September 7, 2021

El Paso County
Planning and Community Development Department
2880 International Circle, Suite 110
Colorado Springs, CO 80910

Re: Colorado Springs Utilities – Northeast Gravel Staging Area
El Paso County Drainage Letter

To Whom It May Concern:

This drainage letter is prepared on behalf of Colorado Springs Utilities (Utilities) in support of the site development application for the relocation of the Northeast Gravel Staging Area (Staging Area). This letter demonstrates compliance with the El Paso County drainage requirements for land development improvements in El Paso County. The proposed drainage improvements comply with the *El Paso County Land Development Code 2016* and the *Urban Drainage and Flood Control District's Urban Storm Drainage Criteria Manual (USDCM)* requirements.

**Location**
Utilities is expanding the existing Briargate substation, located at the John Pinkerton site (East Woodmen Road and North Powers Blvd.), into the adjacent parcel that currently contains Utilities' Northeast gravel staging area. As a result of the substation expansion, Utilities is looking to relocate the Staging Area. The new Staging Area is located in the NE 1/4 of the SE 1/4 of Section 29, T13S, R65W in El Paso County, Colorado. The site is an undeveloped parcel located at 7723 North Carefree Circle, southwest of the intersection of North Carefree Circle and Akers Drive. The proposed location is just west of the Utilities' existing Gas Propane Air Plant (GPAP). A map showing the Staging Area location is provided as Figure 1 in Attachment 1.

The Staging Area is located within a RR-5 (residential rural 5-acres intended to accommodate low-density, rural, single family residential development) CAD-O (commercial airport overlay district) zoned area of the City of Colorado Springs.

**Description of Property**
The Staging Area is located on a 9.58-acre parcel owned by City of Colorado Springs. The site is bounded on the north by North Carefree Circle, the GPAP to the east, the El Paso County Department of Public Works facility to the south, and residential development to the west. Topographic data consisting of 2-foot contours was used as a basis of analysis for the project and shows the site sloping west to east ranging from 0-4 percent. The site soil is Truckton sandy loam according to the Natural Resources Conservation Service (NRCS) Web Soil Survey. Truckton sandy loam soil is classified under Hydrologic Soil Group (HSG) A. The NRCS soil survey

report for the project area is provided in Attachment 2. The Staging Area location is on an undeveloped parcel with a ground cover consisting of rangeland grass. No groundwater characterization has been accomplished to date.

**FEMA Flood Zone**

Based on the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Map No. 08041C0543G for El Paso County, Colorado, Effective Date December 7, 2018, the development is located within Zone X. Zone X is an area of minimal flood hazard. The flood hazard map is provided in Attachment 3.

**Hydrologic Criteria**

Existing point precipitation data used in runoff calculations were obtained from NOAA Atlas 14 database and is shown below in Table 1.

**Table 1 – Rainfall Depths (24-hr Storm)**

| Recurrence Interval (Years) | Depth (Inches) |
|---|---|
| 2 | 1.96 |
| 5 | 2.48 |
| 10 | 2.99 |
| 50 | 4.48 |
| 100 | 5.25 |

**Calculation Methodologies**

Calculations used in the analysis presented in this drainage letter can be found in Attachment 4. Peak runoff rates were calculated for the pre- and post-development site conditions using the rational method option in Hydraflow Hydrographs extension of Autodesk Civil 3D. Time of concentration for the basin was calculated using Technical Release 55 (TR55) within the Hydrographs program. Runoff coefficients used in the calculations were obtained from Table 5-1 of the *El Paso County Land Development Code 2016*.

**Existing Drainage Patterns**

The drainage basin in the pre-development condition flows east toward an existing swale just outside the east property line. An existing swale and berm collect and convey flows from the property to an existing 12-inch culvert. The culvert conveys flows under the berm to an existing detention pond on the adjacent parcel. The detention basin appears to be part of a stormwater facility that handles flows from the western portion of the GPAP and includes a concrete flow pan extending from the southern portion of the site to the pond. The active areas of the GPAP

facility are bounded by rectangular concrete ditches that collect flows and convey them to a lined retention pond. Pre-development drainage patterns and the culvert location are shown on Figure 2 in Attachment 1. Table 2 – Predevelopment Runoff, shown below, provides a summary of the predevelopment runoff included in Attachment 4.

