Final Drainage Report

For: Ms. Phyllis Didleau

Forest Heights Estates

Project No. 2019.012

January 15, 2024

PCD File No: MS206

Prepared for:
Phyllis Didleau
8250 Forest Heights Drive
Colorado Springs, CO 80908
719-440-1949

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APPENDIX

CERTIFICATIONS AND APPROVALS

Engineer's Statement
The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by El Paso County for drainage reports and said drainage report is in conformity with the master plan of the drainage basin, I accept responsibility for any liability caused by any negligent acts, errors or omission on my part in preparation this report

Signature ______________________
(Kenneth C. Harrison, P.E.)

Registered Professional Engineer State of Colorado No. 23635

Seal

KENNETH C. HARRISON
23635

1/17/24

Owner's Statement
I, the Owner, Phyllis Didleau have read and will comply with all of the requirements specified in this drainage report and plan.

Phyllis Didleau Sept. 29, 2023
(Signature)

____
(Phyllis Didleau)

Address: 8250 Forest Heights Drive
Colorado Springs, CO 80908

El Paso County
Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 and 2, El Paso County Engineering Criteria Manual and Land Development Code as amended.

Josh Palmer
El Paso County Engineer

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(Signature) (Joshua Palmer)

Date: ______________________

I. REPORT PURPOSE

The purpose of this study is to evaluate the drainage characteristics for the historic and the developed conditions of the **Didleau Subdivision Filing 1** (the site) in accordance with **El Paso County** criteria. The subdivision subdivides the **Didleau** tract into three (3) lots for single family residences. This analysis will demonstrate that there is only a negligible increase in runoff with the development of the site.

II. GENERAL DESCRIPTION

Location

The site is a portion of the southwest quarter of Section 9, Township 12 South, Range 65 West of the 6th Principal Meridian, El Paso County, Colorado *(Exhibit 1, Appendix).*

The current tract consists of approximately 32.59 acres with 5.11 acres located north of Forest Heights Circle and 27.48 acres located south of Forest Heights Circle. It is proposed to subdivide the tract into 3 lots. The sizes of the lots are:

- Lot 1: 5.0 acres north of Forest Heights Circle
- Lot 2: 5.183 acres south of Forest Heights Circle
- Lot 3: 7.686 acres south of Forest Heights Circle
- Lot 4: 12.108 acres south of Forest Heights Circle
- Tract A: 0.598 acres of the existing 60-foot-wide roadway right of way beginning at the easterly right of way line of Herring Road extending easterly for approximately 434-feet.
- Tract B: 2.093 acres from approximately 950 feet east of Herring Road to the existing cul-de-sac at the easterly end of Forest Heights Road.
- The roadway is also designed with two (2) areas to accommodate fire trucks.

There is a 40-foot-wide easement where three (3) gas lines are located and run north and south. Two (2) carry natural gas are owned and managed by Kinder Morgan. The third line carries liquid petroleum and is owned by Magellan. Contact information is on “flags” located directly over the lines. It is recommended that the contractor notify the companies 72 hours in advance of construction.

III. DESIGN CRITERIA AND METHODOLOGY

The hydrologic and hydraulic characteristics for both the historic and developed conditions of the site were evaluated using the following resources:

- ***Design Manuals***
  - ***El Paso County Drainage Criteria Manual, Volume I.***
    The charts and graphs used from this manual are reproduced in *Exhibit 4 of the Appendix.*
  - ***City of Colorado Springs Drainage Criteria Manual applicable charts and nomographs were included.***
    The charts and graphs used from this manual are reproduced in *Exhibit 4 of the Appendix.*
  - **Soil Survey of El Paso County Area, Colorado United States Department of Agriculture, Soil Conservation Service**
    (See Appendix, Exhibit 3)

  - ***Flood Insurance Rate Map, Federal Emergency Management Agency***
    (See Appendix, Exhibit 2)

  - ***Kettle Creek Drainage Basin Planning Study***
    (See Appendix, Exhibit 5)

- **Design storms**
  - Minor storm: 5-year
    This storm was used to size drainage facilities that cross under Forest Heights Circle.
  - Major storm: 100-year
    This storm was used to evaluate overland flow through the subdivision as it pertains to impacts on existing residences and the existing roadway when overtopped.

- **Drainage Areas**
  - Areas for the offsite and onsite sub basins were determined from topographic mapping from the El Paso County GIS department. This mapping was used as the base for the Drainage Map included in a map pocket (*Exhibit 11, Appendix)* at the back of this report.

- **Runoff Methods**
  - ***Rational Method***
    This method is used to determine runoff quantities for sub basins with less than 100 acres. Intensity-Duration-Frequency (IDF) curves were obtained from the EPC Drainage Criteria Manual (DCM) (*Appendix, Exhibit 4*).

- **Culvert Evaluation**
  Sizing
  - The criteria in Table 6-1 of the Drainage Criteria Manual Chapter 6 were used as the criteria by which each culvert was evaluated.
  - The 100-year storm was used to evaluate the over topping and/or overflow conditions at the three (3) culverts under Forest Heights Drive as well as impacts on the existing structures within the vicinity of the existing swales discussed in this report.

- **Drainage Swale and Borrow Ditch Evaluation**
  - Onsite and offsite drainage swales and the borrow ditches on north side of Forest Heights Drive were evaluated for erosion potential and depth of flow.
  - The assumptions that were made in the evaluation of the culverts are described in the pertinent sections of the report.
  - The Froude Number was calculated to determine the state of flow, subcritical vs. supercritical. Supercritical flow only became an issue when excessive velocities were calculated for either the minor or major storm events.

- **Detention/ Water Quality**
  - The detention/ water quality pond requirements are addressed in Section XII.

- ***Erosion control***
  - Erosion issues were identified and evaluated based on the estimated velocities in the existing swales.

IV. EXISTING REPORTS, MAPPING AND INFORMATION

- The project is located in the upper reaches of the **Kettle Creek Drainage Basin** *(Appendix, Exhibit 5).*
- No drainage reports have been prepared for any of the tracts that surround the site.

V. FEMA FLOODPLAIN

The project is within Zone X as shown on the Flood Rate Insurance Map, El Paso County, Colorado and Incorporated Areas, Map Number 08041C0320G, and dated December 7, 2018. (*Appendix, Exhibit 2).* New construction within this zone is subject to minimal flooding hazards.

VI. HYDROLOGIC SOILS INFORMATION

The hydrologic soils groups were obtained from the USDA National Resource Conservation Service website for soil types in El Paso County, Colorado ***(Appendix, Exhibit 3)***. The soils are identified as follows:

- Elbeth sandy loam (SCS No. 26)
- Kettle Gravelly Loam (SCS No. 40)

The soils and their detailed characteristics are described in ***Exhibit 3, Appendix***. The hydraulic soils group is classified within the B hydrologic group.

VII. OFFSITE DRAINAGE CONDITIONS

Topographic mapping was obtained from El Paso County GIS Department. The site drains from northeast to southwest through the site. There are five (5) defined drainageways that enter and exit the site. All of the drainageways discharge into the Burgess River which discharges into Kettle Creek. The vegetation is characterized by highland grasses and Ponderosa Pine trees. The areas are typically developed as rural large-acre single-family residential tracts with only a small portion of each tract mowed around the residences. The majority of the roads that provide access to these tracts are two lane rural gravel roads with borrow ditches.

VIII. EXISTING/ PROPOSED CONDITIONS CHARACTERISTICS

1.0 General

The proposed hydrologic conditions for this site are nearly identical as the existing conditions except for the construction of single-family residential structures. As a result, both the existing and developed conditions are discussed in this section.

The site is primarily hilly with natural drainage ways. The site, both north and south of Forest Heights Drive, slope from the northeast to the southwest with an average slope of 4.5%. The drainage ways cross Forest Heights Drive via culverts at three (3) locations. The existing Corrugated Metal Pipes (CMPs) will be replaced by Reinforced Concrete Pipe

(RCP) culverts. The size of the proposed pipes will be further described within this section.

The site is vegetated with medium height prairie grasses, small bushes, and Ponderosa Pines. A portion of the site was burned by the Black Forest fire in 2013. There are only negligible signs of erosion except for a small amount in the borrow ditches along both sides of Forest Heights Circle. A significant amount of ash has silted the existing culverts.

The subdivision is located in the northerly end of El Paso County in the upper reaches of Kettle Creek ***(Exhibit 5, Appendix)***.

1.1 Forest Heights Drive

Forest Heights Drive serves as the primary access for the subdivision. The road was initially built in the 1970's. Minimal maintenance has been accomplished since then. The proposed construction will be accomplished according to the El Paso County criteria. The proposed private road is to be a graveled two-lane road with borrow ditches on either side along with three (3) culvert crossings. The road extends approximately 2,450-feet east of the Herring Drive intersection. Forest Heights Circle is currently privately owned and maintained. The improvements are to extend from the Herring Drive intersection to approximately 2400 feet east to an existing cul-de-sac.

The road has a "right-of-way" width of 60 feet with a small portion of only 30-feet wide adjacent to and south of the Yonce lot. The road is currently maintained by Jon and Phyllis Didleau. Future maintenance will be through a maintenance association" will be established and executed by the majority of the homeowners (Exhibit 14, Appendix)

The road crosses three (3) drainage ways, all of which will be discussed in subsequent sections of this report. The approximate locations of the crossings are shown on the drainage plan included in *Exhibit 16, Appendix at* the back of the report.

The erosion and subsequent sedimentation within the project are minimal and only occurs during large storm events. The majority of the erosion and sedimentation has occurred in sections of the existing roadside borrow ditches along each side of Forest Heights Circle. To help minimize erosion and sedimentation during construction, BMPs are recommended. The types and locations of the BMPS are indicated on the Grading and Erosion Control Plan.

1.3 Swales

The site is drained by five (5) natural swales, three (3) of which cross Forest Heights Circle via existing 18-inch CMP culverts. In proposed conditions, the existing CMP culverts at Culverts 1 & 2 will be replaced with a 24" RCP at each culvert location. Culvert 3 will be replaced with an 18" RCP. The water is then carried in a southwest direction. All of the swales, with the exception of the borrow ditches along Forest Heights Circle, are characterized as follows:

- The drainage-ways cross the site in a northeast to southwest direction. They are characterized by large natural cross sections with large bottom widths and gentle side slopes.
- Seasonally wet areas are located in and along low areas and at locations where seasonal ground water comes to the surface. The approximate location of these areas is shown on the Grading and Erosion Control Plan. Drainage easements are shown on the plat along the locations of the swales.
- The upper reaches of the Burgess River, noted as Swale 1, crosses at the most

easterly end of Forest Heights Circle at DP1.

- All of the drainage ways are well established and stable with natural vegetation and only a negligible amount of erosion as shown in the pictures.
- All swales were evaluated for Developed Conditions.

1.4 Culverts

There are three (3) Corrugated Metal Pipe (CMP) culverts that are to be replaced with Reinforced Concrete Pipe (RCP) culverts routes the water under Forest Heights Circle. All three (3) culverts were evaluated based on inlet control with a free outfall and no sediment. Each culvert is discussed under the applicable Design Point (DP) numbers included in the following sections. As explained above, the sediment in the existing culverts consist of a significant amount of ash and silt. The proposed culverts cross under Forest Heights Circle at stations: 1+70, 12+32, and 22+55 feet east of the Herring Road intersection. The proposed culvert locations and profiles can be found on the submitted Roadway Construction Set. Once under Forest Heights Circle the water is routed in a southwesterly direction in natural drainage swales with the same characteristics as described above. All of the swales are stable with only negligible signs of erosion. The depth of flow for water overtopping the road has been evaluated in accordance with DCMV1, Chapter 6.

2.0 Design Points

The Design Points (DP) shown on the Drainage Map were located where natural drainage ways cross Forest Heights Circle, swale intersections, and any other point of interest.

2.1 Design Point 1

Runoff from Sub basin A (16.1 Acres) is collected via a natural swale. In existing conditions, the water is routed to an existing 18” CMP culvert (Culvert 1) which discharges into a natural broad swale. This culvert is approximately 75% full of ash from the 2013 fire and negligible amount of sediment from upstream. It is recommended that this culvert be replaced with a 24” RCP culvert attached to concrete headwall at the downstream side of Forest Heights Circle. Both Swales 1 and 2 are heavily vegetated and only show a negligible amount of erosion (photo 2, 6). Special precautions will be needed in constructing the road in the vicinity of the culvert. There is an apparent “Riparian Wetland” area found both upstream and downstream of the culvert. Approximate boundaries are indicated on the Drainage Plan. Accurate identification and boundaries of the wetland areas are beyond the scope of this report.

Swale 1 has the following:

Physical Characteristics:

- Average slope: 4.5 %
- Bottom width: varies from 50 feet to 75 feet
- Average side slopes: varies from 15 to 1.
- Typical vegetation: Highland grasses, bushes and Ponderosa Pines trees.

Hydrologic/ hydraulic characteristics;

- Design flow: Q5 = 3.1 cfs, Q100 =16.3 cfs
- Depth of Flow: 5 year = 0.0 feet, 100 year = 0.1 feet
- Velocity: 5 year = 1.1 fps, 100 year = 2.3 fps
- Froude #: 5 year = 0.87 Subcritical, 100 year = 1.11 supercritical.

Discussion:
Swale 1 collects the water in sub basin A and directs it to the proposed 24" RCP culvert under the private road at DP1. From DP1, this runoff is routed to DP6 where it combines with runoff from sub-basin F and G. The swale from DP2 to DP6 is noted as Swale 2 and 12 on the drainage plan. The existing swale is very stable with significant vegetation.

Existing Culvert 1 has the following:

P*hysical* characteristics:

- Size: 18"
- Material: Corrugated Metal Pipe
- Slope: Unknown
- End Sections: None

Hydrologic/ hydraulic characteristics:

- Existing Design flow: Q5 = 3.0 cfs, Q100 = 16.1 cfs
- Headwater required to pass (for clean pipe): 5 year = 12.8", 100 year = greater than 7.5 feet (significant roadway overtopping occurs) Based on conversations with the residents, roadway overtopping has infrequently occurred with larger storm events.

Discussion:

The existing culvert has minimal capacity due to sedimentation and the poor end conditions. Overtopping of the roadway is anticipated even with possibly the minor storm event. The downstream end (photo 5) controls the amount of water that the culvert can accommodate. The end is buried with approximately 75% of sediment where wetlands have been established. Sediment removal in the bottom of the existing swale is not recommended since this would require excavating the existing wetland areas for a significant distance downstream.

Proposed Culvert 1 has the following:

P*hysical* characteristics:

- Size: 24"
- Material: Reinforced Concrete Pipe
- Slope: 5.4%
- End Sections:
  - Upstream: 24" RCP Flared End Section (FES)
  - Downstream: Concrete Headwall/Level Spreader

Hydrologic/ hydraulic characteristics:

- Proposed Design flow: Q5 = 3.1 cfs, Q100 = 16.3 cfs
- Invert Elevation: 7579.5 feet
- Crown Elevation: 7583.0 feet
- Max Pipe Flow: 24.0 cfs
- No Roadway Overtopping in the 5-year event
- No Roadway Overtopping in 100-year event

Discussion: Riprap calculations for the outfall require type VL riprap pad 5' wide and 14' long. Site constraints limit the size of the pad to 8' in length maximum. Therefore in lieu of the riprap pad specified in the construction drawings, a concrete stilling basin with baffles and level spreader 7.17' long and flaring to 11.7' wide is specified and detailed in the construction drawings. This stilling basin with baffles will function to reduce the velocities and properly spread the outflows to prevent concentrated discharge.

2.2 Design Point 2

Runoff from Sub basin B (20.4 Acres) is collected via a natural swale, Swales 3, 3a, and 3b, and passes under Forest Heights Circle at DP2 (photos 17, 18, 19). The water passes under Forest Heights Circle via an 18" CMP, Culvert 2 (photos 21 and 24) in existing conditions. This culvert will be replaced with a 24" RCP. There are no wetlands draining to Design Point 2 according to the US Fish and Wildlife National Wetlands Inventory.

Swales 3, 3a, 3b have the following:

Average physical characteristics:

- Average slope: 4.6 %
- Bottom width: varies from 20 feet to 40 feet
- Average side slopes: 10 to 1.
- Typical vegetation: meadow with high grass, bushes, with a few Ponderosa Pines.

Hydrologic/ hydraulic characteristics:

- Design flow: Q5 = 4.2 cfs, Q100 = 22.8 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.3 feet
- Velocity: 5 year = 1.7 fps, 100 year = 3.3 fps
- Froude #: 5 year = 1.02 Supercritical, 100 year = 1.22 Supercritical

Discussion:

Swale 3a and 3b join together at approximately 300 feet upstream of the culvert (Culvert 2). The vegetation along the entire length of Swale 3 is well established with only a minimal amount of erosion.

Existing Culvert 2 has the following:

Physical characteristics:

- Size: 18"
- Material: Corrugated Metal
- Slope: Undetermined
- Condition: ends are crushed, heavy sediment, dense grass and weed growth at both the upstream and downstream ends.
- End Sections: no end sections are present.

Hydrologic/ hydraulic characteristics:

- Existing flow: Q5 = 4.5 cfs, Q100 = 21.5 cfs
- Headwater for clean pipe: 5 year = 15.3" (meets criteria), 100 year = >9ft (does not meet criteria, significant road overtopping occurs, no buildings are in danger of being inundated)

Discussion:

The existing culvert has minimal capacity due to the amount of sediment and poor end conditions. Overtopping of the roadway is anticipated even with minor storm events. The downstream end controls the amount of water that the culvert can accommodate. The end is buried approximately 75% in the sediment where grass and weeds have choked the exit conditions.

Proposed Culvert 2 has the following:

Physical characteristics:

- Size: 24"
- Material: Reinforced Concrete
- Slope: 3.2%
- End Sections: 24" RCP Flared End Sections (FES) on upstream & downstream.

- Type M Void Filled Riprap on downstream portion.

Hydrologic/ hydraulic characteristics:

- Proposed Design flow: Q5 = 4.3 cfs, Q100 = 21.2 cfs
- Invert Elevation: 7548.4 feet
- Roadway Crown Elevation: 7553.99 feet
- Max Pipe Flow: 29.9 cfs
- No Roadway Overtopping in 5-year event
- No Roadway Overtopping in 100-year event

Discussion: All culvert pipe flows continue south downstream in the existing natural swale. Riprap calculations for the outfall require type L riprap pad 6' wide and 20' long. Site constraints limit the size of the pad to 8' in length. Therefor the riprap pad specified in the construction drawings is 8' wide, flaring to 16' wide with 13' length. Riprap sizing shall be type VL grouted riprap with a 24" dia. boulder at the culvert outlet to function as a baffle to reduce the velocities to account for the reduced length.

2.3 Design Point 3

Runoff from Sub basin C, D, and overflow flow from Culvert 2 is collected by the roadside Swales 15 &16. Runoff from Sub basin E (2.3 acres) is routed to DP3 via a natural swale. The cumulative water (Q5: 5.9 cfs, Q100: 33.7 cfs) passes under Forest Heights Circle via an 18" corrugated culvert (Culvert 3) (photo 41, 43). The existing culvert is to be replaced by a proposed 18" RCP culvert.

From DP3 the runoff is routed in a broadly defined swale, Swale 8, south of Forest Heights Road in a southwesterly direction. The swale is characterized by a wide bottom with very gradual side slopes. The area in which Swale 8 is located is a seasonal wet area. No erosion or sedimentation has been noted along the entire length of Swale 8. These flows continue to DP4 located within the southern portion of Sub-basin I.

Swale 8 has the following:

Physical characteristics:

- Average slope: 3.3 %
- Bottom width: average of 35 feet.
- Average side slopes: varies from 30 to 1.
- Typical vegetation: regularly mowed and maintained

Hydrologic/ hydraulic characteristics;

- Design flow: Q5 = 6.3 cfs, Q100 = 29.3 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.3 feet
- Velocity: 5 year = 1.6 fps, 100 year = 2.7 fps
- Froude #: 5 year = 0.92 Subcritical, 100 year = 1.02 super critical

Discussion:

- There are no proposed change of imperviousness within Sub-basin I as this sub-basin contains offsite property.

Swale 6 has the following:

Physical characteristics:

- Average slope: 6.0 %
- Bottom width: varies from 20 feet to 30 feet
- Average side slopes: varies from 10 to 1.
- Typical vegetation: meadow with high grass and Ponderosa Pine trees

Hydrologic/ hydraulic characteristics:

- Proposed Design flow: Q5 = 2.5 cfs, Q100 = 12.2 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.2 feet
- Velocity: 5 year = 1.5 fps, 100 year = 2.8 fps
- Froude #: 5 year = 1.08 Supercritical, 100 year = 1.28 super critical

Existing Culvert 3 has the following:

Physical characteristics:

- Size:18”
- Material: Corrugated Metal Pipe
- Slope: Undetermined
- Condition: silted to about 80%.
- End Sections: none

Hydrologic/ hydraulic characteristics:

- Design flow: Q5 = 4.5 cfs, Q100 = 21.5 cfs (includes runoff from Sub basin C, D & E)
- Depth required to pass: 5 year = 16.7” (meets El Paso County criteria), 100 year =>9 ft. (does not meets El Paso County criteria except that no buildings will be inundated).

Discussion:

- The existing culvert is approximately 80% full of silt and ash from the 2013 fire and only passes a portion of the minor storm event. It is expected that the roadway will be overtopped during the majority of the minor storm events and well as all the major storm events. There are no structures downstream that are in danger of being flooded.

Proposed Culvert 3 has the following:

Physical characteristics:

- Size:18”
- Material: Reinforced Concrete Pipe
- Slope: 1.0%
- End Sections: 18” RCP Flared End Sections (FES) on upstream and downstream.
- Type VL Riprap on downstream.

Hydrologic/ hydraulic characteristics:

- Design flow: Q5 = 4.3 cfs, Q100 = 21.2 cfs (includes runoff from Sub basin C, D & E)
- Invert Elevation: 7515.50 feet
- Max Ponding Elevation: 7518.2 feet
- Max Depth: 2.7 feet
- Pipe Flow: Q5 = 4.3 cfs, Q100 = 13.1 cfs
- Roadway Overtopping: Q5 = 0 cfs, Q100 = 8.1 cfs

- Max Depth Above Road Crown: >0.1 feet

Discussion: The roadway is overtopped in the 100-year event as currently happens in the existing condition. All culvert pipe flows and overtop flows continue south downstream in the existing natural swale. Riprap calculations for the outfall require type L riprap pad 5' wide and 10' long. Site constraints limit the size of the pad to 8' in length. Therefor the riprap pad specified in the construction drawings is 5' wide, flaring to 10' wide with 8' length. Riprap sizing shall be type VL grouted riprap with a 24" dia. boulder at the culvert outlet to function as a baffle to reduce the velocities to account for the reduced length.

2.5 Design Point 4

Once the water passes under Forest Heights Drive via Culvert 3 at DP3, the water is routed to a private 18" CMP located under an existing ***private*** paved residential driveway located south of the Forest Heights' subdivision. This driveway is ***not located*** in the proposed subdivision. Analysis of this culvert indicated that overtopping of the driveway will occur in both the existing and proposed conditions. Since the change in runoff, as a result development is negligible (Q5 = 0.1 cfs, Q100 = -0.1 cfs) ,it is concluded that the increase in the flows will not adversely affect the existing hydraulic properties of the existing private driveway culvert.

Culvert at Design Point 4 **(privately owned and maintained)** is located to the south of the project site under a paved driveway. The property currently contains no residential structures. The culvert has the following:
Hydrologic/ hydraulic characteristics:

- Existing Design Flow: Q5 = 6.2 cfs, Q100 = 29.4 cfs
- Design flow: Q5 = 6.3 cfs, Q100 = 29.3 cfs. This represents runoff from Design Point 3 which includes Sub-basins: C, D, E plus sub-basin I.
- Runoff from Sub basin I flows southerly via Swale 8 to the "ponding" area located upstream of the culvert at Design Point 4.

Flows at this location are negligibly affected with change in discharges of Q5 = 0.1 cfs increase and Q100 = 0.1 cfs decrease. The drainage area is considerably larger than the total area of the proposed subdivision.

2.6 Design Point 5

DP5 is located at an existing culvert that crosses Herring Road. DP5 contains flows from Swales 4 & 8. This runoff flows into a "natural ponding area" next to Herring Road. These flows are conveyed by an existing 30" CMP to the west across Herring Road. The ponding area is poorly defined and only seasonally wet. Due to the minimal increase in storm water flow (Appendix, Exhibit 4) it is concluded that the increase will have no detrimental effect on downstream property owners and drainage facilities.

Swale 4 has the following:

Physical characteristics:

- Average slope: 3.3 %
- Bottom width: average of 85 feet.
- Average side slopes: varies from 3 to 1.
- Typical vegetation: regularly mowed and maintained.

Hydrologic/ hydraulic characteristics:

- Design flow: Q5 = 8.1 cfs, Q100 = 44.5 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.2 feet
- Velocity: 5 year = 1.3 fps, 100 year = 2.9 fps
- Froude #: 5 year = 0.83 Subcritical, 100 year = 0.99 subcritical

Swale 8 has the following:

Physical characteristics:

- Average slope: 3.3 %
- Bottom width: average of 35 feet.
- Average side slopes: varies from 30 to 1.
- Typical vegetation: regularly mowed and maintained.

Hydrologic/ hydraulic characteristics:

- Design flow: Q5 = 6.3 cfs, Q100 = 29.3 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.3 feet
- Velocity: 5 year = 1.6 fps, 100 year = 2.7 fps
- Froude #: 5 year = 0.92 Subcritical, 100 year = 1.02 super critical

- Discussion: In the existing condition the total flows at Design Point 5 are Q5 = 10.4 cfs and Q100 = 57.7 cfs. The developed Design flows at Design Point 5 are Q5 = 11.3 cfs, Q100 = 58.9 cfs. This represents negligible increases of 0.9 cfs in the 5-year event and 1.1 cfs in the 100-year event. In the existing condition, the 100-year event overtops the road at a depth of 0.06' with 0.11' in the developed. The increase of 1.1 cfs in the developed condition has negligible effect on the depth. The increase in flows has a negligible effect on the existing conditions at DP5.

2.7 Design Point 6

Runoff from Sub basin A, F, G (42.8 acres) is collected via a natural swale, Swale 12, and is routed to DP7. The swale is also noted as the upper portion of the Burgess River. The characteristics that are listed below were obtained from measurements taken from topographic data provided by El Paso County for the portion of the Burgess River located in Sub basin G. This section of the Burgess River is characterized by large bottom widths, gradual side slopes, relatively steep slopes, and established wetlands. These flows continue offsite as in existing conditions with negligible impacts to the downstream neighbors.

Swale 12 has the following:

Physical characteristics:

- Average slope: 6.1%
- Bottom width: 40 feet
- Average side slopes: 15 to 1.
- Typical vegetation: meadow with well-established high grass, wetland plant species, and a few Ponderosa Pine trees

Hydrologic characteristics:

- Design flow: Q5 = 11.0 cfs, Q100 = 59.8 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.3 feet
- Velocity: 5 year = 2.3 fps, 100 year = 4.4 fps

  - Froude #: 5 year = 1.25 Supercritical, 100 year = 1.48 Supercritical,
  - BMPs: as shown on the Grading and Erosion Control Plan

Discussion: The total existing condition flows at Design Point 6 are Q5 = 10.4 cfs and Q100 = 59.1 cfs. The developed Design flows at Design Point 6 are Q5 = 11.0 cfs, Q100 = 59.8 cfs. This represents negligible increases of 0.6 cfs in the 5-year event and 0.7 cfs in the 100-year event.

2.8 Design Point 7

Runoff from Sub basin J (4.4 acres) is collected via Swale 11. Water in this swale exits the project site at DP7. The upper end of the swale begins approximately at the southerly property line of Lot 3. These flows continue offsite as in existing conditions with negligible impacts to the downstream neighbors.

Swale 11 has the following:

Physical characteristics:
  - Average slope: 3.1%
  - Bottom width: average of 60 feet.
  - Average side slopes: varies from 15 to 1.
  - Typical vegetation: regularly mowed and maintained.

Hydrologic/ hydraulic characteristics:
  - Design flow: Q5 = 1.1 cfs, Q100 = 8.0 cfs
  - Depth of Flow: 5 year = Neg, 100 year = 0.1 feet
  - Velocity: 5 year = 0.6 fps, 100 year = 1.4 fps
  - Froude #: 5 year = 0.64 Subcritical, 100 year = 0.82 subcritical

Discussion: The total existing condition flows at Design Point 7 are Q5 = 1.1 cfs and Q100 = 8.0 cfs. The developed condition Design flows at Design Point 7 are the same as existing with no increase in the 5-year event or the 100-year event.

3.0 Roadside Swales

The following hydraulic and hydrologic analyses are based on the following conditions and assumptions:

- The areas of the sub basins contributing runoff to the roadside borrow ditches were estimated. Typically, not all of the runoff from sub basins enters the swales adjacent to the road. Some of the water is routed directly to the culvert via existing swales located within the sub basin. It was assumed there would be no backwater due to limited culvert capacity. However, without further field information and culvert analysis, this condition is not possible to accurately determine. Included in the drainage areas is one-half of the gravel roadway.
- The developed flows from the 5-year and 100-year storms were determined based on the percentage of the area assumed to be contributing to the runoff. All flows are based on the developed conditions.
- 5 minutes was used for the Time of Concentration for all swales.
- The slopes of the swales were obtained from the roadway construction plans.
- The physical characteristics of the swales are based on the typical section indicated on the construction plans.
- Types of flow, sub critical and supercritical, were determined for each swale.
- Recommended BMPs were determined from the estimated velocity and not from

flow type.

- BMPs: types and locations are shown on the Grading and Erosion Control Plan

3.1 Swale 13

- Location: Roadside Swale 13 is located along station 17+50 on the north side of Forest Heights Drive between DP1 & DP2. Flow is directed from the east to the west.
- Drainage Area: 0.41 acres
- Design flow: Q100 = 5.7 cfs
- Slope: 6.7%
- Depth of Flow: 100 year = 0.84 feet
- Velocity: 100 year = 2.3 fps
- Froude #: 100 year: supercritical
- BMPs: as shown on the Grading and Erosion Control Plan

3.2 Swale 14

- Location: Roadside Swale 14 is located along station 14+50 on the north side of Forest Heights Drive from DP1 to DP2. Flow is directed from the west to the east. Runoff from a small section of Sub basin B is handled by this swale.
- Drainage Area: 0.4 acres
- Design flow: Q100 = 0.1 cfs
- Slope: 1.0%
- Depth of Flow: 100 year = 0.2 feet
- Velocity: 100 year = 0.8 fps
- Froude #: 100 year: subcritical
- BMPs: as shown on the Grading and Erosion Control Plan

3.3 Swale 15

- Location: Roadside Swale 15 is located along station 4+50 on the north side of Forest Heights Drive from just west of DP2 to culvert 3. It collects water from a portion of Sub basin D. There is no swale along the south side of Forest Heights Drive since all of the water flows overland to the south away from the road.
- Drainage Area: <0.1 acres
- Design flow: Q100 =10.7 cfs
- Slope: 4.4%
- Depth of Flow: 100 year = 0.8 feet
- Velocity: 100 year = 4.7 fps
- Froude 100 year = Supercritical
- BMPs: 4 Ditch Check Structures installed every 135 feet from Sta 4+50 to 9+25
- BMPs: as shown on the Grading and Erosion Control Plan

3.4 Swale 16

- Location: Roadside Swale 16 is located along station 2+25 on the north side of Forest Heights Drive from just west of DP2 to culvert 3. It collects water from a portion of Sub basin D. There is no swale along the south side of Forest Heights Drive since all of the water flows overland to the south away from the road.
- Drainage Area: 5.1 acres
- Design flow: Q100 = 15.7 cfs
- Slope: 4.4%
- Depth of Flow: 100 year = 1.1 feet
- Velocity: 100 year = 3.8 fps

- Froude #: 100 year = Sub critical.
- BMPs: as shown on the Grading and Erosion Control Plan

IX. REPRESENTATIVE DEVELOPED CONDITIONS CHARACTERISTICS

General Overview

The developed conditions were evaluated based on the following conservative assumptions. The assumptions are representative of the type of “development” that has historically occurred within the adjacent areas.

Developed Lot Areas

A hypothetical developed conditions was added to the runoff spreadsheets for the basins containing the most likely building sire for the developed individual lots. The improvements to each lot would typically include a residence and a paved driveway. Asphalt pavement was assumed to be conservative in these calculations. Basin B and Basin G are assumed to contain a new building site along with Basin H containing two new buildings.

Area of proposed development for each Lot:

- Roof area: 5000 sf
- Asphalt Drive: 5,000 sf

Time of Concentration

Design runoff is determined using the longest time of concentration. It was expected that even for the “developed” conditions of the project, the controlling time of concentration would be the same as for the existing conditions. The following summarizes the negligible impact that the “developed” conditions have on the total runoff at the individual Design Points (Exhibit 9) as well as the negligible impact on the hydraulic parameters of each culvert (Exhibit 10).

X. COMPARISON BETWEEN EXISTING AND DEVELOPED RUNOFF

All recommended drainage facilities were designed based on developed conditions. Since there are only negligible increases in the design flows (see Appendix), subsequent changes to all of the hydraulic characteristics; velocity, Froude number, depth, etc.; are minimal.

Sub Basin A

- Existing Discharge: 5 year = 3.0 cfs, 100 year = 16.1 cfs
- “Developed” Discharge: 5 year = 3.1 cfs, 100 year = 16.3 cfs
- Negligible changes to hydrologic conditions

Sub Basin B

- Existing Discharge: 5 year = 3.9 cfs, 100 year = 22.4 cfs
- “Developed” Discharge: 5 year = 4.2 cfs, 100 year = 22.8 cfs
- Negligible changes to hydrologic conditions

Sub Basin C

- Existing Discharge: 5 year = 1.6 cfs, 100 year = 8.2 cfs

- “Developed” Discharge: 5 year = 1.6 cfs, 100 year = 8.2 cfs
- No changes to hydrologic conditions

Sub Basin D
- Existing Discharge: 5 year = 2.7 cfs, 100 year = 12.4 cfs
- “Developed” Discharge: 5 year = 2.5 cfs, 100 year = 12.2 cfs
- Negligible changes to hydrologic conditions

Sub Basin E
- Existing Discharge: 5 year = 0.9 cfs, 100 year = 3.9 cfs
- “Developed” Discharge: 5 year = 0.9 cfs, 100 year = 3.9 cfs
- No changes to hydrologic conditions

Sub Basin F
- Existing Discharge: 5 year = 4.2 cfs, 100 year = 25.4 cfs
- “Developed” Discharge: 5 year = 4.2 cfs, 100 year = 25.4 cfs
- No changes to hydrologic conditions

Sub Basin G
- Existing Discharge: 5 year = 2.8 cfs, 100 year = 15.9 cfs
- “Developed” Discharge: 5 year = 3.5 cfs, 100 year =16.8 cfs
- Minimal changes to hydrologic conditions

Sub Basin H
- Existing Discharge: 5 year = 4.3 cfs, 100 year = 27.3 cfs
- “Developed” Discharge: 5 year = 5.1 cfs, 100 year = 28.4 cfs
- Minimal changes to hydrologic conditions

Sub Basin I
- Existing Discharge: 5 year = 2.4 cfs, 100 year = 11.0 cfs
- “Developed” Discharge: 5 year = 2.7 cfs, 100 year = 11.4 cfs
- Negligible changes to hydrologic conditions

Sub Basin J
- Existing Discharge: 5 year = 1.1 cfs, 100 year = 8.0 cfs
- “Developed” Discharge: 5 year = 1.1 cfs, 100 year = 8.0 cfs It is assumed that there will be no development in “J”

Subdivision Discharge (at structure #4 under private driveway) – DP4
- Existing Discharge: 5 year = 6.2 cfs, 100 year = 29.4 cfs
- “Developed” Discharge: 5 year = 6.3 cfs, 100 year = 29.3 cfs
- Negligible changes to hydrologic conditions

Subdivision Discharge (at structure #5 under Herring Road) – DP5
- Existing Discharge: 5 year = 10.4 cfs, 100 year = 57.7 cfs
- “Developed” Discharge: 5 year = 11.3 cfs, 100 year = 58.9 cfs
- Minimal changes to hydrologic conditions

Subdivision Discharge – DP6

- Existing Discharge: 5 year = 10.4 cfs, 100 year = 59.0 cfs
- “Developed” Discharge: 5 year = 11.0 cfs, 100 year = 59.8 cfs
- Negligible changes to hydrologic conditions

Subdivision Discharge – DP7

- Existing Discharge: 5 year = 1.1 cfs, 100 year = 8.0 cfs
- “Developed” Discharge: 5 year = 1.1 cfs, 100 year = 8.0 cfs
- No changes to hydrologic conditions

XI. PROPOSED DRAINAGE IMPROVEMENTS

The following drainage improvements are recommended:

- Grade the cross section of Forest Heights Circle to the revised typical section approved by El Paso County for this project ***(Exhibit 6, Appendix)***
- Replace all of the culverts with 18” & 24” RCP culverts at a minimum slope of 1%. These culverts shall have the specified Flared End Sections, headwalls, and riprap pads as specified in the design point characteristics. The existing culverts are in very poor shape. Both ends are about 75% full of sediment. The ends of the culvert should be installed in accordance with details on the Grading and Erosion Control Plan.
- Locate the inverts for both ends of the culverts at or slightly above the flowline of the upstream and downstream swales. The culvert should be installed at a sufficient slope to allow for a cleansing velocity to develop.
- It is expected that riprap aprons at the downstream ends of Culverts 2 & 3 will be required. Culvert 1 will require a concrete headwall to mitigate erosive conditions. These culverts will experience full pipe flow during the 100-year event with high velocities greater than 7 feet per second. Riprap calculations can be found in the Appendix.
- In downstream natural swales, there is currently a substantial amount of vegetation typical in seasonally wet areas. No mitigation is necessary for these areas.
- Minimize any grading in the areas immediately upstream and downstream of the culverts to protect the existing “seasonally wet areas”. The areas occupied by “wetlands” are very stable. Disturbing the areas with grading would only increase the erosion potential.
- Install erosion control facilities as noted on the Grading and Erosion Control plan.
- Driveway culverts have purposely not been shown since the final locations will be determined during or after construction.

XII. DETENTION AND WATER QUALITY

Since the runoff exits the “development” in numerous locations, installation of a detention water quality pond is not practical. Also, the proposed development only consists of 4 residential lots each with an estimated area of potential disturbance of less than an acre each. It is anticipated the area to be disturbed with the addition of one (1) residence is as follows:

- Roof area: 5000 sf
- Lawn: 0.75 acres; 32,670 sf
- Asphalt Drive: 5,000 sf
- Total Area to be disturbed = 42,670 acres or 0.98 acres

El Paso County Engineering Criteria Manual, Appendix I, contains the policies and procedures for Stormwater Quality. **Section I.7.1.B** provides for exclusions to the requirements to provide Post Construction Stormwater Quality facilities. All areas of the Forest Heights project qualify for the allowed exemptions. No water quality or detention facilities are required for this site as discussed below.

The project consists of 5-acre and larger single-family residential lots and a private gravel road with a 60 foot right of way (Forest Heights Drive). There are no activities or improvements that require permanent water quality facilities for this project based on the exclusions found in **Section I.7.1.5.B.2, Section I.7.1.5.B.3 and Section I.7.1.5.B.5.**

According to **Section I.7.1.B.5**,

"A single-family residential lot, or agricultural zoned lands, greater than or equal to 2.5 acres in size per dwelling and having a total lot impervious area of less than 10 percent is excluded."

The total area of the site is 32.59 acres (includes Lots 1 through 4 and the tracts along Forest Heights Road. Of the total 32.59 acres are comprised of lots varying in size from 5.00 acres to 12.11 acres residential lots and the remaining 2.691 acres is right-of-way along Forest Heights Drive. The total proposed disturbance to construct/ improve the road will be 3.4 acres which is also indicated on page 2 of the ESQCP. The total lot imperviousness for rural residential lots is less than 10%.

Section I.7.1.B.2 of the ECM provides exclusion for Roadway Redevelopment as follows:

"Redevelopment sites for existing roadways, when 1 of the following criteria is met: 1) The site adds less than 1 acre of paved area per mile of roadway to an existing roadway, or 2) The site does not add more than 8.25 feet of paved width at any location to the existing roadway".

The project involves adding new gravel surface to the existing Forest Heights Drive roadway to meet El Paso requirements. No asphalt pavement will be added to the roadway (criteria 1). The total area of disturbance for adding the gravel is 0.74 acres (criteria 1). The roadway width will be expanded from an average of 20' wide to a consistent 24' width of the travel way with 1' shoulders (criteria 2).

Also, **Section I.7.1.B.3** excludes Existing Roadway Areas.

"For redevelopment sites for existing roadways, only the area of the existing roadway is excluded from the requirements of an applicable development site when the site does not increase the width by 2 times or more, on average, of the original roadway area. The *entire site is not excluded from being considered an applicable development site for this exclusion. The area of the site that is part of the added new roadway area is still an applicable development site".*

Again, the project will add new gravel surface to Forest Heights Drive up to 0.74 acres in area. The roadway width will be expanded from an average of 20' wide to a consistent 24' width of the travel way with 1' shoulders.

Storm Detention is not required for this site since the resulting flow increases from development is found to be negligible and inconsequential as shown in the above sections. The comparison between existing flow and developed is shown on the Drainage Plan and in the applicable section summarized in Section 10 of the Appendix.

XIII. EROSION CONTROL

It is recommended that the following erosion control measures be applied with the Forest Heights Circle improvements and with the construction of the gravel driveways:

- Permanent Seeding (PS) and Mulching (MU) on all non-gravel disturbed areas.
- Ditch Check Structures (See Detail in Appendix)

Erosion control facilities are recommended to minimize erosion in the borrow ditches along both sides of Forest Heights Circle as well as along both sides of proposed gravel driveways accessing the new residences. The erosion control facilities are indicated on the Grading and Erosion Control Plan. It is recommended that temporary facilities include the following:

- Sediment Control Logs (SCLs)
- Silt Fencing (SF)
- Erosion Control Blanket (ECB)
- Vehicle Tracking Control (VTC)
- Stabilized Staging Area (SSA)
- Stockpile Protection (SP)

XIV. RESEEDING AND ALLOWABLE FLOW VELOCITIES

All disturbed areas that are not roadway surfaces or otherwise protected by riprap shall be reseeded using the native seed mix contained in the appendix of this report and on the Grading and Erosion Control Plan for this project. The said native seed mix is a recommended El Paso County Seed Mix from an NRCS memo dated June 19, 2001. The seed mix contains specific species of native seed selected for erosion control properties, suitability to the local climate, growth potential and hardiness. Each of the seed species provides good soil holding capabilities ground coverage. The characteristics of each seed species are shown on the Plant Guides also included in the appendix. The El Paso County Drainage Criteria Manual Table 10-4 is intended to provide guidance on allowable flow velocities for various types of open channel grass linings. However, Table 10-4 does not address species contained in most native grass seed mixtures and is not useful for determining allowable flow velocities with these types of linings. Therefore, a supplemental data table is also included in the appendix which contains better descriptions along with testing and research references that indicate the native grass types in the reseed mix are able to withstand flow velocities ranging from 4 ft/sec to 6 ft/sec or more. With the addition of the rock ditch checks along certain portions of the roadway, flow velocities on all reseeded areas remain below 5 ft/sec and the native grasses are adequate to withstand to flows.

XV. FOUR STEP PROCESS

The El Paso County Engineering Criteria Manual ***(Appendix I, Section I.7.2)*** recommends the consideration of a “Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long term source controls”.

It is determined in the section above that this project is exempt from the requirements of **Section I.7.1** to provide Post Construction Stormwater Management Facilities with Water Quality Capture Volume (WQCV). However, aspects of the Four Step Process are considered and implemented in the Forest Heights project as discussed below.

Step 1: Reduce runoff by disconnecting impervious area, eliminating "unnecessary" impervious area and encouraging infiltration into soils that are suitable.
The impervious areas for the project include roofs, concrete patios and sidewalks, and the possibility of asphalt driveways. All runoff from the impervious areas drains onto open grassed surfaces. All downspouts for each residence are planned to discharge either within landscaped areas or natural areas. The majority of the site will remain in its existing natural condition.

Step 2: Treat and slowly release the WQCV.
This project meets the exemptions or providing Post Construction Stormwater Management Facilities including facilities with Water Quality Capture Volume (WQCV) such as a Full Spectrum Detention Pond and therefore does not have the slow release WQCV component.

Step 3: Stabilize stream channels.
All existing swales will remain heavily vegetated with the existing natural grasses. All of the onsite swales are “U” shaped with wide bottoms widths and gentle side slopes. Based on visual observations the swales are very stable with only negligible indications of erosion. The vegetation for each swale includes medium height prairie grasses that are periodically mowed. It is not anticipated that any of the swales will be modified in the future. No building will be permitted in an area that impedes the existing flow of water. It can be safely assumed that the negligible increase in flow as a result of development will have minimal negative impacts on the existing onsite swales.

Step 4: Implement source controls.
The rural residential site is not anticipated to contain storage of potentially harmful substances or use of potentially harmful substances. No Site Specific or Other Source Control BMPs are required.

XVI. CONSTRUCTION COST ESTIMATE (DRAINAGE IMPROVEMENTS)

Item #	Item Description	Approx Quant	Units	Unit Price	Total Cost
1	Remove Existing 18" CMP	150	LF	$25	$3,750
2	Install 18" RCP	38.1	LF	$76	$2,896
3	Install 18" CMP Flared End Section	6	EA	$456	$2,736
4	Install 24" RCP	121.3	LF	$121	$14,714
5	Install 24" RCP Flared End Section	3	EA	$728	$2,183
6	Install Riprap Pads	34.1	TONS	$115	$3,922
7	Install Concrete Headwall (for 24" RCP)	1	EA	$1,000	$1,000
8	Install Ditch Check Structures	29.5	TONS	$115	$3,393
				Sub Total	$34,593
				Contingency (10%)	$3,459
				Grand Total	$38,052

XVII. DRAINAGE FEE CALCULATIONS

The drainage fee was determined based on a total of 32.59 acres with the development of 4 lots of greater 5 acres each. The site is located in the Kettle Creek Drainage Basin which has the following fees per each impervious acre (*Exhibit 5, Appendix):*

2020 Drainage Fee per impervious acre	$ 10,305
2020 Bridge Fee per impervious	$ 0
2020 Total Fees per impervious acre	$ 10,305

Total Project Area = 32.59 acres
% Impervious = 7% per El Paso County for 5 acre lots
Impervious Area = 2.281 acres
Fee reduction for 5-acre lots = 25%
Total Impervious area = 1.711 acres

Total Fees = $17,632

The Drainage Fees are to be paid prior to the recording of the plat.

XVIII. SUMMARY

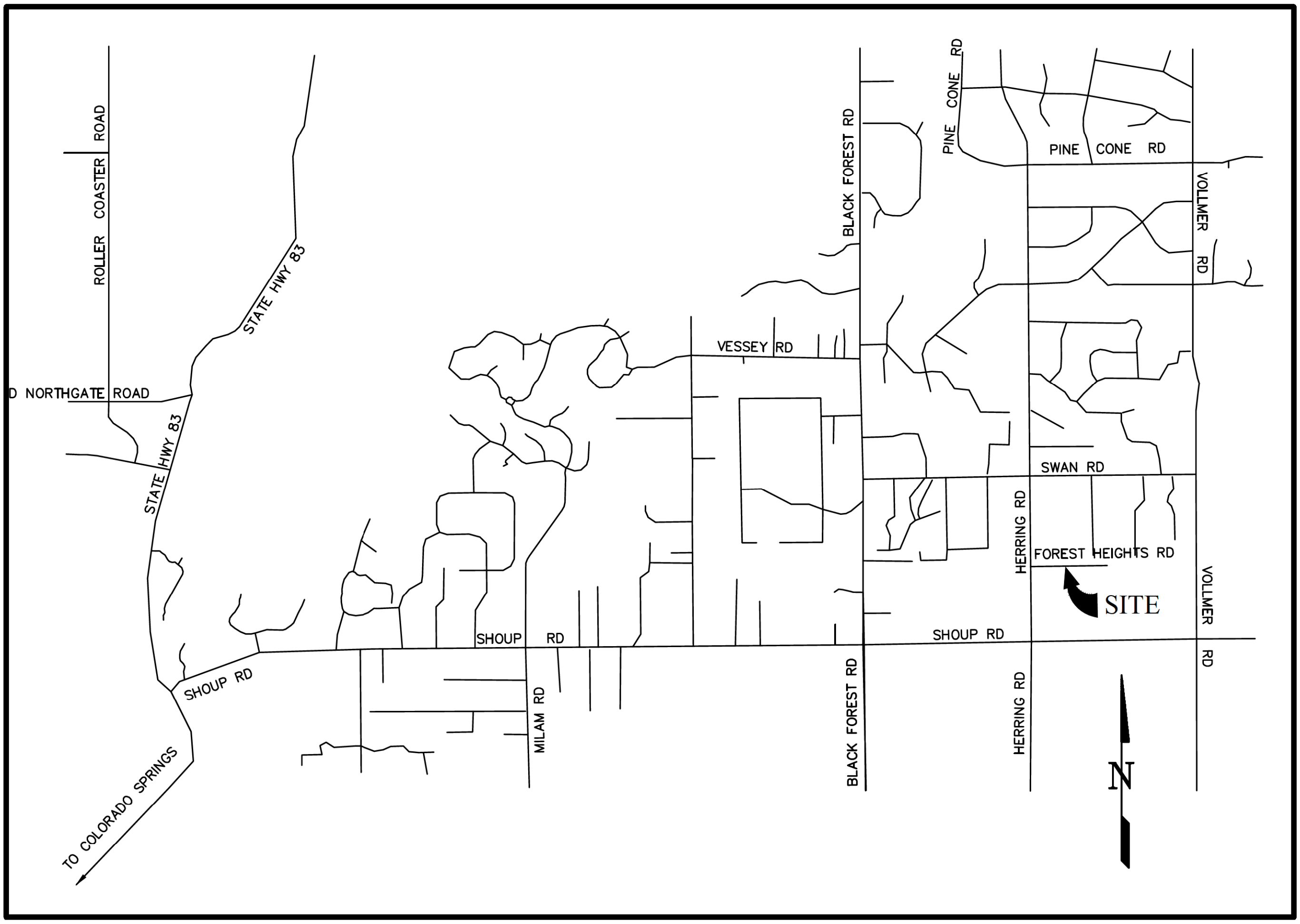
The report addresses the hydrologic and hydraulic parameters for both the existing and developed conditions for the entire site. It has been demonstrated that there will be insignificant increases in the runoff for the developed conditions. The three (3) existing culverts under Forest Heights Circle were evaluated on a limited basis to determine the anticipated hydraulic conditions.

It has been demonstrated that the existing 18” culverts do not have sufficient capacity due to the sedimentation and vegetative growth inside and around the ends of each culvert. It is recommended that these culverts be replaced with the previously mentioned 18 & 24-inch RCP culverts and the inverts set at elevations for the culvert can develop self-cleansing velocities. It has been discussed that extra care be exercised while grading the immediate areas upstream and downstream of the culverts where seasonally wet areas are located. Riprap erosion protection is required at the downstream ends of the culverts. Specific types and dimensions are shown on the Road Construction Plans and Grading and Erosion Control Plans for this project. The insignificant increase associated with developed flows will not adversely affect the downstream nor the surrounding properties.

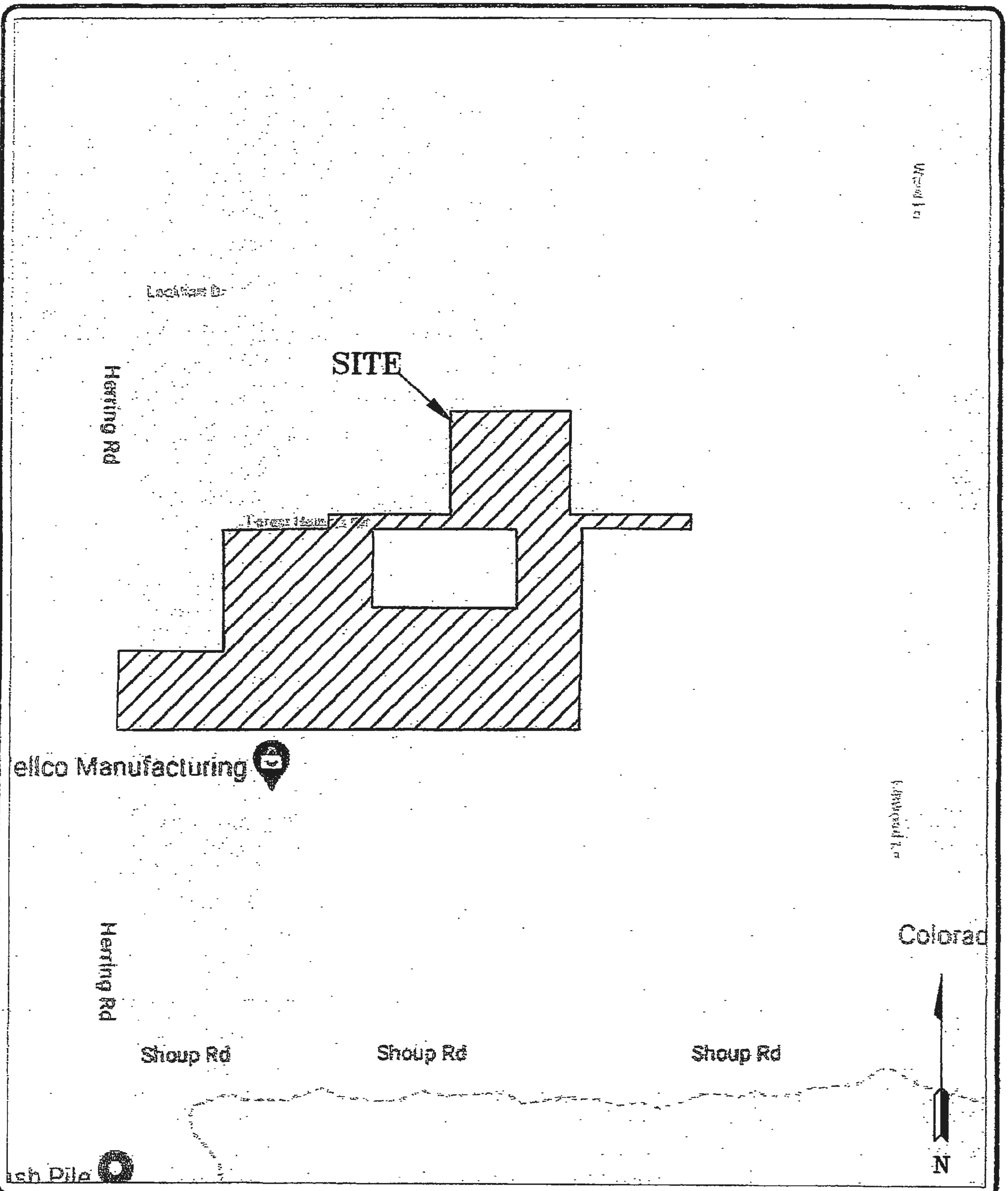
APPENDIX

Exhibit 1:

General Location Map



VICINITY MAP
NOT TO SCALE



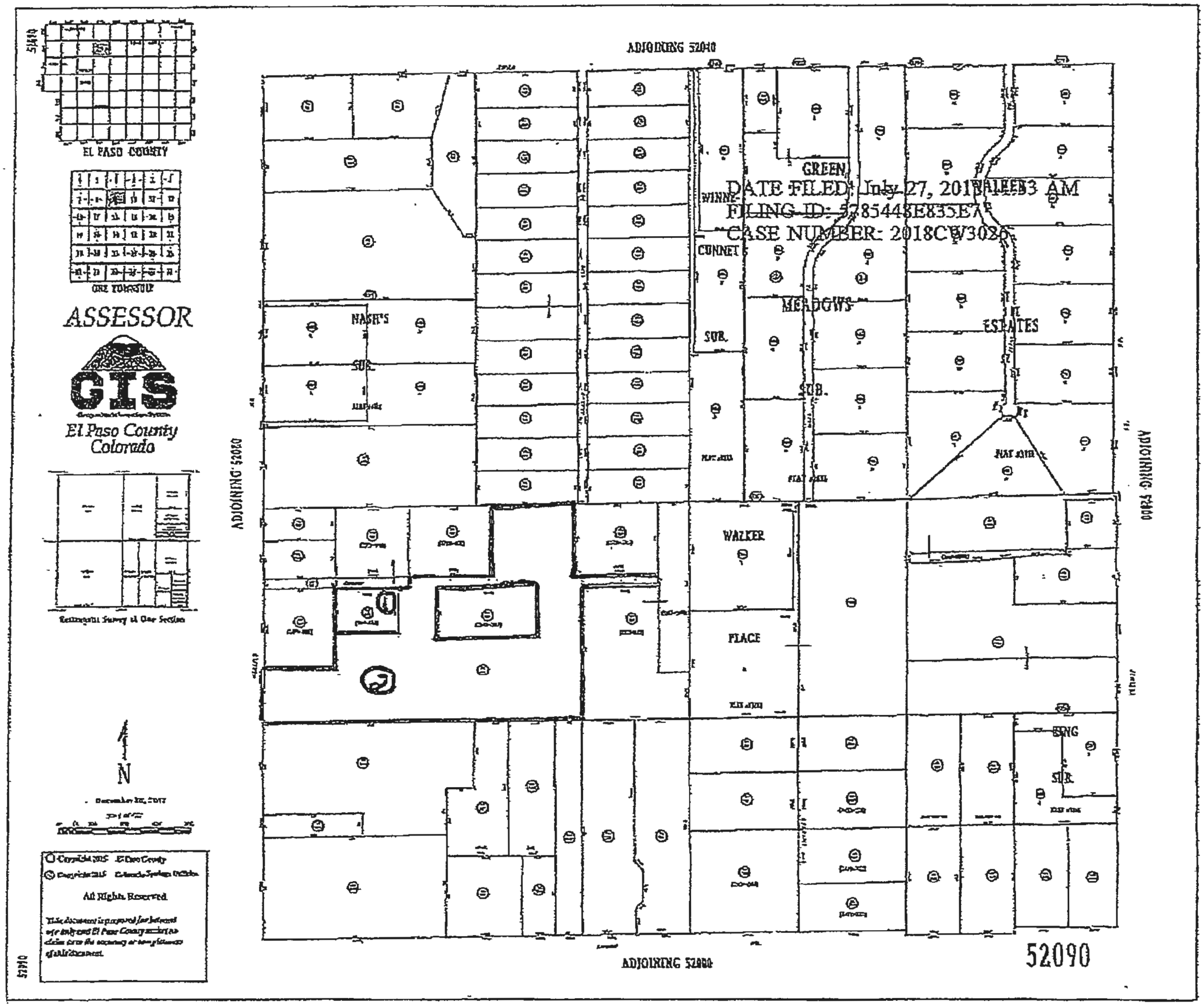
ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907 (719) 531-5599

VICINITY MAP
DIDLEAU SUBDIVISION
HERRING ROAD & FOREST HEIGHTS CIRCLE
EL PASO COUNTY, CO.
FOR: LDC, INC.

DRAWN:	DATE:	CHECKED:	DATE:
LLL	2/28/20		

JOB NO.: 192115

FIG NO.: 1



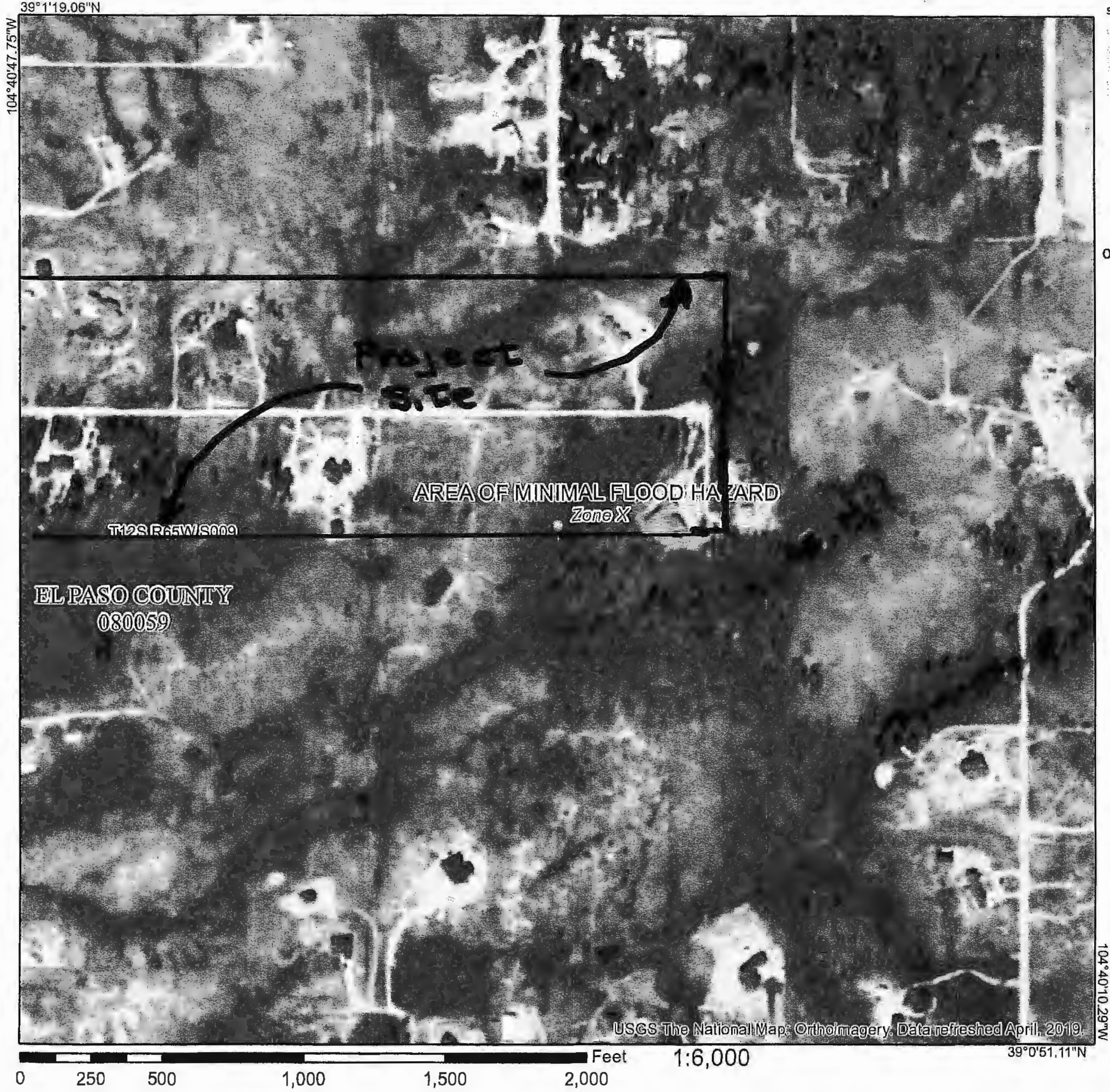
① Parcel 1
② Parcel 2

Exhibit 2:

FEMA FIRM Map

National Flood Hazard Layer FIRMette

FEMA



Legend

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

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

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

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

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

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

OTHER FEATURES
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 11/14/2019 at 3:46:08 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

Exhibit 3:

SCS Soils Map and Data

United States
Department of
Agriculture

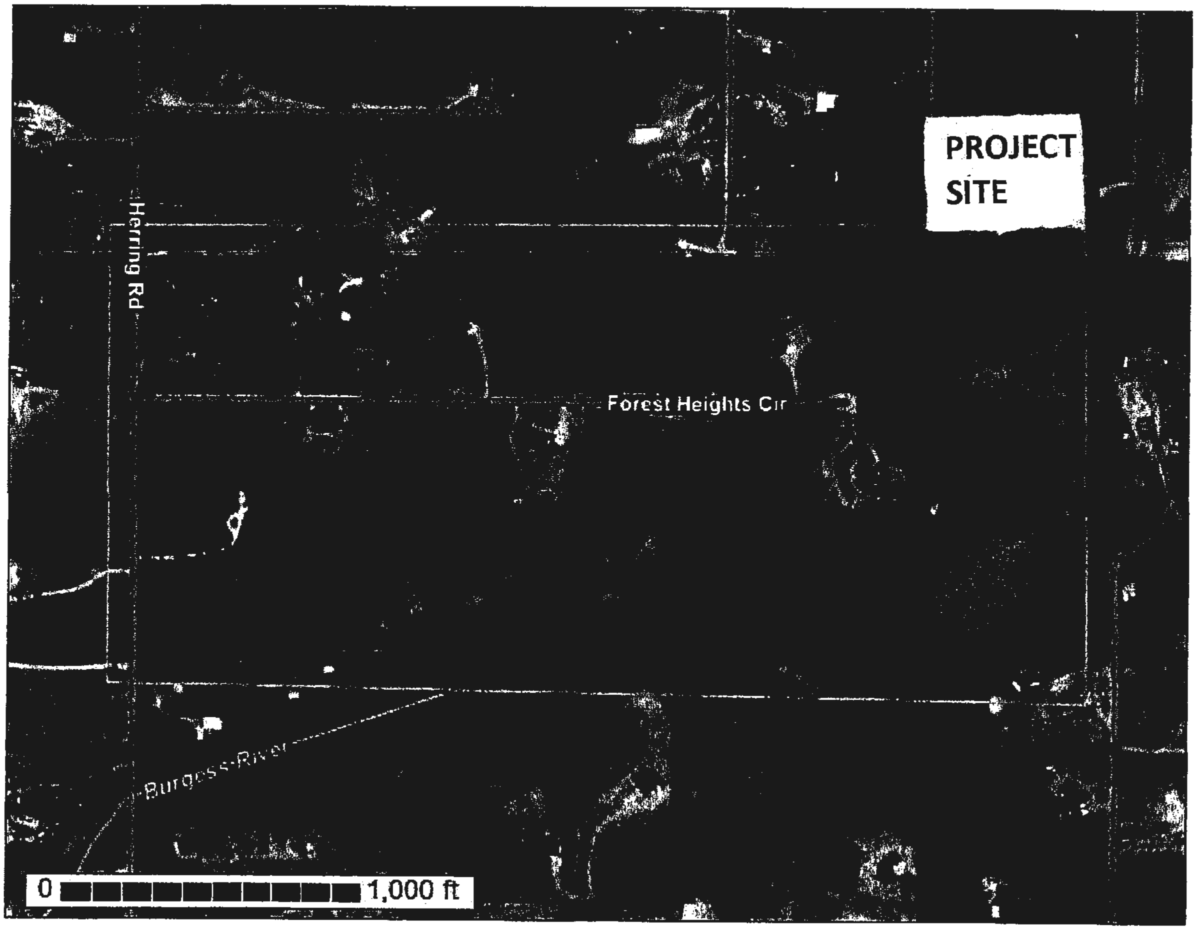
Natural
Resources
Conservation
Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

El Paso County Area, Colorado

Didleau Subdivision, El Paso County



November 11, 2019

United States
Department of
Agriculture

NRCS

Natural
Resources
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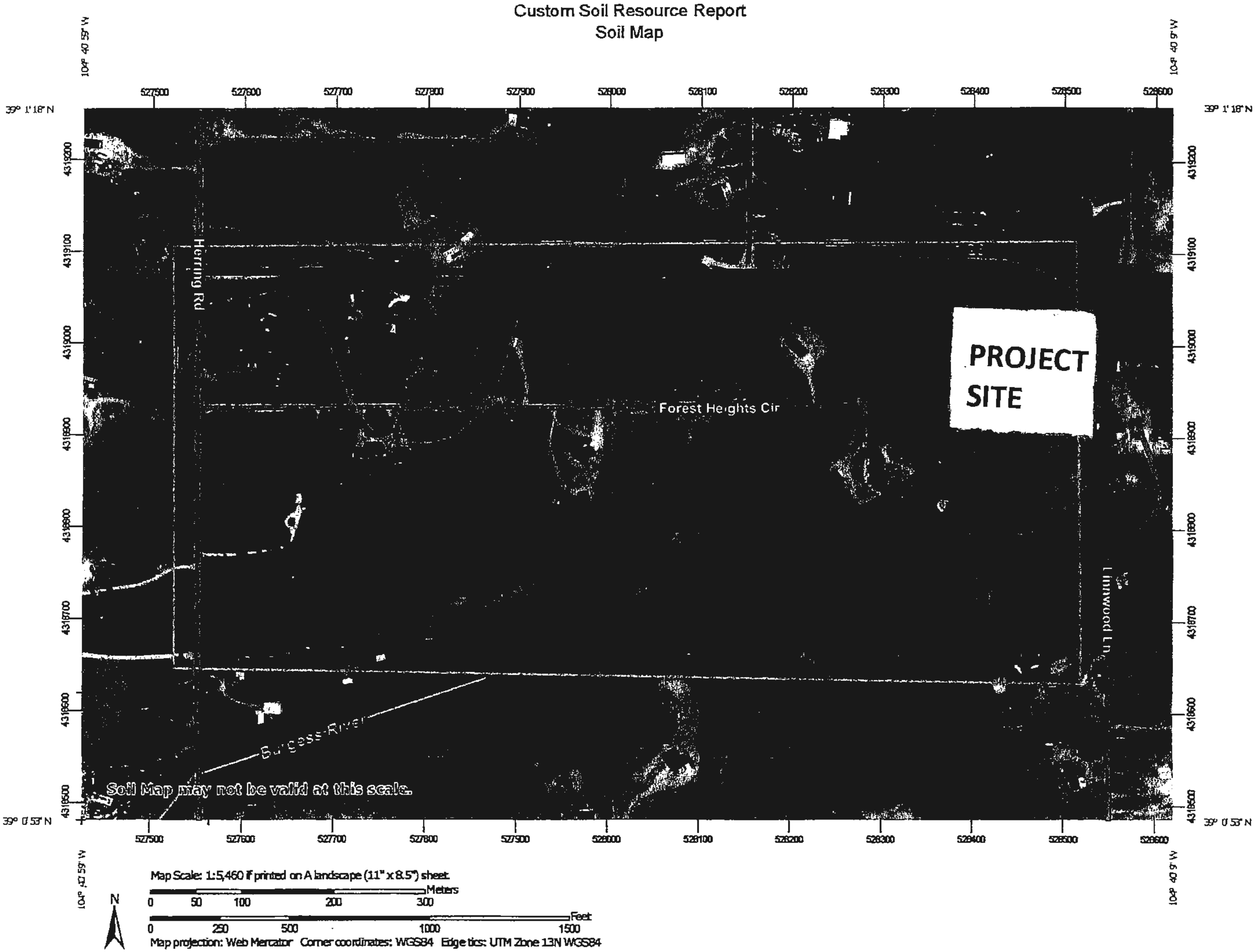
Custom Soil Resource Report for
El Paso County Area, Colorado

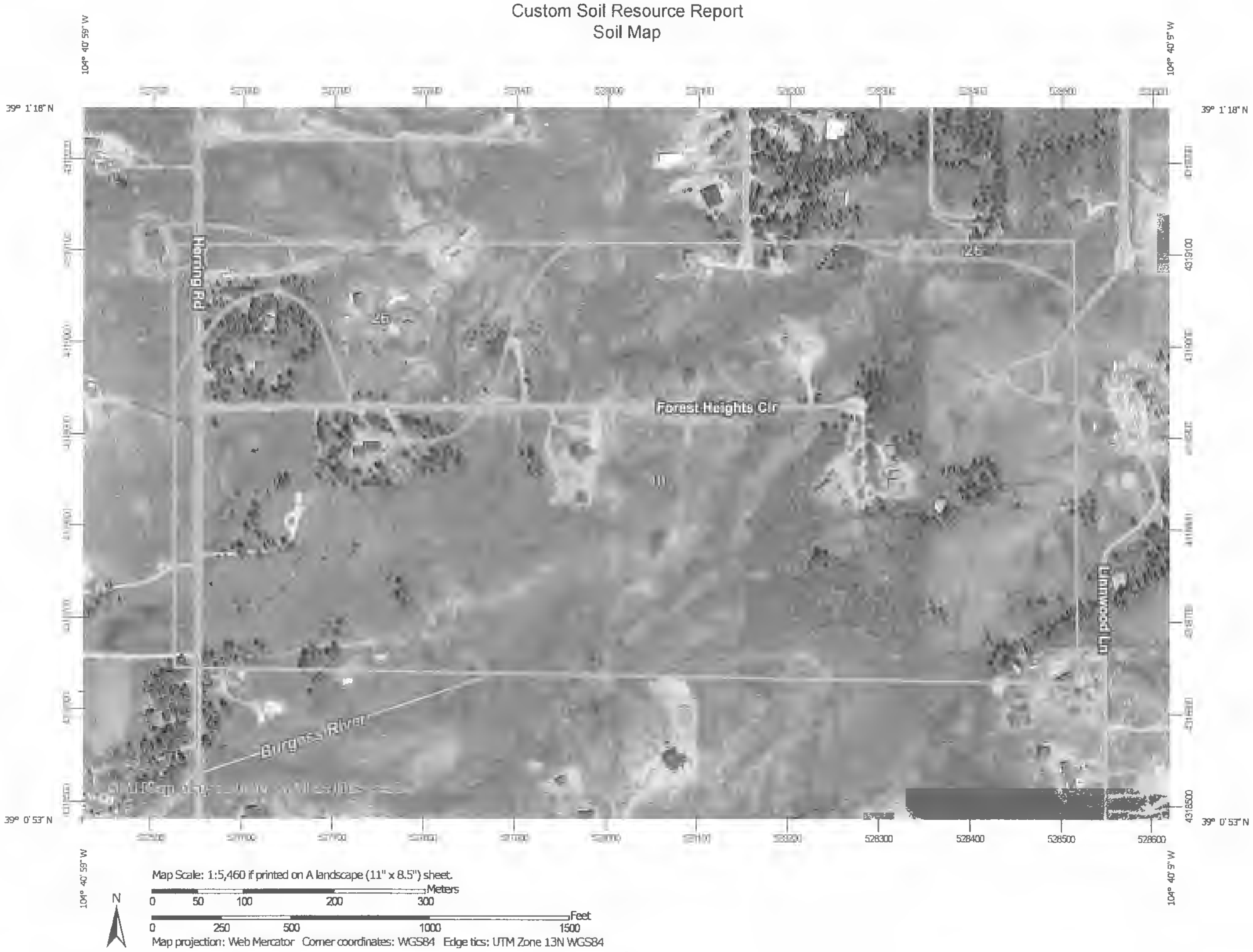
Didleau Subdivision, El Paso County

November 11, 2019

Soil Map


104° 40' 59" W
104° 40' 5" W
39° 1' 18" N
39° 1' 18" N
527500
527600
527700
527800
527900
528000
528100
528200
528300
528400
528500
528600
4319200
4319100
4319000
4318900
4318800
4318700
4318600
4318500
Herring Rd
Forest Heights Cir
PROJECT SITE
Linnwood Ln
Burgess River
Soil Map may not be valid at this scale.
39° 0' 53" N
39° 0' 53" N
104° 40' 59" W
104° 40' 5" W
N
Map Scale: 1:5,460 if printed on A landscape (11" x 8.5") sheet.
Meters
0
50
100
200
300
Feet
0
250
500
1000
1500
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

Soil Map



Map Scale: 1:5,460 if printed on A landscape (11" x 8.5") sheet.

