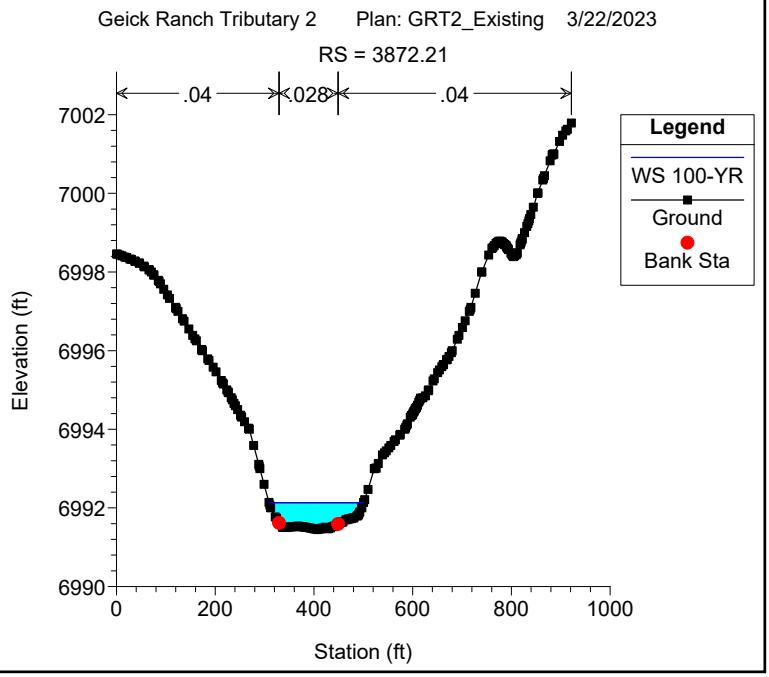
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 3872.21
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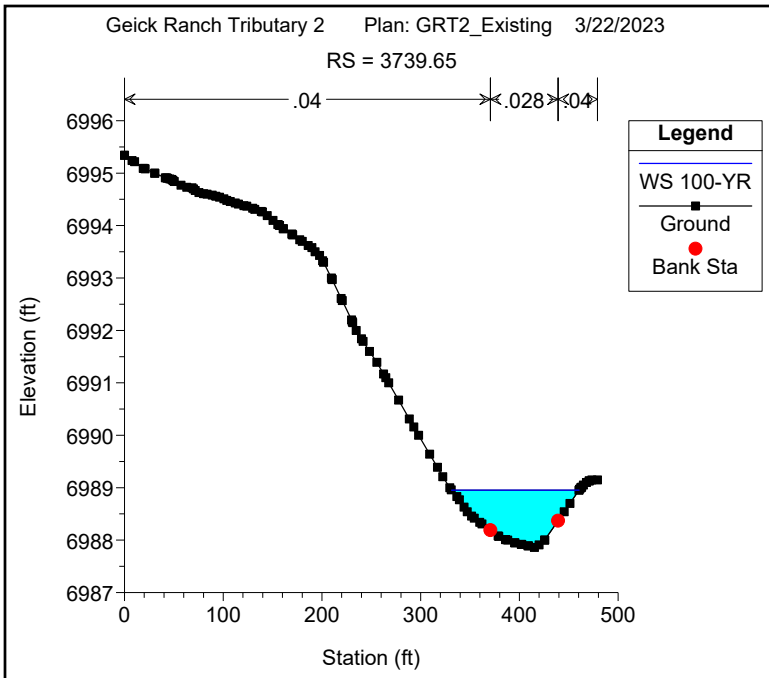
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 3739.65
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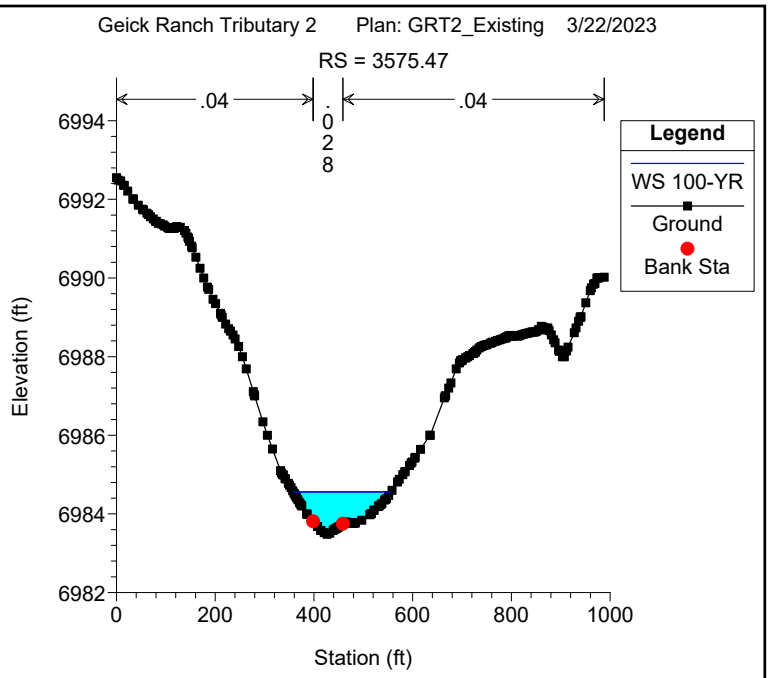
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 3575.47
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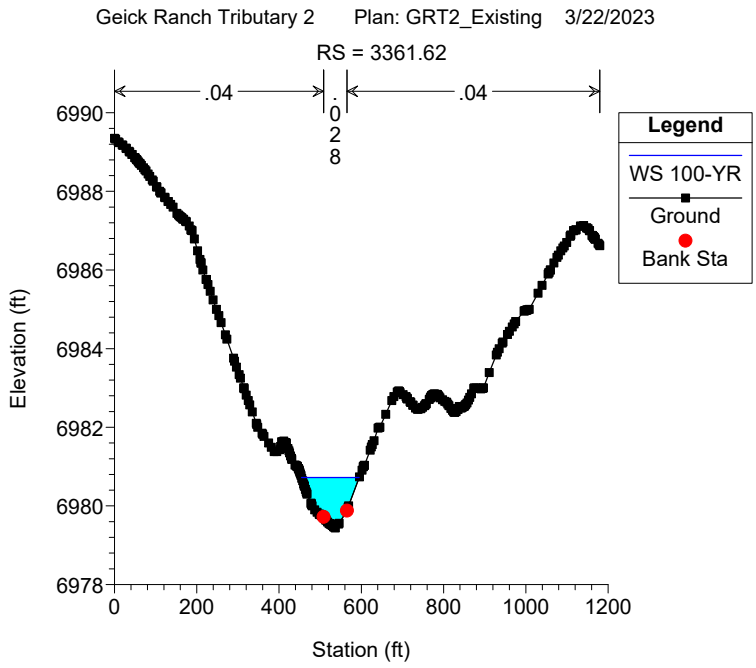
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 3361.62
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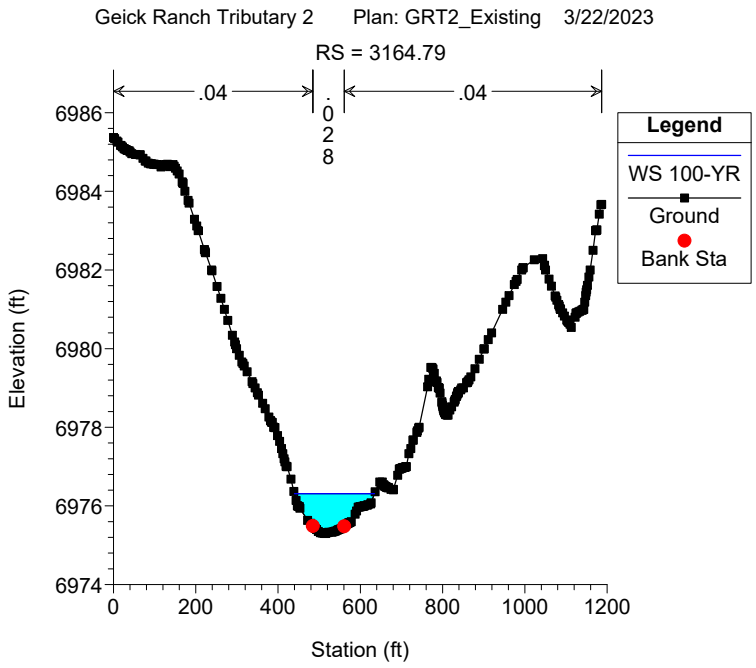
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 3164.79
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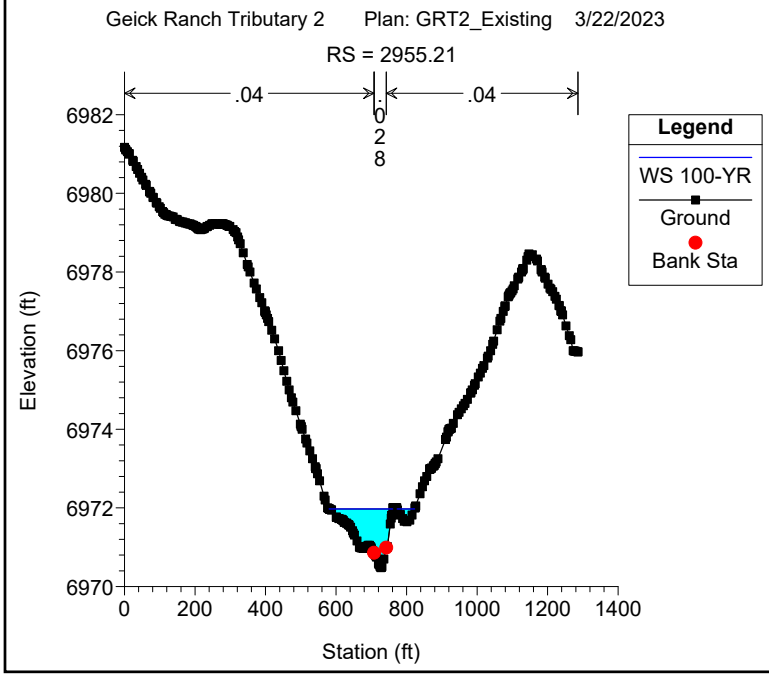
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 2955.21
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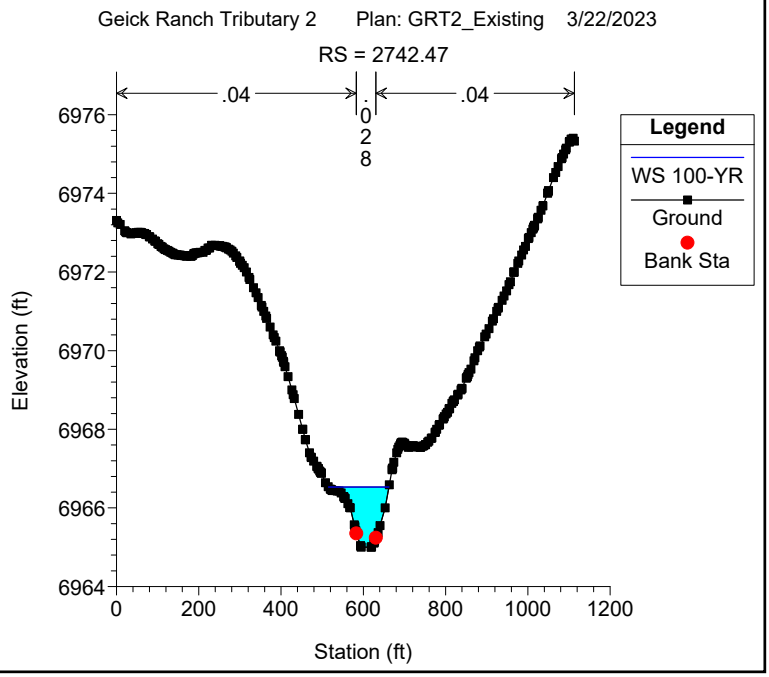
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 2742.47
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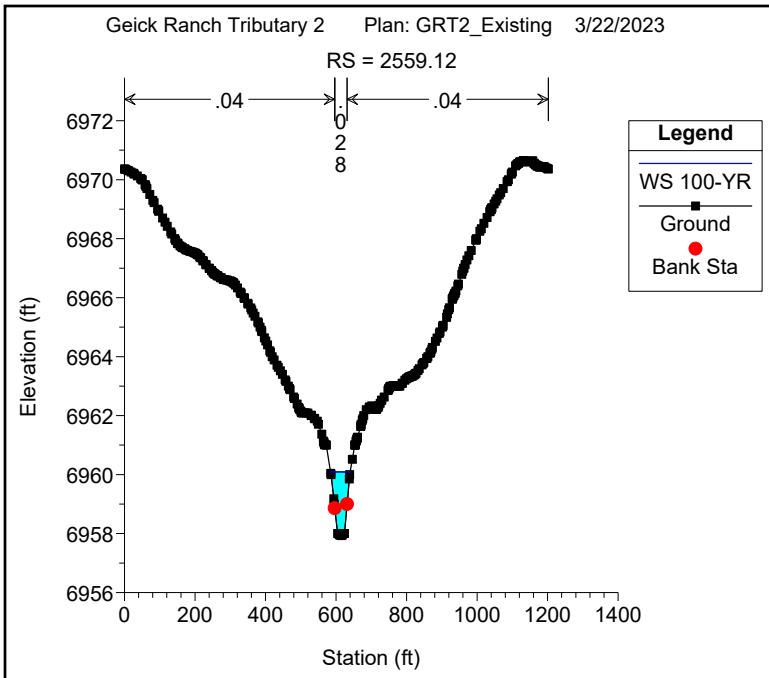
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
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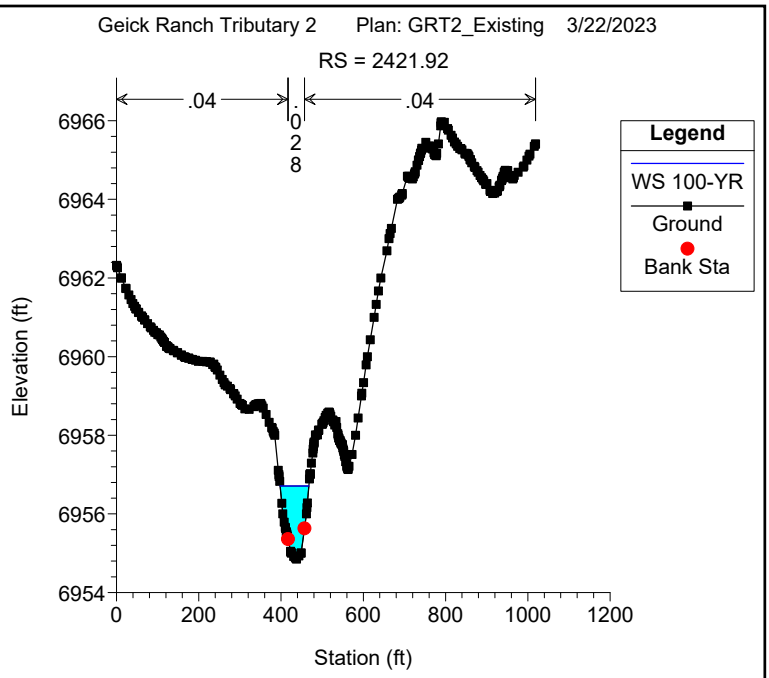
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 2421.92
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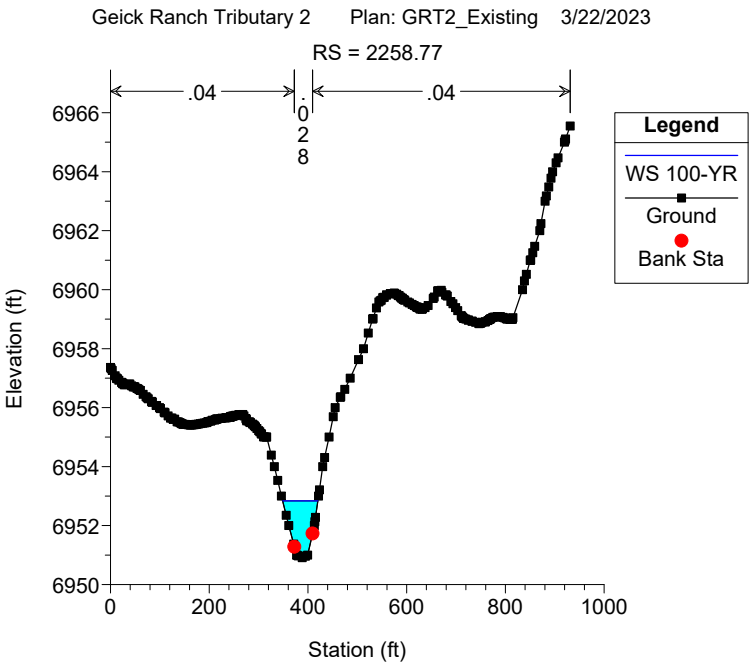
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 2258.77
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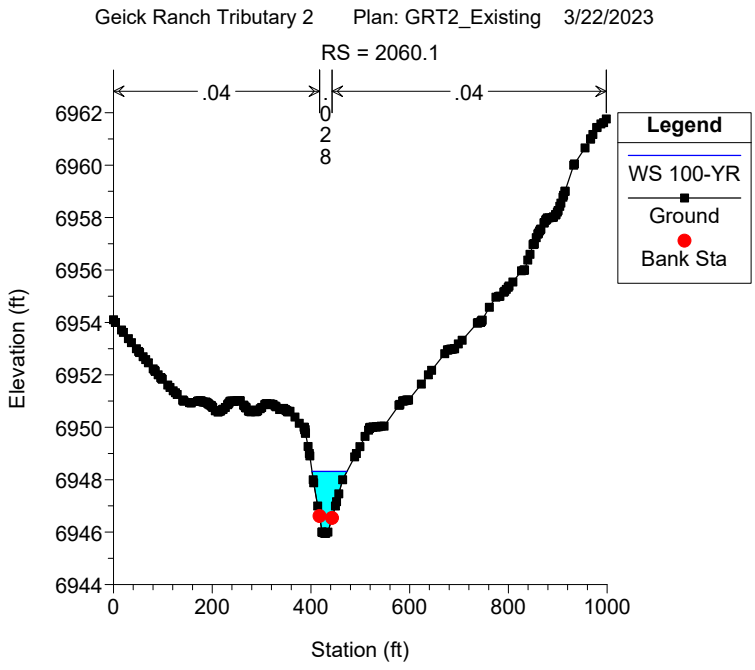
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 2060.1
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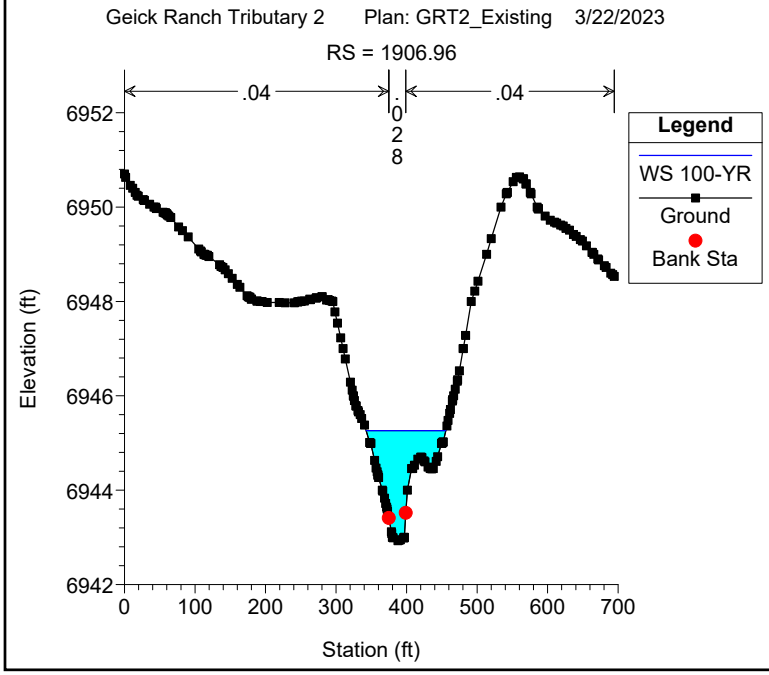
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 1906.96
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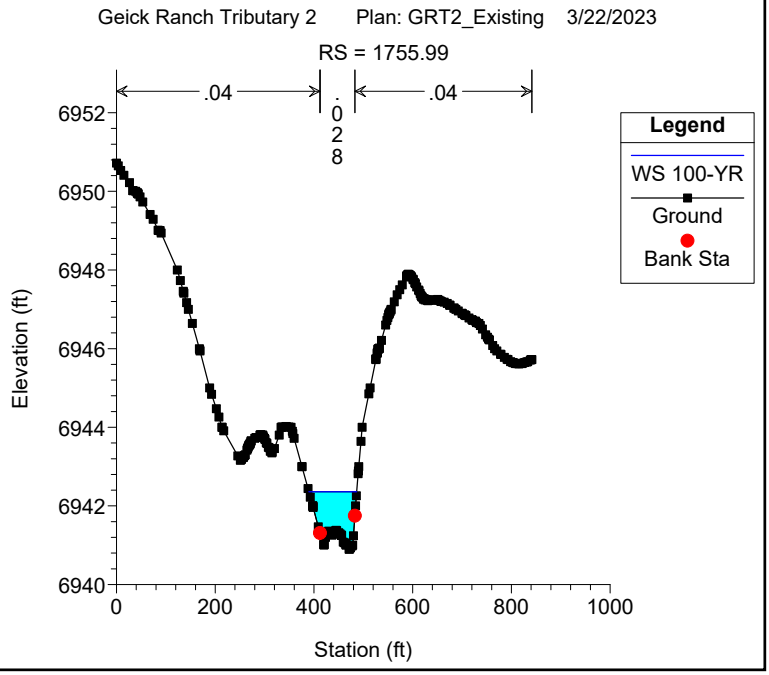
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 1755.99
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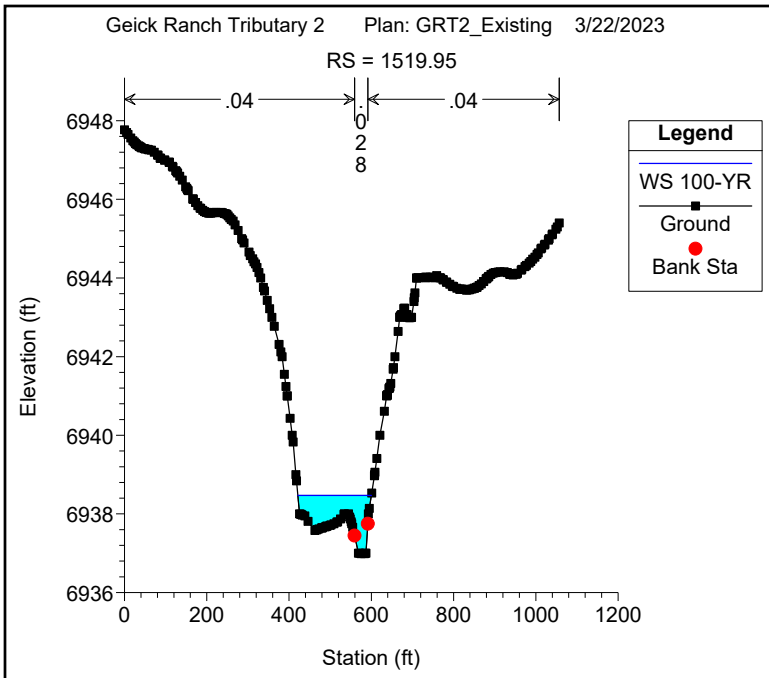
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 1519.95
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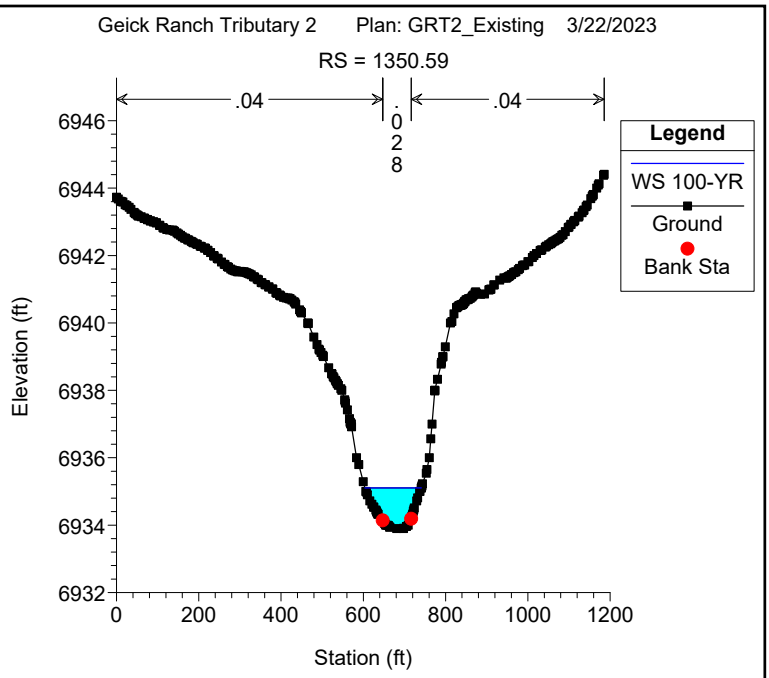
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)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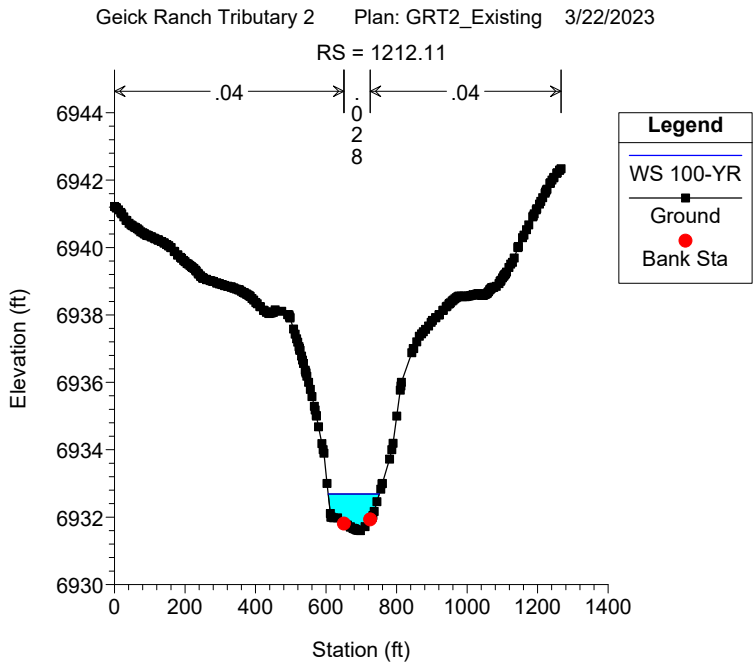
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)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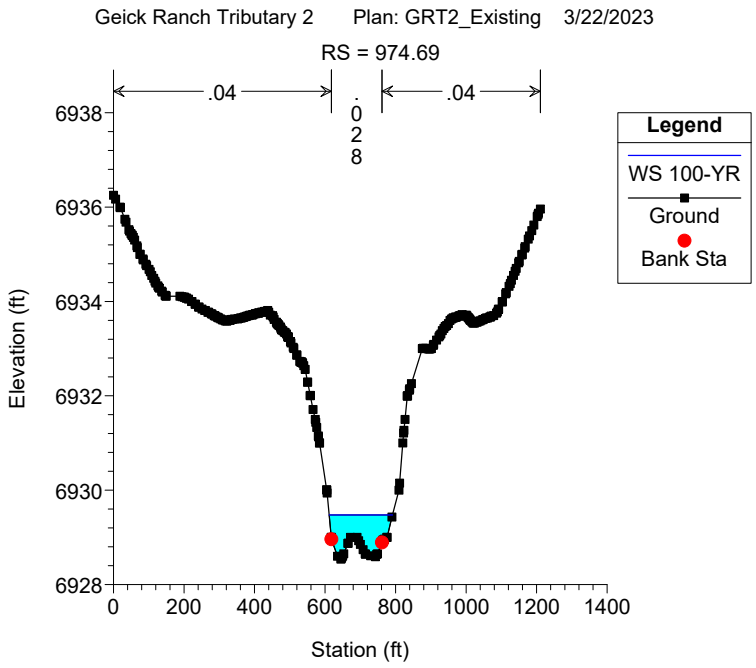
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)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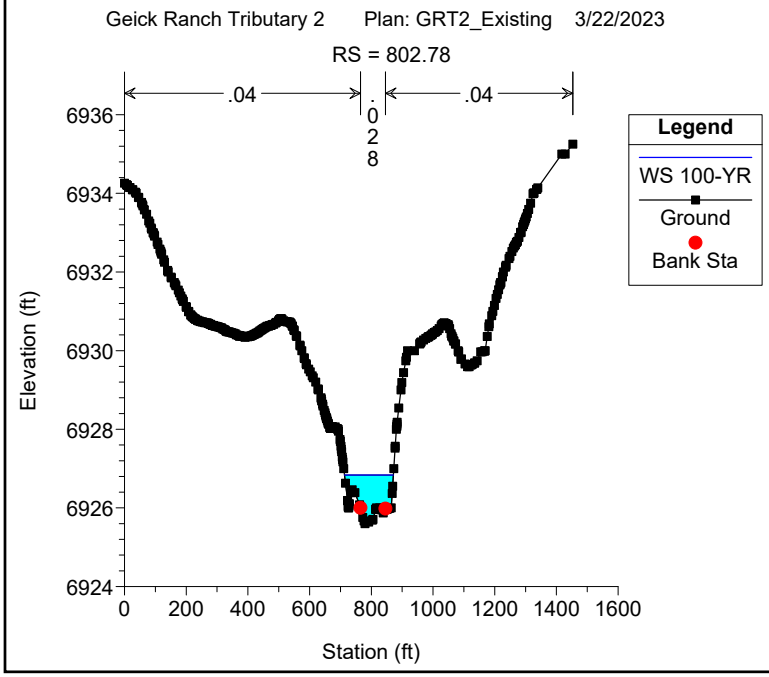
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 802.78
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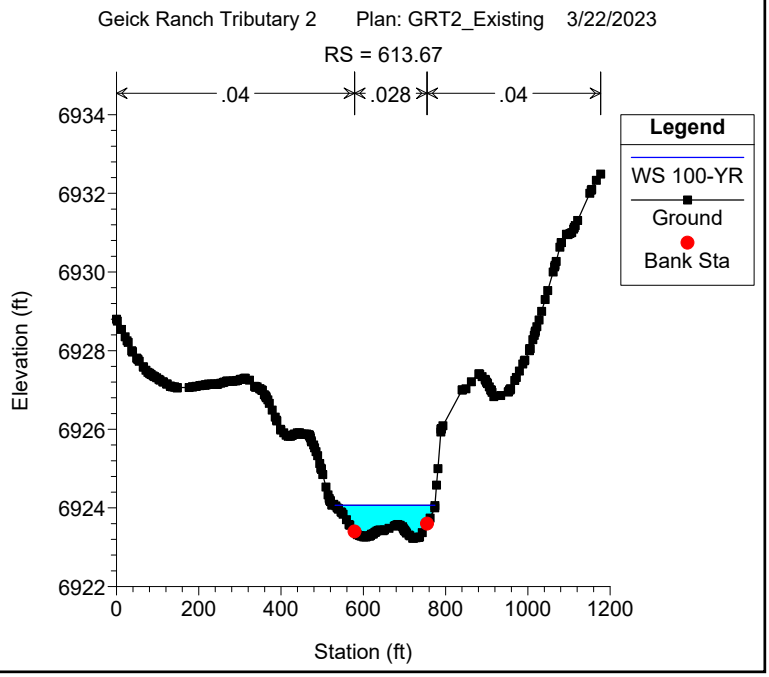
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
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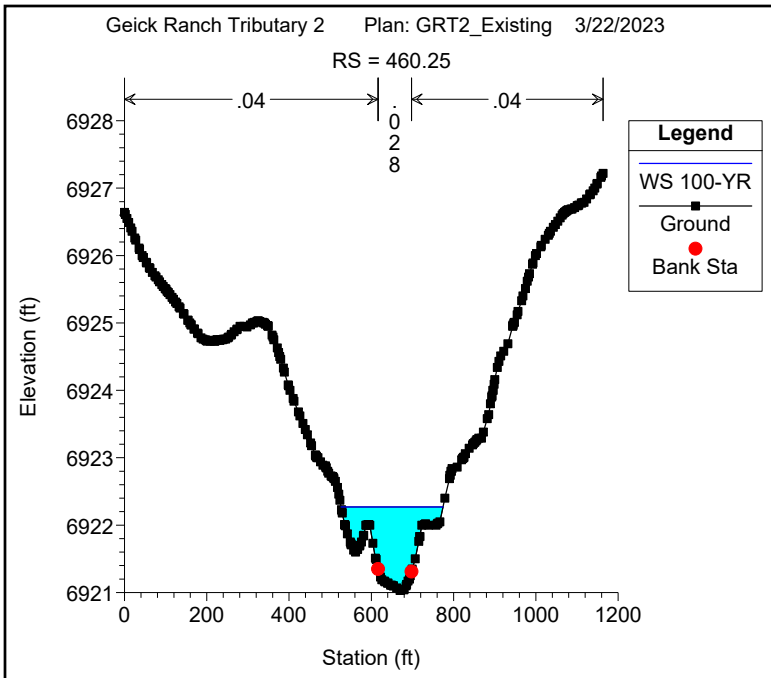
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
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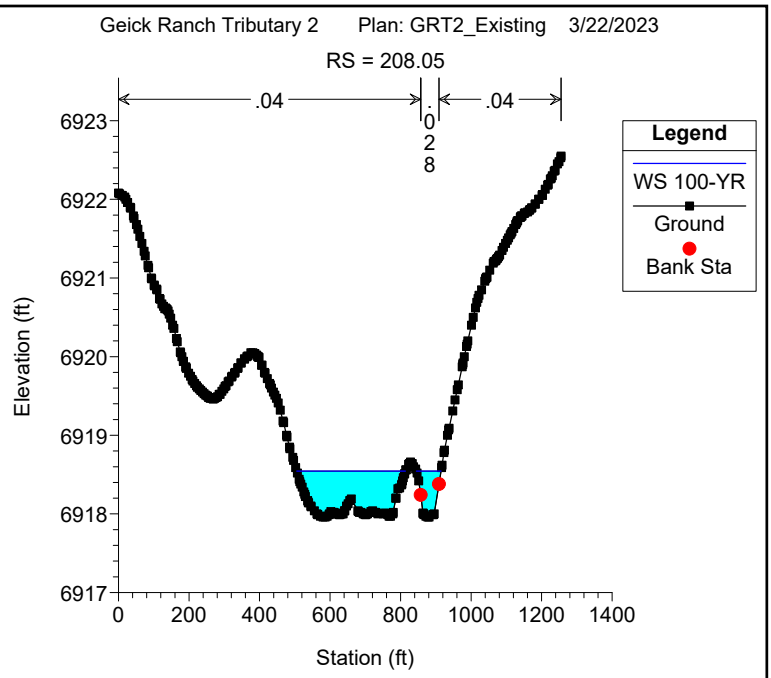
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 208.05
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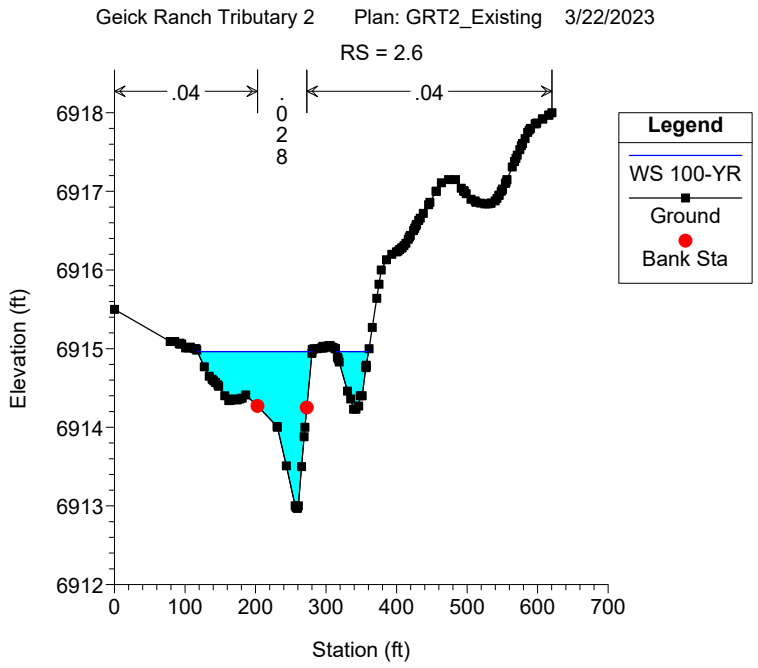
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = 2.6
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.028
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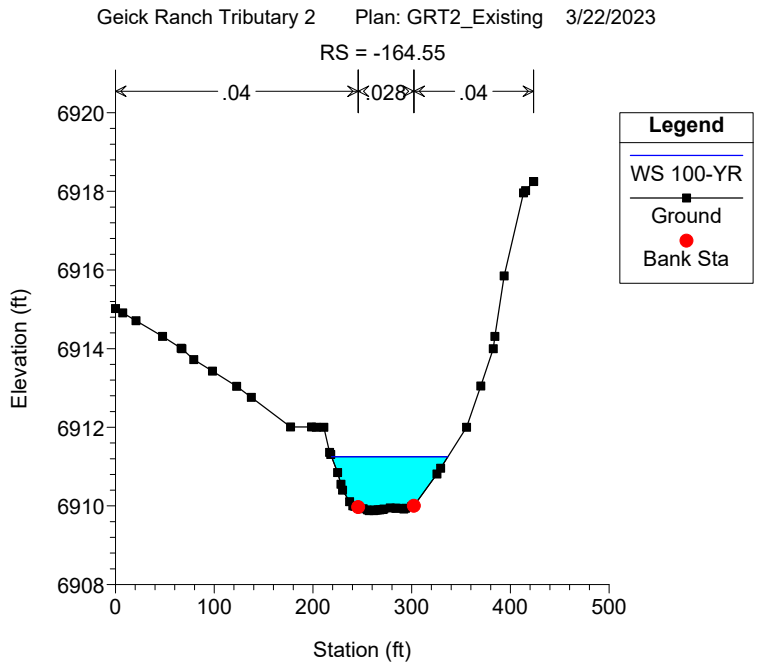
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = -164.55
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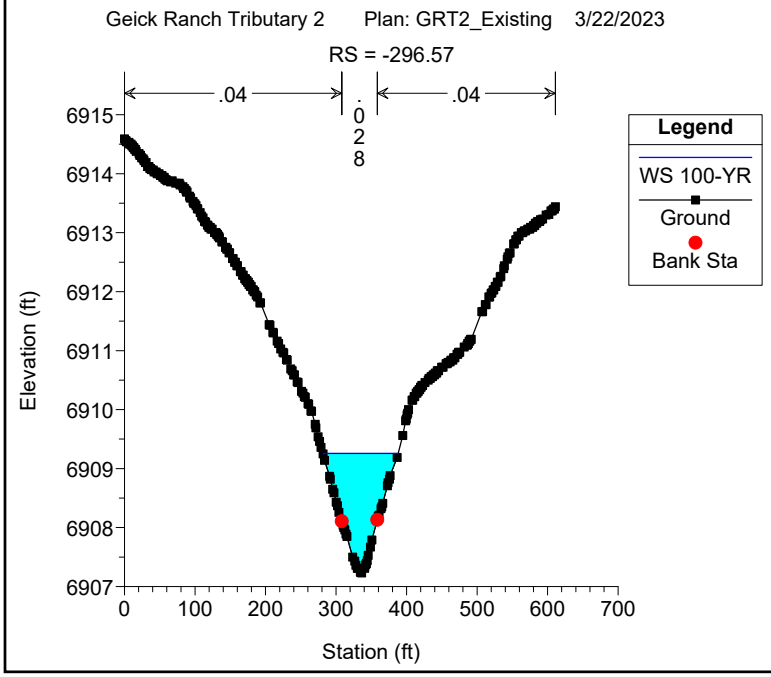
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = -296.57
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.028
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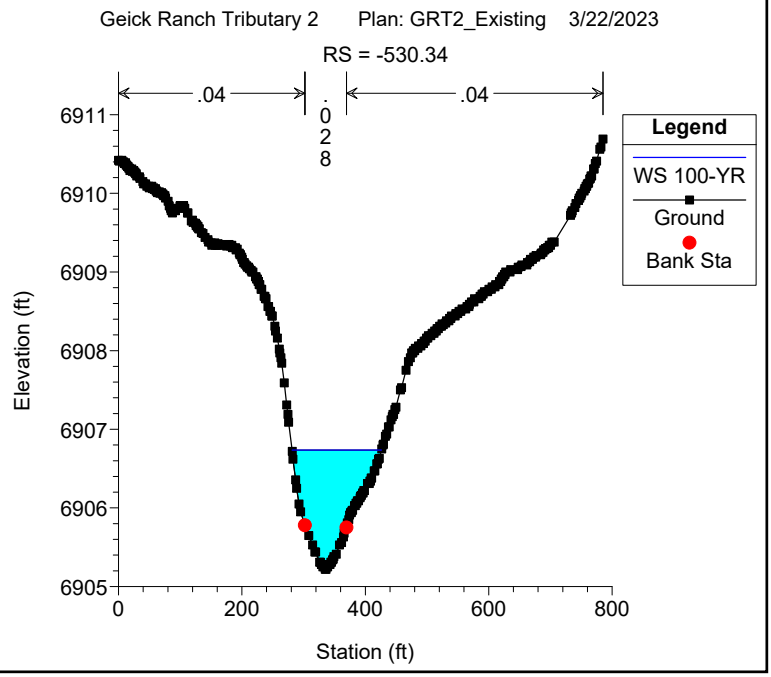
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023
RS = -530.34
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.028
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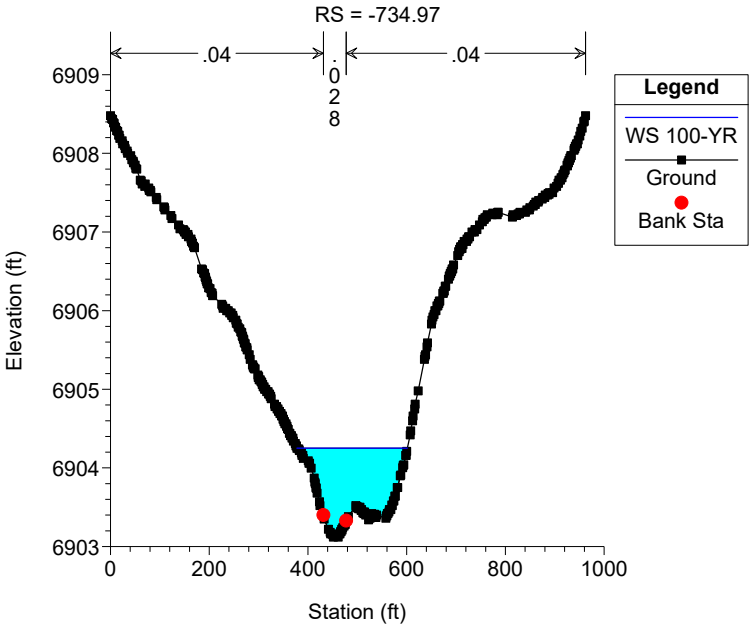
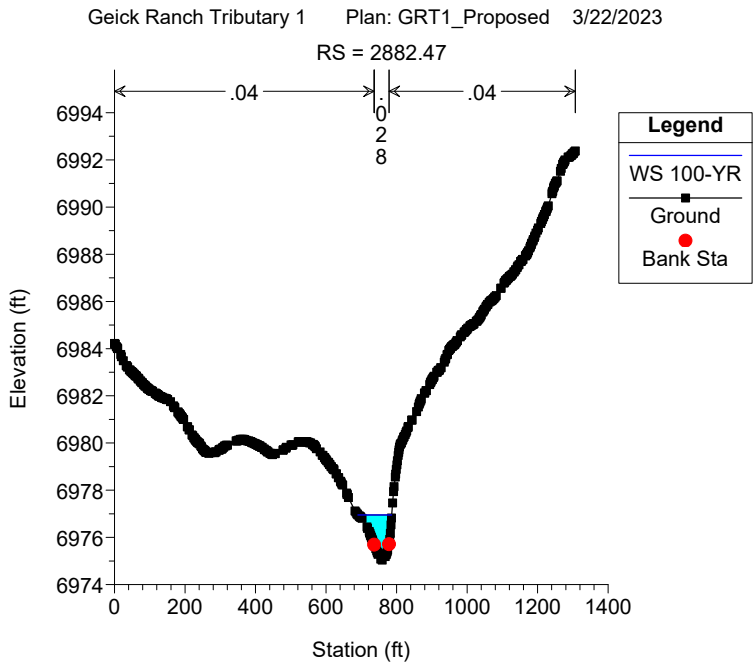
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)