**Table 2 – Pre-Development Runoff**

| Basin ID | Area (Acres) | 10-year Runoff Coefficient | 10-year Peak Flow (cfs) | 100-year Runoff Coefficient | 100-year Peak Flow (cfs) |
|---|---|---|---|---|---|
| EX – 1 | 7.95 | 0.15 | 4.16 | 0.20 | 7.99 |

The material and slope of the existing 12-inch culvert is unknown. Assuming the existing 12-inch culvert is concrete with a one percent slope the maximum capacity provided by the culvert would be 4.11 cubic feet per second (cfs) at a depth of 0.90-feet. This capacity accommodates the 10-year existing conditions peak flow. Calculations for the existing culvert are provided in Attachment 5.

**Improvements Analysis**

The relocated Storage Area will include grading and surfacing of the north 5 acres of the parcel to accommodate the storing of material. Other improvements include the installation of a 7-foot chain link fence, a new asphalt driveway and tracking pad, a new gate, and a new scale and scale house. Excess material from the site grading will be used for the creation of a berm along the north and west side of the site. The new driveway will come off the existing driveway for the GPAP. The post-development conditions are shown on Figure 3 in Attachment 1.

The drainage patterns in the post development condition will remain similar to the pre-development condition with all runoff flowing east toward the existing swale and culvert along the eastern boundary. The berm along the north and west boundary will create a drainage divide between the adjacent property. The addition of the gravel surface and decrease in the vegetative cover will increase the imperviousness of the site. The proposed condition C-values were weighted based on the new gravel surfacing and remaining vegetated areas. Rational method calculations for the post-development conditions are included in Attachment 4 and summarized in Table 3 - Post-Development Runoff.

**Table 3 – Post-Development Runoff**

| Basin ID | Area (Acres) | 10-year Runoff Coefficient | 10-year Peak Flow (cfs) | 100-year Runoff Coefficient | 100-year Peak Flow (cfs) |
|---|---|---|---|---|---|
| PD – 1 | 7.95 | 0.42 | 11.65 | 0.47 | 18.77 |

To accommodate the 10-year peak flow for the post-development condition the culvert should be replaced with an 18-inch culvert. Increasing the size of the culvert will prevent overtopping of the berm and decrease the area of inundation upstream of the culvert that will occur during storm events. An analysis of a proposed 18-inch concrete culvert at one percent slope is included in Attachment 5.

**Maintenance**
During construction, inspections for the performance of drainage controls will be conducted monthly or after a major precipitation event. If sediment control logs, fences, or washout structures are damaged or otherwise unable to perform their desired function, the inspector will notify a competent person, who will coordinate repair or cleaning within one day of the observance. Nearby drainage facilities affected by site drainage will be observed daily by site personnel and cleaned within one day of any observance of sediment or debris.

**Conclusion**
In review of the proposed development for the Staging Area relocation, the improvements were found to be compliant with the *El Paso County Land Development Code 2016* and the *Urban Drainage and Flood Control District's Urban Storm Drainage Criteria Manual (USDCM)* requirements.

**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 established criteria for drainage reports and said 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 omissions on my part in preparing this report.

Joshua Lee, PE
Senior Civil Engineer

Attachment 1: Figures
Attachment 2: NRCS Soils Report
Attachment 3: FEMA Flood Map
Attachment 4: Rational Method Calculations
Attachment 5: Culvert Analysis

**Developer's Statement**
I, the developer have read and will comply with all of the requirements specified in this drainage report and plan.