Meters: 0 50 100 200 300

Feet: 0 250 500 1000 1500

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
26	Elbeth sandy loam, 8 to 15 percent slopes	14.5	12.5%
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	101.2	87.5%
Totals for Area of Interest		**115.7**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

El Paso County Area, Colorado

26—Elbeth sandy loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 367y
Elevation: 7,300 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Elbeth and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Elbeth

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkose

Typical profile

A - 0 to 3 inches: sandy loam
E - 3 to 23 inches: loamy sand
Bt - 23 to 68 inches: sandy clay loam
C - 68 to 74 inches: sandy clay loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

40—Kettle gravelly loamy sand, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 368g
Elevation: 7,000 to 7,700 feet
Farmland classification: Not prime farmland

Map Unit Composition

Kettle and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kettle

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium derived from arkose

Typical profile

E - 0 to 16 inches: gravelly loamy sand
Bt - 16 to 40 inches: gravelly sandy loam
C - 40 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

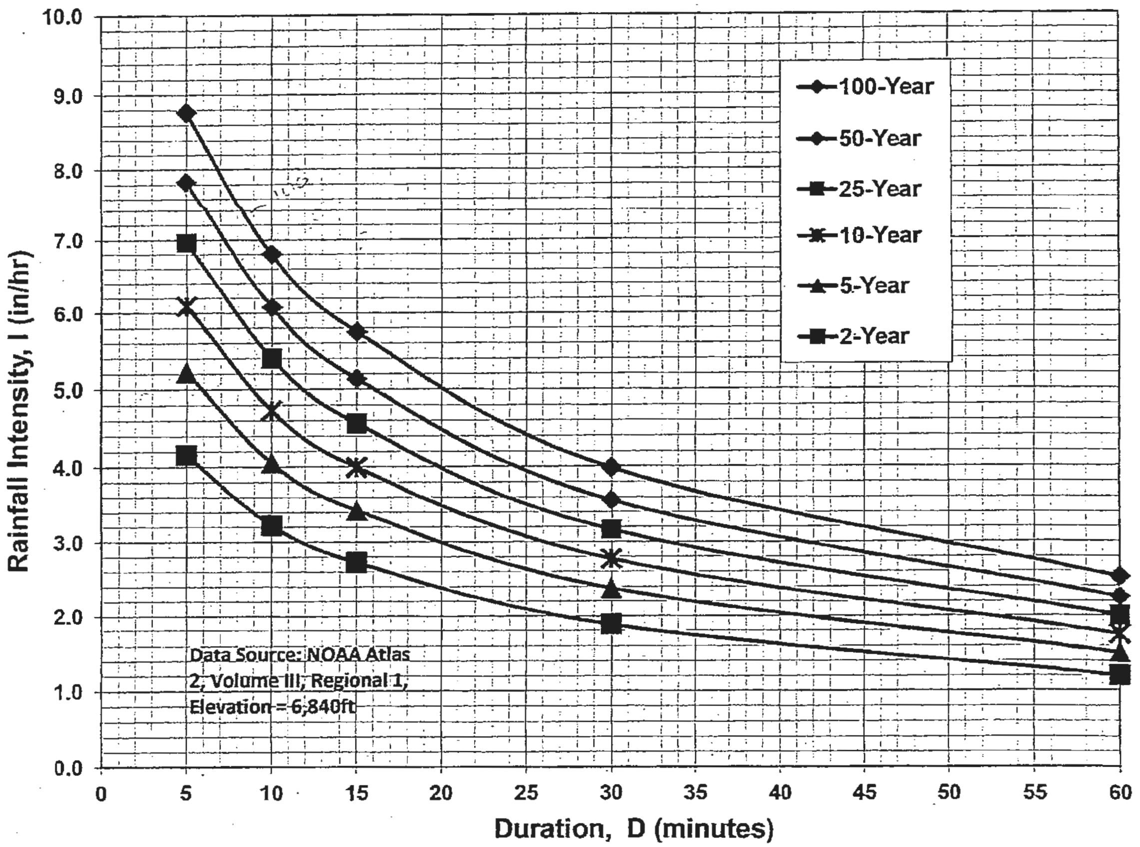
Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Exhibit 4:

Charts and Tables

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

$I_{100} = -2.52 \ln(D) + 12.735$

$I_{50} = -2.25 \ln(D) + 11.375$

$I_{25} = -2.00 \ln(D) + 10.111$

$I_{10} = -1.75 \ln(D) + 8.847$

$I_{5} = -1.50 \ln(D) + 7.583$

$I_{2} = -1.19 \ln(D) + 6.035$

Note: Values calculated by equations may not precisely duplicate values read from figure.

Table 6-6. Runoff Coefficients for Rational Method

(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis-- Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

* For buried riprap, select C_v value based on type of vegetative cover.

The travel time is calculated by dividing the flow distance (in feet) by the velocity calculated using Equation 6-9 and converting units to minutes.

The time of concentration (t_c) is then the sum of the overland flow time (t_i) and the travel time (t_t) per Equation 6-7.

3.2.3 First Design Point Time of Concentration in Urban Catchments

Using this procedure, the time of concentration at the first design point (typically the first inlet in the system) in an urbanized catchment should not exceed the time of concentration calculated using Equation 6-10. The first design point is defined as the point where runoff first enters the storm sewer system.

$$t_c = \frac{L}{180} + 10 \qquad \text{(Eq. 6-10)}$$

Where:

t_c = maximum time of concentration at the first design point in an urban watershed (min)

L = waterway length (ft)

Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional "calibration" of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, the time of concentration is calculated by accumulating the travel times in downstream drainageway reaches.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

3.2.5 Post-Development Time of Concentration

As Equation 6-8 indicates, the time of concentration is a function of the 5-year runoff coefficient for a drainage basin. Typically, higher levels of imperviousness (higher 5-year runoff coefficients) correspond to shorter times of concentration, and lower levels of imperviousness correspond to longer times of

Centerline Grade (Min.-Max.)	1-5%	1-5%	1-5%	1-5%	1-6%
Intersection Grades (Min.-Max.)	1-2%	1-2%	1-3%	1-3%	1-4%

[1] Assumes 4% superelevation, 6% for 70 MPH design speeds
[2] Pavement width in each direction for divided roadways

Table 2-5. Roadway Design Standards for Rural Collectors and Locals

	Collectors		Local	
Criteria	Major	Minor	Local	Gravel
Design Speed / Posted Speed (MPH)	50 / 45	40 / 35	30 / 30	50/45
Clear Zone	20'	14'	7'	12'
Minimum Centerline Curve Radius	930'[2]	565'	300'	As Approved
Number of Through Lanes	2	2	2	2
Lane Width	12'	12'	12'	12'
Right of Way	90'	80'	70'[3]	70'[3]
Paved Width	32'	32'	28'	n/a
Median Width	n/a	n/a	n/a	n/a
Outside Shoulder Width (paved/gravel)	8'(4'/4')	6'(4'/2')	4'(2'/2')	4'(0'/4')
Inside Shoulder Width (paved/gravel)	n/a	n/a	n/a	n/a
Design ADT	3,000	1,500	750	200
Design Vehicle	WB-67	WB-67	WB-50	WB-50
Access Permitted	No	Yes	Yes	Yes
Access Spacing	n/a	Frontage	Frontage	Frontage
Intersection Spacing	¼ mile	660'	330'	330'
Parking Permitted	No	Yes	Yes	No
Minimum Flowline Grade	1%	1%	1%	1%
Centerline Grade (Min.-Max.)	1-8%[1]	1-8%[1]	1-8%[1]	1-8%
Intersection Grades (Min.-Max.)	1-4%	1-4%	1-4%	1-4%

[1] 10% maximum grade permitted at the discretion of the ECM Administrator
[2] Assumes 4% superelevation, 6% for 70 MPH design speeds
[3] 60-foot right-of-way plus two 5-foot Public Improvements Easements granted to El Paso County

$$t_c = t_i + t_t \qquad \text{(Eq. 6-7)}$$

Where:

t_c = time of concentration (min)

t_i = overland (initial) flow time (min)

t_t = travel time in the ditch, channel, gutter, storm sewer, etc. (min)

3.2.1 Overland (Initial) Flow Time

The overland flow time, t_i, may be calculated using Equation 6-8.

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \qquad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{\ 0.5} \qquad \text{(Eq. 6-9)}$$

Where:

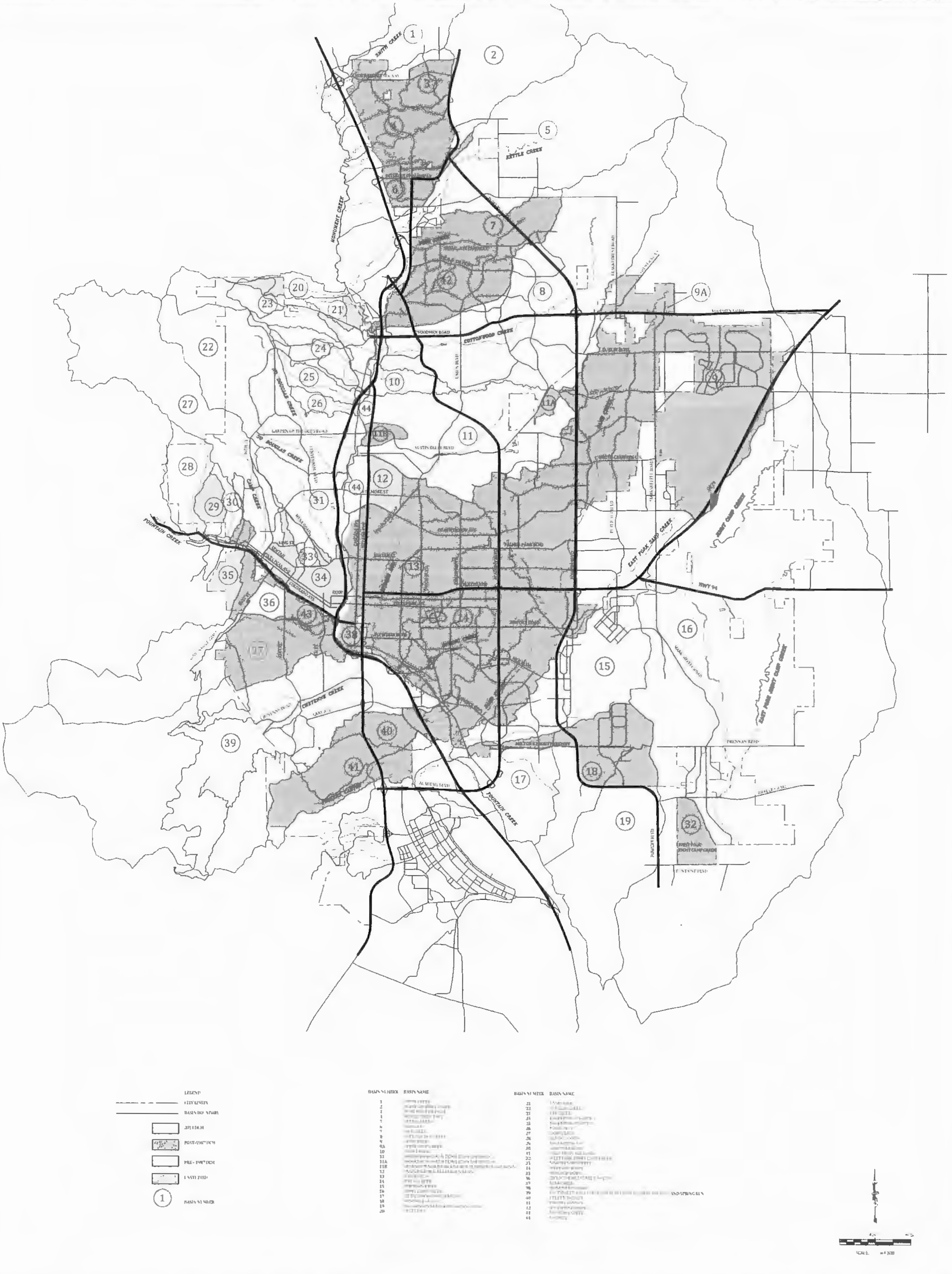
V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

Exhibit 5:

Kettle Creek Drainage Basin Planning Study Exhibits



BASIN NUMBER	BASIN NAME
1	[illegible]
2	[illegible]
3	[illegible]
4	[illegible]
5	[illegible]
6	[illegible]
7	[illegible]
8	[illegible]
9	[illegible]
9A	[illegible]
10	[illegible]
11	[illegible]
11A	[illegible]
11B	[illegible]
12	[illegible]
13	[illegible]
14	[illegible]
15	[illegible]
16	[illegible]
17	[illegible]
18	[illegible]
19	[illegible]
20	[illegible]

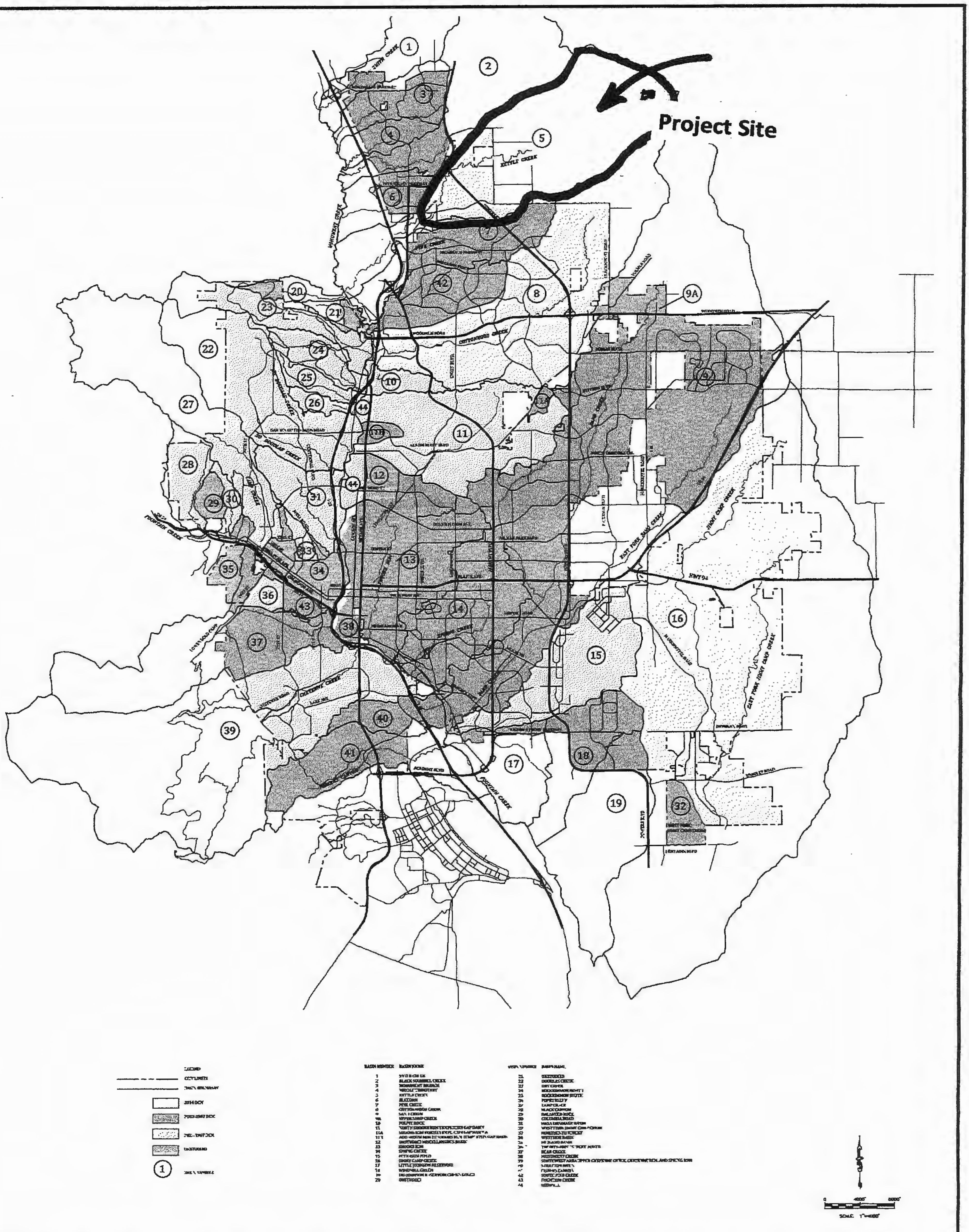
BASIN NUMBER	BASIN NAME
21	[illegible]
22	[illegible]
23	[illegible]
24	[illegible]
25	[illegible]
26	[illegible]
27	[illegible]
28	[illegible]
29	[illegible]
30	[illegible]
31	[illegible]
32	[illegible]
33	[illegible]
34	[illegible]
35	[illegible]
36	[illegible]
37	[illegible]
38	[illegible]
39	[illegible] AND SPRING RUN
40	[illegible]
41	[illegible]
42	[illegible]
43	[illegible]
44	[illegible]

Design	KAW
Drawn	KAW
Check	KAW
File name	

DRAINAGE BASIN PLANNING STUDY INVENTORY

CITY OF COLORADO SPRINGS, COLORADO

Kiowa Engineering Corporation
1604 South 21st Street
Colorado Springs, Colorado 80904
(719) 630-7342



BASIN NUMBER	BASIN NAME	BASIN NUMBER	BASIN NAME
1	SMITH CREEK	21	UNSTUDIED
2	BLACK SQUIRREL CREEK	22	DOUGLAS CREEK
3	MONUMENT BRANCH	23	DRY CREEK
4	MIDDLE TRIBUTARY	24	ROCKRIMMON NORTH
5	KETTLE CREEK	25	ROCKRIMMON SOUTH
6	[illegible]	26	POPES BLUFF
7	PINE CREEK	27	CAMP CREEK
8	COTTONWOOD CREEK	28	BLACK CANYON
9	SAND CREEK	29	BALANCED ROCK
9A	UPPER SAND CREEK	30	COLUMBIA ROAD
10	PULPIT ROCK	31	MESA DRAINAGE BASIN
11	[illegible]	32	WEST FORK JIMMY CAMP CREEK
11A	[illegible]	33	[illegible]
11B	[illegible]	34	WESTSIDE BASIN
12	[illegible] MISCELLANEOUS BASIN	35	[illegible]
13	SHOOKS RUN	36	[illegible]
14	SPRING CREEK	37	BEAR CREEK
15	PETERSON FIELD	38	MONUMENT CREEK
16	JIMMY CAMP CREEK	39	SOUTHWEST AREA [illegible]
17	LITTLE JOHNSON RESERVOIR	40	[illegible]
18	WINDMILL GULCH	41	FISHERS CANYON
19	BIG JOHNSON RESERVOIR [illegible]	42	[illegible] CREEK
20	UNSTUDIED	43	FOUNTAIN CREEK
		44	[illegible]

Project No.: 17002
Date: 7/12/17
Design: RNW
Drawn: EAK
Check: RNW
Revisions:

DRAINAGE BASIN PLANNING STUDY INVENTORY

CITY OF COLORADO SPRINGS, COLORADO

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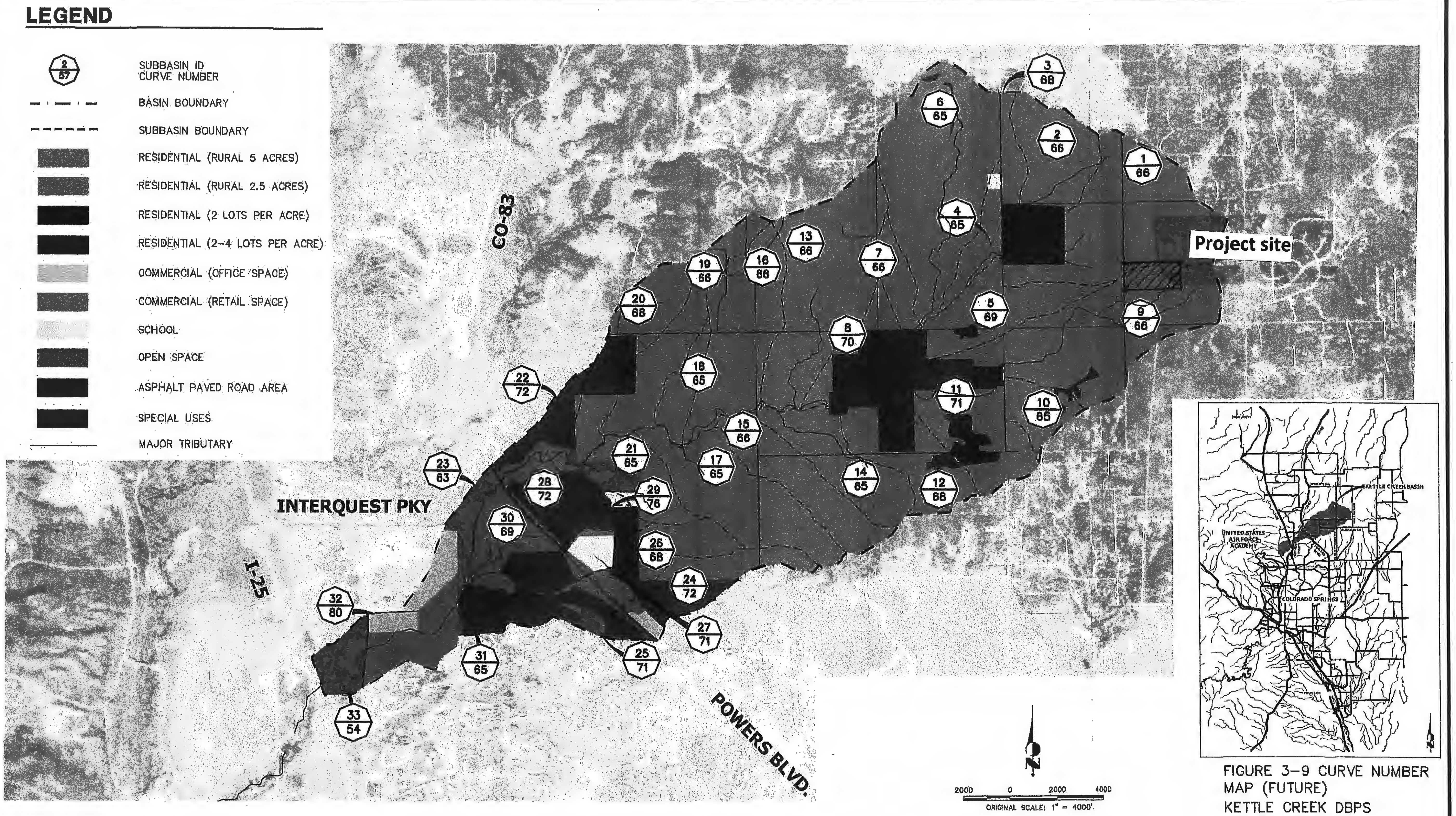

FIGURE 3–9 CURVE NUMBER
MAP (FUTURE)
KETTLE CREEK DBPS
JOB NO. 25100.00
MAY 2015

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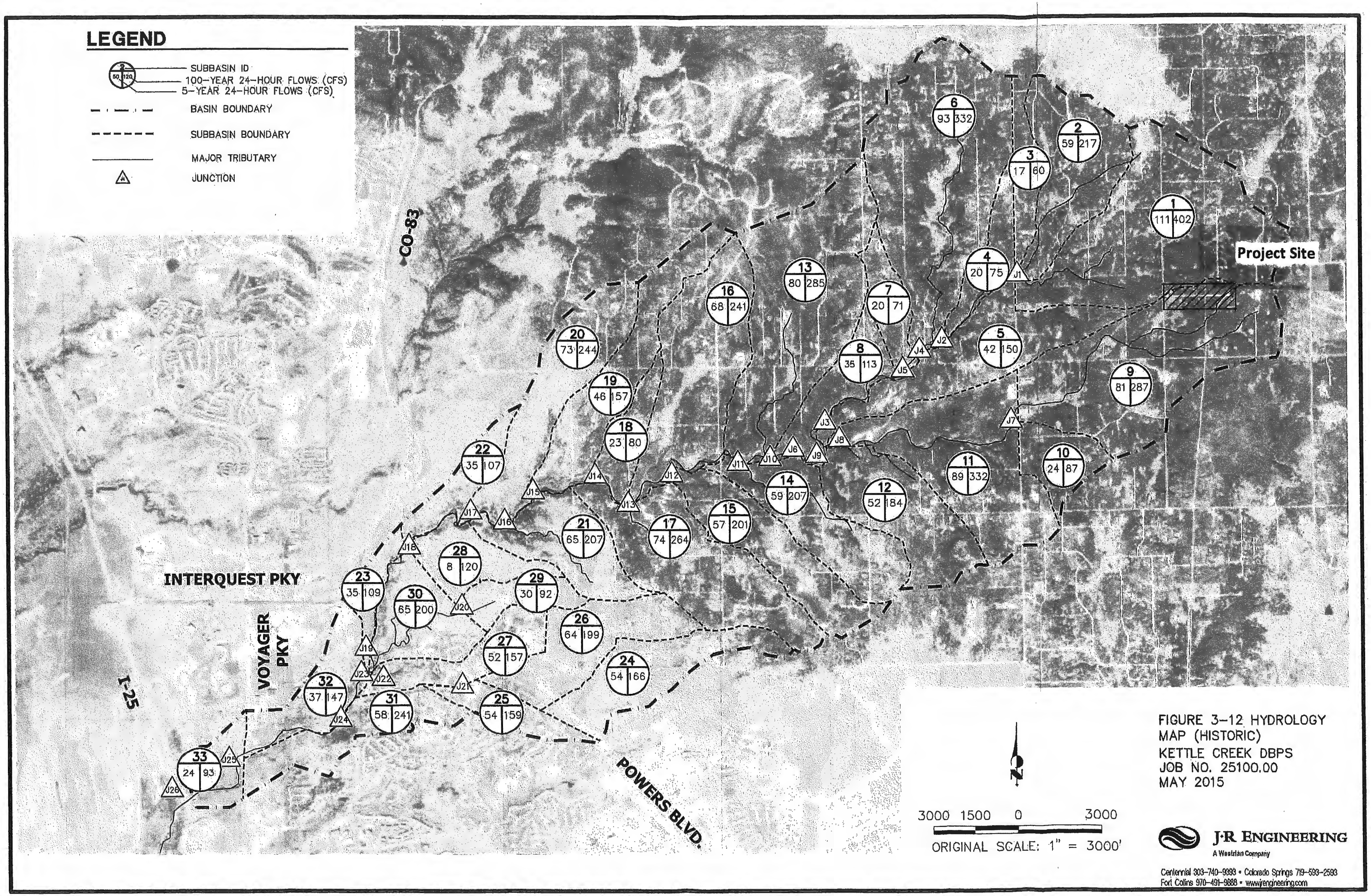

FIGURE 3-12 HYDROLOGY MAP (HISTORIC)
KETTLE CREEK DBPS
JOB NO. 25100.00
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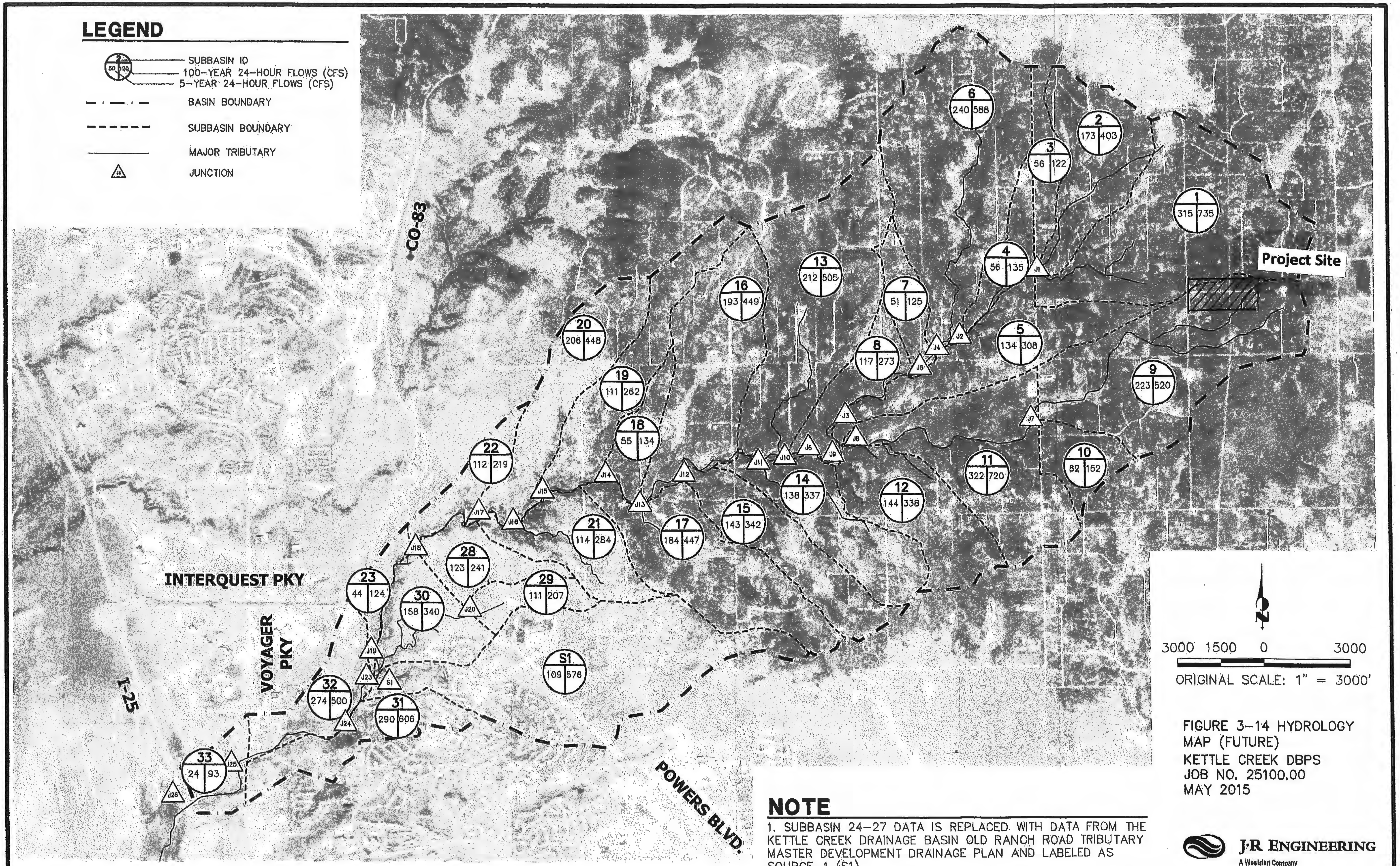

NOTE

1. SUBBASIN 24–27 DATA IS REPLACED WITH DATA FROM THE KETTLE CREEK DRAINAGE BASIN OLD RANCH ROAD TRIBUTARY MASTER DEVELOPMENT DRAINAGE PLAN AND LABELED AS SOURCE-1 (S1).

FIGURE 3–14 HYDROLOGY
MAP (FUTURE)
KETTLE CREEK DBPS
JOB NO. 25100.00
MAY 2015

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El Paso County Drainage Basin Fees

Resolution No. 22-442

Basin Number	Receiving Waters	Year Studied	Drainage Basin Name	2023 Drainage Fee (per Impervious Acre)	2023 Bridge Fee (per Impervious Acre)
Drainage Basins with DBPS's:					
CHMS0200	Chico Creek	2013	Haegler Ranch	$12,985	$1,916
CHWS1200	Chico Creek	2001	Bennett Ranch	$14,536	$5,576
CHWS1400	Chico Creek	2013	Falcon	$37,256	$5,118
FOFO2000	Fountain Creek	2001	West Fork Jimmy Camp Creek	$15,802	$4,675
FOFO2600	Fountain Creek	1991*	Big Johnson / Crews Gulch	$23,078	$2,980
FOFO2800	Fountain Creek	1988*	Widefield	$23,078	$0
FOFO2900	Fountain Creek	1988*	Security	$23,078	$0
FOFO3000	Fountain Creek	1991*	Windmill Gulch	$23,078	$346
FOFO3100 / FOFO3200	Fountain Creek	1988*	Carson Street / Little Johnson	$14,077	$0
FOFO3400	Fountain Creek	1984*	Peterson Field	$16,646	$1,262
FOFO3600	Fountain Creek	1991*	Fisher's Canyon	$23,078	$0
FOFO4000	Fountain Creek	1996	Sand Creek	$23,821	$9,743
FOFO4200	Fountain Creek	1977	Spring Creek	$11,969	$0
FOFO4600	Fountain Creek	1984*	Southwest Area	$23,078	$0
FOFO4800	Fountain Creek	1991	Bear Creek	$23,078	$1,262
FOFO5800	Fountain Creek	1964	Camp Creek	$2,557	$0
FOMO1000	Monument Creek	1981	Douglas Creek	$14,514	$321
FOMO1200	Monument Creek	1977	Templeton Gap	$14,900	$346
FOMO2000	Monument Creek	1971	Pulpit Rock	$7,653	$0
FOMO2200	Monument Creek	1994	Cottonwood Creek / S. Pine	$23,078	$1,262
FOMO2400	Monument Creek	1966	Dry Creek	$18,219	$660
FOMO3600	Monument Creek	1989*	Black Squirrel Creek	$10,478	$660
FOMO3700	Monument Creek	1987*	Middle Tributary	$19,259	$0
FOMO3800	Monument Creek	1987*	Monument Branch	$23,078	$0
FOMO4000	Monument Creek	1996	Smith Creek	$9,409	$1,262
FOMO4200	Monument Creek	1989*	Black Forest	$23,078	$628
FOMO5200	Monument Creek	1993*	Dirty Woman Creek	$23,078	$1,262
FOMO5300	Fountain Creek	1993*	Crystal Creek	$23,078	$1,262
Miscellaneous Drainage Basins: [1]					
CHBS0800	Chico Creek		Book Ranch	$21,654	$3,135
CHEC0400	Chico Creek		Upper East Chico	$11,797	$342
CHWS0200	Chico Creek		Telephone Exchange	$12,962	$304
CHWS0400	Chico Creek		Livestock Company	$21,351	$254
CHWS0600	Chico Creek		West Squirrel	$11,129	$4,619
CHWS0800	Chico Creek		Solberg Ranch	$23,078	$0
FOFO1200	Fountain Creek		Crooked Canyon	$6,968	$0
FOFO1400	Fountain Creek		Calhan Reservoir	$5,817	$339
FOFO1600	Fountain Creek		Sand Canyon	$4,203	$0
FOFO2000	Fountain Creek		Jimmy Camp Creek[3]	$23,078	$1,079
FOFO2200	Fountain Creek		Fort Carson	$18,219	$660
FOFO2700	Fountain Creek		West Little Johnson	$1,521	$0
FOFO3800	Fountain Creek		Stratton	$11,070	$495
FOFO5000	Fountain Creek		Midland	$18,219	$660
FOFO6000	Fountain Creek		Palmer Trail	$18,219	$660
FOFO6800	Fountain Creek		Black Canyon	$18,219	$660
FOMO4600	Monument Creek		Beaver Creek	$13,797	$0
FOMO3000	Monument Creek		Kettle Creek	$12,463	$0
FOMO3400	Monument Creek		Elkhorn	$2,094	$0
FOMO5000	Monument Creek		Monument Rock	$10,003	$0
FOMO5400	Monument Creek		Palmer Lake	$15,995	$0
FOMO5600	Monument Creek		Raspberry Mountain	$5,380	$0
PLPL0200	Monument Creek		Bald Mountain	$11,465	$0
Interim Drainage Basins: [2]					
FOFO1800	Fountain Creek		Little Fountain Creek	$2,950	$0
FOMO4400	Monument Creek		Jackson Creek	$9,135	$0
FOMO4800	Monument Creek		Teachout Creek	$6,343	$953

1. The miscellaneous drainage fee previous to September 1999 resolution was the average of all drainage fees for basins with Basin Planning Studies performed within the last 14 years.

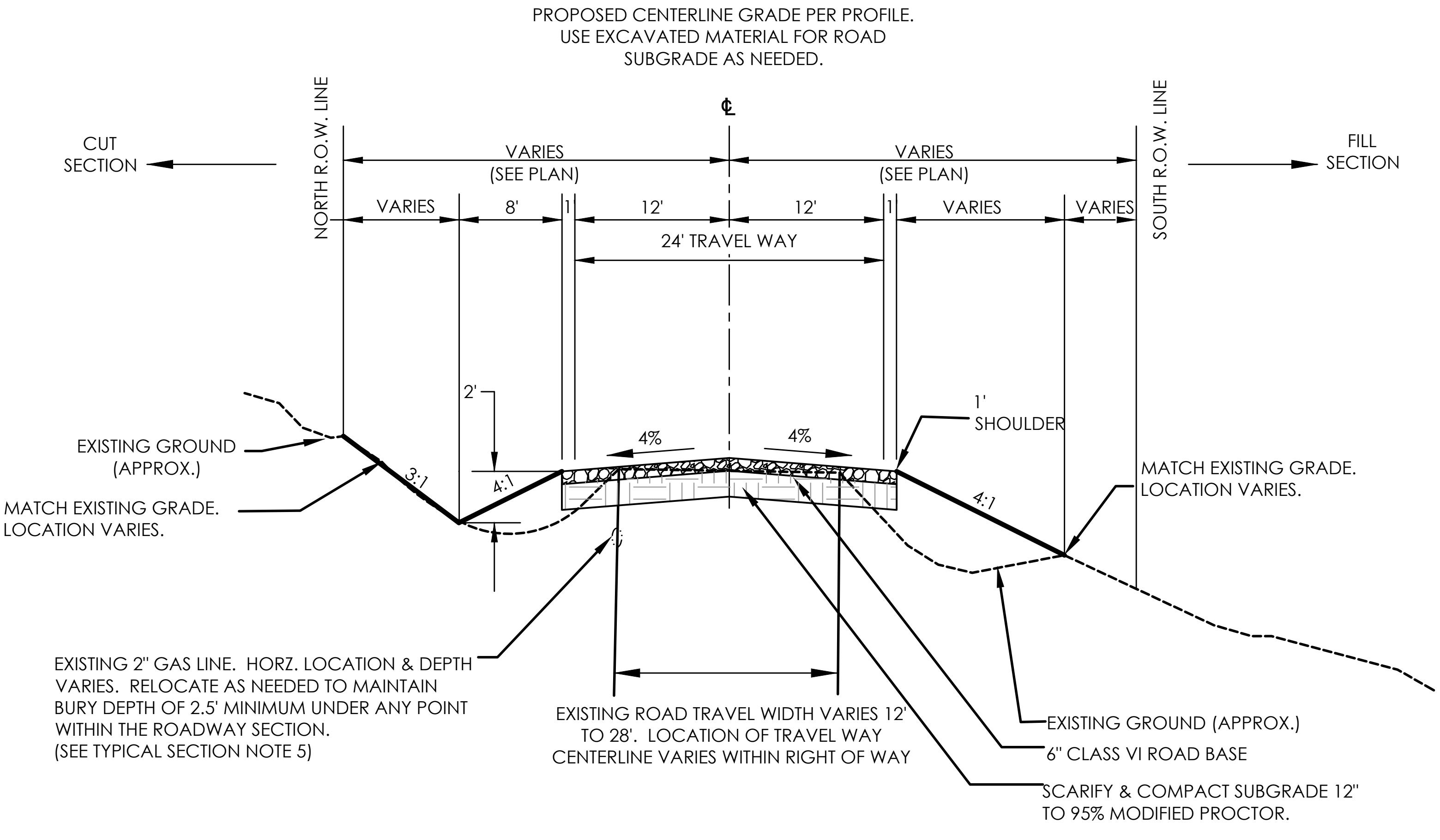
2. Interim Drainage Fees are based upon draft Drainage Basin Planning Studies or the Drainage Basin Identification and Fee Estimation Report. (Best available information suitable for setting a fee.)

3. This is an interim fee and will be adjusted when a DBPS is completed. In addition to the Drainage Fee a surety in the amount of $7,285 per impervious acre shall be provided to secure payment of additional fees in the event that the DBPS results in a fee greater than the current fee. Fees paid in excess of the future revised fee will be reimbursed. See Resolution 06-326 (9/14/06) and Resolution 16-320 (9/07/16).

EPC Stormwater Management *Joshua Palmer, P.E.*

Exhibit 6:

Typical Section



TYPICAL PRIVATE RURAL ROADWAY SECTION
RURAL GRAVEL LOCAL ROADWAY

WITH A DESIGN AND POSTED SPEED OF 20 MPH

SCALE:
HORIZONTAL SCALE: 1" = 10'
VERTICAL SCALE: 1" = 5'

Exhibit 7:

Plat

FOREST HEIGHTS ESTATES

FINAL PLAT
PART OF THE SOUTHWEST QUARTER OF SECTION 9, TOWNSHIP 12 SOUTH, RANGE 65 WEST OF THE 6TH P.M.
COUNTY OF EL PASO, STATE OF COLORADO

KNOW ALL MEN BY THESE PRESENTS:

That Phyllis J. Didleau and Jon Didleaux, being the owners of the following described tract of land:

A Tract of land in the Southwest 1/4 of Section 9, Township 12 South, Range 65 West, of the 6th P.M. County of El Paso, State of Colorado, more specifically described as follows;
Commencing at the West 1/4 corner of Section 9,
Thence Along the North line of said Southwest 1/4, N89°55'03"E a distance of 1391.55 feet to the Point of Beginning of the parcel to be described hereby;
Thence continue along said North line, N89° 55'03"E a distance of 506.51 feet to the Northwest corner of that parcel described at Book 2318, Page 387, of the records of the El Paso County Clerk and Recorder;
Thence S00°03'25"W along the West line of said parcel a distance of 430.00 feet;
Thence N89°55'03"E parallel to said North line, a distance of 506.81 feet to the Northmost West line of the parcel described in Book 721, Page 970 of said records;
Thence S00°09'20"W a distance of 60.00 feet;
Thence S89°55'03"W along the line of said parcel 459.94 feet;
Thence S00°11'43"W along the West line of said parcel a distance of 829.47 feet;
Thence S89°54'44"W a distance of 1941.21 feet to a point on the East Right of Way line of Herring Road;
Thence N00°03'25"E" along said East line a distance of 327.80 feet to the South line of that parcel described in Book 2371 Page 388 of said records;
Thence N89°55'03"E along the South line of said parcel a distance of 434.00 feet;
Thence; N00°03'25"E along the East line of said parcel a distance of 215.85 feet to the Southeast corner of that parcel described in Book1951 at Page 432 of said records;
Thence N89°55'03"E along the South line of said parcel a distance of 381.00 feet to the Southeast corner thereof;
Thence N00°11'21"E along the East line of said parcel a distance of 286.00 feet to a point on the South line of that parcel described in Book 2215 Page 559 of said records;
Thence along said South line N89°55'03"E along said South line a distance of 67.27 feet to the East line of said parcel;
Thence N00°03'25"E along said East line a distance of 60.00 feet;
Thence Thence N89°55'03"E a distance of 506.51 feet,
Thence; N00°03'25"E a distance of 430.00 feet to the Point of Beginning, except that parcel described in Book 2645, Page 207.

EXCEPTION PARCEL: Book 2645, Page 207 of the records of El Paso County, Colorado
A tract of land in the Southwest 1/4 of Section 9, Township 12 South, Range 65 West of the 6th p.m. County of El Paso, State of Colorado more particularly described as follows;
Commencing at the West 1/4 corner of said Section 9,
Thence along the West line of Section 9, S00°03'25"W a distance of 490.00 feet;
Thence N89°55'03"E a distance of 1090.00 feet to the Point of Beginning of the tract described hereby;
Thence N89°55'03"E a distance of 610.00 feet;
Thence S00°03'25"W a distance of 325.00 feet;
Thence S89°55'03"W a distance of 610.00 feet;
Thence N00°03'25"E a distance of 325.00 feet to the Point of Beginning.

This description contains 34.529 acres (not including the exception parcel).

TRACT A
Tract in Northwest quarter of the Southwest quarter of Section 9, Township 12 South, Range 65 West, of the 6th P.M. County of El Paso, State of Colorado, described as follows:
Commencing at the West 1/4 corner of said Section 9, Thence along the west line of said Section 9 S00°03'25"W a distance of 430.00 feet;
Thence N89°55'03"E 30.00 feet to a point on the West Right of Way line of Herring Road and the Point Of Beginning (P.O.B.) of the Tract described hereby;
Thence N89°55'03"E a distance of 435.00 feet;
Thence S01°00'46"W a distance of 60.01 feet;
Thence S89°55'03"W a distance of 434.00 feet to a point on said West Right of Way line;
Thence N00°03'25"E a distance of 60.00 feet to the Point Of Beginning (POB).

Tract A contains 0.598 Acres, more or less.

THE TOTAL ACREAGE OF THIS SUBDIVISION PLAT IS 32.618 ACRES.

DEDICATION:

The undersigned, being all the owners, mortgagees, beneficiaries of deeds of trust and holders of other interests in the land described herein, have laid out, subdivided, and platted said lands into lots, tracts, and easements as shown hereon under the name and subdivision of FOREST HEIGHTS ESTATES, The utility easements shown hereon are hereby dedicated for public utilities and communication systems and other purposes as shown hereon. The entities responsible for providing the services for which the easements are established are hereby granted the perpetual right of ingress and egress from and to adjacent properties for installation, maintenance, and replacement of utility lines and related facilities.

By: ____
Phyllis J. Didleau, Trustee
Phyllis J. Didleau Revocable Trust

STATE OF COLORADO }
COUNTY OF EL PASO } SS

Acknowledged before me this _____ day of ________________, 202__ by Phyllis J. Didleau as Trustee of Phyllis J. Didleau Revocable Trust.

MY COMMISSION EXPIRES ______________

WITNESS MY HAND AND OFFICIAL SEAL_____________________________________
NOTARY PUBLIC

By: ____
Jon P. Didleaux
Owner

STATE OF COLORADO }
COUNTY OF EL PASO } SS

ACKNOWLEDGED BEFORE ME THIS _____ DAY OF ________________, 202__ by Jon P. Didleaux.

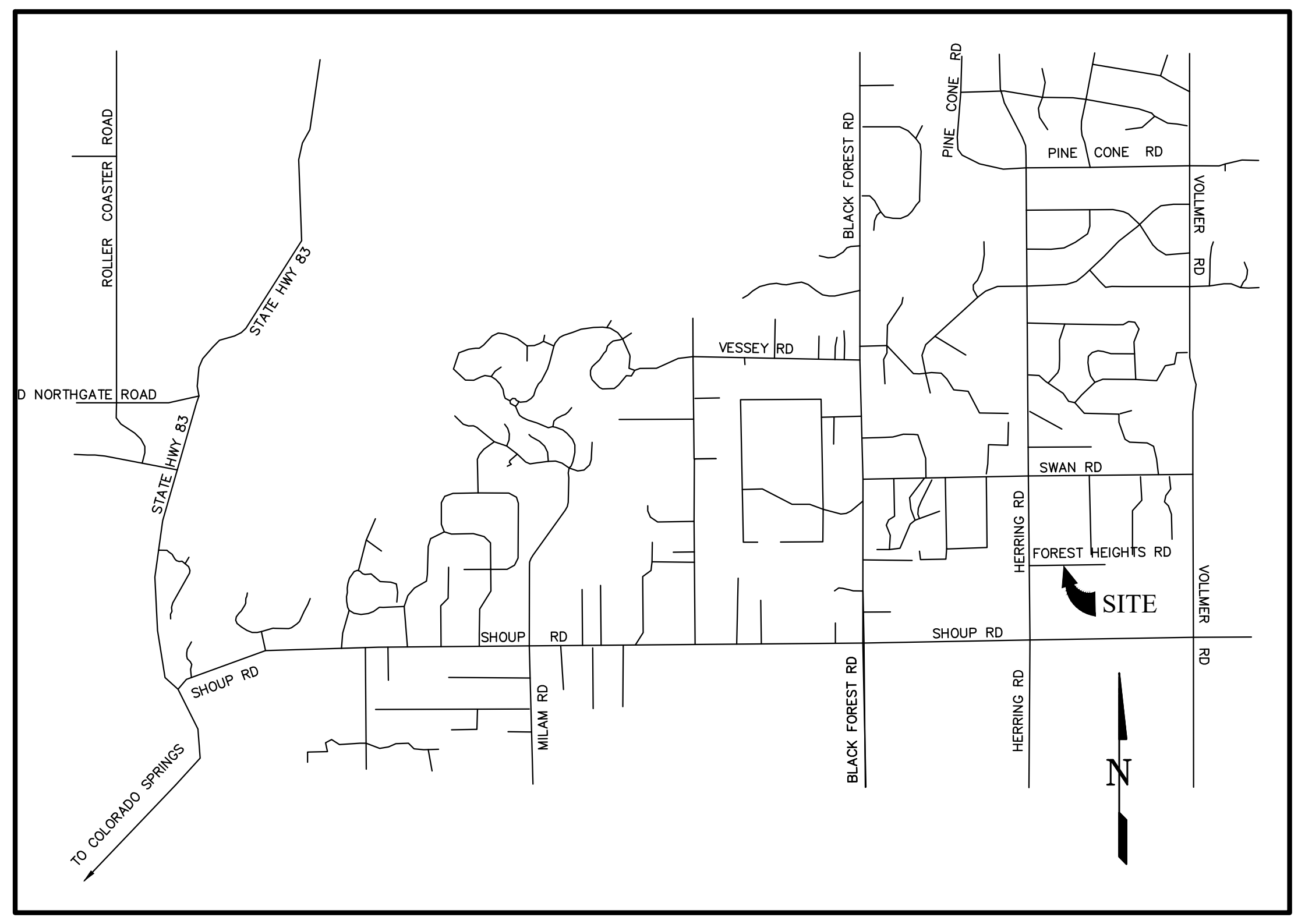
MY COMMISSION EXPIRES ______________

WITNESS MY HAND AND OFFICIAL SEAL_____________________________________
NOTARY PUBLIC

Tract A shall be utilized as a Private Road. Ownership of Tract A shall be vested with the owner of Lot 4.

Tract B shall be utilized as a Private Road. Ownership of Tract B shall be vested with the owner of Lot 1.

Maintenance of Tract A and Tract B shall be vested to the parties that are signatory and designated in the "ACCESS EASEMENT GRANT AND MAINTENANCE AGREEMENT FOR FOREST HEIGHTS CIRCLE AND RESTRICTIVE COVENANTS FOR LOTS 1, 2, 3 & 4 FOREST HEIGHTS ESTATES SUBDIVISION" and their successor and assigns.



VICINITY MAP
NOT TO SCALE

NOTES:

1. ● – Indicates survey monument recovered as shown.
   ○ – Indicates set survey monument no. 4 rebar and plastic cap PLS No. 18465 set flush with ground surface.
   ✳ – Indicates Not a Part of this Subdivision.
2. This survey does not constitute a title search by LDC, Inc. to determine ownership or easements of record. For all information regarding easements, rights–of–way and title of record, LDC, Inc. relied upon Owner's Policy of Title Insurance issued by Stewart Title Guaranty Company, File No. 49789ECS, Policy No. O–9301–004251616, date of policy is June 10, 2020.
3. Each individual property owner is responsible for the construction and operation of a non–evaporative wastewater disposal system approved by the El Paso County Health Department. The Health Department may require a specially designed, or "engineered," system prior to permit approval. Engineered systems may cost more to design, install and maintain than systems which are not engineered
4. The Basis of Bearings as shown on this plat is the Observed Bearing of the line from the Center $\frac{1}{4}$ Corner of Section 9 Township 12 South, Range 65 West of the 6TH P.M. being a 3" aluminum cap PLS No. 18830, and the West $\frac{1}{4}$ corner of Section 9 Township 12 South, Range 65 West of the 6TH P.M. being a 3" aluminum cap PLS No. 9477 as monumented upon the ground, and whose positions, as observed individually, were determined utilising survey quality GPS instruments.
   The line as observed, and as calculated bears N89°55'03"E.
5. All structural foundations shall be located and designed by a Professional Engineer, currently registered in the State of Colorado.
6. Individual wells in the Dawson aquifer are the responsibility of each lot owner. Permits for such wells must be obtained from the Colorado Division of Water Resources. Ground water rights associated with the subdivision were decreed in Case No. 22CW3060, Water Division 2 (adjudication of water rights and plan for augmentation).

   The plan for augmentation was designed to allow pumping of 0.77 acre foot annually from as many as four Dawson aquifer wells in the subdivision. Applicant, it successors and assigns at the time of lot sales, shall transfer rights to underlying ground water to the initial purchaser of each lot in an amount at least sufficient to satisfy the 300 year water supply requirement of El Paso County for four lots, or 924 acre feet from the Dawson aquifer and 943 acre feet from the Laramie–Fox Hills aquifer, as well as an undivided interest in the plan for augmentation. Each subsequent sale of a lot shall convey the remaining portion of such water rights, unless a lot is further subdivided in which case the water will be equally divided; This provision is included only to be consistent with the provisions of the augmentation plan, and does not imply the future approval by El Paso County of further subdivision of any of the four lots. Such conveyance may be accomplished either by separate quit claim deed, by other appropriate deed of the water rights associated with the lot, or by specifically identifying and transferring the water rights in the warranty deed which transfers the real property to the individual lot purchaser.

   Water in the Denver Basin aquifers is allocated based on a 100 year aquifer life. However, for El Paso County planning purposes, water in the Denver Basin aquifers is evaluated based on a 300 year aquifer life. Applicant, and all future owners of lots in the subdivision, should be aware that the economic life of a water supply in the Dawson aquifer may be less than either 100 years or 300 years indicated due to anticipated water level declines.
7. FEDERAL EMERGENCY MANAGEMENT AGENCY, Flood Insurance Rate Map Number 08041C0320G, effective date December 7, 2018, indicates the area in the vicinity of this parcel of land to be a Zone X (area determined to be out of the 500 year flood plain).
8. *(12345)*– Indicates property address. The addresses exhibited on this plat are for informational purposes only. They are not the legal description and are subject to change.
9. Fire protection to be provided by Black Forest Fire Protection District.
10. The following reports and/or documentation have been submitted in association with the Final Plat for this subdivision and are on file at the El Paso County Planning and Community Development Department: Drainage Report; Water Resources Report; Wastewater Disposal Report; Geology and Soils Report; Development Report and Evidence.
11. All property owners are responsible for maintaining proper storm water drainage in and through their property. Public drainage easements as specifically noted on the plat shall be maintained by the individual lot owners unless otherwise indicated. Structures, fences, materials or landscaping that could impede the flow of runoff shall not be placed in drainage easements.
12. Developer shall comply with federal and state laws, regulations, ordinances, review and permit requirements, and other agency requirements, if any, of applicable agencies including, but not limited to, the Colorado Division of Wildlife, Colorado Department of Transportation, U.S. Army Corps of Engineers and/or the U.S. Fish and Wildlife Service regarding the Endangered Species Act, particularly as it relates to the listed species, if applicable.
13. Mailboxes shall be installed in accordance with all El Paso County and United States Postal Service regulations.
14. Any person who knowingly removes, alters or defaces any public land survey monument or land boundary monument or accessory commits a Class Two (2) misdemeanor pursuant to C.R.S. 18–4–508.
15. The Subdivider agrees on behalf of him/herself and any other builders, successors, and assignees that Subdivider and/or said assigns shall be required to pay Traffic Impact Fees in accordance with the El Paso County Road Impact Fee Program Resolution (Resolution No. 19–471) or any amendments thereto, at or prior to the time of Building Permit submittals. the fee obligation if not paiod at final plat recording shall be documented on all salesdocuments and on plat notes plat notes to ensuure that a title serch would find the fee obligation before sale of the property.
16. Forest Heights Estates subdivision as shown is Zoned RR–5.
17. No Driveway shall be established unless an Access Permit has been granted by El Paso County.
18. Individual lot purchasers are responsible for constructing driveways, including necessary drainage culverts from Forest Heights Circle per Land Development Code Sections 6.3.3.C.2 and 6.3.3.C.3. Due to their length some of the driveways will need to be specifically approved by the Black Forest Fire Rescue Protection District.

NOTES (cont.):

19. The area encompassed by the Forest Heights Estates subdivision has been found to be impacted by geologic hazards:
    –Seasonally high groundwater.
    –Potentially high seasonal groundwater.
    Mitigation measures and a map of the hazard area can be found in the report "Soil, Geology, and Geologic Hazard Study ,Didleau Subdivison" by Entech Engineering Inc. Dated March 10, 2020 in file MS–20–004 available at the El Paso County Planning and Community Development Department.
20. The private road as shown on this plat will not be maintained by El Paso County until, and unless the road is constructed in conformance with the El Paso County standards in effect at the date of request for dedication and maintenance.
21. Forest Heights Estates subdivision is Subject to the ACCESS EASEMENT GRANT AND MAINTENANCE AGREEMENT FOR FOREST HEIGHTS CIRCLE AND RESTRICTIVE COVENANTS FOR LOTS 1, 2, 3 & 4 FOREST HEIGHTS ESTATES SUBDIVISION as recorded under Reception No.____________ of the records of the El Paso County Clerk and Recorder
22. NO BUILD AREAS: No permanent structures shall be within No Build Areas shown hereon. Fences, driveways and portable structures may be placed within the No Build Areas. Components of onsite wastewater treatment systems may be placed within No Build Areas and outside of any drainage easements as determined by the system designer.
23. DRAINAGE EASEMENTS: Public drainage easements as specifically noted on the plat shall be maintained by the individual lot owners unless otherwise indicated. Structures, fences, materials or landscaping that could impede the flow of runoff shall not be placed in drainage easements. Components of onsite wastewater treatment systems shall not be placed in drainage easements.
24. All Property within Forest Heights Estates subdivision is subject to a Declaration of Covenants as recorded under Reception No.____________ of the records of the El Paso County Clerk and Recorder

EASEMENTS:

Unless otherwise shown, both sides of all side lot lines and common rear lot lines are hereby platted with a ten (10) feet wide public utility and drainage easement on each side and a ten (10) feet wide public utility and drainage easement on lot lines abutting a public right–of–way and a twenty (20) feet wide public utility and drainage easement on the subdivision boundary lines. Said easements ore hereby dedicated to the public for installation and maintenance of public utilities and drainage facilities as shown hereon, with the sole responsibility for maintenance being vested with the property owners.

SURVEYOR'S CERTIFICATION:

I Daniel L. Kupferer, a duly registered Professional Land Surveyor in the State of Colorado, do hereby certify that this plat correctly represents the results of a survey made on (date of survey), by me or under my direct supervision and accurately shows the subdivision thereof and that all monuments exist as shown hereon; that mathematical closure errors are less than 1:10,000; and that said plat has been prepared in full compliance with all applicable provisions of the El Paso County Land Development Code. and that the requirements of Title 38 of the Colorado Revised Statutes, 1973 have been met to the best of my professional knowledge, bellief and opinion and that it is accordance with applicable standards of practice and this is not a guaranty or warranty, either expressed or implied.

Daniel L. Kupferer
Colorado Professional Land Surveyor No. 18465
For and on behalf of LDC, Inc

18465

BOARD OF COUNTY COMMISSIONERS CERTIFICATE:

This plat of FOREST HEIGHTS ESTATES was approved for filing by the El Paso County, Colorado Board of County Commissioners on the ____ day of ___________________, 20___, subject to any notes specified hereon and any conditions included in the resolution of approval.

______________________________ ________________________
Chair, Board of County Commissioners Date

APPROVALS:

This subdivision was approved by the El Paso County Planning and Community Development Department this ________day of __________________, 20___ A.D.

____
Director, Planning and Community Development Department

RECORDING:

STATE OF COLORADO }
COUNTY OF EL PASO } SS

I hereby certify that this instrument was filed for record in my office at_______ o'clock ___.M.

this __________ day of ______________________, 20____ A.D., and is duly recorded under

Reception No. ______________________________ of the records of El Paso County, Colorado.

Chuck Broerman, Recorder BY: ___________________________________
Deputy

SURCHARGE: ___________________
FEE: _________________________

FEES:

Park Fee: _______________________
Bridge Fee: ______________________
Drainage Fee: ____________________
School Fee: ______________________

PCD File No. MS206

NOTICE:
According to Colorado law you must commence any legal action based upon any defect in this survey within three years after you first discover such defect. In no event may any action based upon any defect in this survey be commenced more than ten years from the date of the certificatioreon. shown hereon.

CALL BEFORE YOU DIG . . .
811
DIAL 811
48 HOURS BEFORE YOU DIG, CALL UTILITY LOCATORS FOR LOCATING AND MARKING GAS, ELECTRIC, WATER AND WASTEWATER

REVISIONS

No.	Description	By	Date
1	LOT REVISIONS	DAS	02/23/2022
2	ROAD REVISIONS	DAS	04/12/2022
3	EPC REVIEW COMMENTS	MVE	9/26/2023

H Scale:	N/A
V Scale:	N/A
Designed By:	XXX
Drawn By:	JLG
Checked By:	DLK
Date:	5/01/2020

Land Development Consultants, Inc.
PLANNING • SURVEYING
www.ldc-inc.com • TEL: (719) 528-6133 • FAX: (719) 528-6848
3898 MAIZELAND ROAD • COLORADO SPRINGS, CO 80909

FOREST HEIGHTS ESTATES
FINAL PLAT.
SW 1/4 SECTION 9, T12S, R65W, 6TH PM
COUNTY OF EL PASO, STATE OF COLORADO

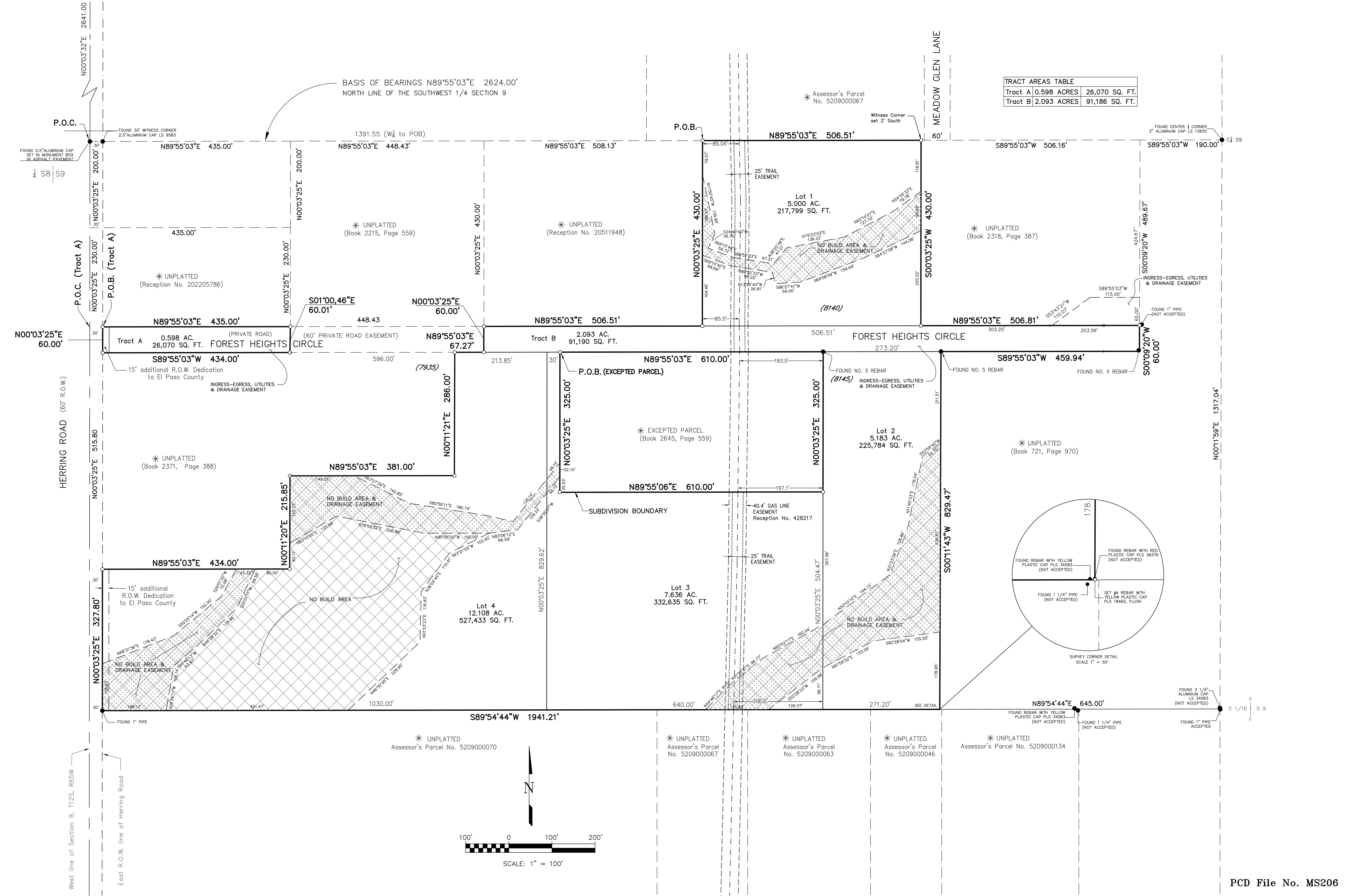
Project No.: 18070

Sheet: 1 of 2

F:_CADemplates\2016 PP-ILC-GICLL TEMPLATES.dwg

FOREST HEIGHTS ESTATES

FINAL PLAT
PART OF THE SOUTHWEST QUARTER OF SECTION 9, TOWNSHIP 12 SOUTH, RANGE 65 WEST OF THE 6TH P.M.
COUNTY OF EL PASO, STATE OF COLORADO



TRACT AREAS TABLE		
Tract A	0.598 ACRES	26,070 SQ. FT.
Tract B	2.093 ACRES	91,186 SQ. FT.