Geick Ranch Tributary 2 Plan: GRT2_Existing 3/22/2023



Appendix I
Future Condition Cross Sections


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 2882.47
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.028
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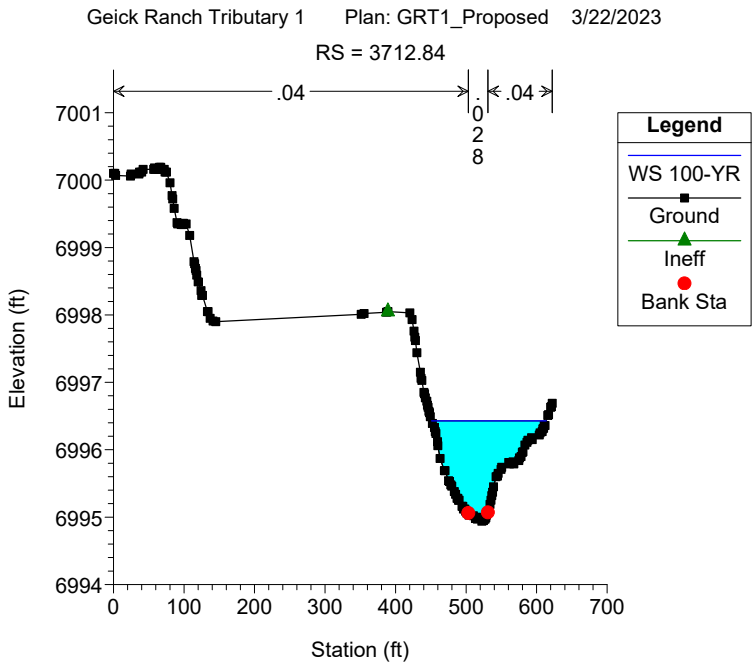
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 3712.84
.04
.028
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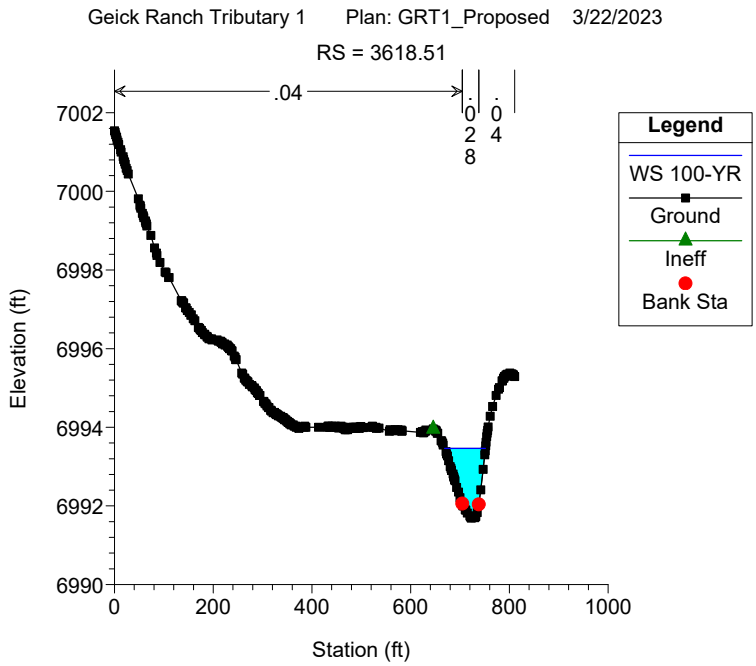
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 3618.51
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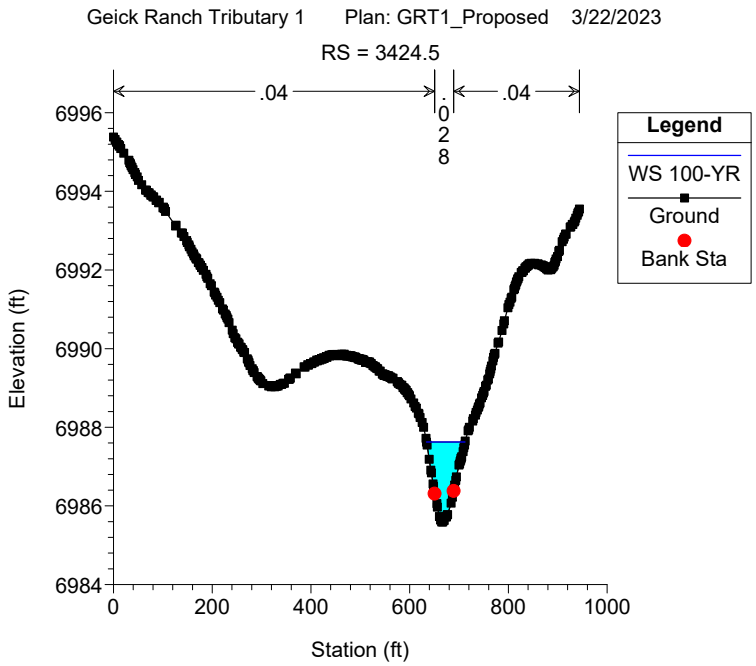
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 3424.5
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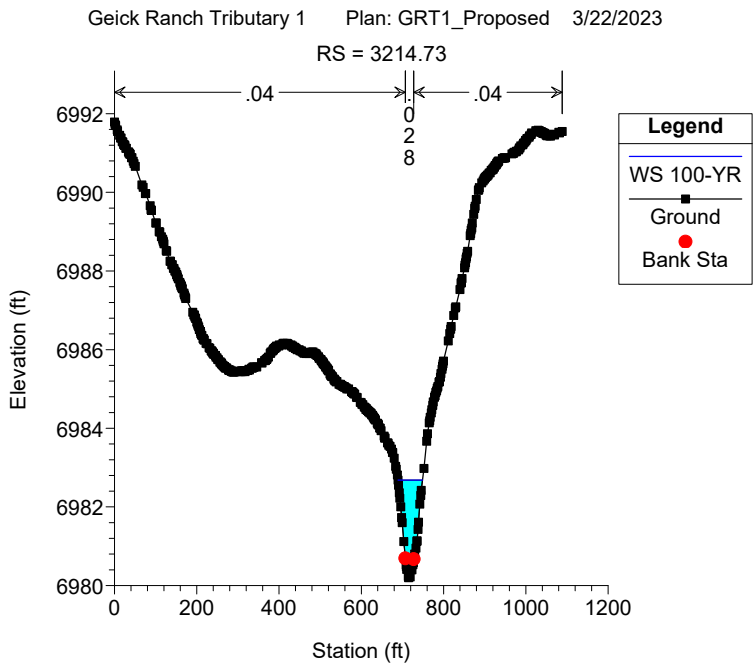
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 3214.73
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.028
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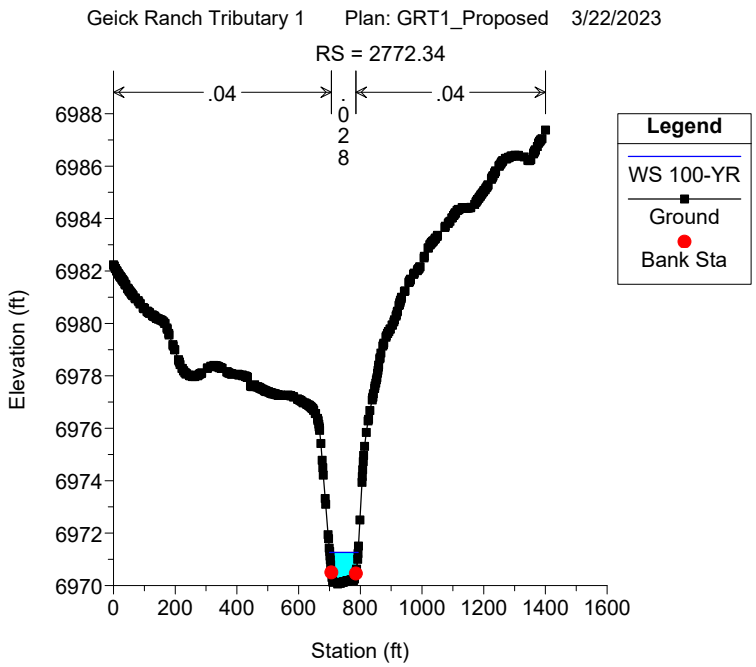
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 2772.34
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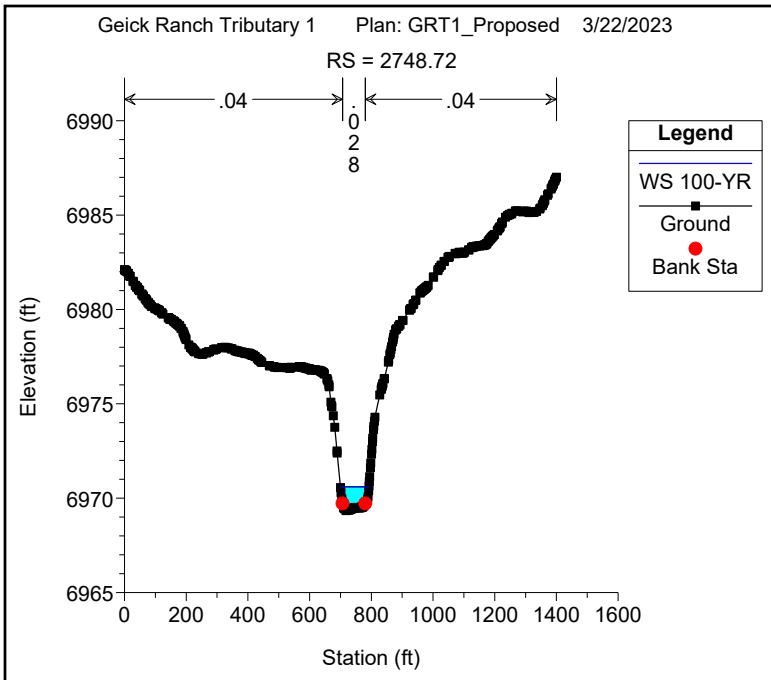
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)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RS = 2748.72
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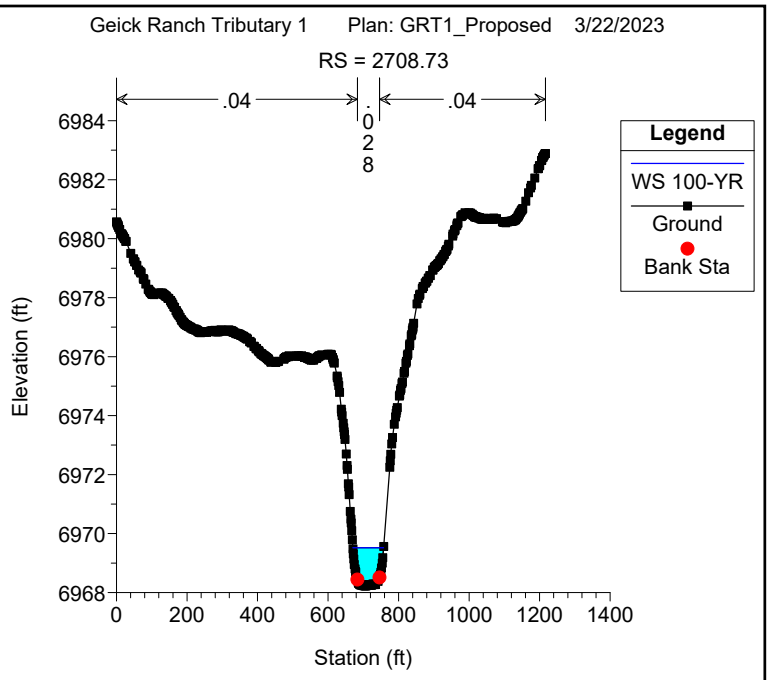
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 2708.73
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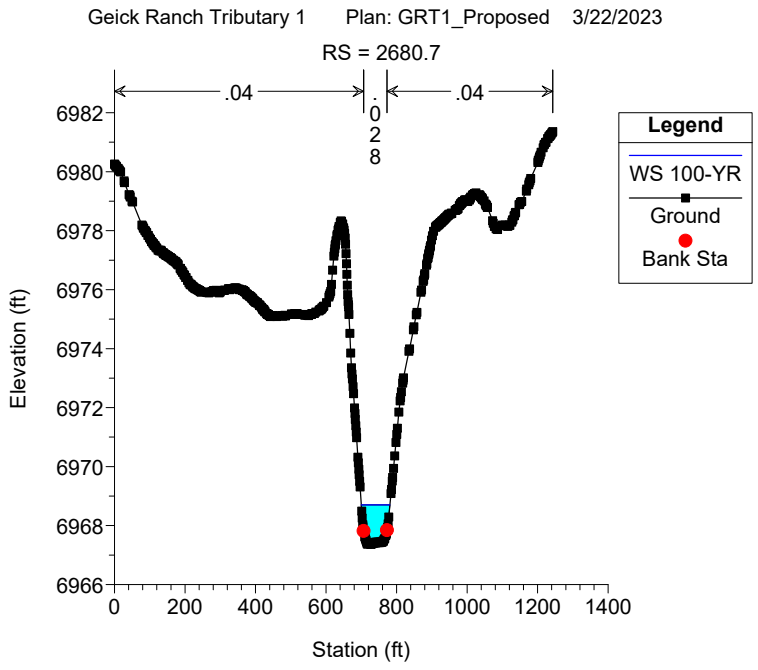
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 2680.7
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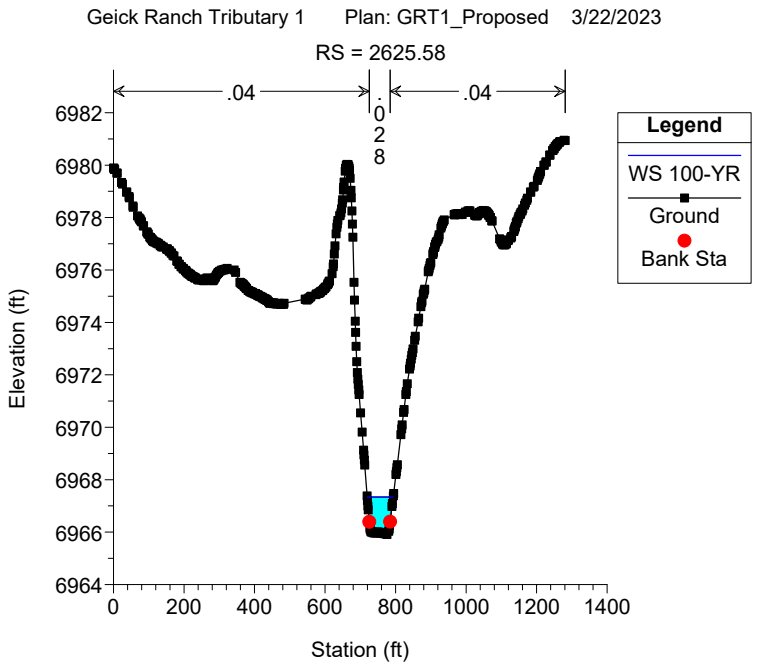
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 2625.58
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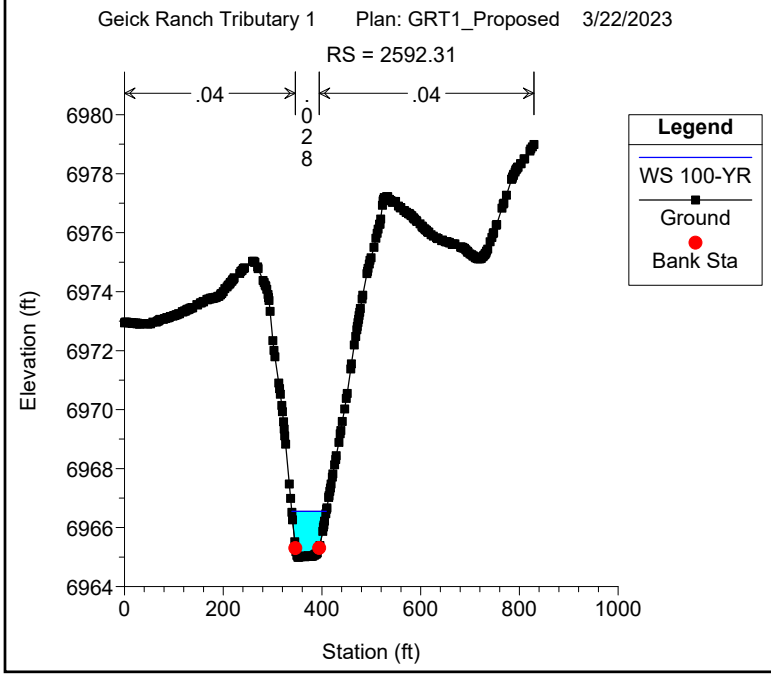
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)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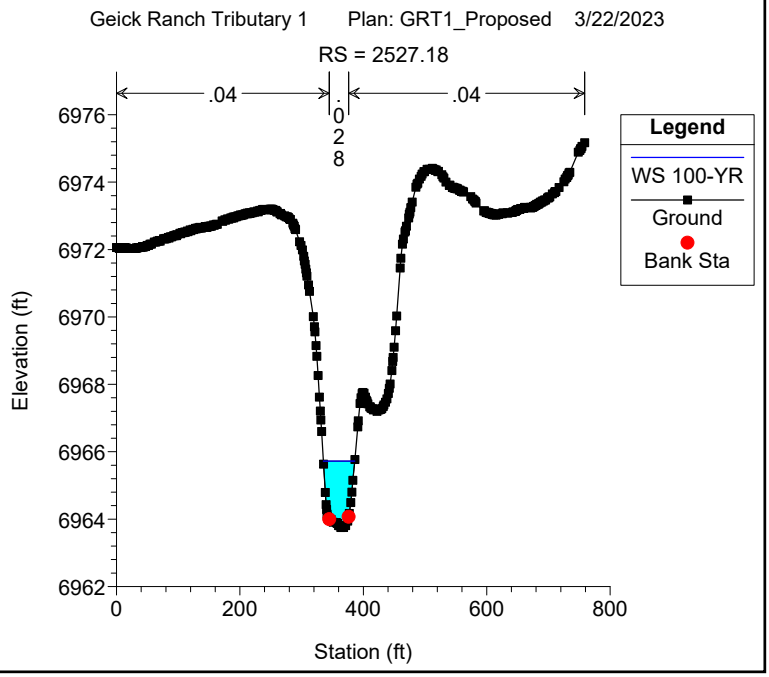
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 2527.18
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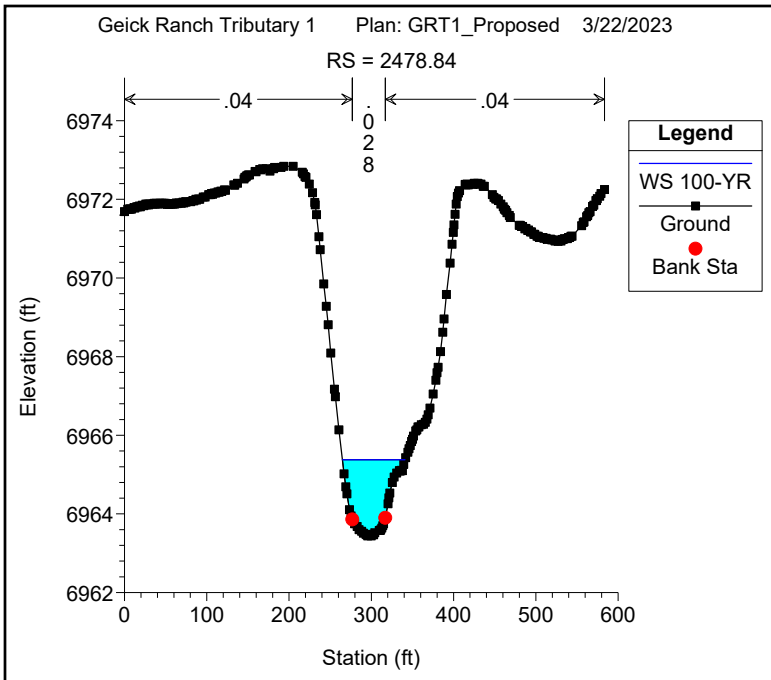
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 2478.84
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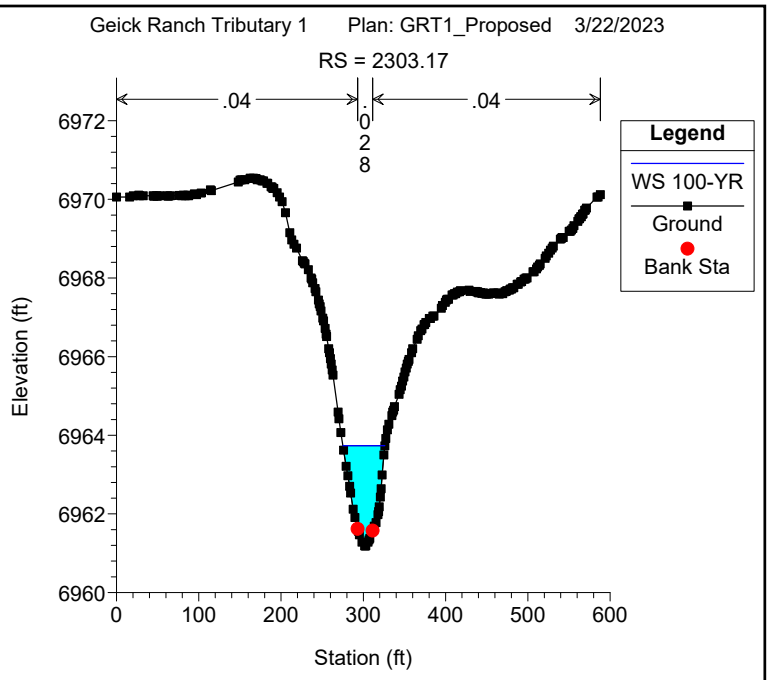
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 2303.17
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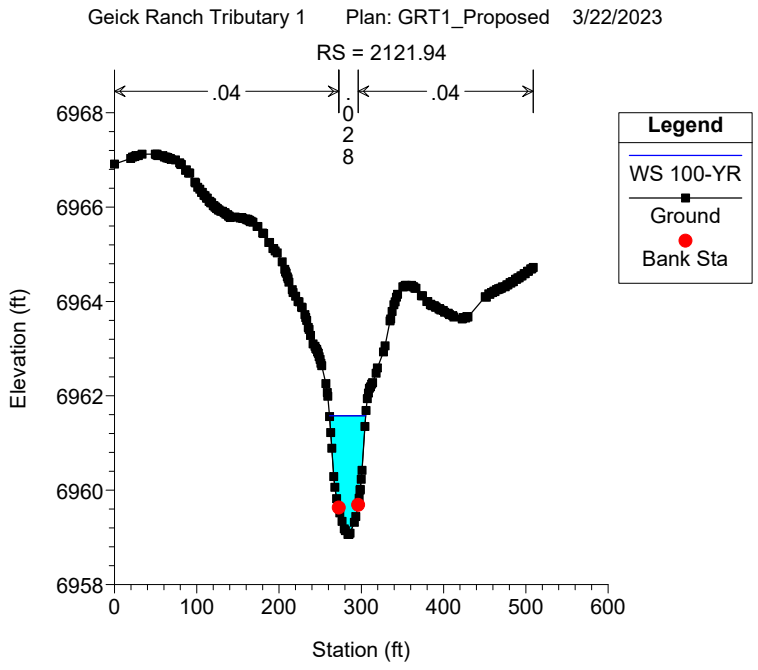
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 2121.94
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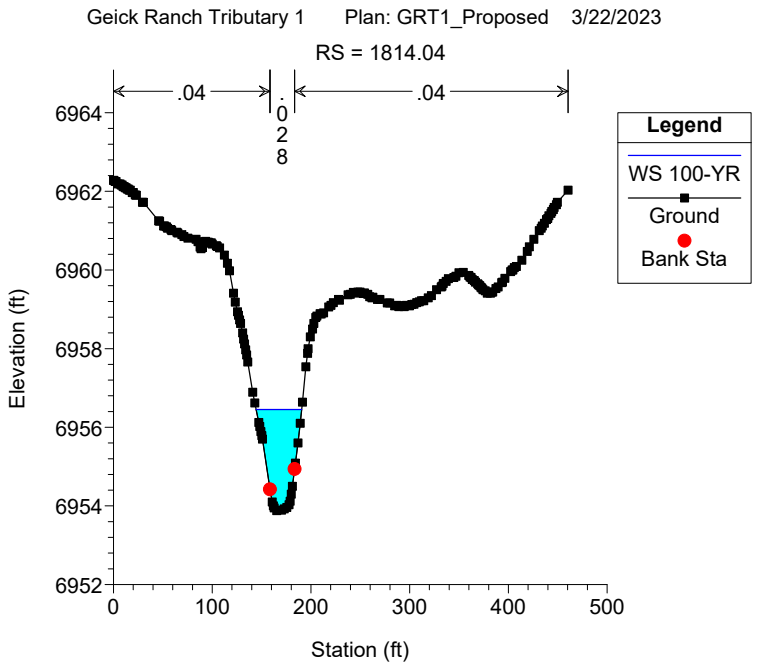
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 1814.04
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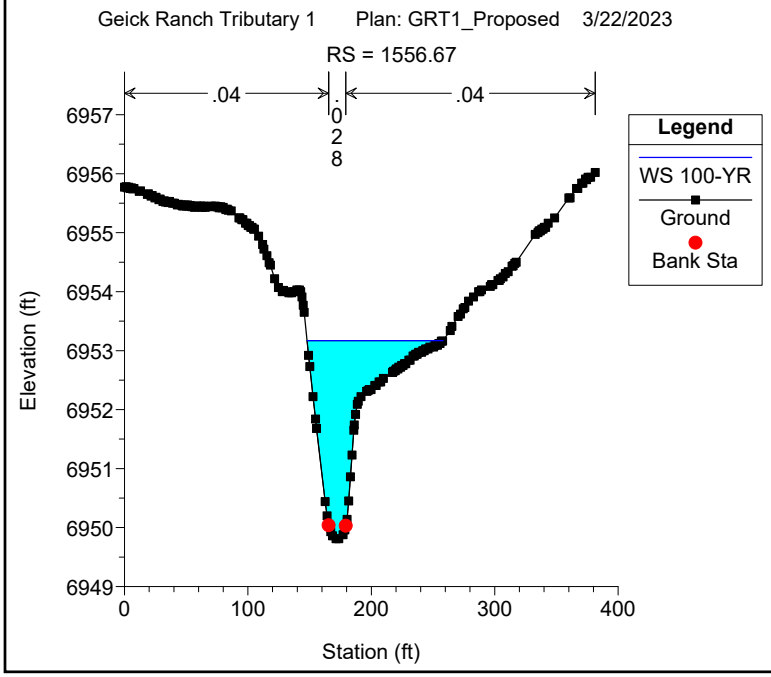