Business Name: _____

Address: _____

By: _____ Title: _____

ATTACHMENT 1 – Figures

EXISTING NORTHEAST GRAVEL STATING AREA

BRIARGATE SUBSTATION AT JOHN PINKERTON SITE


Briargate Substation at John Pinkerton site

Existing Northeast Staging Area

Briargate Staging Area Relocation Site

FIGURE 1

NORTH

0 0.5 1 2

Miles

BURNS McDONNELL

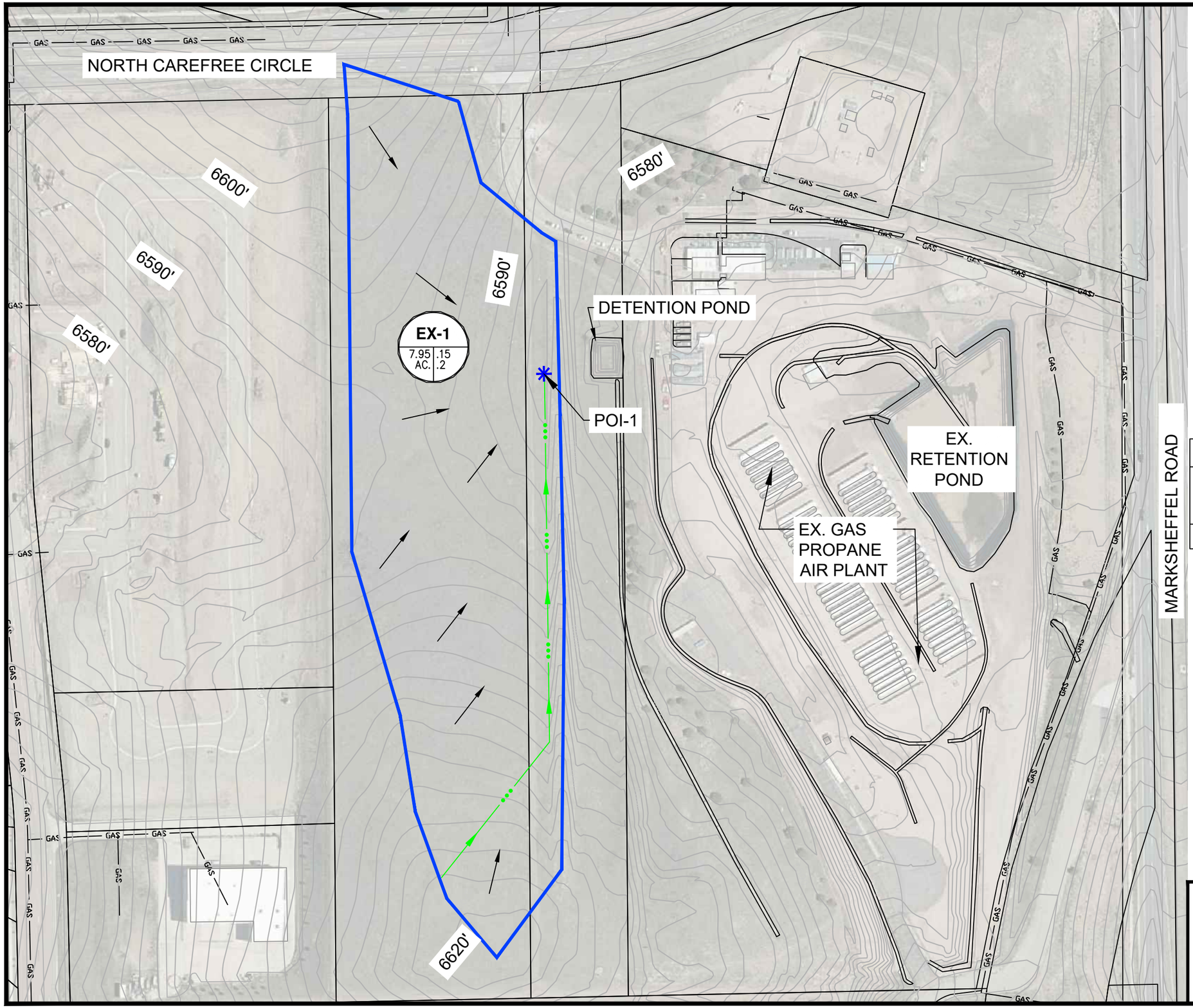
**GRAVEL STAGING AREA RELOCATION**

**BRIARGATE SUBSTATION**

**COLORADO SPRINGS UTILITIES**
**COLORADO SPRINGS, CO**

Issued: 8/24/2021

Path: I:\ESP\Projects\CSU\Figures\MXD\Briargate\FIG_00_Briargate_StorageYard_Relocation.mxd sjensley 8/24/2021