PCD File No. MS206

NOTICE:
According to Colorado law you must commence any legal action based upon any defect in this survey within three years after you first discover such defect. In no event may any action based upon any defect in this survey be commenced more than ten years from the date of the certificatioreon.

CALL BEFORE YOU DIG . . .
811
DIAL 811
48 HOURS BEFORE YOU DIG, CALL UTILITY LOCATORS FOR LOCATING AND MARKING GAS, ELECTRIC, WATER AND WASTEWATER

REVISIONS			
No.	Description	By	Date
1	LOT REVISIONS	DAS	02/23/22
2	ROAD REVISIONS	DAS	04/12/22
3	EPC REVIEW COMMENTS	MVE	9/26/2023

H Scale: 1"=100'
V Scale: N/A
Designed By: N/A
Drawn By: JLG
Checked By: DLK
Date: 5/01/2020

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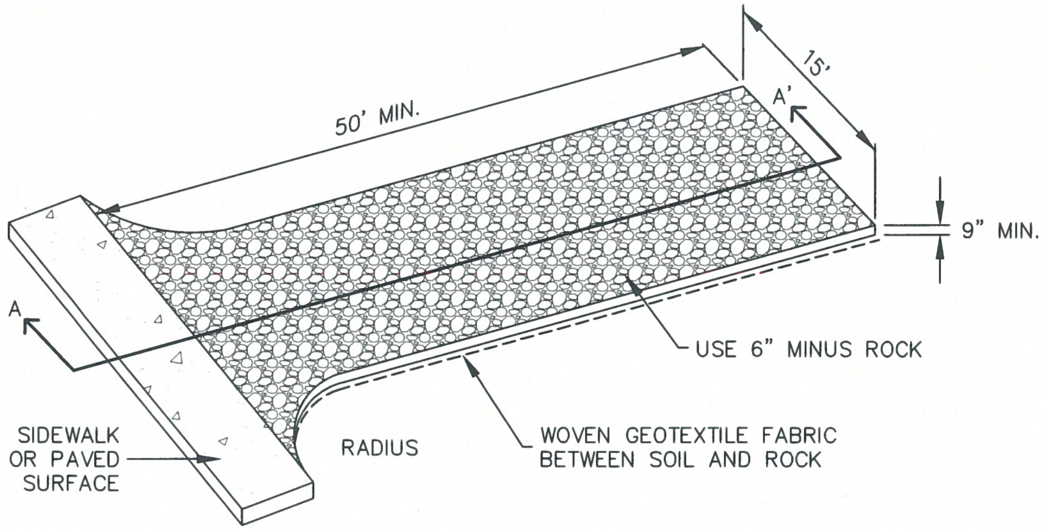
FOREST HEIGHTS ESTATES
FINAL PLAT
PART OF SW 1/4, SEC. 9, T12S, R65W, 6TH P.M.
COUNTY OF EL PASO, STATE OF COLORADO

Project No.: 18070

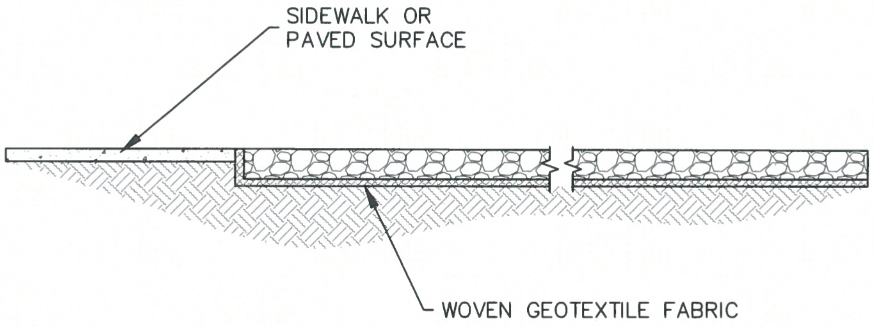
Sheet: 2 of 2

Exhibit 8:

Erosion Control Facilities



AGGREGATE VEHICLE TRACKING CONTROL



SECTION A-A'

INSTALLATION NOTES

1. A STABILIZED CONSTRUCTION ENTRANCE/EXIT SHOULD BE LOCATED AT ALL POINTS WHERE VEHICLES EXIT THE CONSTRUCTION SITE TO ADJACENT ROADWAY.
2. STABILIZED CONSTRUCTION ENTRANCE/EXITS SHALL BE INSTALLED PRIOR TO ANY LAND DISTURBING ACTIVITIES.
3. RADIUS MUST BE ADEQUATE FOR INTENDED CONSTRUCTION VEHICLE TURNING.
4. ROCK SHOULD CONSIST OF 6" MINUS ROCK.
5. INSTALL CONSTRUCTION FENCE ON BOTH SIDES OF VEHICLE TRACKING CONTROL PAD WHEN NEEDED OR REQUIRED BY INSPECTOR.

MAINTENANCE NOTES

1. FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN CONTROL MEASURES IN EFFECTIVE OPERATING CONDITION. INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.
2. SEDIMENT TRACKED ONTO THE ADJACENT ROAD SHALL BE REMOVED DAILY, BY SWEEPING OR SHOVELING, AND NEVER WASHED DOWN STORM DRAINS.
3. ROUGHEN, REPLACE AND/OR ADD ROCK AS NEEDED TO MAINTAIN CONSISTENT DEPTH AND TO PREVENT SEDIMENT TRACKING ONTO ADJACENT STREET.
4. PERMANENTLY STABILIZE AREA AFTER VEHICLE TRACKING CONTROL IS REMOVED.

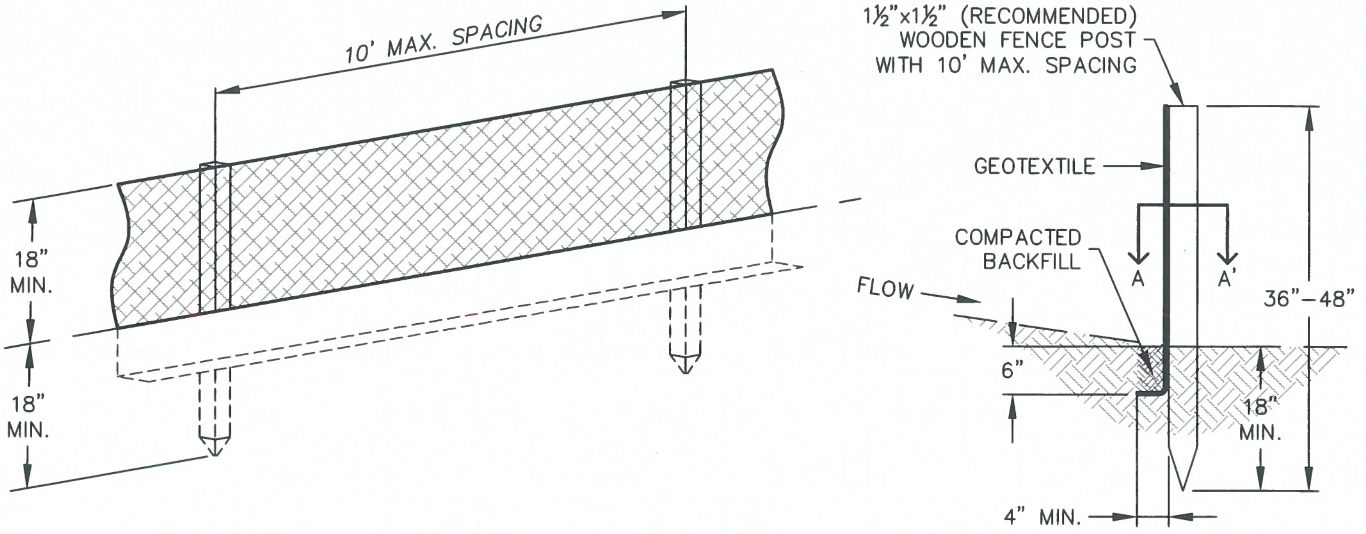
VTC

STORMWATER
ENTERPRISE

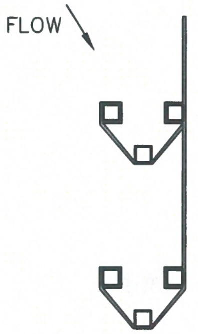
VEHICLE TRACKING
CONTROL

APPROVED:
SWENT MANAGER

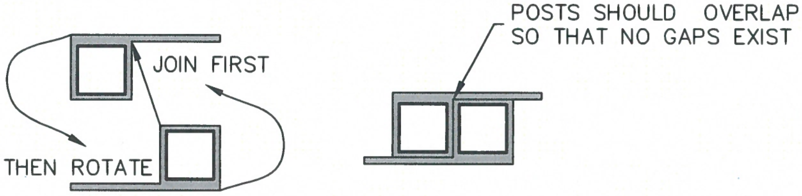
ISSUED: 10/7/19
REVISED: 8/19/2020
DRAWING NO. 900–VTC



SILT FENCE



J-HOOK INSTALLATION



SECTION A-A'

INSTALLATION NOTES

1. SILT FENCE MUST BE PLACED ON A FLAT SURFACE 2'–5' AWAY FROM TOE OF THE SLOPE TO ALLOW FOR PONDING AND DEPOSITION.
2. COMPACT THE TRENCH USING A JUMPING JACK OR WHEEL ROLLING TO THE POINT THAT THE FENCE RESISTS BEING PULLED OUT OF THE GROUND BY HAND.
3. SILT FENCE SHALL BE TAUT WITH NO SAGS AFTER IT HAS BEEN ANCHORED.
4. FABRIC SHALL BE ATTACHED TO POSTS WITH 1" HEAVY DUTY STAPLES OR 1" NAILS. THESE SHOULD BE PLACED VERTICALLY DOWN THE POST, 3" APART.
5. THE PREFERRED INSTALLATION METHOD USES A TRENCHER OR SILT FENCE INSTALLATION DEVICE.
6. INSTALL SILT FENCE ALONG THE CONTOUR OF THE SLOPES OR IN A MANNER TO AVOID CREATING CONCENTRATED FLOW (SUCH AS A "J–HOOK" INSTALLATION).

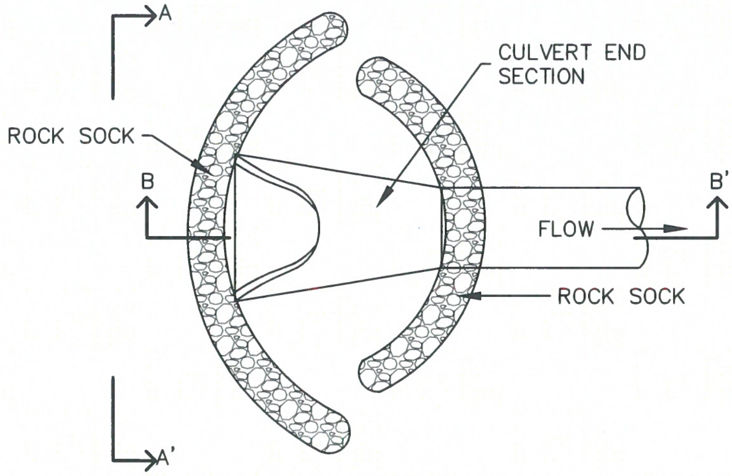
MAINTENANCE NOTES

1. FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN CONTROL MEASURES IN EFFECTIVE OPERATING CONDITION. INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.
2. ACCUMULATED SEDIMENT MUST BE REMOVED WHEN THE HEIGHT REACHES ½ OF THE DESIGN HEIGHT OF THE SILT FENCE.
3. SILT FENCE MUST REMAIN UNTIL THE UPSTREAM DISTURBANCE AREA IS STABILIZED.
4. PERMANENTLY STABILIZE AREA AFTER SILT FENCE IS REMOVED.

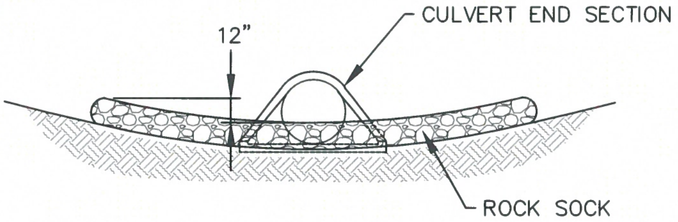
SF

STORMWATER
ENTERPRISE

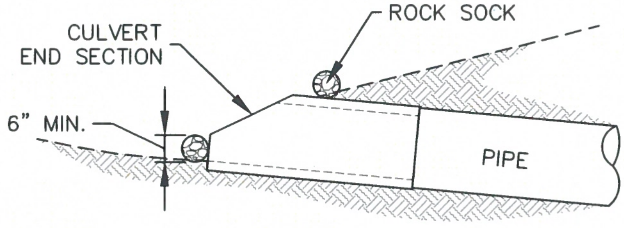
SILT FENCE		
APPROVED: SWENT MANAGER		
ISSUED: 10/7/19	REVISED: 8/19/2020	DRAWING NO. 900–SF



CULVERT INLET PROTECTION PLAN



SECTION A-A'



SECTION B-B'

INSTALLATION NOTES

1. SEE ROCK SOCK DETAIL.

MAINTENANCE NOTES

1. FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN CONTROL MEASURES IN EFFECTIVE OPERATING CONDITION. INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.
2. ACCUMULATED SEDIMENT UPSTREAM OF THE CULVERT SHALL BE REMOVED WHEN THE SEDIMENT DEPTH IS ½ HEIGHT OF THE ROCK SOCK.
3. CULVERT INLET PROTECTION SHALL REMAIN UNTIL THE UPSTREAM AREA IS PERMANENTLY STABILIZED.

CIP

STORMWATER
ENTERPRISE

CULVERT INLET
PROTECTION

APPROVED:
SWENT MANAGER

ISSUED: 10/7/19
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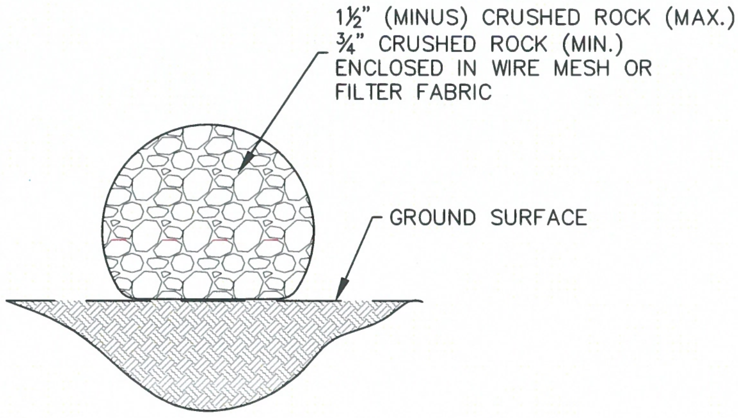
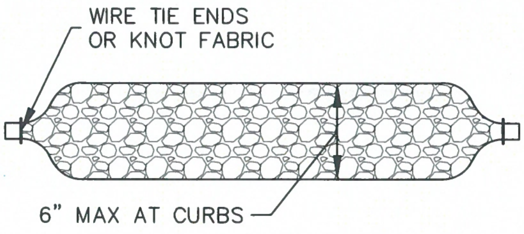
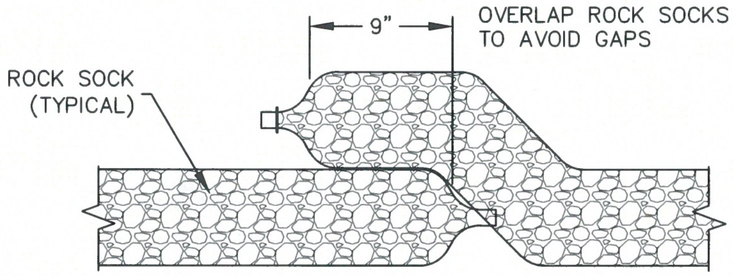
DRAWING NO. 900-CIP



ROCK SOCK SECTION



ROCK SOCK PLAN



ROCK SOCK OVERLAP

GRADATION TABLE

	MASS PERCENT PASSING SQUARE MESH SIEVES
	No. 4
2"	100
1½"	90–100
1"	20–55
¾"	0–15
⅜"	0–5

MATCHES SPECIFICATIONS FOR No. 4 COARSE AGGREGATE FOR CONCRETE PER AASHTO M–43. ALL ROCK SHALL BE FRACTURED FACE, ALL SIDES

INSTALLATION NOTES

1. CRUSHED ROCK SHALL BE BETWEEN MAX. 1½" (MINUS) IN SIZE WITH A FRACTURED FACE (ALL SIDES) AND SHALL COMPLY WITH GRADATION SHOWN ON THIS SHEET AND MIN. ¾" CRUSHED ROCK.
2. WIRE MESH SHALL HAVE OPENINGS SMALLER THAN THE SMALLEST SIZE ROCK.
3. WIRE MESH SHALL BE SECURED USING 'HOG RINGS' OR WIRE TIES AT 6" CENTERS ALONG ALL JOINTS AND AT 2" CENTERS ON ENDS OF SOCKS.

MAINTENANCE NOTES

1. FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN CONTROL MEASURES IN EFFECTIVE OPERATING CONDITION. INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.
2. ROCK SOCKS SHALL BE REPLACED IF THEY BECOME HEAVILY SOILED OR DAMAGED BEYOND REPAIR.
3. ACCUMULATED SEDIMENT SHALL BE REMOVED WHEN THE DEPTH REACHES ½ OF THE HEIGHT OF THE ROCK SOCK.
4. ROCK SOCKS ARE TO REMAIN IN PLACE UNTIL DISTURBED AREA IS STABILIZED.
5. PERMANENTLY STABILIZE AREA AFTER ROCK SOCKS HAVE BEEN REMOVED.

RS

STORMWATER
ENTERPRISE

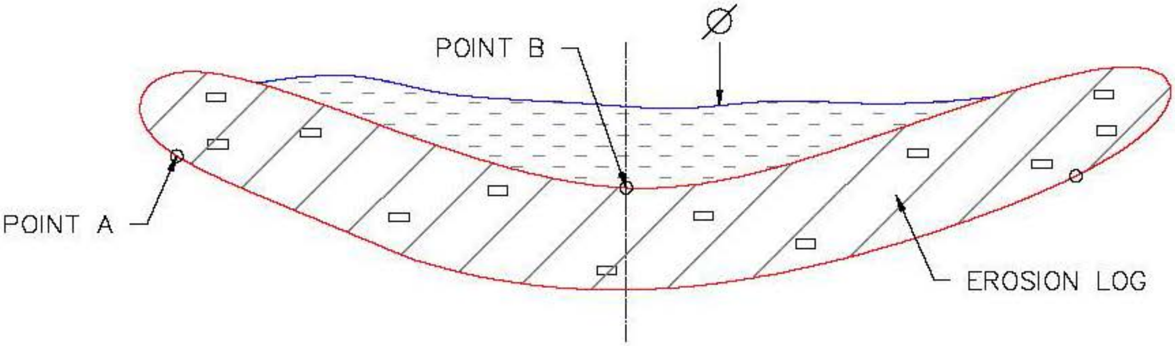
ROCK SOCK

APPROVED:
SWENT MANAGER

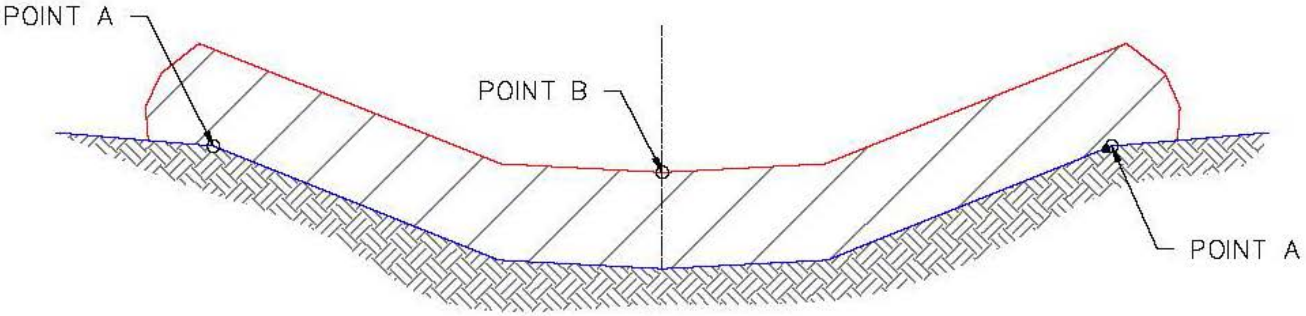
ISSUED: 10/7/19
REVISED: 8/19/2020
DRAWING NO. 900–RS

∅ REMOVE ACCUMULATED SEDIMENT WHEN IT REACHES ONE HALF OF EXPOSED LOG HEIGHT. INSPECTIONS SHALL BE PERFORMED FREQUENTLY FOR PROPER FUNCTION.

EROSION LOGS SHOULD BE KEYED IN TO PREVENT UNDER-CUTTING



PLAN VIEW



POINTS A SHALL BE HIGHER THAN POINT B

ELEVATION
EROSION LOG DETAIL DITCH INSTALLATION

NOTE: EROSION LOGS SHALL BE TIGHTLY ABUTTED WITH NO GAPS.

1/1/08
DATE APPROVED:

John A. McCarty
DEPARTMENT OF TRANSPORTATION

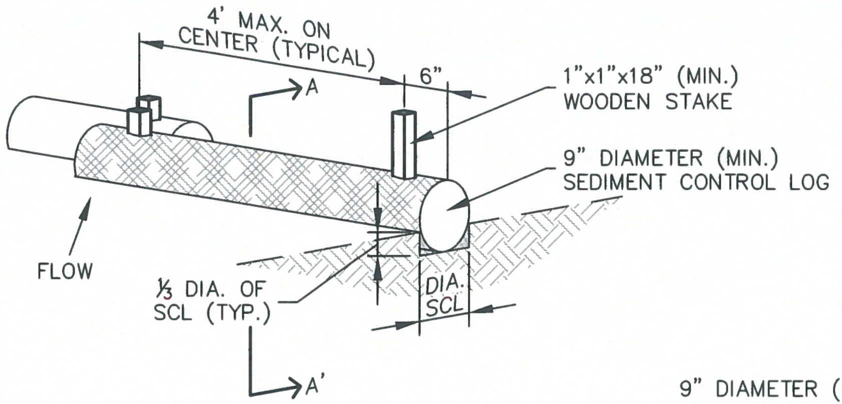
Erosion Log Check Dams

Standard Drawing

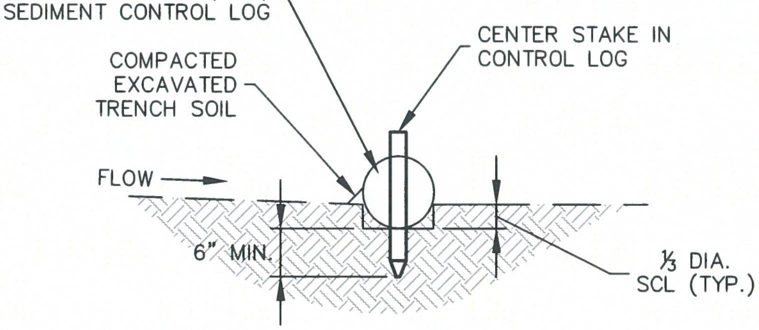
REVISION DATE:
7/17/07

FILE NAME:
SD_3-85

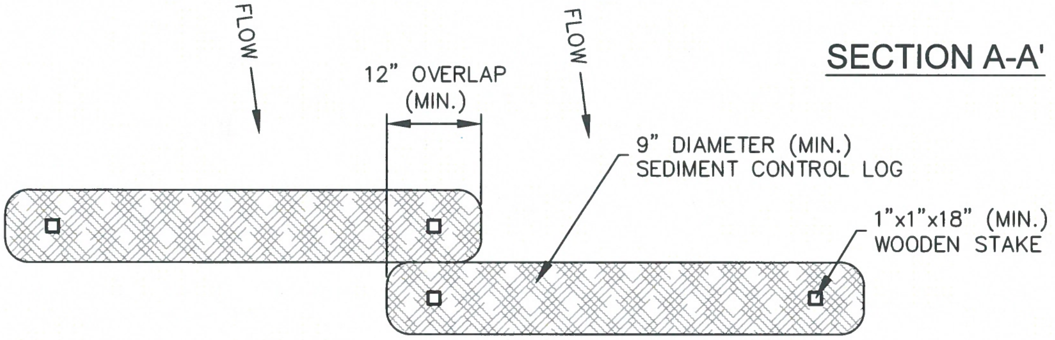
EL PASO COUNTY
DEPARTMENT OF TRANSPORTATION



SEDIMENT CONTROL LOG



SECTION A-A'



SEDIMENT CONTROL LOG JOINTS

INSTALLATION NOTES

1. ALL SEDIMENT CONTROL LOGS MUST BE EMBEDDED TO ⅓ OF THE HEIGHT OF THE LOG
2. LARGER DIAMETER SEDIMENT CONTROL LOGS NEED TO BE EMBEDDED DEEPER.
3. PLACE SEDIMENT CONTROL LOG AGAINST SIDEWALK OR BACK OF CURB WHEN ADJACENT TO THESE FEATURES.
4. SEDIMENT CONTROL LOGS SHALL CONSIST OF STRAW, COMPOST, EXCELSIOR OR COCONUT FIBER, AND SHALL BR FREE FROM ANY NOXIOUS WEED SEEDS OF DEFECTS INCLUDING RIPS, HOLES AND OBVIOUS WEAR.
5. IF USING AS SLOPE PROTECTION, INSTALL SEDIMENT CONTROL LOGS ALONG THE CONTOUR.

MAINTENANCE NOTES

1. FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN CONTROL MEASURES IN EFFECTIVE OPERATING CONDITION. INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.
2. ACCUMULATED SEDIMENT MUST BE REMOVED WHEN THE HEIGHT REACHES ½ OF THE HEIGHT OF THE SEDIMENT CONTROL LOG.
3. PERMANENTLY STABILIZE AREA AFTER SEDIMENT CONTROL LOGS HAVE BEEN REMOVED.

SCL

STORMWATER
ENTERPRISE

SEDIMENT CONTROL LOGS

APPROVED:
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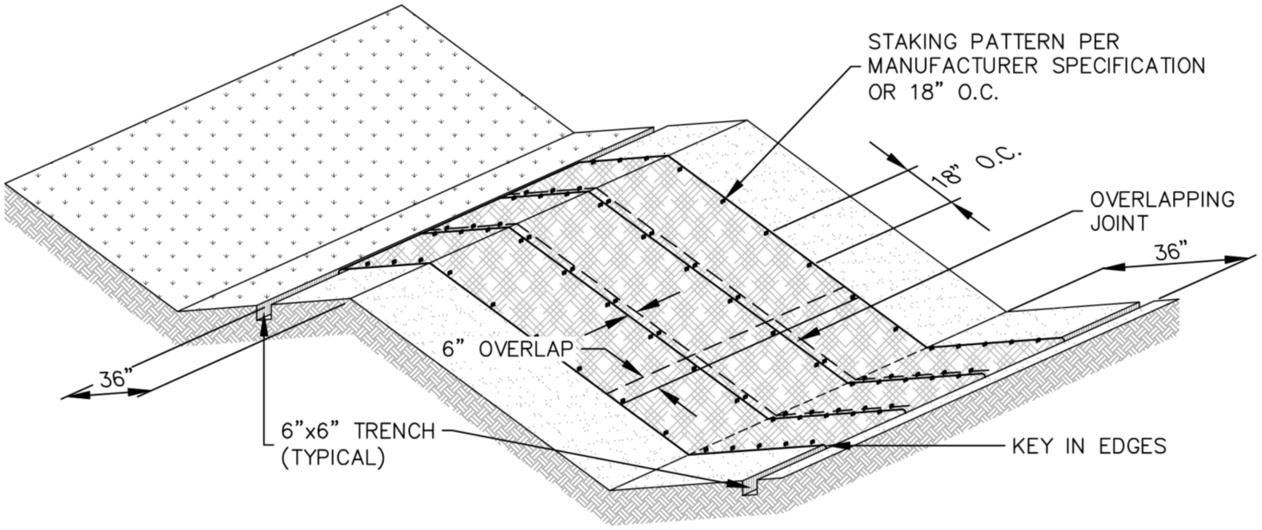
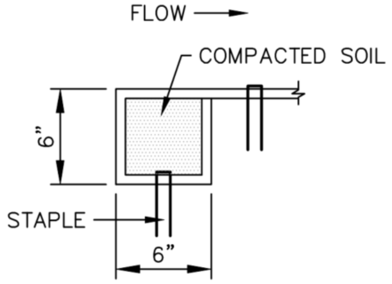
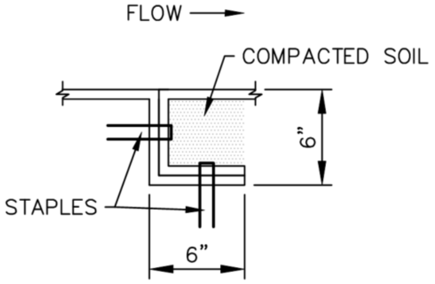
ISSUED:	REVISED:	DRAWING NO.
10/7/19	8/19/2020	900-SCL



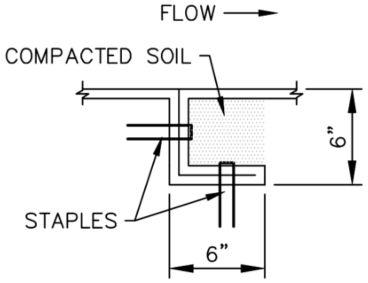
EROSION CONTROL BLANKET



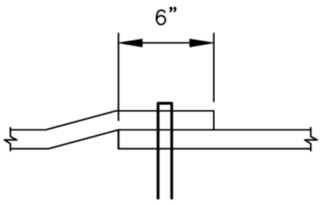
PERIMETER ANCHOR TRENCH



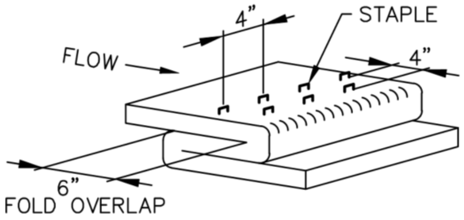
JOINT ANCHOR TRENCH



INTERMEDIATE CHECK SLOT



OVERLAPPING JOINT



STAPLE CHECK

TO BE USED ON SLOPE EVERY 15 FEET

ECB

STORMWATER
ENTERPRISE

EROSION CONTROL
BLANKET

APPROVED:

SWENT MANAGER

ISSUED:	REVISED:	DRAWING NO.
10/7/19	8/19/2020	900-ECB-1

INSTALLATION NOTES

1. 100% NATURAL AND BIODEGRADABLE MATERIALS ARE REQUIRED FOR EROSION CONTROL BLANKETS. TRM PRODUCTS MAY ME USED WHERE APPROPRIATE AS DESIGNATED BY THE ENGINEER.
2. IN AREAS WHERE EROSION CONTROL BLANKETS ARE SHOWN ON THE PLANS, THE PERMITTEE SHALL PLACE TOPSOIL AND PERFORM FINAL GRADING, SURFACE PREPARATION, AND SEEDING AND MULCHING. SUBGRADE SHALL BE SMOOTH AND MOIST PRIOR TO EROSION CONTROL BLANKET INSTALLATION, AND THE EROSION CONTROL BLANKET SHALL BE IN FULL CONTACT WITH THE SUBGRADE. NO GAPS OR VOIDS SHALL EXIST UNDER THE BLANKET.
3. PERIMETER ANCHOR TRENCH SHALL BE USED ALONG THE OUTSIDE PERIMETER OF ALL BLANKET AREAS.
4. JOINT ANCHOR TRENCH SHALL BE USED TO JOIN ROLLS OF EROSION CONTROL BLANKETS TOGETHER (LONGITUDINALLY AND TRANSVERSELY) FOR ALL EROSION CONTROL BLANKETS.
5. INTERMEDIATE CHECK SLOT OR STAPLE CHECK SHALL BE INSTALLED EVERY 15' DOWN SLOPES. IN DRAINAGEWAYS, INSTALL CHECK SLOTS EVERY 25' PERPENDICULAR TO FLOW DIRECTION.
6. OVERLAPPING JOINT DETAIL SHALL BE USED TO JOIN ROLLS OF EROSION CONTROL BLANKETS TOGETHER FOR EROSION CONTROL BLANKETS ON SLOPES.
7. MATERIAL SPECIFICATIONS OF EROSION CONTROL BLANKETS SHALL CONFORM TO TABLE ECB-1.
8. ANY AREAS OF SEEDING AND MULCHING DISTURBED IN THE PROCESS OF INSTALLING EROSION CONTROL BLANKETS SHALL BE RESEEDED AND MULCHED.
9. STRAW EROSION CONTROL BLANKETS SHALL NOT BE USED WITHIN STREAMS AND DRAINAGE CHANNELS.
10. COMPACT ALL TRENCHES.

MAINTENANCE NOTES

1. FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN CONTROL MEASURES IN EFFECTIVE OPERATING CONDITION. INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.
2. EROSION CONTROL BLANKETS SHALL BE LEFT IN PLACE TO EVENTUALLY BIODEGRADE. TRM MUST BE REMOVED AT THE DISCRETION OF THE GEC INSPECTOR.
3. ANY EROSION CONTROL BLANKET PULLED OUT, TORN, OR OTHERWISE DAMAGED SHALL BE REPAIRED OR REINSTALLED. ANY SUBGRADE AREAS BELOW GEOTEXTILE THAT HAVE ERODED TO CREATE A VOID UNDER THE BLANKET, OR THAT REMAIN DEVOID OF GRASS SHALL BE REPAIRED, RESEEDED AND MULCHED AND THE EROSION CONTROL BLANKET REINSTALLED.

TABLE ECB-1, EROSION CONTROL BLANKET MATERIAL SPECIFICATIONS

TYPE	COCONUT CONTENT	STRAW CONTENT	EXCELSIOR CONTENT	RECOMMENDED NETTING
STRAW	–	100%	–	DOUBLE/ NATURAL
STRAW-COCONUT	30% MIN.	70% MAX.	–	DOUBLE/ NATURAL
COCONUT	100%	–	–	DOUBLE/ NATURAL
EXCELSIOR	–	–	100%	DOUBLE/ NATURAL

ECB

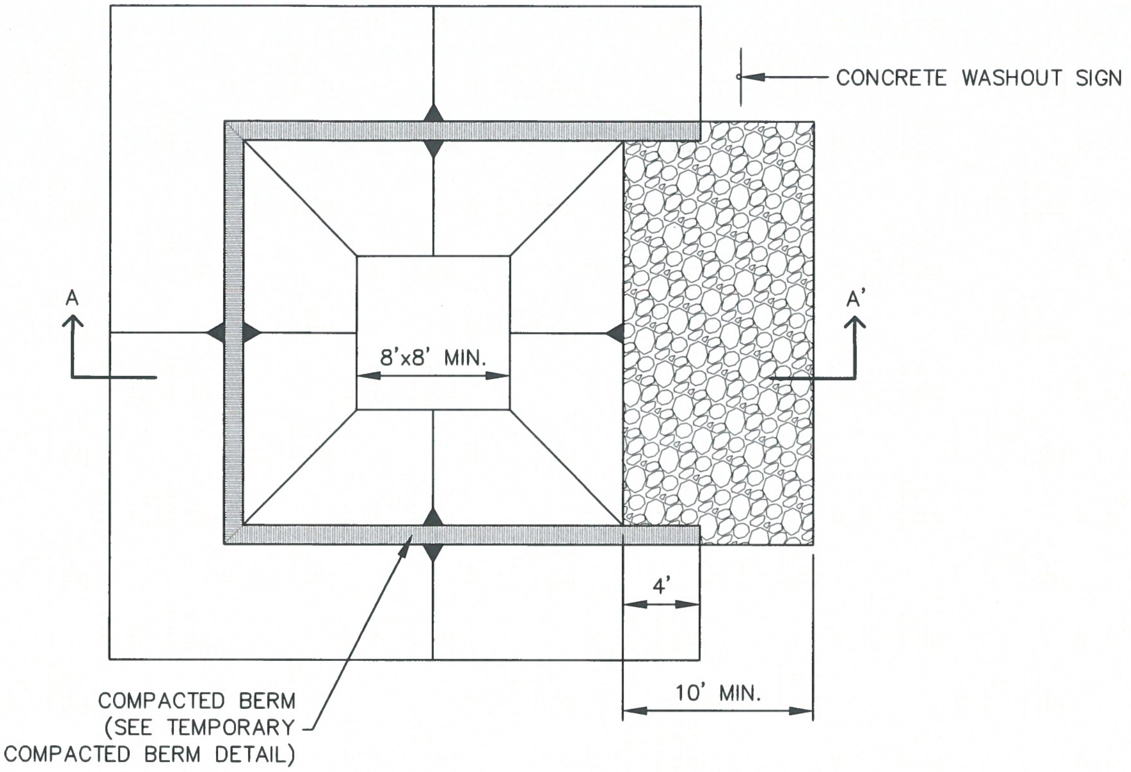
STORMWATER ENTERPRISE

EROSION CONTROL BLANKET

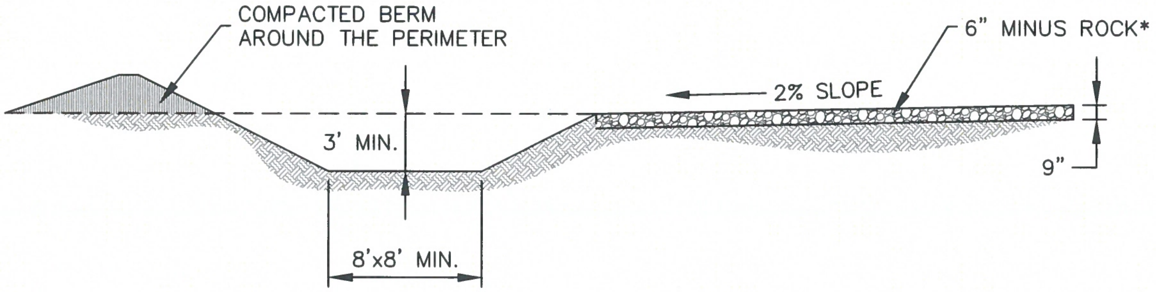
APPROVED:

SWENT MANAGER

ISSUED:	REVISED:	DRAWING NO.
10/7/19	8/19/2020	900-ECB-2



CONCRETE WASHOUT AREA PLAN



SECTION A-A'

*ROCK REQUIRED BASED ON
SITE CONDITIONS AT THE
DISCRETION OF THE GEC
INSPECTOR

CWA

STORMWATER
ENTERPRISE

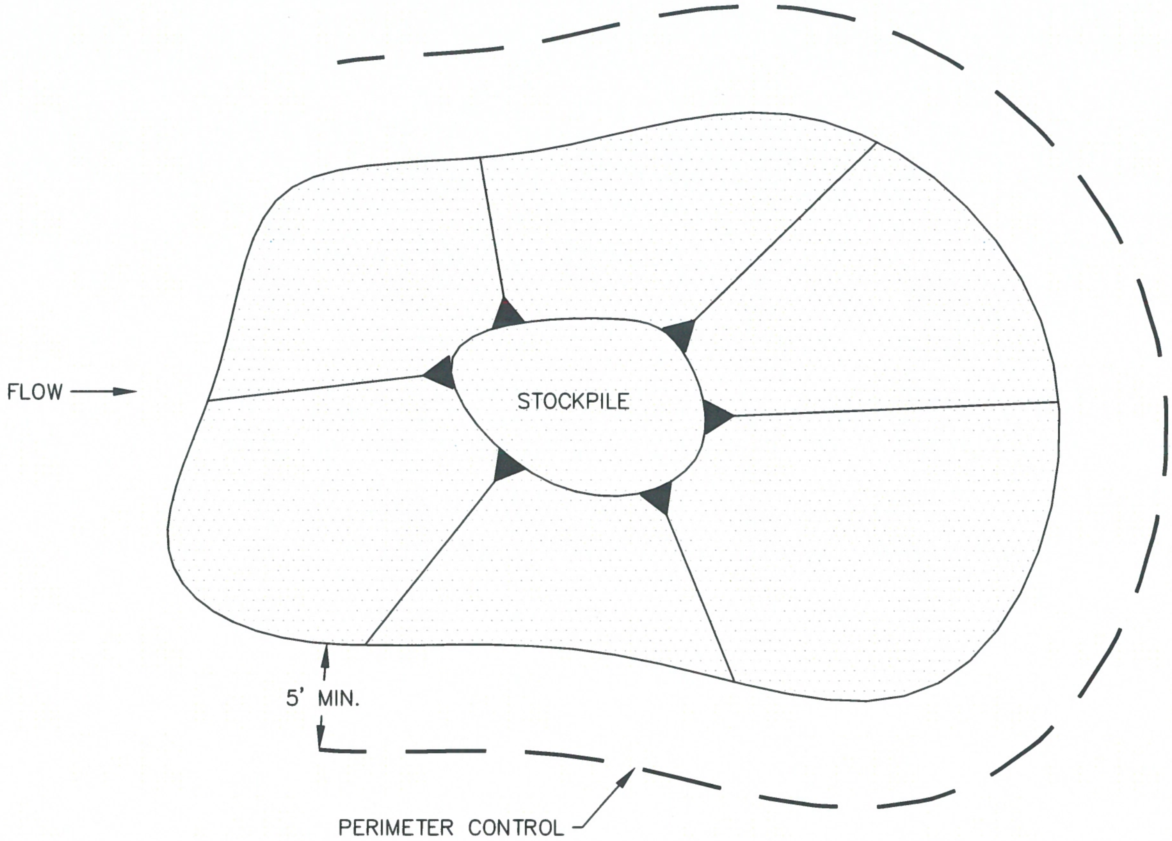
CONCRETE
WASHOUT AREA

APPROVED:
SWENT MANAGER

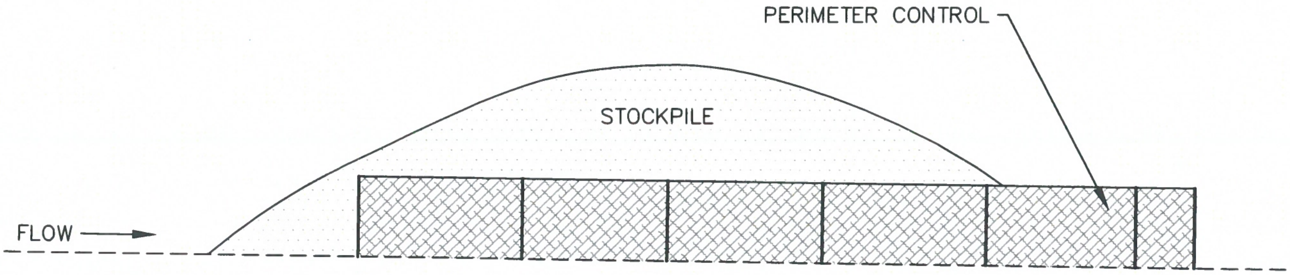
ISSUED:
10/7/19

REVISED:
8/19/2020

DRAWING NO.
900-CWA-1



STOCKPILE PROTECTION PLAN



STOCKPILE PROTECTION ELEVATION

INSTALLATION NOTES

1. INSTALL PERIMETER CONTROL AROUND STOCKPILE ON DOWNGRADIENT SIDE. PERIMETER CONTROL MUST BE SUITABLE TO SITE CONDITIONS AND INSTALLED ACCORDING TO THE RELEVANT DETAIL.
2. FOR STOCKPILES ON THE INTERIOR PORTION OF A CONSTRUCTION SITE, WHERE OTHER DOWNGRADIENT CONTROLS INCLUDING PERIMETER CONTROL ARE IN PLACE, STOCKPILE PERIMETER CONTROLS MAY NOT BE REQUIRED.

MAINTENANCE NOTES

1. FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN CONTROL MEASURES IN EFFECTIVE OPERATING CONDITION. INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.
2. IF PERIMETER CONTROLS MUST BE MOVED TO ACCESS STOCKPILE, REPLACE PERIMETER CONTROLS BY THE END OF THE WORK DAY.
3. ACCUMULATED SEDIMENT MUST BE REMOVED ACCORDING TO PERIMETER CONTROL DETAIL.

SP

STORMWATER
ENTERPRISE

STOCKPILE PROTECTION

APPROVED:
SWENT MANAGER

ISSUED:	REVISED:	DRAWING NO.
10/7/19	8/19/2020	900-SP

INSTALLATION NOTES

1. SEE PLAN VIEW FOR:
   - LOCATION OF CONCRETE WASHOUT AREA
2. LOCATE AT LEAST 50' AWAY FROM STATE WATERS MEASURED HORIZONTALLY.
3. AN IMPERMEABLE LINER (16 MIL. MINIMUM THICKNESS) IS REQUIRED IF CONCRETE WASH AREA IS LOCATED WITHIN 400' OF STATE WATERS OR 1000' OF WELLS OR DRINKING WATER SOURCES.
4. DO NOT LOCATE IN AREAS WHERE SHALLOW GROUNDWATER MAY BE PRESENT.
5. THE CONCRETE WASH AREA SHALL BE INSTALLED PRIOR TO CONCRETE PLACEMENT ON SITE.
6. CONCRETE WASH AREA SHALL INCLUDE A FLAT SUBSURFACE PIT THAT IS AT LEAST 8' BY 8'.
7. BERM SURROUNDING SIDES AND BACK OF CONCRETE WASH AREA SHALL HAVE A MINIMUM HEIGHT OF 2 FEET.
8. CONCRETE WASH AREA ENTRANCE SHALL BE SLOPED 2% TOWARDS THE CONCRETE WASH AREA.
9. SIGNS SHALL BE PLACED AT THE CONCRETE WASH AREA.
10. USE EXCAVATED MATERIAL FOR PERIMETER BERM CONSTRUCTION.

MAINTENANCE NOTES

1. FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN CONTROL MEASURES IN EFFECTIVE OPERATING CONDITION. INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.
2. THE CONCRETE WASH AREA SHALL BE REPAIRED, CLEANED, OR ENLARGED AS NECESSARY TO MAINTAIN CAPACITY FOR CONCRETE WASTE. CONCRETE MATERIALS ACCUMULATED IN THE PIT SHALL BE REMOVED ONCE THE MATERIALS HAVE REACHED A DEPTH OF ⅔ THE HEIGHT OF THE CONCRETE WASH AREA.
3. CONCRETE WASHOUT WATER, WASTED PIECES OF CONCRETE, AND ALL OTHER DEBRIS IN THE SUBSURFACE PIT SHALL BE TRANSPORTED FROM THE JOB SITE IN A WATER-TIGHT CONTAINER AND DISPOSED OF PROPERLY.
4. THE CONCRETE WASH AREA SHALL REMAIN IN PLACE UNTIL ALL CONCRETE FOR THE PROJECT IS PLACED.
5. PERMANENTLY STABILIZE AREA AFTER CONCRETE WASH AREA IS REMOVED.

CWA

STORMWATER
ENTERPRISE

CONCRETE
WASHOUT AREA

APPROVED:

SWENT MANAGER

ISSUED: 10/7/19
REVISED: 8/19/2020
DRAWING NO. 900-CWA-2

SEEDING & MULCHING

ALL SOIL TESTING, SOILS AMENDMENT AND FERTILIZER DOCUMENTATION, AND SEED LOAD AND BAG TICKETS MUST BE ADDED TO THE CSWMP.

SOIL PREPARATION

1. IN AREAS TO BE SEEDED, THE UPPER 6 INCHES OF THE SOIL MUST NOT BE HEAVILY COMPACTED, AND SHOULD BE IN FRIABLE CONDITION. LESS THAN 85% STANDARD PROCTOR DENSITY IS ACCEPTABLE. AREAS OF COMPACTION OR GENERAL CONSTRUCTION ACTIVITY MUST BE SCARIFIED TO A DEPTH OF 6 TO 12 INCHES PRIOR TO SPREADING TOPSOIL TO BREAK UP COMPACTED LAYERS AND PROVIDE A BLENDING ZONE BETWEEN DIFFERENT SOIL LAYERS.
2. AREAS TO BE PLANTED SHALL HAVE AT LEAST 4 INCHES OF TOPSOIL SUITABLE TO SUPPORT PLANT GROWTH.
3. THE CITY RECOMMENDS THAT EXISTING AND/OR IMPORTED TOPSOIL BE TESTED TO IDENTIFY SOIL DEFICIENCIES AND ANY SOIL AMENDMENTS NECESSARY TO ADDRESS THESE DEFICIENCIES. SOIL AMENDMENTS AND/OR FERTILIZERS SHOULD BE ADDED TO CORRECT TOPSOIL DEFICIENCIES BASED ON SOIL TESTING RESULTS.
4. TOPSOIL SHALL BE PROTECTED DURING THE CONSTRUCTION PERIOD TO RETAIN ITS STRUCTURE AVOID COMPACTION, AND TO PREVENT EROSION AND CONTAMINATION. STRIPPED TOPSOIL MUST BE STORED IN AN AREA AWAY FROM MACHINERY AND CONSTRUCTION OPERATIONS, AND CARE MUST BE TAKEN TO PROTECT THE TOPSOIL AS A VALUABLE COMMODITY. TOPSOIL MUST NOT BE STRIPPED DURING UNDESIRABLE WORKING CONDITIONS (E.G. DURING WET WEATHER OR WHEN SOILS ARE SATURATED). TOPSOIL SHALL NOT BE STORED IN SWALES OR IN AREAS WITH POOR DRAINAGE.

SEEDING

1. ALLOWABLE SEED MIXES ARE INCLUDED IN THE CITY OF COLORADO SPRINGS STORMWATER CONSTRUCTION MANUAL. ALTERNATIVE SEED MIXES ARE ACCEPTABLE IF INCLUDED IN AN APPROVED LANDSCAPING PLAN.
2. SEED SHOULD BE DRILL-SEEDED WHENEVER POSSIBLE
   - SEED DEPTH MUST BE ⅓ TO ½ INCHES WHEN DRILL-SEEDING IS USED
3. BROADCAST SEEDING OR HYDRO-SEEDING WITH TACKIFIER MAY BE SUBSTITUTED ON SLOPES STEEPER THAN 3:1 OR ON OTHER AREAS NOT PRACTICAL TO DRILL SEED.
   - SEEDING RATES MUST BE DOUBLED FOR BROADCAST SEEDING OR INCREASED BY 50% IF USING A BRILLION DRILL OR HYDRO-SEEDING
   - BROADCAST SEEDING MUST BE LIGHTLY HAND-RAKED INTO THE SOIL

MULCHING

1. MULCHING SHOULD BE COMPLETED AS SOON AS PRACTICABLE AFTER SEEDING, HOWEVER PLANTED AREAS MUST BE MULCHED NO LATER THAN 14 DAYS AFTER PLANTING.
2. MULCHING REQUIREMENTS INCLUDE:
   - HAY OR STRAW MULCH
     - ONLY CERTIFIED WEED-FREE AND CERTIFIED SEED-FREE MULCH MAY BE USED. MULCH MUST BE APPLIED AT 2 TONS/ACRE AND ADEQUATELY SECURED BY CRIMPING AND/OR TACKIFIER.
     - CRIMPING MUST NOT BE USED ON SLOPES GREATER THAN 3:1 AND MULCH FIBERS MUST BE TUCKED INTO THE SOIL TO A DEPTH OF 3 TO 4 INCHES.
     - TACKIFIER MUST BE USED IN PLACE OF CRIMPING ON SLOPES STEEPER THAN 3:1.
   - HYDRAULIC MULCHING
     - HYDRAULIC MULCHING IS AN OPTION ON STEEP SLOPES OR WHERE ACCESS IS LIMITED.
     - IF HYDRO-SEEDING IS USED, MULCHING MUST BE APPLIED AS A SEPARATE, SECOND OPERATION.
     - WOOD CELLULOSE FIBERS MIXED WITH WATER MUST BE APPLIED AT A RATE OF 2,000 TO 2,500 POUNDS/ACRE, AND TACKIFIER MUST BE APPLIED AT A RATE OF 100 POUNDS/ACRE.
   - EROSION CONTROL BLANKET
     - EROSION CONTROL BLANKET MAY BE USED IN PLACE OF TRADITIONAL MULCHING METHODS.

SM

STORMWATER
ENTERPRISE

SEEDING & MULCHING

APPROVED:
SWENT MANAGER

ISSUED:	REVISED:	DRAWING NO.
10/7/19	8/19/2020	900-SM

Exhibit 9:

Hydrologic Calculations

Job No.: **61197**
Project: **Forest Heights Estates**

Date: **11/20/2023 11:45**
Calcs By: **TJW**
Checked By:

Time of Concentration (Modified from Standard Form SF-1)

	Sub-Basin Data				Overland			Shallow Channel				Channelized				t_c Check		
Sub-Basin	Area (Acres)	C_5	C_{100}/CN	% Imp.	L_0 (ft)	S_0 (%)	t_i (min)	L_{0t} (ft)	S_{0t} (ft/ft)	v_{0sc} (ft/s)	t_t (min)	L_{0c} (ft)	S_{0c} (ft/ft)	v_{0c} (ft/s)	t_c (min)	L (min)	$t_{c,alt}$ (min)	t_c (min)
EX-A																		
EX-B	20.39	0.11	0.38	7%	300	9%	15.1	1080	0.043	0.5	34.9	0	0.000	0.0	0.0	1380	N/A	50.0
EX-C	3.80	0.12	0.38	6%	169	9%	11.2	453	0.057	1.7	4.5	84	0.036	4.9	0.3	706	N/A	16.0
EX-D	7.48	0.15	0.40	9%	300	9%	14.5	536	0.054	0.6	15.4	0	0.000	0.0	0.0	836	N/A	29.8
EX-E	1.87	0.15	0.40	10%	195	5%	14.0	213	0.047	1.1	3.3	265	0.023	1.9	2.3	673	N/A	19.6
EX-F	17.32	0.11	0.38	6%	293	7%	16.0	1558	0.045	1.5	17.5	0	0.000	0.0	0.0	1851	N/A	33.5
EX-G	9.37	0.11	0.37	5%	213	8%	13.4	880	0.030	1.2	12.2	0	0.000	0.0	0.0	1093	N/A	25.6
EX-H	23.44	0.10	0.36	2%	300	6%	17.1	1430	0.041	1.4	16.9	470	0.034	0.8	9.5	2200	N/A	43.5
EX-I	5.79	0.14	0.39	8%	300	6%	16.6	540	0.039	1.4	6.5	0	0.000	0.0	0.0	840	N/A	23.1
EX-J	4.37	0.08	0.35	0%	300	8%	16.1	277	0.036	1.3	3.5	0	0.000	0.0	0.0	577	N/A	19.5
A	16.08	0.12	0.38	6%	291	7%	15.7	1154	0.040	0.5	38.5	0	0.000	0.0	0.0	1445	N/A	54.3
B	20.39	0.12	0.39	8%	300	9%	15.0	1080	0.043	0.5	34.9	0	0.000	0.0	0.0	1380	N/A	49.9
C	3.80	0.12	0.38	6%	169	9%	11.2	453	0.057	1.7	4.5	84	0.036	4.9	0.3	706	N/A	16.0
D	7.48	0.14	0.39	8%	300	9%	14.6	536	0.054	0.6	15.4	0	0.000	0.0	0.0	836	N/A	30.0
E	1.87	0.15	0.40	10%	195	5%	14.0	213	0.047	1.1	3.3	265	0.023	1.9	2.3	673	N/A	19.6
F	17.32	0.11	0.38	6%	293	7%	16.0	1558	0.045	1.5	17.5	0	0.000	0.0	0.0	1851	N/A	33.5
G	9.37	0.14	0.39	8%	213	8%	13.0	880	0.030	1.2	12.2	0	0.000	0.0	0.0	1093	N/A	25.2
H	23.44	0.11	0.37	5%	300	6%	16.8	1430	0.041	1.4	16.9	470	0.034	0.8	9.5	2200	N/A	43.2
I	5.79	0.16	0.41	11%	300	6%	16.3	540	0.039	1.4	6.5	0	0.000	0.0	0.0	840	N/A	22.8
J	4.37	0.08	0.35	0%	300	8%	16.1	277	0.036	1.3	3.5	0	0.000	0.0	0.0	577	N/A	19.5

Job No.: **61197**
Project: **Forest Heights Estates**
Design Storm: **5-Year Storm** *(20% Probability)*
Jurisdiction: **DCM**

Date: **11/20/2023 11:45**
Calcs By: **TJW**
Checked By:

Sub-Basin and Combined Flows (Modified from Standard Form SF-2)

				Direct Runoff				Combined Runoff				Streetflow			Pipe Flow					Travel Time		
	Sub-	Area		t_c	CA	I5	Q5	t_c	CA	I5	Q5	Slope	Length	Q	Q	Slope	Mnngs	Length	D_{Pipe}	Length	v_{0sc}	t_t
DP	Basin	(Acres)	C5	(min)	(Acres)	(in/hr)	(cfs)	(min)	(Acres)	(in/hr)	(cfs)	(%)	(ft)	(cfs)	(cfs)	(%)	n	(ft)	(in)	(ft)	(ft/s)	(min)
	EX-A	16.08	0.12	54.3	1.86	1.59	2.96															
	EX-B	20.39	0.11	50.0	2.29	1.71	3.92															
	EX-C	3.80	0.12	16.0	0.45	3.43	1.55															
	EX-D	7.48	0.15	29.8	1.09	2.49	2.71															
	EX-E	1.87	0.15	19.6	0.27	3.12	0.86															
	EX-F	17.32	0.11	33.5	1.83	2.31	4.24															
	EX-G	9.37	0.11	25.6	1.04	2.72	2.83															
	EX-H	23.44	0.10	43.5	2.24	1.92	4.30															
	EX-I	5.79	0.14	23.1	0.82	2.87	2.35															
	EX-J	4.37	0.08	19.5	0.35	3.13	1.09															
EX-DP3		13.14	0.14					29.8	1.82	2.49	4.5											
EX-DP4		18.94	0.14					32.7	2.63	2.35	6.2											
EX-DP5		62.76	0.11					59.6	7.16	1.45	10.4											
EX-DP6		42.77	0.11					36.5	4.73	2.19	10.4											
	A	16.08	0.12	54.3	1.92	1.59	3.05															
	B	20.39	0.12	49.9	2.46	1.72	4.22															
	C	3.80	0.12	16.0	0.45	3.43	1.55															
	D	7.48	0.14	30.0	1.02	2.48	2.53															
	E	1.87	0.15	19.6	0.27	3.12	0.86															
	F	17.32	0.11	33.5	1.83	2.31	4.24															
	G	9.37	0.14	25.2	1.28	2.74	3.52															
	H	23.44	0.11	43.2	2.65	1.93	5.13															
	I	5.79	0.16	22.8	0.92	2.89	2.65															
	J	4.37	0.08	19.5	0.35	3.13	1.09															
DP3		13.14	0.13					30.0	1.75	2.48	4.3											
DP4		18.94	0.14					32.8	2.66	2.35	6.3											
DP5		62.76	0.12					59.5	7.77	1.45	11.3											
DP6		42.77	0.12					36.5	5.03	2.19	11.0											

DCM: I = C1 * ln (tc) + C2
C1: 1.5
C1: 7.583

Job No.: **61197**
Project: **Forest Heights Estates**
Design Storm: **100-Year Storm** *(1% Probability)*
Jurisdiction: **DCM**

Date: **11/20/2023 11:45**
Calcs By: **TJW**
Checked By:

Sub-Basin and Combined Flows (Modified from Standard Form SF-2)

				Direct Runoff				Combined Runoff				Streetflow			Pipe Flow					Travel Time		
DP	Sub- Basin	Area (Acres)	C100	t_c (min)	CA (Acres)	I100 (in/hr)	Q100 (cfs)	t_c (min)	CA (Acres)	I100 (in/hr)	Q100 (cfs)	Slope (%)	Length (ft)	Q (cfs)	Q (cfs)	Slope (%)	Mnngs n	Length (ft)	D_{Pipe} (in)	Length (ft)	v_{0sc} (ft/s)	t_t (min)
	EX-A	16.08	0.38	54.3	6.05	2.67	16.13															
	EX-B	20.39	0.38	50.0	7.80	2.87	22.42															
	EX-C	3.80	0.38	16.0	1.43	5.75	8.25															
	EX-D	7.48	0.40	29.8	2.97	4.18	12.40															
	EX-E	1.87	0.40	19.6	0.74	5.23	3.89															
	EX-F	17.32	0.38	33.5	6.54	3.88	25.39															
	EX-G	9.37	0.37	25.6	3.48	4.57	15.89															
	EX-H	23.44	0.36	43.5	8.46	3.23	27.32															
	EX-I	5.79	0.39	23.1	2.29	4.82	11.02															
	EX-J	4.37	0.35	19.5	1.53	5.25	8.02															
EX-DP3		13.14	0.39					29.8	5.14	4.18	21.5											
EX-DP4		18.94	0.39					32.7	7.43	3.95	29.4											
EX-DP5		62.76	0.38					59.6	23.69	2.43	57.7											
EX-DP6		42.77	0.38					36.5	16.07	3.67	59.0											
	A	16.08	0.38	54.3	6.09	2.67	16.25															
	B	20.39	0.39	49.9	7.92	2.88	22.83															
	C	3.80	0.38	16.0	1.43	5.75	8.25															
	D	7.48	0.39	30.0	2.92	4.17	12.16															
	E	1.87	0.40	19.6	0.74	5.23	3.89															
	F	17.32	0.38	33.5	6.54	3.88	25.39															
	G	9.37	0.39	25.2	3.65	4.60	16.81															
	H	23.44	0.37	43.2	8.76	3.25	28.42															
	I	5.79	0.41	22.8	2.36	4.85	11.43															
	J	4.37	0.35	19.5	1.53	5.25	8.02															
DP3		13.14	0.39					30.0	5.09	4.17	21.2											
DP4		18.94	0.39					32.8	7.45	3.94	29.3											
DP5		62.76	0.38					59.5	24.13	2.44	58.9											
DP6		42.77	0.38					36.5	16.28	3.67	59.8											

DCM: I = C1 * ln (tc) + C2
C1: 2.52
C1: 12.735

Sub-Basin Ex-A Runoff Calculations

Job No.:	**61197**	Date:	**11/20/2023 11:40**
Project:	**Forest Heights Estates**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		**Runoff Coefficient**						**%**
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre			0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre	28,936	0.66	0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	630,305	14.47	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	7,655	0.18	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	2,355	0.05	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	31,304	0.72	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**700,555**	**16.08**	**0.06**	**0.12**	**0.18**	**0.28**	**0.33**	**0.38**	**5.4%**
	700555								

Basin Travel Time

Shallow Channel Ground Cover Heavy meadow

$L_{max,Overland}$ 300 ft C_v 2.5

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	1,445	67	-	-	-	-	
Initial Time	291	21	0.072	-	15.8	N/A	DCM Eq. 6-8
Shallow Channel	1,154	46	0.040	0.5	38.5	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	Trap Ditch
				t_c	**54.3**	**min.**	

Storage Volume

40 -hr release time

Detention is NOT required

Water Quality is NOT required

EURV 0.00 (in) a = 1

WQCV 0.00 (in)

i (return period)	5-year	10-year	100-year
K_i (ft)	0.0000	0.0000	0
V_i (acre-ft)	0.000	0.000	0
V_i (ft^3)	0	0	0

Design Volume (ft^3)

	% Storage	100-year	WQCV	Total
EURV	0%	0	0	**0**
WQCV	0%		0	**0**

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	1.28	1.59	1.86	2.12	2.39	2.67
Runoff (cfs)	1.2	**3.0**	5.5	9.6	12.6	**16.1**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.2	**3.0**	5.5	9.6	12.6	**16.1**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin Ex-B Runoff Calculations

Job No.:	**61197**	Date:	**11/20/2023 11:40**
Project:	**Forest Heights Estates**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre			0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre	407,534	9.36	0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	457,323	10.50	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved			0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	2,796	0.06	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	20,583	0.47	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**888,236**	**20.39**	**0.06**	**0.11**	**0.20**	**0.29**	**0.34**	**0.38**	**7.2%**
	888236								

Basin Travel Time

Shallow Channel Ground Cover Heavy meadow

$L_{max,Overland}$ 300 ft C_v 2.5

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	1,380	72	-	-	-	-	
Initial Time	300	26	0.087	-	15.1	N/A	DCM Eq. 6-8
Shallow Channel	1,080	46	0.043	0.5	34.9	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	Trap Ditch
				t_c	**50.0**	**min.**	

Storage Volume

40 -hr release time

a = 1

Detention is NOT required

Water Quality is NOT required

EURV 0.00 (in)

WQCV 0.00 (in)

i (return period)	5-year	10-year	100-year
K_i (ft)	0.0000	0.0000	0
V_i (acre-ft)	0.000	0.000	0
V_i (ft^3)	0	0	0

Design Volume (ft^3)

	% Storage	100-year	WQCV	Total
EURV	0%	0	0	**0**
WQCV	0%		0	**0**

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	1.38	1.71	2.00	2.29	2.57	2.87
Runoff (cfs)	1.8	**3.9**	8.0	13.5	17.7	**22.4**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.8	**3.9**	8.0	13.5	17.7	**22.4**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin Ex-C Runoff Calculations

Job No.: **61197**
Date: **11/20/2023 11:40**
Project: **Forest Heights Estates**
Calcs by: **TJW**
Checked by:

Jurisdiction **DCM**
Soil Type **B**
Runoff Coefficient **Surface Type**
Urbanization **Non-Urban**

Basin Land Use Characteristics

	Area		**Runoff Coefficient**						**%**
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre			0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre			0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	154,567	3.55	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	878	0.02	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	4,365	0.10	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	5,738	0.13	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**165,548**	**3.80**	**0.06**	**0.12**	**0.19**	**0.28**	**0.33**	**0.38**	**5.7%**
	165548								

Basin Travel Time

Shallow Channel Ground Cover Short Pasture/Lawns

$L_{max,Overland}$ 300 ft C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	706	44	-	-	-	-	
Initial Time	169	15	0.089	-	11.2	N/A	DCM Eq. 6-8
Shallow Channel	453	26	0.057	1.7	4.5	-	DCM Eq. 6-9
Channelized	84	3	0.036	4.9	0.3	-	V-Ditch
				t_c	**16.0**	**min.**	

Storage Volume

40 -hr release time
a = 1

Detention is NOT required
Water Quality is NOT required

EURV 0.00 (in)
WQCV 0.00 (in)

i (return period)	5-year	10-year	100-year
K_i (ft)	0.0000	0.0000	0
V_i (acre-ft)	0.000	0.000	0
V_i (ft^3)	0	0	0

Design Volume (ft^3)

	% Storage	100-year	WQCV	Total
EURV	0%	0	0	**0**
WQCV	0%		0	**0**

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	2.74	3.43	4.00	4.57	5.14	5.75
Runoff (cfs)	0.6	**1.6**	2.8	4.9	6.4	**8.2**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.6	**1.6**	2.8	4.9	6.4	**8.2**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin Ex-D Runoff Calculations

Job No.:	**61197**	Date:	**11/20/2023 11:40**
Project:	**Forest Heights Estates**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre			0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre			0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	291,747	6.70	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	9,490	0.22	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	8,381	0.19	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	16,005	0.37	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**325,623**	**7.48**	**0.09**	**0.15**	**0.21**	**0.30**	**0.35**	**0.40**	**9.2%**
	325623								

Basin Travel Time

Shallow Channel Ground Cover Heavy meadow

$L_{max,Overland}$ 300 ft C_v 2.5

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	836	56	-	-	-	-	
Initial Time	300	27	0.090	-	14.5	N/A	DCM Eq. 6-8
Shallow Channel	536	29	0.054	0.6	15.4	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				t_c	**29.8**	**min.**	

Storage Volume

40 -hr release time

Detention is NOT required

Water Quality is NOT required

EURV	0.00 (in)	a =	1
WQCV	0.00 (in)		

i (return period)	5-year	10-year	100-year
K_i (ft)	0.0000	0.0000	0
V_i (acre-ft)	0.000	0.000	0
V_i (ft^3)	0	0	0

Design Volume (ft^3)

	% Storage	100-year	WQCV	Total
EURV	0%	0	0	**0**
WQCV	0%		0	**0**

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	1.99	2.49	2.91	3.32	3.74	4.18
Runoff (cfs)	1.3	**2.7**	4.6	7.5	9.8	**12.4**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.3	**2.7**	4.6	7.5	9.8	**12.4**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin Ex-E Runoff Calculations

Job No.: **61197**
Date: **11/20/2023 11:40**
Project: **Forest Heights Estates**
Calcs by: **TJW**
Checked by:
Jurisdiction **DCM**
Soil Type **B**
Runoff Coefficient **Surface Type**
Urbanization **Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre			0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre			0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	72,418	1.66	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	770	0.02	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	4,607	0.11	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	3,589	0.08	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**81,384**	**1.87**	**0.09**	**0.15**	**0.21**	**0.30**	**0.35**	**0.40**	**9.6%**
	81384								

Basin Travel Time

Shallow Channel Ground Cover Forest

$L_{max,Overland}$ 300 ft C_v 5

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	673	26	-	-	-	-	
Initial Time	195	10	0.051	-	14.0	N/A	DCM Eq. 6-8
Shallow Channel	213	10	0.047	1.1	3.3	-	DCM Eq. 6-9
Channelized	265	6	0.023	1.9	2.3	-	V-Ditch
				t_c	**19.6**	**min.**	

Storage Volume

40 -hr release time

a = 1

Detention is NOT required

Water Quality is NOT required

EURV 0.00 (in)

WQCV 0.00 (in)

i (return period)	5-year	10-year	100-year
K_i (ft)	0.0000	0.0000	0
V_i (acre-ft)	0.000	0.000	0
V_i (ft^3)	0	0	0

Design Volume (ft^3)

	% Storage	100-year	WQCV	Total
EURV	0%	0	0	**0**
WQCV	0%		0	**0**

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	2.49	3.12	3.64	4.16	4.68	5.23
Runoff (cfs)	0.4	**0.9**	1.4	2.4	3.1	**3.9**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.4	**0.9**	1.4	2.4	3.1	**3.9**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin Ex-F Runoff Calculations