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 1556.67
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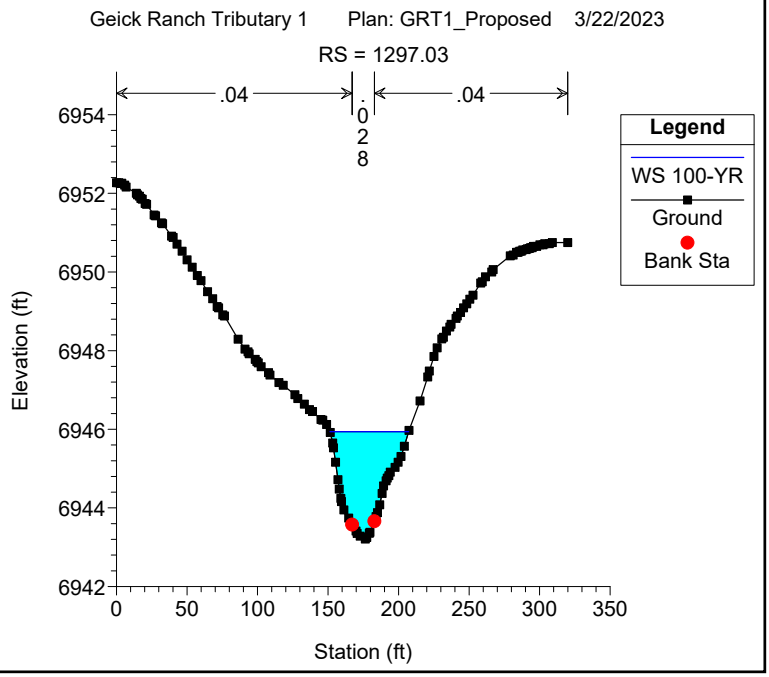
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 1297.03
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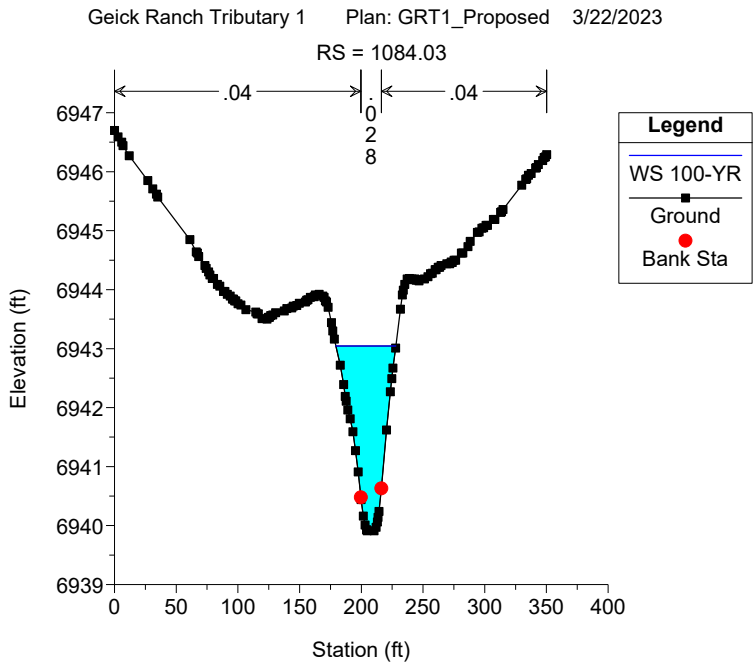
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 1084.03
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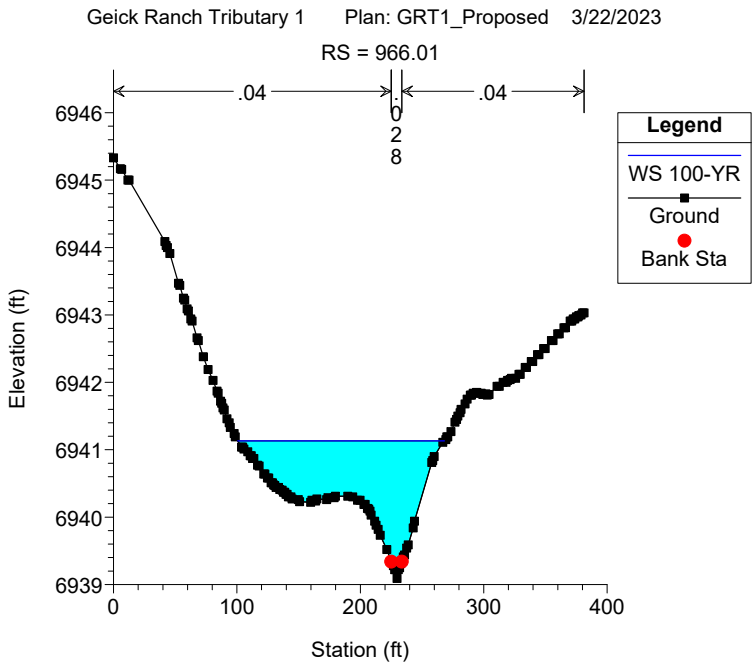
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 966.01
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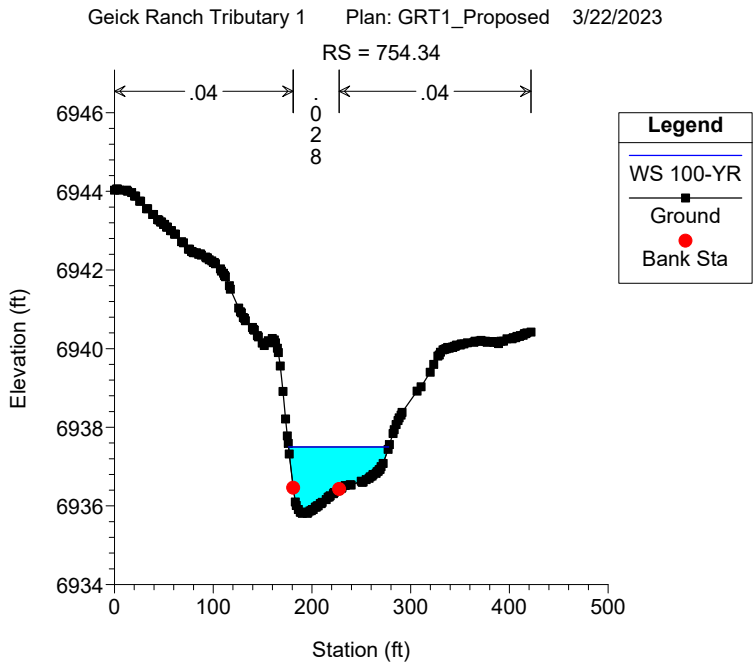
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 754.34
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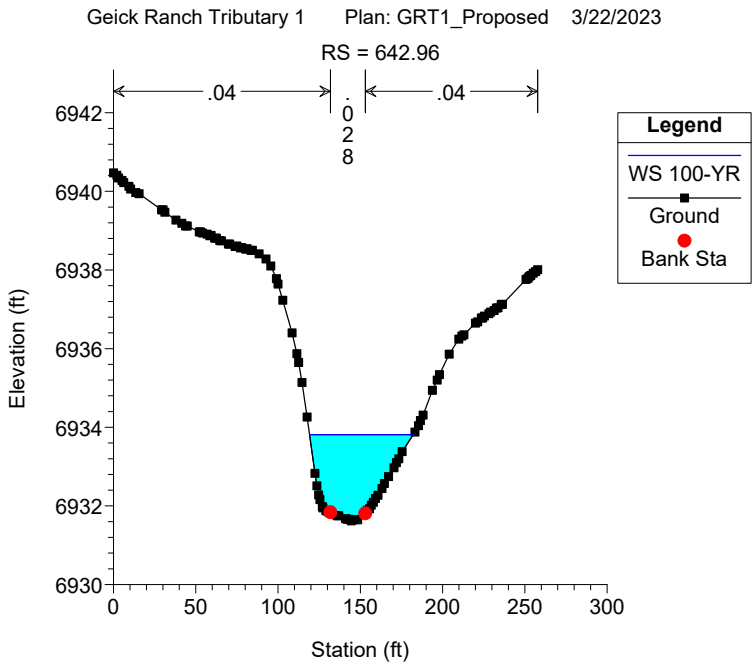
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 642.96
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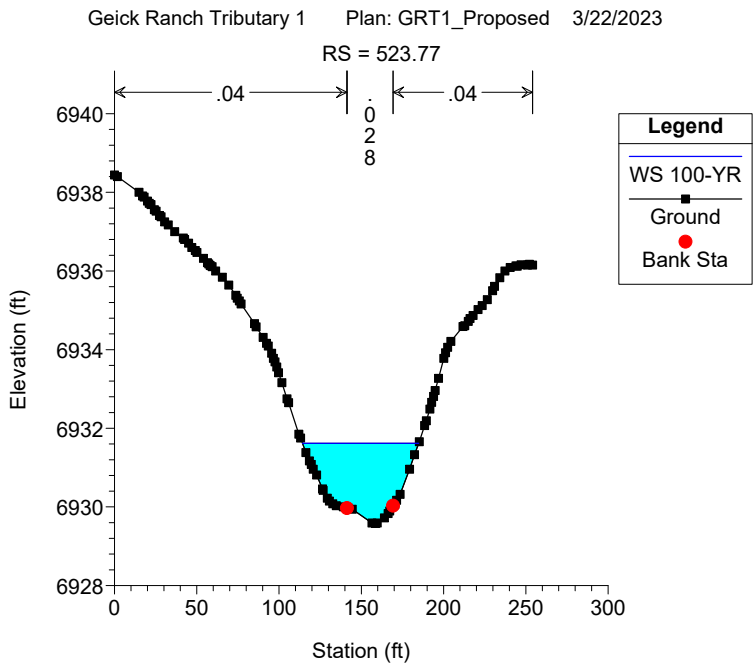
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 523.77
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.028
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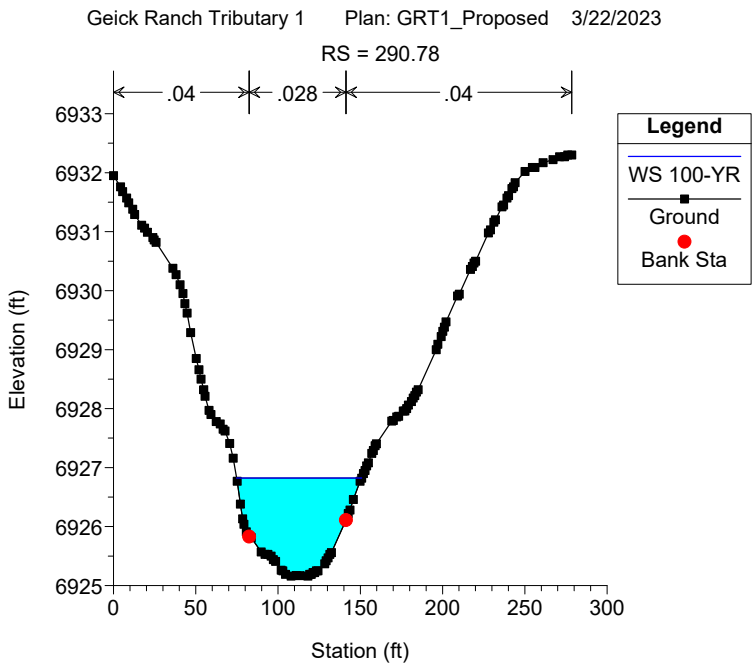
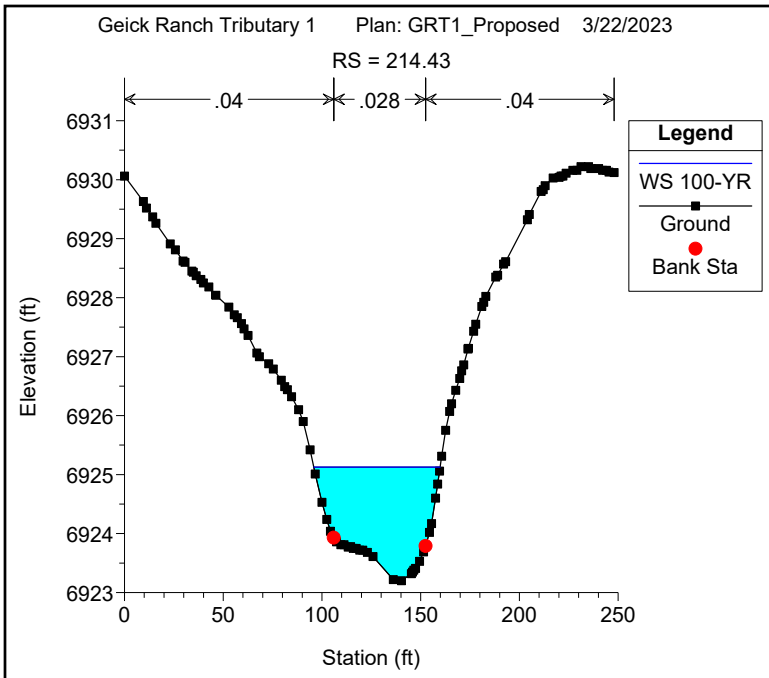
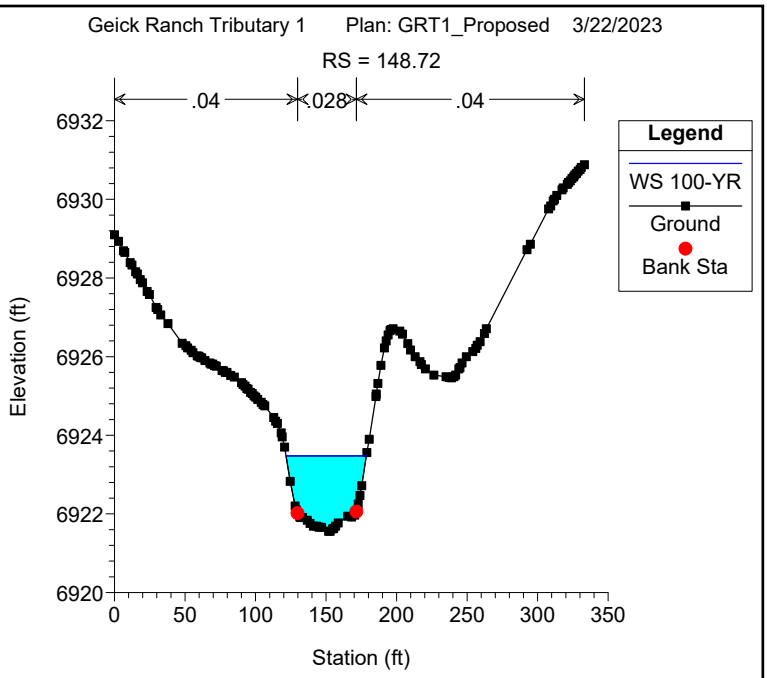
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 290.78
.04
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 214.43
.04
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 148.72
.04
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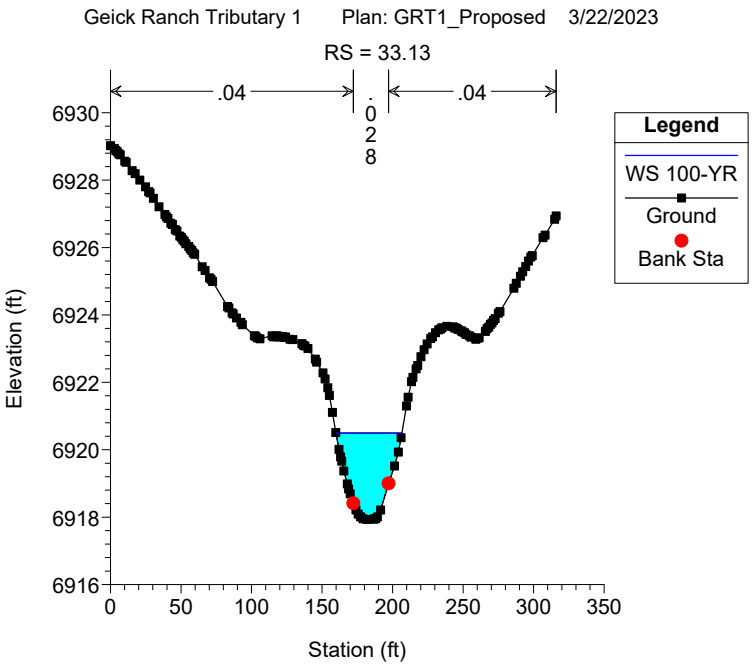
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 1 Plan: GRT1_Proposed 3/22/2023
RS = 33.13
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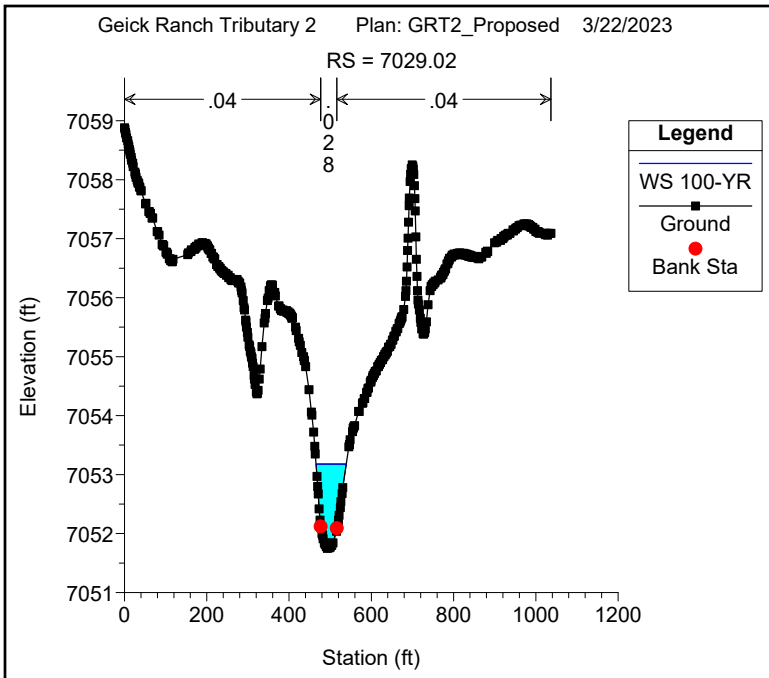
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 7029.02
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.028
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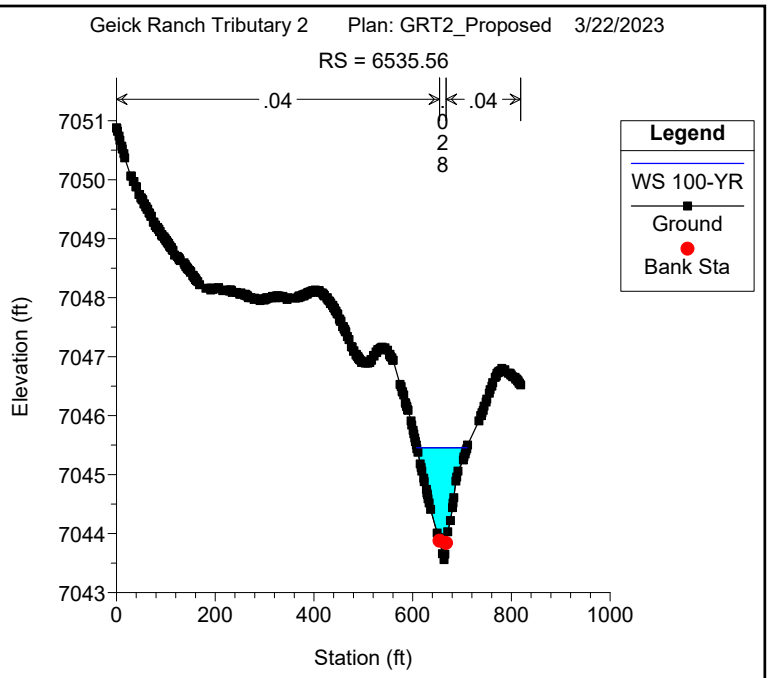
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 6535.56
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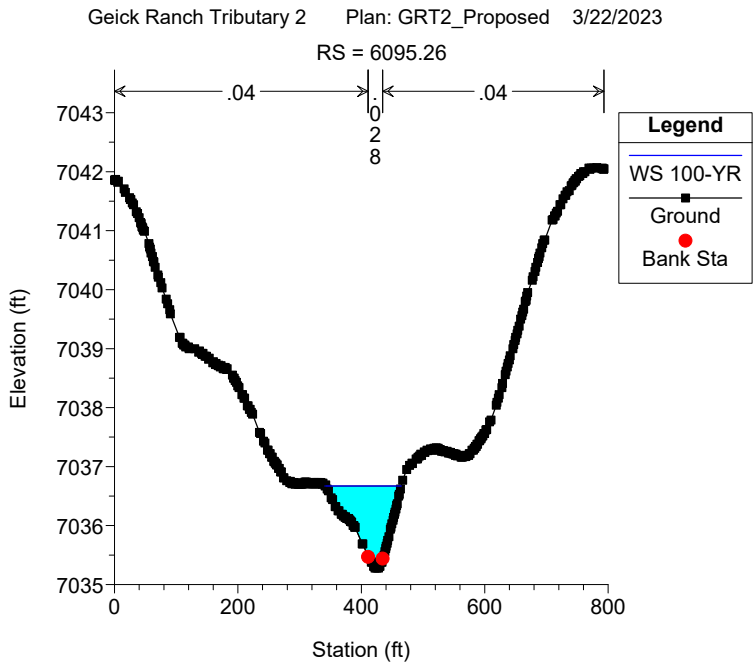
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 6095.26
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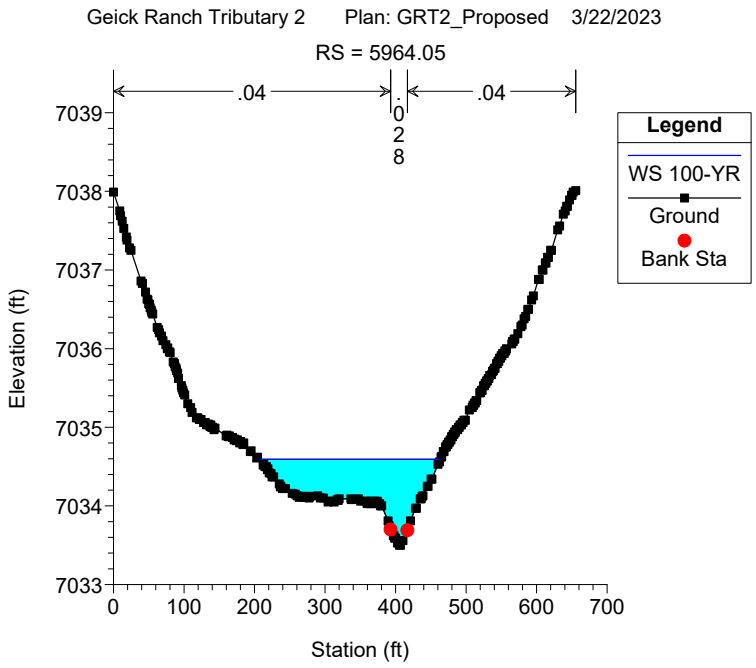
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 5964.05
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.028
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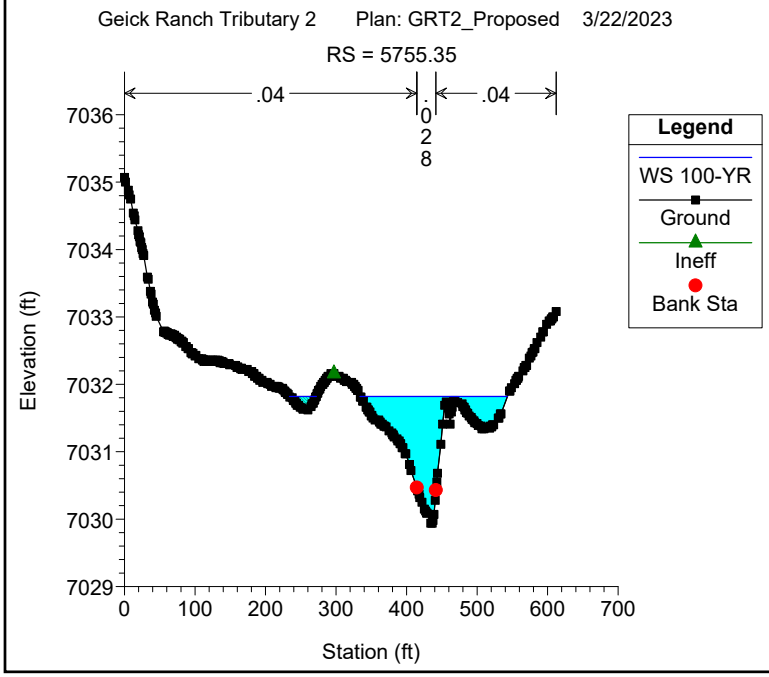
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 5755.35
.04
.028
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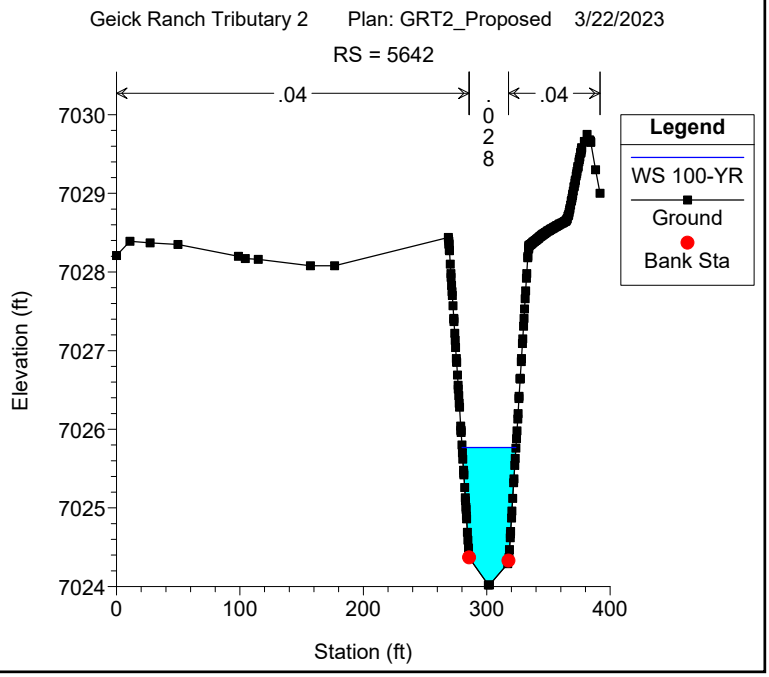
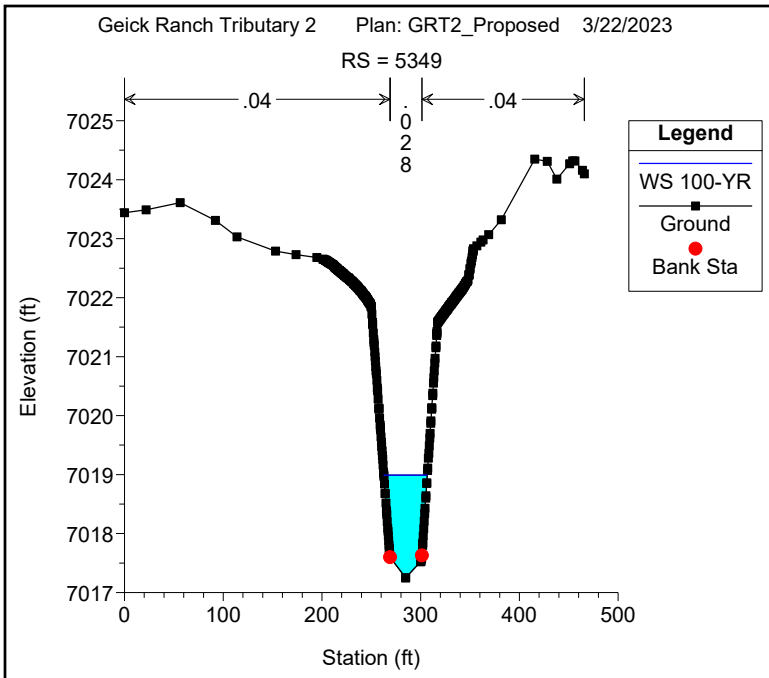
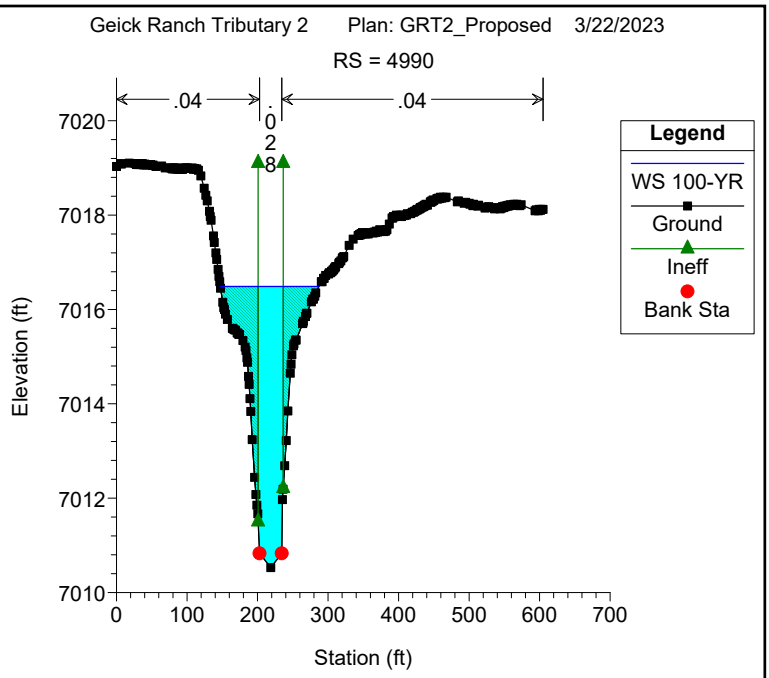
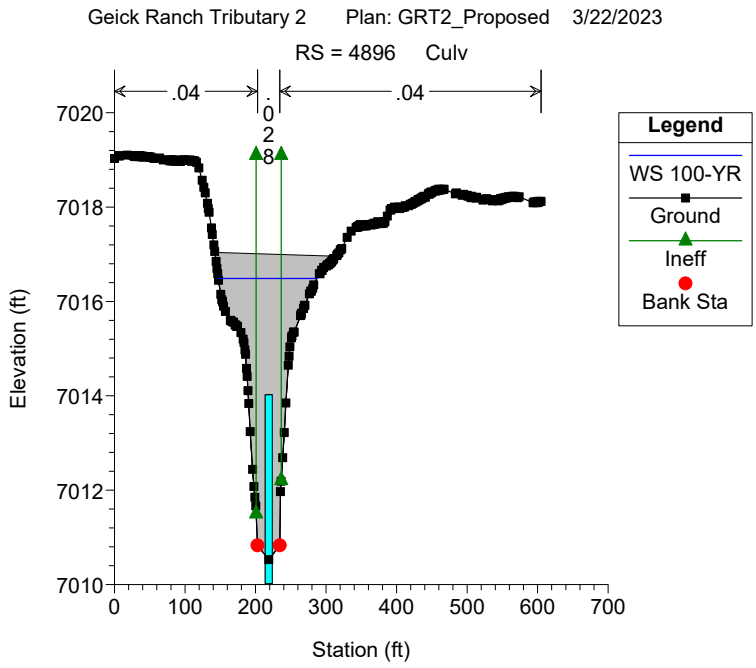
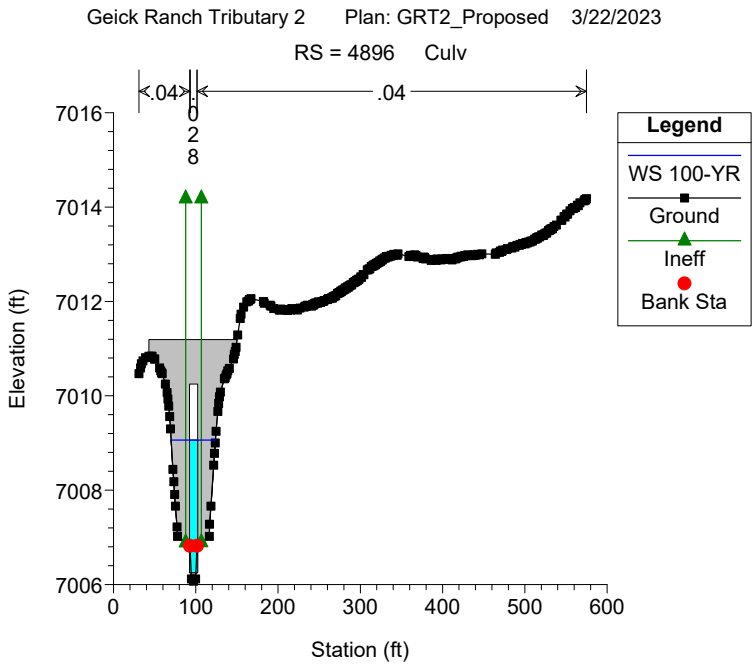
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