**LEGEND**

- PROPERTY LINE
- EDGE OF EXISTING GRAVEL
- EXISTING FENCE
- 4350 EXISTING 2' CONTOUR
- DRAINAGE BOUNDARY
- DESIGN DRAINAGE PATH
- FLOW DIRECTION
- DRAINAGE DESIGN POINT
- GAS GAS EXISTING GAS LINE
- POND

| DRAINAGE POINT SUMMARY TABLE | | | |
|---|---|---|---|
| POINT ID | TIME OF CONCENTRATION (MIN) | 10 YEAR PEAK FLOW (cfs) | 100 YEAR PEAK FLOW (cfs) |
| POI-1 | 34.00 | 4.16 | 7.99 |

NORTH

0 150' 300'

SCALE IN FEET

BURNS McDONNELL

FIGURE 2

COLORADO SPRINGS UTILITIES
BRIARGATE STORAGE YARD
RELOCATION
PRE-DEVELOPMENT DRAINAGE

EL PASO COUNTY, COLORADO

NORTH CAREFREE CIRCLE

EXISTING FENCE

6600'

6590'

6580'

6594'

6590'

PD-1
7.95 AC. | .42 | .47

DETENTION POND

POI-1

SCALE HOUSE

SCALE

EX. RETENTION POND

EX. GAS PROPANE AIR PLANT

PROPOSED FENCE

MARKSHEFFEL ROAD

GAS

## LEGEND

- PROPERTY LINE
- EXISTING FENCE
- PROPOSED FENCE
- 4350 — EXISITING 2' CONTOUR
- 4350 — PROPOSED 2' CONTOUR
- DRAINAGE BOUNDARY
- DESIGN DRAINAGE PATH
- FLOW DIRECTION
- DRAINAGE DESIGN POINT
- GAS — GAS — EXISTING GAS LINE
- POND
- GRAVEL

| DRAINAGE POINT SUMMARY TABLE | | | |
|---|---|---|---|
| POINT ID | TIME OF CONCENTRATION (MIN) | 10 YEAR PEAK FLOW (cfs) | 100 YEAR PEAK FLOW (cfs) |
| POI-1 | 34.00 | 11.65 | 18.77 |

NORTH

0 150' 300'