Job No.:	**61197**	Date:	**11/20/2023 11:40**
Project:	**Forest Heights Estates**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre	455,492	10.46	0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre			0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	280,058	6.43	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved			0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	4,220	0.10	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	14,753	0.34	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**754,523**	**17.32**	**0.06**	**0.11**	**0.19**	**0.29**	**0.33**	**0.38**	**6.3%**
	754523								

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$ 300 ft C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	1,851	91	-	-	-	-	
Initial Time	293	21	0.072	-	16.0	N/A	DCM Eq. 6-8
Shallow Channel	1,558	70	0.045	1.5	17.5	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				t_c	**33.5**	**min.**	

Storage Volume

40 -hr release time

a = 1

Detention is NOT required

Water Quality is NOT required

EURV 0.00 (in)

WQCV 0.00 (in)

i (return period)	5-year	10-year	100-year
K_i (ft)	0.0000	0.0000	0
V_i (acre-ft)	0.000	0.000	0
V_i (ft^3)	0	0	0

Design Volume (ft^3)

	% Storage	100-year	WQCV	Total
EURV	0%	0	0	**0**
WQCV	0%		0	**0**

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	1.85	2.31	2.70	3.09	3.47	3.88
Runoff (cfs)	1.9	**4.2**	9.0	15.2	20.1	**25.4**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.9	**4.2**	9.0	15.2	20.1	**25.4**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin Ex-G Runoff Calculations

Job No.:	**61197**	Date:	**11/20/2023 11:40**
Project:	**Forest Heights Estates**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre			0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre			0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	384,775	8.83	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved			0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	5,849	0.13	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	17,486	0.40	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**408,110**	**9.37**	**0.05**	**0.11**	**0.18**	**0.28**	**0.32**	**0.37**	**4.7%**
	408110								

Basin Travel Time

Shallow Channel Ground Cover Short Pasture/Lawns

$L_{max,Overland}$ 300 ft C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	1,093	42	-	-	-	-	
Initial Time	213	16	0.075	-	13.4	N/A	DCM Eq. 6-8
Shallow Channel	880	26	0.030	1.2	12.2	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				t_c	**25.6**	**min.**	

Storage Volume

40 -hr release time

Detention is NOT required

Water Quality is NOT required

EURV 0.00 (in) a = 1

WQCV 0.00 (in)

i (return period)	5-year	10-year	100-year
K_i (ft)	0.0000	0.0000	0
V_i (acre-ft)	0.000	0.000	0
V_i (ft^3)	0	0	0

Design Volume (ft^3)

	% Storage	100-year	WQCV	Total
EURV	0%	0	0	**0**
WQCV	0%		0	**0**

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	2.18	2.72	3.17	3.63	4.08	4.57
Runoff (cfs)	1.1	**2.8**	5.3	9.4	12.4	**15.9**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.1	**2.8**	5.3	9.4	12.4	**15.9**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin Ex-H Runoff Calculations

Job No.: **61197**

Date: **11/20/2023 11:40**

Project: **Forest Heights Estates**

Calcs by: **TJW**

Checked by:

Jurisdiction **DCM**

Soil Type **B**

Runoff Coefficient **Surface Type**

Urbanization **Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre			0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre			0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	997,422	22.90	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	9,697	0.22	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	5,531	0.13	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	8,238	0.19	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**1,020,888**	**23.44**	**0.04**	**0.10**	**0.16**	**0.26**	**0.31**	**0.36**	**2.1%**

1020888

Basin Travel Time

Shallow Channel Ground Cover Short Pasture/Lawns

$L_{max,Overland}$ 300 ft C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	2,200	93	-	-	-	-	
Initial Time	300	19	0.063	-	17.1	N/A	DCM Eq. 6-8
Shallow Channel	1,430	58	0.041	1.4	16.9	-	DCM Eq. 6-9
Channelized	470	16	0.034	0.8	9.5	-	Trap Ditch
				t_c	**43.5**	**min.**	

Storage Volume

40 -hr release time

Detention is NOT required

Water Quality is NOT required

EURV 0.00 (in) a = 1

WQCV 0.00 (in)

i (return period)	5-year	10-year	100-year
K_i (ft)	0.0000	0.0000	0
V_i (acre-ft)	0.000	0.000	0
V_i (ft^3)	0	0	0

Design Volume (ft^3)

	% Storage	100-year	WQCV	Total
EURV	0%	0	0	**0**
WQCV	0%		0	**0**

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	1.55	1.92	2.25	2.57	2.89	3.23
Runoff (cfs)	1.3	**4.3**	8.7	15.8	21.1	**27.3**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.3	**4.3**	8.7	15.8	21.1	**27.3**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin Ex-I Runoff Calculations

Job No.: **61197**
Project: **Forest Heights Estates**
Jurisdiction **DCM**
Runoff Coefficient **Surface Type**

Date: **11/20/2023 11:40**
Calcs by: **TJW**
Checked by:
Soil Type **B**
Urbanization **Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre			0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre			0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	231,230	5.31	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	14,058	0.32	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	2,609	0.06	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	4,388	0.10	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**252,285**	**5.79**	**0.09**	**0.14**	**0.21**	**0.30**	**0.35**	**0.39**	**7.9%**
	252285								

Basin Travel Time

Shallow Channel Ground Cover Short Pasture/Lawns

$L_{max,Overland}$ 300 ft C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	840	39	-	-	-	-	
Initial Time	300	18	0.060	-	16.6	N/A	DCM Eq. 6-8
Shallow Channel	540	21	0.039	1.4	6.5	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				t_c	**23.1**	**min.**	

Storage Volume

40 -hr release time

a = 1

Detention is NOT required
Water Quality is NOT required

EURV 0.00 (in)
WQCV 0.00 (in)

i (return period)	5-year	10-year	100-year
K_i (ft)	0.0000	0.0000	0
V_i (acre-ft)	0.000	0.000	0
V_i (ft^3)	0	0	0

Design Volume (ft^3)

	% Storage	100-year	WQCV	Total
EURV	0%	0	0	**0**
WQCV	0%		0	**0**

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	2.30	2.87	3.35	3.83	4.31	4.82
Runoff (cfs)	1.1	**2.4**	4.0	6.7	8.7	**11.0**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.1	**2.4**	4.0	6.7	8.7	**11.0**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin Ex-J Runoff Calculations

Job No.:	**61197**	Date:	**11/20/2023 11:40**
Project:	**Forest Heights Estates**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre			0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre			0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	190,373	4.37	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved			0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs			0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel			0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**190,373**	**4.37**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**
	190373								

Basin Travel Time

Shallow Channel Ground Cover	Short Pasture/Lawns						
$L_{max,Overland}$	300	ft		C_v	7		
	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	577	34	-	-	-	-	
Initial Time	300	24	0.080	-	16.1	N/A	DCM Eq. 6-8
Shallow Channel	277	10	0.036	1.3	3.5	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				t_c	**19.5**	**min.**	

Storage Volume

			40	-hr release time			Detention is NOT required	
EURV	0.00 (in)		a =	1			Water Quality is NOT required	
WQCV	0.00 (in)							
i (return period)	5-year	10-year	100-year			**Design Volume (ft^3)**		
K_i (ft)	0.0000	0.0000	0		% Storage	100-year	WQCV	Total
V_i (acre-ft)	0.000	0.000	0	EURV	0%	0	0	**0**
V_i (ft^3)	0	0	0	WQCV	0%		0	**0**

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	2.50	3.13	3.65	4.17	4.69	5.25
Runoff (cfs)	0.2	**1.1**	2.4	4.6	6.1	**8.0**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.2	**1.1**	2.4	4.6	6.1	**8.0**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Combined Sub-Basin Runoff Calculations - EX-DP3

Includes Basins EX-C EX-D EX-E

Job No.:	61197	Date:	11/20/2023 11:40
Project:	Forest Heights Estates	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Non-Urban

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	Imperv.
5 Acre	-	0.00	0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre	-	0.00	0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	518,732	11.91	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	17,353	0.40	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	11,138	0.26	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	25,332	0.58	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**572,555**	**13.14**	**0.08**	**0.14**	**0.20**	**0.30**	**0.34**	**0.39**	**8.2%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	EX-D	-	836	56	-	-	-	-	29.8
Channelized-1									
Channelized-2									
Channelized-3									
Total			836	56					

t_c (min) **29.8**

Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

Q_{Minor} (cfs) - 5-year Storm

Q_{Major} (cfs) - 100-year Storm

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	1.99	2.49	2.91	3.32	3.74	4.18
Site Runoff (cfs)	2.15	**4.52**	7.81	12.99	16.92	**21.50**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**4.5**	-	-	-	**21.5**
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

Combined Sub-Basin Runoff Calculations - EX-DP4

Includes Basins EX-C EX-D EX-E EX-I

Job No.: **61197**
Date: **11/20/2023 11:40**
Project: **Forest Heights Estates**
Calcs by: **TJW**
Checked by:
Jurisdiction **DCM**
Soil Type **B**
Runoff Coefficient **Surface Type**
Urbanization **Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre	-	0.00	0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre	-	0.00	0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	749,962	17.22	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	19,962	0.46	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	25,196	0.58	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	29,720	0.68	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**824,840**	**18.94**	**0.08**	**0.14**	**0.21**	**0.30**	**0.35**	**0.39**	**8.1%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	EX-D	-	836	56	-	-	-	-	29.8
Channelized-1	Trap Ditch	2	505	20	22	6	10	3.0	2.8
Channelized-2									
Channelized-3									
Total			1,341	76					

2 = Natural, Winding, minimal vegetation/shallow grass

t_c (min) **32.7**

Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas
Q_{Minor} (cfs) - 5-year Storm
Q_{Major} (cfs) - 100-year Storm

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	1.89	2.35	2.75	3.14	3.53	3.95
Site Runoff (cfs)	2.97	**6.20**	10.68	17.75	23.12	**29.35**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**6.2**	-	-	-	**29.4**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

Combined Sub-Basin Runoff Calculations - EX-DP5

Includes Basins EX-C EX-D EX-E EX-I EX-B EX-H

Job No.: **61197**

Date: **11/20/2023 11:40**

Project: **Forest Heights Estates**

Calcs by: **TJW**

Checked by:

Jurisdiction **DCM**

Soil Type **B**

Runoff Coefficient **Surface Type**

Urbanization **Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre	-	0.00	0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre	407,534	9.36	0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	2,204,707	50.61	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	28,289	0.65	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	34,893	0.80	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	58,541	1.34	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**2,733,964**	**62.76**	**0.06**	**0.11**	**0.19**	**0.28**	**0.33**	**0.38**	**5.6%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	EX-B	-	1,380	72	-	-	-	-	50.0
Channelized-1	Trap Ditch	2	1,616	54	22	6	10	2.8	9.6
Channelized-2									
Channelized-3									
Total			2,996	126					

2 = Natural, Winding, minimal vegetation/shallow grass

t_c (min) **59.6**

Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

Q_{Minor} (cfs) - 5-year Storm

Q_{Major} (cfs) - 100-year Storm

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	1.17	1.45	1.69	1.94	2.18	2.43
Site Runoff (cfs)	4.33	**10.39**	19.85	34.27	45.19	**57.68**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**10.4**	-	-	-	**57.7**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

Combined Sub-Basin Runoff Calculations - EX-DP6

Includes Basins EX-A EX-F EX-G

Job No.:	**61197**	Date:	**11/20/2023 11:40**
Project:	**Forest Heights Estates**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre	455,492	10.46	0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre	28,936	0.66	0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	1,295,138	29.73	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	12,424	0.29	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	7,655	0.18	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	63,543	1.46	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**1,863,188**	**42.77**	**0.06**	**0.11**	**0.19**	**0.28**	**0.33**	**0.38**	**5.6%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	EX-F	-	1,851	91	-	-	-	-	33.5
Channelized-1	Trap Ditch	2	488	14	25	6	10	2.8	2.9
Channelized-2									
Channelized-3									
Total			2,339	105					

2 = Natural, Winding, minimal vegetation/shallow grass

t_c (min) **36.5**

Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

Q_{Minor} (cfs) - 5-year Storm

Q_{Major} (cfs) - 100-year Storm

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	1.76	2.19	2.55	2.92	3.28	3.67
Site Runoff (cfs)	4.33	**10.35**	20.40	35.08	46.29	**58.99**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**10.4**	-	-	-	**59.0**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

Sub-Basin A Runoff Calculations

Job No.: **61197**
Project: **Forest Heights Estates**
Jurisdiction **DCM**
Runoff Coefficient **Surface Type**

Date: **11/20/2023 11:40**
Calcs by: **TJW**
Checked by:
Soil Type **B**
Urbanization **Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre			0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre	28,936	0.66	0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	625,311	14.36	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	7,655	0.18	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	2,355	0.05	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	36,298	0.83	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**700,555**	**16.08**	**0.06**	**0.12**	**0.19**	**0.28**	**0.33**	**0.38**	**6.0%**
	700555								

Basin Travel Time

Shallow Channel Ground Cover Heavy meadow

$L_{max,Overland}$ 300 ft C_v 2.5

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	1,445	67	-	-	-	-	
Initial Time	291	21	0.072	-	15.7	N/A	DCM Eq. 6-8
Shallow Channel	1,154	46	0.040	0.5	38.5	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	Trap Ditch
				t_c	**54.3**	**min.**	

Storage Volume

40 -hr release time
a = 1

Detention is NOT required
Water Quality is NOT required

EURV 0.00 (in)
WQCV 0.00 (in)

i (return period)	5-year	10-year	100-year
K_i (ft)	0.0000	0.0000	0
V_i (acre-ft)	0.000	0.000	0
V_i (ft^3)	0	0	0

Design Volume (ft^3)

	% Storage	100-year	WQCV	Total
EURV	0%	0	0	**0**
WQCV	0%		0	**0**

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	1.28	1.59	1.86	2.12	2.39	2.67
Runoff (cfs)	1.3	**3.1**	5.6	9.7	12.7	**16.3**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.3	**3.1**	5.6	9.7	12.7	**16.3**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin B Runoff Calculations

Job No.:	**61197**	Date:	**11/20/2023 11:40**
Project:	**Forest Heights Estates**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre			0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre	407,534	9.36	0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	447,323	10.27	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	5,000	0.11	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	7,796	0.18	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	20,583	0.47	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**888,236**	**20.39**	**0.07**	**0.12**	**0.20**	**0.30**	**0.34**	**0.39**	**8.3%**
	888236								

Basin Travel Time

Shallow Channel Ground Cover	Heavy meadow						
$L_{max,Overland}$		300	ft		C_v	2.5	
	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	1,380	72	-	-	-	-	
Initial Time	300	26	0.087	-	15.0	N/A	DCM Eq. 6-8
Shallow Channel	1,080	46	0.043	0.5	34.9	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	Trap Ditch
				t_c	**49.9**	**min.**	

Storage Volume

			40	-hr release time			Detention is NOT required	
EURV	0.00 (in)		a =	1			Water Quality is NOT required	
WQCV	0.00 (in)							
i (return period)	5-year	10-year	100-year			**Design Volume (ft^3)**		
K_i (ft)	0.0000	0.0000	0		% Storage	100-year	WQCV	Total
V_i (acre-ft)	0.000	0.000	0	EURV	0%	0	0	**0**
V_i (ft^3)	0	0	0	WQCV	0%		0	**0**

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	1.38	1.72	2.00	2.29	2.58	2.88
Runoff (cfs)	2.0	**4.2**	8.3	13.8	18.1	**22.8**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	2.0	**4.2**	8.3	13.8	18.1	**22.8**
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin C Runoff Calculations

Job No.: **61197**
Project: **Forest Heights Estates**
Date: **11/20/2023 11:40**
Calcs by: **TJW**
Checked by:

Jurisdiction **DCM**
Runoff Coefficient **Surface Type**
Soil Type **B**
Urbanization **Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre			0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre			0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	154,567	3.55	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	878	0.02	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	4,365	0.10	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	5,738	0.13	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**165,548**	**3.80**	**0.06**	**0.12**	**0.19**	**0.28**	**0.33**	**0.38**	**5.7%**
	165548								

Basin Travel Time

Shallow Channel Ground Cover Short Pasture/Lawns

$L_{max,Overland}$ 300 ft C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	706	44	-	-	-	-	
Initial Time	169	15	0.089	-	11.2	N/A	DCM Eq. 6-8
Shallow Channel	453	26	0.057	1.7	4.5	-	DCM Eq. 6-9
Channelized	84	3	0.036	4.9	0.3	-	V-Ditch
				t_c	**16.0**	**min.**	

Storage Volume

40 -hr release time

a = 1

Detention is NOT required
Water Quality is NOT required

EURV 0.00 (in)
WQCV 0.00 (in)

i (return period)	5-year	10-year	100-year
K_i (ft)	0.0000	0.0000	0
V_i (acre-ft)	0.000	0.000	0
V_i (ft^3)	0	0	0

Design Volume (ft^3)

	% Storage	100-year	WQCV	Total
EURV	0%	0	0	**0**
WQCV	0%		0	**0**

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	2.74	3.43	4.00	4.57	5.14	5.75
Runoff (cfs)	0.6	**1.6**	2.8	4.9	6.4	**8.2**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.6	**1.6**	2.8	4.9	6.4	**8.2**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin D Runoff Calculations

Job No.:	**61197**	Date:	**11/20/2023 11:40**
Project:	**Forest Heights Estates**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre			0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre			0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	297,780	6.84	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	9,490	0.22	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	8,381	0.19	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	9,972	0.23	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**325,623**	**7.48**	**0.08**	**0.14**	**0.20**	**0.30**	**0.34**	**0.39**	**7.7%**
	325623								

Basin Travel Time

Shallow Channel Ground Cover Heavy meadow

$L_{max,Overland}$ 300 ft C_v 2.5

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	836	56	-	-	-	-	
Initial Time	300	27	0.090	-	14.6	N/A	DCM Eq. 6-8
Shallow Channel	536	29	0.054	0.6	15.4	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				t_c	**30.0**	**min.**	

Storage Volume

40 -hr release time

a = 1

Detention is NOT required

Water Quality is NOT required

EURV 0.00 (in)

WQCV 0.00 (in)

i (return period)	5-year	10-year	100-year
K_i (ft)	0.0000	0.0000	0
V_i (acre-ft)	0.000	0.000	0
V_i (ft^3)	0	0	0

Design Volume (ft^3)

	% Storage	100-year	WQCV	Total
EURV	0%	0	0	**0**
WQCV	0%		0	**0**

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	1.99	2.48	2.90	3.31	3.73	4.17
Runoff (cfs)	1.2	**2.5**	4.4	7.3	9.6	**12.2**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.2	**2.5**	4.4	7.3	9.6	**12.2**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin E Runoff Calculations

Job No.:	**61197**	Date:	**11/20/2023 11:40**
Project:	**Forest Heights Estates**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre			0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre			0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	72,418	1.66	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	770	0.02	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	4,607	0.11	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	3,589	0.08	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**81,384**	**1.87**	**0.09**	**0.15**	**0.21**	**0.30**	**0.35**	**0.40**	**9.6%**
	81384								

Basin Travel Time

Shallow Channel Ground Cover Forest

$L_{max,Overland}$ 300 ft C_v 5

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	673	26	-	-	-	-	
Initial Time	195	10	0.051	-	14.0	N/A	DCM Eq. 6-8
Shallow Channel	213	10	0.047	1.1	3.3	-	DCM Eq. 6-9
Channelized	265	6	0.023	1.9	2.3	-	V-Ditch
				t_c	**19.6**	**min.**	

Storage Volume

40 -hr release time

a = 1

Detention is NOT required

Water Quality is NOT required

EURV 0.00 (in)

WQCV 0.00 (in)

i (return period)	5-year	10-year	100-year
K_i (ft)	0.0000	0.0000	0
V_i (acre-ft)	0.000	0.000	0
V_i (ft^3)	0	0	0

Design Volume (ft^3)

	% Storage	100-year	WQCV	Total
EURV	0%	0	0	**0**
WQCV	0%		0	**0**

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	2.49	3.12	3.64	4.16	4.68	5.23
Runoff (cfs)	0.4	**0.9**	1.4	2.4	3.1	**3.9**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.4	**0.9**	1.4	2.4	3.1	**3.9**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin F Runoff Calculations

Job No.: **61197**
Date: **11/20/2023 11:40**
Project: **Forest Heights Estates**
Calcs by: **TJW**
Checked by:
Jurisdiction **DCM**
Soil Type **B**
Runoff Coefficient **Surface Type**
Urbanization **Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre	455,492	10.46	0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre			0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	280,058	6.43	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved			0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	4,220	0.10	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	14,753	0.34	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**754,523**	**17.32**	**0.06**	**0.11**	**0.19**	**0.29**	**0.33**	**0.38**	**6.3%**
	754523								

Basin Travel Time

Shallow Channel Ground Cover Short Pasture/Lawns

$L_{max,Overland}$ 300 ft C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	1,851	91	-	-	-	-	
Initial Time	293	21	0.072	-	16.0	N/A	DCM Eq. 6-8
Shallow Channel	1,558	70	0.045	1.5	17.5	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				t_c	**33.5**	**min.**	

Storage Volume

40 -hr release time
a = 1

Detention is NOT required
Water Quality is NOT required

EURV 0.00 (in)
WQCV 0.00 (in)

i (return period)	5-year	10-year	100-year
K_i (ft)	0.0000	0.0000	0
V_i (acre-ft)	0.000	0.000	0
V_i (ft^3)	0	0	0

Design Volume (ft^3)

	% Storage	100-year	WQCV	Total
EURV	0%	0	0	**0**
WQCV	0%		0	**0**

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	1.85	2.31	2.70	3.09	3.47	3.88
Runoff (cfs)	1.9	**4.2**	9.0	15.2	20.1	**25.4**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.9	**4.2**	9.0	15.2	20.1	**25.4**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin G Runoff Calculations

Job No.:	**61197**	Date:	**11/20/2023 11:40**
Project:	**Forest Heights Estates**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre			0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre			0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	368,478	8.46	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	5,000	0.11	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	10,849	0.25	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	23,783	0.55	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**408,110**	**9.37**	**0.08**	**0.14**	**0.20**	**0.30**	**0.34**	**0.39**	**8.3%**
	408110								

Basin Travel Time

Shallow Channel Ground Cover Short Pasture/Lawns

$L_{max,Overland}$ 300 ft C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	1,093	42	-	-	-	-	
Initial Time	213	16	0.075	-	13.0	N/A	DCM Eq. 6-8
Shallow Channel	880	26	0.030	1.2	12.2	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				t_c	**25.2**	**min.**	

Storage Volume

40 -hr release time

Detention is NOT required

Water Quality is NOT required

EURV 0.00 (in) a = 1

WQCV 0.00 (in)

i (return period)	5-year	10-year	100-year
K_i (ft)	0.0000	0.0000	0
V_i (acre-ft)	0.000	0.000	0
V_i (ft^3)	0	0	0

Design Volume (ft^3)

	% Storage	100-year	WQCV	Total
EURV	0%	0	0	**0**
WQCV	0%		0	**0**

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	2.19	2.74	3.20	3.65	4.11	4.60
Runoff (cfs)	1.7	**3.5**	6.1	10.2	13.2	**16.8**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.7	**3.5**	6.1	10.2	13.2	**16.8**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin H Runoff Calculations

Job No.:	**61197**	Date:	**11/20/2023 11:40**
Project:	**Forest Heights Estates**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre			0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre			0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	967,886	22.22	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	14,699	0.34	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	15,531	0.36	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	22,772	0.52	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**1,020,888**	**23.44**	**0.06**	**0.11**	**0.18**	**0.28**	**0.33**	**0.37**	**4.6%**
	1020888								

Basin Travel Time

Shallow Channel Ground Cover Short Pasture/Lawns

$L_{max,Overland}$ 300 ft C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	2,200	93	-	-	-	-	
Initial Time	300	19	0.063	-	16.8	N/A	DCM Eq. 6-8
Shallow Channel	1,430	58	0.041	1.4	16.9	-	DCM Eq. 6-9
Channelized	470	16	0.034	0.8	9.5	-	Trap Ditch
				t_c	**43.2**	**min.**	

Storage Volume

40 -hr release time

Detention is NOT required

Water Quality is NOT required

EURV 0.00 (in) a = 1

WQCV 0.00 (in)

i (return period)	5-year	10-year	100-year
K_i (ft)	0.0000	0.0000	0
V_i (acre-ft)	0.000	0.000	0
V_i (ft^3)	0	0	0

Design Volume (ft^3)

	% Storage	100-year	WQCV	Total
EURV	0%	0	0	**0**
WQCV	0%		0	**0**

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	1.55	1.93	2.26	2.58	2.90	3.25
Runoff (cfs)	2.0	**5.1**	9.6	16.8	22.1	**28.4**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	2.0	**5.1**	9.6	16.8	22.1	**28.4**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin I Runoff Calculations

Job No.: **61197**

Date: **11/20/2023 11:40**

Project: **Forest Heights Estates**

Calcs by: **TJW**

Checked by:

Jurisdiction **DCM**

Soil Type **B**

Runoff Coefficient **Surface Type**

Urbanization **Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre			0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre			0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	222,704	5.11	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	14,058	0.32	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	2,609	0.06	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	12,914	0.30	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**252,285**	**5.79**	**0.10**	**0.16**	**0.22**	**0.31**	**0.36**	**0.41**	**10.6%**

252285

Basin Travel Time

Shallow Channel Ground Cover Short Pasture/Lawns

$L_{max,Overland}$ 300 ft C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	840	39	-	-	-	-	
Initial Time	300	18	0.060	-	16.3	N/A	DCM Eq. 6-8
Shallow Channel	540	21	0.039	1.4	6.5	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				t_c	**22.8**	**min.**	

Storage Volume

40 -hr release time

Detention is NOT required

EURV 0.00 (in) a = 1

Water Quality is NOT required

WQCV 0.00 (in)

i (return period)	5-year	10-year	100-year
K_i (ft)	0.0000	0.0000	0
V_i (acre-ft)	0.000	0.000	0
V_i (ft^3)	0	0	0

Design Volume (ft^3)

	% Storage	100-year	WQCV	Total
EURV	0%	0	0	**0**
WQCV	0%		0	**0**

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	2.31	2.89	3.37	3.86	4.34	4.85
Runoff (cfs)	1.4	**2.7**	4.4	7.0	9.1	**11.4**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.4	**2.7**	4.4	7.0	9.1	**11.4**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin J Runoff Calculations

Job No.: **61197**

Project: **Forest Heights Estates**

Date: **11/20/2023 11:40**

Calcs by: **TJW**

Checked by:

Jurisdiction **DCM**

Runoff Coefficient **Surface Type**

Soil Type **B**

Urbanization **Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre			0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre			0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	190,373	4.37	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved			0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs			0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel			0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**190,373**	**4.37**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**
	190373								

Basin Travel Time

Shallow Channel Ground Cover Short Pasture/Lawns

$L_{max,Overland}$ 300 ft

C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	577	34	-	-	-	-	
Initial Time	300	24	0.080	-	16.1	N/A	DCM Eq. 6-8
Shallow Channel	277	10	0.036	1.3	3.5	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				t_c	**19.5**	**min.**	

Storage Volume

40 -hr release time

a = 1

Detention is NOT required

Water Quality is NOT required

EURV 0.00 (in)

WQCV 0.00 (in)

i (return period)	5-year	10-year	100-year
K_i (ft)	0.0000	0.0000	0
V_i (acre-ft)	0.000	0.000	0
V_i (ft^3)	0	0	0

Design Volume (ft^3)

	% Storage	100-year	WQCV	Total
EURV	0%	0	0	**0**
WQCV	0%		0	**0**

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	2.50	3.13	3.65	4.17	4.69	5.25
Runoff (cfs)	0.2	**1.1**	2.4	4.6	6.1	**8.0**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.2	**1.1**	2.4	4.6	6.1	**8.0**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Combined Sub-Basin Runoff Calculations - DP3

Includes Basins C D E

Job No.:	**61197**	Date:	**11/20/2023 11:40**
Project:	**Forest Heights Estates**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre	-	0.00	0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre	-	0.00	0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	524,765	12.05	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	17,353	0.40	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	11,138	0.26	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	19,299	0.44	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**572,555**	**13.14**	**0.08**	**0.13**	**0.20**	**0.29**	**0.34**	**0.39**	**7.4%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	D	-	836	56	-	-	-	-	30.0
Channelized-1									
Channelized-2									
Channelized-3									
Total			836	56					
								t_c (min)	**30.0**

Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

Q_{Minor} (cfs) - 5-year Storm

Q_{Major} (cfs) - 100-year Storm

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	1.99	2.48	2.90	3.31	3.73	4.17
Site Runoff (cfs)	2.00	**4.34**	7.59	12.77	16.68	**21.23**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**4.3**	-	-	-	**21.2**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

Combined Sub-Basin Runoff Calculations - DP4

Includes Basins C D E I

Job No.: **61197**

Date: **11/20/2023 11:40**

Project: **Forest Heights Estates**

Calcs by: **TJW**

Checked by:

Jurisdiction **DCM**

Soil Type **B**

Runoff Coefficient **Surface Type**

Urbanization **Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre	-	0.00	0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre	-	0.00	0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	747,469	17.16	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	19,962	0.46	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	25,196	0.58	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	32,213	0.74	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**824,840**	**18.94**	**0.08**	**0.14**	**0.21**	**0.30**	**0.35**	**0.39**	**8.4%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	D	-	836	56	-	-	-	-	30.0
Channelized-1	Trap Ditch	2	505	20	22	6	10	3.0	2.8
Channelized-2									
Channelized-3									
Total			1,341	76					

2 = Natural, Winding, minimal vegetation/shallow grass

t_c (min) **32.8**

Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

Q_{Minor} (cfs) - 5-year Storm

Q_{Major} (cfs) - 100-year Storm

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	1.88	2.35	2.74	3.13	3.52	3.94
Site Runoff (cfs)	3.02	**6.25**	10.73	17.78	23.13	**29.35**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**6.3**	-	-	-	**29.3**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

Combined Sub-Basin Runoff Calculations - DP5

Includes Basins C D E I B H

Job No.:	**61197**	Date:	**11/20/2023 11:40**
Project:	**Forest Heights Estates**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre	-	0.00	0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre	407,534	9.36	0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	2,162,678	49.65	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	43,289	0.99	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	44,895	1.03	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	75,568	1.73	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**2,733,964**	**62.76**	**0.07**	**0.12**	**0.20**	**0.29**	**0.34**	**0.38**	**6.9%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	B	-	1,380	72	-	-	-	-	49.9
Channelized-1	Trap Ditch	2	1,616	54	22	6	10	2.8	9.6
Channelized-2									
Channelized-3									
Total			2,996	126					

2 = Natural, Winding, minimal vegetation/shallow grass

t_c (min) 59.5

Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

Q_{Minor} (cfs) - 5-year Storm

Q_{Major} (cfs) - 100-year Storm

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	1.17	1.45	1.70	1.94	2.18	2.44
Site Runoff (cfs)	5.11	**11.31**	20.87	35.31	46.31	**58.87**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**11.3**	-	-	-	**58.9**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

Combined Sub-Basin Runoff Calculations - DP6

Includes Basins A F G

Job No.: **61197**
Date: **11/20/2023 11:40**
Project: **Forest Heights Estates**
Calcs by: **TJW**
Checked by:
Jurisdiction **DCM**
Soil Type **B**
Runoff Coefficient **Surface Type**
Urbanization **Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre	455,492	10.46	0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre	28,936	0.66	0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	1,273,847	29.24	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	17,424	0.40	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	12,655	0.29	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	74,834	1.72	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**1,863,188**	**42.77**	**0.07**	**0.12**	**0.19**	**0.29**	**0.34**	**0.38**	**6.6%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	F	-	1,851	91	-	-	-	-	33.5
Channelized-1	Trap Ditch	2	488	14	25	6	10	2.8	2.9
Channelized-2									
Channelized-3									
Total			2,339	105					

2 = Natural, Winding, minimal vegetation/shallow grass

t_c (min) **36.5**

Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas
Q_{Minor} (cfs) - 5-year Storm
Q_{Major} (cfs) - 100-year Storm

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	1.76	2.19	2.55	2.92	3.28	3.67
Site Runoff (cfs)	4.89	**11.01**	21.12	35.80	47.05	**59.78**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**11.0**	-	-	-	**59.8**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

Combined Sub-Basin Runoff Calculations - Swale 2

Includes Basins A G

Job No.: **61197**
Date: **11/20/2023 11:40**
Project: **Forest Heights Estates**
Calcs by: **TJW**
Checked by:
Jurisdiction **DCM**
Soil Type **B**
Runoff Coefficient **Surface Type**
Urbanization **Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre	-	0.00	0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre	28,936	0.66	0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	993,789	22.81	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	13,204	0.30	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	12,655	0.29	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	60,081	1.38	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**1,108,665**	**25.45**	**0.07**	**0.13**	**0.19**	**0.29**	**0.34**	**0.38**	**6.8%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	A	-	1,445	67	-	-	-	-	54.3
Channelized-1	Trap Ditch	2	666	22	25	6	10	2.9	3.8
Channelized-2									
Channelized-3									
Total			2,111	89					

2 = Natural, Winding, minimal vegetation/shallow grass

t_c (min) **58.1**

Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas
Q_{Minor} (cfs) - 5-year Storm
Q_{Major} (cfs) - 100-year Storm

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	1.20	1.49	1.74	1.99	2.24	2.50
Site Runoff (cfs)	2.13	**4.77**	8.58	14.57	19.09	**24.34**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**4.8**	-	-	-	**24.3**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

Combined Sub-Basin Runoff Calculations - Swale 4

Includes Basins B C H

Job No.:	**61197**	Date:	**11/20/2023 11:40**
Project:	**Forest Heights Estates**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre	-	0.00	0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre	407,534	9.36	0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	1,569,776	36.04	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	27,692	0.64	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	20,577	0.47	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	49,093	1.13	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**2,074,672**	**47.63**	**0.06**	**0.12**	**0.19**	**0.29**	**0.33**	**0.38**	**6.2%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	B	-	1,380	72	-	-	-	-	49.9
Channelized-1	Trap Ditch	2	1,616	54	25	6	10	2.9	9.2
Channelized-2									
Channelized-3									
Total			2,996	126					

2 = Natural, Winding, minimal vegetation/shallow grass

t_c (min) 59.1

Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

Q_{Minor} (cfs) - 5-year Storm

Q_{Major} (cfs) - 100-year Storm

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	1.18	1.46	1.71	1.95	2.20	2.45
Site Runoff (cfs)	3.52	**8.14**	15.51	26.53	34.92	**44.46**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**8.1**	-	-	-	**44.5**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

Combined Sub-Basin Runoff Calculations - Swale 8

Includes Basins C D E I

Job No.: **61197**
Date: **11/20/2023 11:40**
Project: **Forest Heights Estates**
Calcs by: **TJW**
Checked by:
Jurisdiction **DCM**
Soil Type **B**
Runoff Coefficient **Surface Type**
Urbanization **Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre	-	0.00	0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre	-	0.00	0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	747,469	17.16	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	19,962	0.46	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	25,196	0.58	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	32,213	0.74	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**824,840**	**18.94**	**0.08**	**0.14**	**0.21**	**0.30**	**0.35**	**0.39**	**8.4%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	D	-	836	56	-	-	-	-	30.0
Channelized-1	Trap Ditch	2	505	20	22	6	10	3.0	2.8
Channelized-2									
Channelized-3									
Total			1,341	76					

2 = Natural, Winding, minimal vegetation/shallow grass

t_c (min) **32.8**

Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas
Q_{Minor} (cfs) - 5-year Storm
Q_{Major} (cfs) - 100-year Storm

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	1.88	2.35	2.74	3.13	3.52	3.94
Site Runoff (cfs)	3.02	**6.25**	10.73	17.78	23.13	**29.35**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**6.3**	-	-	-	**29.3**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

Combined Sub-Basin Runoff Calculations - Swale 12

Includes Basins A F G

Job No.:	**61197**	Date:	**11/20/2023 11:40**
Project:	**Forest Heights Estates**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre	455,492	10.46	0.06	0.1	0.2	0.29	0.34	0.38	7%
2-1/2 Acre	28,936	0.66	0.08	0.12	0.22	0.31	0.36	0.4	11%
Pasture/Meadow	1,273,847	29.24	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	17,424	0.40	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	12,655	0.29	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	74,834	1.72	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**1,863,188**	**42.77**	**0.07**	**0.12**	**0.19**	**0.29**	**0.34**	**0.38**	**6.6%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	F	-	1,851	91	-	-	-	-	33.5
Channelized-1	Trap Ditch	2	488	14	25	6	10	2.8	2.9
Channelized-2									
Channelized-3									
Total			2,339	105					

2 = Natural, Winding, minimal vegetation/shallow grass

t_c (min) 36.5

Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

Q_{Minor} (cfs) - 5-year Storm

Q_{Major} (cfs) - 100-year Storm

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	1.76	2.19	2.55	2.92	3.28	3.67
Site Runoff (cfs)	4.89	**11.01**	21.12	35.80	47.05	**59.78**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**11.0**	-	-	-	**59.8**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

Exhibit 10

Hydraulic Calculations

EXIST & PROP BASIN SUMMARY

BASIN I.D.	AREA	RUNOFF COEFFICIENTS (existing)		RUNOFF COEFFICIENTS (developed)		EXSITING RUNOFF		DEVELOPED RUNOFF	
						Q5	Q100	Q5	Q100
	(acres)	C5	C100	C5	C100	cfs	cfs	cfs	cfs
A	17.4	0.09	0.35	0.09	0.36	3.4	23.6	3.7	24
B	20.8	0.09	0.36	0.10	0.36	4.4	29.1	4.6	29.5
C	3.9	0.11	0.37	0.14	0.39	1.4	7.9	1.8	8.4
D	7.5	0.1	0.36	0.12	0.38	2.3	14.3	2.7	14.8
E	2.3	0.12	0.38	0.18	0.42	1	4.9	1.4	5.5
F	18.7	0.08	0.35	0.09	0.35	2	20.7	3.1	21.1
G	9.9	0.09	0.36	0.10	0.37	2.7	17.8	3	18.2
H	23.3	0.09	0.36	0.10	0.36	5.3	34.3	5.6	34.7
I	5.7	0.11	0.37	0.13	0.38	2.4	13.7	2.8	14.3
J	3.4	0.08	0.35	0.08	0.35	1	7.1	1	7.1

EXISTING DESIGN POINT SUMMARY

DESIGN POINT	CONTRIB SUB BASINS	AREA (acres)	Q5 (cfs)	Q100 (cfs)
1	A	16.1	3.0	16.1
2	B	20.4	3.9	22.4
3	C,D,E	13.1	4.5	21.5
4	C,D,E,I	18.4	6.2	29.4
5	B,C,D,E,H,I	62.8	10.4	57.7
6	A,F,G	42.8	10.4	59.1
7	J	4.4	1.1	8.0

PROPOSED DESIGN POINT SUMMARY

DESIGN POINT	CONTRIB SUB BASINS	AREA (acres)	Q5 (cfs)	Q100 (cfs)
1	A	16.1	3.1	16.3
2	B	20.4	4.2	22.8
3	C,D,E	13.1	4.3	21.2
4	C,D,E,I	18.4	6.3	29.3
5	B,C,D,E,H,I	62.8	11.3	58.9
6	A,F,G	42.8	11.0	59.8
7	J	4.4	1.1	8.0

KCH Engineering Solutions
5228 Cracker Barrel Circle
Colorado Springs, CO 80917
(719) 246-4471

JOB Didleau Subdivision
SHEET NO. 1 OF
CALCULATED BY K. Harrison DATE 2/10/2020
CHECKED BY DATE
SCALE

Developed Conditions

A. Area

Typical area of disturbance per a 5 acres+ tract = 1.5 acres
= 65,340 S.F

Typical Roof area = 2800 S.F

Landscaping/Lawn = 3/4 acre = 32,670 S.F

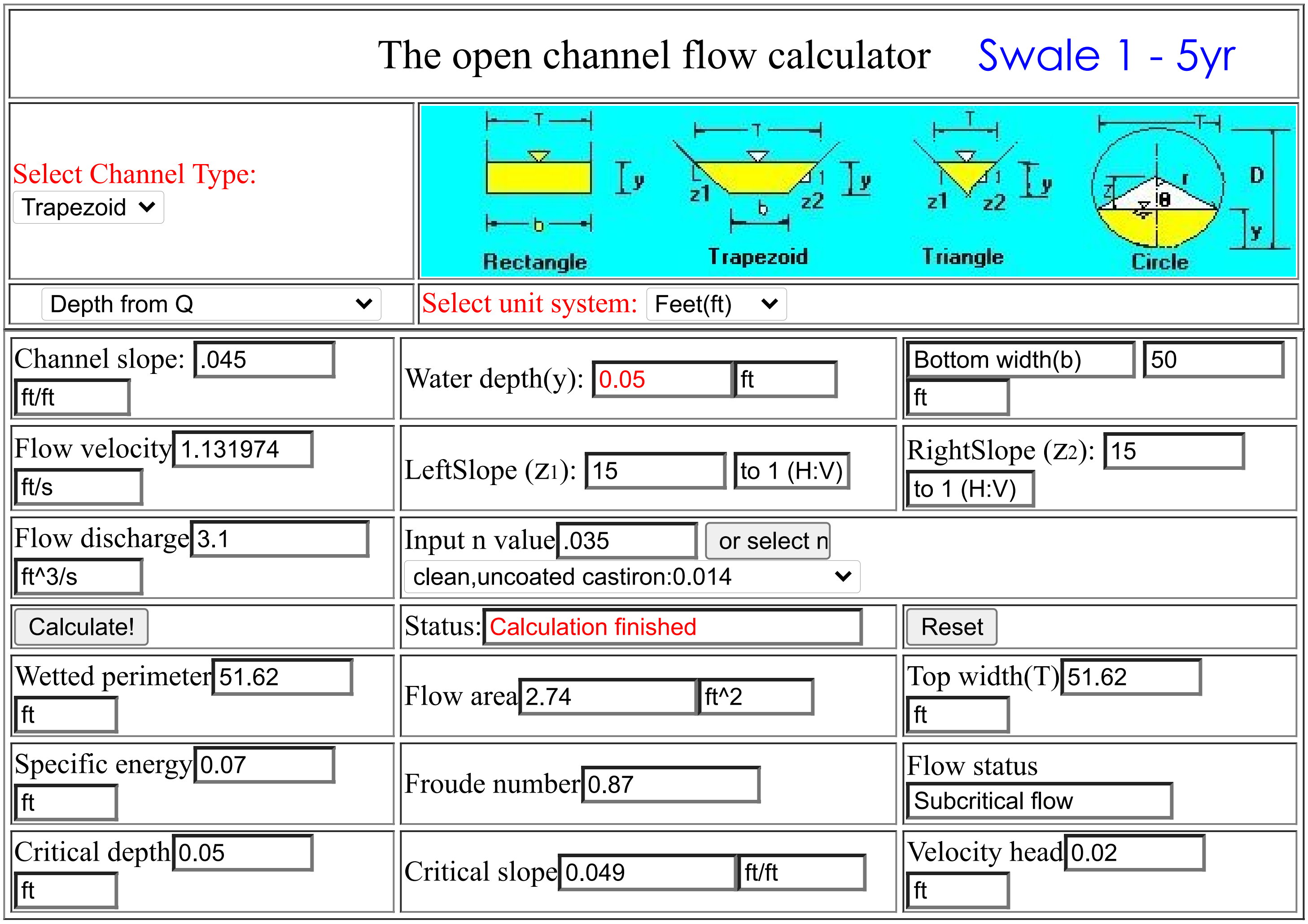
Driveway (Gravel) = 20'*200' = 4000 S.F

B Runoff coefficients (per 1.5 acre developed area)

	5yr	100yr	Area
Roof Area	0.73	0.81	2800 SF
Landscaping/Lawn	0.12	0.39	32,670 S.F
Driveway (gravel)	0.59	0.70	4,000 S.F
Natural	0.08	0.35	25,870 S.F
Composite "C"	0.16	0.41	

SWALE SUMMARY

SWALE #	CONTRIBUTING SUBBASINS	SLOPE	DESIGN FLOW		DEPTH OF FLOW		VELOCITY		FROUDE #	
			Q5	Q100	Q5	Q100	V5	V100		
		%	cfs	cfs	ft	ft	fps	fps	5 year	100 year
1	A	4.5	3.1	16.3	0.0	0.1	1.1	2.3	0.87	1.11
2	A,G	3.1	4.8	24.3	0.1	0.2	1.4	2.5	0.82	0.98
3	B	4.6	4.2	22.8	0.1	0.3	1.7	3.3	1.02	1.22
4	B,C,H	3.3	8.1	44.5	0.1	0.2	1.3	2.9	0.83	0.99
5	C	5.5	1.8	8.4	0.1	0.1	1.3	2.4	1.00	1.20
6	D	6.0	2.5	12.2	0.1	0.2	1.5	2.8	1.08	1.28
8	C,D,E,I	3.3	6.3	29.3	0.1	0.3	1.6	2.7	0.92	1.02
10	F	5.3	4.2	25.4	0.1	0.3	2.0	3.6	1.15	1.31
11	J	3.1	1.1	8.0	0.0	0.1	0.6	1.4	0.64	0.82
12	A,G,F	6.1	11.0	59.8	0.1	0.3	2.3	4.4	1.25	1.48
13 RD DITCH	PORTION OF SUBBASIN B	6.7	0.1	0.6	0.1	0.2	1.5	2.1	1.01	1.19
14 RD DITCH	PORTION OF SUBBASIN B	1.0	0.1	0.1	0.1	0.2	0.8	0.8	0.44	0.44
15 RD DITCH	PORTION OF SUBBASIN C	4.5	2.2	10.7	0.5	0.8	3.1	4.7	1.15	1.28
16 RD DITCH	PORTION OF SUBBASIN D	2.0	3.2	15.7	0.6	1.1	2.5	3.8	0.82	0.92



The open channel flow calculator Swale 1 - 5yr

Select Channel Type: Trapezoid

Depth from Q

Select unit system: Feet(ft)

Channel slope: .045 ft/ft

Water depth(y): 0.05 ft

Bottom width(b) 50 ft

Flow velocity 1.131974 ft/s

LeftSlope (Z1): 15 to 1 (H:V)

RightSlope (Z2): 15 to 1 (H:V)

Flow discharge 3.1 ft^3/s

Input n value .035 or select n

clean,uncoated castiron:0.014

Calculate!

Status: Calculation finished

Reset

Wetted perimeter 51.62 ft

Flow area 2.74 ft^2

Top width(T) 51.62 ft

Specific energy 0.07 ft

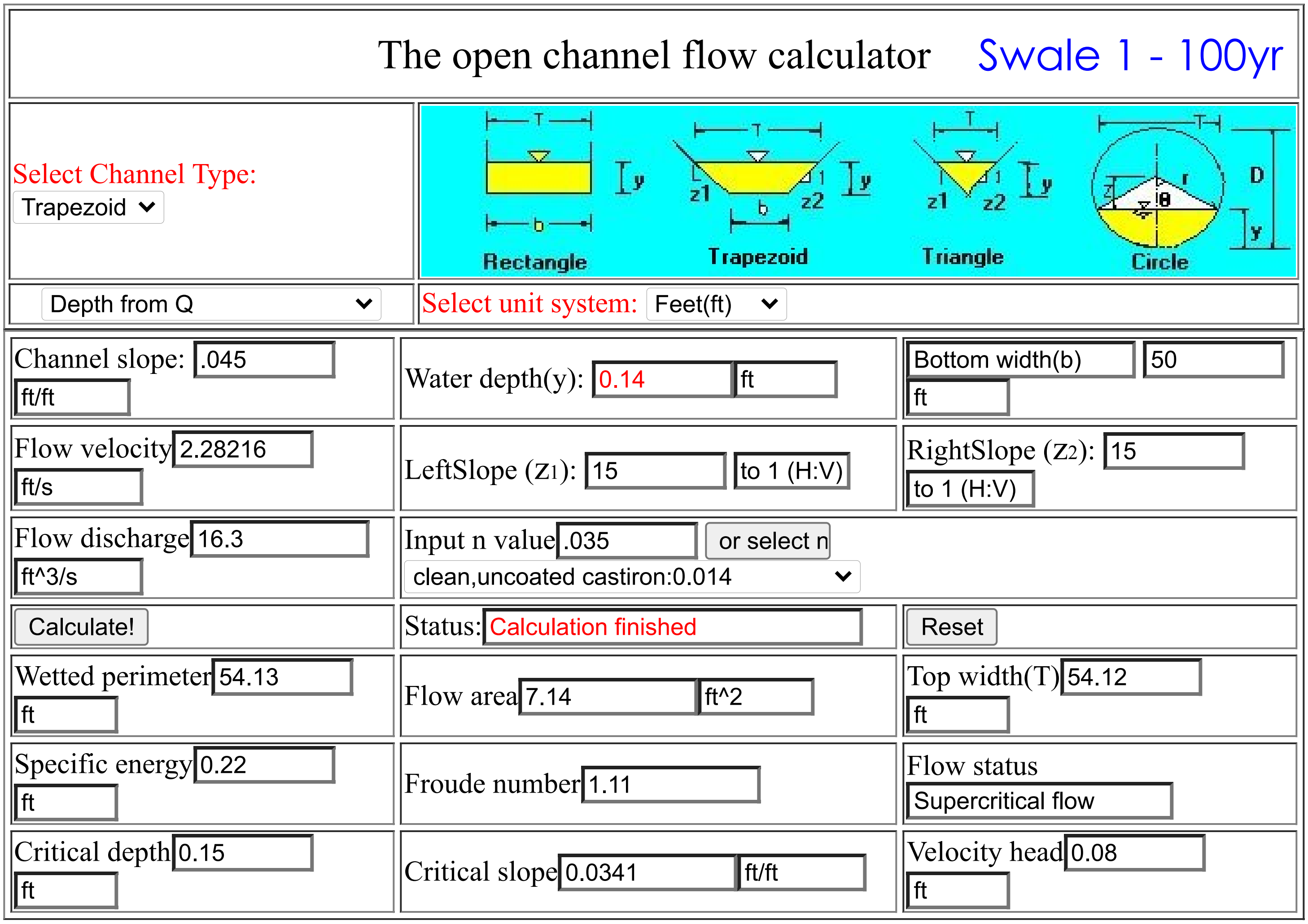
Froude number 0.87

Flow status Subcritical flow

Critical depth 0.05 ft

Critical slope 0.049 ft/ft

Velocity head 0.02 ft



The open channel flow calculator Swale 1 - 100yr

Select Channel Type: Trapezoid

Depth from Q

Select unit system: Feet(ft)

Channel slope: .045 ft/ft

Water depth(y): 0.14 ft

Bottom width(b) 50 ft

Flow velocity 2.28216 ft/s

LeftSlope (Z1): 15 to 1 (H:V)

RightSlope (Z2): 15 to 1 (H:V)

Flow discharge 16.3 ft^3/s

Input n value .035

clean,uncoated castiron:0.014

Status: Calculation finished

Wetted perimeter 54.13 ft

Flow area 7.14 ft^2

Top width(T) 54.12 ft

Specific energy 0.22 ft

Froude number 1.11

Flow status Supercritical flow

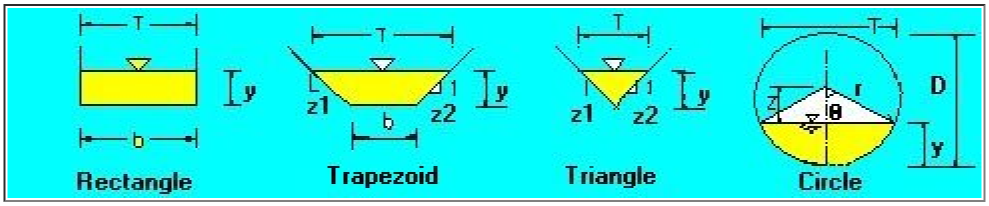
Critical depth 0.15 ft

Critical slope 0.0341 ft/ft

Velocity head 0.08 ft

The open channel flow calculator Swale 2 - 5yr

Select Channel Type: Trapezoid

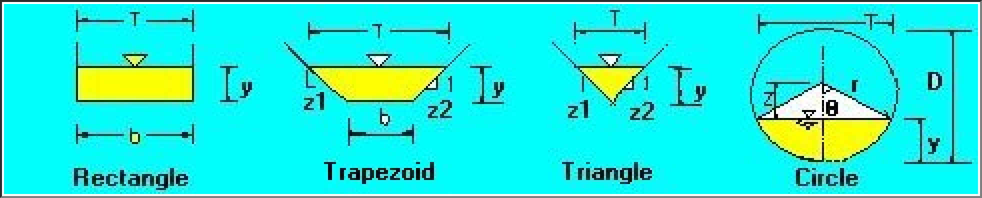


Depth from Q

Select unit system: Feet(ft)

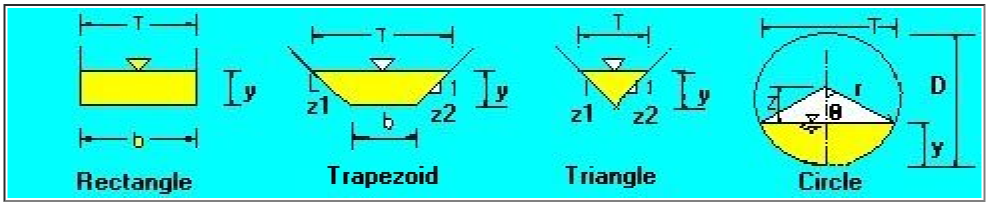
Channel slope: 0.031 ft/ft	Water depth(y): 0.09 ft	Bottom width(b) 35 ft
Flow velocity 1.381219 ft/s	LeftSlope (Z1): 25 to 1 (H:V)	RightSlope (Z2): 25 to 1 (H:V)
Flow discharge 4.8 ft^3/s	Input n value 0.035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 39.66 ft	Flow area 3.48 ft^2	Top width(T) 39.66 ft
Specific energy 0.12 ft	Froude number 0.82	Flow status Subcritical flow
Critical depth 0.08 ft	Critical slope 0.0396 ft/ft	Velocity head 0.03 ft

The open channel flow calculator Swale 2 - 100yr

Select Channel Type: Trapezoid		
Depth from Q	Select unit system: Feet(ft)	
Channel slope: 0.031 ft/ft	Water depth(y): 0.24 ft	Bottom width(b) 35 ft
Flow velocity 2.527307 ft/s	LeftSlope (Z1): 25 to 1 (H:V)	RightSlope (Z2): 25 to 1 (H:V)
Flow discharge 24.3 ft^3/s	Input n value 0.035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 46.77 ft	Flow area 9.61 ft^2	Top width(T) 46.76 ft
Specific energy 0.33 ft	Froude number 0.98	Flow status Subcritical flow
Critical depth 0.24 ft	Critical slope 0.0292 ft/ft	Velocity head 0.1 ft

The open channel flow calculator Swale 3 - 5yr

Select Channel Type: Trapezoid

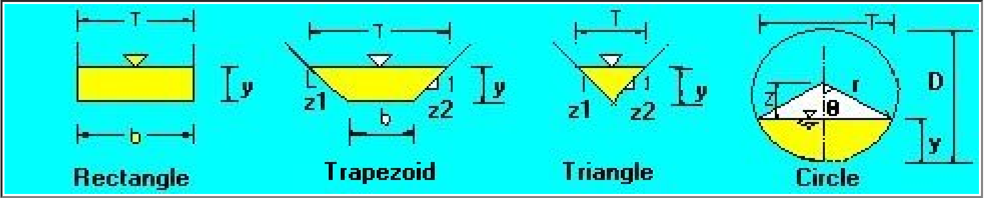


Depth from Q | Select unit system: Feet(ft)

Channel slope: 0.046 ft/ft	Water depth(y): 0.09 ft	Bottom width(b) 25 ft
Flow velocity 1.739724 ft/s	LeftSlope (z_1): 10 to 1 (H:V)	RightSlope (z_2): 10 to 1 (H:V)
Flow discharge 4.2 ft^3/s	Input n value 0.035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 26.87 ft	Flow area 2.41 ft^2	Top width(T) 26.86 ft
Specific energy 0.14 ft	Froude number 1.02	Flow status Supercritical flow
Critical depth 0.1 ft	Critical slope 0.0351 ft/ft	Velocity head 0.05 ft

The open channel flow calculator Swale 3 - 100yr

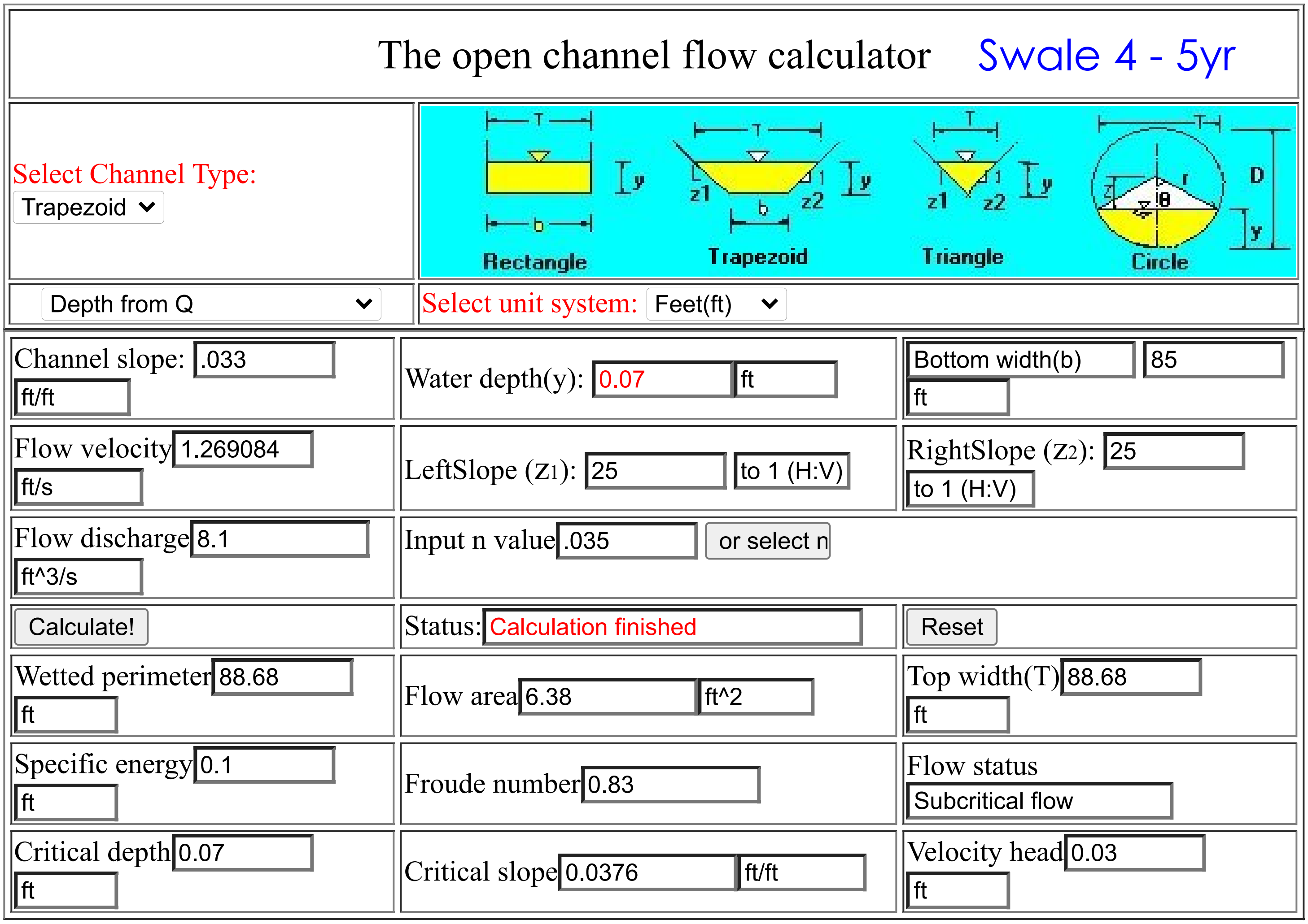
Select Channel Type: Trapezoid



Depth from Q

Select unit system: Feet(ft)

Channel slope: 0.046 ft/ft	Water depth(y): 0.25 ft	Bottom width(b) 25 ft
Flow velocity 3.317811 ft/s	LeftSlope (Z1): 10 to 1 (H:V)	RightSlope (Z2): 10 to 1 (H:V)
Flow discharge 22.8 ft^3/s	Input n value 0.035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 30.02 ft	Flow area 6.87 ft^2	Top width(T) 30 ft
Specific energy 0.42 ft	Froude number 1.22	Flow status Supercritical flow
Critical depth 0.28 ft	Critical slope 0.0281 ft/ft	Velocity head 0.17 ft



The open channel flow calculator Swale 4 - 5yr

Select Channel Type: Trapezoid

Depth from Q

Select unit system: Feet(ft)

Channel slope: .033 ft/ft

Water depth(y): 0.07 ft

Bottom width(b) 85 ft

Flow velocity 1.269084 ft/s

LeftSlope (Z1): 25 to 1 (H:V)

RightSlope (Z2): 25 to 1 (H:V)

Flow discharge 8.1 ft^3/s

Input n value .035 or select n

Calculate!