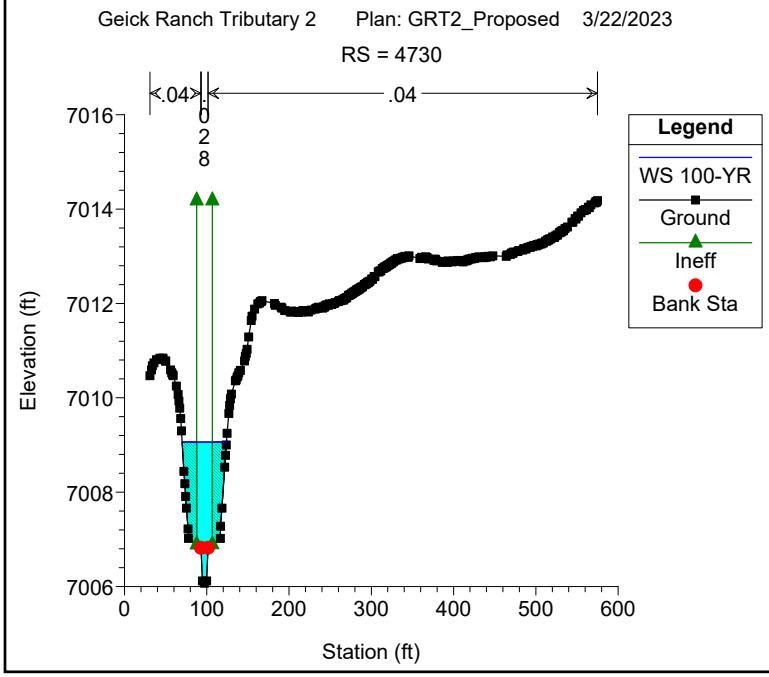

Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 5642
.04
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 5349
.04
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 4990
.04
.028
.04
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 4896 Culv
.04
.028
.04
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 4896 Culv
.04
.028
.04
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 4730
.04
.028
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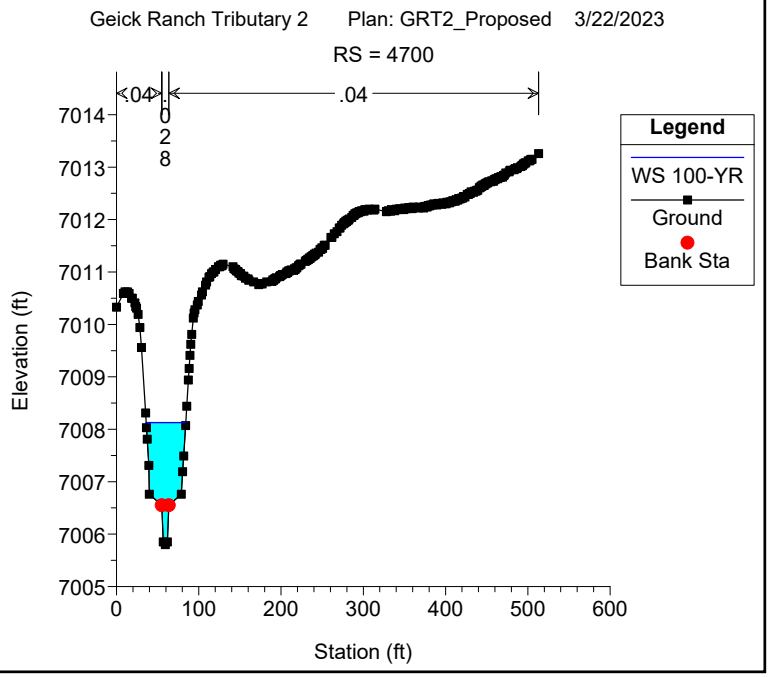
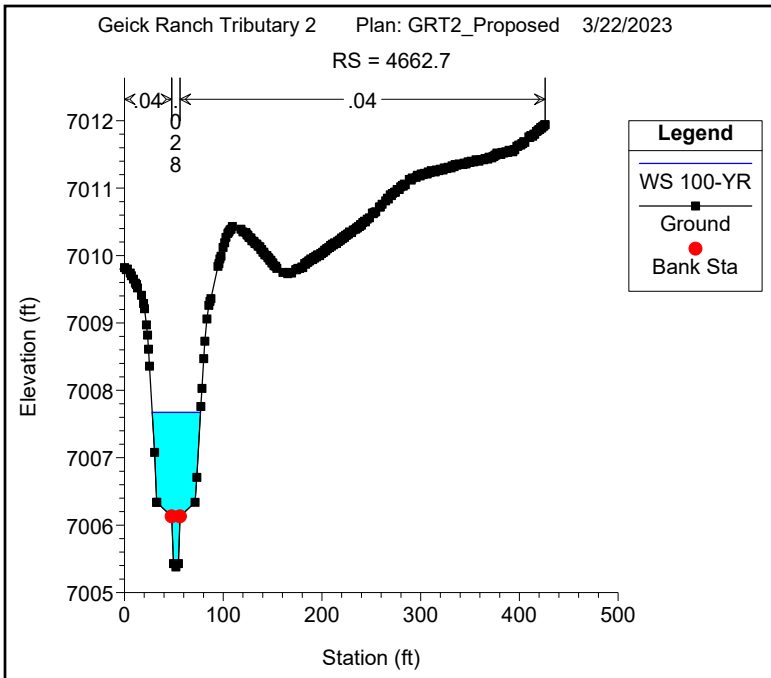
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 4700
.04
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 4662.7
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.028
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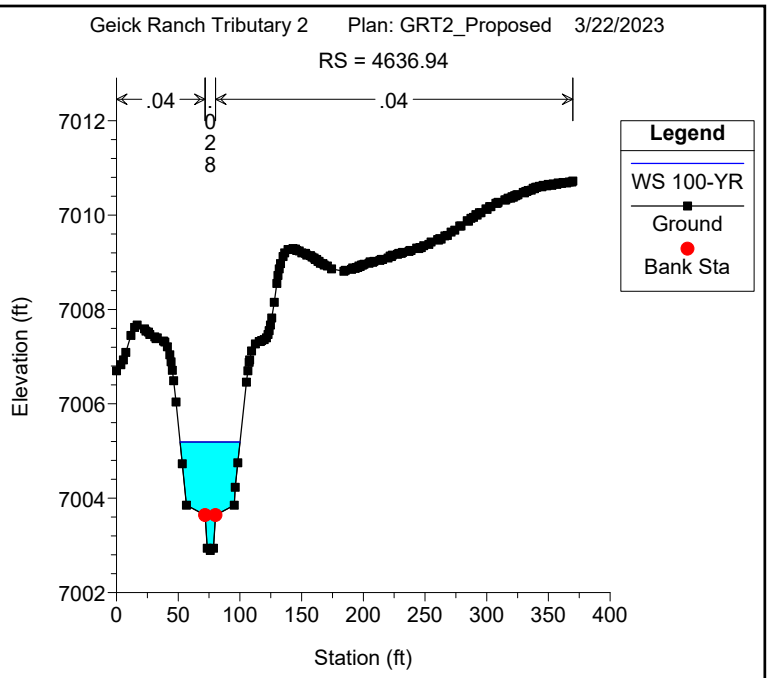
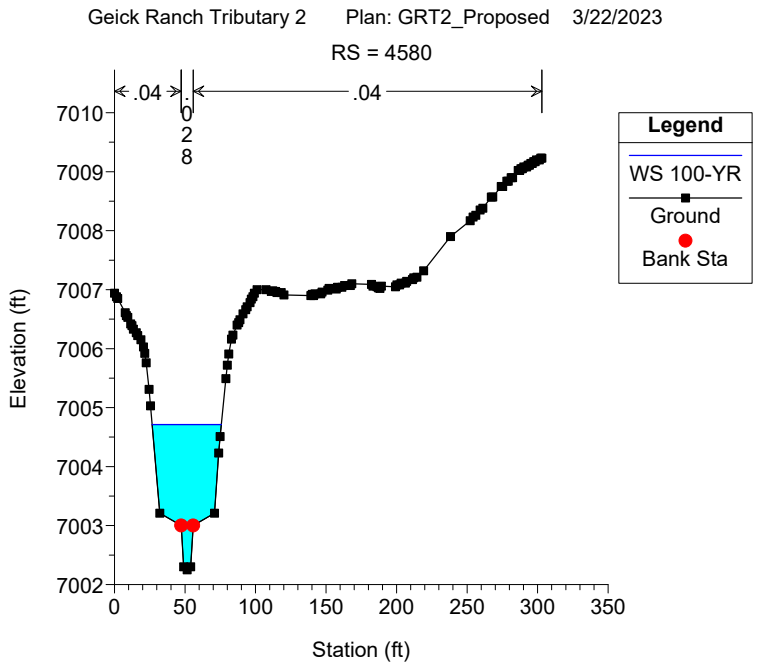
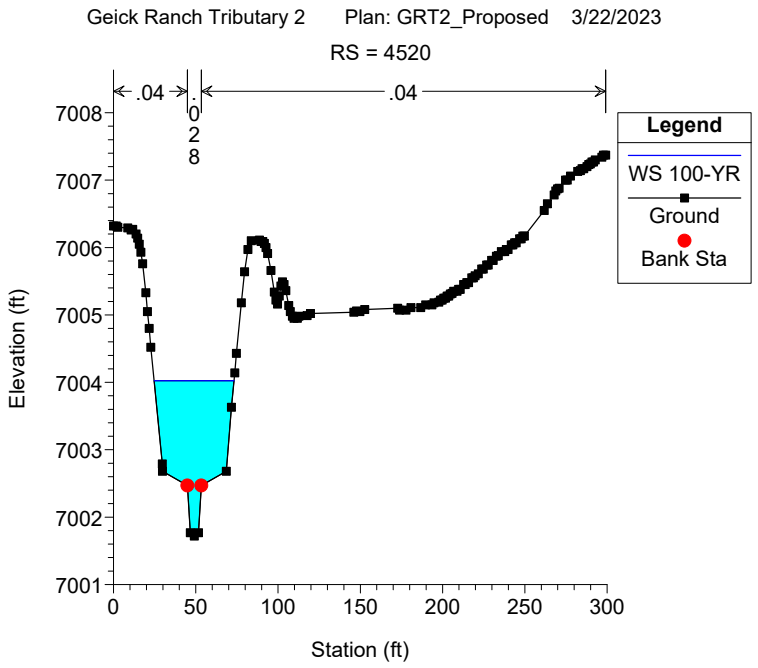
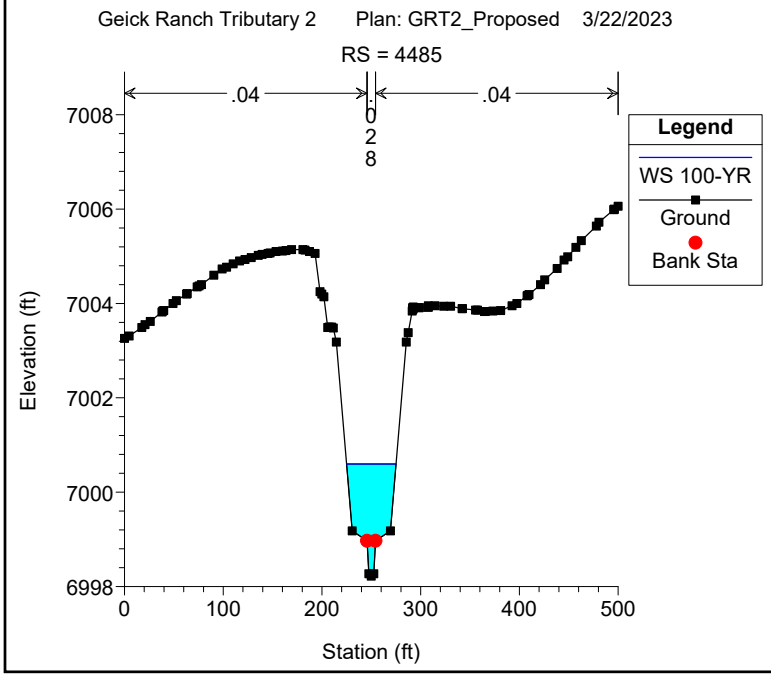
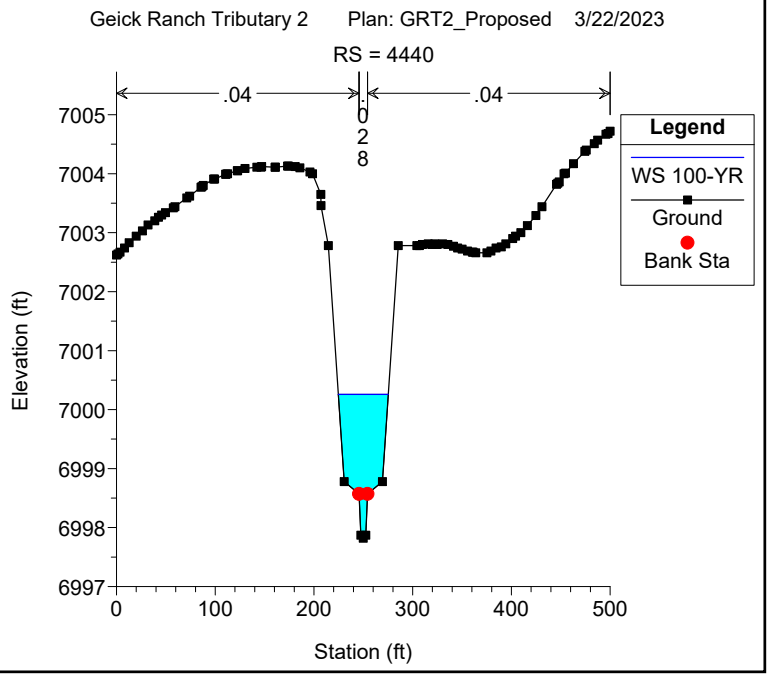
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)

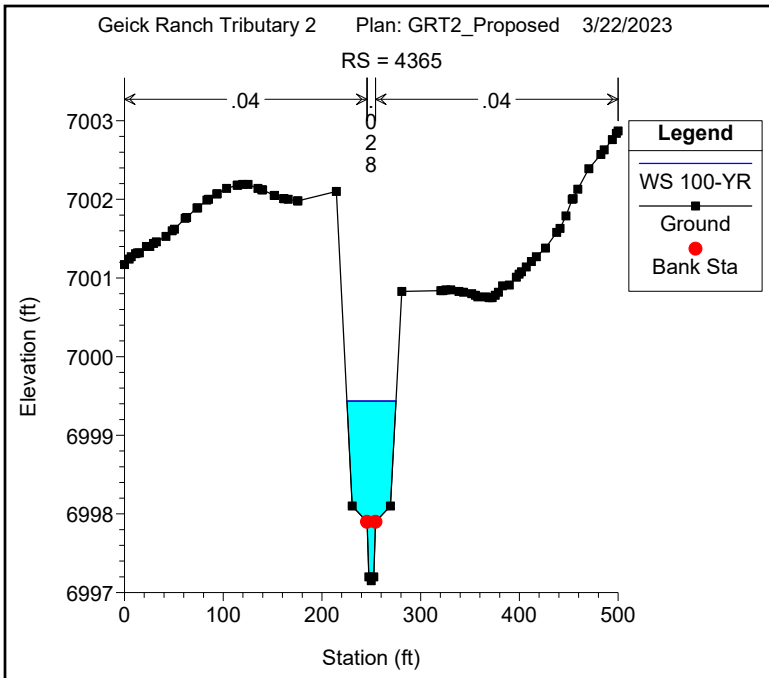

Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 4636.94
.04
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 4580
.04
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 4520
.04
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 4485
.04
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 4440
.04
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 4365
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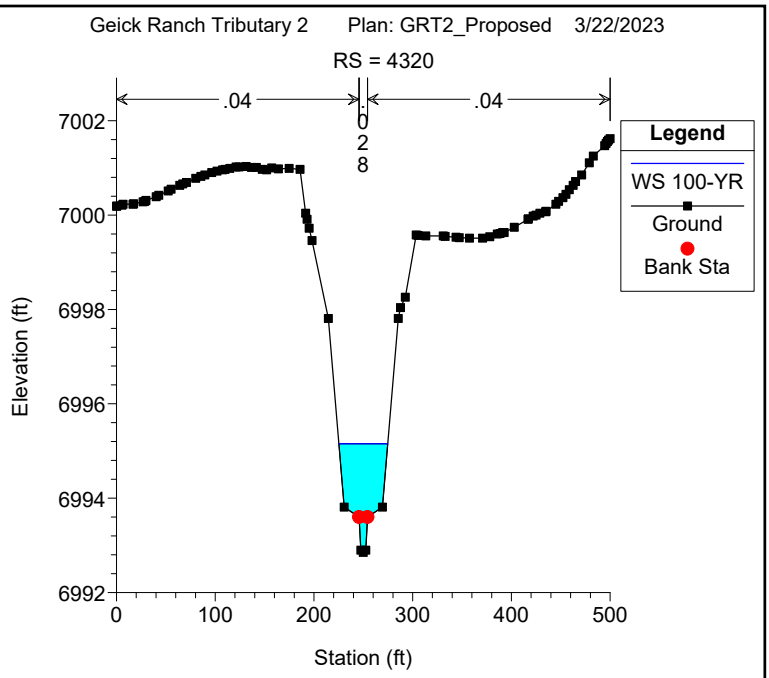
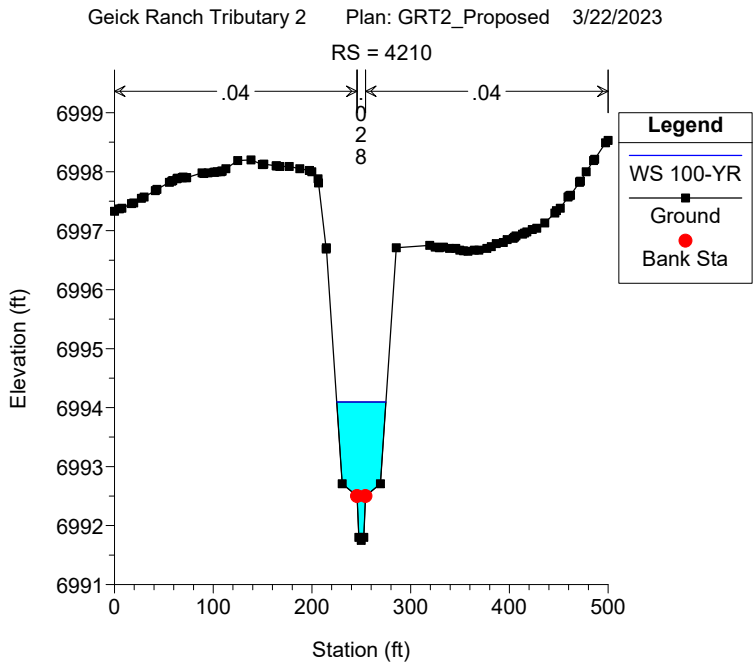
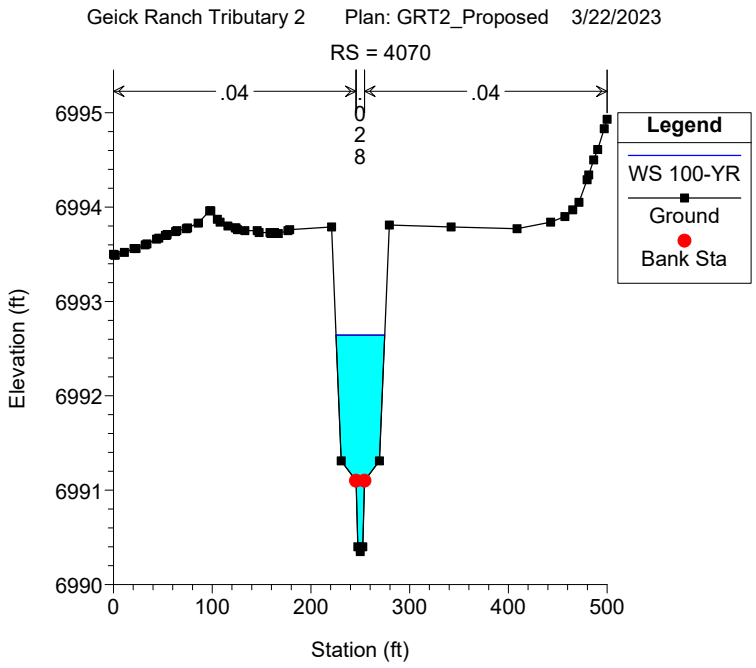
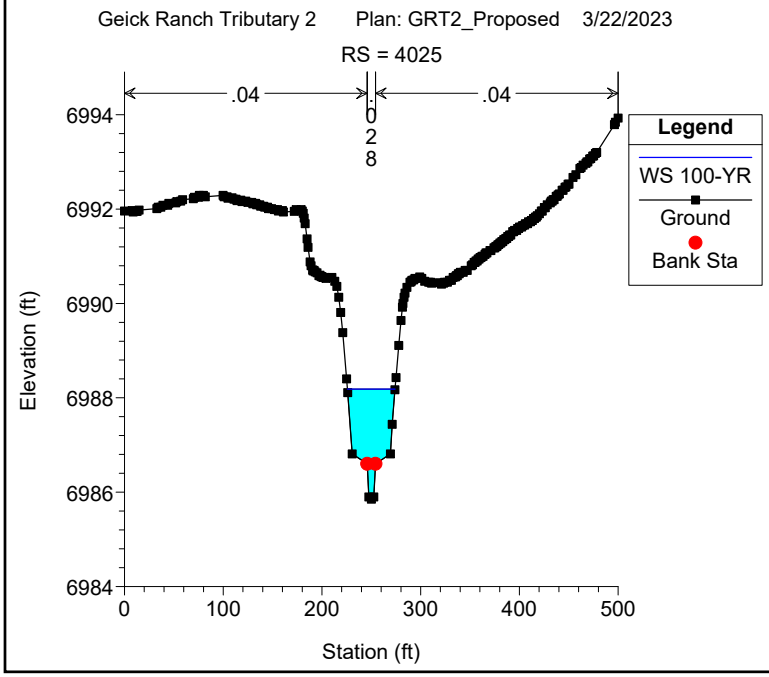
.04
.028
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 4320
.04
.04
.028
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 4210
.04
.04
.028
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 4070
.04
.04
.028
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 4025
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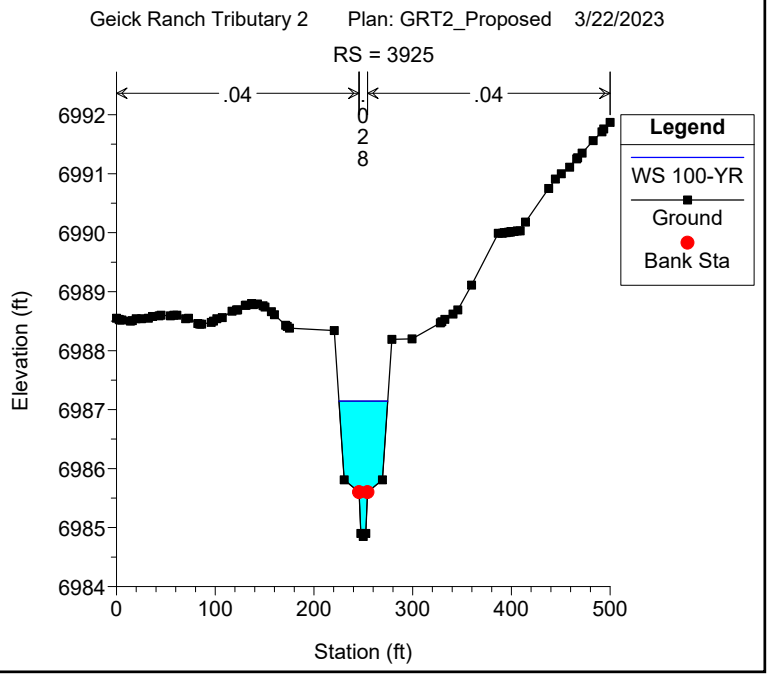
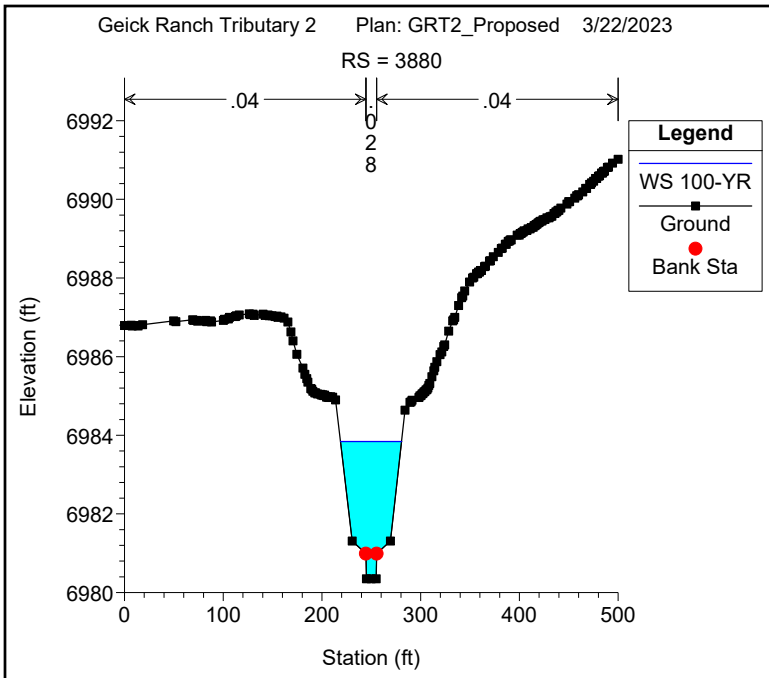
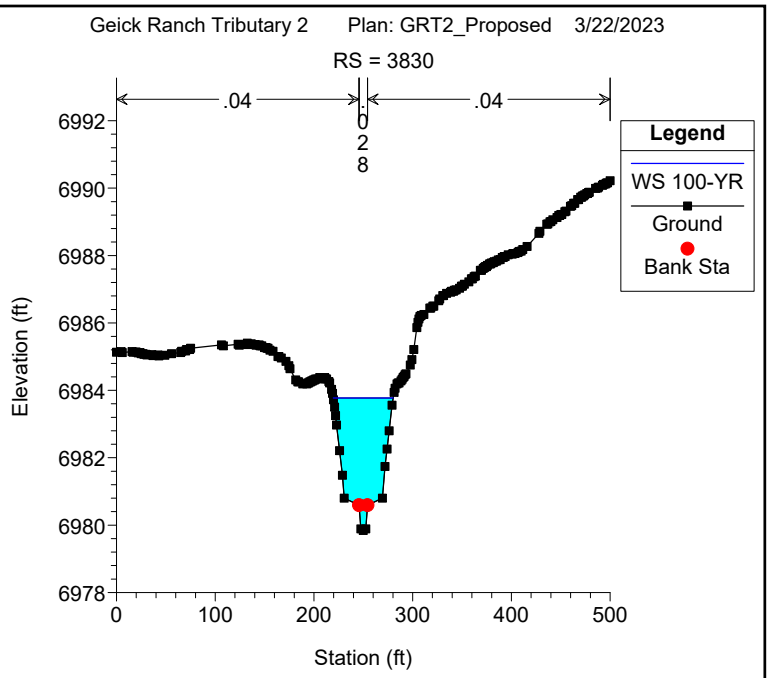
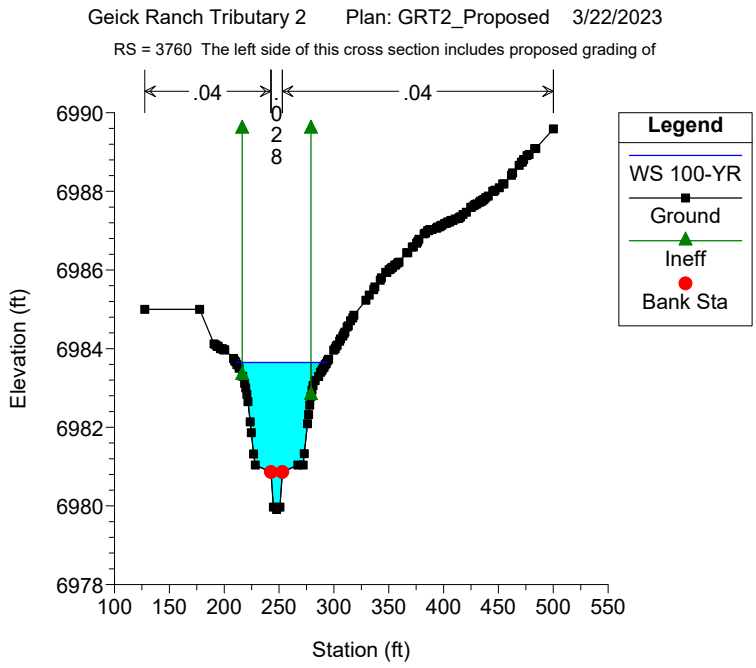
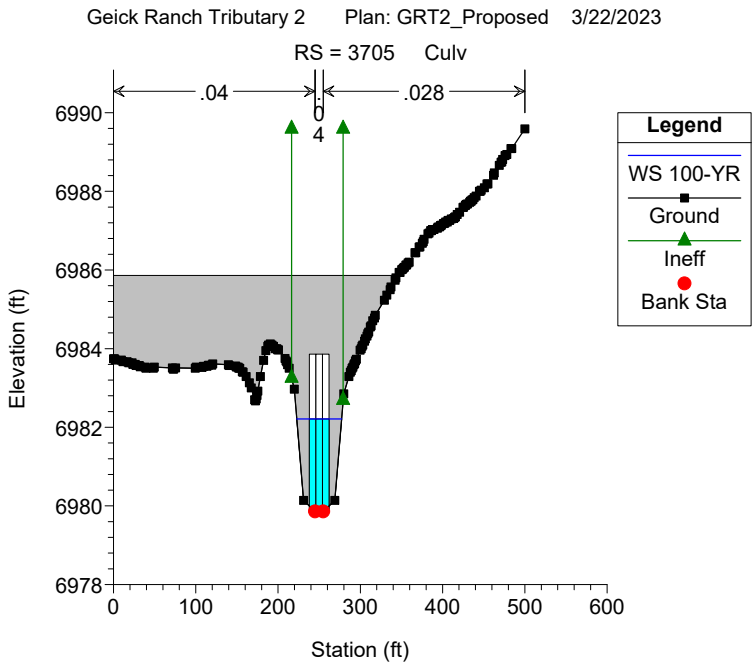
.04
.028
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)

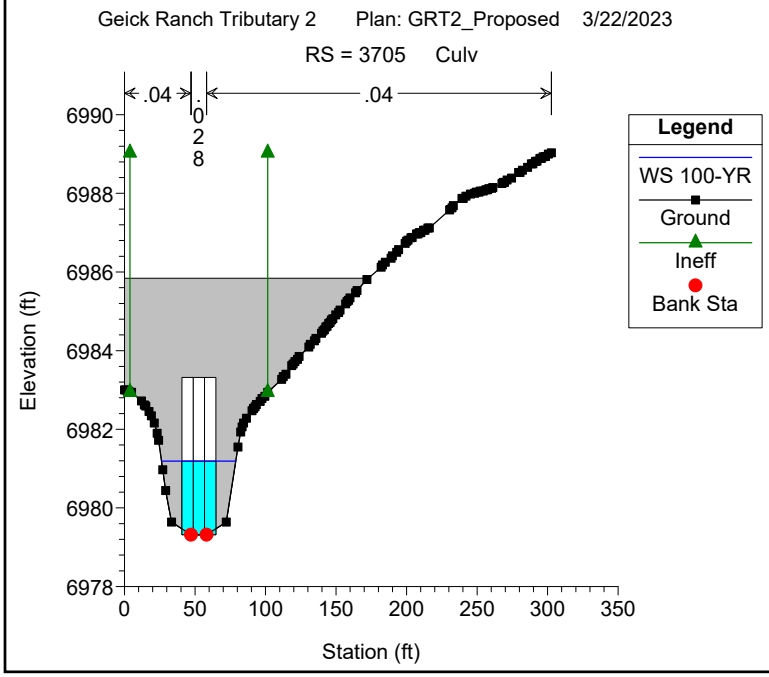

Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 3925
.04
.04
.028
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)

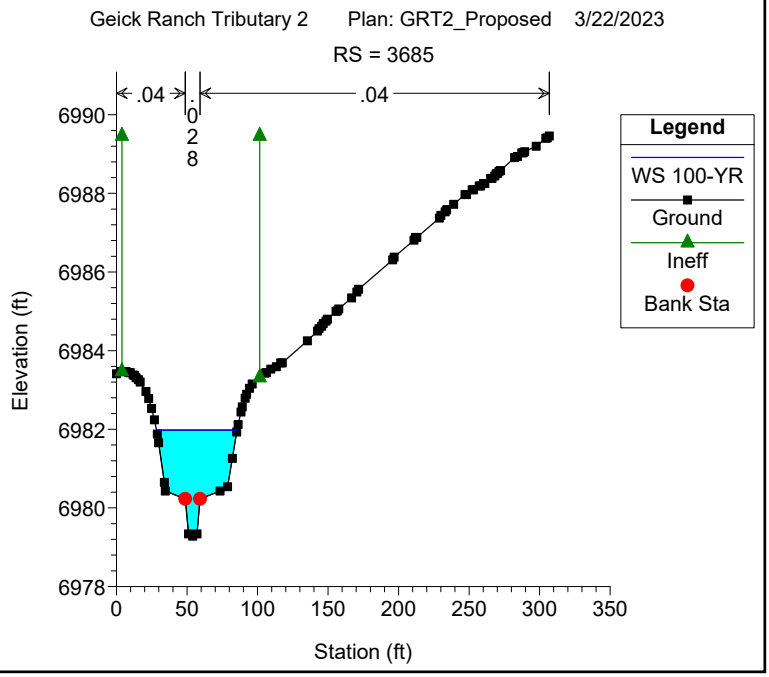

Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 3880
.04
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)

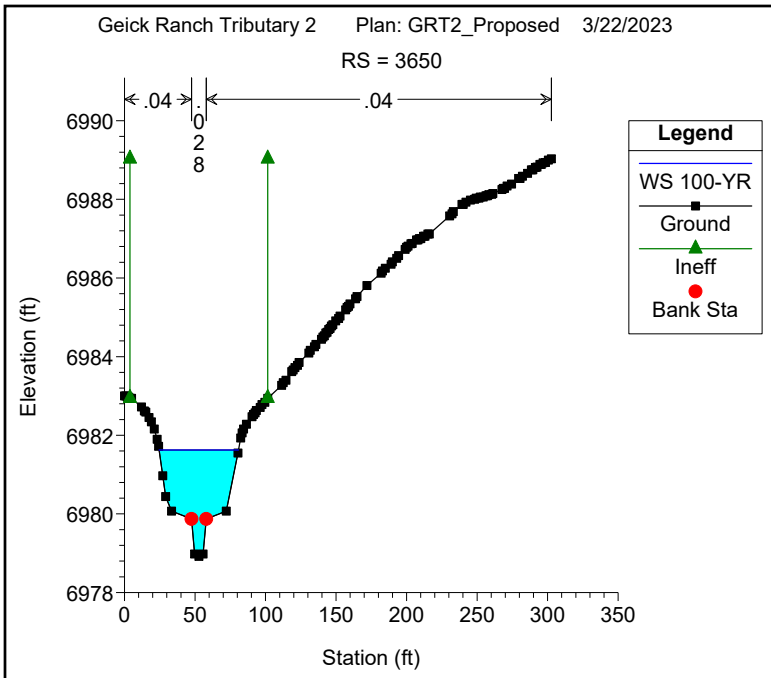

Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 3830
.04
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)

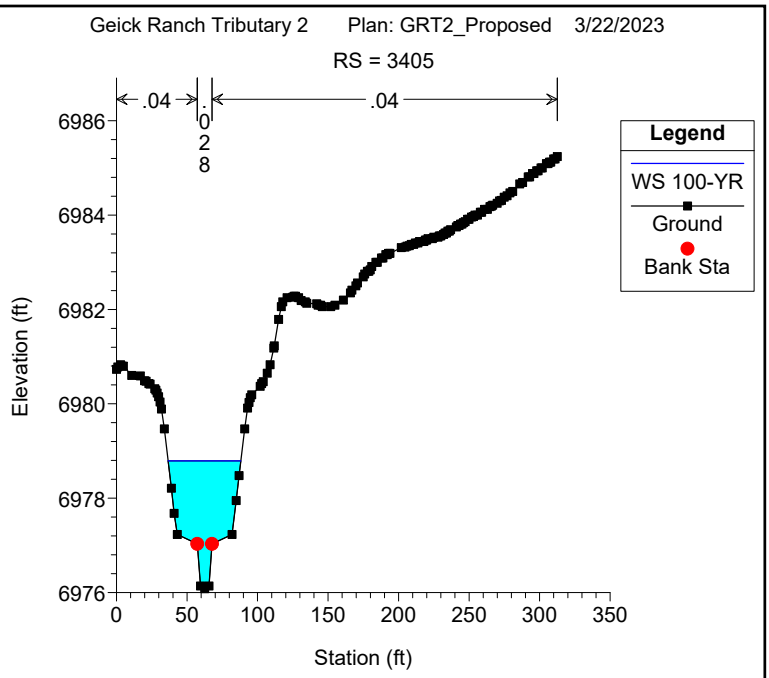

Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 3760 The left side of this cross section includes proposed grading of
.04
.028
.04
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

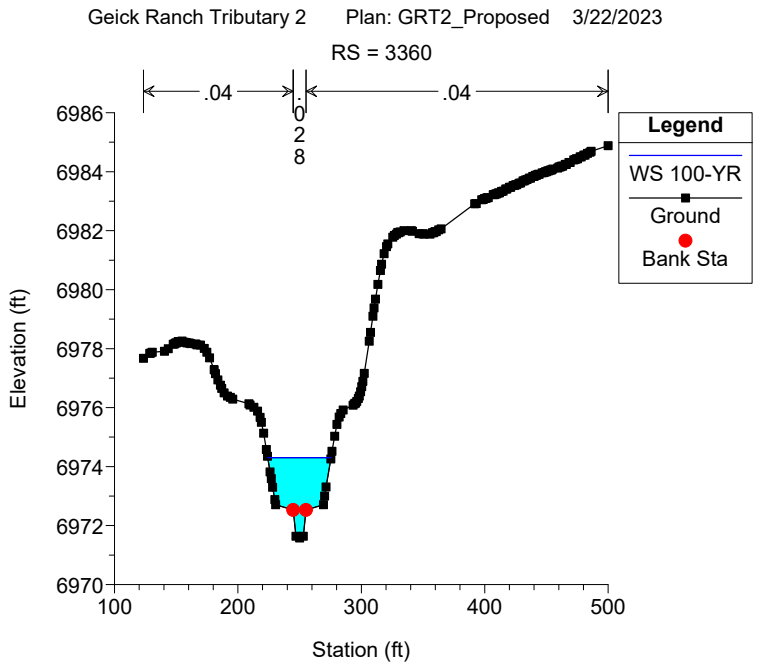

Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 3705 Culv
.04
.04
.04
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

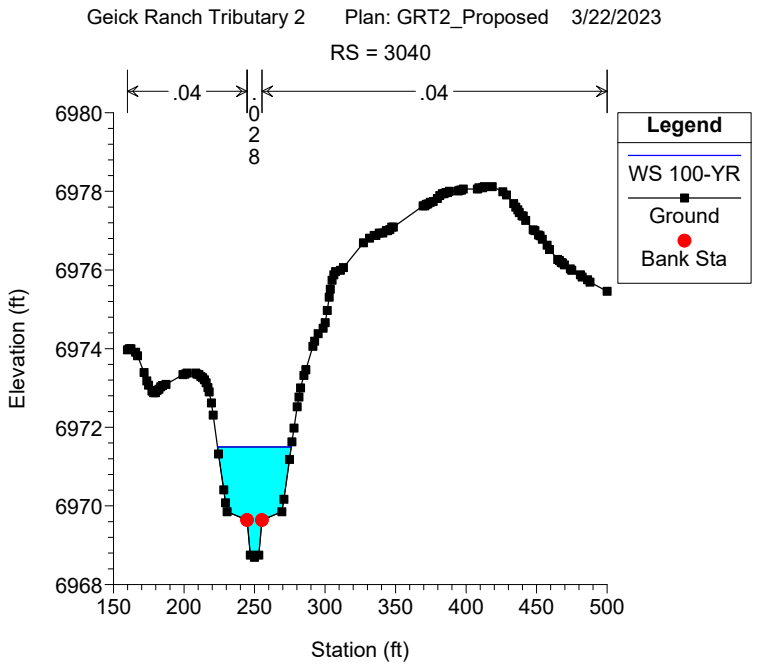

Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 3705 Culv
.04
.028
.04
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

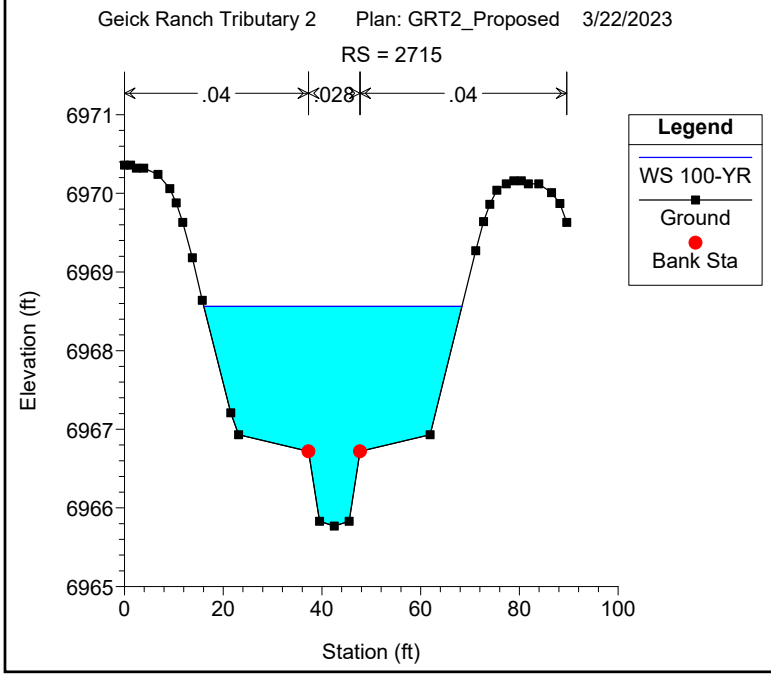

Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 3685
.04
.028
.04
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

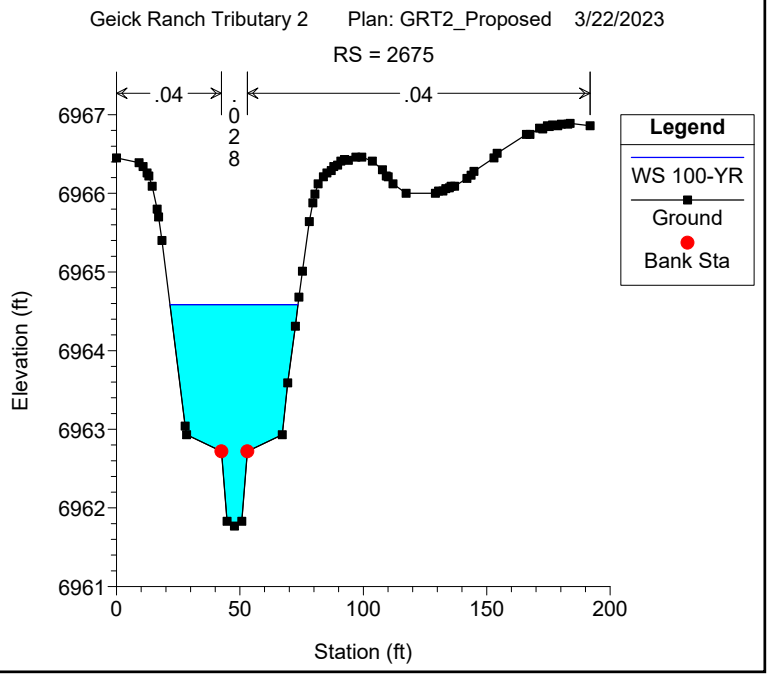

Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 3650
.04
.028
.04
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

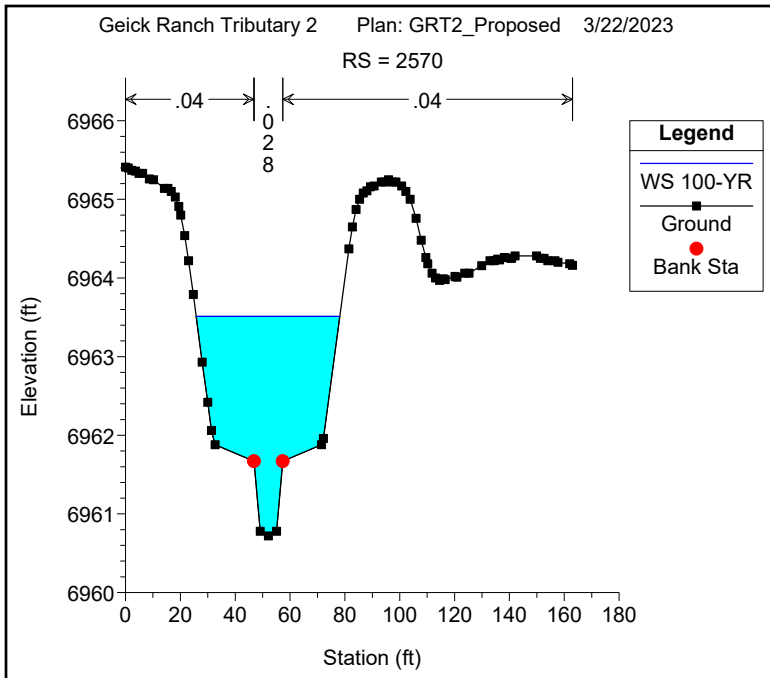

Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 3405
.04
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)

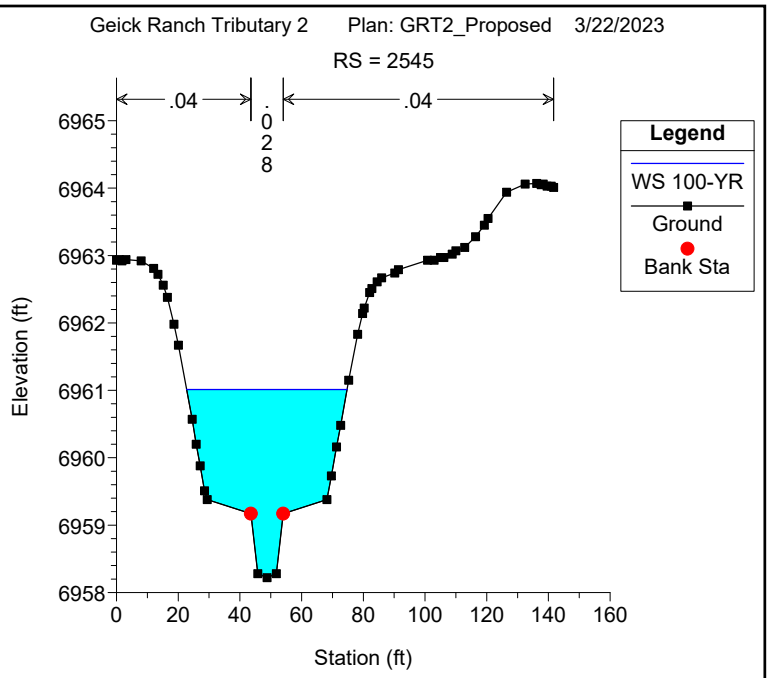

Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 3360
.04
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 3040
.04
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 2715
.04
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 2675
.04
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 2570
.04
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
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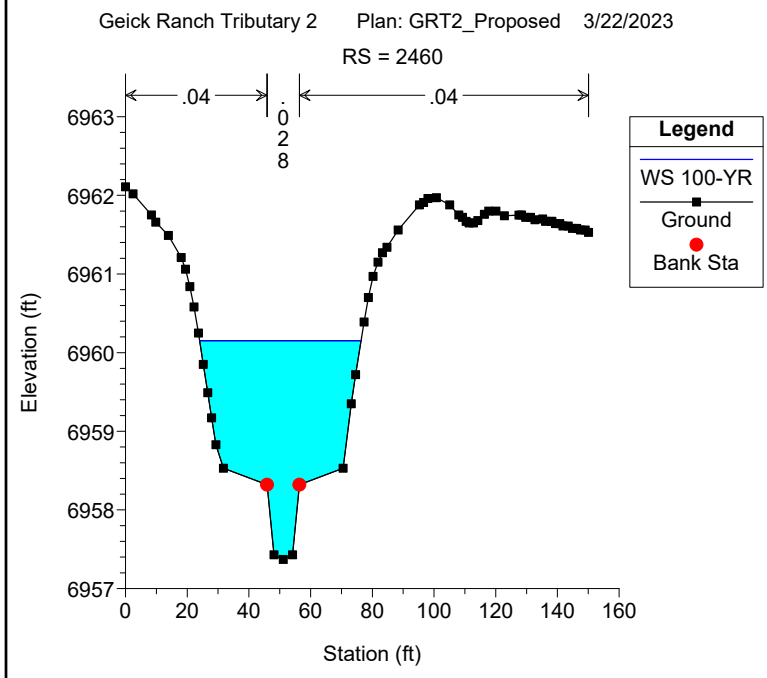
.028
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 2460
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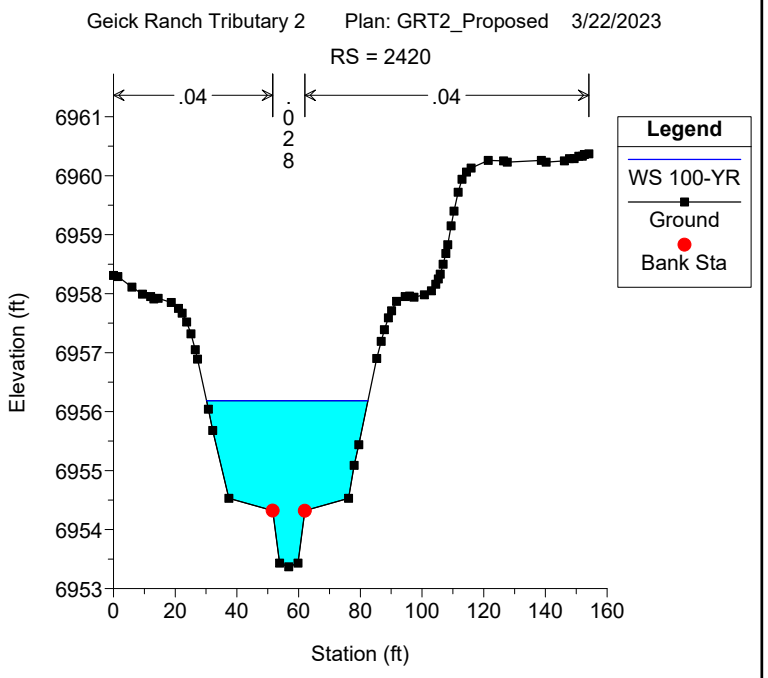
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
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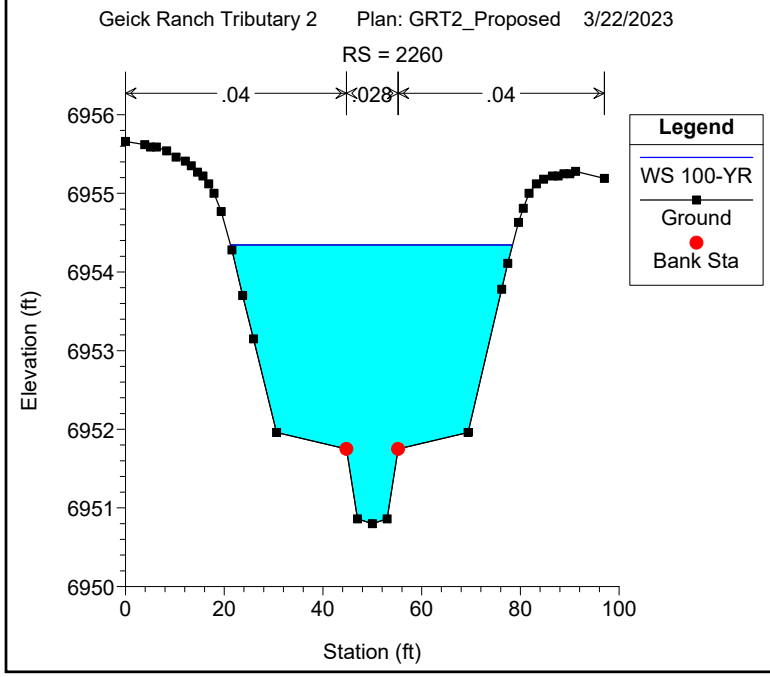
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
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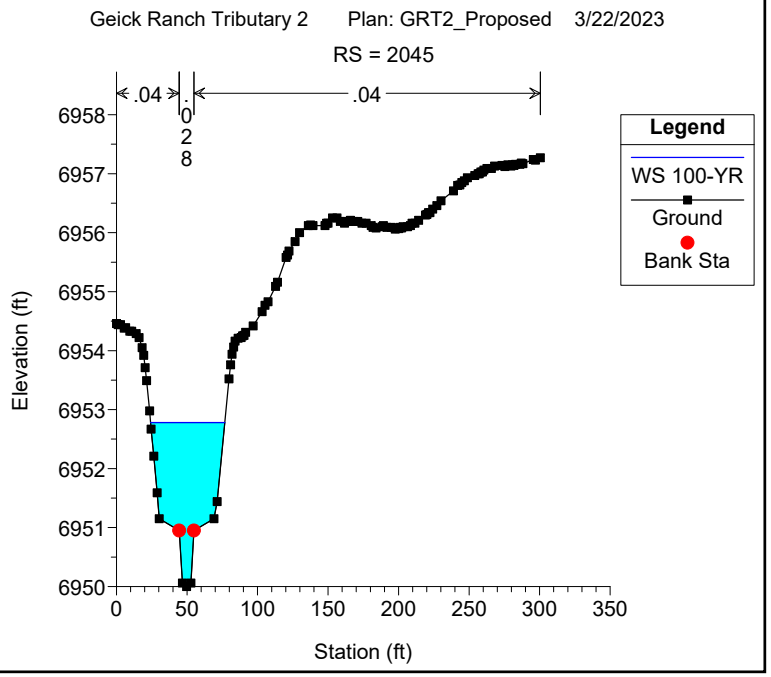
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)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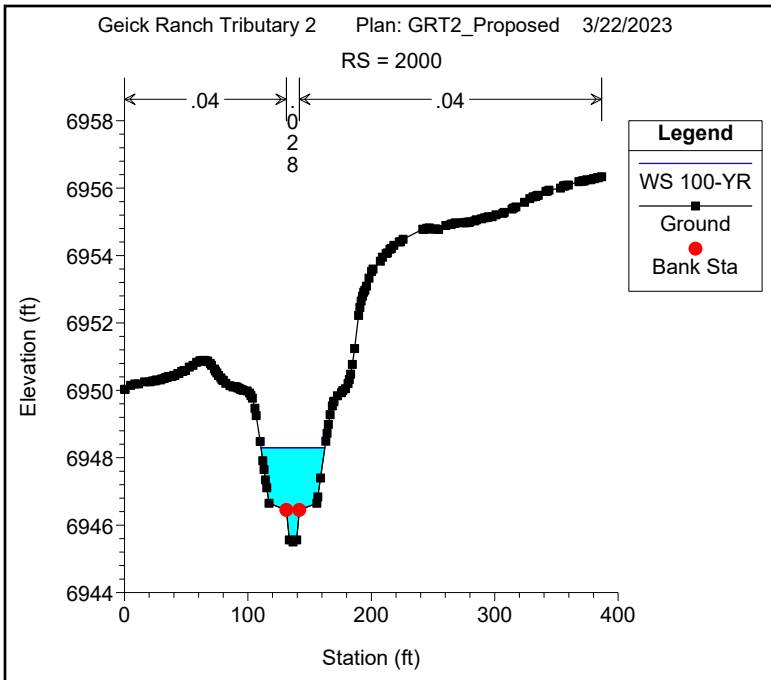
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)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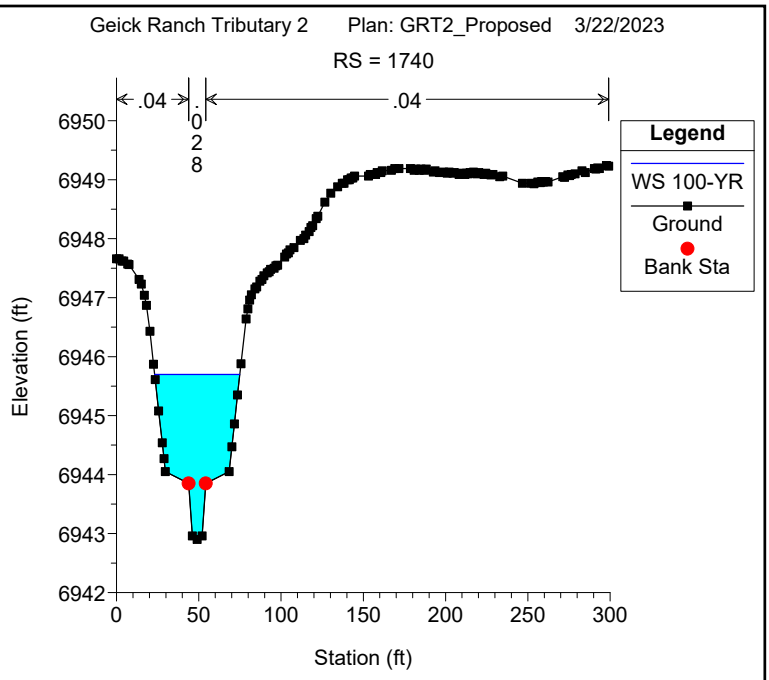
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
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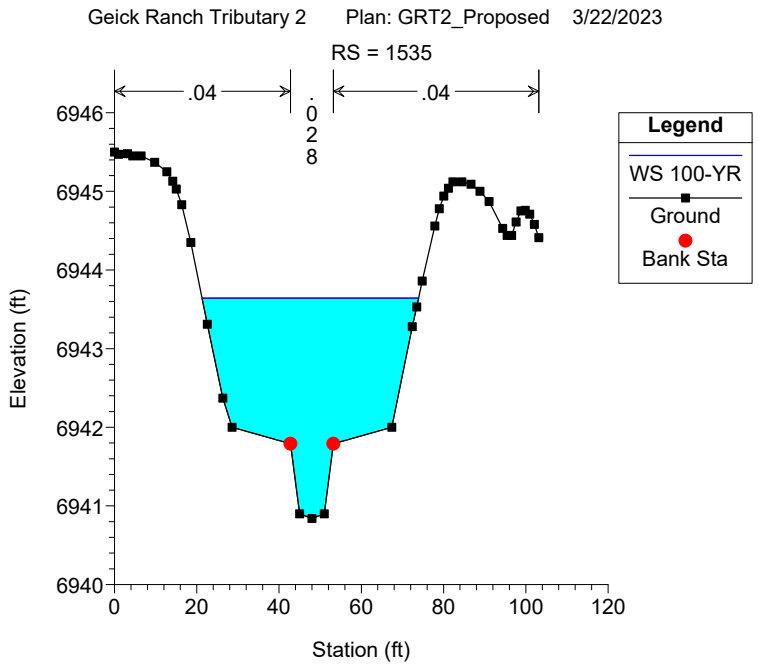
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
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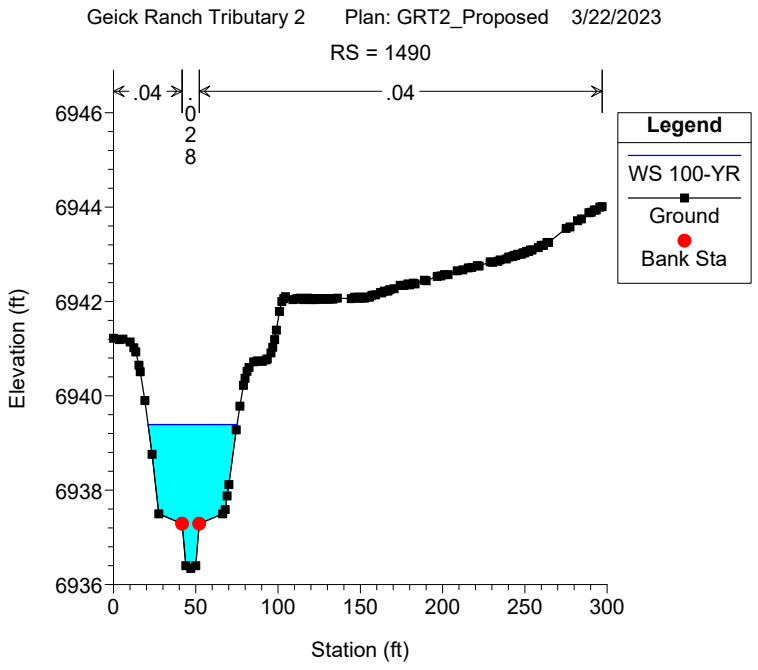
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)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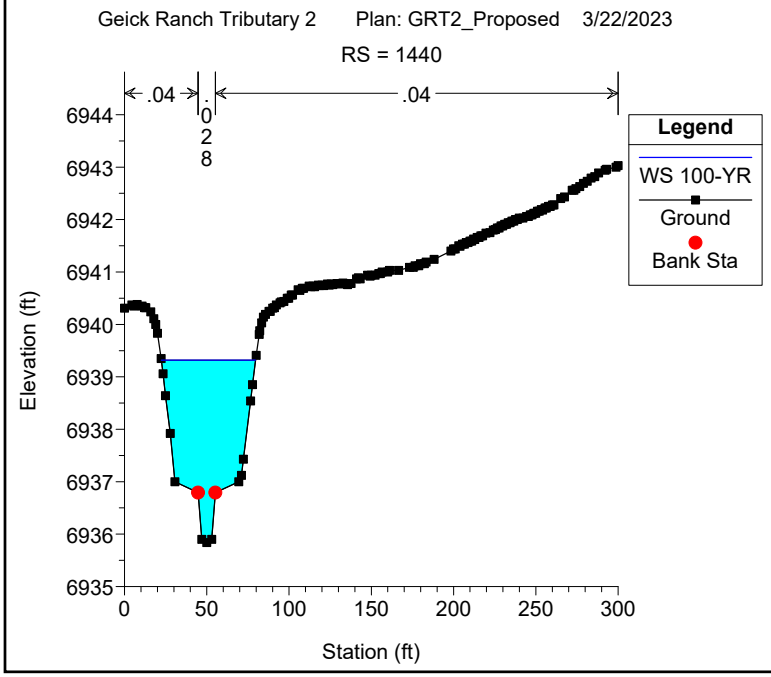
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
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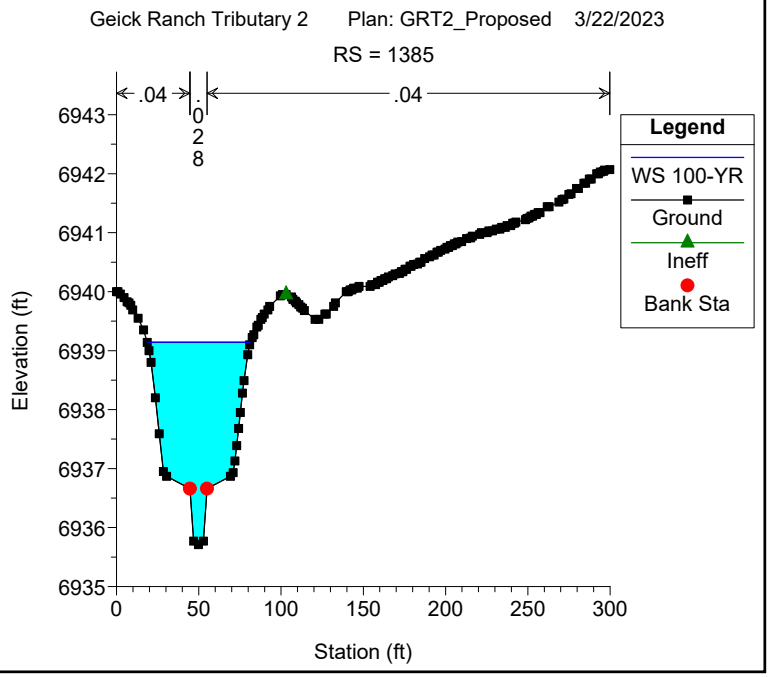
.04
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
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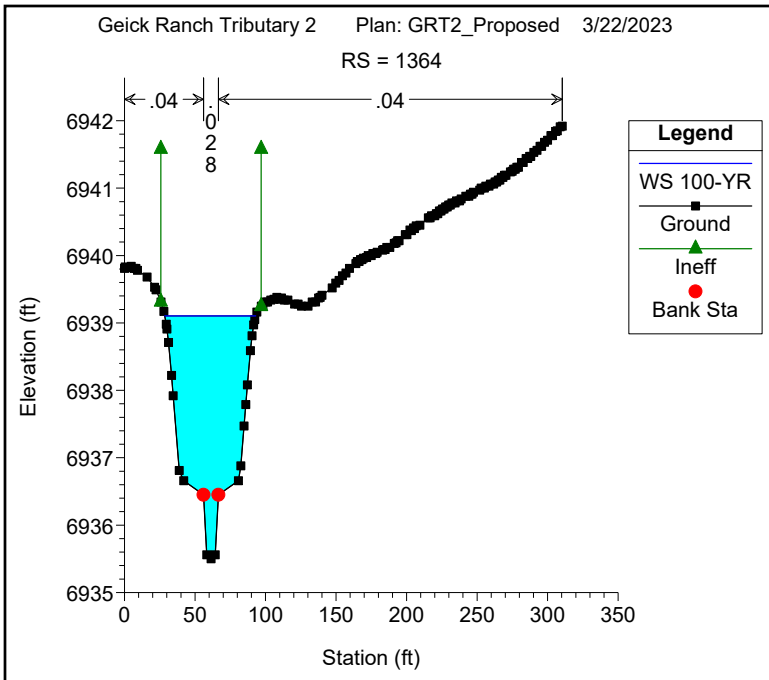
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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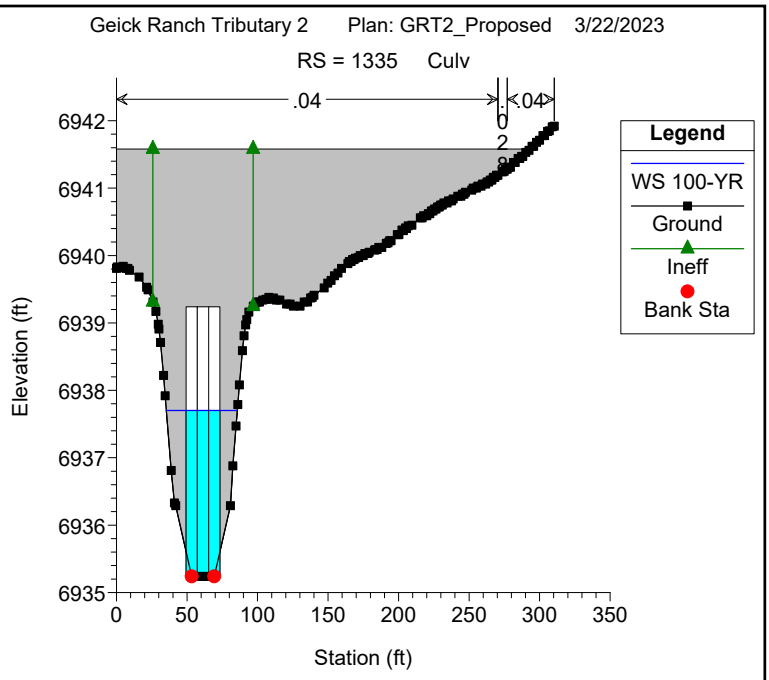
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 1335 Culv
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.028
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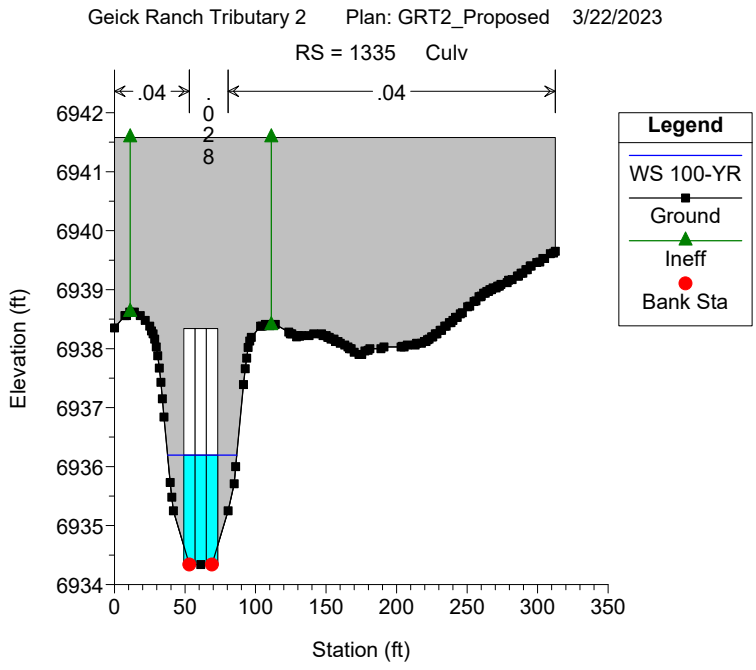
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = 1335 Culv
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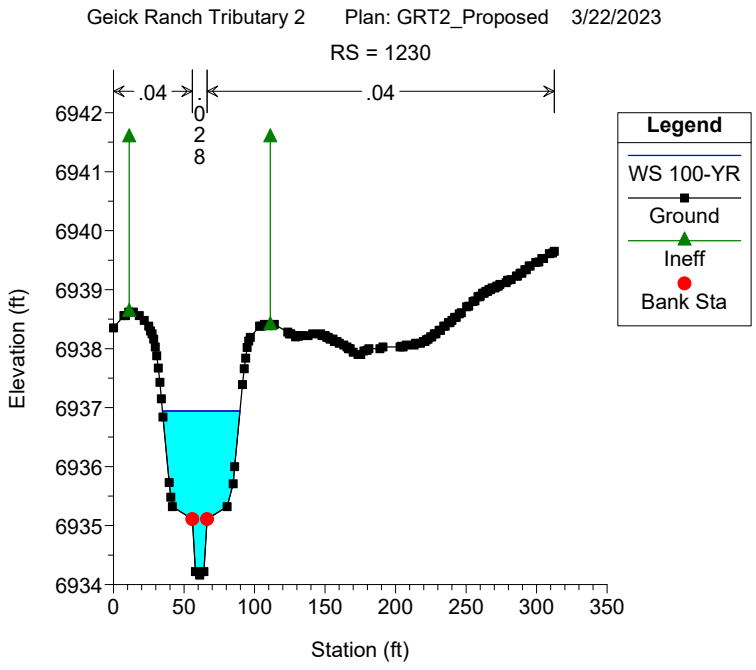
.028
.04
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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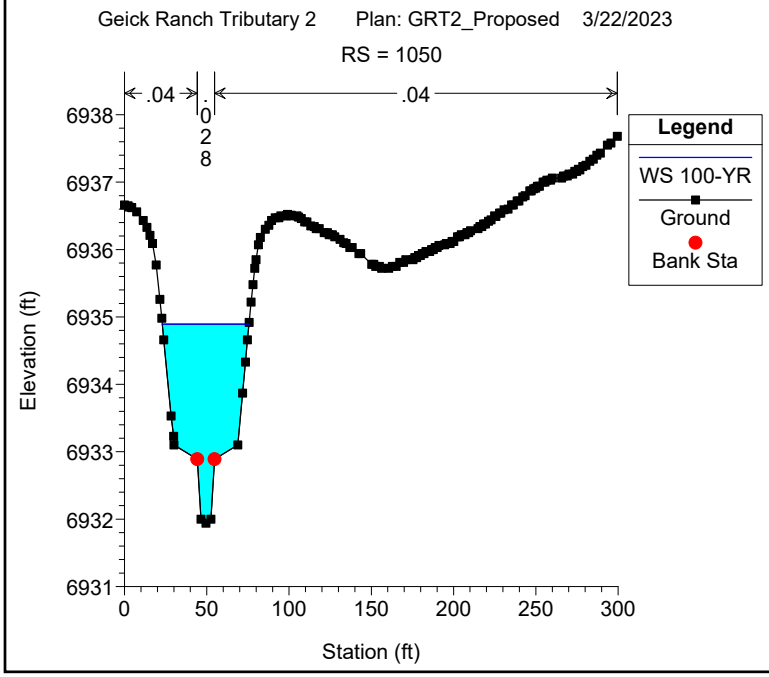
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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RS = 1050
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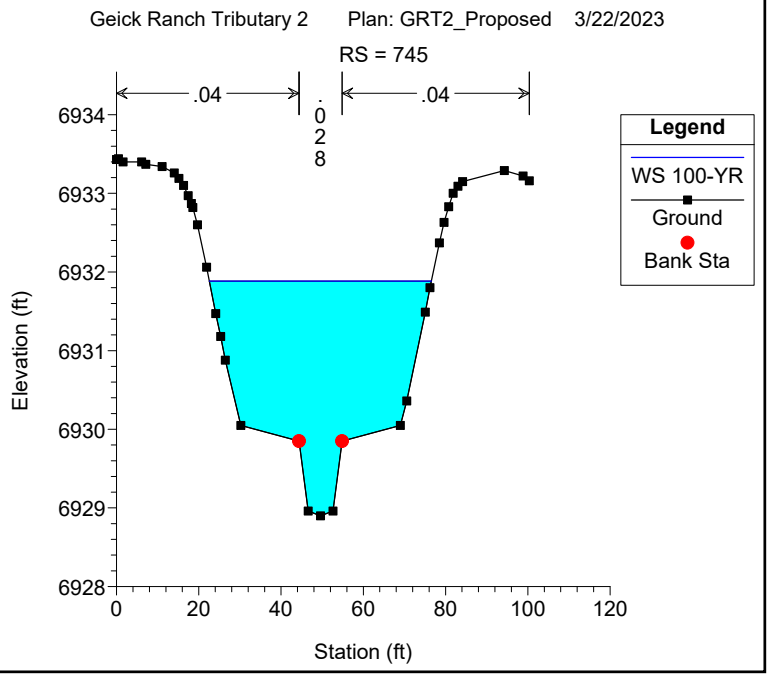
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)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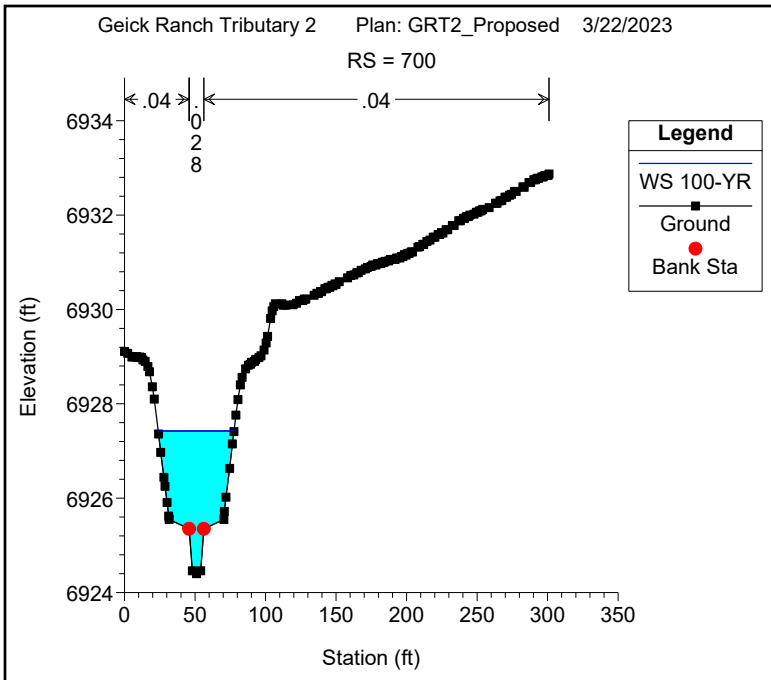
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)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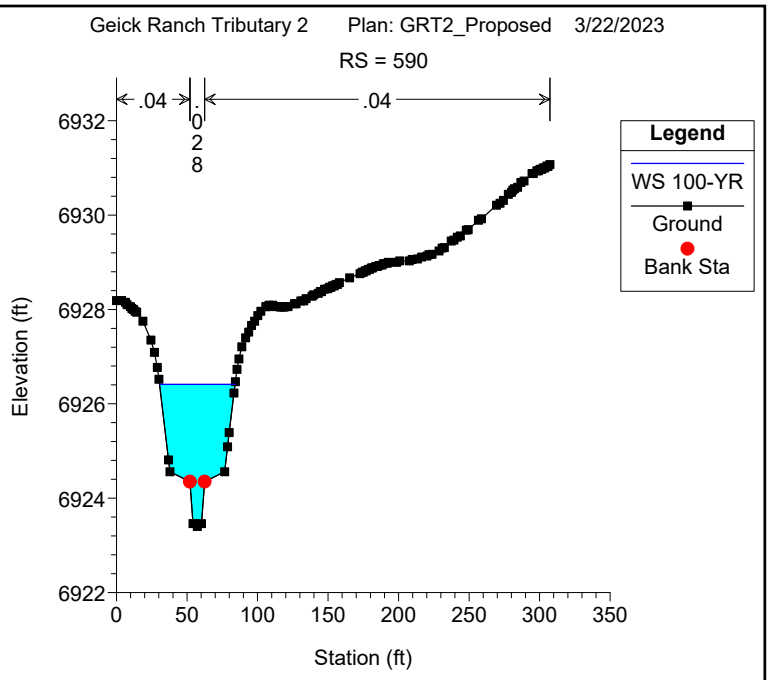
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)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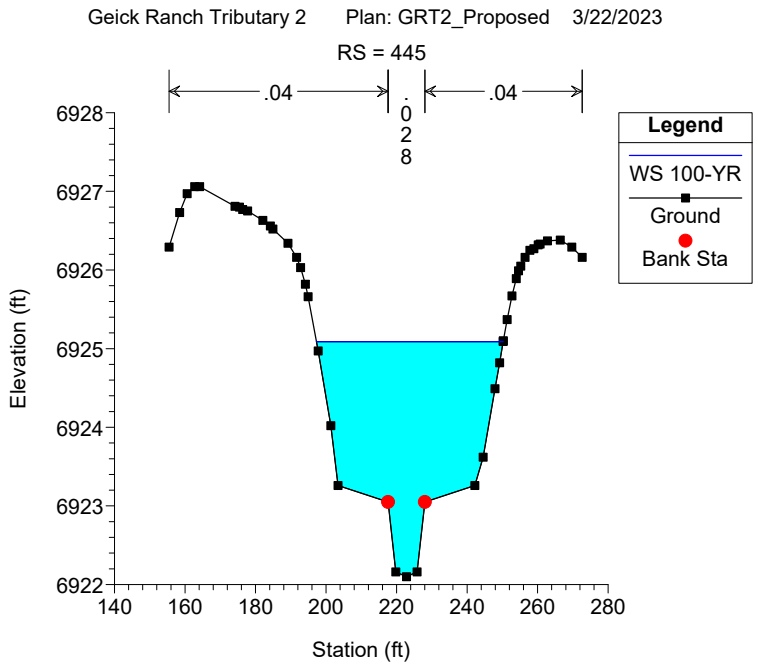
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)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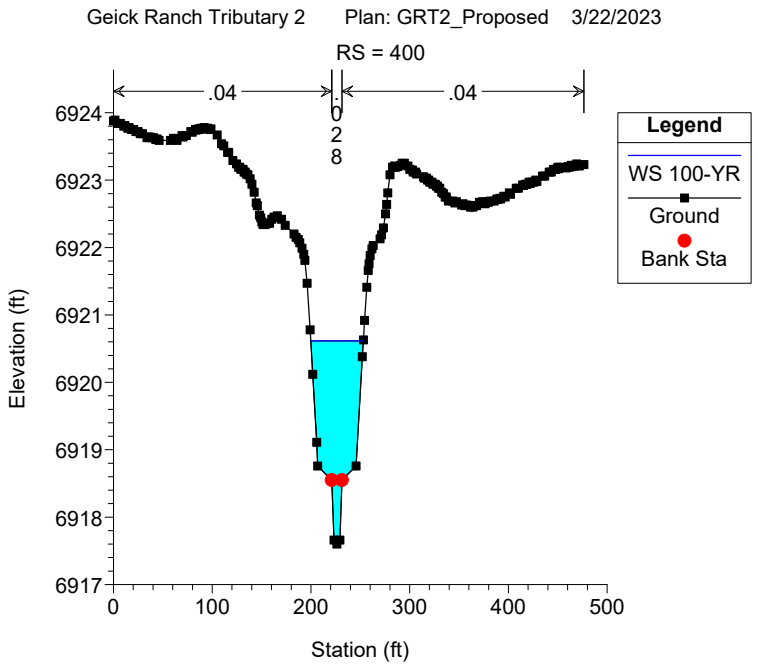
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
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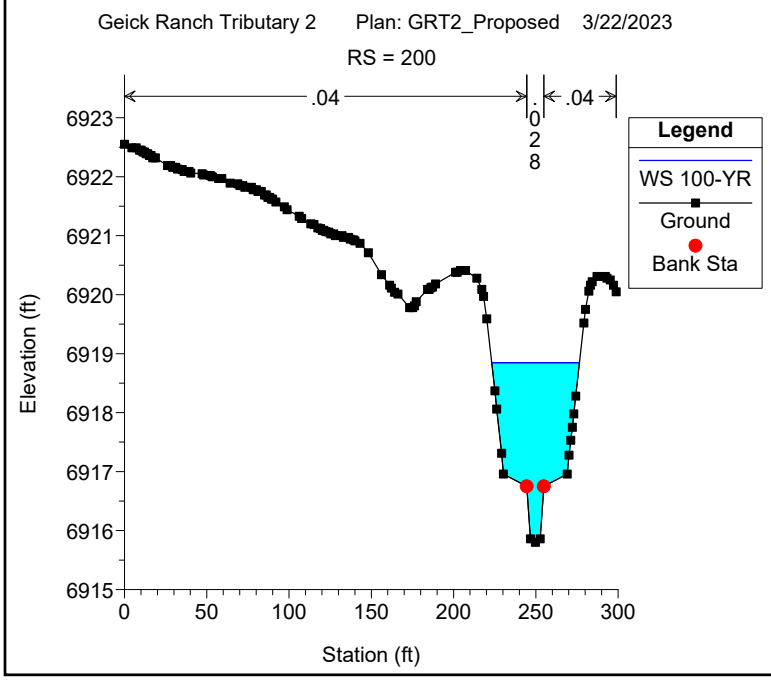
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
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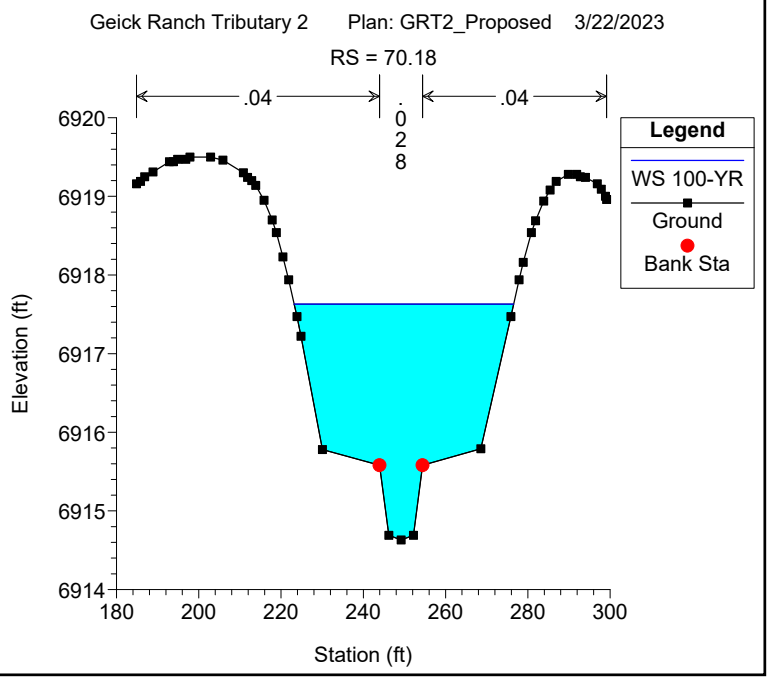
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)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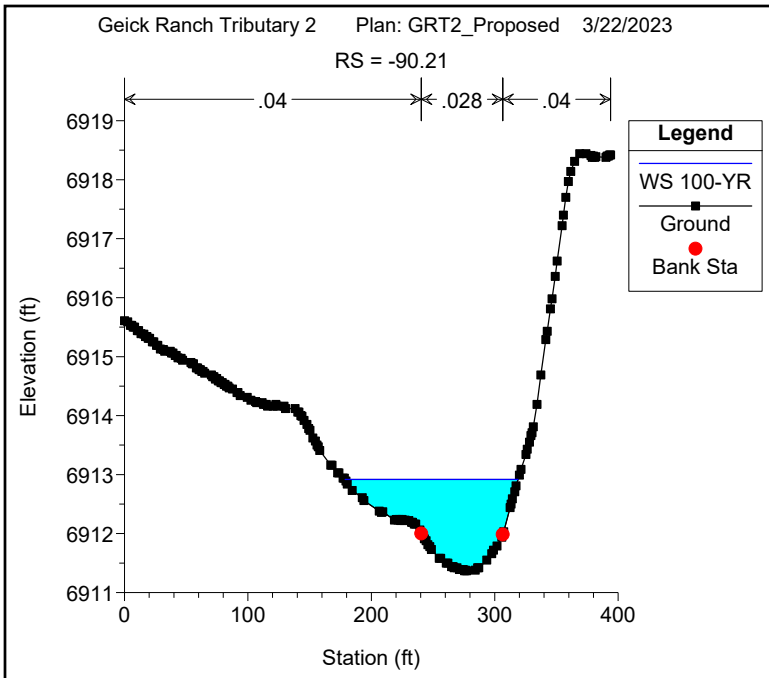
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = -90.21
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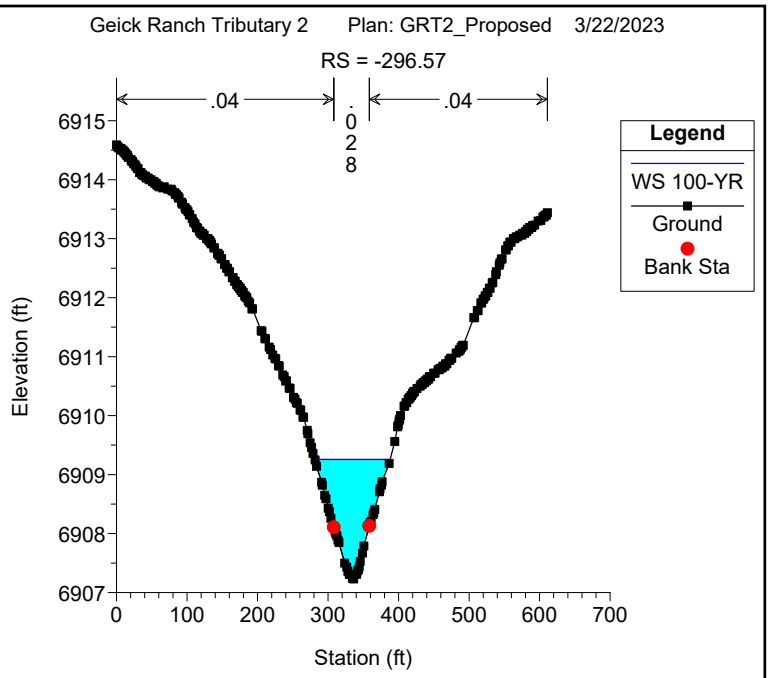
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)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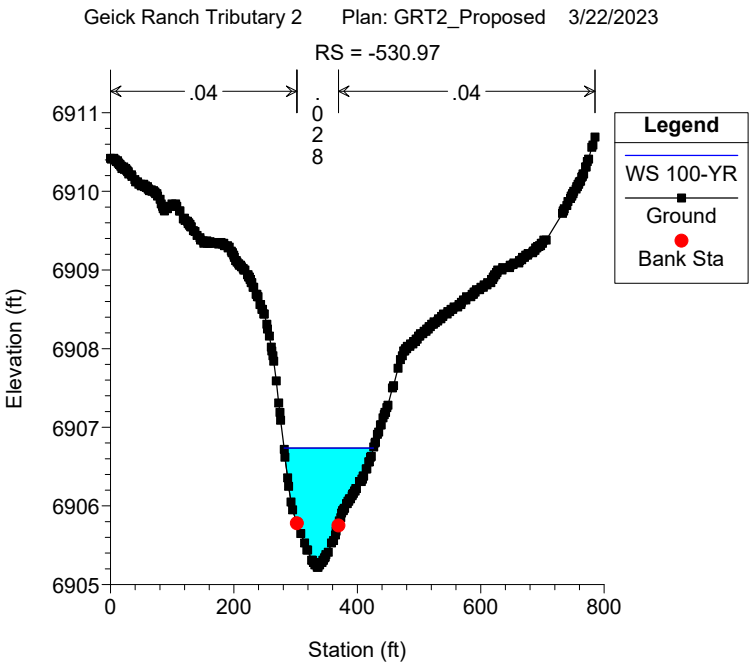
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)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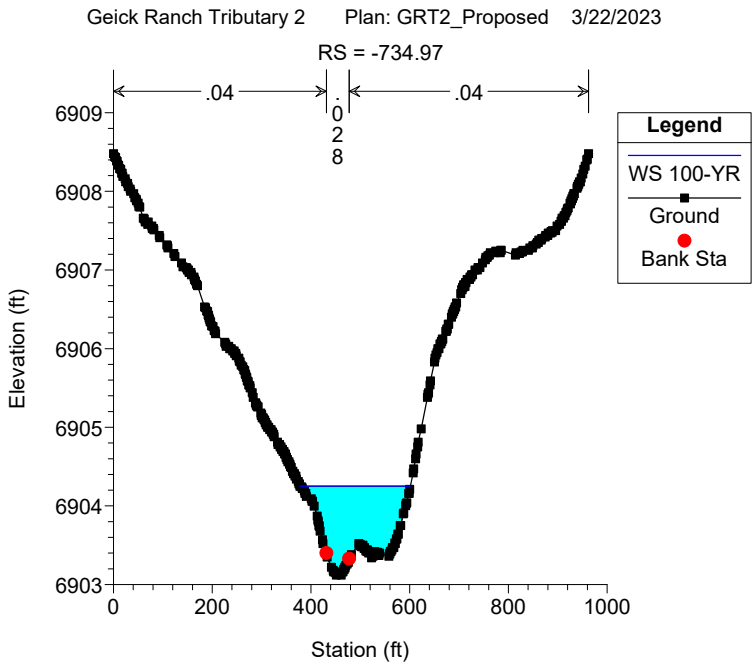
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Tributary 2 Plan: GRT2_Proposed 3/22/2023
RS = -734.97
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.028
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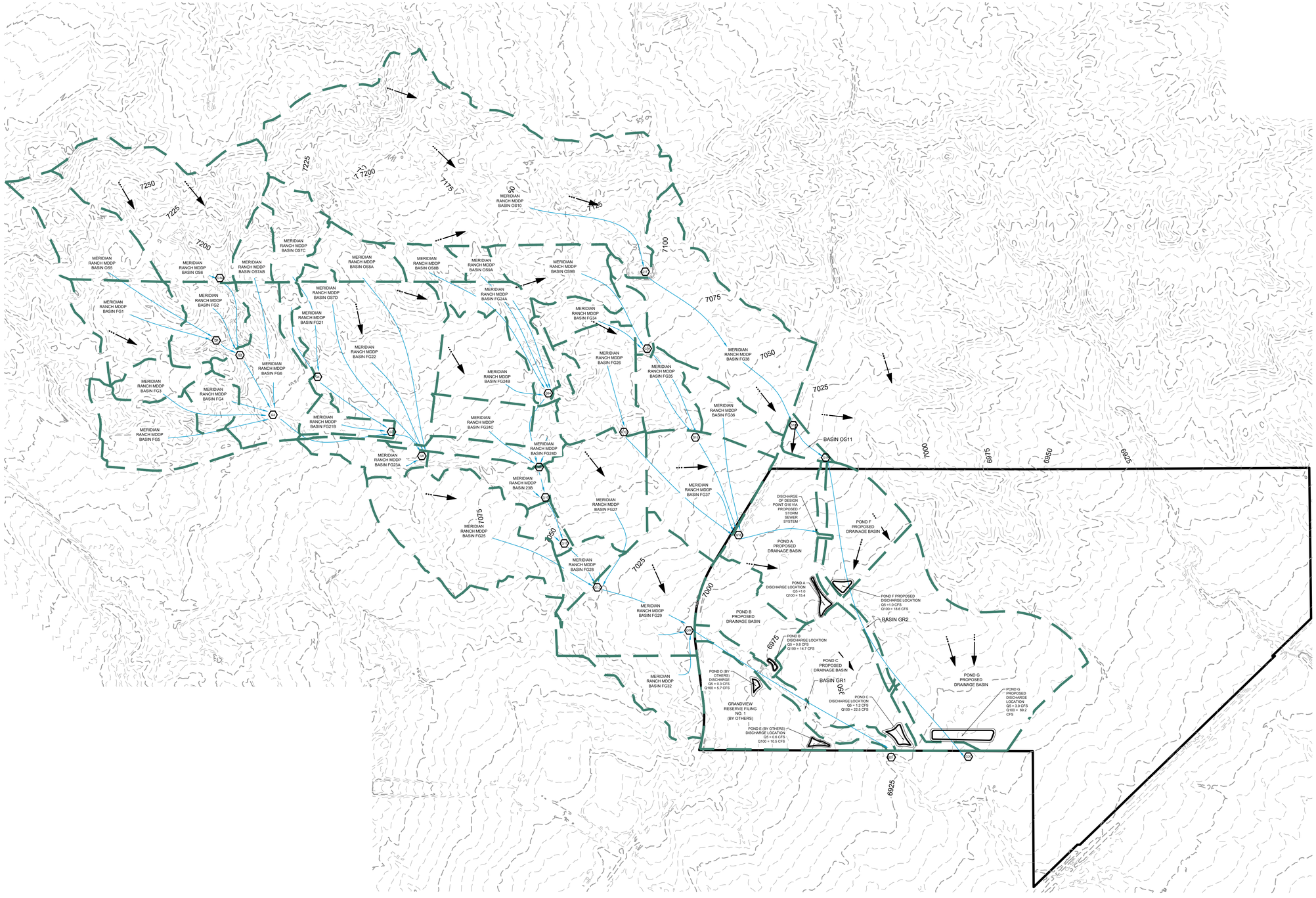
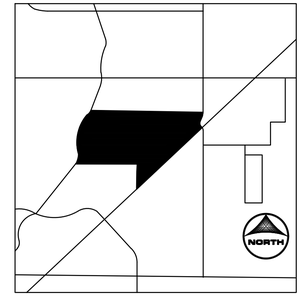
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)