Status: Calculation finished

Reset

Wetted perimeter 88.68 ft

Flow area 6.38 ft^2

Top width(T) 88.68 ft

Specific energy 0.1 ft

Froude number 0.83

Flow status Subcritical flow

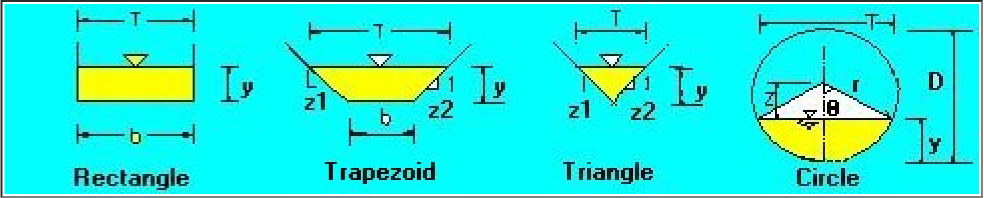
Critical depth 0.07 ft

Critical slope 0.0376 ft/ft

Velocity head 0.03 ft

The open channel flow calculator Swale 4 - 100yr

Select Channel Type: Trapezoid



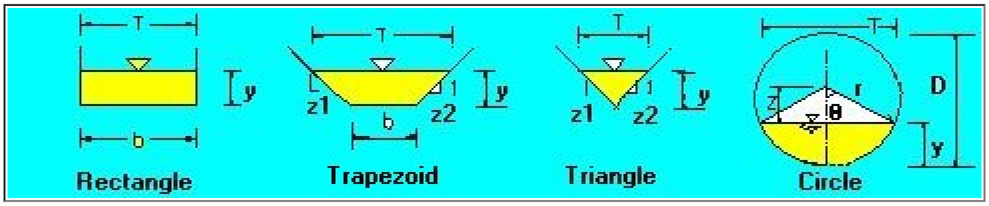
Depth from Q

Select unit system: Feet(ft)

Channel slope: 0.033 ft/ft	Water depth(y): 0.24 ft	Bottom width(b) 85 ft
Flow velocity 2.875619 ft/s	LeftSlope (Z1): 25 to 1 (H:V)	RightSlope (Z2): 25 to 1 (H:V)
Flow discharge 44.5 ft^3/s	Input n value 0.035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 95.05 ft	Flow area 18.09 ft^2	Top width(T) 95.04 ft
Specific energy 0.29 ft	Froude number 0.99	Flow status Subcritical flow
Critical depth 0.2 ft	Critical slope 0.0307 ft/ft	Velocity head 0.09 ft

The open channel flow calculator Swale 5 - 5yr

Select Channel Type: Trapezoid



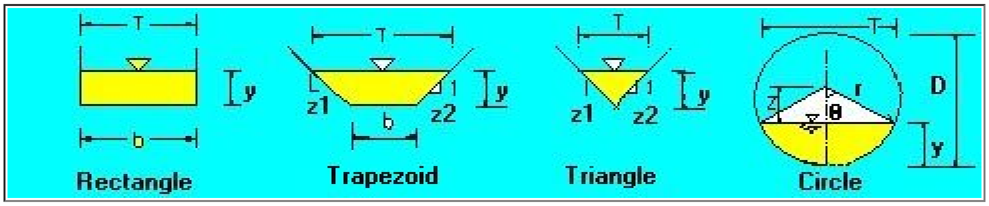
Depth from Q

Select unit system: Feet(ft)

Channel slope: 0.055 ft/ft	Water depth(y): 0.05 ft	Bottom width(b) 25 ft
Flow velocity 1.307615 ft/s	LeftSlope (Z_1): 10 to 1 (H:V)	RightSlope (Z_2): 10 to 1 (H:V)
Flow discharge 1.8 ft^3/s	Input n value 0.035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 26.08 ft	Flow area 1.38 ft^2	Top width(T) 26.08 ft
Specific energy 0.08 ft	Froude number 1	Flow status Critical flow
Critical depth 0.06 ft	Critical slope 0.0358 ft/ft	Velocity head 0.03 ft

The open channel flow calculator Swale 5 - 100yr

Select Channel Type:
Trapezoid



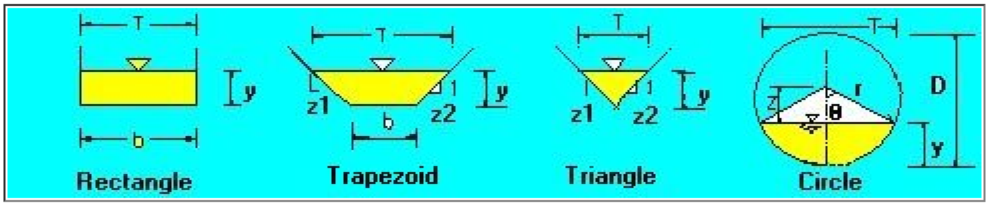
Depth from Q

Select unit system: Feet(ft)

Channel slope: 0.055 ft/ft	Water depth(y): 0.13 ft	Bottom width(b) 25 ft
Flow velocity 2.412038 ft/s	LeftSlope (Z_1): 10 to 1 (H:V)	RightSlope (Z_2): 10 to 1 (H:V)
Flow discharge 8.4 ft^3/s	Input n value 0.035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 27.66 ft	Flow area 3.48 ft^2	Top width(T) 27.65 ft
Specific energy 0.22 ft	Froude number 1.2	Flow status Supercritical flow
Critical depth 0.15 ft	Critical slope 0.0321 ft/ft	Velocity head 0.09 ft

The open channel flow calculator Swale 6 - 5yr

Select Channel Type: Trapezoid



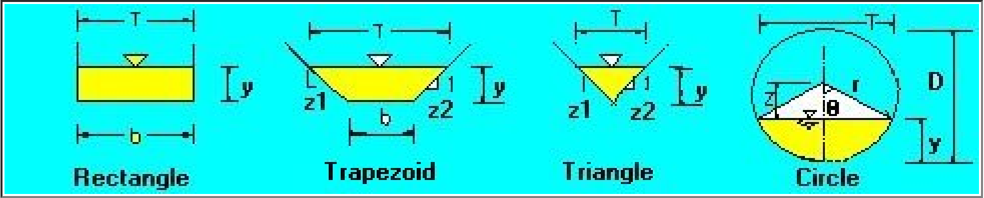
Depth from Q

Select unit system: Feet(ft)

Channel slope: 0.06 ft/ft	Water depth(y): 0.06 ft	Bottom width(b) 25 ft
Flow velocity 1.530853 ft/s	LeftSlope (Z1): 10 to 1 (H:V)	RightSlope (Z2): 10 to 1 (H:V)
Flow discharge 2.5 ft^3/s	Input n value 0.035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 26.28 ft	Flow area 1.63 ft^2	Top width(T) 26.27 ft
Specific energy 0.1 ft	Froude number 1.08	Flow status Supercritical flow
Critical depth 0.07 ft	Critical slope 0.0412 ft/ft	Velocity head 0.04 ft

The open channel flow calculator Swale 6 - 100yr

Select Channel Type: Trapezoid



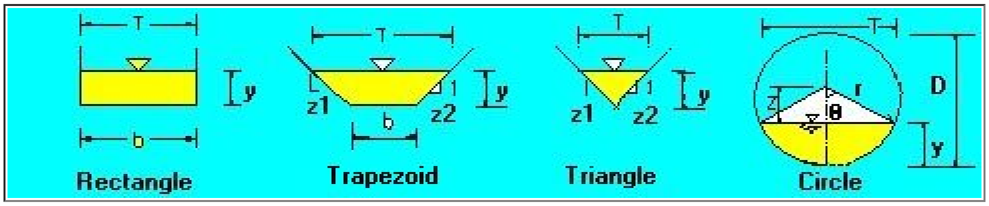
Depth from Q

Select unit system: Feet(ft)

Channel slope: 0.06 ft/ft	Water depth(y): 0.16 ft	Bottom width(b) 25 ft
Flow velocity 2.834593 ft/s	LeftSlope (Z1): 10 to 1 (H:V)	RightSlope (Z2): 10 to 1 (H:V)
Flow discharge 12.2 ft^3/s	Input n value 0.035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 28.25 ft	Flow area 4.3 ft^2	Top width(T) 28.23 ft
Specific energy 0.29 ft	Froude number 1.28	Flow status Supercritical flow
Critical depth 0.19 ft	Critical slope 0.0311 ft/ft	Velocity head 0.12 ft

The open channel flow calculator Swale 8 - 5yr

Select Channel Type: Trapezoid



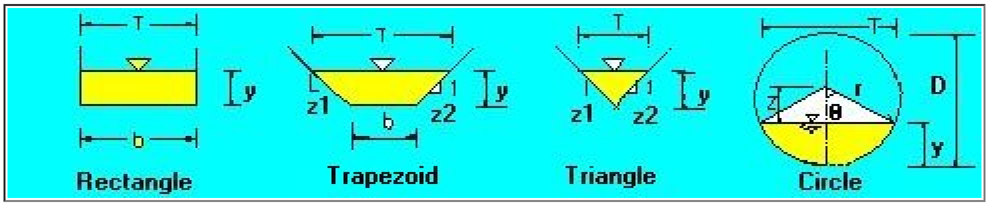
Depth from Q

Select unit system: Feet(ft)

Channel slope: 0.033 ft/ft	Water depth(y): 0.1 ft	Bottom width(b) 35 ft
Flow velocity 1.60749 ft/s	LeftSlope (Z1): 30 to 1 (H:V)	RightSlope (Z2): 30 to 1 (H:V)
Flow discharge 6.3 ft^3/s	Input n value 0.035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 41.18 ft	Flow area 3.92 ft^2	Top width(T) 41.17 ft
Specific energy 0.14 ft	Froude number 0.92	Flow status Subcritical flow
Critical depth 0.1 ft	Critical slope 0.0389 ft/ft	Velocity head 0.04 ft

The open channel flow calculator Swale 8 - 100yr

Select Channel Type:
Trapezoid ⌄



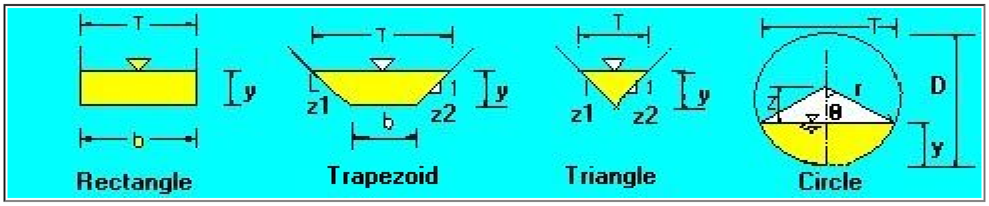
Depth from Q ⌄

Select unit system: Feet(ft) ⌄

Channel slope: 0.033 ft/ft	Water depth(y): 0.25 ft	Bottom width(b) 35 ft
Flow velocity 2.696561 ft/s	LeftSlope (z_1): 30 to 1 (H:V)	RightSlope (z_2): 30 to 1 (H:V)
Flow discharge 29.3 ft^3/s	Input n value 0.035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 50.3 ft	Flow area 10.87 ft^2	Top width(T) 50.29 ft
Specific energy 0.37 ft	Froude number 1.02	Flow status Supercritical flow
Critical depth 0.26 ft	Critical slope 0.0291 ft/ft	Velocity head 0.11 ft

The open channel flow calculator Swale 10 - 5yr

Select Channel Type: Trapezoid



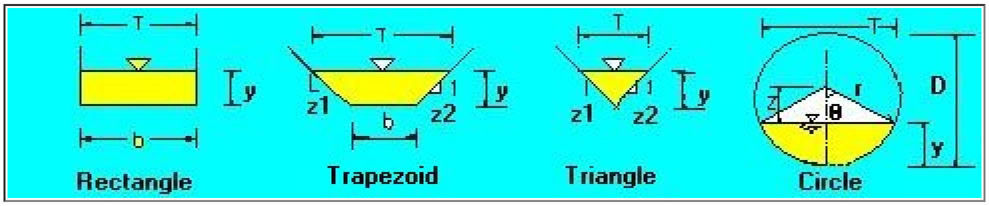
Depth from Q

Select unit system: Feet(ft)

Channel slope: 0.053 ft/ft	Water depth(y): 0.1 ft	Bottom width(b) 20 ft
Flow velocity 1.9516 ft/s	LeftSlope (Z1): 20 to 1 (H:V)	RightSlope (Z2): 20 to 1 (H:V)
Flow discharge 4.2 ft^3/s	Input n value 0.035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 23.92 ft	Flow area 2.15 ft^2	Top width(T) 23.92 ft
Specific energy 0.16 ft	Froude number 1.15	Flow status Supercritical flow
Critical depth 0.11 ft	Critical slope 0.0379 ft/ft	Velocity head 0.06 ft

The open channel flow calculator Swale 10 - 100yr

Select Channel Type: Trapezoid ⌄



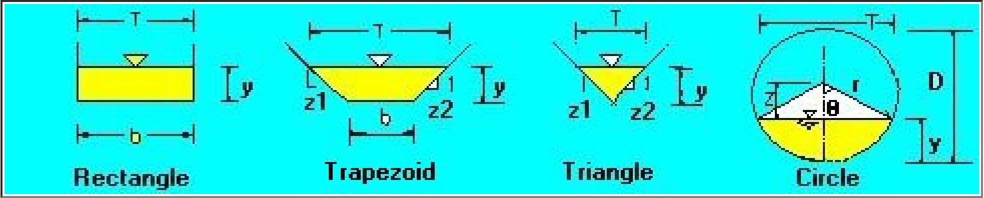
Depth from Q ⌄

Select unit system: Feet(ft) ⌄

Channel slope: 0.053 ft/ft	Water depth(y): 0.28 ft	Bottom width(b) 20 ft
Flow velocity 3.554352 ft/s	LeftSlope (Z_1): 20 to 1 (H:V)	RightSlope (Z_2): 20 to 1 (H:V)
Flow discharge 25.4 ft^3/s	Input n value 0.035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 31.19 ft	Flow area 7.15 ft^2	Top width(T) 31.17 ft
Specific energy 0.48 ft	Froude number 1.31	Flow status Supercritical flow
Critical depth 0.33 ft	Critical slope 0.0264 ft/ft	Velocity head 0.2 ft

The open channel flow calculator Swale 11 - 5yr

Select Channel Type:
Trapezoid ⌄



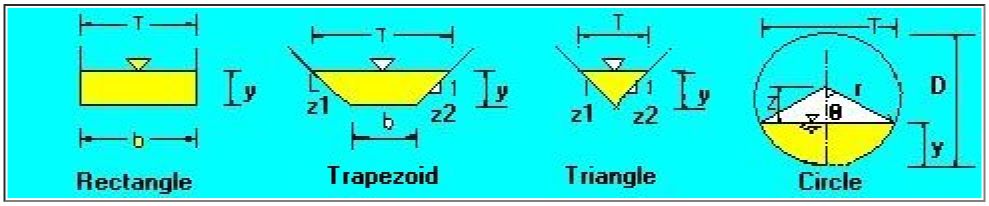
Depth from Q ⌄

Select unit system: Feet(ft) ⌄

Channel slope: 0.031 ft/ft	Water depth(y): 0.03 ft	Bottom width(b) 60 ft
Flow velocity 0.616919 ft/s	LeftSlope (Z_1): 15 to 1 (H:V)	RightSlope (Z_2): 15 to 1 (H:V)
Flow discharge 1.1 ft^3/s	Input n value 0.035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 60.89 ft	Flow area 1.78 ft^2	Top width(T) 60.89 ft
Specific energy 0.04 ft	Froude number 0.64	Flow status Subcritical flow
Critical depth 0.02 ft	Critical slope 0.0435 ft/ft	Velocity head 0.01 ft

The open channel flow calculator Swale 11 - 100yr

Select Channel Type: Trapezoid



Depth from Q

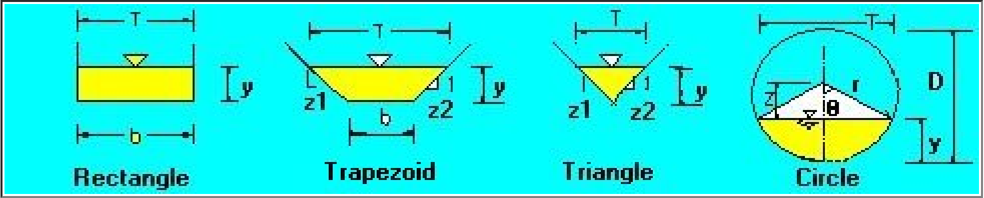
Select unit system: Feet(ft)

Channel slope: 0.031 ft/ft	Water depth(y): 0.09 ft	Bottom width(b) 60 ft
Flow velocity 1.399577 ft/s	LeftSlope (Z_1): 15 to 1 (H:V)	RightSlope (Z_2): 15 to 1 (H:V)
Flow discharge 8 ft^3/s	Input n value 0.035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 62.8 ft	Flow area 5.72 ft^2	Top width(T) 62.79 ft
Specific energy 0.12 ft	Froude number 0.82	Flow status Subcritical flow
Critical depth 0.08 ft	Critical slope 0.0385 ft/ft	Velocity head 0.03 ft

The open channel flow calculator

Swale 12 - 5yr

Select Channel Type: Trapezoid ⌄



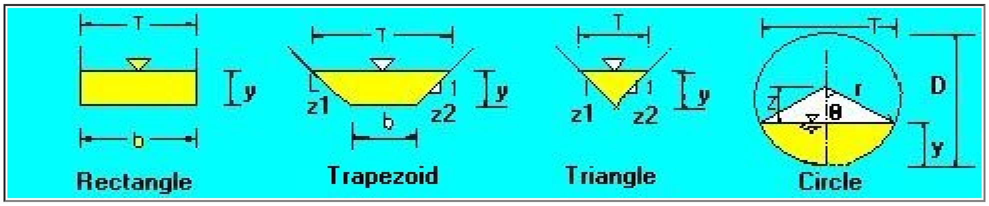
Depth from Q ⌄

Select unit system: Feet(ft) ⌄

Channel slope: 0.061 ft/ft	Water depth(y): 0.11 ft	Bottom width(b) 40 ft
Flow velocity 2.341163 ft/s	LeftSlope (Z_1): 15 to 1 (H:V)	RightSlope (Z_2): 15 to 1 (H:V)
Flow discharge 11 ft^3/s	Input n value 0.035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 43.39 ft	Flow area 4.7 ft^2	Top width(T) 43.38 ft
Specific energy 0.2 ft	Froude number 1.25	Flow status Supercritical flow
Critical depth 0.13 ft	Critical slope 0.0343 ft/ft	Velocity head 0.09 ft

The open channel flow calculator Swale 12 - 100yr

Select Channel Type:
Trapezoid ⌄



Depth from Q ⌄

Select unit system: Feet(ft) ⌄

Channel slope: 0.061 ft/ft	Water depth(y): 0.3 ft	Bottom width(b) 40 ft
Flow velocity 4.417713 ft/s	LeftSlope (Z_1): 15 to 1 (H:V)	RightSlope (Z_2): 15 to 1 (H:V)
Flow discharge 59.8 ft^3/s	Input n value 0.035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 49.13 ft	Flow area 13.54 ft^2	Top width(T) 49.11 ft
Specific energy 0.61 ft	Froude number 1.48	Flow status Supercritical flow
Critical depth 0.39 ft	Critical slope 0.0251 ft/ft	Velocity head 0.3 ft

Channel Report

61197-Sta 2+25 (21'L) Ditch Capacity Check 5YR

Triangular

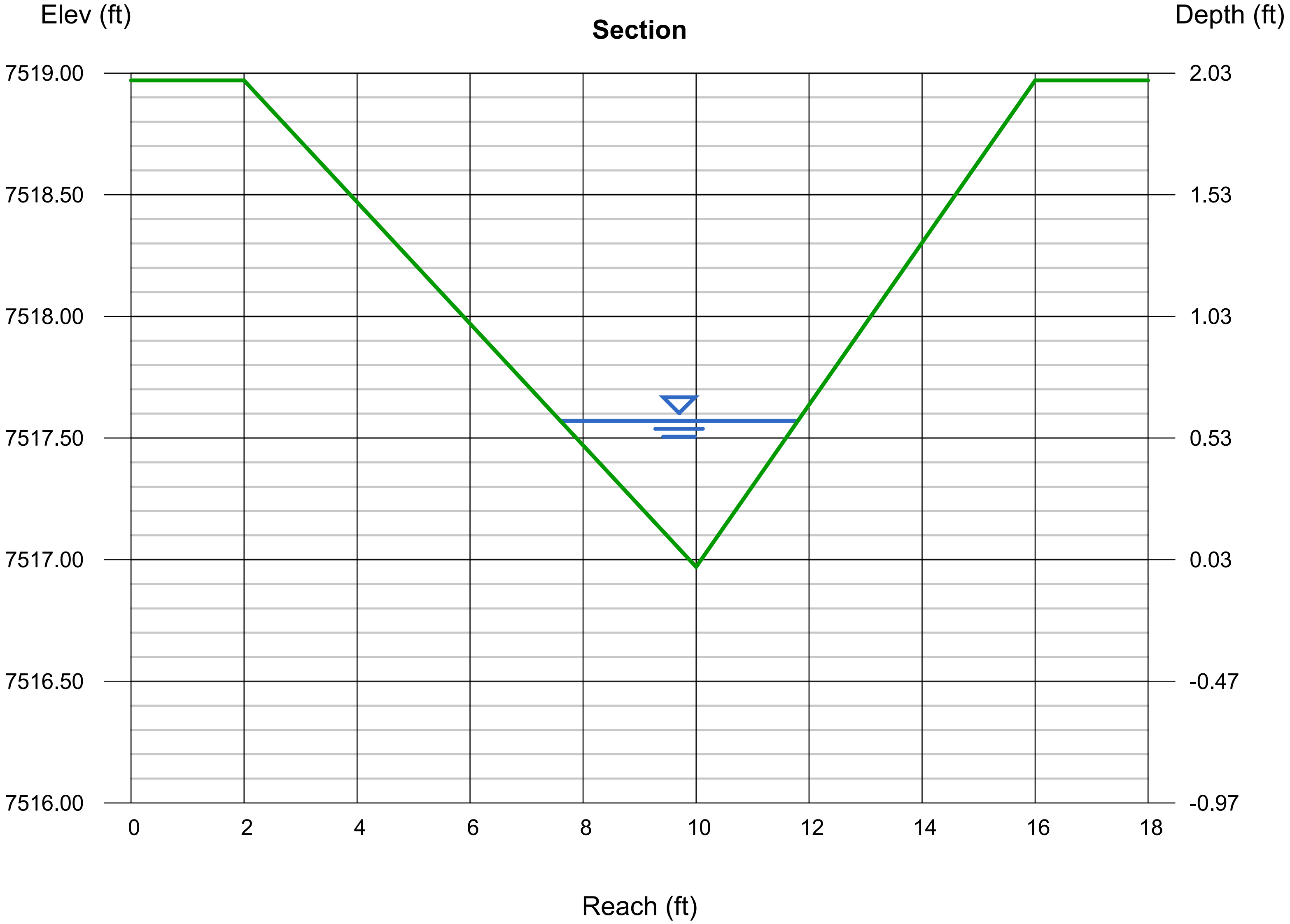
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 7516.97
Slope (%)	= 2.00
N-Value	= 0.035

Calculations

Compute by:	Known Q
Known Q (cfs)	= 3.20

Highlighted

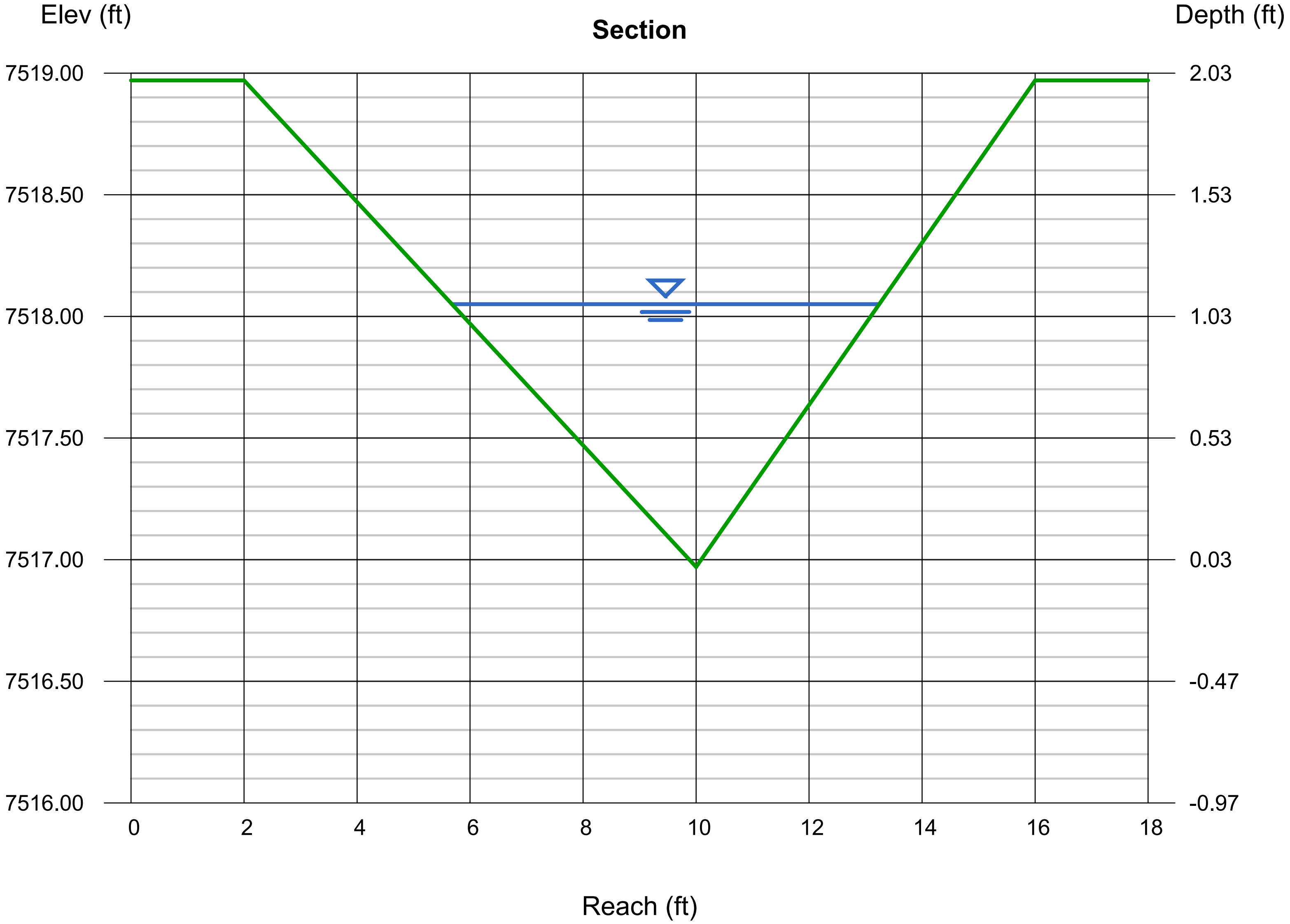
Depth (ft)	= 0.60
Q (cfs)	= 3.200
Area (sqft)	= 1.26
Velocity (ft/s)	= 2.54
Wetted Perim (ft)	= 4.37
Crit Depth, Yc (ft)	= 0.56
Top Width (ft)	= 4.20
EGL (ft)	= 0.70



Channel Report

61197-Sta 2+25 (21'L) Ditch Capacity Check

Triangular		**Highlighted**	
Side Slopes (z:1)	= 4.00, 3.00	Depth (ft)	= 1.08
Total Depth (ft)	= 2.00	Q (cfs)	= 15.70
		Area (sqft)	= 4.08
Invert Elev (ft)	= 7516.97	Velocity (ft/s)	= 3.85
Slope (%)	= 2.00	Wetted Perim (ft)	= 7.87
N-Value	= 0.035	Crit Depth, Yc (ft)	= 1.05
		Top Width (ft)	= 7.56
Calculations		EGL (ft)	= 1.31
Compute by:	Known Q		
Known Q (cfs)	= 15.70		



Channel Report

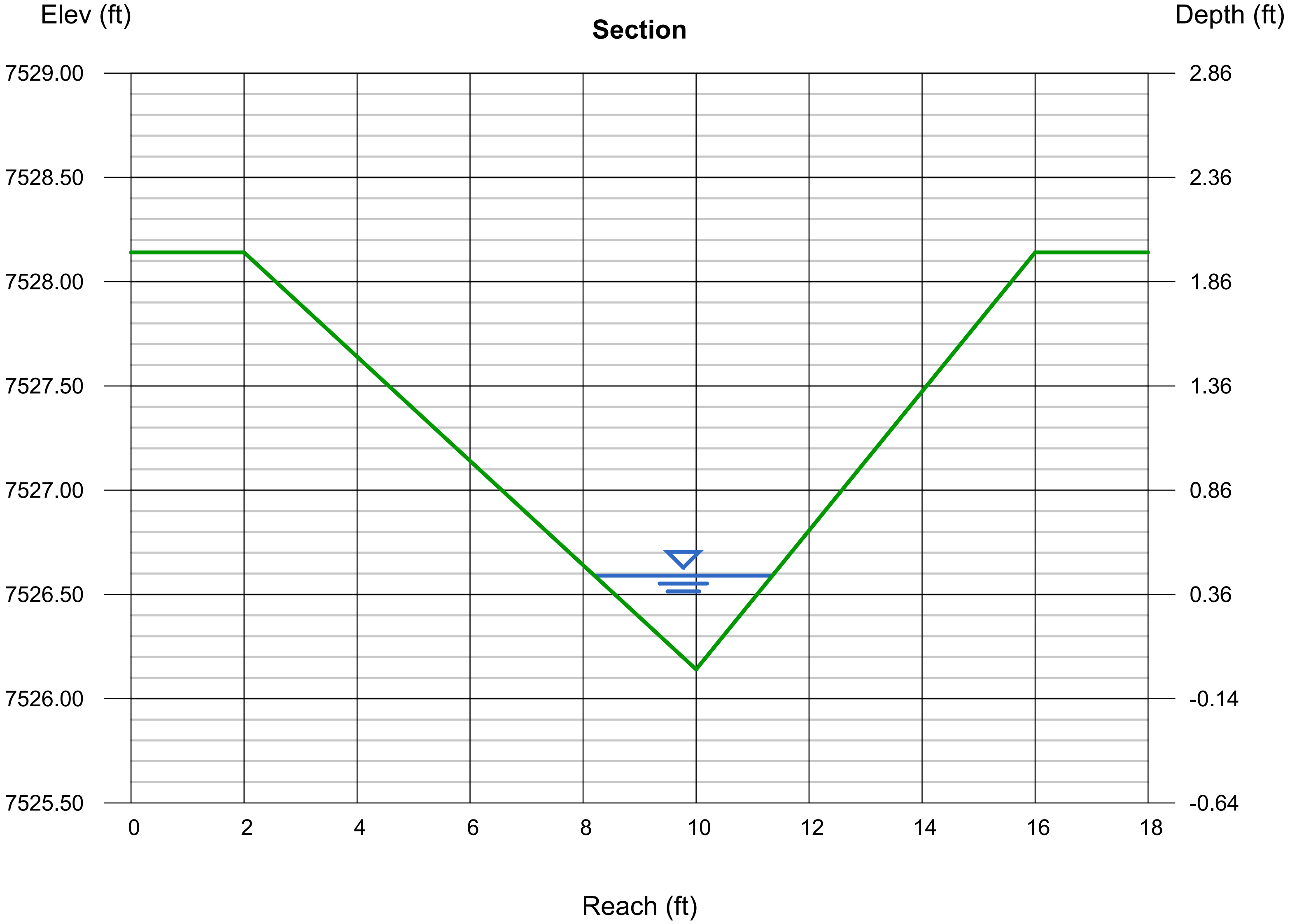
61197-Sta 4+50 (21'L) Velocity Check - 5YR

Triangular
Side Slopes (z:1) = 4.00, 3.00
Total Depth (ft) = 2.00

Invert Elev (ft) = 7526.14
Slope (%) = 4.42
N-Value = 0.035

Calculations
Compute by: Known Q
Known Q (cfs) = 2.20

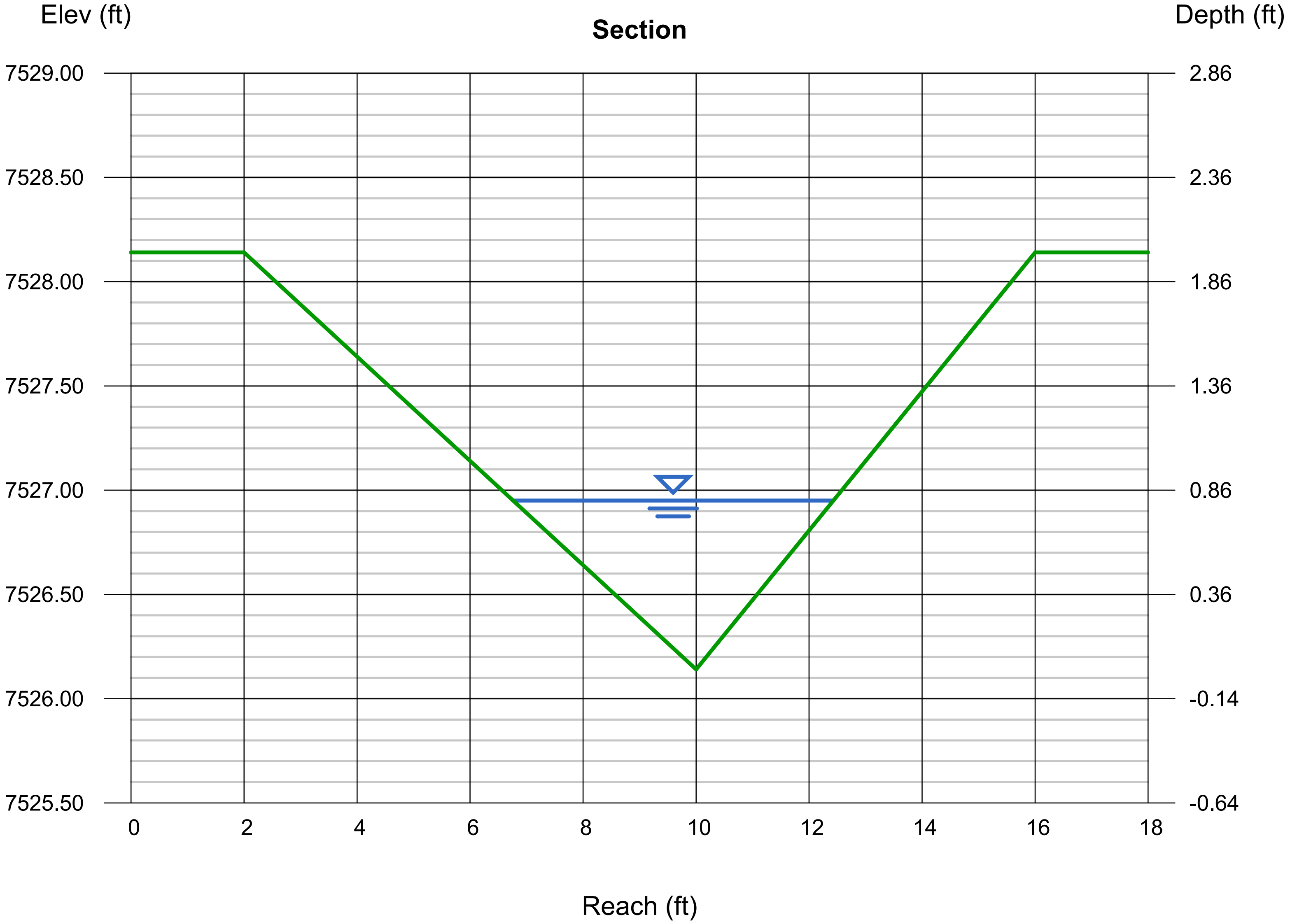
Highlighted
Depth (ft) = 0.45
Q (cfs) = 2.200
Area (sqft) = 0.71
Velocity (ft/s) = 3.10
Wetted Perim (ft) = 3.28
Crit Depth, Yc (ft) = 0.48
Top Width (ft) = 3.15
EGL (ft) = 0.60



Channel Report

61197-Sta 4+50 (21'L) Velocity Check

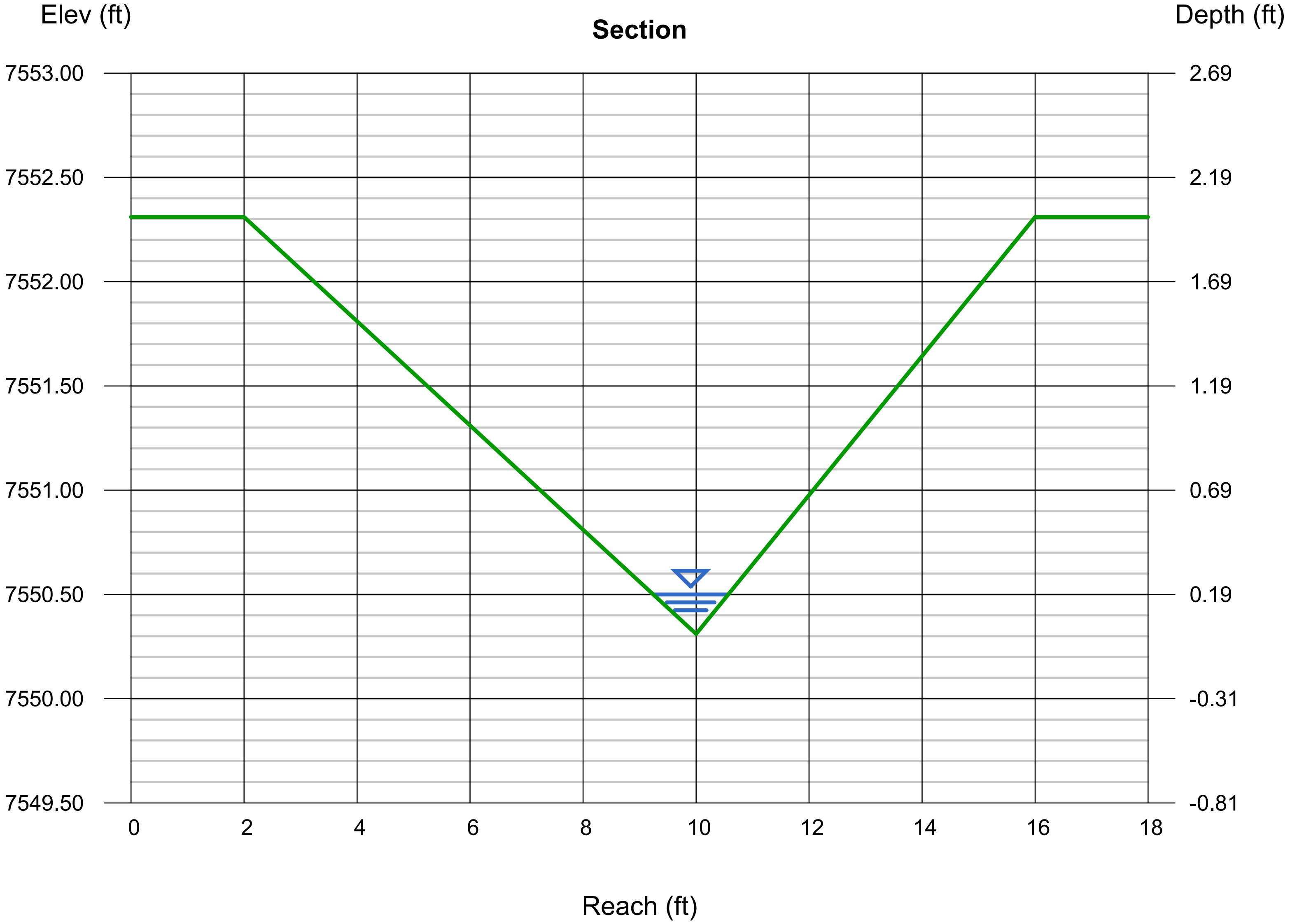
Triangular		**Highlighted**	
Side Slopes (z:1)	= 4.00, 3.00	Depth (ft)	= 0.81
Total Depth (ft)	= 2.00	Q (cfs)	= 10.70
		Area (sqft)	= 2.30
Invert Elev (ft)	= 7526.14	Velocity (ft/s)	= 4.66
Slope (%)	= 4.42	Wetted Perim (ft)	= 5.90
N-Value	= 0.035	Crit Depth, Yc (ft)	= 0.90
		Top Width (ft)	= 5.67
Calculations		EGL (ft)	= 1.15
Compute by:	Known Q		
Known Q (cfs)	= 10.70		



Channel Report

Sta 11+25 (21'L) Velocity Check-5YR

Triangular		**Highlighted**	
Side Slopes (z:1)	= 4.00, 3.00	Depth (ft)	= 0.19
Total Depth (ft)	= 2.00	Q (cfs)	= 0.100
		Area (sqft)	= 0.13
Invert Elev (ft)	= 7550.31	Velocity (ft/s)	= 0.79
Slope (%)	= 1.00	Wetted Perim (ft)	= 1.38
N-Value	= 0.035	Crit Depth, Yc (ft)	= 0.14
		Top Width (ft)	= 1.33
Calculations		EGL (ft)	= 0.20
Compute by:	Known Q		
Known Q (cfs)	= 0.10		



Channel Report

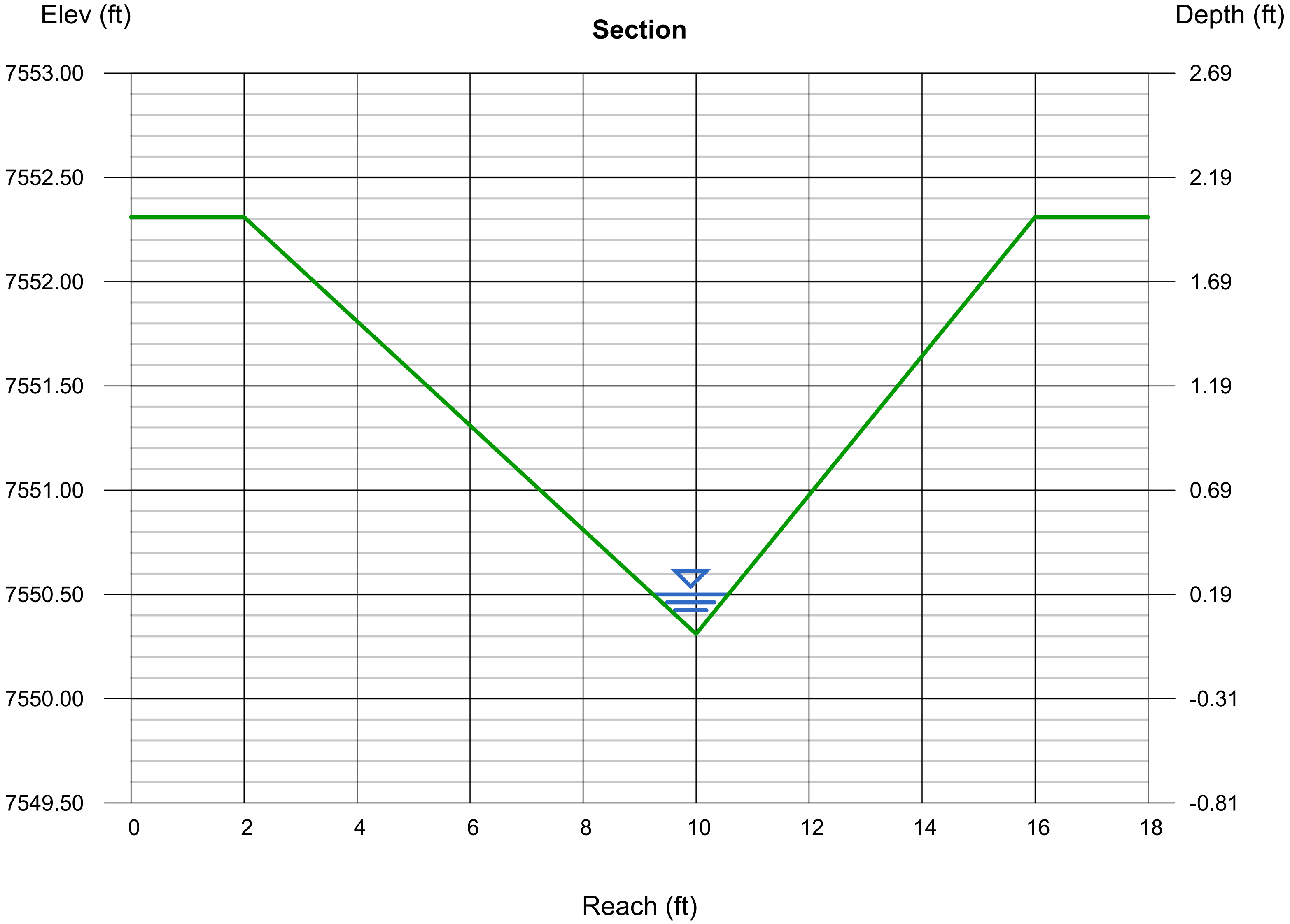
Sta 11+25 (21'L) Velocity Check

Triangular
Side Slopes (z:1) = 4.00, 3.00
Total Depth (ft) = 2.00

Invert Elev (ft) = 7550.31
Slope (%) = 1.00
N-Value = 0.035

Calculations
Compute by: Known Q
Known Q (cfs) = 0.10

Highlighted
Depth (ft) = 0.19
Q (cfs) = 0.100
Area (sqft) = 0.13
Velocity (ft/s) = 0.79
Wetted Perim (ft) = 1.38
Crit Depth, Yc (ft) = 0.14
Top Width (ft) = 1.33
EGL (ft) = 0.20



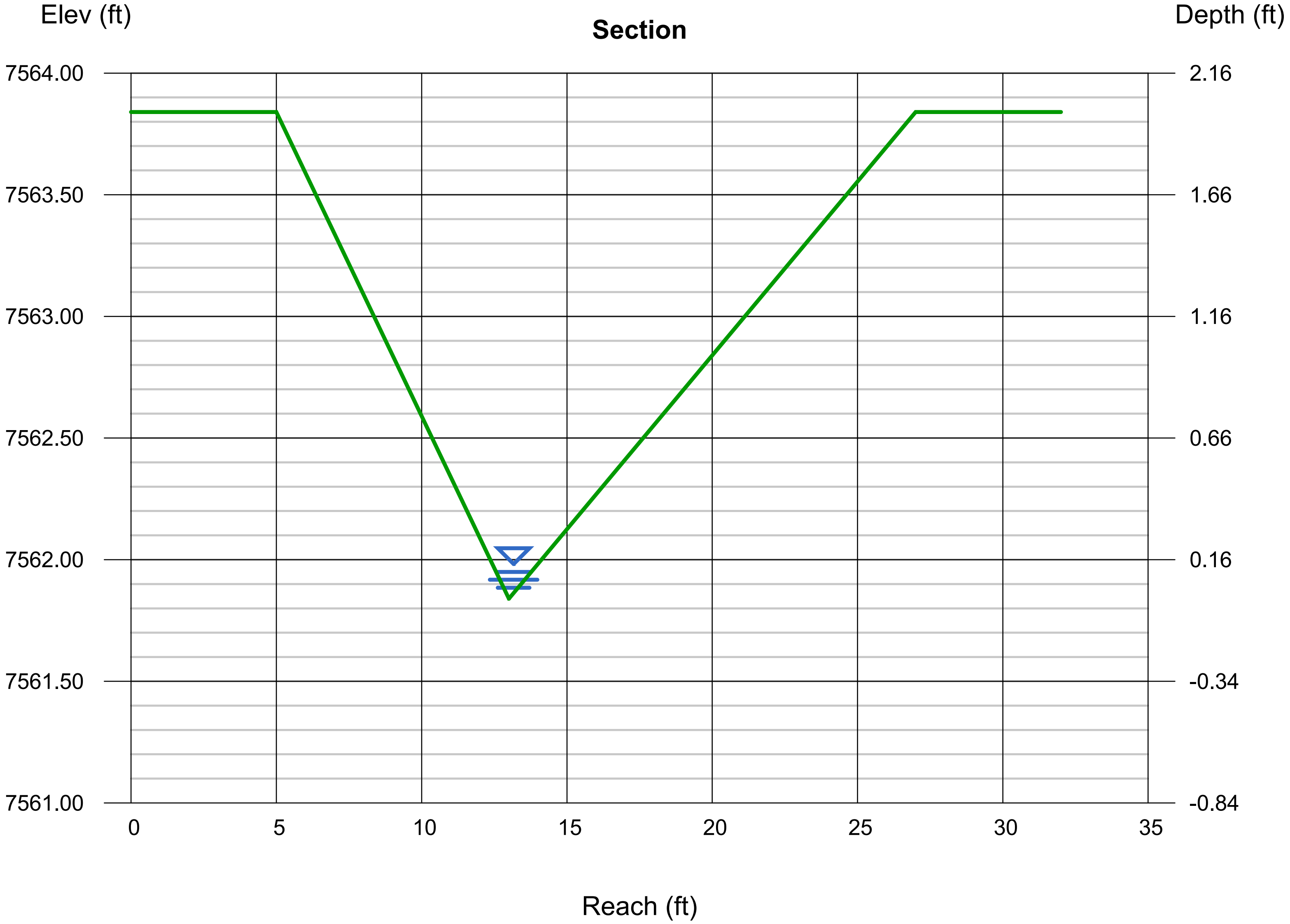
Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Friday, Oct 13 2023

61197-Sta 14+50 (21'L) Velocity Check-5YR

Triangular	
Side Slopes (z:1)	= 4.00, 7.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 7561.84
Slope (%)	= 6.70
N-Value	= 0.035
Calculations	
Compute by:	Known Q
Known Q (cfs)	= 0.10

Highlighted	
Depth (ft)	= 0.11
Q (cfs)	= 0.100
Area (sqft)	= 0.07
Velocity (ft/s)	= 1.50
Wetted Perim (ft)	= 1.23
Crit Depth, Yc (ft)	= 0.12
Top Width (ft)	= 1.21
EGL (ft)	= 0.15



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Friday, Oct 13 2023

61197-Sta 14+50 (21'L) Velocity Check

Triangular

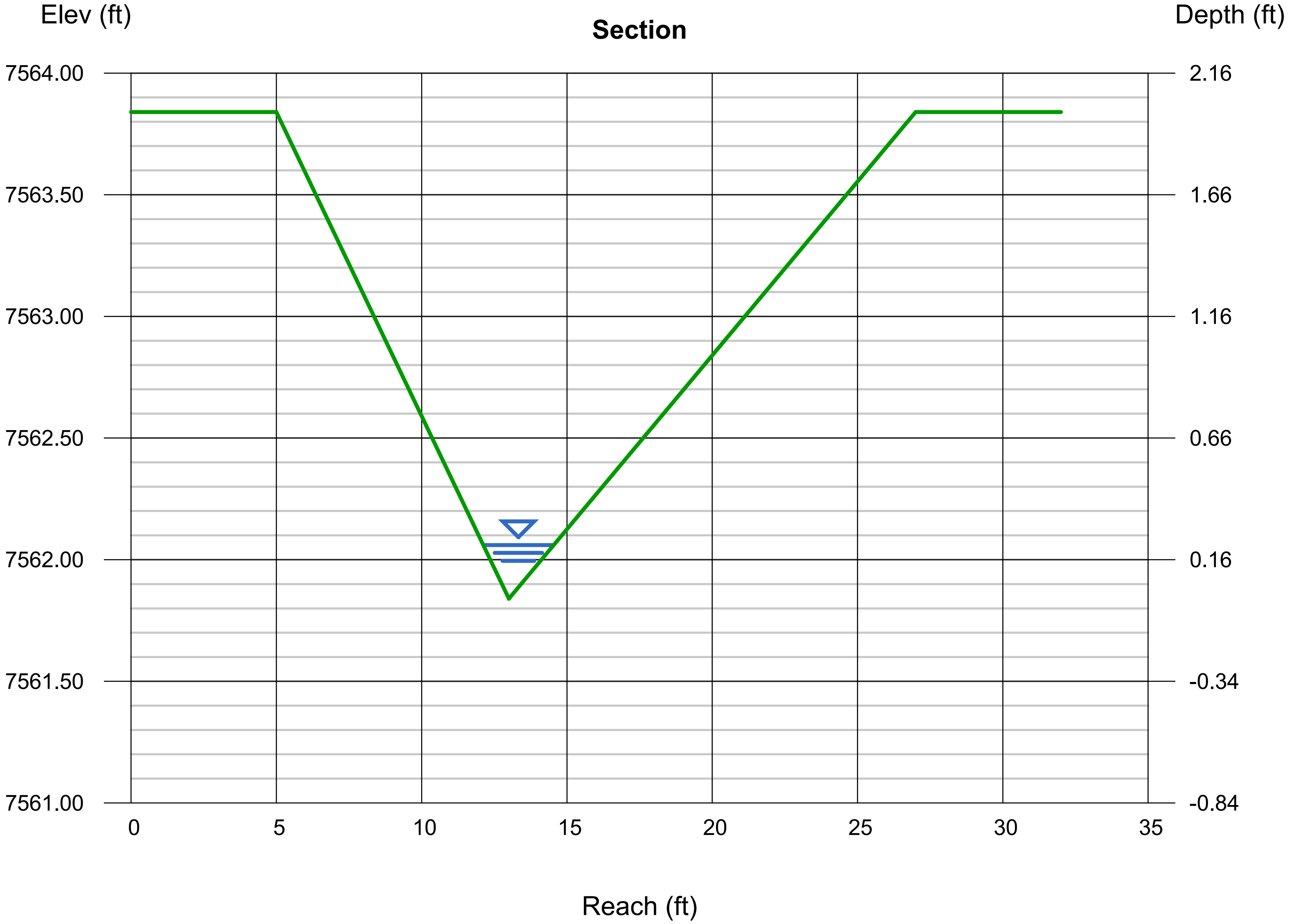
Side Slopes (z:1)	= 4.00, 7.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 7561.84
Slope (%)	= 6.70
N-Value	= 0.035

Calculations

Compute by:	Known Q
Known Q (cfs)	= 0.60

Highlighted

Depth (ft)	= 0.22
Q (cfs)	= 0.600
Area (sqft)	= 0.27
Velocity (ft/s)	= 2.25
Wetted Perim (ft)	= 2.46
Crit Depth, Yc (ft)	= 0.24
Top Width (ft)	= 2.42
EGL (ft)	= 0.30



M.V.E., Inc.
Date: 10/3/2023
Project: 61197
Forest Heights Estates Private Road

Ditch Velocities & Erosion Protection

Ditch Data:

S. Slope H	4.0
S. Slope H	3.0
Manning's n	0.035

Permissible Velocities by Soil Type:

26 - Elbeth Sandy Loam, 8-15% Slopes	4.5 fps
40 - Kettle Gravelly Loamy Sand, 3-8% Slopes	4.5 fps

Permissible Velocities by Grass Linings:

Grass-legume mixture (0-5%)	4.5 fps
Grass-legume mixture (5-10%)	4.5 fps

> > >

Sub-basin Designation	Road Name	Stations	Full Sub-Basin Area (Ac)	Full Sub-Basin Q_{100} (cfs)	Partial Sub-Basin Area (Ac)	Partial Sub-Basin Flow (cfs)	Max. Longit. Ditch Slope in Reach (ft/ft)	Ditch Flow Depth (ft)	Ditch Flow Area (ft^2)	Permissible Velocity (ft/sec)	**Ditch Flow Velocity (ft/sec)**	**Ditch Protection Required?**
Culvert 3	Forest Heights Dr.	2+25 (21'L) to 4+50 (21'L)	13.1	21.2	7.5	12.1	0.020	1.1	4.1	4.5	**3.0**	**NO**
Culvert 3	Forest Heights Dr.	4+50 (21'L) TO 11+25 (21'L)	13.1	21.2	5.1	8.3	0.044	0.8	2.3	4.5	**3.6**	**NO**
Culvert 3	Forest Heights Dr.	11+25 (21'L) TO 11+95 (21'L)	13.1	21.2	0.0	0.1	0.040	0.2	0.1	4.5	**0.5**	**NO**
Culvert 2	Forest Heights Dr.	14+50 (21'L) TO 17+50 (21'L)	20.4	22.8	0.4	0.4	0.067	0.2	0.3	4.5	**1.7**	**NO**

EXISTING CULVERT SUMMARY

CULVERT #	SIZE	MATERIAL	CONTRIBUTING SUBBASINS	5 YEAR		100 YEAR		CONDITION
				Q (cfs)	HEADWATER REQUIRED	Q (cfs)	HEADWATER REQUIRED	
1	18”	CMP	A	3.1	12.8”	16.3	> 7.5 FT	75% SILTED, ROADWAY OVERTOPPING WITH 100 YR
2	18”	CMP	B	4.2	15.3”	22.8	> 9 FT	75% SILTED, ROADWAY OVERTOPPING WITH 100 YR
3	18”	CMP	C, D, E	4.3	16.7”	21.2	> 9 FT	75% SILTED, ROADWAY OVERTOPPING WITH 100 YR

PROPOSED CULVERT SUMMARY

CULVERT #	SIZE	MATERIAL	CONTRIBUTING SUBBASINS	5 YEAR			100 YEAR		
				Q_5	Q_{PIPE}	$Q_{OVERFLOW}$	Q_{100}	Q_{PIPE}	$Q_{OVERFLOW}$
1	24”	RCP	A	3.1	3.1	N/A	16.3	16.3	0.0
2	24”	RCP	B	4.2	4.2	N/A	22.8	22.8	0.0
3	18”	RCP	C, D, E	4.3	4.3	N/A	21.2	13.1	8.1

Culvert Report

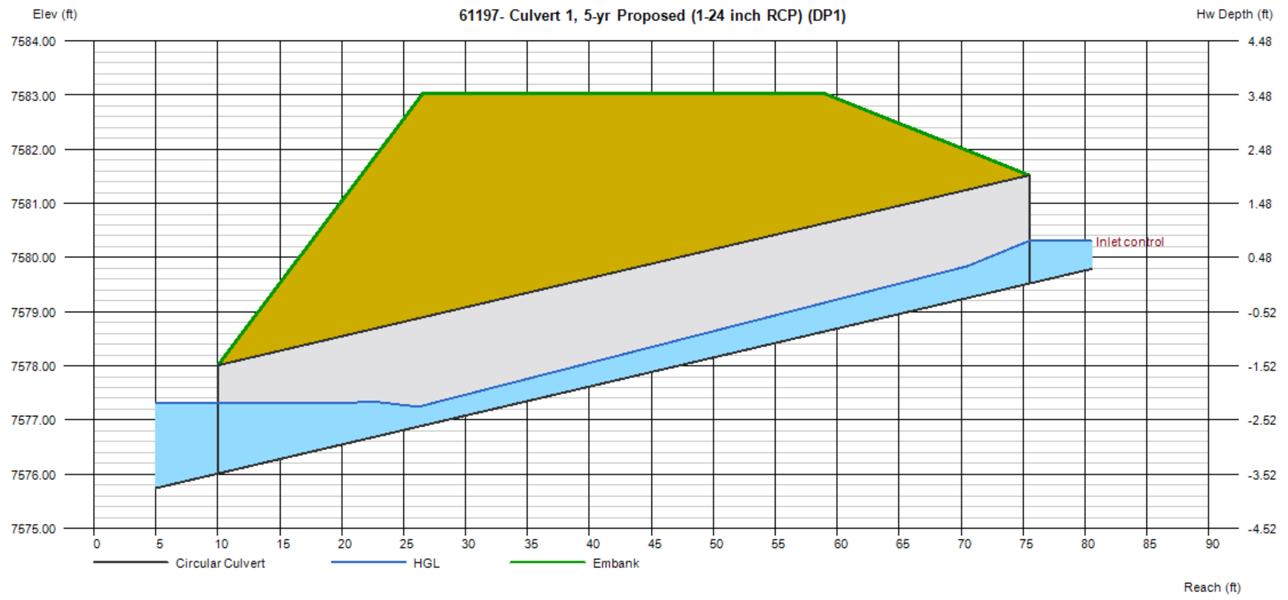
61197- Culvert 1, 5-yr Proposed (1-24 inch RCP) (DP1)

Invert Elev Dn (ft) = 7576.01
Pipe Length (ft) = 65.50
Slope (%) = 5.36
Invert Elev Up (ft) = 7579.52
Rise (in) = 24.0
Shape = Circular
Span (in) = 24.0
No. Barrels = 1
n-Value = 0.011
Culvert Type = Circular Concrete
Culvert Entrance = Groove end projecting (C)
Coeff. K,M,c,Y,k = 0.0045, 2, 0.0317, 0.69, 0.2

Embankment
Top Elevation (ft) = 7583.03
Top Width (ft) = 32.40
Crest Width (ft) = 100.00

Calculations
Qmin (cfs) = 3.10
Qmax (cfs) = 3.10
Tailwater Elev (ft) = (dc+D)/2

Highlighted
Qtotal (cfs) = 3.10
Qpipe (cfs) = 3.10
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 1.43
Veloc Up (ft/s) = 3.78
HGL Dn (ft) = 7577.32
HGL Up (ft) = 7580.13
Hw Elev (ft) = 7580.31
Hw/D (ft) = 0.39
Flow Regime = Inlet Control



Culvert Report

61197- Culvert 1, 100-yr Proposed (1-24 inch RCP) (DP1)

Invert Elev Dn (ft) = 7576.01
Pipe Length (ft) = 65.50
Slope (%) = 5.36
Invert Elev Up (ft) = 7579.52
Rise (in) = 24.0
Shape = Circular
Span (in) = 24.0
No. Barrels = 1
n-Value = 0.011
Culvert Type = Circular Concrete
Culvert Entrance = Groove end projecting (C)
Coeff. K,M,c,Y,k = 0.0045, 2, 0.0317, 0.69, 0.2

Embankment

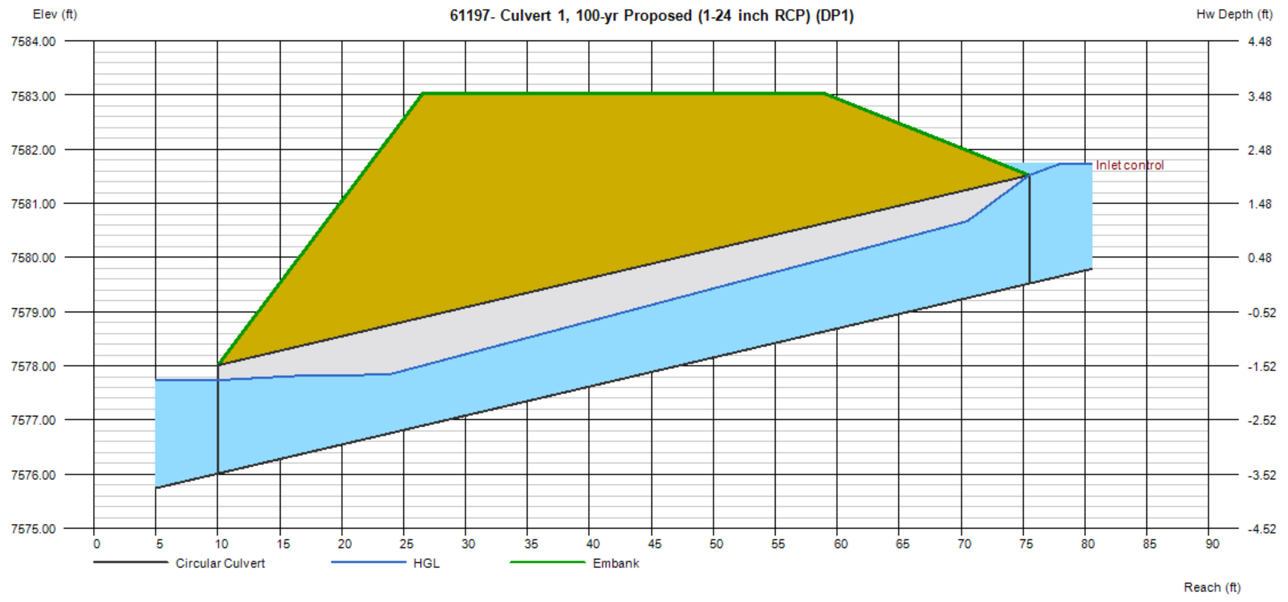
Top Elevation (ft) = 7583.03
Top Width (ft) = 32.40
Crest Width (ft) = 100.00

Calculations

Qmin (cfs) = 16.30
Qmax (cfs) = 16.30
Tailwater Elev (ft) = (dc+D)/2

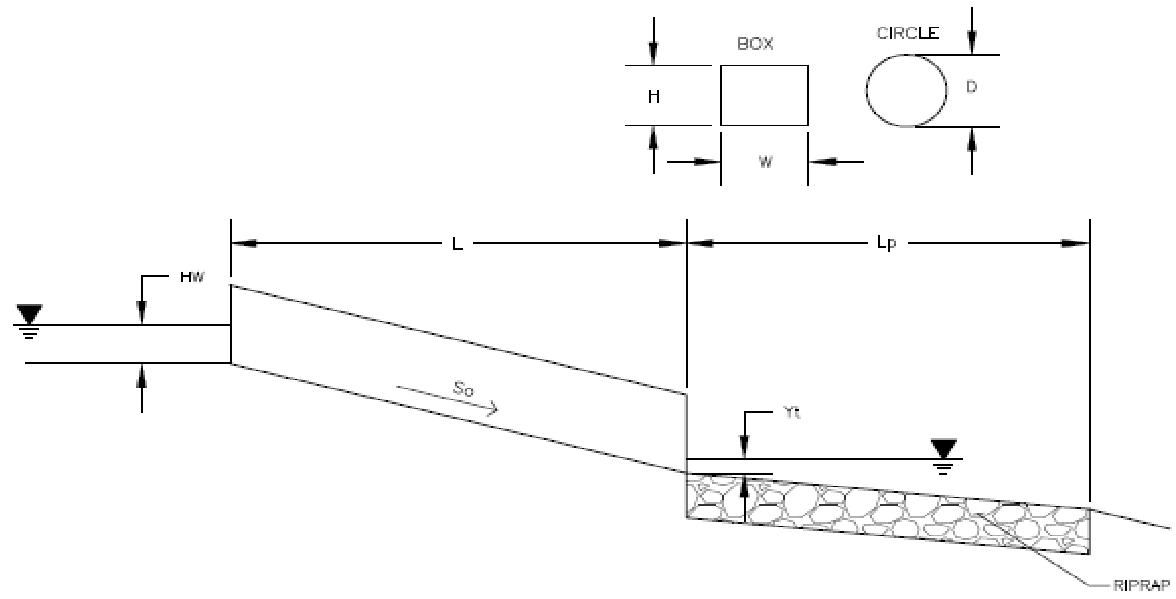
Highlighted

Qtotal (cfs) = 16.30
Qpipe (cfs) = 16.30
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 5.65
Veloc Up (ft/s) = 6.66
HGL Dn (ft) = 7577.74
HGL Up (ft) = 7580.98
Hw Elev (ft) = 7581.73
Hw/D (ft) = 1.11
Flow Regime = Inlet Control



Determination of Culvert Headwater and Outlet Protection

Project: 61197-Forest Heights Estates
Basin ID: Culvert 1 Riprap



Soil Type:
Choose One:
● Sandy
○ Non-Sandy

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

Design Discharge	Q =	16.3	cfs

Circular Culvert:

Barrel Diameter in Inches	D =	24	inches
Inlet Edge Type (Choose from pull-down list)		Grooved End Projection	

Box Culvert:

		OR	
Barrel Height (Rise) in Feet	Height (Rise) =		ft
Barrel Width (Span) in Feet	Width (Span) =		ft
Inlet Edge Type (Choose from pull-down list)		Square Edge w/ 90-15 Deg. Headwall	
Number of Barrels	No =	1	
Inlet Elevation	Elev IN =	7579.52	ft
Outlet Elevation **OR** Slope	Elev OUT =	7576.01	ft
Culvert Length	L =	59	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	Elev Y_t =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.80	ft
Flow Area at Max Channel Velocity	A_t =	3.26	ft^2
Culvert Cross Sectional Area Available	A =	3.14	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	0.73	
Sum of All Losses Coefficients	k_s =	1.93	ft
Culvert Normal Depth	Y_n =	0.74	ft
Culvert Critical Depth	Y_c =	1.46	ft
Tailwater Depth for Design	d =	1.73	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	1.37	ft
Expansion Factor	1/(2*tan(Θ)) =	6.58	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	2.88	$ft^{0.5}/s$
Froude Number	Fr =	3.64	Supercritical!
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.58	
Inlet Control Headwater	HW_I =	2.18	ft
Outlet Control Headwater	HW_O =	-0.98	
Design Headwater Elevation	**HW =**	**7,581.70**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.09**	
Minimum Theoretical Riprap Size	d_{50} =	5	in
Nominal Riprap Size	d_{50} =	6	in
UDFCD Riprap Type	**Type =**	**VL**	
Length of Protection	**L_p =**	**14**	**ft**
Width of Protection	**T =**	**5**	**ft**

Site constraints limit the size of the pad to 8' in length maximum. Therefor in lieu of the riprap pad specified in the construction drawings, a concrete stilling basin with baffles and level spreader 7.17' long and flaring to 11.7' wide is specified and detailed in the construction drawings. This stilling basin with baffles will function to reduce the velocities and properly spread the ouflows to prevent concentrated discharge.

Culvert Report

61197- Culvert 2, 5-yr Proposed (1-24 inch RCP) (DP2)

Invert Elev Dn (ft) = 7545.93
Pipe Length (ft) = 75.17
Slope (%) = 3.22
Invert Elev Up (ft) = 7548.35
Rise (in) = 24.0
Shape = Circular
Span (in) = 24.0
No. Barrels = 1
n-Value = 0.011
Culvert Type = Circular Concrete
Culvert Entrance = Groove end projecting (C)
Coeff. K,M,c,Y,k = 0.0045, 2, 0.0317, 0.69, 0.2

Embankment

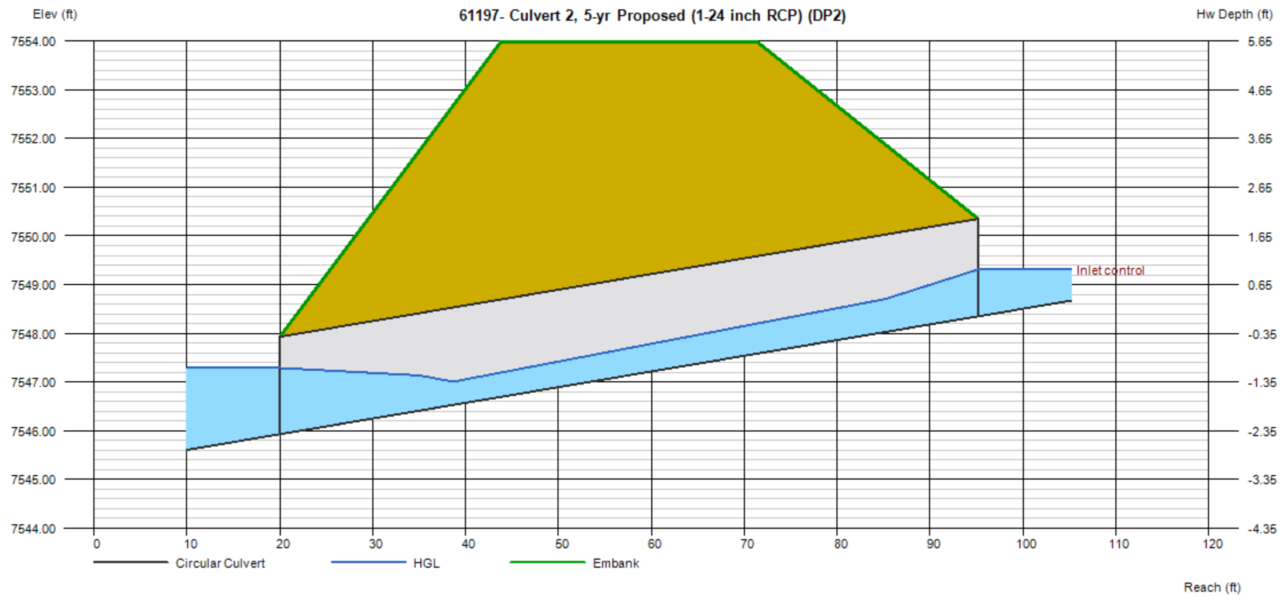
Top Elevation (ft) = 7553.99
Top Width (ft) = 27.50
Crest Width (ft) = 100.00

Calculations

Qmin (cfs) = 4.20
Qmax (cfs) = 4.20
Tailwater Elev (ft) = (dc+D)/2

Highlighted

Qtotal (cfs) = 4.20
Qpipe (cfs) = 4.20
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 1.85
Veloc Up (ft/s) = 4.13
HGL Dn (ft) = 7547.29
HGL Up (ft) = 7549.07
Hw Elev (ft) = 7549.31
Hw/D (ft) = 0.48
Flow Regime = Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc.　　Monday, Nov 20 2023

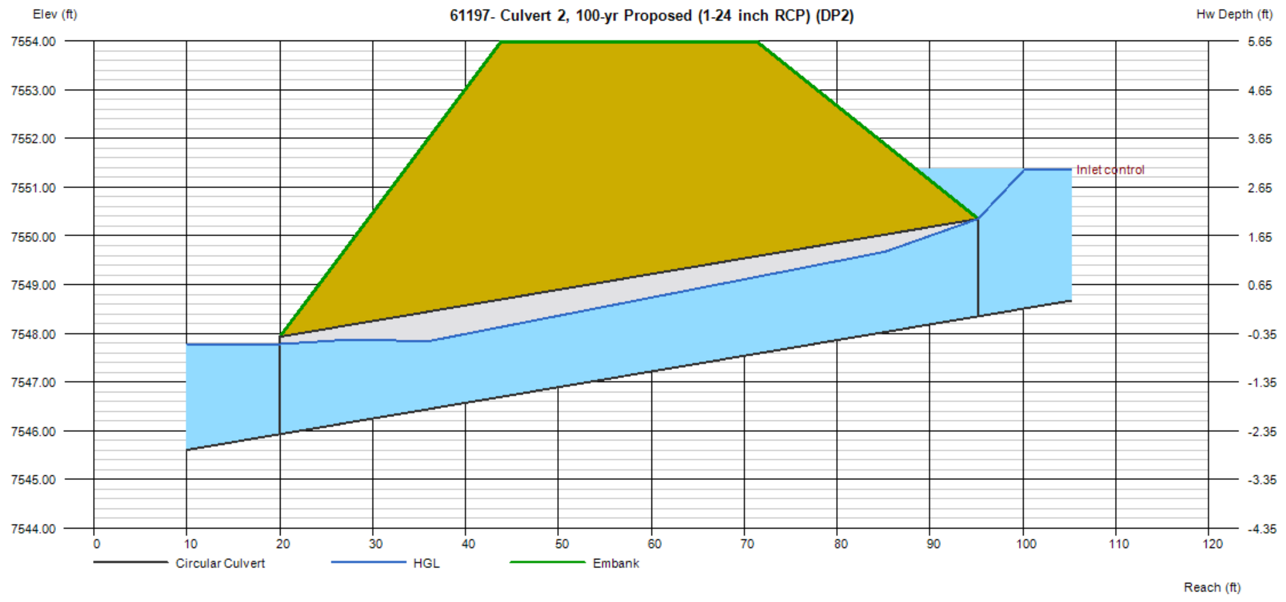
61197- Culvert 2, 100-yr Proposed (1-24 inch RCP) (DP2)

Invert Elev Dn (ft) = 7545.93
Pipe Length (ft) = 75.17
Slope (%) = 3.22
Invert Elev Up (ft) = 7548.35
Rise (in) = 24.0
Shape = Circular
Span (in) = 24.0
No. Barrels = 1
n-Value = 0.011
Culvert Type = Circular Concrete
Culvert Entrance = Groove end projecting (C)
Coeff. K,M,c,Y,k = 0.0045, 2, 0.0317, 0.69, 0.2

Embankment
Top Elevation (ft) = 7553.99
Top Width (ft) = 27.50
Crest Width (ft) = 100.00

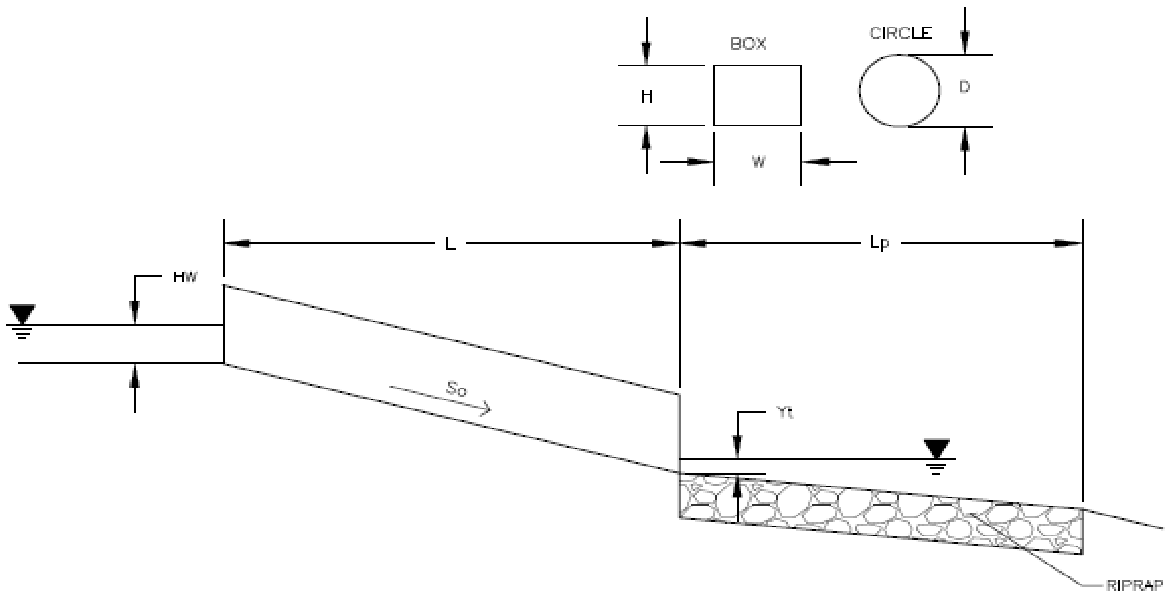
Calculations
Qmin (cfs) = 22.80
Qmax (cfs) = 22.80
Tailwater Elev (ft) = (dc+D)/2

Highlighted
Qtotal (cfs) = 22.80
Qpipe (cfs) = 22.80
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 7.51
Veloc Up (ft/s) = 8.01
HGL Dn (ft) = 7547.78
HGL Up (ft) = 7550.05
Hw Elev (ft) = 7551.37
Hw/D (ft) = 1.51
Flow Regime = Inlet Control



Determination of Culvert Headwater and Outlet Protection

Project: 61197-Forest Heights Estates
Basin ID: Culvert 2 Riprap



Soil Type:
Choose One:
● Sandy
○ Non-Sandy

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

Design Discharge	Q =	22.8	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	24	inches
Inlet Edge Type (Choose from pull-down list)	Grooved End Projection		
Box Culvert:		OR	
Barrel Height (Rise) in Feet	Height (Rise) =		ft
Barrel Width (Span) in Feet	Width (Span) =		ft
Inlet Edge Type (Choose from pull-down list)	Square Edge w/ 90-15 Deg. Headwall		
Number of Barrels	No =	1	
Inlet Elevation	Elev IN =	7548.35	ft
Outlet Elevation **OR** Slope	Elev OUT =	7545.93	ft
Culvert Length	L =	75.2	ft
Manning's Roughness	n =	0.011	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	Elev Y_t =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.80	ft
Flow Area at Max Channel Velocity	A_t =	4.56	ft^2
Culvert Cross Sectional Area Available	A =	3.14	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	0.66	
Sum of All Losses Coefficients	k_s =	1.86	ft
Culvert Normal Depth	Y_n =	0.97	ft
Culvert Critical Depth	Y_c =	1.70	ft
Tailwater Depth for Design	d =	1.85	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	1.48	ft
Expansion Factor	1/(2*tan(Θ)) =	5.31	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	4.03	$ft^{0.5}/s$
Froude Number	Fr =	3.06	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.54	
Inlet Control Headwater	HW_I =	3.01	ft
Outlet Control Headwater	HW_O =	0.96	
Design Headwater Elevation	**HW =**	**7,551.36**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.50**	**HW/D > 1.5!**
Minimum Theoretical Riprap Size	d_{50} =	7	in
Nominal Riprap Size	d_{50} =	9	in
UDFCD Riprap Type	**Type =**	**L**	
Length of Protection	**L_p =**	**20**	**ft**
Width of Protection	**T =**	**6**	**ft**

Site constraints limit the size of the pad to 8' in length. Therefor the riprap pad specified in the construction drawings is 8' wide, flaring to 16' wide with 13' length. Riprap sizing shall be type VL grouted riprap with a 24” dia boulder at the culvert outlet to function as a baffle to reduce the velocities to account for the reduced length.