Appendix J
Proposed Hydrology Calculations and Reference Materials





KEYMAP

PROJECT LEGEND:

- PROPERTY LINE
- ROAD CENTERLINE
- RIGHT-OF-WAY LINE
- PROPOSED DETENTION BASIN
- 5250 PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 5250 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- FLOW ARROW
- PROPOSED BASIN LINE
- G06 DESIGN POINT

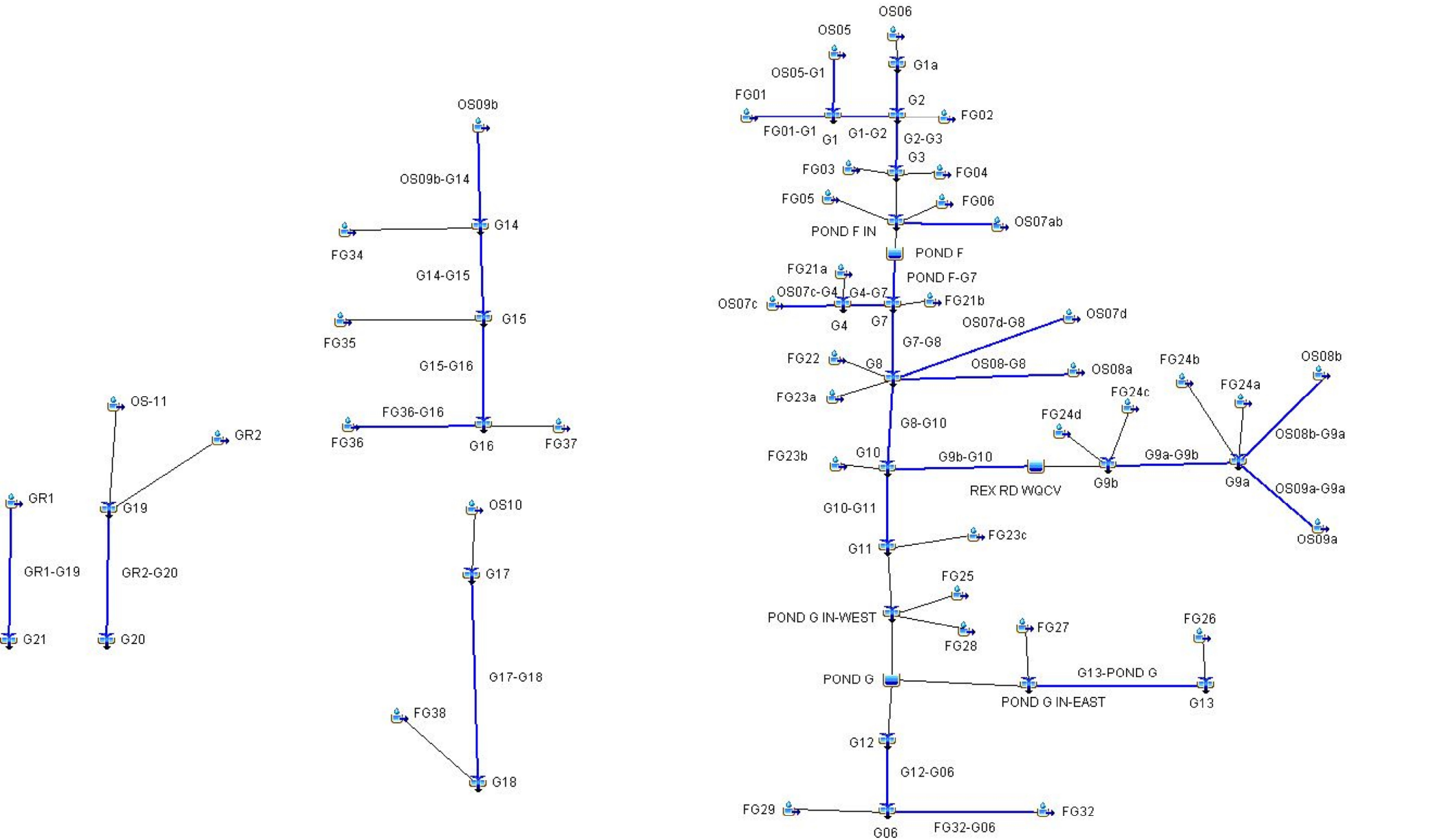
NOTE:

1. BASINS WEST OF EASTONVILLE ROAD ARE FROM THE LOCALLY APPROVED AND ACCEPTED BASIN STUDY REFERRED TO AS THE MERIDIAN RANCH MASTER DEVELOPMENT DRAINAGE PLAN
2. ALL PONDS ARE SIZED AND HAVE DISCHARGE RATES BASED OFF OF MHFD UD-DETENTION SPREADSHEET LOCATED IN APPENDIX K.
3. VERTICAL DATUM IS NAVD88.

811 UNCC CALL BEFORE YOU DIG 811 OR 1-800-922-1987 Utility Notification Center of Colorado

COLORADO LICENSED GREGORY L. PAYNE 37081 PROFESSIONAL ENGINEER 08-25-23

HEC-HMS STICK MODEL



COMPOSITE 'C' FACTORS

PROJECT: **The Sanctuary PDR-FDR** Date 3/21/2023

BASIN DESIGNATION	AREA (AC.)																AREA (MI^2)	COMPOSITE 'C' FACTOR	PERCENT IMPERV.
	UNDEV	LATIGO UNDEV.	GRADED	2.5 AC	1 DU/AC	2 DU/AC	3 DU/AC	4 DU/AC	5 DU/AC	6 DU/AC	8 DU/AC or more	STREETS	SCHOOL, CLUB HSE, REC CTR	OPEN SPACE PARKS/GC	COMM.	TOTAL			
FUTURE																			
OS05	37															37	0.0578	**61.0**	**0.0%**
OS06	84															84	0.1313	**61.0**	**0.0%**
OS07ab	11															11	0.0170	**61.0**	**0.0%**
OS07c	19															19	0.0296	**61.0**	**0.0%**
OS07d	2.2															2.2	0.0034	**61.0**	**0.0%**
OS08a	16															16	0.0251	**61.0**	**0.0%**
OS08b	11															11	0.0165	**61.0**	**0.0%**
OS09a	5.9															5.9	0.0093	**61.0**	**0.0%**
OS09b	28															28	0.0435	**61.0**	**0.0%**
FG01	13				19										2.1	34	0.0538	**66.4**	**16.9%**
FG02	12				13											25	0.0391	**64.6**	**10.4%**
FG03					13											13	0.0203	**68.0**	**20.0%**
FG04					11											11	0.0172	**68.0**	**20.0%**
FG05	1.5				33							3.0				37	0.0580	**70.1**	**25.7%**
FG06	15				27							0.9		0.5		43	0.0675	**66.1**	**14.4%**
FG21a	4.7				1.4											6.1	0.0095	**62.6**	**4.6%**
FG21b						3.8								2.5	3.3	9.6	0.0150	**73.1**	**43.1%**
FG22	17				16	48						2.1		0.9	3.3	87	0.1354	**69.0**	**23.4%**
FG23a	3.1					2.8	5.0					0.6		2.3		14	0.0216	**68.6**	**20.6%**
FG23b	14							0.9								15	0.0236	**61.8**	**2.4%**
FG23c	4.9							2.1								7.0	0.0109	**65.2**	**12.0%**
FG24a	18							2.3	2.4							22	0.0348	**64.3**	**8.8%**
FG24b	0.2				4.1	2.7	11.3	14	5.7					0.1		38	0.0589	**73.4**	**34.0%**
FG24c								19								19	0.0291	**75.0**	**40.0%**
FG24d	5.5							5.7				4.8		0.8		17	0.0262	**76.4**	**42.3%**
FG25							9.3	57	0.9					2.6		69	0.1084	**74.1**	**37.3%**
FG26									36			0.4		0.5		36	0.0570	**78.0**	**43.1%**
FG27	2.5								1.7		35	2.8		1.7		43	0.0679	**83.3**	**56.2%**
FG28								1.7			0.1			10		12	0.0184	**64.1**	**8.0%**
FG29	62							0.7								63	0.0983	**61.2**	**0.4%**
FG32													26			26	0.0402	**80.0**	**52.0%**
FG34	16								1.8							18	0.0275	**62.7**	**4.4%**
FG35	15								1.6			1.5				18	0.0282	**65.5**	**11.9%**
FG36	16											2.4				18	0.0286	**65.9**	**13.1%**
FG37	48											3.4				51	0.0797	**63.5**	**6.7%**
OS11	4.5															4	0.0070	**61.0**	**2.0%**

Additional Time of Concentration Calcs

Name	Sheet Flow						Shallow Concentrated Flow (Unpaved)						Shallow Concentrated Flow (Paved)					
	Length (ft)	US Elev	DS Elev	Slope (ft/ft)	Manning's n	Travel Time (hr)	Length (ft)	US Elev	DS Elev	Slope (ft/ft)	Velocity (fps)	Travel Time (hr)	Length (ft)	US Elev	DS Elev	Slope (ft/ft)	Velocity (fps)	Travel Time (hr)
OS10	300.0	7266.0	7258.0	0.027	0.04	0.16	3061.0	7258.0	7140.0	0.039	3.2	0.27				0.000	0.0	0.00
FG38	300.0	7134.0	7120.0	0.047	0.15	0.37	1572.0	7120.0	7075.0	0.029	2.7	0.16				0.000	0.0	0.00
OS11	500.0	7030.0	7020.0	0.020	0.04	0.27	248.0	7020.0	7014.0	0.024	2.5	0.03				0.000	0.0	0.00

Channel Flow											
Length (ft)	US Elev	DS Elev	Slope (ft/ft)	Manning's n	Bottom Width (ft)	Side Slopes (X:1)	Depth (ft)	Hydraulic Radius (ft)	Velocity (fps)	Travel Time (hr)	Time of Conc. (hr)
2168.0	7140.0	7098.0	0.019	0.035	10	5	5.0	2.9	12.0	0.05	0.48
2152.4	7075.0	7029.0	0.021	0.035	28	20	1.5	1.0	6.2	0.10	0.62
3782.3	6994.9	6917.9	0.020	0.035	10	4	2.0	1.4	7.5	0.14	0.14
7728.5	7051.8	6903.3	0.019	0.035	25	4	2.5	1.9	9.1	0.24	0.24

Name	Time of Conc. (min)	Lag Time (min)
OS10	28.66	17.19
FG38	37.34	22.41
OS11	0.30	0.18
GR1	8.46	5.08
GR2	14.14	8.49

HEC-HMS Input Data			
Subbasin	Area (sq.mi.)	Curve Number	Lag Time (min)
FG01	0.0538	66.4	33.8
FG02	0.0391	64.6	16.1
FG03	0.0203	68	11.6
FG04	0.0172	68	7.6
FG05	0.058	70.1	28.4
FG06	0.0675	66.1	18.4
FG21a	0.0095	62.6	21.4
FG21b	0.015	73.1	12.7
FG22	0.1354	69	20.3
FG23a	0.0216	68.6	18
FG23b	0.0236	61.8	15
FG23c	0.0109	65.2	12.1
FG24a	0.0348	64.3	21.9
FG24b	0.0589	73.4	14.5
FG24c	0.0291	75	14.7
FG24d	0.0262	76.4	13.9
FG25	0.1084	74.1	23.8
FG26	0.057	78	25.5
FG27	0.0679	83.3	22.1
FG28	0.0184	64.1	14.8
FG29	0.0983	61.2	19.1
FG32	0.0402	80	23.9
FG34	0.0275	62.7	16.8
FG35	0.0292	65.3	15
FG36	0.0295	65.1	25.8
FG37	0.0754	61.4	21
FG38	0.133064	61	22.41
GR1	0.028	61	5.08
GR2	0.021	61	22.6
OS05	0.0578	61	15.2
OS06	0.1313	61	18.7
OS07ab	0.017	61	13.9
OS07c	0.0296	61	17.4
OS07d	0.0034	61	13.1
OS08a	0.0251	61	16.7
OS08b	0.0165	61	20.3
OS09a	0.0093	61	20.9
OS09b	0.0435	61	25.4
OS10	0.369334	64.72	17.19
OS11	0.0077	61	0.18

HEC-HMS Proposed 5-Year Flows				
Hydrologic Element	Area	Peak Discharge	Time of Peak	Volume
	(sq.mi.)	CFS	(min)	(in)
FG01	0.0538	3.4	01Jul2015, 12:36	0.28
FG01-G1	0.0538	3.4	01Jul2015, 12:36	0.28
FG02	0.0391	2.7	01Jul2015, 12:18	0.24
FG03	0.0203	3	01Jul2015, 12:06	0.33
FG04	0.0172	3.1	01Jul2015, 12:06	0.34
FG05	0.058	6.7	01Jul2015, 12:30	0.4
FG06	0.0675	5.8	01Jul2015, 12:18	0.28
FG21a	0.0095	0.4	01Jul2015, 12:24	0.19
FG21b	0.015	3.9	01Jul2015, 12:06	0.5
FG22	0.1354	16.8	01Jul2015, 12:18	0.36
FG23a	0.0216	2.7	01Jul2015, 12:18	0.35
FG23b	0.0236	0.9	01Jul2015, 12:18	0.18
FG23c	0.0109	1	01Jul2015, 12:12	0.26
FG24a	0.0348	2	01Jul2015, 12:24	0.23
FG24b	0.0589	14.8	01Jul2015, 12:12	0.52
FG24c	0.0291	8.4	01Jul2015, 12:12	0.58
FG24d	0.0262	8.7	01Jul2015, 12:06	0.64
FG25	0.1084	21.8	01Jul2015, 12:18	0.54
FG26	0.057	15.6	01Jul2015, 12:18	0.7
FG27	0.0679	30	01Jul2015, 12:18	0.97
FG28	0.0184	1.2	01Jul2015, 12:12	0.23
FG29	0.0983	2.9	01Jul2015, 12:24	0.16
FG32	0.0402	13.6	01Jul2015, 12:18	0.8
FG32-G06	0.0402	13.2	01Jul2015, 12:24	0.8
FG34	0.0275	1.3	01Jul2015, 12:18	0.2
FG35	0.0292	2.4	01Jul2015, 12:12	0.26
FG36	0.0295	1.7	01Jul2015, 12:30	0.25
FG36-G16	0.0295	1.7	01Jul2015, 12:36	0.25
FG37	0.0754	2.3	01Jul2015, 12:30	0.17
FG38	0.133064	3.5	01Jul2015, 12:30	0.16
GR1	0.028	1.2	01Jul2015, 12:06	0.16
GR1-G19	0.028	1.2	01Jul2015, 12:36	0.16
GR2	0.021	0.6	01Jul2015, 12:30	0.16
GR2-G20	0.0287	0.7	01Jul2015, 14:06	0.15
G06	1.3011	22.4	01Jul2015, 15:30	0.24
G1	0.1116	4.9	01Jul2015, 12:36	0.22
G1a	0.1313	3.8	01Jul2015, 12:24	0.16
G1a-G2	0.1313	3.7	01Jul2015, 12:30	0.16
G1-G2	0.1116	4.8	01Jul2015, 12:36	0.22
G10	0.9	45.9	01Jul2015, 12:30	0.26
G10-G11	0.9	43.8	01Jul2015, 12:36	0.26
G11	0.9109	44.3	01Jul2015, 12:36	0.26
G12	1.1626	20.5	01Jul2015, 15:24	0.23
G12-G06	1.1626	20.5	01Jul2015, 15:36	0.23

G13	0.057	15.6	01Jul2015, 12:18	0.7
G13-POND G	0.057	15.6	01Jul2015, 12:24	0.7
G14	0.071	2	01Jul2015, 12:36	0.17
G14-G15	0.071	1.9	01Jul2015, 12:54	0.17
G15	0.1002	3	01Jul2015, 12:48	0.19
G15-G16	0.1002	3	01Jul2015, 13:06	0.19
G16	0.2051	6.1	01Jul2015, 12:36	0.19
G17	0.369334	25.5	01Jul2015, 12:18	0.24
G17-G18	0.369334	24.7	01Jul2015, 12:30	0.24
G18	0.502397	28.3	01Jul2015, 12:30	0.22
G19	0.0287	0.7	01Jul2015, 12:30	0.16
G2	0.282	10.3	01Jul2015, 12:30	0.19
G2-G3	0.282	10.2	01Jul2015, 12:42	0.19
G20	0.0287	0.7	01Jul2015, 14:06	0.15
G21	0.028	1.2	01Jul2015, 12:36	0.16
G3	0.3195	12.1	01Jul2015, 12:36	0.21
G4	0.0391	1.2	01Jul2015, 12:36	0.16
G4-G7	0.0391	1.2	01Jul2015, 12:36	0.16
G7	0.5161	8.9	01Jul2015, 14:12	0.2
G7-G8	0.5161	8.9	01Jul2015, 14:18	0.2
G8	0.7016	24	01Jul2015, 12:18	0.23
G8-G10	0.7016	23.8	01Jul2015, 12:30	0.23
G9a	0.1195	16.2	01Jul2015, 12:12	0.35
G9a-G9b	0.1195	15.5	01Jul2015, 12:18	0.35
G9b	0.1748	32.3	01Jul2015, 12:12	0.43
G9b-G10	0.1748	30.8	01Jul2015, 12:18	0.42
OS05	0.0578	1.8	01Jul2015, 12:18	0.16
OS05-G1	0.0578	1.7	01Jul2015, 12:24	0.16
OS06	0.1313	3.8	01Jul2015, 12:24	0.16
OS07ab	0.017	0.5	01Jul2015, 12:18	0.16
OS07ab-POND F	0.017	0.5	01Jul2015, 12:42	0.16
OS07c	0.0296	0.9	01Jul2015, 12:24	0.16
OS07c-G4	0.0296	0.9	01Jul2015, 12:36	0.16
OS07d	0.0034	0.1	01Jul2015, 12:18	0.16
OS07d-G8	0.0034	0.1	01Jul2015, 12:30	0.16
OS08a	0.0251	0.7	01Jul2015, 12:24	0.16
OS08b	0.0165	0.4	01Jul2015, 12:24	0.16
OS08b-G9a	0.0165	0.4	01Jul2015, 13:00	0.15
OS08-G8	0.0251	0.7	01Jul2015, 12:30	0.16
OS09a	0.0093	0.3	01Jul2015, 12:30	0.16
OS09a-G9a	0.0093	0.2	01Jul2015, 13:00	0.15
OS09b	0.0435	1.1	01Jul2015, 12:36	0.16
OS09b-G14	0.0435	1.1	01Jul2015, 12:42	0.16
OS10	0.369334	25.5	01Jul2015, 12:18	0.24
OS11	0.0077	0.5	01Jul2015, 12:00	0.16
POND F	0.462	8	01Jul2015, 14:12	0.2
POND F IN	0.462	22.8	01Jul2015, 12:36	0.24

POND F-G7	0.462	8	01Jul2015, 14:24	0.19
POND G	1.1626	20.5	01Jul2015, 15:24	0.23
POND G IN-EAST	0.1249	44.3	01Jul2015, 12:18	0.85
POND G IN-WEST	1.0377	63.3	01Jul2015, 12:30	0.29
REX RD WQCV	0.1748	30.9	01Jul2015, 12:18	0.42