Culvert Report

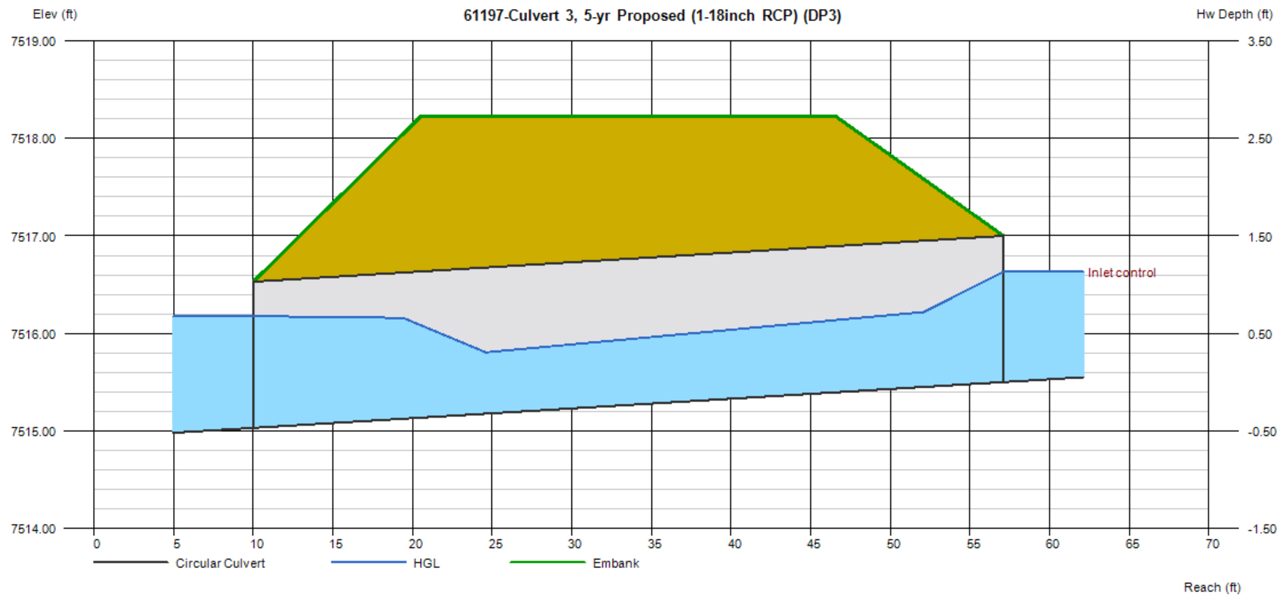
61197-Culvert 3, 5-yr Proposed (1-18inch RCP) (DP3)

Invert Elev Dn (ft) = 7515.03
Pipe Length (ft) = 47.10
Slope (%) = 1.00
Invert Elev Up (ft) = 7515.50
Rise (in) = 18.0
Shape = Circular
Span (in) = 18.0
No. Barrels = 1
n-Value = 0.011
Culvert Type = Circular Concrete
Culvert Entrance = Groove end projecting (C)
Coeff. K,M,c,Y,k = 0.0045, 2, 0.0317, 0.69, 0.2

Embankment
Top Elevation (ft) = 7518.23
Top Width (ft) = 26.00
Crest Width (ft) = 275.00

Calculations
Qmin (cfs) = 4.30
Qmax (cfs) = 4.30
Tailwater Elev (ft) = (dc+D)/2

Highlighted
Qtotal (cfs) = 4.30
Qpipe (cfs) = 4.30
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 2.97
Veloc Up (ft/s) = 4.53
HGL Dn (ft) = 7516.18
HGL Up (ft) = 7516.29
Hw Elev (ft) = 7516.63
Hw/D (ft) = 0.75
Flow Regime = Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Nov 20 2023

61197-Culvert 3, 100-yr Proposed (1-18inch RCP) (DP3)

Invert Elev Dn (ft) = 7515.03
Pipe Length (ft) = 47.10
Slope (%) = 1.00
Invert Elev Up (ft) = 7515.50
Rise (in) = 18.0
Shape = Circular
Span (in) = 18.0
No. Barrels = 1
n-Value = 0.011
Culvert Type = Circular Concrete
Culvert Entrance = Groove end projecting (C)
Coeff. K,M,c,Y,k = 0.0045, 2, 0.0317, 0.69, 0.2

Embankment

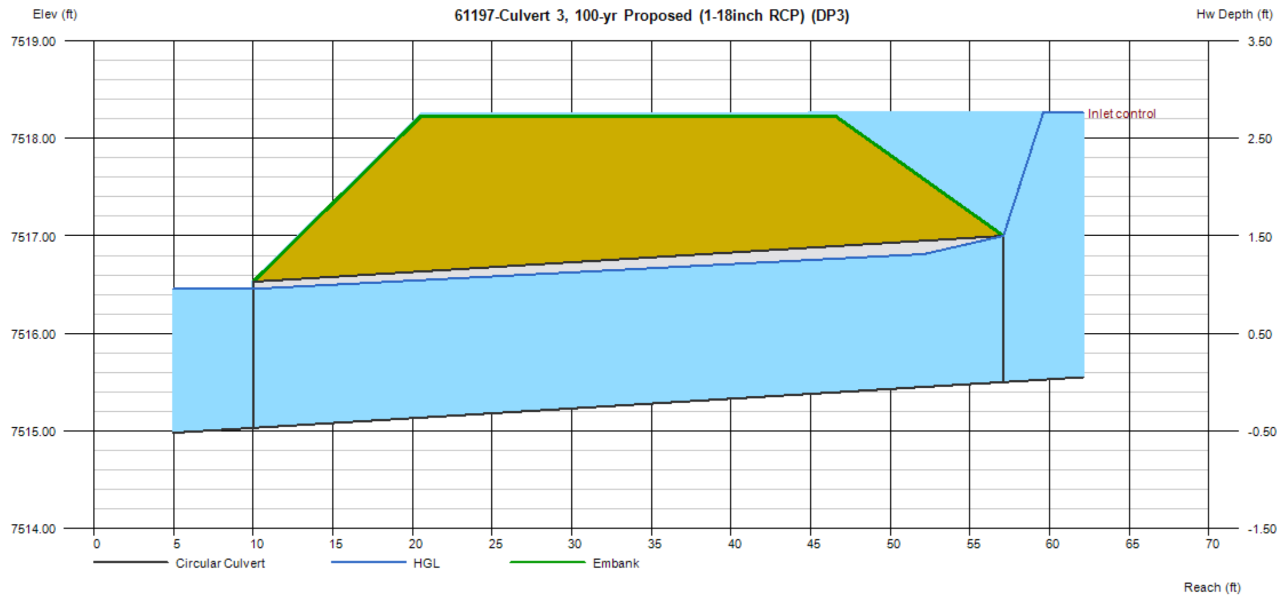
Top Elevation (ft) = 7518.23
Top Width (ft) = 26.00
Crest Width (ft) = 275.00

Calculations

Qmin (cfs) = 21.20
Qmax (cfs) = 21.20
Tailwater Elev (ft) = (dc+D)/2

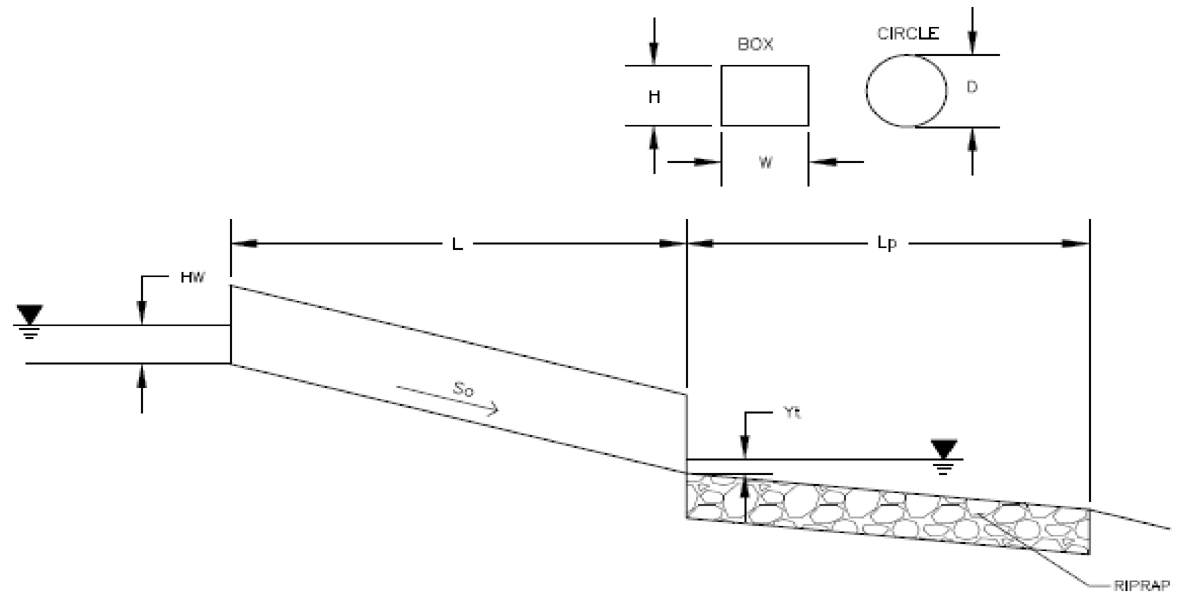
Highlighted

Qtotal (cfs) = 21.20
Qpipe (cfs) = 13.09
Qovertop (cfs) = 8.11
Veloc Dn (ft/s) = 7.54
Veloc Up (ft/s) = 7.79
HGL Dn (ft) = 7516.46
HGL Up (ft) = 7516.86
Hw Elev (ft) = 7518.27
Hw/D (ft) = 1.84
Flow Regime = Inlet Control



Determination of Culvert Headwater and Outlet Protection

Project: 61197-Forest Heights Estates
Basin ID: Culvert 3 Riprap



Soil Type:
Choose One:
● Sandy
○ Non-Sandy

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

Design Discharge	Q =	13.1	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	18	inches
Inlet Edge Type (Choose from pull-down list)		Grooved End Projection ▼	
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	Height (Rise) =		ft
Barrel Width (Span) in Feet	Width (Span) =		ft
Inlet Edge Type (Choose from pull-down list)		Square Edge w/ 90-15 Deg. Headwall ▼	
Number of Barrels	No =	1	
Inlet Elevation	Elev IN =	7515.5	ft
Outlet Elevation **OR** Slope	Elev OUT =	7514.94	ft
Culvert Length	L =	46.7	ft
Manning's Roughness	n =	0.011	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	Elev Y_t =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.60	ft
Flow Area at Max Channel Velocity	A_t =	2.62	ft^2
Culvert Cross Sectional Area Available	A =	1.77	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	0.61	
Sum of All Losses Coefficients	k_s =	1.81	ft
Culvert Normal Depth	Y_n =	1.18	ft
Culvert Critical Depth	Y_c =	1.35	ft
Tailwater Depth for Design	d =	1.43	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	1.34	ft
Expansion Factor	1/(2*tan(Θ)) =	3.20	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	4.75	$ft^{0.5}/s$
Froude Number	Fr =	1.41	Supercritical!
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.45	
Inlet Control Headwater	HW_I =	2.76	ft
Outlet Control Headwater	HW_O =	2.41	
Design Headwater Elevation	**HW =**	**7,518.26**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.84**	**HW/D > 1.5!**
Minimum Theoretical Riprap Size	d_{50} =	6	in
Nominal Riprap Size	d_{50} =	9	in
UDFCD Riprap Type	**Type =**	**L**	
Length of Protection	**L_p =**	**10**	**ft**
Width of Protection	**T =**	**5**	**ft**

Site constraints limit the size of the pad to 8' in length. Therefor the riprap pad specified in the construction drawings is 5' wide, flaring to 10' wide with 8' length. Riprap sizing shall be type VL grouted riprap with a 24" dia boulder at the culvet outlet to function as a baffle to reduce the velocities to account for the reduced length.

Culvert Report

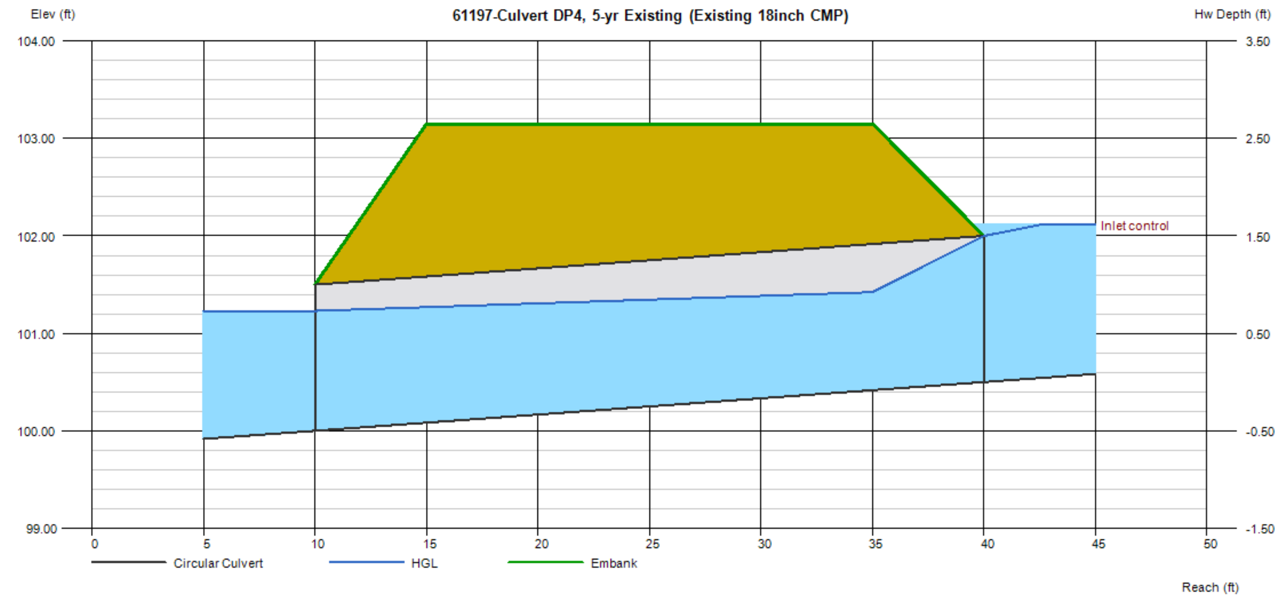
61197-Culvert DP4, 5-yr Existing (Existing 18inch CMP)

Invert Elev Dn (ft) = 100.00
Pipe Length (ft) = 30.00
Slope (%) = 1.67
Invert Elev Up (ft) = 100.50
Rise (in) = 18.0
Shape = Circular
Span (in) = 18.0
No. Barrels = 1
n-Value = 0.023
Culvert Type = Circular Corrugate Metal Pipe
Culvert Entrance = Projecting
Coeff. K,M,c,Y,k = 0.034, 1.5, 0.0553, 0.54, 0.9

Embankment
Top Elevation (ft) = 103.15
Top Width (ft) = 20.00
Crest Width (ft) = 50.00

Calculations
Qmin (cfs) = 6.20
Qmax (cfs) = 6.20
Tailwater Elev (ft) = (dc+D)/2

Highlighted
Qtotal (cfs) = 6.20
Qpipe (cfs) = 6.20
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 4.00
Veloc Up (ft/s) = 5.18
HGL Dn (ft) = 101.23
HGL Up (ft) = 101.46
Hw Elev (ft) = 102.11
Hw/D (ft) = 1.08
Flow Regime = Inlet Control



Culvert Report

61197-Culvert DP4, 5-yr Proposed (Existing 18inch CMP)

Invert Elev Dn (ft) = 100.00
Pipe Length (ft) = 30.00
Slope (%) = 1.67
Invert Elev Up (ft) = 100.50
Rise (in) = 18.0
Shape = Circular
Span (in) = 18.0
No. Barrels = 1
n-Value = 0.023
Culvert Type = Circular Corrugate Metal Pipe
Culvert Entrance = Projecting
Coeff. K,M,c,Y,k = 0.034, 1.5, 0.0553, 0.54, 0.9

Embankment

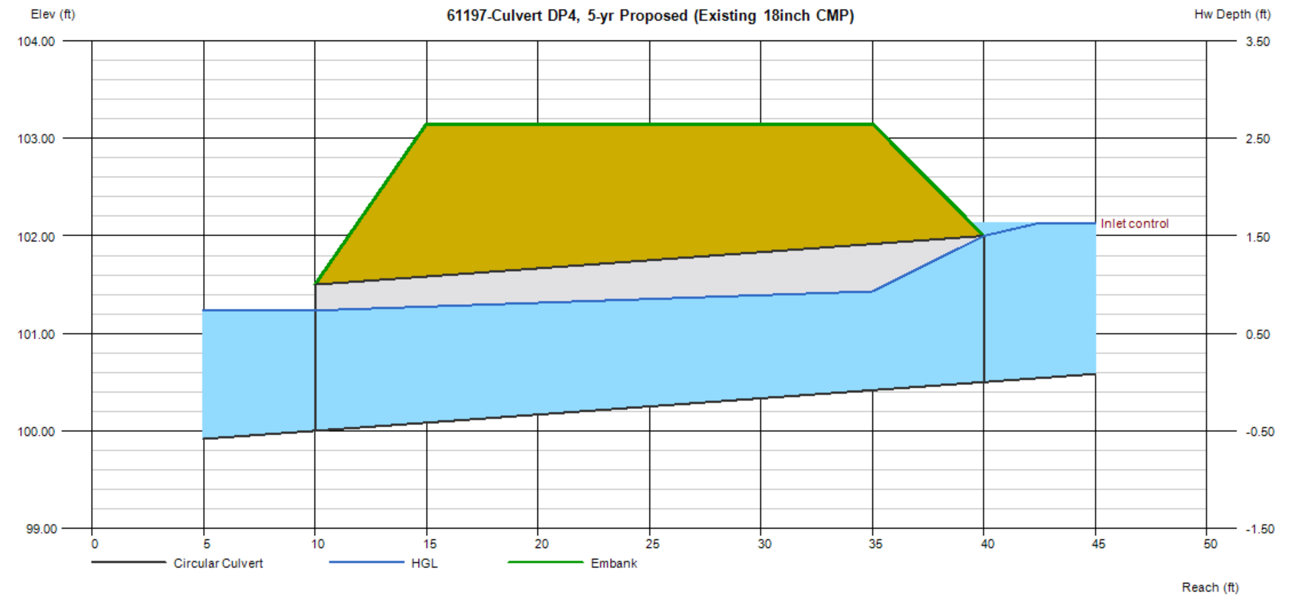
Top Elevation (ft) = 103.15
Top Width (ft) = 20.00
Crest Width (ft) = 50.00

Calculations

Qmin (cfs) = 6.30
Qmax (cfs) = 6.30
Tailwater Elev (ft) = (dc+D)/2

Highlighted

Qtotal (cfs) = 6.30
Qpipe (cfs) = 6.30
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 4.05
Veloc Up (ft/s) = 5.21
HGL Dn (ft) = 101.23
HGL Up (ft) = 101.47
Hw Elev (ft) = 102.13
Hw/D (ft) = 1.09
Flow Regime = Inlet Control



Culvert Report

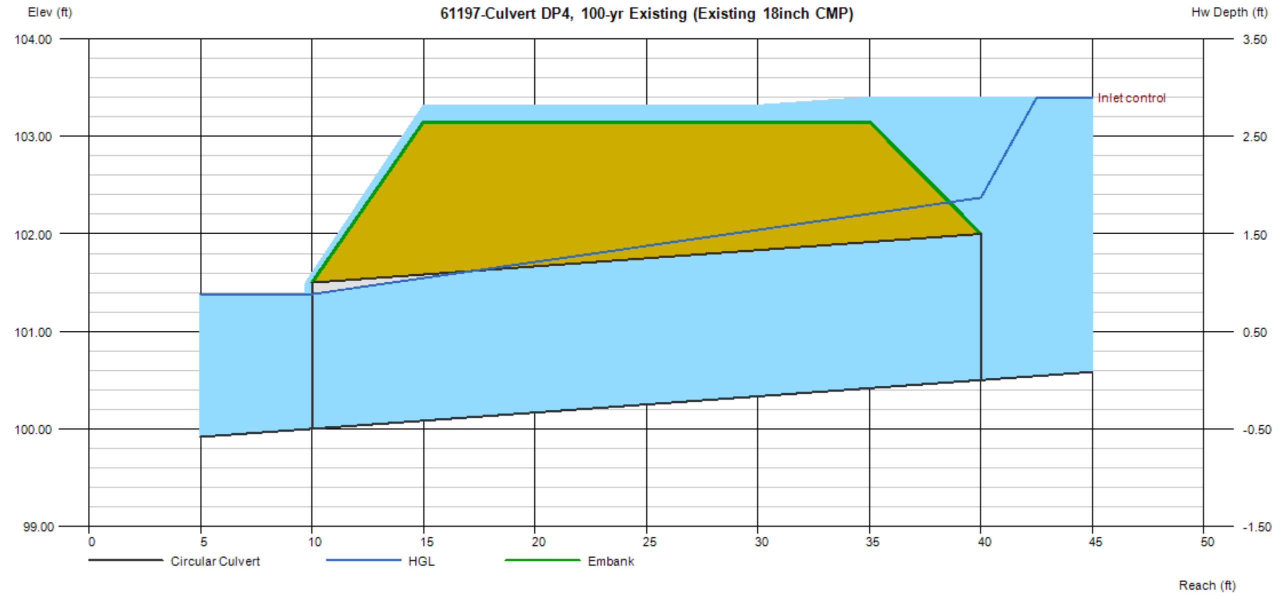
61197-Culvert DP4, 100-yr Existing (Existing 18inch CMP)

Invert Elev Dn (ft) = 100.00
Pipe Length (ft) = 30.00
Slope (%) = 1.67
Invert Elev Up (ft) = 100.50
Rise (in) = 18.0
Shape = Circular
Span (in) = 18.0
No. Barrels = 1
n-Value = 0.023
Culvert Type = Circular Corrugate Metal Pipe
Culvert Entrance = Projecting
Coeff. K,M,c,Y,k = 0.034, 1.5, 0.0553, 0.54, 0.9

Embankment
Top Elevation (ft) = 103.15
Top Width (ft) = 20.00
Crest Width (ft) = 50.00

Calculations
Qmin (cfs) = 29.40
Qmax (cfs) = 29.40
Tailwater Elev (ft) = (dc+D)/2

Highlighted
Qtotal (cfs) = 29.40
Qpipe (cfs) = 10.89
Qovertop (cfs) = 18.51
Veloc Dn (ft/s) = 6.40
Veloc Up (ft/s) = 6.16
HGL Dn (ft) = 101.38
HGL Up (ft) = 102.37
Hw Elev (ft) = 103.40
Hw/D (ft) = 1.93
Flow Regime = Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Jan 8 2024

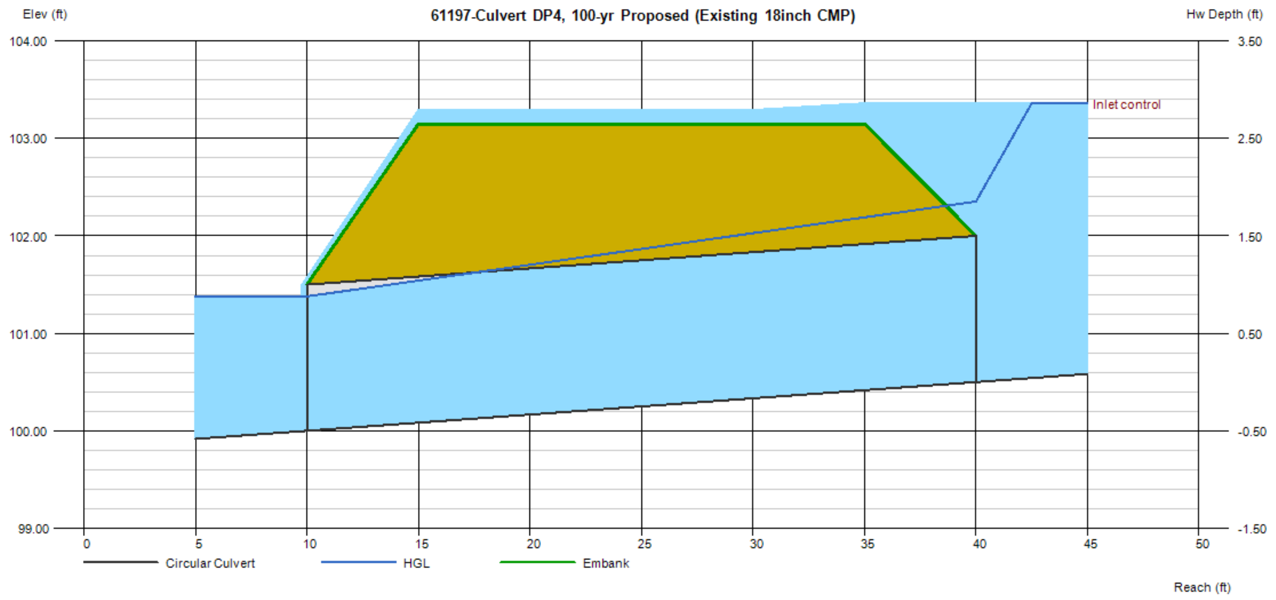
61197-Culvert DP4, 100-yr Proposed (Existing 18inch CMP)

Invert Elev Dn (ft) = 100.00
Pipe Length (ft) = 30.00
Slope (%) = 1.67
Invert Elev Up (ft) = 100.50
Rise (in) = 18.0
Shape = Circular
Span (in) = 18.0
No. Barrels = 1
n-Value = 0.023
Culvert Type = Circular Corrugate Metal Pipe
Culvert Entrance = Projecting
Coeff. K,M,c,Y,k = 0.034, 1.5, 0.0553, 0.54, 0.9

Embankment
Top Elevation (ft) = 103.15
Top Width (ft) = 20.00
Crest Width (ft) = 50.00

Calculations
Qmin (cfs) = 29.30
Qmax (cfs) = 29.30
Tailwater Elev (ft) = (dc+D)/2

Highlighted
Qtotal (cfs) = 29.30
Qpipe (cfs) = 10.79
Qovertop (cfs) = 18.51
Veloc Dn (ft/s) = 6.35
Veloc Up (ft/s) = 6.11
HGL Dn (ft) = 101.38
HGL Up (ft) = 102.35
Hw Elev (ft) = 103.36
Hw/D (ft) = 1.91
Flow Regime = Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Jan 8 2024

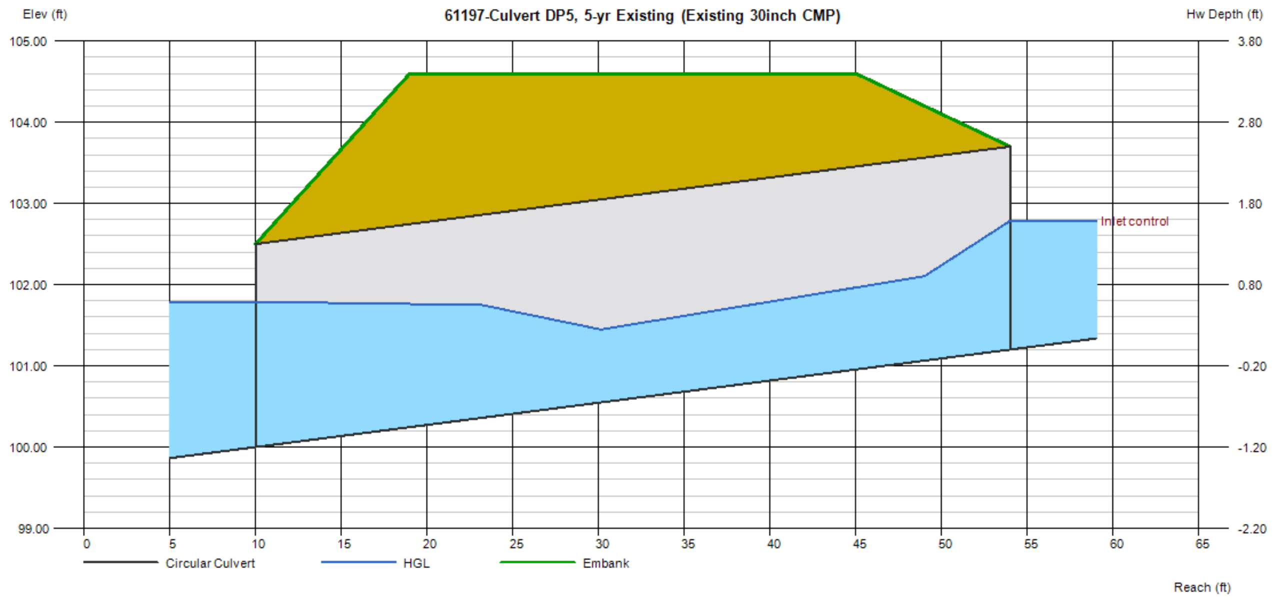
61197-Culvert DP5, 5-yr Existing (Existing 30inch CMP)

Invert Elev Dn (ft) = 100.00
Pipe Length (ft) = 44.00
Slope (%) = 2.73
Invert Elev Up (ft) = 101.20
Rise (in) = 30.0
Shape = Circular
Span (in) = 30.0
No. Barrels = 1
n-Value = 0.023
Culvert Type = Circular Corrugate Metal Pipe
Culvert Entrance = Projecting
Coeff. K,M,c,Y,k = 0.034, 1.5, 0.0553, 0.54, 0.9

Embankment
Top Elevation (ft) = 104.60
Top Width (ft) = 26.00
Crest Width (ft) = 300.00

Calculations
Qmin (cfs) = 10.40
Qmax (cfs) = 10.40
Tailwater Elev (ft) = (dc+D)/2

Highlighted
Qtotal (cfs) = 10.40
Qpipe (cfs) = 10.40
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 2.77
Veloc Up (ft/s) = 5.14
HGL Dn (ft) = 101.79
HGL Up (ft) = 102.28
Hw Elev (ft) = 102.79
Hw/D (ft) = 0.63
Flow Regime = Inlet Control



Culvert Report

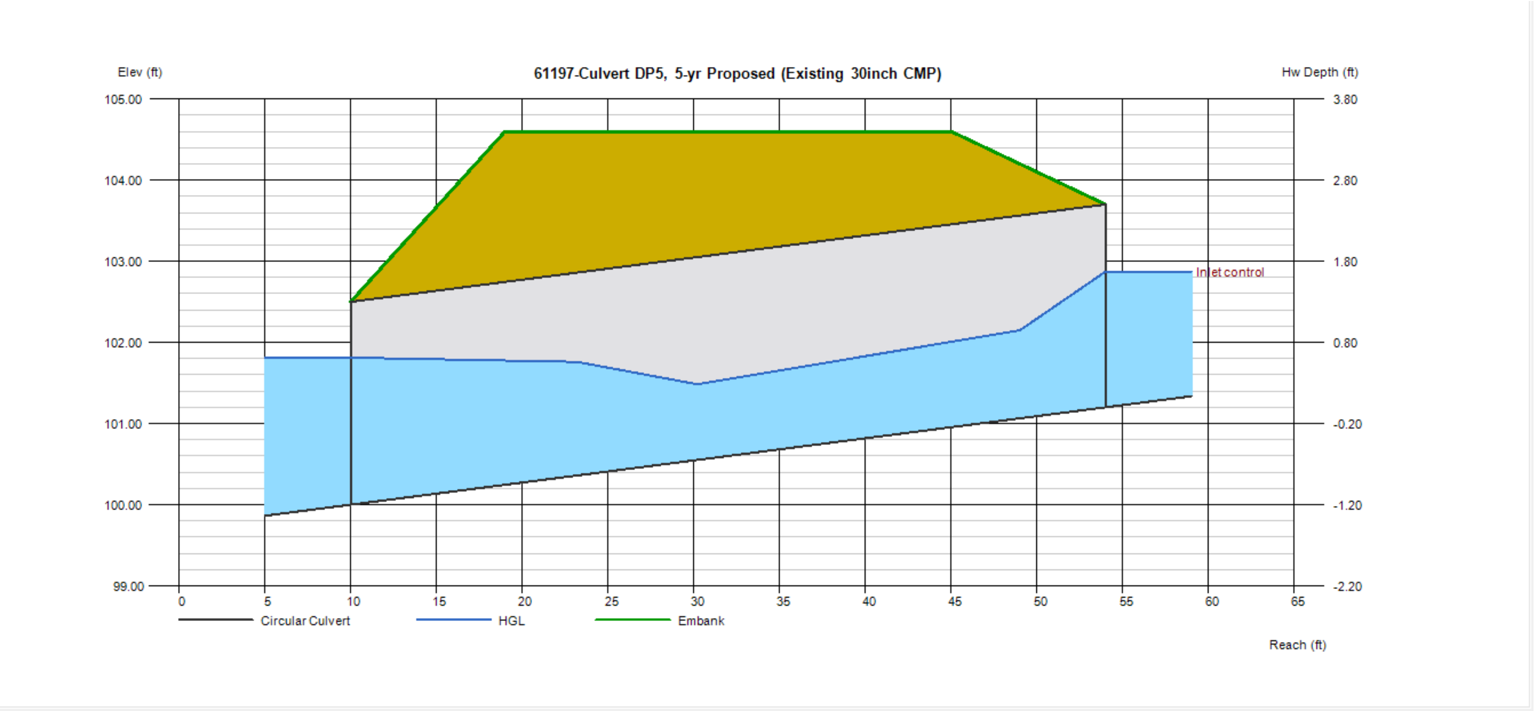
61197-Culvert DP5, 5-yr Proposed (Existing 30inch CMP)

Invert Elev Dn (ft) = 100.00
Pipe Length (ft) = 44.00
Slope (%) = 2.73
Invert Elev Up (ft) = 101.20
Rise (in) = 30.0
Shape = Circular
Span (in) = 30.0
No. Barrels = 1
n-Value = 0.023
Culvert Type = Circular Corrugate Metal Pipe
Culvert Entrance = Projecting
Coeff. K,M,c,Y,k = 0.034, 1.5, 0.0553, 0.54, 0.9

Embankment
Top Elevation (ft) = 104.60
Top Width (ft) = 26.00
Crest Width (ft) = 300.00

Calculations
Qmin (cfs) = 11.30
Qmax (cfs) = 11.30
Tailwater Elev (ft) = (dc+D)/2

Highlighted
Qtotal (cfs) = 11.30
Qpipe (cfs) = 11.30
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 2.96
Veloc Up (ft/s) = 5.28
HGL Dn (ft) = 101.81
HGL Up (ft) = 102.32
Hw Elev (ft) = 102.87
Hw/D (ft) = 0.67
Flow Regime = Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Jan 8 2024

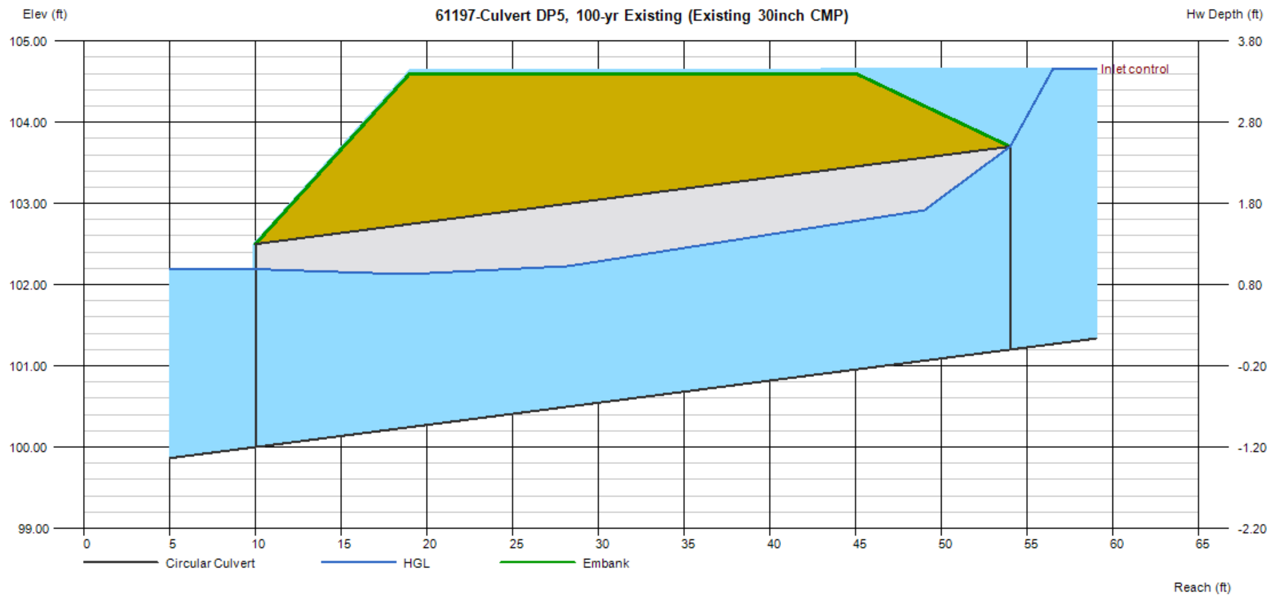
61197-Culvert DP5, 100-yr Existing (Existing 30inch CMP)

Invert Elev Dn (ft) = 100.00
Pipe Length (ft) = 44.00
Slope (%) = 2.73
Invert Elev Up (ft) = 101.20
Rise (in) = 30.0
Shape = Circular
Span (in) = 30.0
No. Barrels = 1
n-Value = 0.023
Culvert Type = Circular Corrugate Metal Pipe
Culvert Entrance = Projecting
Coeff. K,M,c,Y,k = 0.034, 1.5, 0.0553, 0.54, 0.9

Embankment
Top Elevation (ft) = 104.60
Top Width (ft) = 26.00
Crest Width (ft) = 300.00

Calculations
Qmin (cfs) = 57.70
Qmax (cfs) = 57.70
Tailwater Elev (ft) = (dc+D)/2

Highlighted
Qtotal (cfs) = 57.70
Qpipe (cfs) = 30.56
Qovertop (cfs) = 27.14
Veloc Dn (ft/s) = 6.70
Veloc Up (ft/s) = 7.71
HGL Dn (ft) = 102.19
HGL Up (ft) = 103.08
Hw Elev (ft) = 104.66
Hw/D (ft) = 1.38
Flow Regime = Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Jan 8 2024

61197-Culvert DP5, 100-yr Proposed (Existing 30inch CMP)

Invert Elev Dn (ft) = 100.00
Pipe Length (ft) = 44.00
Slope (%) = 2.73
Invert Elev Up (ft) = 101.20
Rise (in) = 30.0
Shape = Circular
Span (in) = 30.0
No. Barrels = 1
n-Value = 0.023
Culvert Type = Circular Corrugate Metal Pipe
Culvert Entrance = Projecting
Coeff. K,M,c,Y,k = 0.034, 1.5, 0.0553, 0.54, 0.9

Embankment
Top Elevation (ft) = 104.60
Top Width (ft) = 26.00
Crest Width (ft) = 300.00

Calculations
Qmin (cfs) = 58.90
Qmax (cfs) = 58.90
Tailwater Elev (ft) = (dc+D)/2

Highlighted
Qtotal (cfs) = 58.90
Qpipe (cfs) = 30.89
Qovertop (cfs) = 28.01
Veloc Dn (ft/s) = 6.76
Veloc Up (ft/s) = 7.75
HGL Dn (ft) = 102.20
HGL Up (ft) = 103.09
Hw Elev (ft) = 104.71
Hw/D (ft) = 1.40
Flow Regime = Inlet Control

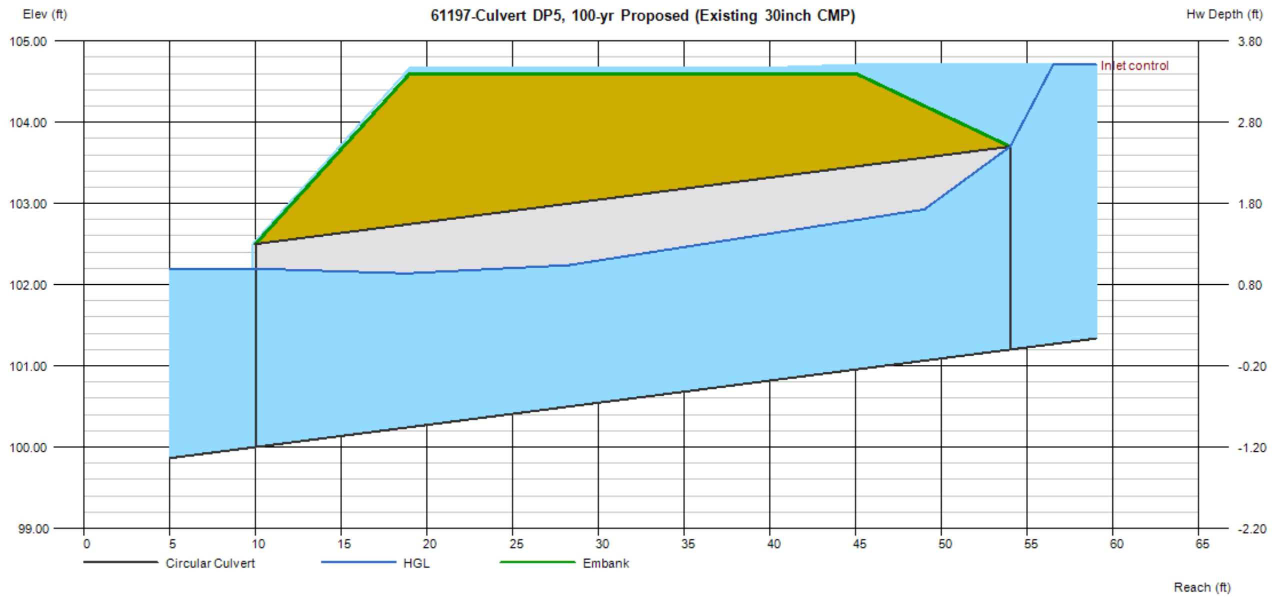


Exhibit 11:

Entech Engineering Report

March 10, 2020

ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907
PHONE (719) 531-5599
FAX (719) 531-5238

Land Development Consultants, Inc.
3898 Maizeland Road
Colorado Springs, CO 80909

Attn: Daniel Kupferer

Re: Soil, Geology, and Geologic Hazard Study
Didleau Subdivison
Herring Road & Forest Heights Circle
Parcel Nos. 52090-00-050 & 52090-00-120
El Paso County, Colorado

Dear Mr. Kupferer:

GENERAL SITE CONDITIONS AND PROJECT DESCRIPTION

The site is located in a portion of the SW¼ of Section 9, Township 12 South, Range 65 West of the 6th Principal Meridian in El Paso County, Colorado. The site is located approximately 4 miles northeast of Colorado Springs city limits, northeast of Shoup Road and Herring Road in El Paso County, Colorado. The location of the site is as shown on the Vicinity Map, Figure 1.

The topography of the site is gradually sloping generally to the southwest with moderate slopes along the ridge that bisects the site. Burgess Creek is located in the eastern portion of the site and flows in a southwesterly direction. A minor drainage is located in the western portion of the property. Water was not observed in the drainages at the time of this investigation. The site boundaries are indicated on the USGS Map, Figure 2. Previous land uses have included undeveloped and a rural residential development. The site is located within the Black Forest burn scar. The site contains primarily field grasses and weeds with scattered areas of ponderosa pines in the western portion of the site and around the existing house located on Lot 2. Site photographs, taken January 30, 2020, are included in Appendix A.

Total acreage involved in the proposed subdivision is 32.25-acres. Four rural residential lots are proposed as part of the replat. The proposed lot sizes range from approximately 5-acres to 15-acres. The existing house located on Lot 2 will remain. The new lots will be serviced by individual wells and on-site wastewater treatment systems. The Site Plan with the proposed replat is presented in Figure 3.

LAND USE AND ENGINEERING GEOLOGY

This site was found to be suitable for the proposed development. Areas were encountered where the geologic conditions will impose some constraints on development and land use. These include areas of potentially seasonal shallow and seasonal shallow groundwater. Based on the proposed development plan, it appears that these areas will have some minor impacts on the development. These conditions will be discussed in greater detail in the report.

In general, it is our opinion that the development can be achieved if the observed geologic conditions on site are either avoided or properly mitigated. All recommendations are subject to the limitations discussed in the report.

SCOPE OF THE REPORT

The scope of the report will include the following:

- A general geologic analysis utilizing published geologic data. Detailed site-specific mapping will be conducted to obtain general information in respect to major geographic and geologic features, geologic descriptions and their effects on the development of the property.

FIELD INVESTIGATION

Our field investigation consisted of the preparation of a geologic map of any bedrock features and significant surficial deposits. The Natural Resource Conservation Service (NRCS), previously the Soil Conservation Service (SCS) survey was also reviewed to evaluate the site. The position of mappable units within the subject property are shown on the Geologic Map. Our mapping procedures involved both field reconnaissance and measurements, and aerial photo reconnaissance and interpretation. The same mapping procedures have also been utilized to produce the Geology/Engineering Geology Map which identified pertinent geologic conditions affecting development. The field mapping was performed by personnel of Entech Engineering, Inc. on January 3 and 30, 2020.

Two test borings and two test pits were excavated on the site to determine general suitability for the use of on-site wastewater treatment systems and general soil characteristics. The location of the test pit is indicated on the Site Plan/Test Pit Location Map, Figure 3. The Test Pit Log is presented in Appendix B. Results of this testing will be discussed later in this report.

Laboratory testing was also performed on some of the soils to classify and determine the soils engineering characteristics. Laboratory tests included grain-size analysis, ASTM D-422, and Atterberg Limits, ASTM D-4318. Results of the laboratory testing are included in Appendix C. A Summary of Laboratory Test Results is presented in Table 1.

SOIL AND GEOLOGIC CONDITIONS

Soil Survey

The Natural Resource Conservation Service (NRCS) (Reference 1, Figure 4), previously the Soil Conservation Service (Reference 2) has mapped two soil types on the site. Complete descriptions of the soil types are presented in Appendix D. In general, the soils consist of sandy loam to gravelly loamy sand. The soils are described as follows:

Type	Description
26	Elbeth Sandy Loam, 8 – 15% Slopes
40	Kettle Gravelly Loamy Sand, 3 – 8% Slopes

The soils have been described to have moderate to rapid permeabilities. The soils are described as well suited for use as homesites. Possible hazards with soils erosion are present on the site. The erosion potential can be controlled with vegetation. The soils have been described to have moderate erosion hazards (Reference 2).

Soils

The soils encountered in the test borings and test pits consisted of silty sand to very clayey sand overlying weathered to formational silty sandstone and very sandy claystone. Bedrock was encountered at depths ranging from 2 to 6 feet. The upper sands were encountered at loose to dense states and moderate moisture conditions, and the sandstone was encountered at very dense states and moderate moisture conditions. The claystone was encountered at hard consistencies and moderate moisture conditions. The samples of sand tested had approximately 12 to 38 percent of the soil size particles passing the No. 200 sieve. FHA Swell Testing on a sample of the very clayey sand resulted in an expansion pressure of 1640 psf, which indicates a moderate expansion potential. The samples of sandstone tested had 10 to 22 percent of the soil size particles passing the No. 200 sieve. The samples of claystone tested had 54 to 59 percent of the soil size particles passing the No. 200 sieve. FHA Swell Testing on a sample of the claystone resulted in an expansion pressure of 730 psf, which indicates a low to moderate expansion potential. Highly expansive claystone and siltstone lenses are commonly interbedded in the Dawson Formation.

Groundwater

Groundwater or signs of seasonally occurring water were not encountered in the test borings or test pits, which were drilled to 20 feet and excavated to 6 to 7 feet. It is anticipated groundwater will not affect shallow foundations on the majority of the site. Areas of potentially seasonal shallow and seasonal shallow groundwater have been mapped in drainages on the site that are discussed in the following sections. Fluctuations in groundwater conditions may occur due to variations in rainfall or other factors not readily apparent at this time. Isolated sand layers within the soil profile can carry water in the subsurface. Contractors should be cognizant of the potential for the occurrence of subsurface water features during construction.

Geology

Approximately 12 miles west of the site is a major structural feature known as the Rampart Range Fault. This fault marks the boundary between the Great Plains Physiographic Province and the Southern Rocky Mountain Province. The site exists within a large structural feature known as the Denver Basin. Bedrock in the area is typically gently dipping in a northerly direction (Reference 3). The bedrock underlying the site consists of the Dawson Formation of Cretaceous Age. The Dawson Formation typically consists of coarse-grained arkosic sandstone with interbedded layers claystone or siltstone.

The geology of the site was evaluated using the *Geologic Map of the Black Forest,* by Thorson in 2003, (Reference 4, Figure 5). The Geology Map for the site is presented in Figure 6. Four mappable units were identified on this site which is described as follows:

Qaf	**Artificial Fill of Holocene Age:** These consist of man-made fill deposits associated with a gas pipeline that bisects the site in portions of Lot 1 and Lot 2. Fill piles consisting of logs and branches are located across the site.
Qal	**Recent Alluvium of Holocene Age:** These are recent deposits that have been deposited in the drainages that exist on-site. These materials consist of silty to clayey sands. Some of these alluviums can contain highly organic soils.
Qau	**Alluvium, Undivided of Holocene and Pleistocene Age:** These are sheetwash and stream deposited alluvium that exists in the western portion of the site associated with alluvial-filled valley heads. These materials typically consist of silty to clayey sands and gravel.
Qc/Tkd	**Colluvium of Quaternary Age overlying Dawson Formation of Tertiary to Cretaceous Age:** The materials consist of colluvial or residual soils overlying the bedrock materials on-site. The colluvial soils were deposited by the action of sheetwash and gravity. The residual soils were derived from the in-situ weathering of the bedrock on site. These materials typically consist of silty to clayey sand with potential areas of sandy clays. The bedrock consists of the Dawson Formation. The Dawson Formation typically consists of coarse-grained, arkosic sandstone with interbedded lenses of fine-grained sandstone, siltstone and claystone.

The soils listed above were mapped from site-specific mapping, the *Geologic Map of the Black Forest Quadrangle* distributed by the Colorado Geologic Survey in 2003 (Reference 4, Figure 5), The *Geologic Map of the Colorado Springs-Castle Rock Area,* distributed by the US Geological Survey in 1979 (Reference 5), and the *Geologic Map of the Pueblo 1° x 2° Quadrangle,* distributed by the US Geological Survey in 1978 (Reference 6). The test borings and test pits were used in evaluating the site and is included in Appendix B. The Geology Map prepared for the site is presented in Figure 6.

ENGINEERING GEOLOGIC HAZARDS

Mapping has been performed on this site to identify areas where various geologic conditions exist of which developers should be cognizant during the planning, design and construction stages where new construction is proposed. The engineering geologic hazards identified on this site include potentially seasonal shallow and seasonally shallow groundwater areas. These hazards and recommended mitigation techniques are discussed as follows:

Expansive Soils

Expansive soils were encountered in Test Boring No. 2 located on Lot 3. These occurrences are typically sporadic; therefore, none have been indicated on the maps. Highly expansive claystone and siltstone are commonly interbedded in the sandstone of the Dawson Formation. These clays, if encountered beneath foundations, can cause differential movement in the structure foundation.

Mitigation: Should expansive soils be encountered beneath the foundation; mitigation will be necessary. Mitigation of expansive soils will require special foundation design. Overexcavation and replacement with non-expansive soils at a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557 is a suitable mitigation, which is common in the area. Floor slabs on expansive soils should be expected to experience movement. Overexcavation and replacement has been successful in minimizing slab movements.

Potentially Seasonal Shallow and Seasonal Shallow Groundwater Area

The site is not mapped within any floodplains according to the FEMA Map No. 08041CO320G, dated December 7, 2018 (Figure 7, Reference 7). Areas of potentially seasonal shallow and seasonal shallow groundwater were observed on the site (Figure 6). In these areas, we would anticipate the potential for periodically high subsurface moisture conditions and frost heave potential. These areas lie within low-lying areas and along the drainages in the eastern and western portions of the site. The seasonal shallow groundwater area is located along Burgess Creek located along the eastern portion of the site on Lot 4. The potentially seasonal shallow groundwater area is located in the western portion of the site on Lot 2. Water was not observed in any of the drainages at the time of our site investigation. These areas can likely be avoided or properly mitigated by development. The potential exists for high groundwater levels during high moisture periods and should structures encroach on these areas the following precautions should be followed.

Mitigation: Foundations must have a minimum 30-inch depth for frost protection. In areas where high subsurface moisture conditions are anticipated periodically, subsurface perimeter drains are recommended to help prevent the intrusion of water into areas below grade. Typical drain details are presented in Figure 8. Any grading in these areas should be done to direct surface flow around construction to avoid areas of ponded water. All organic material would be completely removed prior to any fill placement. **Specific drainage studies are beyond the scope of this report.**

RELEVANCE OF GEOLOGIC CONDITIONS TO LAND USE PLANNING

The proposed development will be rural-residential utilizing individual on-site wastewater treatment systems and water wells. Total acreage involved in the proposed subdivision is 32.25-acres. Four rural residential lots are proposed as part of the replat. The proposed lot sizes range from approximately 5-acres to 15-acres. The existing house located on Lot 2 will remain. The house on Lot 2 has an existing water well and on-site wastewater treatment system. The new lots will be serviced by an individual wells and on-site wastewater treatment systems. The existing geologic and engineering geologic conditions will impose minor constraints on development and construction. The geologic conditions on the site include potentially seasonal shallow and shallow groundwater areas, which can be satisfactorily mitigated through avoidance or proper engineering design and construction practices.

The upper granular soils encountered in the test borings and test pits on the site were encountered at loose to dense states, the sandstone was encountered at very dense states, and the claystone at hard consistencies. Highly expansive claystone and siltstone are commonly interbedded in the sandstone of the Dawson Formation. Mitigation of expansive soils will require special foundation design. Overexcavation and replacement with non-expansive soils at a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557 is a suitable mitigation, which is common in the area. Floor slabs on expansive soils should be expected to experience movement. Overexcavation and replacement has been successful in minimizing slab movements. These soils will not prohibit development.

Areas of potentially seasonal shallow and seasonal shallow groundwater were observed on the site (Figure 6). In these areas, we would anticipate the potential for periodically high subsurface moisture conditions and frost heave potential. These areas lie within low-lying areas and along the minor drainage in the western portion of the site, and Burgess Creek in the eastern portion of the site. These areas can likely be avoided or properly mitigated by development. The potential exists for high groundwater levels during high moisture periods and should structures encroach on these areas. Subsurface perimeter drains are recommended should structures encroach on this area. Typical drain details are presented in Figure 8. Septic systems are not recommended in in these areas due to the potential for shallow groundwater. Any grading in theses areas should be done to direct surface flow around construction to avoid areas of ponded water. All organic material should be completely removed prior to any fill placement. Specific drainage studies are beyond the scope of this report. The site is not mapped within any floodplains according to the FEMA Map No. 80841C0320G (Figure 7, Reference 7).

In summary, the granular soils will likely provide suitable support for shallow foundations. The geologic conditions encountered on site can be mitigated with avoidance or proper engineering and construction practices.

ECONOMIC MINERAL RESOURCES

Some of the sandy materials on-site could be considered a low-grade sand resource. According to the *El Paso County Aggregate Resource Evaluation Map* (Reference 8), of the area of the site is not mapped with any potential aggregate resources. According to the *Atlas of Sand, Gravel and Quarry Aggregate Resources, Colorado Front Range Counties* distributed by the Colorado Geological Survey (Reference 9), the site is not mapped with any resources. According to the *Evaluation of Mineral and Mineral Fuel Potential* (Reference 10), the area of the site has been mapped as "little or no potential" for industrial minerals.

According to *the Evaluation of Mineral and Mineral Fuel Potential of El Paso County State Mineral Lands* (Reference 10), the site is mapped within the Denver Basin Coal Region. However, the area of the site has been mapped as "Poor" for coal resources. No active or inactive mines have been mapped in the area of the site. No metallic mineral resources have been mapped on the site (Reference 10).

The site has been mapped as "Fair" for oil and gas resources (Reference 10). No oil or gas fields have been discovered in the area of the site. The sedimentary rocks in the area may lack the geologic structure for trapping oil or gas; therefore, it may not be considered a significant resource. Hydraulic fracturing is a new method that is being used to extract oil and gas from rocks. It utilizes pressurized fluid to extract oil and gas from rocks that would not normally be productive. The area of the site has not been explored to determine if the rocks underlying the site would be commercially viable utilizing hydraulic fracturing. The practice of hydraulic fracturing has come under review due to concerns about environmental impacts, health and safety.

EROSION CONTROL

The soil types observed on the site are mildly to highly susceptible to wind erosion, and moderately to highly susceptible to water erosion. A minor wind erosion and dust problem may be created for a short time during and immediately after construction. Should the problem be considered severe enough during this time, watering of the cut areas or the use of chemical palliative may be required to control dust. However, once construction has been completed and vegetation re-established, the potential for wind erosion should be considerably reduced.

With regard to water erosion, loosely compacted soils will be the most susceptible to water erosion, residually weathered soils and weathered bedrock materials become increasingly less susceptible to water erosion. For the typical soils observed on site, allowable velocities or unvegetated and unlined earth channels would be on the order of 3 to 4 feet/second, depending upon the sediment load carried by the water. Permissible velocities may be increased through the use of vegetation to something on the order of 4 to 7 feet/second, depending upon the type of vegetation established. Should the anticipated velocities exceed these values, some form of channel lining material may be required to reduce erosion potential. These might consist of some of the synthetic channel lining materials on the market or conventional riprap. In cases where ditch-lining materials are still insufficient to control erosion, small check dams or sediment traps may be required. The check dams will serve to reduce flow velocities, as well as provide small traps for containing sediment. The determination of the amount, location and placement of ditch linings, check dams and of the special erosion control features should be performed by or in conjunction with the drainage engineer who is more familiar with the flow quantities and velocities.

Cut and fill slope areas will be subjected primarily to sheetwash and rill erosion. Unchecked rill erosion can eventually lead to concentrated flows of water and gully erosion. The best means to combat this type of erosion is, where possible, the adequate re-vegetation of cut and fill slopes. Cut and fill slopes having gradients more than three (3) horizontal to one (1) vertical become increasingly more difficult to revegetate successfully. Therefore, recommendations pertaining to the vegetation of the cut and fill slopes may require input from a qualified landscape architect and/or the Soil Conservation Service.

CLOSURE

It is our opinion that the existing geologic engineering and geologic conditions will impose some minor constraints on development and construction of the site. The majority of these conditions can be avoided by construction. Others can be mitigated through proper engineering design and construction practices. The proposed development and use are consistent with anticipated geologic and engineering geologic conditions.

It should be pointed out that because of the nature of data obtained by random sampling of such variable and non-homogeneous materials as soil and rock, it is important that we be informed of any differences observed between surface and subsurface conditions encountered in construction and those assumed in the body of this report. Individual investigations for new building sites and septic systems will be required prior to construction. Construction and design personnel should be made familiar with the contents of this report. Reporting such discrepancies to Entech Engineering, Inc. soon after they are discovered would be greatly appreciated and could possibly help avoid construction and development problems.

This report has been prepared for Land Development Consultants, Inc., for application to the proposed project in accordance with generally accepted geologic soil and engineering practices. No other warranty expressed or implied is made.

We trust that this report has provided you with all the information that you required. Should you require additional information, please do not hesitate to contact Entech Engineering, Inc.

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Logan L. Langford, P.G.
Geologist

Reviewed by:

Joseph C. Goode, Jr., P.E.
President

COLORADO LICENSED PROFESSIONAL ENGINEER
JOSEPH COLLIN GOODE JR
23725

LLL/lll

Encl.

Entech Job No. 192115
AAprojects/2019/192115 sg&ghs

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TABLES

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT LDC, INC.
PROJECT DIDLEAU SUBDIVISION
JOB NO. 192115

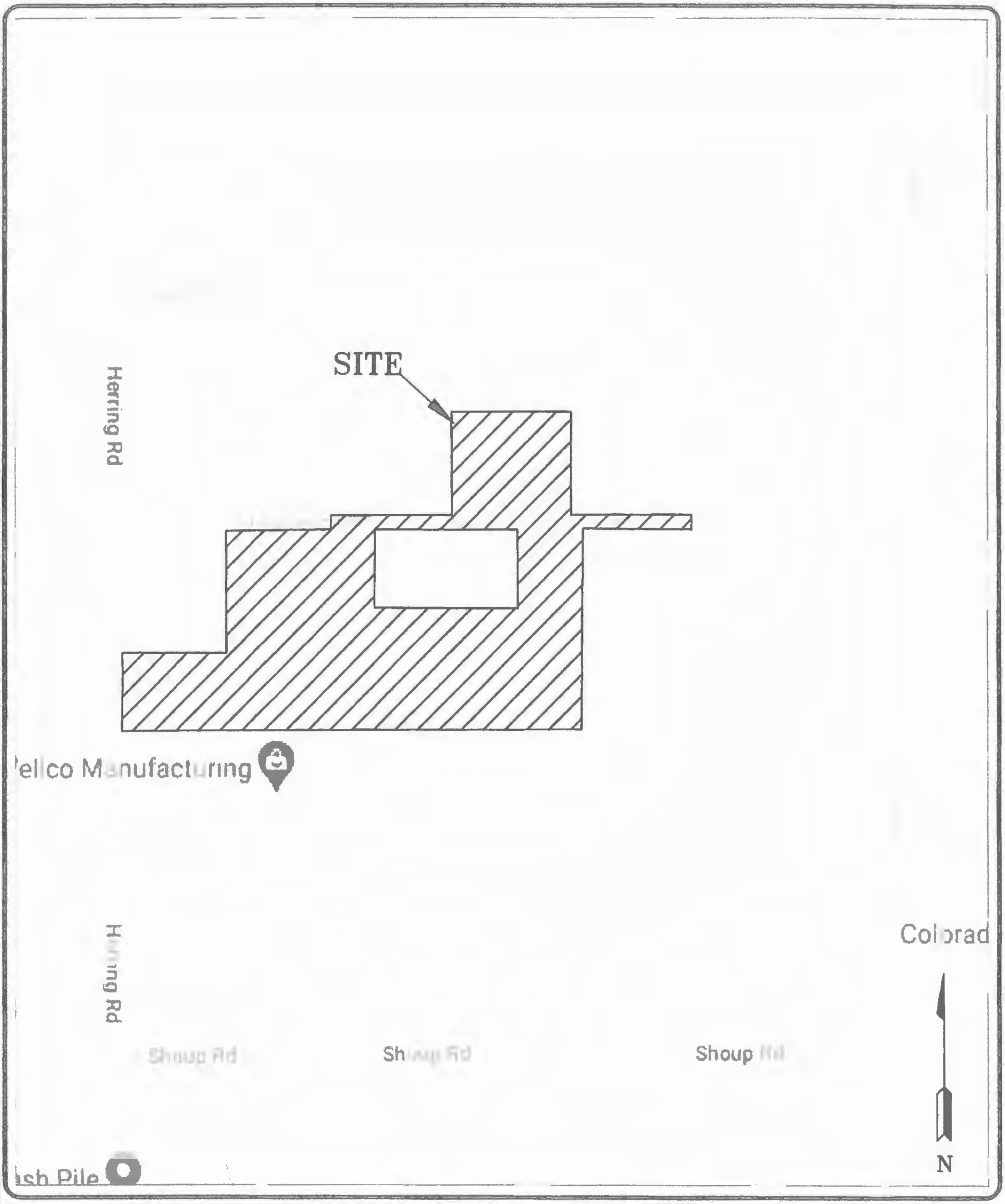
SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	FHA SWELL (PSF)	SWELL/ CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1	1	2-3			12.2						SM	SAND, SILTY
1	2	2-3			38.4				1640		SC	SAND, VERY CLAYEY
1	TP-2	2-3			14.9						SM	SAND, SILTY
2	TP-1	5-6			9.6						SM	SANDSTONE, SILTY
2	1	15			22.2						SM	SANDSTONE, SILTY
3	2	10			59.3				730		CL	CLAYSTONE, VERY SANDY
3	2	5			54.2						CL	CLAYSTONE, VERY SANDY

Table 2: Summary Tactile Test Pit Results

Test Pit No.	USDA Soil Type	LTAR Value	Depth to Redrock (ft.)	Depth to Seasonally Occurring Groundwater (ft.)
1	3A*	0.30*	3*	N/A
2	3A*	0.30*	2*	N/A

*- Conditions that will require an engineered OWTS

FIGURES



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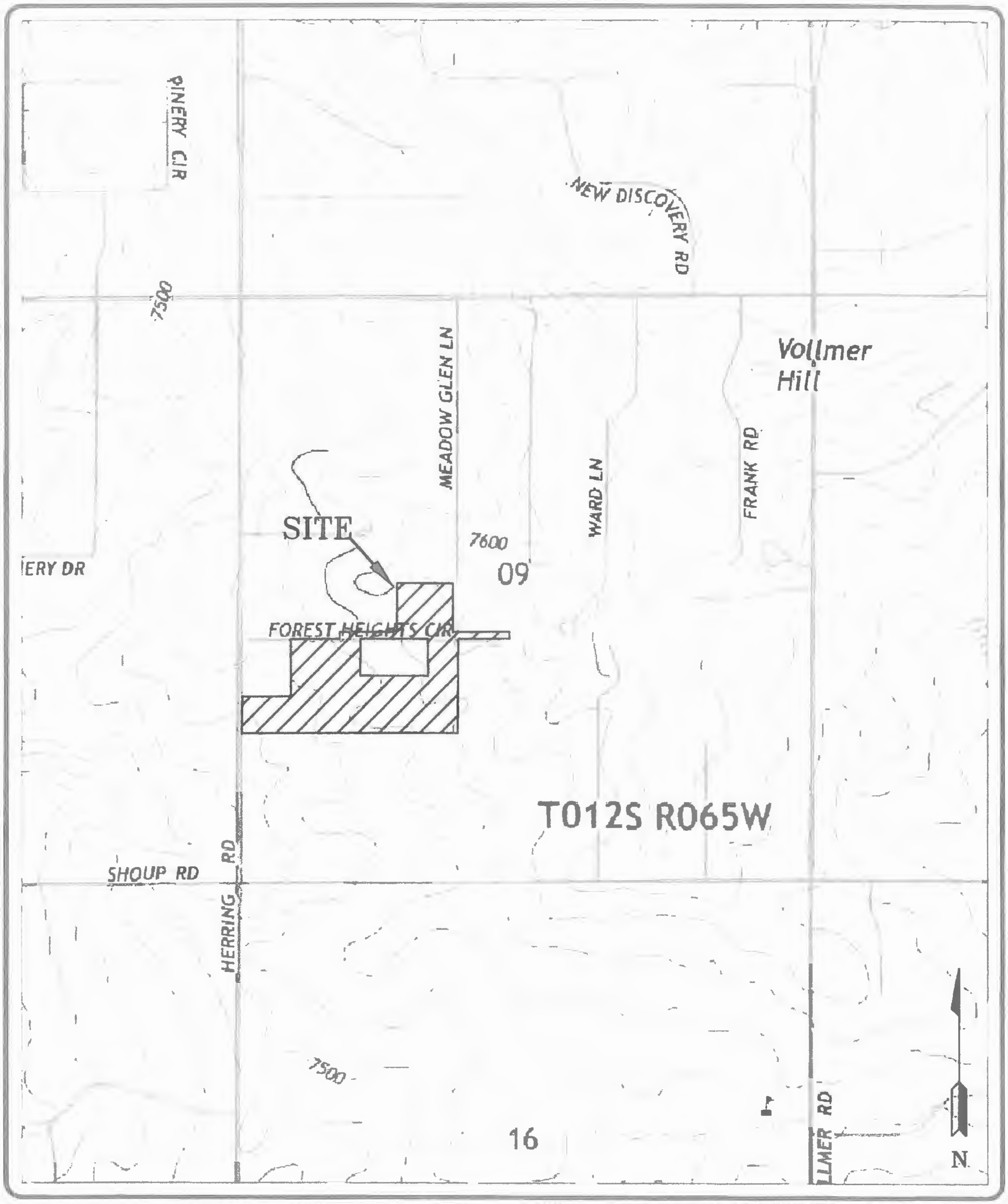
COLORADO SPRINGS, CO. 80907 (719) 531-5599

VICINITY MAP
DIDLEAU SUBDIVISION
HERRING ROAD & FOREST HEIGHTS CIRCLE
EL PASO COUNTY, CO.
FOR: LDC, INC.