HEC-HMS Proposed 100-Year Flows				
Hydrologic Element	Area	Peak Discharge	Time of Peak	Volume
	(sq.mi.)	CFS	(min)	(in)
FG01	0.0538	31.2	01Jul2015, 12:30	1.7
FG01-G1	0.0538	31.1	01Jul2015, 12:30	1.7
FG02	0.0391	32	01Jul2015, 12:12	1.58
FG03	0.0203	23.6	01Jul2015, 12:06	1.84
FG04	0.0172	22.2	01Jul2015, 12:00	1.84
FG05	0.058	45	01Jul2015, 12:24	1.98
FG06	0.0675	56.2	01Jul2015, 12:12	1.69
FG21a	0.0095	5.9	01Jul2015, 12:18	1.43
FG21b	0.015	20.7	01Jul2015, 12:06	2.24
FG22	0.1354	121.3	01Jul2015, 12:12	1.91
FG23a	0.0216	20.6	01Jul2015, 12:12	1.88
FG23b	0.0236	16.9	01Jul2015, 12:12	1.38
FG23c	0.0109	10.8	01Jul2015, 12:06	1.63
FG24a	0.0348	23.6	01Jul2015, 12:18	1.55
FG24b	0.0589	75.9	01Jul2015, 12:06	2.26
FG24c	0.0291	39.5	01Jul2015, 12:06	2.4
FG24d	0.0262	39	01Jul2015, 12:06	2.52
FG25	0.1084	111.4	01Jul2015, 12:18	2.31
FG26	0.057	65	01Jul2015, 12:18	2.65
FG27	0.0679	98.2	01Jul2015, 12:12	3.14
FG28	0.0184	15	01Jul2015, 12:12	1.55
FG29	0.0983	59.5	01Jul2015, 12:12	1.34
FG32	0.0402	50.9	01Jul2015, 12:18	2.83
FG32-G06	0.0402	50.3	01Jul2015, 12:18	2.82
FG34	0.0275	19.9	01Jul2015, 12:12	1.45
FG35	0.0292	25.3	01Jul2015, 12:12	1.63
FG36	0.0295	18.8	01Jul2015, 12:18	1.61
FG36-G16	0.0295	18.7	01Jul2015, 12:24	1.6
FG37	0.0754	43.8	01Jul2015, 12:18	1.35
FG38	0.133064	72.9	01Jul2015, 12:18	1.32
GR1	0.028	30	01Jul2015, 12:00	1.34
GR1-G19	0.028	26.8	01Jul2015, 12:12	1.3
GR2	0.021	11.5	01Jul2015, 12:18	1.32
GR2-G20	0.0287	13	01Jul2015, 12:54	1.38
G06	1.3011	491	01Jul2015, 12:48	1.66
G1	0.1116	61	01Jul2015, 12:18	1.51
G1a	0.1313	79.8	01Jul2015, 12:12	1.33
G1a-G2	0.1313	78.6	01Jul2015, 12:18	1.32
G1-G2	0.1116	60.6	01Jul2015, 12:18	1.5
G10	0.9	390.3	01Jul2015, 12:24	1.63
G10-G11	0.9	389.1	01Jul2015, 12:30	1.62
G11	0.9109	392.7	01Jul2015, 12:30	1.62
G12	1.1626	449.6	01Jul2015, 12:48	1.66
G12-G06	1.1626	448.7	01Jul2015, 12:54	1.65

G13	0.057	65	01Jul2015, 12:18	2.65
G13-POND G	0.057	63.5	01Jul2015, 12:24	2.64
G14	0.071	37.3	01Jul2015, 12:18	1.36
G14-G15	0.071	37.1	01Jul2015, 12:24	1.35
G15	0.1002	54.9	01Jul2015, 12:18	1.43
G15-G16	0.1002	53.8	01Jul2015, 12:24	1.41
G16	0.2051	112.1	01Jul2015, 12:24	1.41
G17	0.369334	296.1	01Jul2015, 12:12	1.59
G17-G18	0.369334	292.3	01Jul2015, 12:18	1.57
G18	0.502397	365.2	01Jul2015, 12:18	1.51
G19	0.0287	14	01Jul2015, 12:00	1.33
G2	0.282	166.7	01Jul2015, 12:18	1.43
G2-G3	0.282	163.4	01Jul2015, 12:18	1.42
G20	0.0287	13	01Jul2015, 12:54	1.38
G21	0.028	26.8	01Jul2015, 12:12	1.3
G3	0.3195	184.9	01Jul2015, 12:18	1.47
G4	0.0391	24.7	01Jul2015, 12:18	1.35
G4-G7	0.0391	23.8	01Jul2015, 12:18	1.34
G7	0.5161	194.5	01Jul2015, 12:42	1.47
G7-G8	0.5161	194	01Jul2015, 12:42	1.46
G8	0.7016	279	01Jul2015, 12:30	1.55
G8-G10	0.7016	277.7	01Jul2015, 12:36	1.54
G9a	0.1195	97.2	01Jul2015, 12:12	1.85
G9a-G9b	0.1195	95.7	01Jul2015, 12:12	1.84
G9b	0.1748	170.1	01Jul2015, 12:12	2.04
G9b-G10	0.1748	157.9	01Jul2015, 12:18	2.02
OS05	0.0578	39.1	01Jul2015, 12:12	1.33
OS05-G1	0.0578	38.6	01Jul2015, 12:12	1.33
OS06	0.1313	79.8	01Jul2015, 12:12	1.33
OS07ab	0.017	11.9	01Jul2015, 12:06	1.33
OS07ab-POND F	0.017	11.8	01Jul2015, 12:18	1.31
OS07c	0.0296	18.9	01Jul2015, 12:12	1.33
OS07c-G4	0.0296	18.8	01Jul2015, 12:18	1.32
OS07d	0.0034	2.5	01Jul2015, 12:06	1.33
OS07d-G8	0.0034	2.4	01Jul2015, 12:12	1.32
OS08a	0.0251	16.3	01Jul2015, 12:12	1.33
OS08b	0.0165	9.5	01Jul2015, 12:18	1.33
OS08b-G9a	0.0165	9.4	01Jul2015, 12:30	1.29
OS08-G8	0.0251	15.6	01Jul2015, 12:18	1.32
OS09a	0.0093	5.3	01Jul2015, 12:18	1.33
OS09a-G9a	0.0093	5.2	01Jul2015, 12:30	1.3
OS09b	0.0435	21.8	01Jul2015, 12:24	1.32
OS09b-G14	0.0435	21.7	01Jul2015, 12:24	1.31
OS10	0.369334	296.1	01Jul2015, 12:12	1.59
OS11	0.0077	9.4	01Jul2015, 12:00	1.34
POND F	0.462	177.6	01Jul2015, 12:42	1.46
POND F IN	0.462	293	01Jul2015, 12:18	1.56

POND F-G7	0.462	177.3	01Jul2015, 12:42	1.45
POND G	1.1626	449.6	01Jul2015, 12:48	1.66
POND G IN-EAST	0.1249	160.3	01Jul2015, 12:18	2.91
POND G IN-WEST	1.0377	503.2	01Jul2015, 12:24	1.69
REX RD WQCV	0.1748	158.1	01Jul2015, 12:18	2.02

Appendix K
Preliminary Onsite Pond Sizing Spreadsheets

MILE HIGH FLOOD DISTRICT

DETENTION BASIN DESIGN WORKBOOK

MHFD-Detention, Version 4.06 (July 2022)
Mile High Flood District
Denver, Colorado
www.mhfd.org

Purpose:

This workbook aids in the estimation of stormwater detention basin sizing and outlet routing based on the modified puls routing method for urban watersheds. Several different BMP types and various outlet configurations can be sized.

Function:

1. Approximates the stage-area-volume relationship for a detention basin based on watershed parameters and basin geometry parameters. Also evaluates existing user-defined basin stage-area relationships.

2. Sizes filtration media orifice, outlet orifices, elliptical slots, weirs, trash racks, and develops stage-discharge relationships. Uses the Modified Puls method to route a series of hydrographs (i.e., 2-, 5-, 10-, 25-, 50-, 100- and 500-year) and calibrates the peak discharge out of the basin to match the pre-development peak discharges for the watershed.

Content: **This workbook consists of the following sheets:**

Basin	Tabulates stage-area-volume relationship estimates based on watershed parameters
Outlet Structure	Tabulates a stage-discharge relationship for the user-defined outlet structure (inlet control).
Reference	Provides reference equations and figures.
User Tips and Tools	Provides instructions and video links to assist in using this workbook. Includes a stage-area calculator.
BMP Zone Images	Provides images of typical BMP zone confirgurations corresponding with Zone pulldown selections.

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Professor, Department of Civil Engineering, University of Colorado at Denver

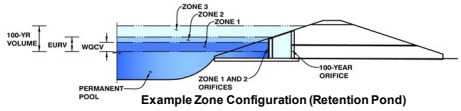
Comments? Direct all comments regarding this spreadsheet workbook to: **MHFD E-Mail**
Revisions? Check for revised versions of this or any other workbook at: **Downloads**

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: Grandview - Filing 2

Basin ID: Basin A



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	36.13	acres
Watershed Length =	2,360	ft
Watershed Length to Centroid =	1,180	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	64.30%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	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) =	0.757	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	2.874	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	2.126	acre-feet	1.19 inches
5-yr Runoff Volume (P1 = 1.5 in.) =	2.790	acre-feet	1.50 inches
10-yr Runoff Volume (P1 = 1.75 in.) =	3.322	acre-feet	1.75 inches
25-yr Runoff Volume (P1 = 2 in.) =	4.022	acre-feet	2.00 inches
50-yr Runoff Volume (P1 = 2.25 in.) =	4.709	acre-feet	2.25 inches
100-yr Runoff Volume (P1 = 2.52 in.) =	5.545	acre-feet	2.52 inches
500-yr Runoff Volume (P1 = 3.68 in.) =	9.033	acre-feet	3.68 inches
Approximate 2-yr Detention Volume =	1.869	acre-feet	
Approximate 5-yr Detention Volume =	2.444	acre-feet	
Approximate 10-yr Detention Volume =	2.948	acre-feet	
Approximate 25-yr Detention Volume =	3.549	acre-feet	
Approximate 50-yr Detention Volume =	3.912	acre-feet	
Approximate 100-yr Detention Volume =	4.293	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.757	acre-feet
Zone 2 Volume (EURV - Zone 1) =	2.117	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.419	acre-feet
Total Detention Basin Volume =	4.293	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	

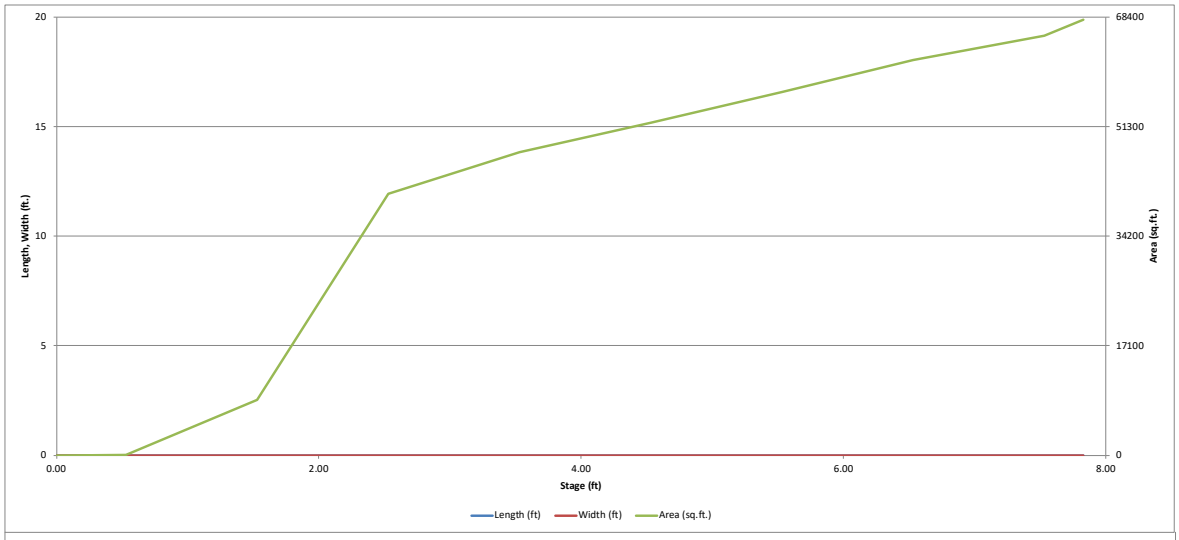
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	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

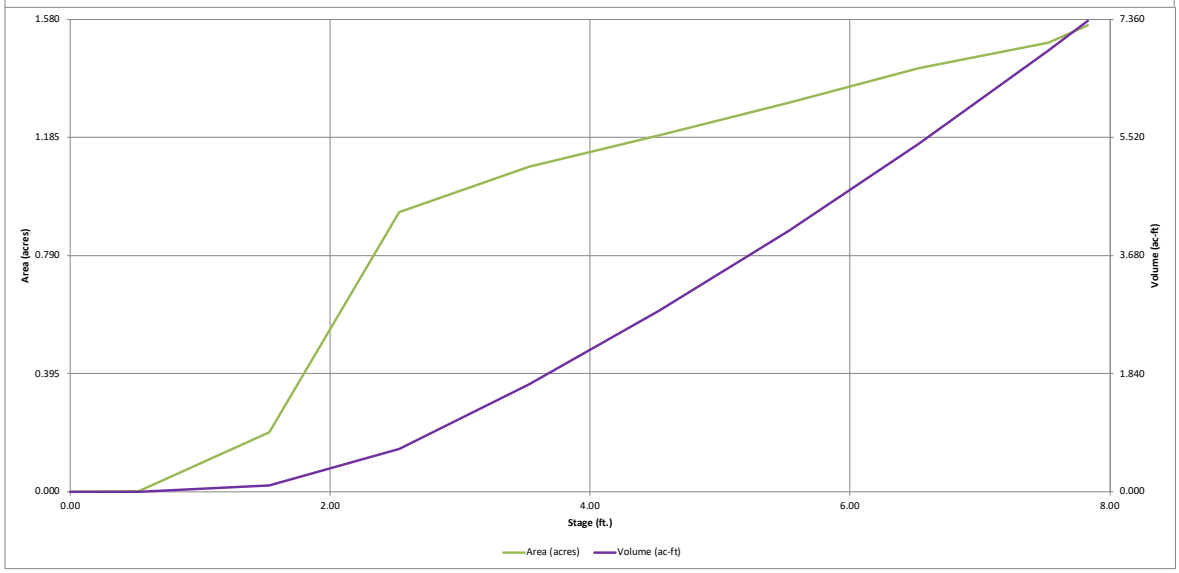
Depth Increment = ft

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)
6967.47 **Top of Micropool**	--	0.00	--	--	--	0	0.000		
6968	--	0.53	--	--	--	68	0.002	18	0.000
	--	1.53	--	--	--	8,624	0.198	4,364	0.100
	--	2.53	--	--	--	40,781	0.936	29,066	0.667
	--	3.53	--	--	--	47,311	1.086	73,112	1.678
	--	4.53	--	--	--	51,922	1.192	122,729	2.817
	--	5.53	--	--	--	56,697	1.302	177,038	4.064
	--	6.53	--	--	--	61,730	1.417	236,252	5.424
6975	--	7.53	--	--	--	65,473	1.503	299,853	6.884
6975.3	--	7.83	--	--	--	68,045	1.562	319,881	7.343

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



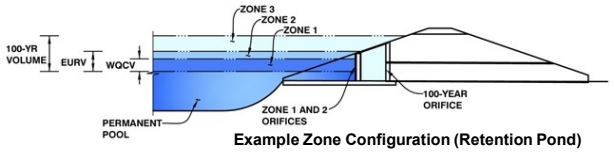


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Grandview - Filing 2

Basin ID: Basin A



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.63	0.757	Orifice Plate
Zone 2 (EURV)	4.58	2.117	Rectangular Orifice
Zone 3 (100-year)	5.71	1.419	Weir&Pipe (Restrict)
Total (all zones)		4.293	

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 Area =	N/A	ft²
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	1.681E-02	ft²
Depth at top of Zone using Orifice Plate =	2.63	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	10.50	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	2.42	sq. inches (diameter = 1-3/4 inches)	Elliptical Slot Area =	N/A	ft²

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.88	1.75					
Orifice Area (sq. inches)	2.42	2.42	2.42					

	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 Rectangular	Not Selected				
Invert of Vertical Orifice =	2.63	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.10	N/A
Depth at top of Zone using Vertical Orifice =	4.58	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.08	N/A
Vertical Orifice Height =	2.00	N/A	inches			
Vertical Orifice Width =	6.89		inches			

Calculated Parameters for Vertical Orif

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

	Zone 3 Weir	Not Selected				
Overflow Weir Front Edge Height, Ho =	4.58	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	4.58	N/A
Overflow Weir Front Edge Length =	4.00	N/A	feet	Overflow Weir Slope Length =	4.00	N/A
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	8.02	N/A
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	11.14	N/A
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	5.57	N/A
Debris Clogging % =	50%	N/A	%			

Calculated Parameters for Overflow W

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

	Zone 3 Restrictor	Not Selected				
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.39	N/A
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.61	N/A
Restrictor Plate Height Above Pipe Invert =	13.20		inches	Half-Central Angle of Restrictor Plate on Pipe =	2.06	N/A

Calculated Parameters for Outlet Pipe w/ Flow Restriction Pla

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.70	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.97	feet
Spillway Crest Length =	25.00	feet	Stage at Top of Freeboard =	7.67	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	1.53	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	7.10	acre-ft

Calculated Parameters for Spillway

Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52
CUHP Runoff Volume (acre-ft) =	0.757	2.874	2.126	2.790	3.322	4.022	4.709	5.545
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	2.126	2.790	3.322	4.022	4.709	5.545
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.2	0.4	0.6	5.0	10.1	16.9
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A						
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.02	0.14	0.28	0.47
Peak Inflow Q (cfs) =	N/A	N/A	28.8	37.7	44.5	57.1	68.1	81.4
Peak Outflow Q (cfs) =	0.3	1.1	0.9	1.0	2.8	8.0	14.3	15.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.6	5.0	1.6	1.4	0.9
Structure Controlling Flow =	Vertical Orifice 1	Overflow Weir 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.1	0.6	1.2	1.3
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	67	61	67	70	69	68	66
Time to Drain 99% of Inflow Volume (hours) =	**40**	72	65	72	76	75	75	75
Maximum Ponding Depth (ft) =	2.63	4.58	3.81	4.36	4.74	4.99	5.22	5.64
Area at Maximum Ponding Depth (acres) =	0.95	1.20	1.11	1.17	1.21	1.24	1.27	1.31
Maximum Volume Stored (acre-ft) =	0.762	2.877	1.976	2.616	3.070	3.377	3.653	4.208

ice

ft^2
feet

eir

feet
feet

ft^2
ft^2

ate

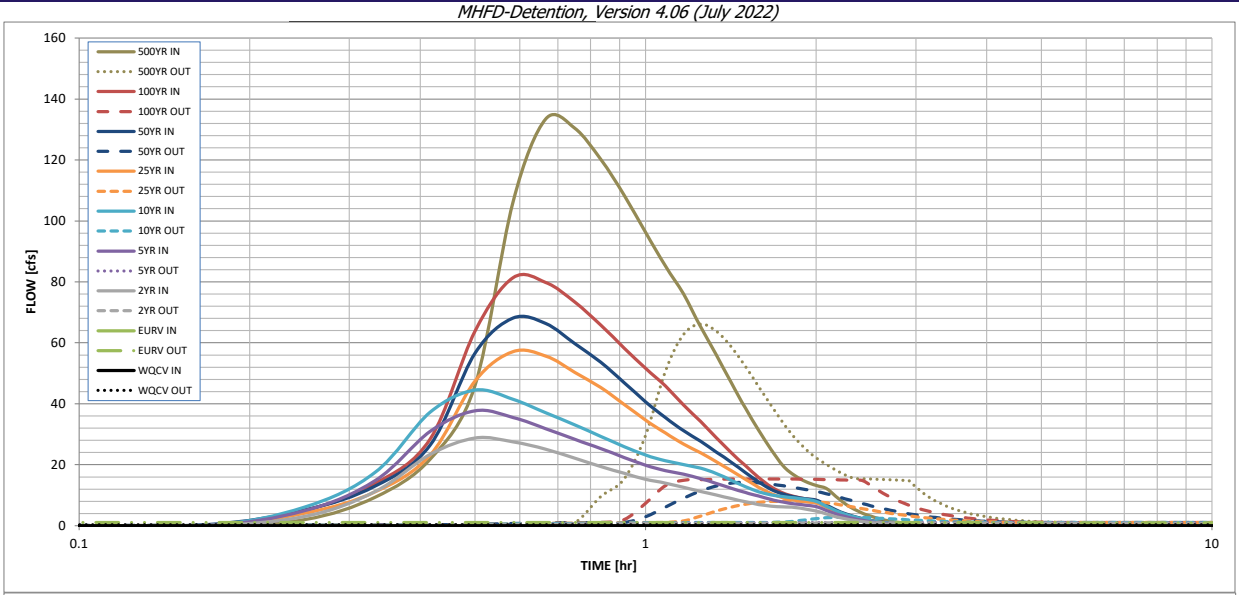
ft^2
feet
radians

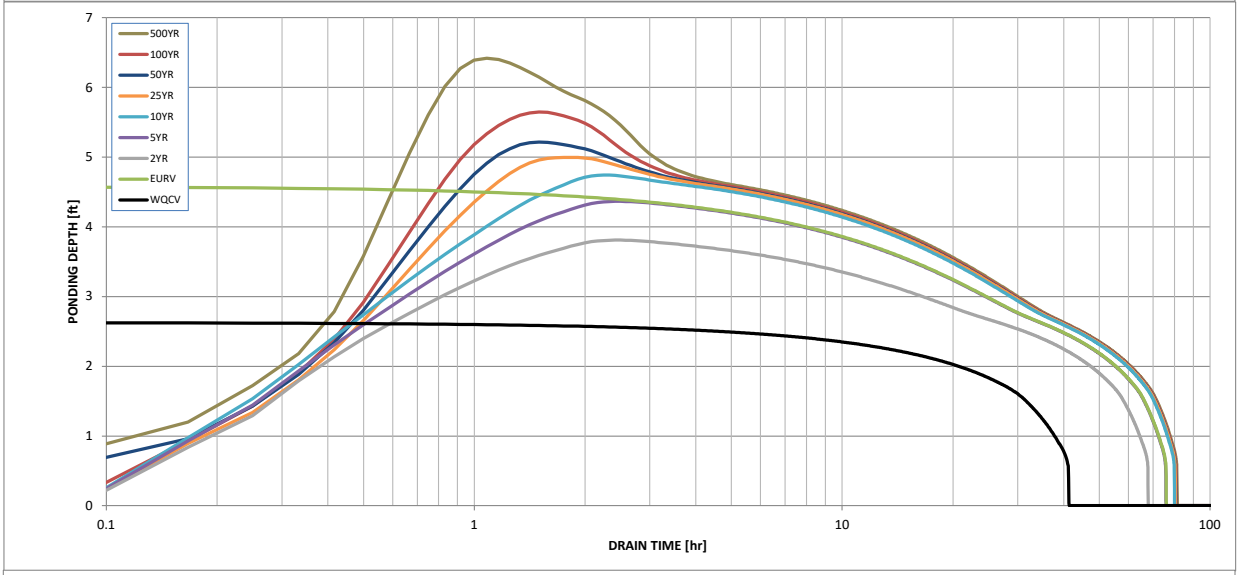
5).

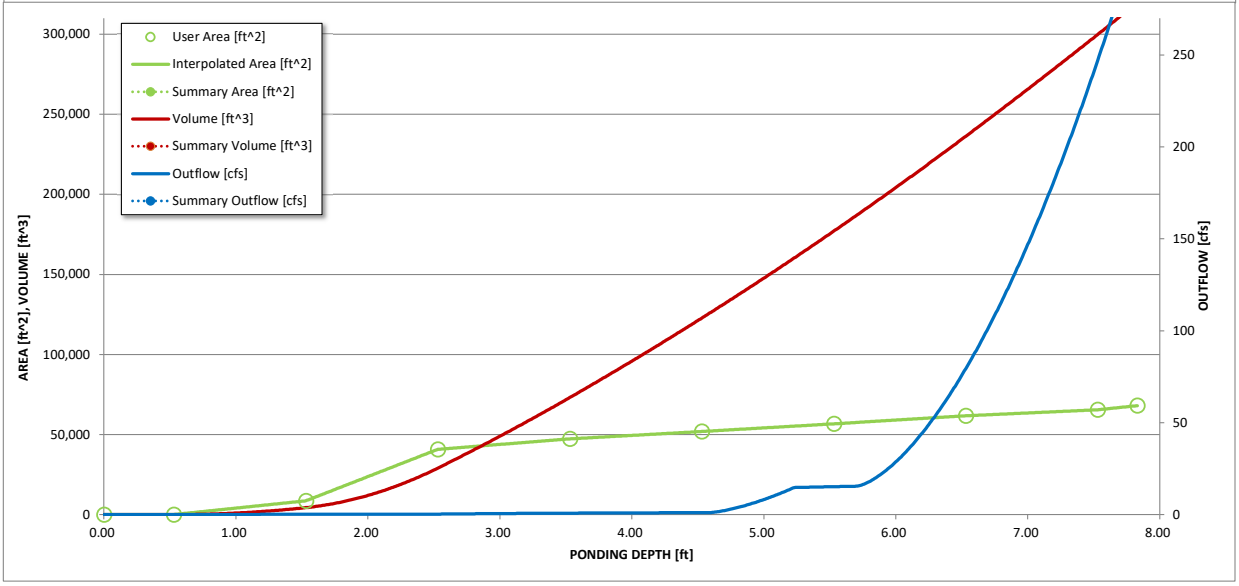
500 Year
3.68
9.033
9.033
44.1
1.22
133.4
66.1
1.5
Spillway
1.3
N/A
61
72
6.42
1.40
5.254

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.03	2.03
	0:15:00	0.00	0.00	3.01	4.89	6.06	4.08	5.15	4.99	9.39
	0:20:00	0.00	0.00	11.19	14.81	17.48	11.07	12.96	13.82	21.85
	0:25:00	0.00	0.00	23.40	30.92	37.22	23.15	26.47	28.47	45.97
	0:30:00	0.00	0.00	28.77	37.72	44.48	47.43	56.58	63.83	106.22
	0:35:00	0.00	0.00	27.53	35.53	41.46	57.08	68.10	81.36	133.45
	0:40:00	0.00	0.00	25.09	31.83	37.05	55.68	66.30	79.83	130.37
	0:45:00	0.00	0.00	22.11	28.32	33.07	50.29	59.71	73.41	120.23
	0:50:00	0.00	0.00	19.45	25.34	29.32	45.33	53.61	65.87	108.49
	0:55:00	0.00	0.00	17.16	22.39	25.96	39.83	46.94	58.31	96.22
	1:00:00	0.00	0.00	15.26	19.81	23.15	34.68	40.66	51.61	85.23
	1:05:00	0.00	0.00	13.99	18.10	21.35	30.40	35.45	45.91	76.01
	1:10:00	0.00	0.00	12.58	16.88	20.07	26.81	31.18	39.61	65.35
	1:15:00	0.00	0.00	11.24	15.46	18.87	23.92	27.71	34.22	56.01
	1:20:00	0.00	0.00	10.05	13.85	17.13	20.94	24.19	28.88	46.87
	1:25:00	0.00	0.00	8.90	12.27	14.89	18.10	20.82	23.98	38.59
	1:30:00	0.00	0.00	7.83	10.86	12.81	15.24	17.47	19.69	31.36
	1:35:00	0.00	0.00	6.96	9.71	11.15	12.64	14.40	15.87	24.92
	1:40:00	0.00	0.00	6.42	8.55	10.11	10.51	11.88	12.70	19.60
	1:45:00	0.00	0.00	6.16	7.72	9.51	9.17	10.33	10.73	16.46
	1:50:00	0.00	0.00	6.01	7.15	9.10	8.36	9.41	9.56	14.51
	1:55:00	0.00	0.00	5.42	6.73	8.66	7.85	8.83	8.79	13.19
	2:00:00	0.00	0.00	4.82	6.27	8.00	7.49	8.42	8.25	12.25
	2:05:00	0.00	0.00	3.87	5.05	6.44	6.05	6.80	6.57	9.68
	2:10:00	0.00	0.00	2.98	3.88	4.95	4.63	5.20	4.93	7.22
	2:15:00	0.00	0.00	2.30	2.99	3.80	3.54	3.97	3.72	5.41
	2:20:00	0.00	0.00	1.76	2.28	2.88	2.69	3.02	2.83	4.10
	2:25:00	0.00	0.00	1.33	1.73	2.17	2.03	2.28	2.14	3.10
	2:30:00	0.00	0.00	1.01	1.28	1.61	1.51	1.69	1.60	2.31
	2:35:00	0.00	0.00	0.74	0.93	1.20	1.11	1.24	1.19	1.71
	2:40:00	0.00	0.00	0.54	0.68	0.89	0.83	0.93	0.89	1.28
	2:45:00	0.00	0.00	0.38	0.48	0.63	0.60	0.68	0.64	0.92
	2:50:00	0.00	0.00	0.24	0.33	0.42	0.41	0.46	0.44	0.62
	2:55:00	0.00	0.00	0.14	0.20	0.26	0.26	0.28	0.27	0.38
	3:00:00	0.00	0.00	0.07	0.11	0.13	0.14	0.15	0.14	0.20
	3:05:00	0.00	0.00	0.03	0.04	0.05	0.05	0.06	0.05	0.07
	3:10:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

MILE HIGH FLOOD DISTRICT

DETENTION BASIN DESIGN WORKBOOK

MHFD-Detention, Version 4.06 (July 2022)
Mile High Flood District
Denver, Colorado
www.mhfd.org

Purpose:

This workbook aids in the estimation of stormwater detention basin sizing and outlet routing based on the modified puls routing method for urban watersheds. Several different BMP types and various outlet configurations can be sized.

Function:

1. Approximates the stage-area-volume relationship for a detention basin based on watershed parameters and basin geometry parameters. Also evaluates existing user-defined basin stage-area relationships.

2. Sizes filtration media orifice, outlet orifices, elliptical slots, weirs, trash racks, and develops stage-discharge relationships. Uses the Modified Puls method to route a series of hydrographs (i.e., 2-, 5-, 10-, 25-, 50-, 100- and 500-year) and calibrates the peak discharge out of the basin to match the pre-development peak discharges for the watershed.

Content: **This workbook consists of the following sheets:**

Basin	Tabulates stage-area-volume relationship estimates based on watershed parameters
Outlet Structure	Tabulates a stage-discharge relationship for the user-defined outlet structure (inlet control).
Reference	Provides reference equations and figures.
User Tips and Tools	Provides instructions and video links to assist in using this workbook. Includes a stage-area calculator.
BMP Zone Images	Provides images of typical BMP zone confirgurations corresponding with Zone pulldown selections.

Acknowledgements: ***Spreadsheet Development Team:***
Ken MacKenzie, P.E., Holly Piza, P.E.
Mile High Flood District

Derek N. Rapp, P.E.
Peak Stormwater Engineering, LLC

Dr. James C.Y. Guo, Ph.D., P.E.
Professor, Department of Civil Engineering, University of Colorado at Denver

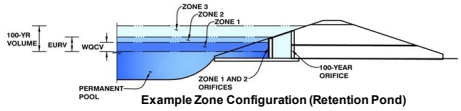
Comments? Direct all comments regarding this spreadsheet workbook to: **MHFD E-Mail**
Revisions? Check for revised versions of this or any other workbook at: **Downloads**

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: Grandview - Filing 2

Basin ID: Basin B



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	28.83	acres
Watershed Length =	1,700	ft
Watershed Length to Centroid =	850	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	61.90%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	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) =	0.583 acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	2.184 acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	1.618 acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	2.128 acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	2.537 acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	3.086 acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	3.627 acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	4.289 acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	5.737 acre-feet		inches
Approximate 2-yr Detention Volume =	1.418 acre-feet		
Approximate 5-yr Detention Volume =	1.856 acre-feet		
Approximate 10-yr Detention Volume =	2.243 acre-feet		
Approximate 25-yr Detention Volume =	2.707 acre-feet		
Approximate 50-yr Detention Volume =	2.989 acre-feet		
Approximate 100-yr Detention Volume =	3.292 acre-feet		

Define Zones and Basin Geometry

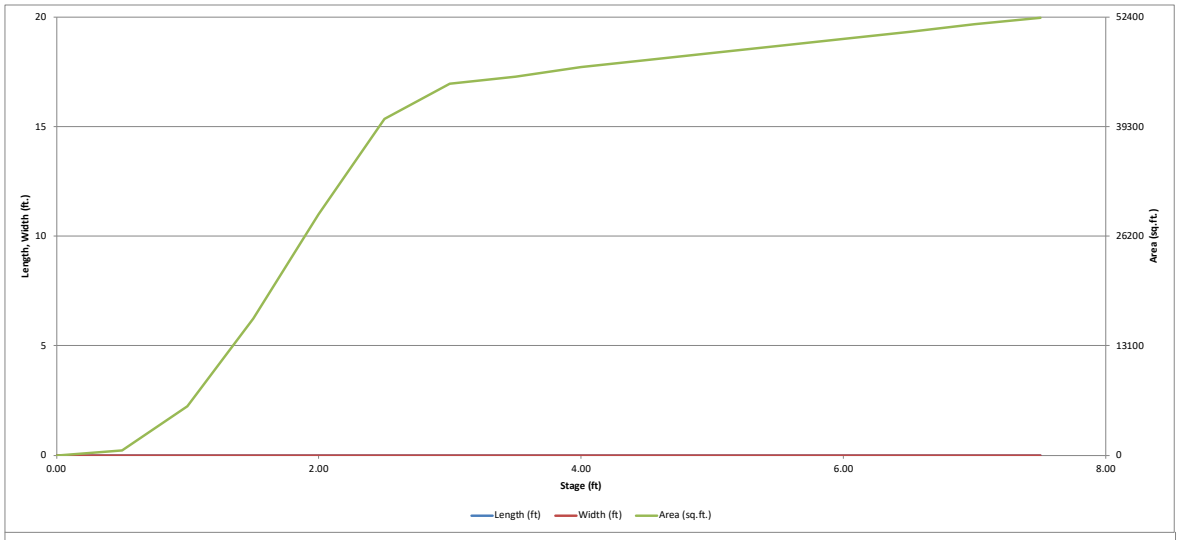
Zone 1 Volume (WQCV) =	0.583	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.601	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.107	acre-feet
Total Detention Basin Volume =	3.292	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (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

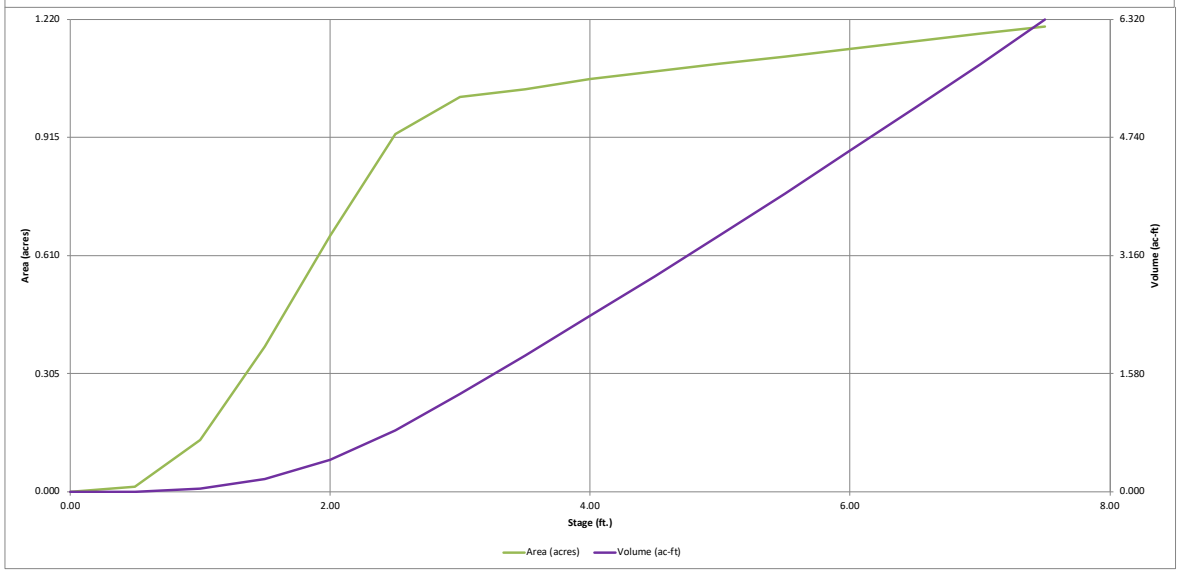
Depth Increment = 0.50 ft

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)
6962.5 **Top of Micropool**	--	0.00	--	--	--	0	0.000		
6963	--	0.50	--	--	--	544	0.012	136	0.003
6963.5	--	1.00	--	--	--	5,847	0.134	1,734	0.040
6964	--	1.50	--	--	--	16,307	0.374	7,272	0.167
6964.5	--	2.00	--	--	--	28,817	0.662	18,553	0.426
6965	--	2.50	--	--	--	40,205	0.923	35,808	0.822
6965.5	--	3.00	--	--	--	44,431	1.020	56,967	1.308
6966	--	3.50	--	--	--	45,303	1.040	79,401	1.823
6966.5	--	4.00	--	--	--	46,440	1.066	102,337	2.349
6967	--	4.50	--	--	--	47,282	1.085	125,767	2.887
6967.5	--	5.00	--	--	--	48,125	1.105	149,619	3.435
6968	--	5.50	--	--	--	48,969	1.124	173,892	3.992
6968.5	--	6.00	--	--	--	49,816	1.144	198,589	4.559
6969	--	6.50	--	--	--	50,666	1.163	223,709	5.136
6969.5	--	7.00	--	--	--	51,522	1.183	249,256	5.722
6970	--	7.50	--	--	--	52,387	1.203	275,233	6.318