DRAWN:	DATE:	CHECKED:	DATE:
LLL	2/28/20		

JOB NO.:
192115

FIG NO.:
1



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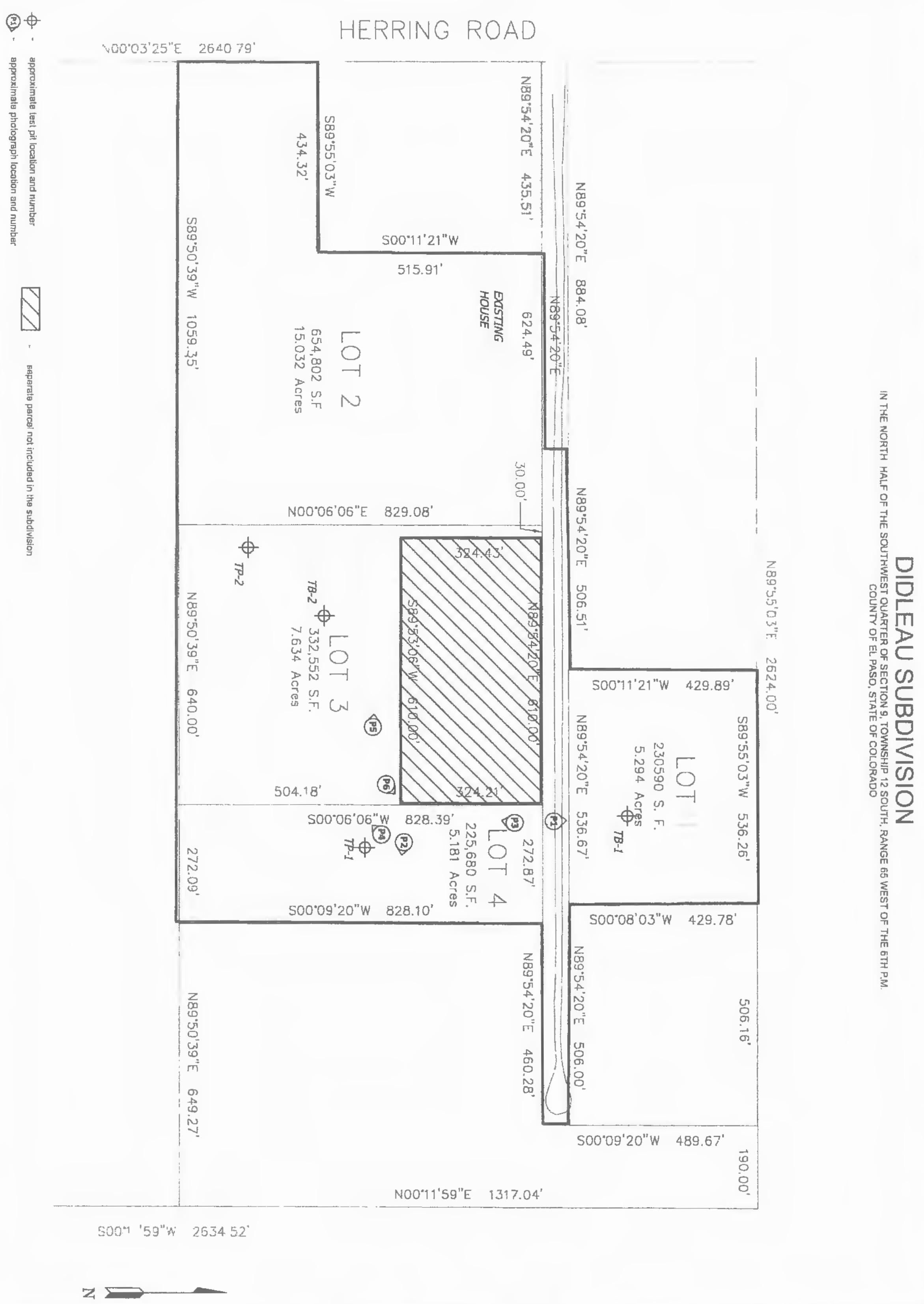
USGS MAP
DIDLEAU SUBDIVISION
HERRING ROAD & FOREST HEIGHTS CIRCLEEL
PASO COUNTY, CO.
FOR: LDC, INC.

DRAWN: LLL	DATE: 2/28/20	CHECKED:	DATE:

JOB NO.:
192115

FIG NO.:
2



SITE PLAN/TESTING LOCATION MAP
DIDLEAU SUBDIVISION
HERRING ROAD & FOREST HEIGHTS
CIRCLECOLORADO SPRINGS, CO.
FOR: LDC, INC.

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COLORADO SPRINGS, CO. 80907 (719) 531-5599

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LLL
CHECKED
DATE
2/28/20
SCALE
AS SHOWN
JOB NO.
192115
FIGURE NO.
3

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▨ - SEPERATE PARCEL NOT INCLUDED IN THE SUBDIVISION

N

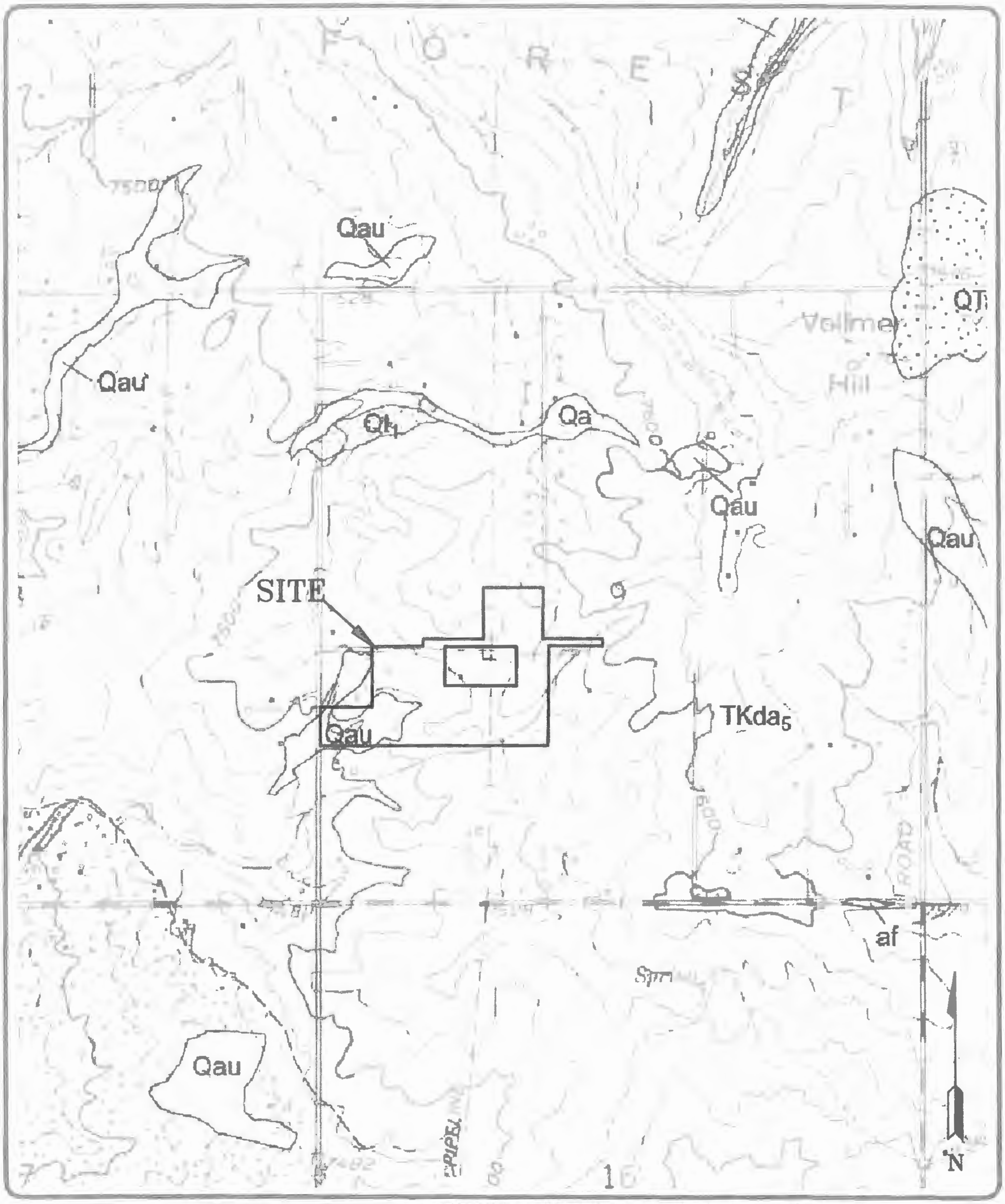
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

SOIL SURVEY MAP
DIDLEAU SUBDIVISION
HERRING ROAD & FOREST HEIGHTS CIRCLE
EL PASO COUNTY, CO.
FOR: LDC, INC.

DRAWN:	DATE:	CHECKED:	DATE:
LLL	2/28/20		

JOB NO.: 192115

FIG NO.: 4



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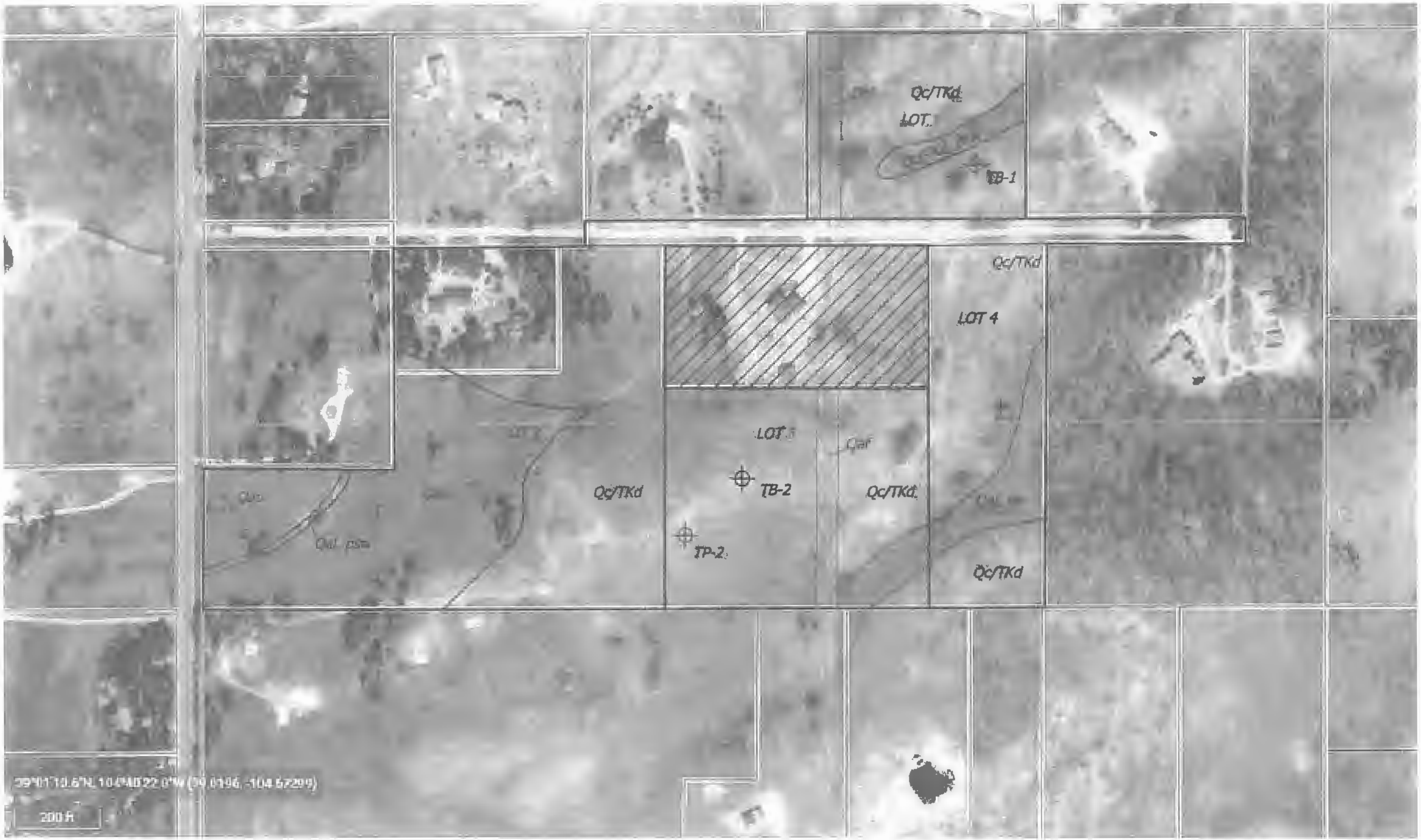
BLACK FOREST QUADRANGLE GEOLOGIC MAP
DIDLEAU SUBDIVISION
HERRING ROAD & FOREST HEIGHTS CIRCLE
EL PASO COUNTY, CO.
FOR: LDC, INC.

DRAWN:	DATE:	CHECKED:	DATE:
LLL	2/28/20		

JOB NO.:
192115

FIG NO.:
5



Legend:

Qaf - Artificial Fill of Holocene Age:
man-made fill deposits

Qal - Recent Alluvium of Holocan Age:
recent water deposited materials

Qau - Alluvium Undividad of Holocene and Pleistocene Age:
sheetwash and stream deposited alluvium associated with alluvial-filled valley heads

QcTKd - Colluvium of Quaternary Age overlying Dawson Formation of Tertiary to Cretaceous Age:
colluvial and residual soils overlying arkosic sandstone with interbedded fine-grained sandstone, siltstone and claystone

sw - shallow groundwater area

psw - potentially shallow groundwater area

▨ - seperate parcel not included in the subdivision

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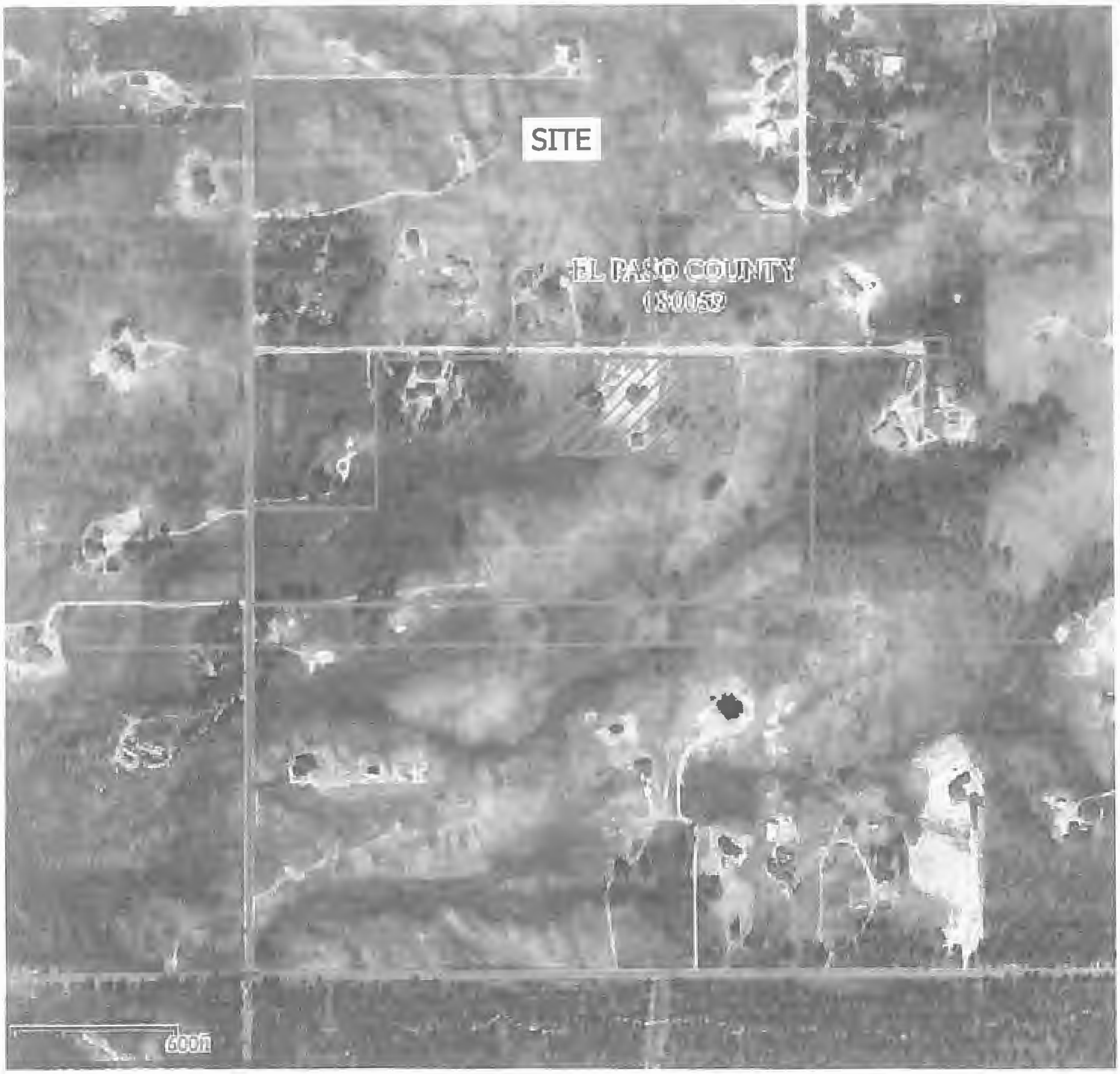
GEOLOGY/ENGINEERING GEOLOGY MAP
DIDLEAU SUBDIVISION
HERRING ROAD & FOREST HEIGHTS CIRCLE
EL PASO COUNTY, CO.
FOR: LDC, INC.

DRAWN
LLL
CHECKED

DATE
2/26/20
SCALE
AS SHOWN
JOB NO.
192115
FIGURE No.
6



▨ SEPERATE PARCEL NOT INCLUDED IN THE SUBDIVISION

N

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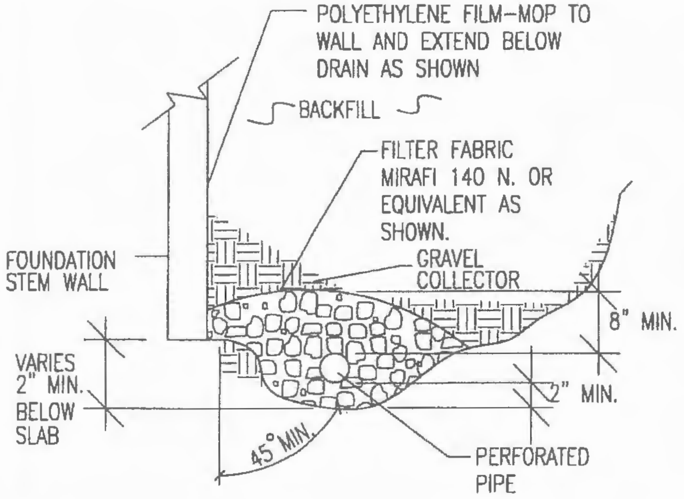
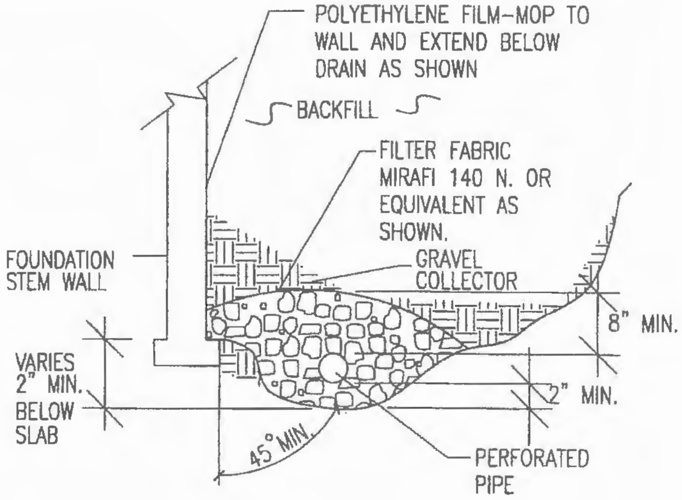
FEMA FLOODPLAIN MAP
DIDLEAU SUBDIVISION
HERRING ROAD & FOREST HEIGHTS CIRCLE
EL PASO COUNTY, CO.
FOR: LDC, INC.

DRAWN:	DATE:	CHECKED:	DATE:
LLL	2/28/20		

JOB NO.:
192115

FIG NO.:
7





NOTES:

-GRAVEL SIZE IS RELATED TO DIAMETER OF PIPE PERFORATIONS-85% GRAVEL GREATER THAN 2x PERFORATION DIAMETER.

-PIPE DIAMETER DEPENDS UPON EXPECTED SEEPAGE. 4-INCH DIAMETER IS MOST OFTEN USED.

-ALL PIPE SHALL BE PERFORATED PLASTIC. THE DISCHARGE PORTION OF THE PIPE SHOULD BE NON-PERFORATED PIPE.

-FLEXIBLE PIPE MAY BE USED UP TO 8 FEET IN DEPTH, IF SUCH PIPE IS DESIGNED TO WITHSTAND THE PRESSURES. RIGID PLASTIC PIPE WOULD OTHERWISE BE REQUIRED.

-MINIMUM GRADE FOR DRAIN PIPE TO BE 1% OR 3 INCHES OF FALL IN 25 FEET.

-DRAIN TO BE PROVIDED WITH A FREE GRAVITY OUTFALL, IF POSSIBLE. A SUMP AND PUMP MAY BE USED IF GRAVITY OUT FALL IS NOT AVAILABLE.

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PERIMETER DRAIN DETAIL

DRAWN:	DATE:	DESIGNED:	CHECKED:
		DS	LLL

JOB NO.: 192115

FIG NO.: 8

APPENDIX A: Photographs

1

Looking north towards Lot 1 in the eastern portion of the site.

January 30, 2020

2

Looking north from the central portion of Lot 2.

January 30, 2020

3

Looking south from the northern portion of Lot 4.

January 30, 2020

4

Looking south towards one of the stockpiles of cut trees.

January 30, 2020

5

Looking northeast towards stockpile of trees on Lot 3.

January 30, 2020

6

Looking north from the eastern portion of Lot 3.

January 30, 2020

APPENDIX B: Test Boring and Test Pit Logs

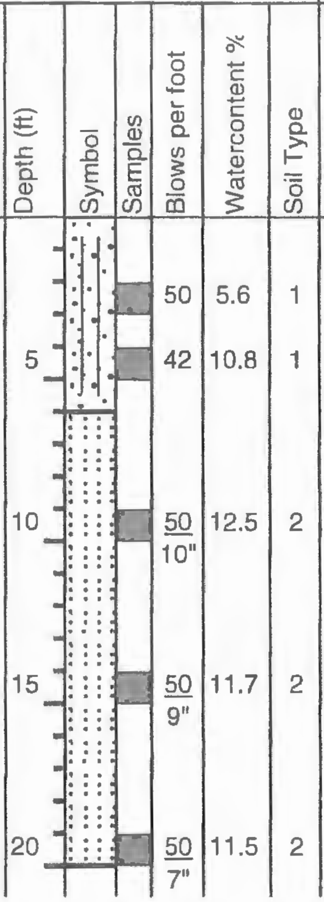
TEST BORING NO. 1
DATE DRILLED 1/3/2020
Job # 192115

REMARKS

DRY TO 17.5', 1/6/20

SAND, SILTY, FINE TO COARSE GRAINED, BROWN, VERY DENSE TO DENSE, MOIST

SANDSTONE, SILTY, FINE TO COARSE GRAINED, BROWN, VERY DENSE, MOIST



Depth (ft)	Blows per foot	Watercontent %	Soil Type
	50	5.6	1
5	42	10.8	1
10	50/10"	12.5	2
15	50/9"	11.7	2
20	50/7"	11.5	2

TEST BORING NO. 2
DATE DRILLED 1/3/2020
CLIENT LDC, INC.
LOCATION DIDLEAU SUBDIVISION

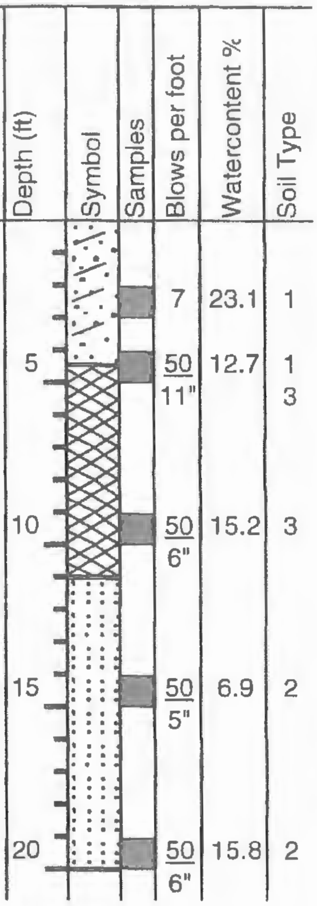
REMARKS

DRY TO 18.5', 1/6/20

SAND, VERY CLAYEY, FINE TO MEDIUM GRAINED, BROWN, LOOSE, MOIST

CLAYSTONE, VERY SANDY, BROWN, HARD, MOIST

SANDSTONE, SILTY, FINE TO COARSE GRAINED, BROWN, VERY DENSE, MOIST



Depth (ft)	Blows per foot	Watercontent %	Soil Type
	7	23.1	1
5	50/11"	12.7	1 3
10	50/6"	15.2	3
15	50/5"	6.9	2
20	50/6"	15.8	2

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COLORADO SPRINGS, COLORADO 80907

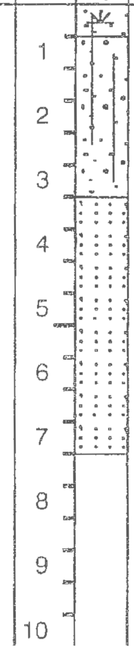
TEST BORING LOG

DRAWN: DATE: CHECKED: DATE: 1/17/20

JOB NO. 192115
FIG NO. B-1

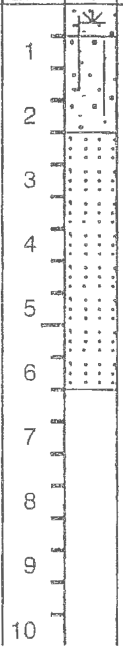
TEST PIT NO. 1
DATE EXCAVATED 4/23/2019
Job # 192115

REMARKS	Soil Structure Shape	Soil Structure Grade	USDA Soil Type
topsoil sandy loam, brown			
gravelly sandy loam, fine to coarse grained, light brown	gr	m	2
weathered to formational silty sandstone, fine to coarse grained, tan	ma		3A



TEST PIT NO. 2
DATE EXCAVATED 4/23/2019
CLIENT LDC, INC.
LOCATION DIDLEAU SUBDIVISION

REMARKS	Soil Structure Shape	Soil Structure Grade	USDA Soil Type
topsoil sandy loam, brown			
gravelly sandy loam, fine to coarse grained, light brown	gr	m	2
weathered to formational silty sandstone, fine to coarse grained, tan	ma		3A



Soil Structure Shape
granular - gr
platy - pl
blocky - bl
prismatic - pr
single grain - sg
massive - ma

Soil Structure Grade
weak - w
moderate - m
strong - s
loose - l

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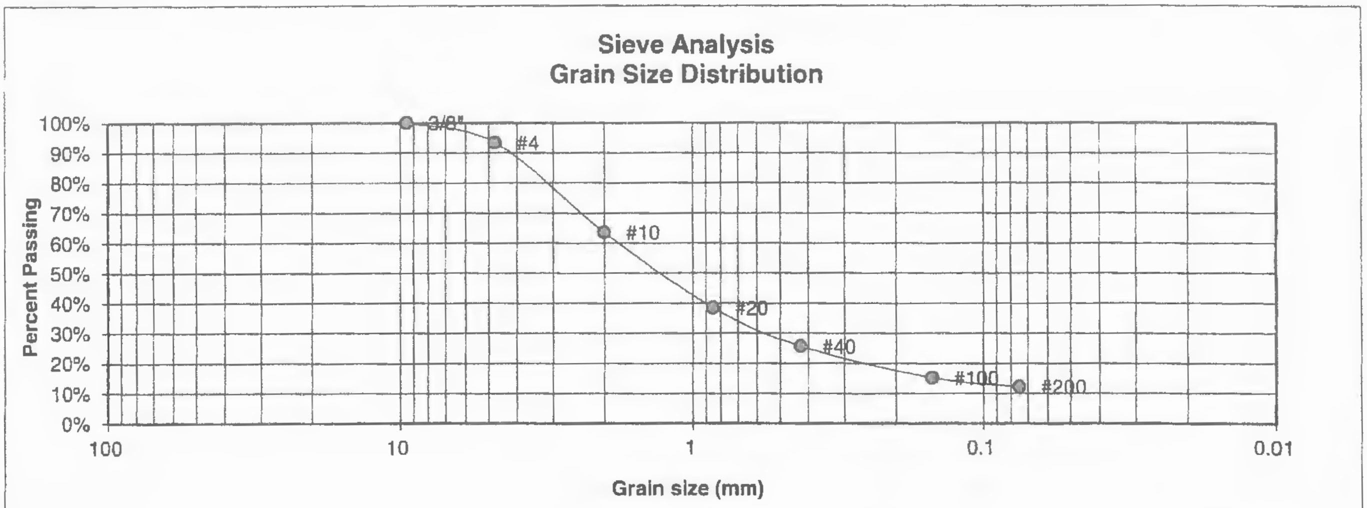
TEST PIT LOG

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	2/25/20

JOB NO.: 192115
FIG NO.: B-2

APPENDIX C: Laboratory Test Results

UNIFIED CLASSIFICATION	SM	CLIENT	LDC, INC.
SOIL TYPE #	1	PROJECT	DIDLEAU SUBDIVISION
TEST BORING #	1	JOB NO.	192115
DEPTH (FT)	2-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	93.4%
10	63.6%
20	38.4%
40	25.6%
100	15.1%
200	12.2%

Atterberg
Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

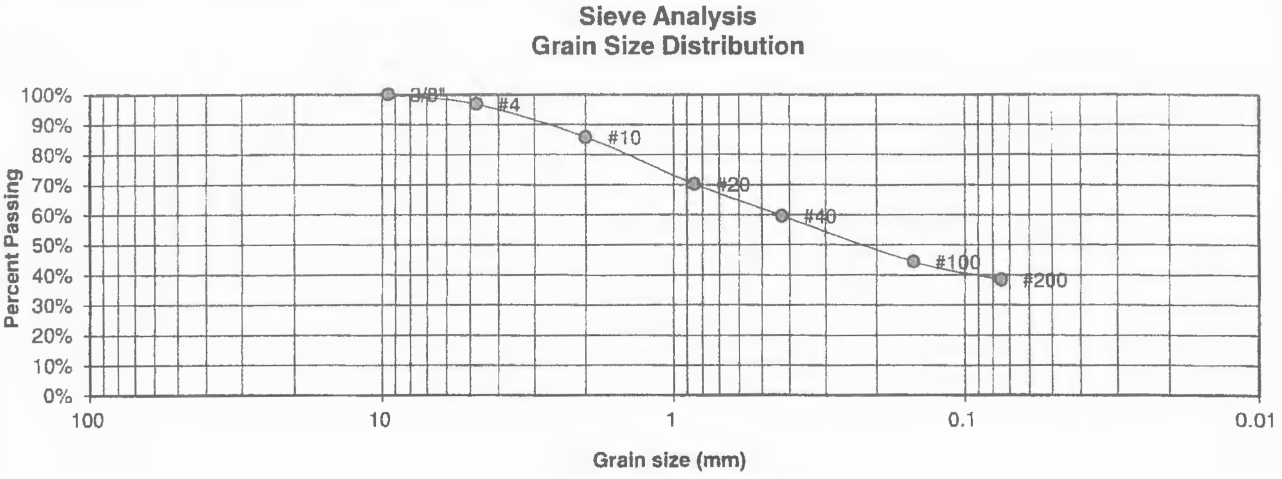
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		h	1/17/20

JOB NO.:
192115

FIG NO.:
C-1

UNIFIED CLASSIFICATION	SC	CLIENT	LDC, INC.
SOIL TYPE #	1	PROJECT	DIDLEAU SUBDIVISION
TEST BORING #	2	JOB NO.	192115
DEPTH (FT)	2-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	96.8%
10	85.8%
20	70.2%
40	59.7%
100	44.3%
200	38.4%

Atterberg
Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell	
Moisture at start	13.8%
Moisture at finish	25.6%
Moisture increase	11.8%
Initial dry density (pcf)	95
Swell (psf)	1640

ENTECH
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COLORADO SPRINGS, COLORADO 80907

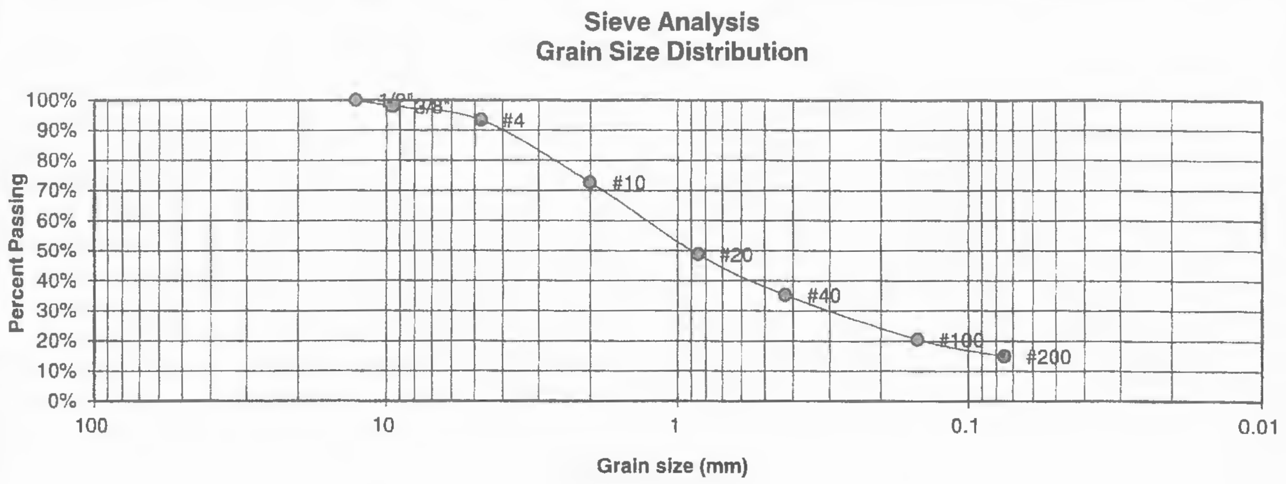
LABORATORY TEST
RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		h	1/17/20

JOB NO
192115

FIG NO.
L-2

UNIFIED CLASSIFICATION	SM	CLIENT	LDC, INC.
SOIL TYPE #	1	PROJECT	DIDLEAU SUBDIVISION
TEST BORING #	TP-2	JOB NO.	192115
DEPTH (FT)	2-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	97.9%
4	93.3%
10	72.7%
20	48.7%
40	35.2%
100	20.5%
200	14.9%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

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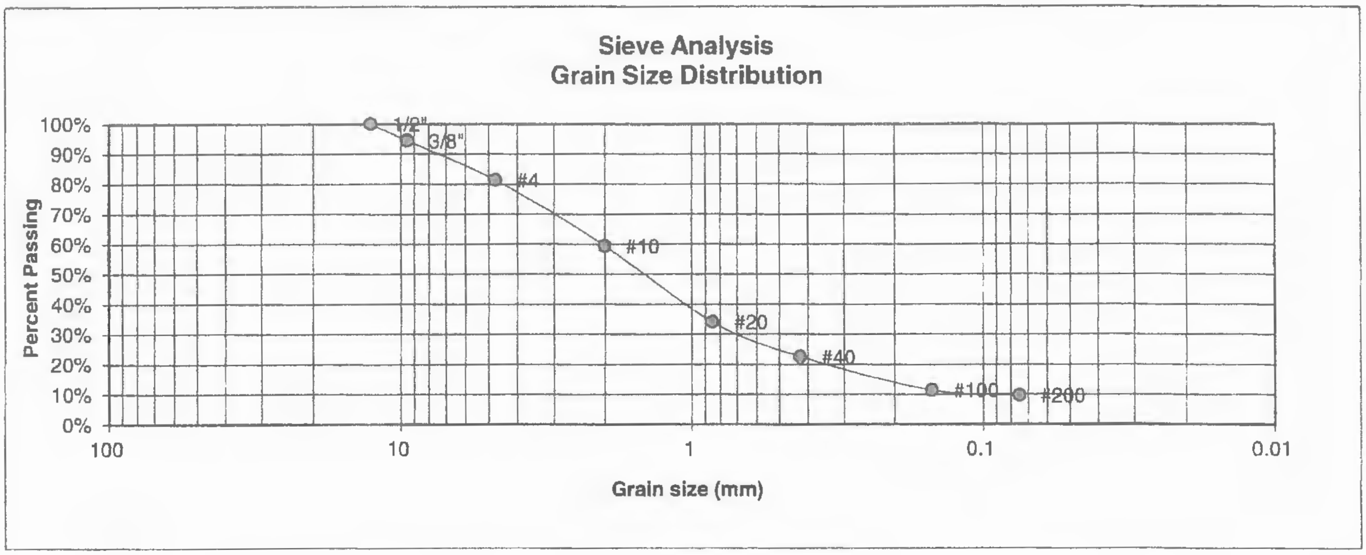
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN	DATE:	CHECKED:	DATE:
		LLL	1/17/20

JOB NO.: 192115
FIG NO.: C-3

UNIFIED CLASSIFICATION	SM	CLIENT	LDC, INC.
SOIL TYPE #	2	PROJECT	DIDLEAU SUBDIVISION
TEST BORING #	TP-1	JOB NO.	192115
DEPTH (FT)	5-6	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	94.5%
4	81.3%
10	59.5%
20	34.1%
40	22.5%
100	11.4%
200	9.6%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

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COLORADO SPRINGS, COLORADO 80907

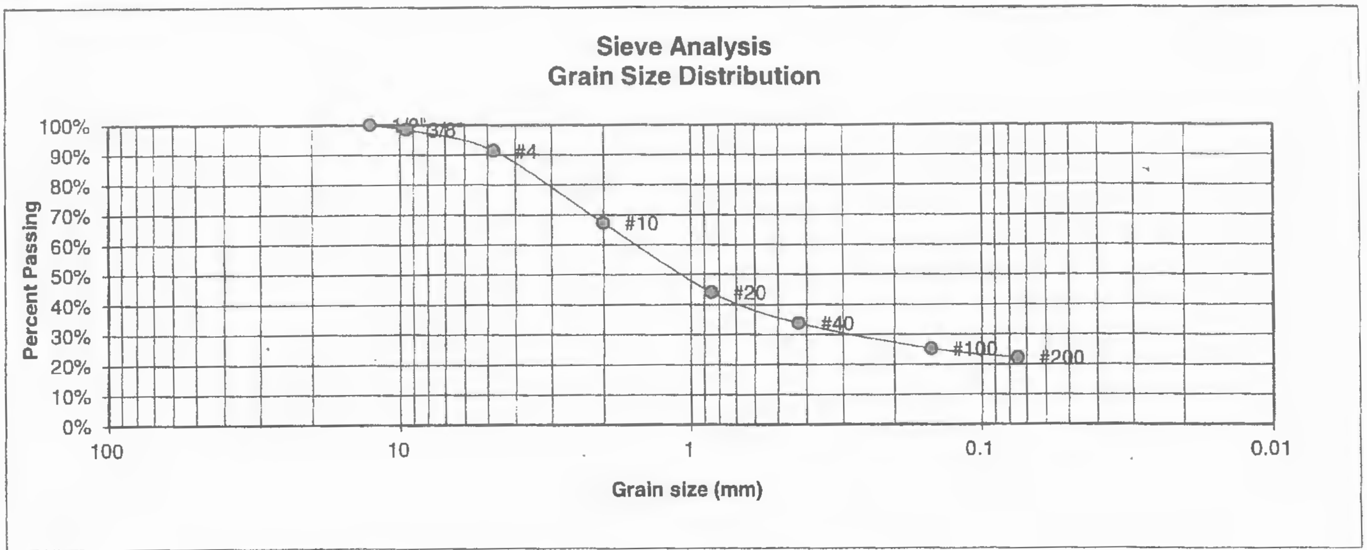
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	1/17/20

JOB NO.: 192115

FIG NO.: C-4

UNIFIED CLASSIFICATION	SM	CLIENT	LDC, INC.
SOIL TYPE #	2	PROJECT	DIDLEAU SUBDIVISION
TEST BORING #	1	JOB NO.	192115
DEPTH (FT)	15	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	98.4%
4	91.4%
10	67.2%
20	44.1%
40	33.8%
100	25.2%
200	22.2%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

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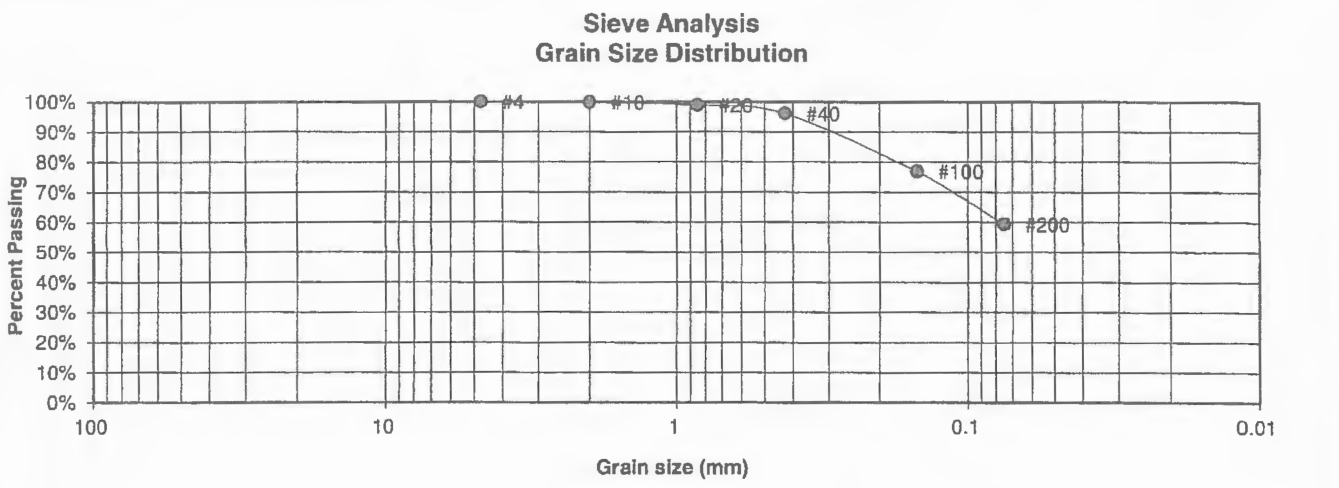
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE: 1/17/20

JOB NO.: 192115

FIG NO.: C-5

UNIFIED CLASSIFICATION	CL	CLIENT	LDC, INC.
SOIL TYPE #	3	PROJECT	DIDLEAU SUBDIVISION
TEST BORING #	2	JOB NO.	192115
DEPTH (FT)	10	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.8%
20	98.9%
40	96.1%
100	76.9%
200	59.3%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell	
Moisture at start	16.1%
Moisture at finish	20.4%
Moisture increase	4.3%
Initial dry density (pcf)	104
Swell (psf)	730

ENTECH ENGINEERING, INC.
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COLORADO SPRINGS, COLORADO 80907

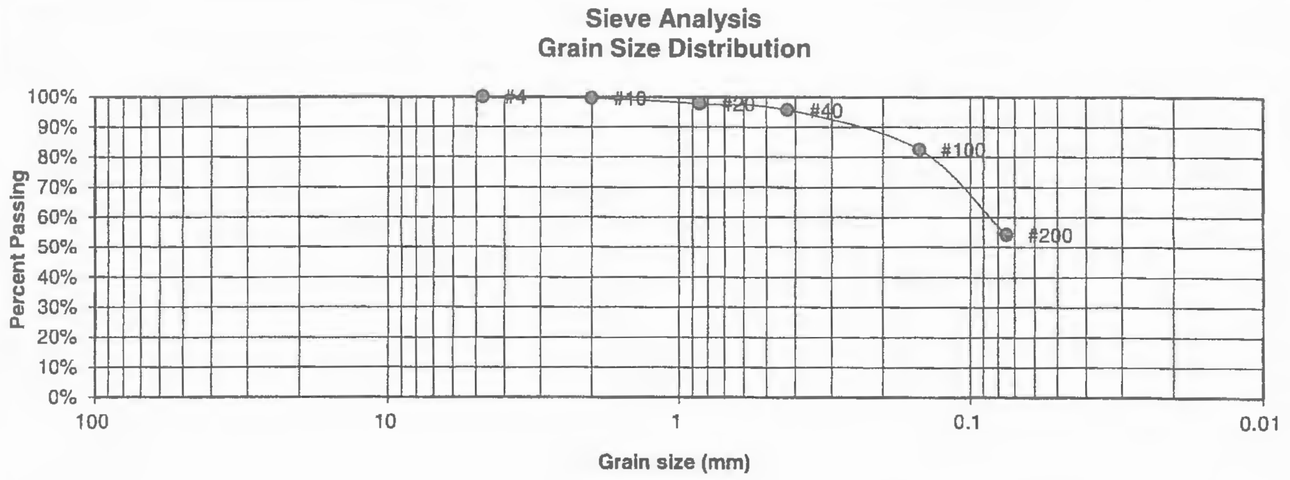
LABORATORY TEST RESULTS

DRAWN: DATE: CHECKED: A DATE: 1/17/20

JOB NO.: 192115

FIG NO.: C-6

UNIFIED CLASSIFICATION	CL	CLIENT	LDC, INC.
SOIL TYPE #	3	PROJECT	DIDLEAU SUBDIVISION
TEST BORING #	2	JOB NO.	192115
DEPTH (FT)	5	TEST BY	BL


Sieve Analysis
Grain Size Distribution

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.6%
20	97.7%
40	95.7%
100	82.6%
200	54.2%

Atterberg
Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: a	DATE: 1/17/20

JOB NO.: 192115

FIG NO.: C-7

APPENDIX D: Soil Survey Descriptions

El Paso County Area, Colorado

26—Elbeth sandy loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 367y
Elevation: 7,300 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Elbeth and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Elbeth

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkose

Typical profile

A - 0 to 3 inches: sandy loam
E - 3 to 23 inches: loamy sand
Bt - 23 to 68 inches: sandy clay loam
C - 68 to 74 inches: sandy clay loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 17, Sep 13, 2019

El Paso County Area, Colorado

40—Kettle gravelly loamy sand, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 368g
Elevation: 7,000 to 7,700 feet
Farmland classification: Not prime farmland

Map Unit Composition

Kettle and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kettle

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium derived from arkose

Typical profile

E - 0 to 16 inches: gravelly loamy sand
Bt - 16 to 40 inches: gravelly sandy loam
C - 40 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Other soils

Percent of map unit:

Hydric soil rating: No

Data Source Information

Soil Survey Area: El Paso County Area, Colorado

Survey Area Data: Version 17, Sep 13, 2019

Exhibit 12:

Discussion Summaries

Black Forest Fire Rescue Protection District
11445 Teachout Road
Colorado Springs, Colorado 80908
Ph-719.495.4300
Fax 719.495.7504
Web- www.bffire.org

"Always Ready, Always Forward, Always Learning."

Office of the Fire Marshal

Thursday, August 27, 2020

Dear Ms. Didleau

Thank you for reaching out to me regarding your future road needs for the Forest Heights Estates subdivision. Per our current code Black Forest Fire Rescue is requiring the following Fire Access to your sub.

1. **403.3 Fire apparatus access road. (2006 WUI code)**When required, fire apparatus access roads shall be all-weather roads with a minimum width of 20 feet (6096 mm) and a clear height of 13 feet 6 inches (4115 mm); shall be designed to accommodate the loads (75,000lbs) and turning radii for fire apparatus; and have a gradient negotiable by the specific fire apparatus normally used at that location within the jurisdiction. Dead-end roads in excess of 150 feet (45 720 mm) in length shall be provided with turnarounds as approved by the code official. An all-weather road surface shall be any surface material acceptable to the code official that would normally allow the passage of emergency service vehicle.
2. Per 2015 IFC (amended), sec D103.4. Requirements for Dead-End Fire Apparatus Access Roads we are requiring a minimum of an 80-foot diameter cul-de-sac with curb and gutter or a 100-foot diameter cul-de-sac without curb and gutter.
3. As the road length is approximately 2200 ft to cul-de-sac, we will require a minimum of two turnouts along the main access roadway for emergency vehicle turnarounds. These turnouts should be spaced and located for maximum efficiency and shall be no less than 30 ft in length and 10 ft deep.

As you begin development of your project please be advised that your project, if 5 or more homes, will require a firefighting water supply source which is generally a water cistern located with the project and accessible to all fire apparatus or departments working in our district. This information is found in the NFPA sec 1142 (Standard on Water Supplies for suburban and Rural Fire Fighting) chapters 7 & 8. I will be happy to sit down and go over thee requirements with you as you progress in your project.

Thank you,

James Rebitski
Deputy Fire Chief

"Serving the citizens of Black Forest since 1945"

Exhibit 13:

Photos

Figure 1: Upstream End of Culvert #1

Figure 2: Facing Downstream of Culvert #1

Figure 3: Wetlands upstream of Culvert 1

Figure 4: Facing NE from Wetland Area

Figure 5: Downstream End of Culvert 1

Figure 6: Facing downstream of Culvert 1

Figure 7: 8250 Forest Heights Circle

Figure 8: Facing west along northerly edge of road

Figure 9: Facing west along southerly edge of road

Figure 10: Facing south along property line

Figure 11: First Residence off of cul-de-sac

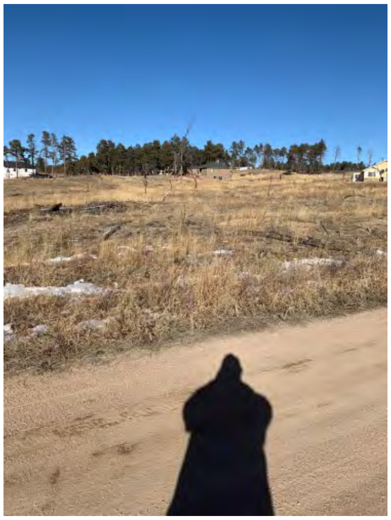


Figure 12: Facing NE to Swale 3

Figure 13: Wetland Area along east fork of Swale 3

Figure 14: Facing south along prop line

Figure 15: Facing SW of Prop Corner

Figure 16: Facing north along gas line easement


Figure 17: Wetland area in Swale 3


Figure 20: Facing SW along Swale 3


Figure 18: Facing SW at upper end of wetland area


Figure 21: Upstream end of Culvert 2


Figure 19: facing NE along w. branch of swale 3


Figure 22: Facing NE of Culvert 2

Figure 23: Facing SW along PL

Figure 24: Downstream end of Culvert 2

Figure 25: west along southerly edge

Figure 26: Facing east along northerly edge

Figure 27: 7960 Forest Heights Circle

Figure 28: Facing south along PL

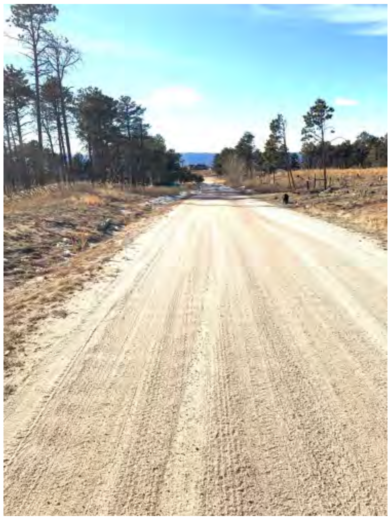


Figure 29:Top of high pnt facing west


Figure 30: Facing NE along Swale 5

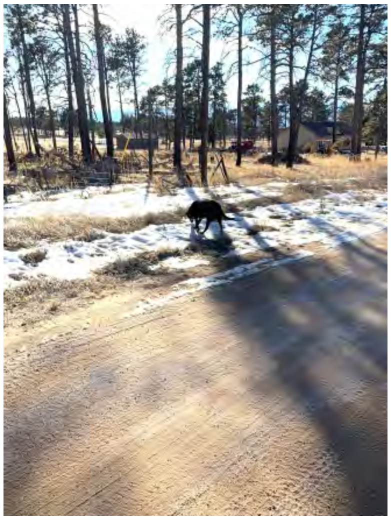


Figure 31:Facing SW along Swale 6


Figure 32: Water routed in northern borrow ditch


Figure 33: Facing west along north side

Figure 34: photo omitted

Figure 35: Facing west along S edge

Figure 36: 7940 Forest Heights Circle

Figure 37: Asphalt drive 7940 FHC

Figure 38: Facing west along northern edge

Figure 39: Facing west along southerly edge


Figure 40: wetland area east of culvert 3


Figure 41: Upstream end Culvert 3


Figure 42:Facing north of Culvert 3


Figure 43:Downstream end of Culvert 3


Figure 44: Facing downstream of Culvert 3


Figure 45: Herring Road Intersection


Figure 46: Facing east of intersection


Figure 47: Facing south to culvert under Herring


Figure 48: 18" CMP under Drive


Figure 49: Facing SW at Herring Rd Crossing


Figure 50: Facing west from High pnt 1 east of Herring

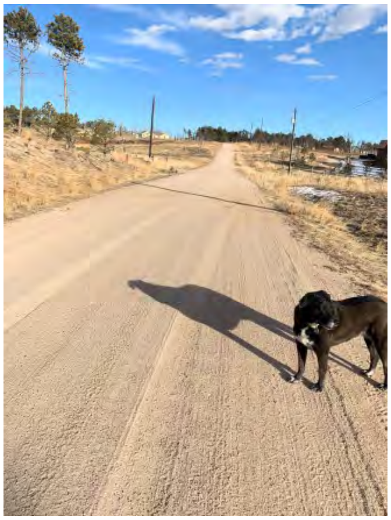


Figure 51: Facing east from first HP


Figure 52: Facing downstream of culvert 2

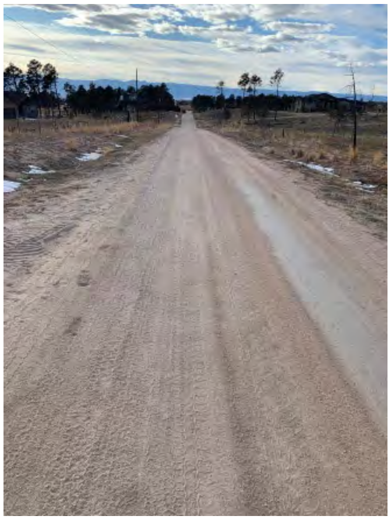


Figure 53: Facing west of 2nd HP

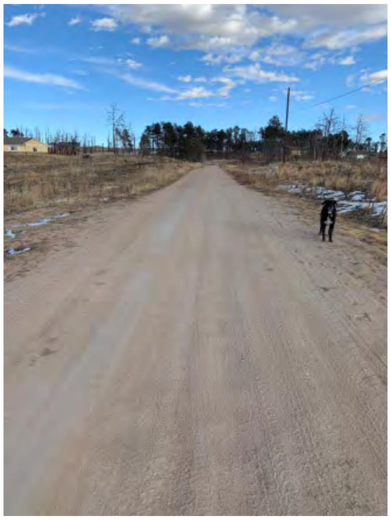


Figure 54: Facing west from 2nd HP


Figure 55: culvert under Herring


Figure 56: Culvert under Herring

Exhibit 14:

Maintenance Agreement

ACCESS EASEMENT GRANT AND MAINTENANCE AGREEMENT
FOR FOREST HEIGHTS CIRCLE
AND
RESTRICTIVE COVENANTS FOR
LOTS 1, 2, 3 & 4
FOREST HEIGHTS ESTATES SUBDIVISION

This Access Easement Grant and Maintenance Agreement For Forest Heights Circle and Restrictive Covenants for Forest Heights Estates Subdivision, dated for reference this ________day of __________________, 20___, (Agreement) is made among Phyllis J Didleau Revocable Trust, Jon P. Didleaux, Leilani A Ritchie, Charles F. Bauer and Shirley L. Bauer, and Frederick J. Yonce (each individually an “Owner” and collectively the “Owners”).

RECITALS:

A. Phyllis J Didleau Revocable Trust and Jon P Didleaux are the owner of the real property situated in the County of El Paso, State of Colorado described on Exhibit A (Assessor Parcel # 5209000121).
B. Phyllis J Didleau Revocable Trust is the owner of the real property situated in El Paso County State of Colorado described on Exhibit A-1 (Assessor Parcel 5209000081)
C. Phyllis J Didleau Revocable Trust and Jon Didleaux are the owners of real property situated in the County of El Paso, State of Colorado described on Exhibit B (Assessor Parcel # 5209000120).
D. Phyllis J Didleau Revocable Trust and Jon P Didleaux are the owners of the real property situated in the County of El Paso, State of Colorado described on Exhibit C (Assessor Parcel # 5209000050).
E. Leilani A Ritchie Trust is the owner of the real estate situated in the County of El Paso, State of Colorado described on Exhibit D (Assessor Parcel # 5209000103).
F. Charles, F. Bauer and Shirley L Bauer are the owners of the real property situated in the County of El Paso, State of Colorado described on Exhibit E (Assessor Parcel # 5209000100).

G. Frederick J. Yonce is the owner of the real property situated in the County of El Paso, State of Colorado described on Exhibit F (Assessor Parcel # 5209000119).
H. Judith P. Von Ahlefeldt is the owner of the real property situated in the County of El Paso, State of Colorado described on Exhibit G (Assessor Parcel # 5209000108).
I. Phyllis J Didleau Revocable Trust, Jon P. Didleaux (a/k/a Jon Didleaux) and Frederick J. Yonce, (collectively referred to herein as "Grantors") wish to grant an access easement to the Owners across the property described in Exhibits A, A-1, B, and F and to establish and provide for the maintenance of a private right of way and road within the access easement for the use and benefit of all Owners and Judith P. Von Ahlefeldt.
J. The access easement within which the private right of way and road is located is legally described in Exhibit H (the "Private Road Land").
K. The Owners understand that El Paso County does not maintain private roads such as the one subject to this Agreement.
L. The Owners wish to provide for and set forth their understandings and agreement with respect to use and maintenance of the private road and improvements thereon.
M. Phyllis J Didleau Revocable Trust and Jon P. Didleaux have submitted an application to subdivide the property described in Exhibits A and B with El Paso County and desire to have this Agreement meet the requirements of El Paso County for County approval of such subdivision.
N. This Agreement shall become fully in force, as to all Owners who have signed, upon the recording of the Final Plat of Forest Heights Estates Subdivision in the real estate records of El Paso County, Colorado.

NOW THEREFORE, in consideration of the sum of Ten Dollars ($10.00) and other valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the following grants, agreement, covenants, declaration and restrictions are made:

PRIVATE ROAD – FOREST HEIGHTS CIRCLE

1. Grant of Easement. Each of the Grantors hereby grants to each Owner and to Judith P. Von Ahlefeldt and their successors and assigns, a nonexclusive easement for access, utilities and drainage for the benefit of each such landowner's respective parcel described above across the Private Road Land.

2. Use of the Owners' Real Estate. Use of the Private Road Land by the Owners is not confined to the present configuration of their respective properties, and the Owners or their successors may subdivide, reconfigure, construct improvements on or otherwise modify or use their property. However, the Owners agree to construct no fences or place any other obstructions on their respective properties in a manner which would prevent, or reasonably impede, vehicle or personnel travel, utility access or drainage across the Private Road Land. Otherwise, the respective Owners

each shall have full use and occupancy of their respective real estate which is subject to the easement set forth above.

3. Construction of the Private Road. After recording of the Final Plat submitted by Phyllis J Didleau Revocable Trust and Jon Didleaux, without cost to the other Owners, Phyllis J Didleau Revocable Trust and Jon Didleaux shall improve the road to meet the standards required by the County approval of the Final Plat and shall provide maintenance of the road until such improvements are substantially complete.

4. Maintenance of the Private Road. Following construction of the Private Road, as a general standard, the Owners agree that they shall provide maintenance sufficient to provide reasonable access for emergency vehicles and in no event less than has traditionally been the maintenance level of this access prior to the subdivision. The Owners may by majority vote adopt (and modify) specific standards for maintenance from time to time. The Owners of each residence shall collectively have one vote regardless of the number of Owners of that residence. The Owners agree to share the cost and expense of maintaining the improvements on the Private Road Land in good operating condition and to share equally the cost and expense of affecting any repair to said Improvements accruing from and after the date of this Agreement. For purposes of this cost sharing, each Owner shall pay a share for each residential dwelling unit on such Owner's real estate, including a dwelling unit under construction and a "mother-in-law" unit. For example, if there are seven parcels of real estate, and five residences (whether occupied or not), each Owner with a residence on such Owner's property shall pay one fifth (1/5th) of the cost of maintaining the improvements for each such residence on such Owner's property.

5. Maintenance Process. The Owners appoint Jon P. Didleaux and Frederick J. Yonce as Co-Administrators for maintenance of the road under this Agreement. Whenever in the opinion of the Administrators the road requires such maintenance, on behalf of the Owners, the Administrators shall order and arrange for sufficient maintenance meet the standard above and to enable the Owners and emergency vehicles to use the roadway. Such maintenance shall include snow removal, grading, re-gravelling, cleaning culverts, weed treatment, tree and debris removal, and any other maintenance generally desired by Owners. The Administrators shall annually no later than September 30 submit to the Owners a budget for the succeeding 12 months. If the budget is approved by the majority of the Owners, each Owner shall by December 1 pay such Owner's share of the amount set forth in the budget into a fund run by the Administrators. The budget shall include a reasonable amount to build up a reserve to prevent the need for large expenditures in any one year. The Administrators shall use the fund to pay for maintenance to meet the standards above and any which may be adopted by the Owners. To the extent any Owner fails to pay such Owner's proportionate share of the adopted budget, the Administrators, on behalf of all the Owners, shall have a lien on each such Owner's respective real estate as set forth above until such Owner's share is paid in full with interest accruing on any unpaid amount at the rate of 10% per annum simple interest and

the Administrators shall be entitled to recover the costs of enforcing such lien and collecting such amount, including reasonable legal fees, expert witness fees and costs. The Administrators may refuse to order such maintenance until there is, in the Administrators' opinion, sufficient commitment or actual payment to pay for such maintenance. Each Owner's share shall be the proportion that the number of dwelling units (including dwelling units under construction) on such Owner's real estate above bears to the total number of dwelling units on the real estate above of all Owners. Owners of the real estate with 60% of the dwelling units accessing by the road may change who are the Co-Administrators. Administrators shall serve without compensation unless otherwise determined by Owners of the real estate with 60% of the dwelling units on the real estate of All Owners.

RESTRICTIVE COVENANTS FOR LOTS 1, 2, 3 & 4 TO PRESERVE THE RURAL/RESIDENTIAL CHARACTER OF FOREST HEIGHTS ESTATES

6. Property Uses.
   Lots 1, 2, 3 and 4 in Forest Heights Estates Subdivision shall be used exclusively for private residential purposes. No dwelling erected or maintained within the Subdivision shall be used or occupied for any purpose other than for a single-family dwelling. The construction of separate guest quarters and "mother-in-law" quarters may be allowed on a Lot on a case-by-case basis if approved by the appropriate zoning authority, subject to any conditions in such approvals.

7. Construction Type. All construction on Lots 1, 2, 3 and 4 of Forest Heights Estates Subdivision shall be new.

8. Substantial Completion. A Structure shall not be occupied in the course of original construction until substantially completed and approved for occupancy by the appropriate governmental authorities.

9. Dwelling Area Requirements. No dwelling Structure shall be constructed unless the ground floor area, or footprint area, of the main Structure, exclusive of open porches, basements and garages, is more than 1,500 square feet.

10. Enforcement. Each Owner of a Lot in Forest Heights Estates Subdivision shall have the right to enforce these Covenants To Preserve The Rural/Residential Character Of Forest Heights Estates and no other persons shall gain any legal or equitable rights to enforce these Restrictive Covenants.

BINDING AGREEMENT

11. Agreement Runs With the Land. This Agreement shall be binding upon the undersigned Owners, and their respective successors, assigns, and personal representatives. This Agreement may not be revoked without the written unanimous consent of the affected Owners. This Agreement shall be recorded in the land records of the Office of the Clerk and Recorder of El Paso County, Colorado, and

shall be a covenant running with the lands of the Owners as those lands are described herein above, and shall be enforceable by the Owners' successors and assigns and personal representatives. Any persons or other entities who acquire title to the Owners' property hereinabove described, whether by purchase or otherwise, shall be subject to the provisions of this Agreement to the same extent as if such parties had been signatory to this Agreement. This Agreement may be executed in multiple counterparts, each of which shall constitute an original and all of which shall constitute one document.

12. Effectiveness. This Agreement shall be effective as to each signatory hereto, on the later of the (a) date on which they sign or the (b) date this Agreement is recorded in the real estate records of El Paso County after County approval of the Final Plat of Forest Heights Estates.

OWNERS:

Phyllis J Didleau Revocable Trust

By: ____________________
Phyllis Didleau, Trustee

STATE OF COLORADO)
) ss.
COUNTY OF EL PASO)

This instrument was acknowledged before me on ____________________, by Phyllis Didleau as Trustee of the Phyllis J Didleau Revocable Trust and by Jon P. Didleaux (a/k/a Jon Didleaux).

[Seal]
____
________________, Notary Public
My commission expires: _________

By: ____________________
Jon P. Didleaux (a/k/a Jon Didleaux)

STATE OF COLORADO)
) ss.
COUNTY OF EL PASO)

This instrument was acknowledged before me on ____________________, by Jon P. Didleaux (a/k/a Jon Didleaux).

[Seal]
____
________________, Notary Public
My commission expires: _________

Leilani A Ritchie Trust

By: ____________________
Leilani A Ritchie, Trustee

STATE OF COLORADO)
) ss.
COUNTY OF EL PASO)

This instrument was acknowledged before me on ____________________, by Leilani A Ritchie as Trustee of Leilani A Ritchie Trust.

[Seal]

____
________________, Notary Public
My commission expires: _________

_____________________ _____________________

Charles, F. Bauer Shirley L Bauer

STATE OF COLORADO)
) ss.
COUNTY OF EL PASO)

This instrument was acknowledged before me on ____________________, by Charles, F. Bauer and Shirley L Bauer.

[Seal] ______________________________
________________, Notary Public
My commission expires: _________

____

Frederick J. Yonce

STATE OF COLORADO)
) ss.
COUNTY OF EL PASO)

This instrument was acknowledged before me on ____________________, by Frederick J. Yonce.

[Seal] ______________________________
________________, Notary Public
My commission expires: _________

EXHIBIT A (Assessor Parcel# 5209000121)

Tract in Northwest quarter of the Southwest quarter of Section 9, Township 12 South, Range 65 West, County of El Paso, State of Colorado, described as follows:
Commencing at the Northwest corner of said Northwest quarter of the Southwest quarter;
Thence Southerly on Westerly line 430.0 feet, angling left 90° 13' Easterly 30.0 feet for point of beginning;
Thence continuing Easterly on same course 435.0 feet, angling right Southerly 60.0 feet, angling right 434.0 feet;
Thence angling right Northerly 60.0 feet to point of beginning.

EXHIBIT A-1 (Assessor Parcel# 5209000081)

A TRACT OF LAND IN THE NORTHEAST QUARTER OF THE SOUTHWEST QUARTER OF SECTION 9, TOWNSHIP 12 SOUTH, RANGE 65 WEST OF THE 6TH P.M., SITUATE IN EL PASO COUNTY, COLORADO, AND DESCRIBED AS FOLLOWS:

COMMENCING AT THE WEST QUARTER CORNER OF SAID SECTION 9; THENCE NORTH 89 DEGREES 47 MINUTES EAST ON THE EAST-WEST CENTERLINE THEREOF FOR 1926.45 FEET TO THE POINT OF BEGINNING OF THE TRACT DESCRIBED HEREBY; THENCE (1) CONTINUE NORTH 89 DEGREES 47 MINUTES EAST ON SAID EAST-WEST CENTERLINE FOR 506.16 FEET TO THE NORTHWEST CORNER OF THAT TRACT DESCRIBED IN DEED RECORDED IN BOOK 1500 AT PAGE 633 OF THE RECORDS OF SAID COUNTY; (2) SOUTH 0 DEGREES 06 MINUTES 04 SECONDS WEST ON THE WEST LINE THEREOF FOR 430.0 FEET; (3) SOUTH 89 DEGREES 47 MINUTES WEST PARALLEL WITH SAID EAST-WEST CENTERLINE FOR 505.40 FEET; (4) NORTH PARALLEL WITH THE WEST LINE OF THE SOUTHWEST QUARTER OF SAID SECTION 9 FOR 430.0 FEET TO THE POINT OF BEGINNING; TOGETHER WITH A NON-EXCLUSIVE RIGHT OF WAY FOR EGRESS AND INGRESS OVER A TRACT OF LAND 33 FEET WIDE, THE CENTER LINE OF WHICH IS DESCRIBED AS FOLLOWS: BEGINNING AT A POINT LOCATED 446 ½ FEET SOUTH OF THE NORTH LINE OF SAID SOUTHWEST QUARTER OF SECTION 9 ON THE WEST SIDE OF SAID SECTION; THENCE EAST PARALLEL WITH THE NORTH LINE OF SAID SOUTHWEST QUARTER OF SECTION 9 TO THE EAST LINE OF THE LAND DESCRIBED IN DEED RECORDED IN BOOK 1500 AT PAGE 633, COUNTY OF EL PASO, STATE OF COLORADO.

EXHIBIT B (Assessor Parcel# 5209000120)

Tract of land in Section 9, Township 12 South, Range 65 West, County of El Paso, State of Colorado, described as follows: Commencing at the West corner of East/West center line of subdivision Section 9;
Thence Easterly 1419.94 feet for point of beginning;
Thence continuing on same Easterly course 540.0 feet m/l to tract described at Book 2318, Page 387, Southerly along the West boundary of subdivision tract 430.0 feet, Easterly along South line of same tract 505.40 feet;
Thence Southerly 60.0 feet m/l to tract described in Book 721, Page 970;
Thence Westerly along North line 460.74 feet, Southerly along West line of same subdivision tract 829.87 feet, Westerly at R/A 1969.86 feet to a point on the East line of Herring Road;
Thence Northerly along that East line 320.0 feet to the South line of tract described in Book 2371, Page 388;
Thence Easterly on subdivision South line 434.0 feet, Northerly on East line of same subdivision tract 230.0 feet to Southwest corner of tract described in Book 1951, Page 432, Easterly on South line of said tract 381.0 feet, Northerly on East line of same tract 286.0 feet, Easterly at R/A 67.43 feet, Northerly at r/a 60 feet to Southeast corner of tract described in Book 2215, Page 559, Easterly at r/a 506.51 feet m/l;
Thence Northerly 430.0 feet to point of beginning, except tract described in Book 2645, Page 207.