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



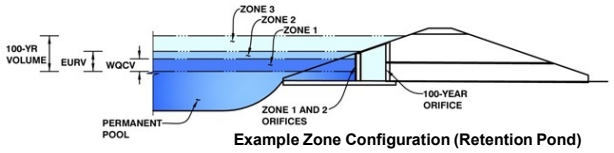


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Grandview - Filing 2

Basin ID: Basin B



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.22	0.583	Orifice Plate
Zone 2 (EURV)	3.85	1.601	Rectangular Orifice
Zone 3 (100-year)	4.88	1.107	Weir&Pipe (Restrict)
Total (all zones)		3.292	

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 Area =	N/A	ft²
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft²
Depth at top of Zone using Orifice Plate =	2.18	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	sq. inches	Elliptical Slot Area =	N/A	ft²

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.73	1.50					
Orifice Area (sq. inches)	2.11	2.11	2.11					

	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 Rectangular	Not Selected		Calculated Parameters for Vertical Orif	Zone 2 Rectangular	Not Selected
Invert of Vertical Orifice =	2.22	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.08	N/A
Depth at top of Zone using Vertical Orifice =	3.85	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.08	N/A
Vertical Orifice Height =	2.00	N/A	inches			
Vertical Orifice Width =	5.46		inches			

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

	Zone 3 Weir	Not Selected			Calculated Parameters for Overflow W Zone 3 Weir	Not Selected
Overflow Weir Front Edge Height, Ho =	3.83	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.83	N/A
Overflow Weir Front Edge Length =	4.00	N/A	feet	Overflow Weir Slope Length =	4.00	N/A
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	7.60	N/A
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	11.14	N/A
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	5.57	N/A
Debris Clogging % =	50%	N/A	%			

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

	Zone 3 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Pla Zone 3 Restrictor	Not Selected
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.46	N/A
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.64	N/A
Restrictor Plate Height Above Pipe Invert =	13.90		inches	Half-Central Angle of Restrictor Plate on Pipe =	2.15	N/A

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.80	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.67	feet
Spillway Crest Length =	38.00	feet	Stage at Top of Freeboard =	6.47	feet
Spillway End Slopes =	10.00	H:V	Basin Area at Top of Freeboard =	1.16	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	5.10	acre-ft

Calculated Parameters for Spillway

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52
CUHP Runoff Volume (acre-ft) =	0.583	2.184	1.618	2.128	2.537	3.086	3.627	4.289
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.618	2.128	2.537	3.086	3.627	4.289
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.2	0.4	0.5	4.9	9.8	16.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A						
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.02	0.17	0.34	0.56
Peak Inflow Q (cfs) =	N/A	N/A	24.9	32.7	38.5	49.7	59.6	72.1
Peak Outflow Q (cfs) =	0.3	0.9	0.7	0.8	2.5	6.6	12.0	14.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.0	4.7	1.3	1.2	0.9
Structure Controlling Flow =	Vertical Orifice 1	Overflow Weir 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	0.01	N/A	N/A	0.1	0.5	1.0	1.2
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	67	61	67	70	69	67	66
Time to Drain 99% of Inflow Volume (hours) =	**40**	72	65	72	75	75	75	74
Maximum Ponding Depth (ft) =	2.22	3.85	3.20	3.67	3.99	4.19	4.40	4.76
Area at Maximum Ponding Depth (acres) =	0.78	1.06	1.03	1.05	1.07	1.07	1.08	1.10
Maximum Volume Stored (acre-ft) =	0.584	2.190	1.513	2.000	2.339	2.553	2.768	3.171

ice

ft^2
feet

eir

feet
feet

ft^2
ft^2

ate

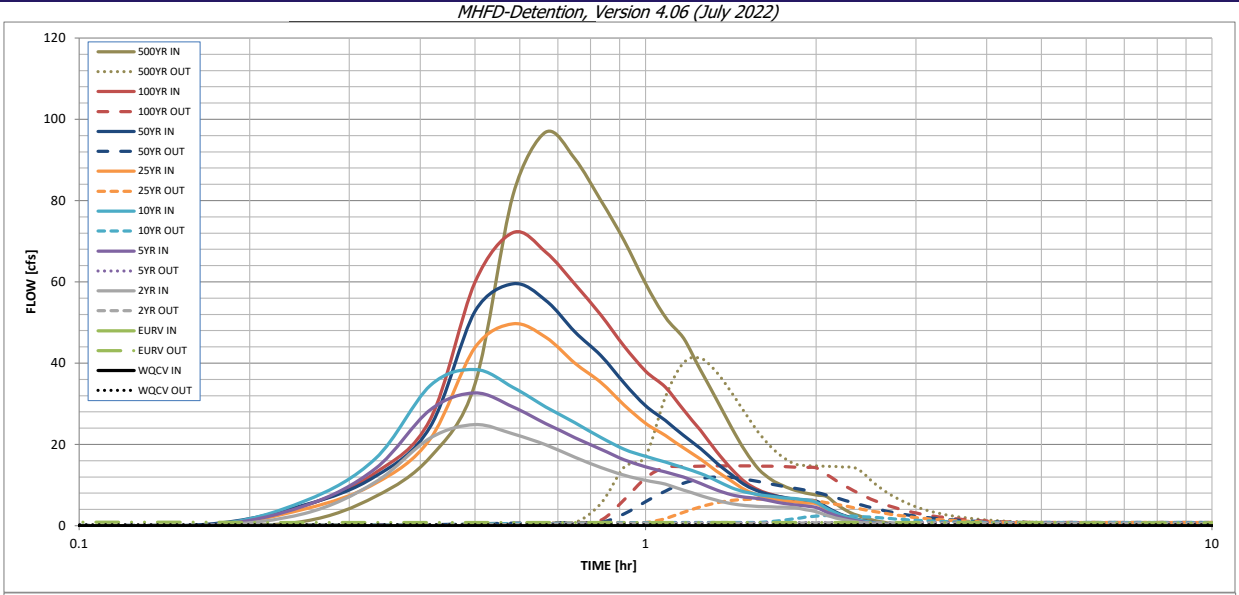
ft^2
feet
radians

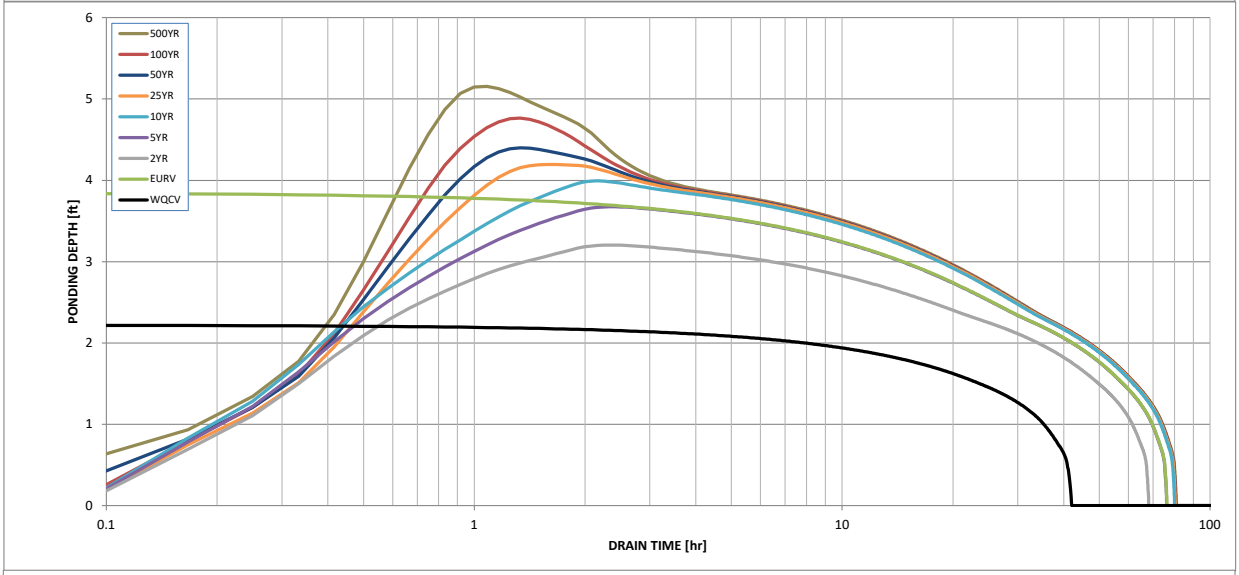
5).

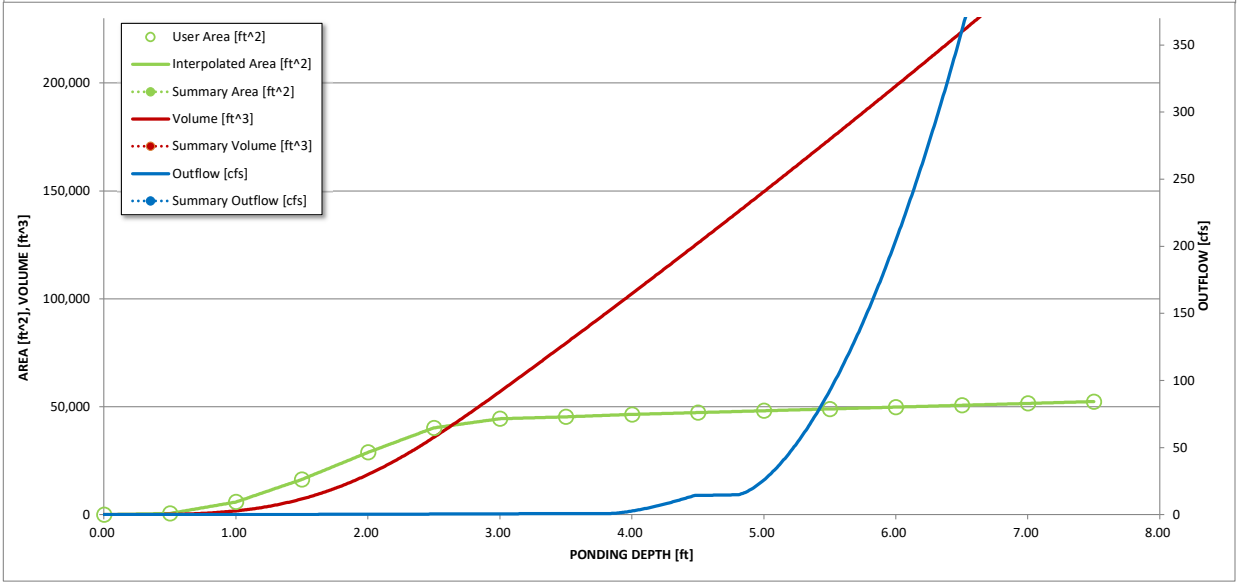
500 Year
3.14
5.737
5.737
29.2
1.01
96.8
41.2
1.4
Spillway
1.3
N/A
62
73
5.15
1.11
3.601

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.03	1.09
	0:15:00	0.00	0.00	3.00	4.87	6.04	4.06	5.08	4.96	7.13
	0:20:00	0.00	0.00	10.67	13.98	16.45	10.38	12.09	12.97	16.87
	0:25:00	0.00	0.00	21.56	28.51	34.45	21.33	24.33	26.17	34.87
	0:30:00	0.00	0.00	24.85	32.66	38.46	43.83	52.74	59.96	81.45
	0:35:00	0.00	0.00	22.59	29.18	34.04	49.69	59.55	72.15	96.83
	0:40:00	0.00	0.00	19.88	25.15	29.24	46.35	55.47	67.35	90.29
	0:45:00	0.00	0.00	16.87	21.67	25.35	40.00	47.70	59.47	80.09
	0:50:00	0.00	0.00	14.33	18.83	21.71	35.26	41.88	51.87	70.16
	0:55:00	0.00	0.00	12.41	16.24	18.84	29.72	35.08	44.19	59.60
	1:00:00	0.00	0.00	11.16	14.51	17.05	25.19	29.53	38.05	51.31
	1:05:00	0.00	0.00	10.19	13.20	15.63	22.18	25.89	34.10	46.13
	1:10:00	0.00	0.00	8.78	11.95	14.24	19.14	22.24	28.50	38.29
	1:15:00	0.00	0.00	7.43	10.39	12.85	16.40	18.96	23.43	31.20
	1:20:00	0.00	0.00	6.26	8.81	11.11	13.49	15.51	18.34	24.25
	1:25:00	0.00	0.00	5.42	7.64	9.33	11.01	12.56	14.01	18.36
	1:30:00	0.00	0.00	4.97	7.03	8.29	8.81	9.97	10.71	13.91
	1:35:00	0.00	0.00	4.74	6.71	7.66	7.50	8.47	8.79	11.34
	1:40:00	0.00	0.00	4.61	6.05	7.21	6.71	7.55	7.67	9.81
	1:45:00	0.00	0.00	4.53	5.52	6.88	6.19	6.96	6.91	8.76
	1:50:00	0.00	0.00	4.47	5.14	6.65	5.83	6.56	6.40	8.06
	1:55:00	0.00	0.00	3.92	4.85	6.34	5.59	6.29	6.03	7.55
	2:00:00	0.00	0.00	3.44	4.50	5.77	5.42	6.09	5.77	7.20
	2:05:00	0.00	0.00	2.60	3.40	4.35	4.11	4.62	4.34	5.41
	2:10:00	0.00	0.00	1.92	2.48	3.16	2.98	3.35	3.15	3.92
	2:15:00	0.00	0.00	1.40	1.81	2.30	2.17	2.44	2.31	2.87
	2:20:00	0.00	0.00	1.02	1.31	1.67	1.58	1.77	1.69	2.10
	2:25:00	0.00	0.00	0.72	0.92	1.19	1.12	1.26	1.20	1.49
	2:30:00	0.00	0.00	0.50	0.63	0.83	0.79	0.88	0.85	1.05
	2:35:00	0.00	0.00	0.34	0.44	0.58	0.56	0.62	0.60	0.74
	2:40:00	0.00	0.00	0.21	0.29	0.37	0.37	0.41	0.39	0.48
	2:45:00	0.00	0.00	0.11	0.17	0.21	0.22	0.24	0.23	0.28
	2:50:00	0.00	0.00	0.05	0.08	0.10	0.10	0.11	0.11	0.13
	2:55:00	0.00	0.00	0.02	0.02	0.03	0.03	0.03	0.03	0.04
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

MILE HIGH FLOOD DISTRICT

DETENTION BASIN DESIGN WORKBOOK

MHFD-Detention, Version 4.06 (July 2022)
Mile High Flood District
Denver, Colorado
www.mhfd.org

Purpose:

This workbook aids in the estimation of stormwater detention basin sizing and outlet routing based on the modified puls routing method for urban watersheds. Several different BMP types and various outlet configurations can be sized.

Function:

1. Approximates the stage-area-volume relationship for a detention basin based on watershed parameters and basin geometry parameters. Also evaluates existing user-defined basin stage-area relationships.

2. Sizes filtration media orifice, outlet orifices, elliptical slots, weirs, trash racks, and develops stage-discharge relationships. Uses the Modified Puls method to route a series of hydrographs (i.e., 2-, 5-, 10-, 25-, 50-, 100- and 500-year) and calibrates the peak discharge out of the basin to match the pre-development peak discharges for the watershed.

Content: **This workbook consists of the following sheets:**

Basin	Tabulates stage-area-volume relationship estimates based on watershed parameters
Outlet Structure	Tabulates a stage-discharge relationship for the user-defined outlet structure (inlet control).
Reference	Provides reference equations and figures.
User Tips and Tools	Provides instructions and video links to assist in using this workbook. Includes a stage-area calculator.
BMP Zone Images	Provides images of typical BMP zone confirgurations corresponding with Zone pulldown selections.

Acknowledgements: ***Spreadsheet Development Team:***
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Peak Stormwater Engineering, LLC

Dr. James C.Y. Guo, Ph.D., P.E.
Professor, Department of Civil Engineering, University of Colorado at Denver

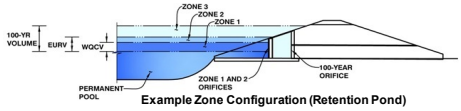
Comments? Direct all comments regarding this spreadsheet workbook to: **MHFD E-Mail**
Revisions? Check for revised versions of this or any other workbook at: **Downloads**

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: Grandview

Basin ID: Basin C



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	43.52	acres
Watershed Length =	1,890	ft
Watershed Length to Centroid =	1,050	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	61.20%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	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) =	0.871 acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	3.250 acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	2.420 acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	3.184 acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	3.797 acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	4.625 acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	5.440 acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	6.440 acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.68 in.) =	10.618 acre-feet	3.68	inches
Approximate 2-yr Detention Volume =	2.109 acre-feet		
Approximate 5-yr Detention Volume =	2.761 acre-feet		
Approximate 10-yr Detention Volume =	3.338 acre-feet		
Approximate 25-yr Detention Volume =	4.031 acre-feet		
Approximate 50-yr Detention Volume =	4.454 acre-feet		
Approximate 100-yr Detention Volume =	4.910 acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.871	acre-feet
Zone 2 Volume (EURV - Zone 1) =	2.379	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.661	acre-feet
Total Detention Basin Volume =	4.910	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	

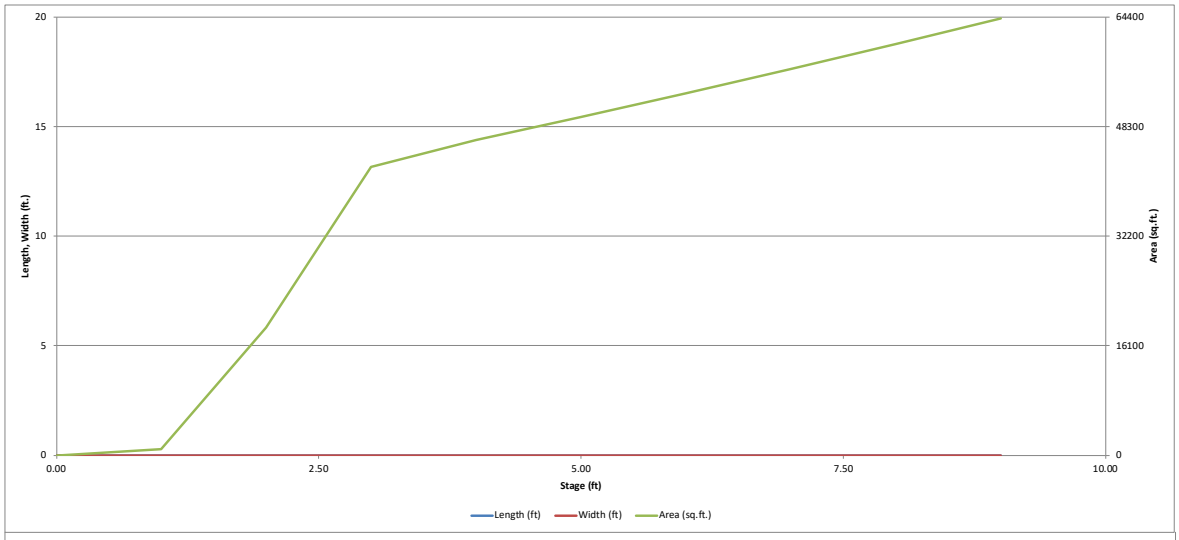
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	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

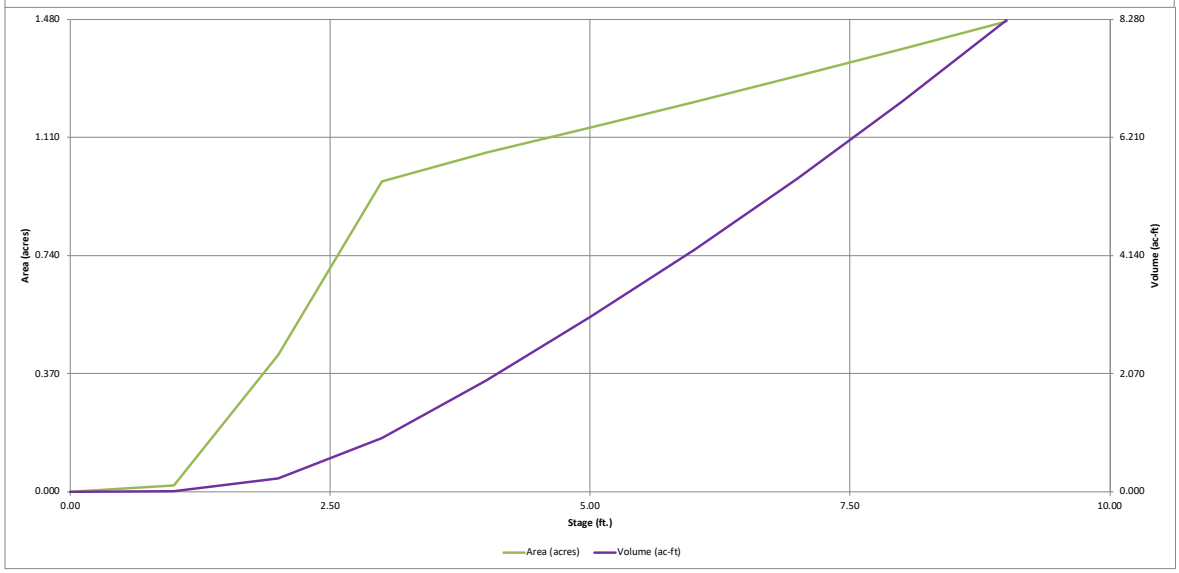
Depth Increment = ft

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)
6925 **Top of Micropool**	--	0.00	--	--	--	0	0.000		
	--	1.00	--	--	--	885	0.020	442	0.010
	--	2.00	--	--	--	18,707	0.429	10,238	0.235
	--	3.00	--	--	--	42,382	0.973	40,783	0.936
	--	4.00	--	--	--	46,291	1.063	85,119	1.954
	--	5.00	--	--	--	49,702	1.141	133,116	3.056
	--	6.00	--	--	--	53,188	1.221	184,561	4.237
	--	7.00	--	--	--	56,755	1.303	239,532	5.499
	--	8.00	--	--	--	60,439	1.387	298,129	6.844
	--	9.00	--	--	--	64,244	1.475	360,471	8.275

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



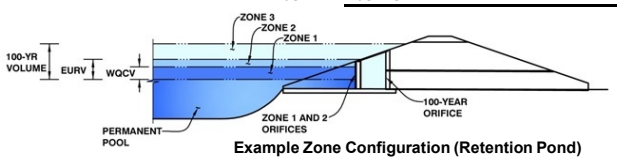


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Grandview

Basin ID: Basin C



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.94	0.871	Orifice Plate
Zone 2 (EURV)	5.17	2.379	Rectangular Orifice
Zone 3 (100-year)	6.55	1.661	Weir&Pipe (Restrict)
Total (all zones)		4.910	

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 Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	1.840E-02	ft^2
Depth at top of Zone using Orifice Plate =	2.94	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	11.80	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	2.65	sq. inches (diameter = 1-13/16 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.98	1.96					
Orifice Area (sq. inches)	2.65	2.65	2.65					

	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 Rectangular	Not Selected				Calculated Parameters for Vertical Orif
					Zone 2 Rectangular	Not Selected
Invert of Vertical Orifice =	2.94	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.10	N/A
Depth at top of Zone using Vertical Orifice =	5.19	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.08	N/A
Vertical Orifice Height =	2.00	N/A	inches			
Vertical Orifice Width =	7.19		inches			

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

	Zone 3 Weir	Not Selected				Calculated Parameters for Overflow W
					Zone 3 Weir	Not Selected
Overflow Weir Front Edge Height, Ho =	5.19	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	5.19	N/A
Overflow Weir Front Edge Length =	4.00	N/A	feet	Overflow Weir Slope Length =	4.00	N/A
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	5.85	N/A
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	11.14	N/A
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	5.57	N/A
Debris Clogging % =	50%	N/A	%			

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

	Zone 3 Restrictor	Not Selected				Calculated Parameters for Outlet Pipe w/ Flow Restriction Pla
					Zone 3 Restrictor	Not Selected
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.90	N/A
Outlet Pipe Diameter =	24.00	N/A	inches	Outlet Orifice Centroid =	0.66	N/A
Restrictor Plate Height Above Pipe Invert =	14.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.74	N/A

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.50	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.94	feet
Spillway Crest Length =	37.00	feet	Stage at Top of Freeboard =	8.44	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	1.43	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	7.46	acre-ft

Calculated Parameters for Spillway

Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52
CUHP Runoff Volume (acre-ft) =	0.871	3.250	2.420	3.184	3.797	4.625	5.440	6.440
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	2.420	3.184	3.797	4.625	5.440	6.440
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.3	0.6	0.8	7.7	15.3	25.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A						
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.02	0.18	0.35	0.58
Peak Inflow Q (cfs) =	N/A	N/A	38.0	50.0	59.0	76.3	91.6	111.0
Peak Outflow Q (cfs) =	0.4	1.2	1.0	1.2	3.6	9.8	18.2	22.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.0	4.3	1.3	1.2	0.9
Structure Controlling Flow =	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.2	0.8	1.5	1.9
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	67	61	68	70	69	68	66
Time to Drain 99% of Inflow Volume (hours) =	**40**	72	65	72	76	75	75	74
Maximum Ponding Depth (ft) =	2.94	5.17	4.29	4.95	5.39	5.67	5.94	6.42
Area at Maximum Ponding Depth (acres) =	0.94	1.15	1.09	1.14	1.17	1.19	1.22	1.26
Maximum Volume Stored (acre-ft) =	0.879	3.251	2.266	2.988	3.507	3.826	4.164	4.757

ice

ft^2
feet

eir

feet
feet

ft^2
ft^2

ate

ft^2
feet
radians

5).

500 Year
3.68
10.618
10.618
65.3
1.50
183.8
97.0
1.5
Spillway
2.0
N/A
60
72
7.23
1.32
5.788

DETENTION BASIN OUTLET STRUCTURE DESIGN

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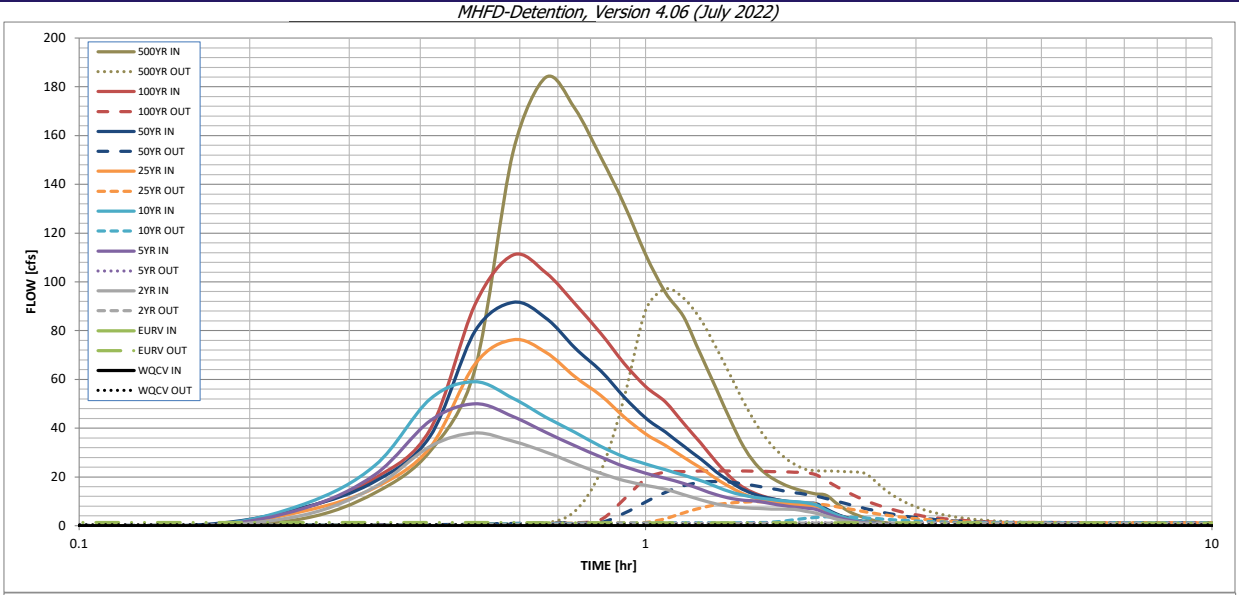

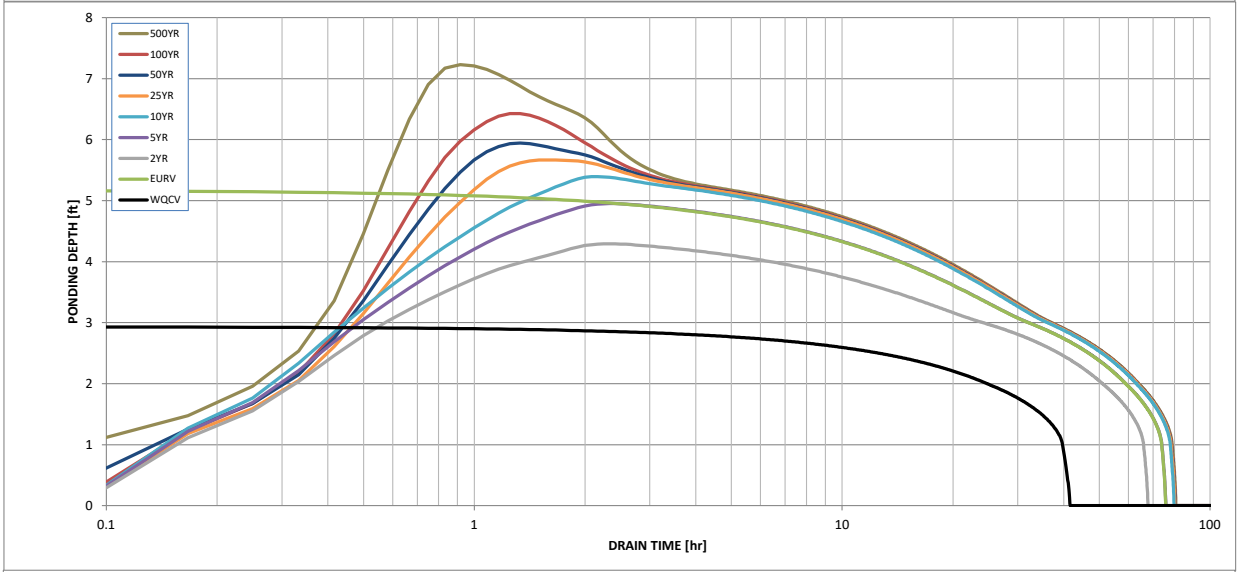

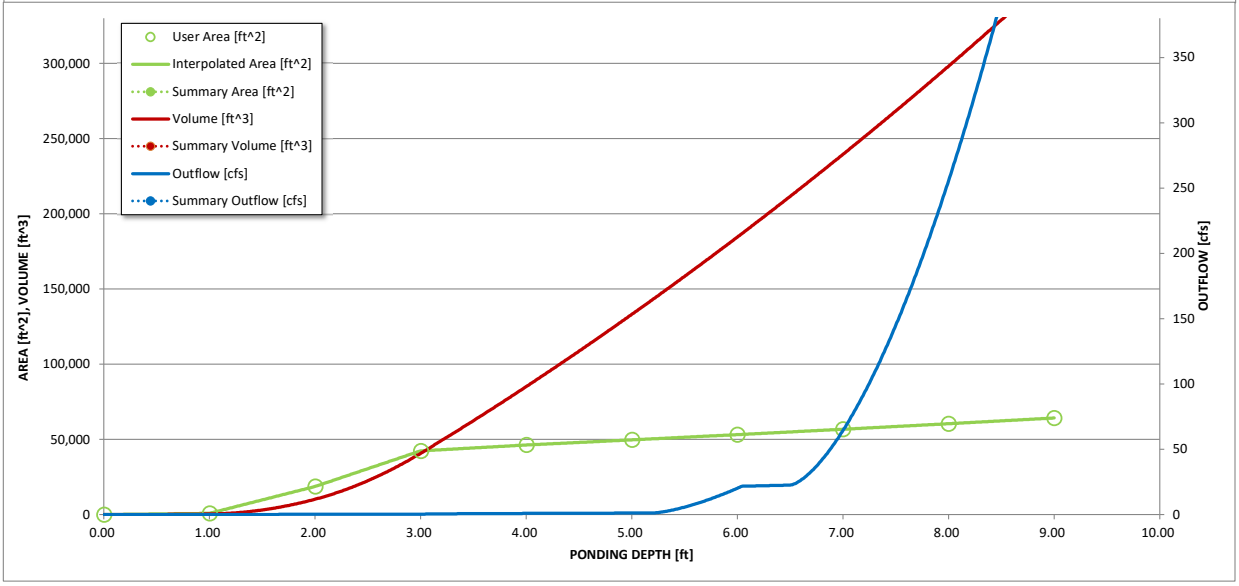

S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.05	2.99
	0:15:00	0.00	0.00	4.43	7.20	8.94	6.01	7.53	7.34	13.50
	0:20:00	0.00	0.00	15.99	21.02	24.75	15.65	18.24	19.54	30.61
	0:25:00	0.00	0.00	32.57	43.04	52.02	32.20	36.74	39.50	64.21
	0:30:00	0.00	0.00	38.00	50.01	58.99	66.24	79.77	90.70	153.22
	0:35:00	0.00	0.00	34.58	44.76	52.23	76.30	91.64	111.00	183.84
	0:40:00	0.00	0.00	30.23	38.29	44.51	71.10	85.23	103.75	171.13
	0:45:00	0.00	0.00	25.49	32.74	38.28	61.09	72.97	91.10	151.18
	0:50:00	0.00	0.00	21.46	28.21	32.54	53.36	63.47	78.86	131.81
	0:55:00	0.00	0.00	18.52	24.27	28.14	44.66	52.75	66.58	111.30
	1:00:00	0.00	0.00	16.57	21.56	25.32	37.65	44.16	57.05	95.71
	1:05:00	0.00	0.00	14.99	19.41	22.99	32.90	38.40	50.80	85.71
	1:10:00	0.00	0.00	12.75	17.36	20.70	28.08	32.62	42.04	70.29
	1:15:00	0.00	0.00	10.64	14.97	18.55	23.74	27.42	34.00	56.12
	1:20:00	0.00	0.00	8.96	12.67	16.04	19.26	22.10	26.11	42.48
	1:25:00	0.00	0.00	7.89	11.18	13.73	15.56	17.67	19.51	31.18
	1:30:00	0.00	0.00	7.34	10.41	12.28	12.71	14.36	15.17	23.95
	1:35:00	0.00	0.00	7.04	9.96	11.36	10.94	12.33	12.67	19.72
	1:40:00	0.00	0.00	6.87	9.01	10.69	9.85	11.08	11.12	17.03
	1:45:00	0.00	0.00	6.75	8.20	10.22	9.11	10.24	10.08	15.19
	1:50:00	0.00	0.00	6.66	7.62	9.88	8.61	9.69	9.37	13.93
	1:55:00	0.00	0.00	5.85	7.19	9.41	8.27	9.30	8.86	13.03
	2:00:00	0.00	0.00	5.12	6.67	8.57	8.03	9.03	8.53	12.46
	2:05:00	0.00	0.00	3.87	5.05	6.45	6.12	6.88	6.48	9.45
	2:10:00	0.00	0.00	2.81	3.64	4.62	4.38	4.92	4.64	6.75
	2:15:00	0.00	0.00	2.02	2.62	3.32	3.16	3.54	3.36	4.88
	2:20:00	0.00	0.00	1.44	1.86	2.38	2.26	2.53	2.42	3.50
	2:25:00	0.00	0.00	1.01	1.28	1.66	1.58	1.76	1.69	2.44
	2:30:00	0.00	0.00	0.68	0.87	1.14	1.09	1.22	1.17	1.68
	2:35:00	0.00	0.00	0.44	0.59	0.77	0.75	0.84	0.80	1.14
	2:40:00	0.00	0.00	0.26	0.37	0.47	0.47	0.52	0.50	0.71
	2:45:00	0.00	0.00	0.13	0.20	0.24	0.26	0.28	0.27	0.37
	2:50:00	0.00	0.00	0.05	0.08	0.10	0.11	0.12	0.11	0.15
	2:55:00	0.00	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.02
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00