EXHIBIT C (Assessor Parcel# 5209000050)

THAT PORTION OF THE NORTHWEST QUARTER OF THE SOUTHWEST QUARTER OF SECTION 9 TOWNSHIP 12 SOUTH, RANGE 65 WEST OF THE 6TH P M , DESCRIBED AS FOLLOWS:

FROM THE NORTHWEST CORNER OF THE NORTHWEST QUARTER OF THE SOUTHWEST QUARTER OF SAID SECTION 9, RUN SOUTH ON THE WEST LINE THEREOF, 490.0 FEET; THENCE EAST PARALLEL TO THE NORTH LINE OF SAID NORTHWEST QUARTER OF THE SOUTHWEST QUARTER, A DISTANCE OF 464 FEET TO THE POINT OF BEGINNING OF THE TRACT TO BE DESCRIBED HEREBY; THENCE CONTINUE ON SAID PARALLEL LINE EAST, A DISTANCE OF 381.0 FEET, THENCE SOUTH PARALLEL TO THE WEST LINE OF SAID NORTHWEST QUARTER OF THE SOUTHWEST QUARTER, A DISTANCE OF 286.0 FEET; THENCE WEST PARALLEL WITH THE FIRST COURSE, A DISTANCE OF 381 0 FEET; THENCE NORTH PARALLEL WITH THE SECOND COURSE, 286.0 FEET TO THE POINT OP BEGINNING, COUNTY OF EL PASO, STATE OP COLORADO

EXHIBIT D (Assessor Parcel# 5209000103)

A tract of land in the North half of the Southwest quarter of Section 9, Township 12 South, Range 65 West of the 6th P.M. described as follows: Commencing at the West quarter corner of said Section 9, thence North 89 degrees 47 minutes East on the East-West center line thereof for 913.43 feet to the Point of Beginning of the tract hereby described; thence (1) continuing North 89 degrees 47 minutes East for 506.51 feet along said line; (2) South for 430.0 feet; (3) South 89 degrees 47 minutes West for 506.51 feet; (4) North for 430.0 feet to the Point of Beginning, in El Paso County, Colorado. Together with a tract of land in the North half of the Southwest quarter of Section 9, Township 12 South, Range 65 West of the 6th P.M. El Paso County, Colorado, described as follows: A non-exclusive easement for ingress and egress being 60 feet in width, 30 feet on each side of the following described center line; beginning at a point on the West line of said Section 9 that lies 460 feet south from the West quarter corner of said Section 9; thence North 89 degrees 47 minutes East, parallel with the North line of said Southwest quarter a distance of 1,419.94 feet, County of El Paso, State of Colorado.

EXHIBIT E (Assessor Parcel# 5209000100)

A tract of Land in the North half of the Southwest Quarter of Section 9, Township 12 South, Range 65 West of the 6th P.M., County of El Paso, State of Colorado, described as follows:

Commencing at the West quarter corner of said Section 9; thence Southerly on the West line thereof for 490 feet; thence angle left 90 degrees 13 minutes Easterly parallel with the North line of said Southwest quarter of Section 9 for 1090 feet to the point of beginning of the tract to be described hereby; thence (1) continue Easterly 610 feet; (2) angle right 90 degrees 13 minutes Southerly parallel to said West line for 325 feet; (3) angle right 89 degrees 47 minutes Westerly parallel to said North line for 610 feet; (4) angle right 90 degrees 13 minutes Northerly parallel to said West line for 325 feet to the point of beginning; TOGETHER with a right of way for ingress and egress over a strip of land 60 feet in width, being 30 feet on each side of the following described center line; beginning at a point on the West line of Section 9, Township 12 South, Range aforesaid that is 460 feet Southerly from the West quarter corner of said Section 9; thence angle left 90 degrees 13 minutes Easterly parallel with the aforesaid North line for 1700 feet.

EXHIBIT F (Assessor Parcel# 5209000119)

That portion of the Northwest quarter of the Southwest quarter of Section 9 in Township 12 South, Range 65 West of the 6th P.M., described as follows: Commencing at the Northwest corner of said Northwest quarter of the Southwest quarter of Section 9; thence Southerly on the Westerly line thereof a distance of 430 feet; thence angle left 90 degrees 13 minutes on a line parallel with the North line of said Northwest quarter of the Southwest quarter a distance of 465 feet to the Southeast corner of a tract described in Book 1501 at page 299 under Reception No. 962187 of the records of El Paso County, Colorado and the point of beginning of the tract to be described hereby; thence Northerly on the Easterly line of said tract described in Book 1501 at page 299 a distance of 430 feet to the North line of said Northwest quarter of the Southwest quarter of Section 9; thence Easterly on said Northerly line a distance of 448.43 feet to a point; thence angle right 90 degrees 13 minutes Southerly a distance of 430 feet; thence angle right 89 degrees 47 minutes Westerly a distance of 448.43 feet to the point of beginning.

Together with a non-exclusive right of way for ingress and egress over a tract of land 60 feet wide, being 30 feet on either side of a centerline which is described as follows: Beginning at a point on the West line of the Southwest corner of section 9 in Township 12 South, Range 65 West of the 6th P.M., that is 460 feet Southerly thereon from the Northwest corner of said Southwest quarter; thence Easterly parallel with the North line of said Southwest quarter a distance of 913.43 feet.

EXHIBIT G (Assessor Parcel# 5209000108)

A tract of land located in the NE1/4 of the SW1/4 of Section 9, Township 12 South, Range 65 West more particularly described as follows:

Commencing at the W1/4 of said Section 9, thence south along the west section line of said Section 9 a distance of 490.00 feet; thence N 89º47'00" E parallel with the east-west center line of said Section 9, a distance of 1971.00 feet to the **Point of Beginning:**

Thence continuing N 89º47'00" E a distance of 460.74 feet;

Thence N 00º06'04" E a distance of 490.00 feet to the intersection of said east-west center line;

Thence continuing N 89º47'00" E along said east-west center line a distance of 190.00 feet;

Thence S 00º06'04" W a distance of 1320.00 feet;

Thence S 89º45'20" W a distance of 649.27 feet;

Thence northerly a distance of 829.87 feet to the **Point of Beginning.**

EXHIBIT H (Private Road Land)

A tract of located in the SW1/4 of Section 9, Township 12 South, Range 65 West of the 6th P.M. being over and across a portion of the properties described in Exhibits A, A-1, B and F, to be known as Forest Heights Circle and shown as 15' additional R.O.W. Dedication to El Paso County, Tract A, 60' Private Road Easement, Tract B and Ingress-Egress, Utilities & Drainage Easement on the plat of Forest Heights Estates, more particularly described as follows:

Commencing at the NW corner of said SW1/4; Thence S 00º03'25" W a distance of 430.00 feet along the west line of said SW1/4; Thence N 89º55'03" E a distance of 30.00 feet to the **Point of Beginning:**

Thence N 89º55'03" E a distance of 2199.70 feet;

Thence N 53º43'21" E a distance of 110.07 feet;

Thence N 89º55'03" E a distance of 115.00 feet;

Thence S 00º09'20" W a distance of 125.00 feet;

Thence S 89º55'03" W a distance of 2403.55 feet;

Thence N 00º03'25" E a distance of 60.00 feet to the **Point of Beginning.**

Exhibit 15

Reseeding Mix, Grass Characteristics and Allowable Velocities

Recommended El Paso County Grass Seed Mixes

Grass mix for quick revegetation – all sites:

Grass:	Variety	PLS lbs per acre
Crested Wheat Grass	Ephraim or HyCrest	4.0
Perennial Rye	Linn	2.0
Western Wheatgrass	Barton	3.0
Smooth Brome Grass	Lincoln or Manchar	5.0
Sideoats Grama	El Reno	2.5
		Total: 16.5

Grass mix for heavier soil areas:

Grass:	Variety	PLS lbs per acre
Crested Wheat Grass	Ephraim	3.0
Slender Wheat Grass	Sodar	2.5
Western Wheatgrass	Barton	5.0
Smooth Brome Grass	Lincoln or Manchar	4.0
Sideoats Grama	El Reno	3.0
		Total: 17.5

Grass mix for sandy soils:

Grass:	Variety	PLS lbs per acre
Sideoats Grama	El Reno	3.0
Western Wheatgrass	Barton	2.5
Slender Wheat Grass	Native	2.0
Little Bluestem	Pastura	2.0
Sand Dropseed	Native	0.5
Switch Grass	Nebraska 28	3.0
Weeping Love Grass	Morpha	1.0
Optional: Perennial Rye		2.0
		Total: 14-16

(From NRCS memo dated June 19, 2001)

SIDE-OATS GRAMA

Bouteloua curtipendula (Michx.) Torr.

Plant Symbol = BOCU

Contributed by: USDA NRCS Plant Materials Center, Manhattan, Kansas

Alan Shadow, East Texas Plant Materials Center, Nacogdoches, Texas

Uses

Forage: Side-oats grama produces high quality, nutritious forage that is relished by all classes of livestock throughout the summer and fall, and it remains moderately palatable into winter. This makes it one of the most important range grass species.

Erosion Control: Weaver and Albertson (1944) described the role of side-oats grama in the recovery of grasslands following the drought of the 1930's. It was one of the few grasses that covered large areas bared by the loss of other grasses during the drought period. Side-oats grama is recommended in grass mixtures for range and pasture seeding, for earth fill and bank stabilization, for other critical areas and recreational plantings. Successful seeding can be obtained in rocky, stony or shallow soil sites. In fact side-oats is often found in nearly pure stands on caliche outcrops, stony hillsides and breaks (Harlan, 1954).

Wildlife: Side-oats provides some forage for antelope and deer when actively growing. Elk will use this grass as forage throughout the year. Leithead et al. (1971) indicated that the seed of this species was consumed by wild turkeys.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description

General: Side-oats grama is a deep rooted, perennial grass. The plants crown will spread very slowly by means of extremely short, stout rhizomes. A mid-grass in height, it has rather wide leaves and a very distinct inflorescence consisting of a zigzag stalk with small compressed spikes dangling from it at even intervals. The short spikes dangle from one side of the stalk, thus providing the plant with its common name. In the vegetative state the grass is easily recognized by the long, evenly spaced hairs attached to the margins of the leaf near its base. Side-oats grama possesses the C-4 photosynthetic pathway common to warm-season grasses (Waller and Lewis, 1979).

Distribution: For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site. One of the most widely distributed of the grama grasses. It has a widespread distribution eastward from the Rocky Mountains to near the east coast except in the southeast.

Habitat: Side-oats grama grows effectively in the dryer mid-grass prairie section of the Great Plains that has an annual rainfall of 12-20 inches. This species occurs naturally in mixed stands with blue grama (*Bouteloua gracilis*) and little bluestem (*Schizachyrium scoparium*). This grass is better adapted to calcareous and moderately alkaline soils than to neutral or acidic soils (Leithead etal., 1971)

Adaptation

Side-oats is adapted to a broad range of sandy to clayey textured soils; it is least tolerant of loose sands and dense clays. The best stands of side-oats are found on medium to fine texture upland soils. This species has shown varying tolerance to soil salinity from weak to moderate. Side-oats is moderately drought tolerant, but less than blue grama. It is moderately tolerant of semi-shaded conditions and can be found in open woodlands. It will sustain damage from wildfires when actively growing and under drought stress conditions, but is fairly tolerant of fire in a dormant state. It is also fairly tolerant of spring flooding. It probably has the widest range of adaptation of any of the warm-season perennial grass plants. It grows in combination with tall warm-season grasses such as big bluestem (*Andropogon gerardii*) and switchgrass (*Panicum virgatum*) all the way to the short grass plants such as buffalo grass (*Bouteloua dactyloides*) and blue grama (*Bouteloua gracilis*). Thus, it can successfully grow in a variety of climates and habitats in the continental U.S.

Establishment
Seed improved cultivars of this grass no deeper than ¼ inch on fine textured soils and ¾ inch on coarser textured soils. Planting with a grass seed drill on a firm, weed free seedbed at the rate of 2.5 to 5.0 pounds of pure live seed (PLS) is encouraged. Broadcasting at a higher seeding rate (50 to 100 percent increase) can be utilized on a previously prepared seedbed that will be culti-packed after seeding is completed. Increased seeding rate should also be used on bare areas, harsh sites, or on areas that require denser or quicker stand establishment. Seeding is more likely to be successful if moisture conditions are good and if mulch is used to retain moisture on the seeding site. Most seed germinates within 7 days under good field conditions. Seedling vigor is good when compared to other warm season grasses. Field germination, emergence and establishment of this species are better than other grama grasses. Protection from grazing is encouraged while seedlings are in the juvenile stage of growth.

Management
As a mid-grass, side-oats grama is intermediate in many respects between the tall and short grass species. Side-oats grama is not as resistant to grazing pressure as is blue grama due to its taller growth habit. Side-oats seedlings are vigorous and stands tend to establish quickly and can often be utilized for forage production the second year after planting. Side-oats grama is usually included in range mixes and should be managed as native rangeland. Management should include proper livestock stocking rates and correct season of use.

Pests and Potential Problems
Grasshoppers can be destructive of seedling stands. Some stem and leaf rust occurs in wet years and Mankin (1969) found several leaf spot and root rot fungi occurred on side-oats grama.

Seeds and Plant Production
Seed production experiments conducted in Nebraska in the 1950's found that side-oats grama response to nitrogen fertilization was dependent on moisture conditions during critical growth periods (Newell et al., 1962). Seed yields measured as whole spikes were substantially increased over unfertilized check plots by all rates of nitrogen applied. Under drought conditions the application of 60 and 90 pounds of nitrogen yielded whole spike yields of approximately equal amounts. Under favorable moisture conditions nitrogen fertilization improved the quality of the caryopsis by increased weight per 1000 caryopsis over unfertilized plots.

Seed of side-oats grama normally found on the open market consists of either whole spikes or individual florets, or mixtures of these, which vary widely in their content of germinable caryopsis. Thus, seeding rates of side-oats must be computed on the basis of purity and viability of the seed lot. Purity analysis of side-oats can be complicated by the inclusion of adhering glumes and spike fragments as part of the seed unit. As long as the seed unit has a germinable caryopsis in the spike it is considered viable and used in the computation of pure live seed by the seed analyst. Thus a spike may contain several germinable caryopses, but is counted only as one for the purpose of germination percentage.

The effect of burning on seed yield was studied by Newell etal. (1962) in fertilized and unfertilized plots. Although the seed yield results were numerically larger from both levels of fertilized plots when burned, the differences could not be proven to be statistically different. This finding is noteworthy since it proves that proper burning, if not conducted too late in the spring, does not reduce seed yield. Burning is a proven method of cleaning the field for the new seed crop year. Burning has also been known to help control cool season weeds and reduce disease inoculums for the new crop.

Thus, side-oats grama may be grown for seed in cultivated rows, and will respond to timely fertilization and irrigation applications.

Cultivars, Improved, and Selected Materials (and area of origin)
Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under "United States Government". The Natural Resources Conservation Service will be listed under the subheading "Department of Agriculture."

'Butte' was selected at Nebraska AES, Lincoln, USDA-ARS and SCS cooperatively by E.C. Conard and L.C. Newell. It represents native collections from Holt and Platte Counties in Nebraska that were combined and tested as Nebraska 37. Repeated field plantings revealed superior germination and establishment characteristics when compared with other sources.

‘El Reno’ was released cooperatively in 1944 by the SCS, Manhattan, Kansas Plant Materials Center and Kansas AES. The original seed was collected in a field location near El Reno, Oklahoma in 1934. The material was outstanding for leafiness, forage production and vigor. It also ranked well for disease resistance, seed production, and winter hardiness. It is widely used in range seedings and is adapted to Kansas, Oklahoma and northern Texas.

‘Haskell’ was released in 1983 by the James E. “Bud” Smith Plant Materials Center, Texas AES and USDA-ARS. The seed for this release was originally collected in 1960 by J.C. Yeary, Jr. in Haskell, Texas. It was selected based on rhizome production and adaptation as far south as the Rio Grande Valley in Texas. It is also known for its high forage palatability and prolific seed production.

Killdeer was informally released in the late 1960’s by the Bismarck Plant Materials Center in Bismarck, ND. It is composed of seed collected from native stands in 1956 near Bowman, Bowman County and Killdeer, Dunn County, North Dakota. Killdeer possesses outstanding vigor, leafiness, fair seed production, freedom from disease and persistence in a cold, semi-arid environment.

‘Niner’ was released in 1984 by SCS and the New Mexico and Colorado AES. The original seed for the release was collected by G.C. Niner and J.A. Anderson in 1957 west of Socorro, New Mexico. Niner was a bulk increase of the collection made by Niner and Anderson.

Pierre was informally released in 1961 by the Bismarck Plant Materials Center and the South Dakota AES. The original seed for the release was collected in 1954 in Stanley County west of Pierre, South Dakota. The release is described as outstanding in vigor, leafiness, freedom from disease, seedling vigor and persistence in a semi-arid environment.

‘Premier’ was released in 1960 cooperatively by Texas AES and USDA-ARS and NRCS. The original seed was collected in 1953 from a single plant growing between Cuauhtemoc and Chichuahua, Mexico. The release is described as having good seedling vigor, good seed yield, drought tolerance, upright growth form and leafiness.

‘Trailway’ was cooperatively released in 1958 by Nebraska AES and USDA-ARS. The original seed was collected in 1953 in northern Holt County by L.C. Newell. The release is described as winter hardy, long lived, late maturing with a somewhat indeterminate heading and flowering response. Requires most of the growing season to mature a crop in eastern Nebraska and may fail to produce seed in areas with a shorter growing season.

‘Vaughn’ was released in 1940 by the New Mexico AES and SCS Plant Science Division. The original seed was collected from native stands in 1935 near Vaughn, New Mexico. The release is described as slightly variable, but all have erect leaves, good seedling vigor and easy to establish.

Northern, Central and Southern Iowa Germplasms were released in 1995 as source identified releases, by the Elsberry Plant Materials Center, University of Northern Iowa, Iowa Department of Transportation, Iowa Crop Improvement Association and NRVC. They are all composite lines from collections made in Northern, Central and Southern Iowa.

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Prepared by and Species Coordinator

Richard Wynia, USDA NRCS Manhattan Plant Materials Center, Manhattan, Kansas

Edited: 070717 jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Plant Fact Sheet

WESTERN WHEATGRASS

Pascopyrum smithii (Rydb.) A. Love

Plant Symbol = PASM

Contributed by: USDA NRCS Plant Materials Program

Robert H. Mohlenbrock
USDA NRCS 1989.
Midwestern Wetland Flora
@ USDA NRCS PLANTS

Alternate Names

Agropyron smithii Rydb.

Uses

Erosion control: Western wheatgrass is an excellent erosion control plant because of its spreading rhizomes. It is widely used in seed mixtures for range seeding, revegetation of saline and alkaline areas, and in critical areas for erosion control in the central and northern Great Plains region. This grass protected watershed dams in Kansas from damage when they were overtopped during a 14-inch rainfall event.

Reclamation: Western wheatgrass is frequently used in the northern Great Plains for surface mine revegetation. Because of its strong rhizomes and adaptation to a variety of soils, it performs well as part of a reclamation mixture.

Livestock: Forage quality is high for pasture or range seedings.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description

Pascopyrum smithii (Rydb.) A. Love, western wheatgrass, is perhaps one of the best known and most commonly used native grasses. It is a long-lived, cool season species that has coarse blue- green leaves with prominent veins. Because of this bluish appearance it has sometimes been called bluestem wheatgrass or bluejoint. It is a sod former with very strong, spreading rhizomes. Stems arise singly or in clusters of a few and reach heights of 1 to 3 feet. The sheaths are hairy and the purplish auricles typically clasp the stem. The seed spike is erect and about 2 to 6 inches long.

Adaptation and Distribution

Western wheatgrass is adapted to fine and very fine soils and is replaced by thickspike wheatgrass on coarser soils. Although it is able to grow on a wide variety of soils it prefers the heavier but well drained soils. It requires moderate to high soil moisture content and is most common in the 10 to 14 inch annual precipitation zones. Above 20 inches per year it behaves as an increaser on rangelands, below 20 inches it is a decreaser. Its elevational range is 1,000 to 9,000 feet.

Western wheatgrass tolerates saline and saline-sodic soils, poor drainage and moderately severe drought. It will tolerate spring flooding, high water tables, and considerable silt deposition. It is very cold hardy and can grow in partial shade. It is grazing resistant and can survive fires if in the dormant stage; recovery from fire, however, is slow.

Western wheatgrass grows in association with many species, the more common being blue grama, buffalograss, needlegrasses, bluebunch wheatgrass, rough fescue, Idaho fescue, and prairie junegrass. It begins growth about 2 to 3 weeks before blue grama and does not mature until much later in the growing season.

Western wheatgrass performs poorly in the East and is not recommended for any use in the region.

Western wheatgrass is distributed throughout the west and midwest portions of the United States. For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

Establishment

Seed of western wheatgrass should be planted 1/2 to 1 inch deep in fine to medium soil. Seeding rates should be 5 to 15 pounds PLS per acre drilled or 20 to 25 PLS per row foot. If seed is broadcast or used on harsh sites, the rate should be doubled. This species should be seeded in early spring, late fall or in the period of late summer, early fall. It can be sodded.

Seedling vigor is fair and stands may be slow to establish. It has stronger rooting abilities than does thickspike wheatgrass but spreads more slowly and may take several years to become firmly established. Once established, it is very hardy and enduring. It is moderately compatible with other species and is moderately aggressive.

Management

Western wheatgrass greens up in March or early April and matures in August. If moisture is adequate, it will make fair summer or fall regrowth. If nitrogen is applied it will compete with warm season grasses.

Western wheatgrass is moderately palatable to elk and cattle all year although this quality diminishes in late summer. It is palatable to deer only in spring. It is preferred by cattle more than by sheep. It can be grazed if 50 to 60 percent of the annual growth is allowed to remain (3 or 4 inch stubble). Rest rotation of western wheatgrass is advised. In areas where it is dense, it makes an excellent hay as well as pasture.

Irrigation will improve western wheatgrass stands and aid establishment. Weed control and fertilization will also help. Pitting, chiseling, disking, and interseeding can be used to stimulate stands of western wheatgrass.

Pests and Potential Problems

The primary pests to western wheatgrass are grasshoppers, ergot, and stem and leaf rusts.

Cultivars, Improved, and Selected Materials (and area of origin)

‘Ariba’ western wheatgrass was released for dry land hay production, grazing, and conservation seedings in the western part of the Central Plains and in the southwestern United States. ‘Flintlock’ is a broad-based cultivar. It is recommended for conservation seeding, dry land hay production, and grazing in the Central Plains. ‘Barton’ is a strongly rhizomatous, leafy ecotype, intermediate in growth between northern and southern types. ‘Barton’ is relatively disease free and high in forage and seed production. ‘Rosana’ is a northern type western wheatgrass. Plants are blue-green, leafy, with moderately fine stems. Rhizomes produce a tight sod. ‘Rosana’ is recommended for reseeding depleted range lands and the reclamation of disturbed lands in the Northern Great Plains. ‘Rodan’ northern type western wheatgrass is moderately rhizomatous and forms a dense blue-green sward. Leaves are thinner and less heavily veined than other western wheatgrasses. Western wheatgrass seed is available at most farm seed stores.

Prepared By & Species Coordinator:

USDA NRCS Plant Materials Program

Edited: 05Feb2002 JLK; 060802 jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

CRESTED WHEATGRASS

(DESERTORUM TYPE)

Agropyron desertorum (Fisch. ex Link) J.A. Schultes

Plant Symbol = AGDE2

Contributed by: USDA NRCS Idaho State Office

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Smithsonian Institution
@ USDA NRCS PLANTS

Alternate Names

standard crested wheatgrass, crested wheatgrass

Uses

Grazing/rangeland/hayland: Crested wheatgrass is commonly recommended for forage production. It is palatable to livestock and wildlife and is a desirable feed in spring, and in the fall if it re-grows enough. It is used for cattle and horse winter forage, but protein supplements are required to ensure good animal health. It withstands heavy grazing pressure (65% use and greater) once stands are established. The best forage types in order are Siberian, desertorum, and Hycrest.

Erosion control/reclamation: Crested wheatgrasses are useful for soil stabilization. They compete well with other aggressive introduced grasses, but because of this trait, they are not compatible in mixes with native species. Their drought tolerance, fibrous root systems, and good seedling vigor make these species ideal for reclamation in areas with 8 to 20 inches annual precipitation. These grasses can be used in urban areas where irrigation water is limited to provide ground cover and to stabilize ditchbanks, dikes, pipelines, powerlines and roadsides.

Wildlife: Birds and small rodents eat crested wheatgrass seeds; deer, antelope and elk graze it, especially in spring and fall. Upland and song birds utilize stands for nesting.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description

Crested wheatgrasses *Agropyron cristatum*, *Agropyron desertorum*, and Siberian wheatgrass *Agropyron fragile* are perennial grasses commonly seeded in the western United States. They are long-lived, cool season, drought tolerant, introduced grasses with extensive root systems. Crested wheatgrass grows from 1 to 3 feet tall and seed spikes may be 1.5 to 3 inches long. Spiklets flattened, closely overlapping, located divergent (flatwise) at a slight angle on the rachis flower stem. The lemmas generally narrow to a short awn and glumes are firm, keeled, tapering into a short bristle. Culms are erect, in a dense tuft and leafy. Leaves are flat, smooth below, slightly coarse above and vary in width from 2 to 6 mm.

Adaptation and Distribution

Crested wheatgrasses are adapted for non-irrigated seedings where annual precipitation averages 8 inches or more and where the frost free period is generally less than 140 days. The desertorum type is adapted to the Northwest, Intermountain and Great Plains regions with at least 8 inches of annual precipitation below 6500 feet elevation. It does well on shallow to deep, moderately course to fine textured, moderately well to well drained and weakly acidic to moderately alkaline soils. Under saline conditions, vigor and production are reduced. The desertorum type is more saline tolerant and equal to or more productive than other crested wheatgrass types. All wheatgrasses are cold tolerant, can withstand moderate periodic flooding in the spring, and are very tolerant of fire. They will not tolerate long periods of inundation, poorly drained soils or excessive irrigation.

Crested wheatgrass is distributed throughout much of the West and Midwest. For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Web site.

Establishment

Crested wheatgrass should be seeded with a drill at a depth of 1/2 inch or less on medium to fine textured soils and 1 inch or less on coarse textured soils. Single species seeding rates recommended for all crested wheatgrasses are 5 to 7 pounds Pure Live Seed (PLS) or 20 to 30 PLS per square foot. If used as a component of a mix, adjust to percent of mix desired. For critical areas, increase the seeding rate to 40 to 50 PLS per square foot. Mulching and light irrigations on highly disturbed areas are beneficial for stand establishment.

Best seeding results are obtained in very early spring on heavy to medium textured soils and in late fall on medium to light textured soils. Late summer (August to mid September) seedings are not recommended unless irrigation is available. If weed control is needed, application of 2,4-D should not be made until plants have reached the four to six leaf stage. Mow weeds that are beginning to bloom to reduce weed seed development. New stands may also be damaged by grasshoppers and other insects; pesticides may be required.

Management

Crested wheatgrasses produce leaves in the spring about 10 days after bluegrass species and about 2 to 3 weeks earlier than native wheatgrasses. New stands of crested wheatgrass should not be grazed until they are firmly established and have started to produce seed heads. Six inches of new growth should be attained in spring before grazing is allowed in established stands. Three inches of stubble should remain at the end of the grazing season to maintain the long term health of the plant.

Crested wheatgrasses are low maintenance plants; however, spring/fall deferment or grazing rotations are recommended to maintain plant health and to maximize forage production potential. Crested wheatgrass can be used for hay production and will make nutritious feed, but is more suited to pasture use. Light, infrequent applications of nitrogen (25 pounds/acre) and irrigation will increase total biomass production and lengthen the green period.

Environmental Concerns

Crested wheatgrasses are long-lived, spread primarily via seed, but may also spread via rhizomes in the case of the cristatum types. They are not considered "weedy" or invasive species. Most seedings do not spread beyond original plantings, or if they do spread, the rate of spread is not alarming. They will cross with each other, but do not cross with native species. Crested wheatgrasses resist winter annual competition better than native species because they germinate earlier and grow more rapidly at colder temperatures. Due to commonly being planted in monocultures (single species) stands in the past, some feel crested wheatgrasses are not ecologically appropriate. It is important to consider multiple species mixes to avoid this conception.

Cultivars, Improved, and Selected Materials (and area of origin)

‘Nordan’ (central Asia/former USSR) has good seedling vigor and seed quality and long term forage yields are as good or better than other types. ‘Summit’ (former USSR) is considered very similar to ‘Nordan.’ *Agropyron cristatum* x *Agropyron desertorum* (Hycrest type) is a hybrid between the cristatum and desertorum types which results in a plant with excellent seedling vigor. ‘Hycrest’ (central Asia/former USSR) is easier to establish than either of its parents and is more productive during the establishment period than either parent. Long term productivity exceeds the cristatum type and is equal to the desertorum type.

Prepared By & Species Coordinator:

Dan Ogle, Plant Materials Specialist
USDA NRCS Idaho State Office, Boise, Idaho

Edited: 31Jan2002 JLK; 24may06jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

United States Department of Agriculture

A Conservation Plant Released by the Natural Resources Conservation Service
Los Lunas Plant Materials Center, Los Lunas, NM

‘Pastura’ little bluestem

Schizachyrium scoparium (Michx.) Nash

‘Pastura’ little bluestem (*Schizachyrium scoparium*)

‘Pastura’ little bluestem was released in 1964 by the New Mexico State University’s Los Lunas Agricultural Science Center and the Los Lunas Plant Materials Center in Los Lunas, New Mexico.

Description

‘Pastura’ little bluestem is a warm-season, long-lived, perennial, native grass having good seed and forage production, and good seedling vigor.

‘Pastura’ is a bunchgrass of medium height having uniform size, growth habit, and color. It is of the green type in contrast to the bluish-green type commonly found further east. Plants are erect, non-lodging at maturity, with dense, basal leaf growth averaging 12 inches in height; culms average 24 inches. Little bluestem is a cross-pollinated species.

Source

The original seed was collected in 1957 between Glorieta and Rowe, New Mexico. It was under evaluation until its release in 1964.

Conservation Uses

For this species, ‘Pastura’ little bluestem produces an average amount of high-quality forage. This variety has a uniform appearance, with good basal leaf growth of a greater density than other strains tested.

Area of Adaptation and Use

‘Pastura’ is well-suited for range plantings on light-textured soils of the foothills and plains in central and eastern New Mexico and eastern Colorado. In these areas, it has produced more seed and forage than native collections originating further east. ‘Pastura’ is well adapted to adverse climatic conditions, particularly extremes in temperature and precipitation.

Establishment and Management for Conservation Plantings

Keep the established fields free of weeds by using the recommended herbicide(s) for this species.

Ecological Considerations

‘Pastura’ little bluestem does not appear to have insect problems in either range plantings or seed production plantings.

Seed and Plant Production

Under irrigation, ‘Pastura’ little bluestem grows well on light- to medium-textured soil. Plant in late spring to early summer after the soil has warmed.

For ease of cultivation and irrigation, plant in rows with a spacing of approximately 3 feet (spacing may be adjusted to fit conventional equipment). Plant seed about ½ inch deep with rows in beds or beside shallow furrows so that the seedbed can be irrigated without getting water directly on the row before the seedlings have emerged and begun to grow.

Apply 80 to 100 lbs. nitrogen on established stands at the time of the first irrigation. A color change in the seed heads and early seed shattering indicate the time to harvest seed. The seed heads and, consequently, the whole field becomes a uniformly brownish color.

Use an all-crop type of combine to harvest seed; cut the air flow to a minimum; operate the cylinder at high speed. Spread and dry the harvested material to avoid heating.

Availability

Foundation seed is produced by the Los Lunas Plant Materials Center. Foundation seed is available to certified growers through New Mexico State Seed Certification.

For more information, contact:
Los Lunas Plant Materials Center
1036 Miller Road
Los Lunas, NM 87031
Tele: 505-865-4684
FAX: 505-865-5163
http://plant-materials.nrcs.usda.gov/nmpmc/

Citation

Conservation Plant Release Brochure for 'Pastura' little bluestem (*Andropogon scoparius)* (Michx.) Nash. USDA-Natural Resources Conservation Service, Los Lunas Plant Materials Center, Los Lunas, NM 87031. Published April 1964; edited 21Oct2014ds

For additional information about this and other plants, please contact your local USDA Service Center, NRCS field office, or Conservation District <http://www.nrcs.usda.gov/>, and visit the PLANTS Web site <http://plants.usda.gov> or the Plant Materials Program Web site <http://www.plant-materials.nrcs.usda.gov>

United States Department of Agriculture

This is a cooperative release between New Mexico State University's Los Lunas Agricultural Science and the USDA-Natural Resources Conservation Service's Los Lunas Plant Materials Center.

SAND DROPSEED

Sporobolus cryptandrus (Torr.) A. Gray

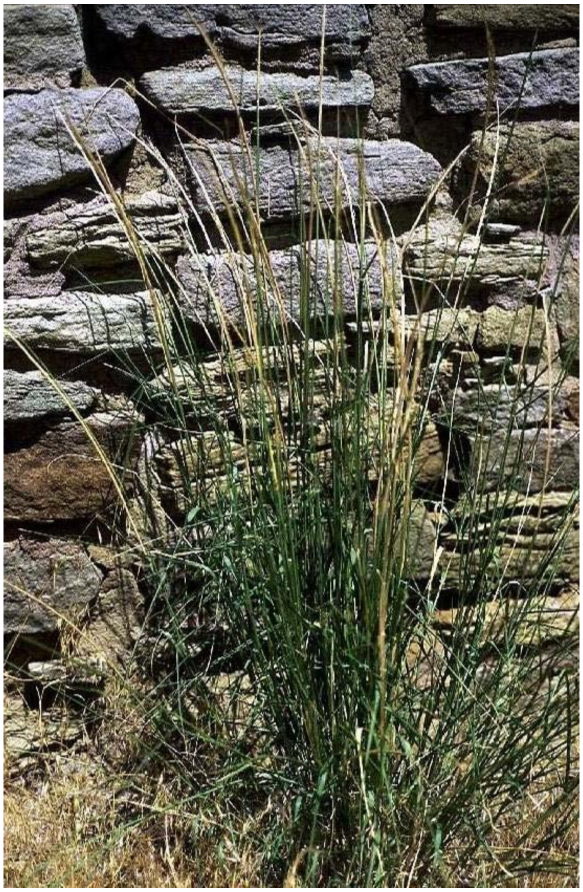
Plant Symbol = SPCR

Alternative Scientific Names: Agrostis cryptandra Torr. and *Vilfa cryptandra* (Torr.) Trin.

Description

General: Grass Family (Poaceae). Sand dropseed is a long-lived perennial warm season bunchgrass, native throughout North America (Monsen et al., 2004; Ogle et al., 2009). The scientific name, *Sporobolus*, comes from the Greek *sporos* (seed) and *bolos* (a throw), and the common name, dropseed, both refer to the seeds which fall or may be ejected from the inflorescence when the mucilaginous fruit wall dries (Peterson, et al., 2003). Mature plants range from 11 to 40 inches tall. Plants are typically erect but may also be decumbent. The collar is a conspicuous tuft of white hairs which may be up to 0.16 inches long. Leaf blades are 0.08 to 0.25 inches wide and 3 to 10 inches long. The inflorescence is a panicle, 6 to 16 inches long and 1 to 5 inches wide, initially contracted and spike-like, but opening with maturity into a pyramidal shape as the inflorescence escapes the subtending sheath (Welsh et al., 2003). Spikelets contain a small, single brown to purplish floret, 0.06 to 0.1 inches long. The glumes, lemmas and paleas are membranous (Peterson, et al., 2003) and contain a 1 mm long caryopsis (Welsh et al., 2003).

This species produces a dense, sand binding network of roots which can spread up to 2 feet laterally and over 8 feet deep (Coupland and Johnson, 1965).



Sand dropseed © Robert Soreng USDA-NRCS

Sand dropseed is a prolific seed producer. In one study, a single panicle yielded approximately 10,000 seeds (Brown, 1943). Seeds are very small; there are approximately 5.6 million seeds/lb, and 67 pounds of seed per bushel.

Distribution: Sand dropseed is native throughout North America but is most important as a rangeland species in the Southwest and certain parts of the Snake, Salmon, and Clearwater River drainages in Idaho and Oregon (USDA, 1937). For current distribution, consult the Plant Profile page for this species on the PLANTS web site.

Habitat: In the Intermountain West, sand dropseed is commonly associated with Indian ricegrass, bluebunch wheatgrass and galletta grass in sagebrush, desert shrub and pinyon-juniper plant communities. In its southern range, it is often found growing with side-oats grama and *Muhlenbergia* species. It is common in the short-grass prairies and chaparral communities. It also can be found in a variety of habitats in South Texas, from deep sands where it is a member of the climax plant community to heavier soils where it is an early successional colonizer.

Adaptation

Sand dropseed is extremely drought tolerant and is adapted to sites receiving 7 to 16 inches annual precipitation (Ogle et al., 2009; USDA 2009). Its fine root system allows sand dropseed to extract water at depths between 0 and 30 cm more effectively than broom snakeweed (*Gutierrezia sarothrae*) (Wan et al., 1993). During periods of summer drought the leaves roll up to reduce surface area and evapotranspiration (Wan et al. 1993). It is considered to be one of the most drought resistant species in short-grass prairie (Wan et al. 1993).

Sand dropseed is most common at lower elevations in sandy soils but can also be found on coarse soils at upper elevations to 8,000 ft (Jensen et al., 2001; Ogle et al., 2009). It is adapted to slightly acidic to slightly basic soils and has a salt tolerance of less than 4 mmhos/cm (Dickerson, 1998).

Uses

Erosion control/rehabilitation of disturbed areas: Sand dropseed is widely used in disturbed area plantings in the Southwest, Intermountain West and short-grass prairies of the Great Plains. The fibrous root system effectively stabilizes sand dunes and hills. Its abundant seed production makes it a pioneer plant in disturbed areas and an invader of sandy soils. It has also been noted as an early native colonizer in sites suffering from water stress (Coupland, 1958).

Ethnobotany

Sand dropseed seed has been used to make bread and porridge by Apache, Hopi and Navajo tribes (Castetter et al., 1936; Colton, 1974; Vestal, 1952). The plant has also been used to create a cold infusion that is applied to sores and bruises on the legs of horses (Vestal, 1952).

Status

Threatened or Endangered: This species is listed as threatened in Connecticut and New Hampshire (New Hampshire Natural Heritage Bureau, 2006; State of Connecticut, 2004), and rare in Pennsylvania (Commonwealth of PA, 2009). It is not considered a rare plant in the western United States. Please consult the PLANTS Web site (http://plants.usda.gov/) and your State Department of Natural Resources for this plant's current status (e.g., threatened or endangered species, state noxious status, and wetland indicator values).

Weedy or Invasive: This plant may become weedy or invasive in some regions or habitats and may displace desirable vegetation if not properly managed. Please consult with your local NRCS Field Office, Cooperative Extension Service office, state natural resource, or state agriculture department regarding its status and use.

Please consult the PLANTS Web site (http://plants.usda.gov/) and your state's Department of Natural Resources for this plant's current status (e.g., threatened or endangered species, state noxious status, and wetland indicator values).

Planting Guidelines

Seedbed preparation should begin well in advance of planting. Establish a clean, weed-free seedbed by either tillage or herbicides. Prior to planting, the site should be firm and have accumulated soil moisture.

In some areas, sand dropseed requires overwintering or scarification for successful germination. The seed coat is very hard and impermeable. Seed lots frequently contain up to 50% hard seed; however, the seed can retain high levels of viability for many years under proper seed storage conditions. One seed lot that was twenty year old recorded 75% viability (USDA, 1937). Older seed generally has better germination and establishment than younger seed (Monsen et al., 2004).

For rangeland plantings, use 0.5 to 1.0 lbs pure live seed (PLS)/ac for solid stands (Allison, 1988; Ogle et al., 2009). Drill or broadcast seed onto the surface to 1/8 inch depth into lightly prepared sandy and fine soils. Seed can be planted slightly deeper into coarse soils. Follow seeding with a light harrowing or cultipacking. Establishment is dependent upon spring and summer soil moisture. Sand dropseed seedlings have low vigor, but once established the plants are able to withstand severe summer drought periods. Due to slow development, grazing should be deferred for at least two years to ensure good establishment.

Management

This species spreads naturally from seed once established (Plummer et al., 1955) and increases on depleted rangelands and wastelands (Welsh et al., 2003). Sand dropseed plants are able to withstand heavy use due to their protected root crown, late maturity and because they are less preferred than other species (Monsen et al., 2004). However, plants can be killed by overgrazing as a result of continued close cropping. When grazed properly, sand dropseed increases on poor condition, low seral ecological sites (USDA, 1937).

Pests and Potential Problems

There are no potential problems or pests associated with sand dropseed.

Environmental Concerns

There are no potential problems or pests associated with sand dropseed.

Control

Please contact your local agricultural extension specialist or county weed specialist to learn what works best in your area and how to use it safely. Always read label and safety instructions for each control method.

Seeds and Plant Production

For seed production fields, sand dropseed should be seeded at a rate of 0.5 lbs/ac in 20 to 36 inch row spacing in a firm weed-free seedbed. In the Southwest it is possible to have multiple harvests in a single growing season (USDA-NRCS, 2016). Seed shatters readily, however portions of the mature inflorescence are held in the sheath preventing some seed loss (Majerus 2009). Seed yields range from 250 to 1,000 lbs/ac with an average of 90% PLS. Fields will produce good seed yields for two to three years before needing to be re-established.

Cultivars, Improved, and Selected Materials (and area of origin)

Borden County Germplasm sand dropseed was released in 2000 by the James E. 'Bud' Smith Plant Materials Center in Knox City, Texas. The original collection was made near Gail, Texas in MLRA 78B. Its primary intended use is for rangeland seeding for livestock and wildlife. It is recommended for use in central and western Texas and western Oklahoma in MLRAs 42, 77, 78, 80A, 80B, 81A, 81B and 84B. Generation 0 seed is maintained by the Plant Materials Center and is available in limited quantities for seed increase (USDA-NRCS, 1999).

Nueces Germplasm sand dropseed was cooperatively released in 2016 by the E. "Kika" de la Garza Plant Material Center and *South Texas Natives*. It was selected for its vigor, forage production, and seed quality throughout the intended area of use. Nueces Germplasm is recommended for use in Rio Grande Plains (MLRA 83 A-E, and Gulf Coast Prairies and Marshes of Texas (MLRA 150A and B) in critical site revegetation and for inclusion in range seeding mixes. Nueces Germplasm is adapted to a wide variety of soil types throughout the Rio Grande Plains. Sand dropseed is widely distributed throughout North America, however Nueces Germplasm has not been tested outside of the recommended area of use.

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Citation

Tilley, D., L. St. John, and D. Ogle. 2009. Plant guide for sand dropseed (*Sporobolus cryptandrus*). USDA-Natural Resources Conservation Service, Idaho Plant Materials Center. Aberdeen, ID.

Published February 2010

Edited 5Aug2016 sdm

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Plant Fact Sheet

SWITCHGRASS

Panicum virgatum L.

Plant Symbol = PAVI2

Contributed by: USDA NRCS Plant Materials Program

Robert H. Mohlenbrock
From the Southern Wetland Flora (1991)
@ plants.usda.gov

Uses

Livestock: Switchgrass is noted for its heavy growth during late spring and early summer. It provides good warm-season pasture and high quality hay for livestock.

Erosion Control: Switchgrass is perhaps our most valuable native grass on a wide range of sites. It is a valuable soil stabilization plant on strip-mine spoils, sand dunes, dikes, and other critical areas. It is also suitable for low windbreak plantings in truck crop fields.

Wildlife: Switchgrass provides excellent nesting and fall and winter cover for pheasants, quail, and rabbits. It holds up well in heavy snow (particularly 'Shelter' and 'Kanlow' cultivars) and is useful on shooting preserves. The seeds provide food for pheasants, quail, turkeys, doves, and songbirds.

Biofuel Source: Interest in switchgrass as a renewable biofuel resource has been increasing in recent years, primarily in the Southern United States. The Booneville, Arkansas, Plant Materials Center (PMC) and the Plant and Soil Science Department of Oklahoma State University (OSU) are cooperating to evaluate several upland types of switchgrass for use as a biomass energy resource. Selections of upland types of switchgrass have been evaluated by OSU for several years. The development of hybrid progeny with substantial heterosis for increased biomass yield will ultimately result in improved hybrid cultivars for the Central and Southern United States. The PMC is in the process of assessing several improved lines along with commercially available cultivars for dry-matter potential and environmental adaptation. Results of this study may contribute to producers cashing in on a growing demand for renewable fuels and a decrease on our dependency on fossil fuels.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Weediness

This plant may become weedy or invasive in some regions or habitats and may displace desirable vegetation if not properly managed. Please consult with your local NRCS Field Office, Cooperative Extension Service office, or state natural resource or agriculture department regarding its status and use. Weed information is also available from the PLANTS Web site at plants.usda.gov.

Description

Panicum virgatum L., switchgrass, is native to all of the United States except California and the Pacific Northwest. It is a perennial sod-forming grass that grows 3 to 5 feet tall and can be distinguished from other warm-season grasses, even when plants are young, by the white patch of hair at the point where the leaf attaches to the stem. The stem is round and usually has a reddish tint. The seed head is an open, spreading panicle.

Adaptation and Distributions

On suitable soils, switchgrass is climatically adapted throughout the most of the United States. Moderately deep to deep, somewhat dry to poorly drained, sandy to clay loam soils are best. It does poorly on heavy soils. In the East, it performs well on shallow and droughty soil.

Switchgrass is distributed throughout the majority of the United States, excluding the far west states. For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

Establishment

Switchgrass should be seeded in a pure stand when used for pasture or hay because it can be managed better alone than in a mixture. Its slick, free-flowing seed can be planted with most seed drills or with a broadcast spreader. In the Southeast, a planting rate of approximately 10 pounds PLS per acre is recommended. Seedbeds should be firmed with a roller prior to the drilling or broadcasting of seed. If seeds are planted using the broadcast method, the area should be rolled afterward to help cover the seed. When drilled, seeds should be planted 1/4 inch deep. No-tillage seedings in closely grazed or burned sod also have been successful, where control of sod is accomplished with clipping, grazing, or proper herbicides.

Phosphorus and potassium should be applied according to soil tests before or at seeding. Nitrogen, however, should not be used at seeding time because it will stimulate weed growth.

Management

To control weeds during establishment, mow switchgrass to a height of 4 inches in May or 6 inches in June or July. Grazing is generally not recommended the first year, but a vigorous stand can be grazed late in the year if grazing periods are short with at least 30 days of rest provided between grazings. Switchgrass is the earliest maturing of the common native warm-season grasses and it is ready to graze in early summer.

Established stands of switchgrass may be fertilized in accordance with soil tests. Phosphorus and potassium may not be needed if the field is grazed since these elements will be recycled back to the soil by the grazing animal. Apply nitrogen after switchgrass has begun to produce using a single application in mid-to-late May or a split application in both May and early July. Avoid high rates of nitrogen because carry-over could spur cool-season grass growth and harm young plants the following spring.

Switchgrass will benefit from burning of plant residues just prior to initiation of spring growth. Burning fields once every 3 to 5 years decreases weed competition, eliminates excessive residue and stimulates switch grass growth. Switchgrass used for wildlife food and cover should be burned once every 3 to 4 years to reduce mulch accumulations that inhibit movement of hatchlings and attract nest predators.

Under continuous grazing management, begin grazing switchgrass after it has reached a height of 14 to 16 inches, and stop when plants are grazed to within 4 inches of the ground during late spring, 8 inches in early summer, and 12 inches in late summer. A rest before frost is needed to allow plants to store carbohydrates in the stem bases and crown. Plants may be grazed to a height of 6 to 8 inches after frost. The winter stubble is needed to provide insulation.

With management intensive systems, grazing can begin in the first paddocks when plants reach a height of 10 inches and should not be grazed below a stubble height of 6 to 8 inches. Grazed paddocks need to be rested 30-60 days before being grazed again.

Pests and Potential Problems

Grasshoppers and leafhoppers can be major pests in new seedings. Some stands are impacted by damping off and seedling blight. Leaf rust occasionally affects forage quality.

Cultivars, Improved, and Selected Materials (and area of origin)

‘Alamo’ (TX), ‘Blackwell’ (OK), ‘Cave-In-Rock’ (IL), ‘Dacotah’ (ND), ‘Forestburg’ (SD), ‘Kanlow’ (OK), ‘Nebraska 28’ (NE), ‘Shawnee,’ ‘Shelter’ (WV) (cultivars); Grenville (NM) (informal release); Miami (Dade Co, FL), Stuart (Stuart, FL), Wabasso (Wabasso, FL) (source identified releases). Seeds are available from most commercial sources and through large agricultural supply firms.

Control

Please contact your local agricultural extension specialist or county weed specialist to learn what works best in your area and how to use it safely. Always read label and safety instructions for each control method. Trade names and control measures appear in this document only to provide specific information. USDA, NRCS does not guarantee or warranty the products and control methods named, and other products may be equally effective.

Prepared By & Species Coordinator:

USDA NRCS Plant Materials Program

Edited: 16Jan2001 JLK; 28sep05 jsp; 24may06jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the

PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Plant Fact Sheet

WEEPING LOVEGRASS

Eragrostis curvula (Schrad.) Nees

Plant Symbol = ERCU2

Contributed by: USDA NRCS Plant Materials Program

USDA NRCS National Plant Materials Center
Beltsville, MD

Uses

Erosion control: Weeping lovegrass is used as a temporary cover for erosion control purposes. On surface mine spoil, it provides almost immediate cover on steep outer slopes where spoil is rather acidic and of low fertility.

Crops: Weeping lovegrass is used as a nurse crop when seeding sericea lespedeza, coastal panic grass, or switchgrass. When seeding black locust or bristly locust, it serves as a companion species.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description

Eragrostis curvula (Schrad.) Nees, weeping lovegrass, is a rapidly growing warm-season bunchgrass that was introduced into the U. S. from East Africa. The many long, narrow leaves emerging from a tight tuft are pendulous, with the tips almost touching the ground. The drooping leaf characteristic gives rise to the name "weeping" lovegrass. Leaf height is rarely above 12 inches. The seed heads are open panicles, reaching a height of 30 to 40 inches and containing numerous small, fine seeds.

Adaptation

Weeping lovegrass prefers a light-textured, well-drained soil, and will thrive on soils of low fertility. Climatic conditions determine its range of adaptation. Low winter temperatures will prevent regrowth and cause the grass to act as an annual or a short-lived perennial.

Weeping lovegrass is distributed throughout the southern United States. For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

Establishment

This grass is easy to establish by seed. Seed alone at a rate of 3 to 5 pounds per acre, or 1 to 2 pounds per acre in mixtures with other species. Seeds will germinate quickly and plant growth is rapid. The seed is extremely fine, requiring mechanical seeding equipment to have small seed attachments. If seeded with a 'hand' cyclone seeder, the lovegrass seed should be mixed with a diluent or a carrier (cornmeal, sand, or fine sawdust) for uniform distribution of seed. Do not cover seed more than 1/2 to 1 inch on sandy soils; 1/4 inch is sufficient on silt loams. Cultipacking soil before seeding is helpful.

Sites too steep or stony for use of mechanical equipment can be seeded without soil scarification. Broadcast seeding by air or use of hydroseeders is successful if seeding rates are increased to compensate for poor seedbed. Where possible, the soil should be scarified and firmed.

Normally, weeping lovegrass can be planted after danger of severe frost is over, and anytime throughout the summer with success. Lime and fertilizer needs are similar to that for tall fescue and ryegrass when used for temporary cover.

Management

Because of its short duration, there is no management required for weeping lovegrass. It is palatable to livestock and should be protected where this possibility exists.

Pests and Potential Problems

There are no serious pests of weeping lovegrass.

Cultivars, Improved, and Selected Materials (and area of origin)

'A-67', 'Ermelo', and 'Morpa'. Seed is commercially available from most of the large seed companies**.**

Prepared By & Species Coordinator:

USDA NRCS Plant Materials Program

Edited: 01Feb2002 JLK; 06jun06 jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Table 2. Permissible Shear and Velocity for Selected Lining Materials[1]

Boundary Category	Boundary Type	Permissible Shear Stress (lb/sq ft)	Permissible Velocity (ft/sec)	Citation(s)
Soils	Fine colloidal sand	0.02 - 0.03	1.5	A
	Sandy loam (noncolloidal)	0.03 - 0.04	1.75	A
	Alluvial silt (noncolloidal)	0.045 - 0.05	2	A
	Silty loam (noncolloidal)	0.045 - 0.05	1.75 – 2.25	A
	Firm loam	0.075	2.5	A
	Fine gravels	0.075	2.5	A
	Stiff clay	0.26	3 – 4.5	A, F
	Alluvial silt (colloidal)	0.26	3.75	A
	Graded loam to cobbles	0.38	3.75	A
	Graded silts to cobbles	0.43	4	A
	Shales and hardpan	0.67	6	A
Gravel/Cobble	1-in.	0.33	2.5 – 5	A
	2-in.	0.67	3 – 6	A
	6-in.	2.0	4 – 7.5	A
	12-in.	4.0	5.5 – 12	A
Vegetation	Class A turf	3.7	6 – 8	E, N
	Class B turf	2.1	4 - 7	E, N
	Class C turf	1.0	3.5	E, N
	Long native grasses	1.2 – 1.7	4 – 6	G, H, L, N
	Short native and bunch grass	0.7 - 0.95	3 – 4	G, H, L, N
	Reed plantings	0.1-0.6	N/A	E, N
	Hardwood tree plantings	0.41-2.5	N/A	E, N
Temporary Degradable RECPs	Jute net	0.45	1 – 2.5	E, H, M
	Straw with net	1.5 – 1.65	1 – 3	E, H, M
	Coconut fiber with net	2.25	3 – 4	E, M
	Fiberglass roving	2.00	2.5 – 7	E, H, M
Non-Degradable RECPs	Unvegetated	3.00	5 – 7	E, G, M
	Partially established	4.0-6.0	7.5 – 15	E, G, M
	Fully vegetated	8.00	8 – 21	F, L, M
Riprap	6 – in. d_{50}	2.5	5 – 10	H
	9 – in. d_{50}	3.8	7 – 11	H
	12 – in. d_{50}	5.1	10 – 13	H
	18 – in. d_{50}	7.6	12 – 16	H
	24 – in. d_{50}	10.1	14 – 18	E
Soil Bioengineering	Wattles	0.2 – 1.0	3	C, I, J, N
	Reed fascine	0.6-1.25	5	E
	Coir roll	3 - 5	8	E, M, N
	Vegetated coir mat	4 - 8	9.5	E, M, N
	Live brush mattress (initial)	0.4 – 4.1	4	B, E, I
	Live brush mattress (grown)	3.90-8.2	12	B, C, E, I, N
	Brush layering (initial/grown)	0.4 – 6.25	12	E, I, N
	Live fascine	1.25-3.10	6 – 8	C, E, I, J
	Live willow stakes	2.10-3.10	3 – 10	E, N, O
Hard Surfacing	Gabions	10	14 – 19	D
	Concrete	12.5	>18	H

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[1] Ranges of values generally reflect multiple sources of data or different testing conditions.

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USACE TR EL 97-8

Exhibit 16

Historic/ Developed Drainage Conditions Map

EXISTING DESIGN POINT SUMMARY

DESIGN POINT	CONTRIB SUB BASINS	AREA	Q5	Q100
		(acres)	(cfs)	(cfs)
1	A	16.1	3.0	16.1
2	B	20.4	3.9	22.4
3	C,D,E	13.1	4.5	21.5
4	C,D,E,I	18.4	6.2	29.4
5	B,C,D,E,H,I	62.8	10.4	57.7
6	A,F,G	42.8	10.4	59.1
7	J	4.4	1.1	8.0

PROPOSED DESIGN POINT SUMMARY

DESIGN POINT	CONTRIB SUB BASINS	AREA	Q5	Q100
		(acres)	(cfs)	(cfs)
1	A	16.1	3.1	16.3
2	B	20.4	4.2	22.8
3	C,D,E	13.1	4.3	21.2
4	C,D,E,I	18.4	6.3	29.3
5	B,C,D,E,H,I	62.8	11.3	58.9
6	A,F,G	42.8	11.0	59.8
7	J	4.4	1.1	8.0

SWALE SUMMARY

SWALE #	CONTRIBUTING SUBBASINS	SLOPE	DESIGN FLOW		DEPTH OF FLOW		VELOCITY		FROUDE #	
			Q5	Q100	Q5	Q100	V5	V100		
		%	cfs	cfs	ft	ft	fps	fps	5 year	100 year
1	A	4.5	3.1	16.3	0.0	0.1	1.1	2.3	0.87	1.11
2	A,G	3.1	4.8	24.3	0.1	0.2	1.4	2.5	0.82	0.98
3	B	4.6	4.2	22.8	0.1	0.3	1.7	3.3	1.02	1.22
4	B,C,H	3.3	8.1	44.5	0.1	0.2	1.3	2.9	0.83	0.99
5	C	5.5	1.8	8.4	0.1	0.1	1.3	2.4	1.00	1.20
6	D	6.0	2.5	12.2	0.1	0.2	1.5	2.8	1.08	1.28
8	C,D,E,I	3.3	6.3	29.3	0.1	0.3	1.6	2.7	0.92	1.02
10	F	5.3	4.2	25.4	0.1	0.3	2.0	3.6	1.15	1.31
11	J	3.1	1.1	8.0	0.0	0.1	0.6	1.4	0.64	0.82
12	A,G,F	6.1	11.0	59.8	0.1	0.3	2.3	4.4	1.25	1.48
13 RD DITCH	PORTION OF SUBBASIN B	6.7	0.1	0.6	0.1	0.2	1.5	2.1	1.01	1.19
14 RD DITCH	PORTION OF SUBBASIN B	1.0	0.1	0.1	0.1	0.2	0.8	0.8	0.44	0.44
15 RD DITCH	PORTION OF SUBBASIN C	4.5	2.2	10.7	0.5	0.8	3.1	4.7	1.15	1.28
16 RD DITCH	PORTION OF SUBBASIN D	2.0	3.2	15.7	0.6	1.1	2.5	3.8	0.82	0.92

EXIST & PROP BASIN SUMMARY

BASIN I.D.	AREA	RUNOFF COEFFICIENTS (existing)		RUNOFF COEFFICIENTS (developed)		EXSITING RUNOFF		DEVELOPED RUNOFF	
						Q5	Q100	Q5	Q100
	(acres)	C5	C100	C5	C100	cfs	cfs	cfs	cfs
A	17.4	0.09	0.35	0.09	0.36	3.4	23.6	3.7	24
B	20.8	0.09	0.36	0.10	0.36	4.4	29.1	4.6	29.5
C	3.9	0.11	0.37	0.14	0.39	1.4	7.9	1.8	8.4
D	7.5	0.1	0.36	0.12	0.38	2.3	14.3	2.7	14.8
E	2.3	0.12	0.38	0.18	0.42	1	4.9	1.4	5.5
F	18.7	0.08	0.35	0.09	0.35	2	20.7	3.1	21.1
G	9.9	0.09	0.36	0.10	0.37	2.7	17.8	3	18.2
H	23.3	0.09	0.36	0.10	0.36	5.3	34.3	5.6	34.7
I	5.7	0.11	0.37	0.13	0.38	2.4	13.7	2.8	14.3
J	3.4	0.08	0.35	0.08	0.35	1	7.1	1	7.1

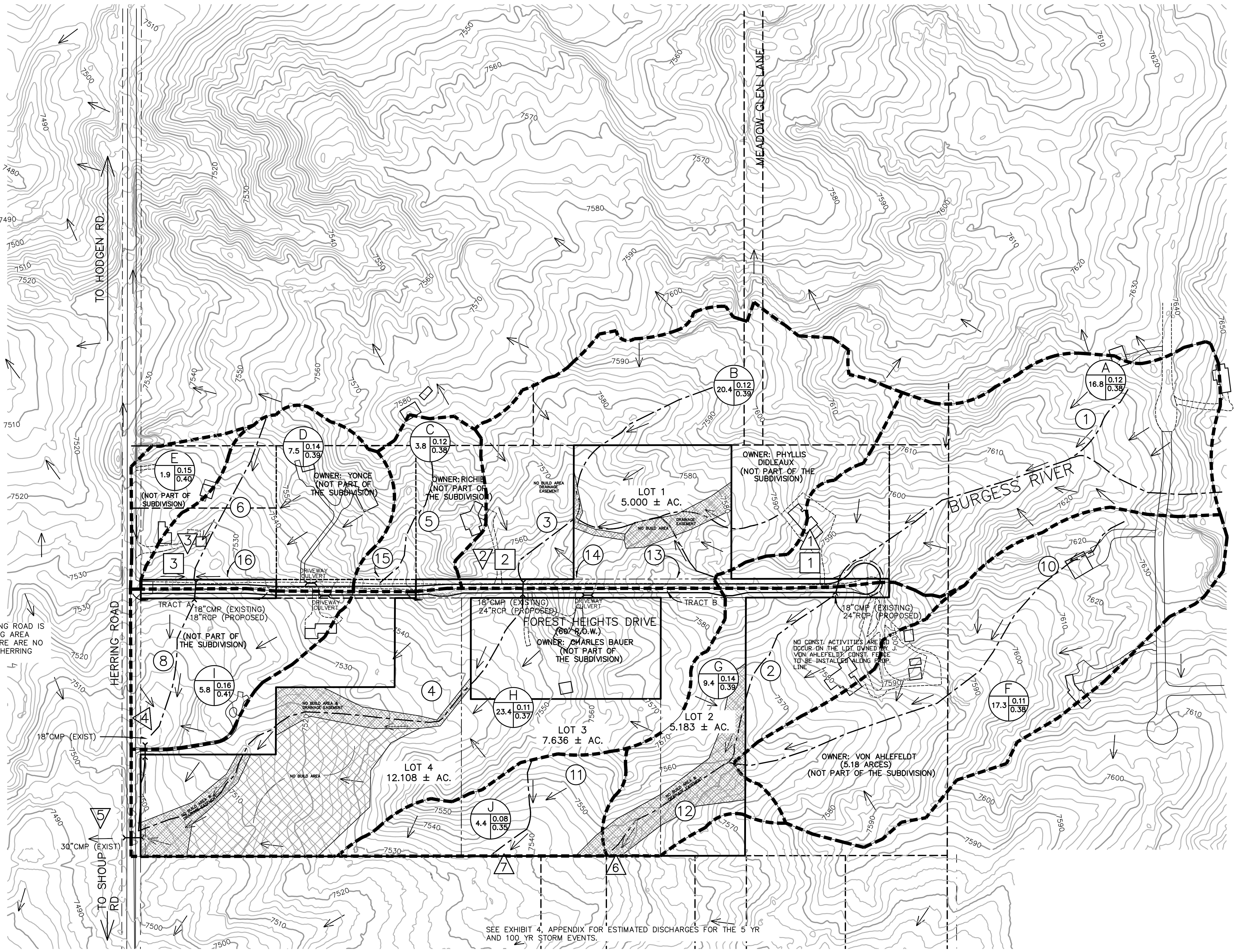
EXISTING CULVERT SUMMARY

CULVERT #	SIZE	MATERIAL	CONTRIBUTING SUBBASINS	5 YEAR		100 YEAR		CONDITION
				Q (cfs)	HEADWATER REQUIRED	Q (cfs)	HEADWATER REQUIRED	
1	18"	CMP	A	3.1	12.8"	16.3	> 7.5 FT	75% SILTED, ROADWAY OVERTOPPING WITH 100 YR
2	18"	CMP	B	4.2	15.3"	22.8	> 9 FT	75% SILTED, ROADWAY OVERTOPPING WITH 100 YR
3	18"	CMP	C, D, E	4.3	16.7"	21.2	> 9 FT	75% SILTED, ROADWAY OVERTOPPING WITH 100 YR

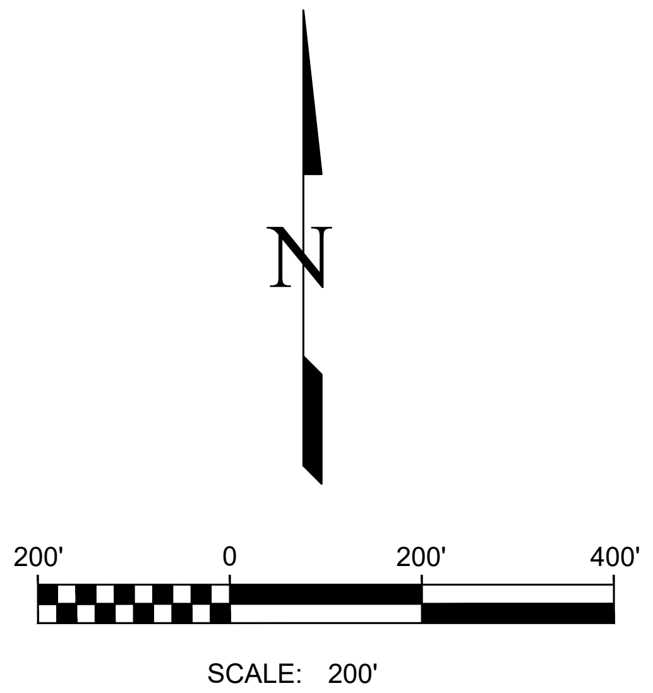
PROPOSED CULVERT SUMMARY

CULVERT #	SIZE	MATERIAL	CONTRIBUTING SUBBASINS	5 YEAR			100 YEAR		
				Q_5	Q_{PIPE}	$Q_{OVERFLOW}$	Q_{100}	Q_{PIPE}	$Q_{OVERFLOW}$
1	24"	RCP	A	3.1	3.1	N/A	16.3	16.3	0.0
2	24"	RCP	B	4.2	4.2	N/A	22.8	22.8	0.0
3	18"	RCP	C, D, E	4.3	4.3	N/A	21.2	13.1	8.1

ALL RUNOFF FROM HERRING ROAD IS DIRECTED TO THE PONDING AREA UPSTREAM FROM #5. THERE ARE NO BORROW DITCHES ALONG HERRING ROAD.



SEE EXHIBIT 4, APPENDIX FOR ESTIMATED DISCHARGES FOR THE 5 YR AND 100 YR STORM EVENTS.



LEGEND:

- ← – DIRECTION OF FLOW
- – PROJECT BOUNDRY
- – FLOWLINE NATURAL SWALE
- – SUBBASIN BOUNDRY
- ▷X – DESIGN POINT
- (X) – SWALE NUMBER
- AREA (ARCES) – SUBDIVISION I.D. – 5 YR. RUNOFF COEFFICIENT – 100 YR. RUNOFF COEFFICIENT
- – CULVERT
- ☒ – CULVERT NUMBER
- – INDEX CONTOURS
- – INTERMEDIATE CONTOURS
- ⬚ – EXISTING RESIDENCE (APPROX.)
- ☐ – PROPOSED RESIDENCE
- ▨ – NO BUILD AREA
- ▨ – DRAINAGE EASEMENT
- – EXISTING LOT LINES
- – PROPOSED LOT LINE
- – SUBDIVISION BOUNDRY
- – EXISTING ROAD (GRAVEL)
- – EXISTING ROAD (ASPHALT)
- ▬ – PROPOSED ROAD (GRAVEL)
- – ROADSIDE DITCHES

NOTES:

1. NO NEW CONSTRUCTION; BUILDINGS, BARNS, FENCES, DRIVEWAYS, AND/OR LANDSCAPING, SHALL BE INSTALLED IN ANY EXISTING DRAINAGEWAY AND/OR SWALE SO AS TO IMPEDE THE FLOW OF STORM WATER RUNOFF.

2. PROPOSED TOPOGRAPHIC DATA IS NOT SHOWN DUE TO MINIMAL CHANGES TO EXISTING GRADE. NO OVERLOT GRADING IS PROPOSED.

3. RUNOFF COEFFICIENTS FOR BOTH THE 5 YR & 100 YR CONDITIONS ARE INDICATED IN THE ABOVE BASIN SUMMARY TABLES.

4. SEE THE "GRADING & EROSION CONTROL PLAN" FOR RECOMMENDED CONTROL MEASURES.

5. ALL DRIVEWAY CULVERTS ARE TO BE REMOVED AND REPLACED AS DEEMED NECESSARY DURING CONSTRUCTION. EXISTING DRIVEWAY CULVERTS ARE SHOWN AT APPROPRIATE LOCATIONS. FINAL LOCATION WILL BE DETERMINED DURING CONSTRUCTION.

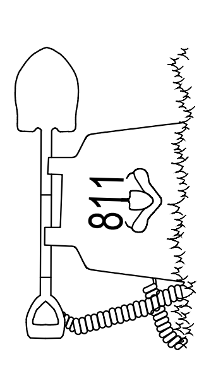
6. ONLY ONE DRAINAGE MAP HAS BEEN INCLUDED IN THIS REPORT SINCE ANY AND ALL IMPROVEMENTS DO NOT NEGATIVELY IMPACT THE FLOW RATE, FLOW REGIME, FLOW VELOCITY, EROSIVE CONDITIONS, ETC.

7. ALL PROPOSED DRIVEWAY CULVERTS ARE TO INCLUDE 18" CMP FLARED END SECTIONS.

NOT FOR CONSTRUCTION:

THESE PLANS ARE INTENDED FOR SUBMITTAL, REVIEW AND APPROVAL BY CITY/COUNTY PLANNING DEPARTMENTS AND SHOULD NOT BE USED ON SITE FOR CONSTRUCTION OR LAYOUT.

CALL BEFORE YOU DIG . . .



DIAL 811

48 HOURS BEFORE YOU DIG, CALL UTILITY LOCATORS FOR LOCATING AND MARKING GAS, ELECTRIC, WATER AND WASTEWATER

REVISIONS

No.	Description	By	Date
1	REV PER COUNTY COMMENTS	DAS	10/15/21
2	LOT REVISIONS	DAS	02/16/22
3	ROAD REVISIONS	DAS	04/12/22
4	MAP REVISIONS	MVE	10/2/23

H Scale: 1" = 200'
V Scale:
Designed By: KH
Drawn By: TLC
Checked By: KH
Date: 07/16/221

CIVIL ENGINEERING SOLUTIONS

DRAINAGE MAP
DIDLEAU SUBDIVISON
FOREST HEIGHT ESTATES

Project Number: 18070

Sheet: 1 of 1

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