SCALE IN FEET

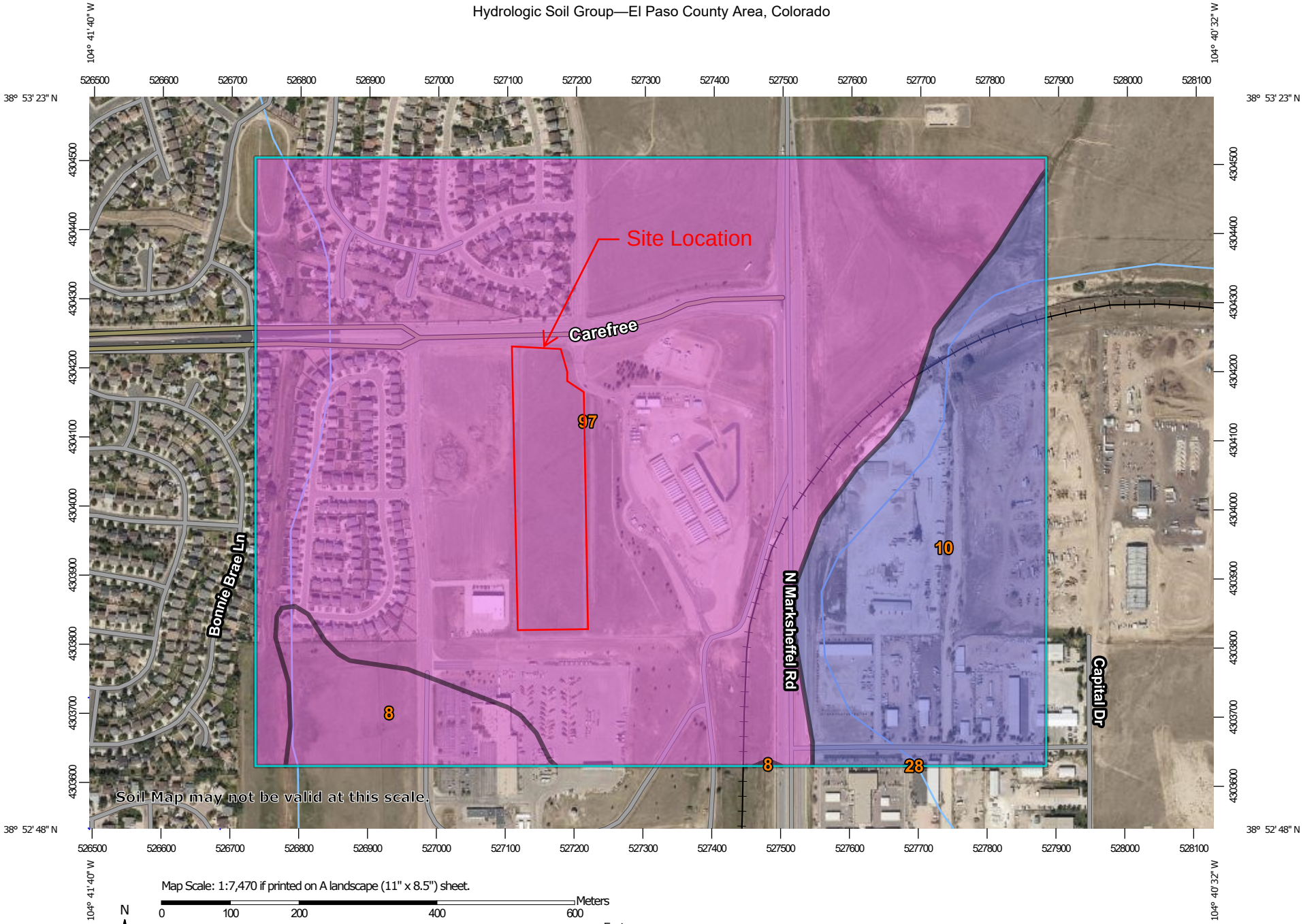
BURNS McDONNELL

FIGURE 3

COLORADO SPRINGS UTILITIES
BRIARGATE STORAGE YARD
RELOCATION
POST-DEVELOPMENT DRAINAGE

EL PASO COUNTY, COLORADO

ATTACHMENT 2 – NRCS Soil Report




Map Scale: 1:7,470 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 350 700 1400 2100

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

## MAP LEGEND

**Area of Interest (AOI)**

- Area of Interest (AOI)

**Soils**

**Soil Rating Polygons**

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

**Soil Rating Lines**

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

**Soil Rating Points**

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

**Water Features**

- Streams and Canals

**Transportation**

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

**Background**

- Aerial Photography

## MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 18, Jun 5, 2020

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

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

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

# Hydrologic Soil Group

| Map unit symbol | Map unit name | Rating | Acres in AOI | Percent of AOI |
|---|---|---|---|---|
| 8 | Blakeland loamy sand, 1 to 9 percent slopes | A | 12.6 | 5.0% |
| 10 | Blendon sandy loam, 0 to 3 percent slopes | B | 51.4 | 20.5% |
| 28 | Ellicott loamy coarse sand, 0 to 5 percent slopes | A | 0.0 | 0.0% |
| 97 | Truckton sandy loam, 3 to 9 percent slopes | A | 187.0 | 74.5% |
| **Totals for Area of Interest** | | | **251.1** | **100.0%** |

## Description

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

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

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

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

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

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

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

## Rating Options

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff: None Specified*

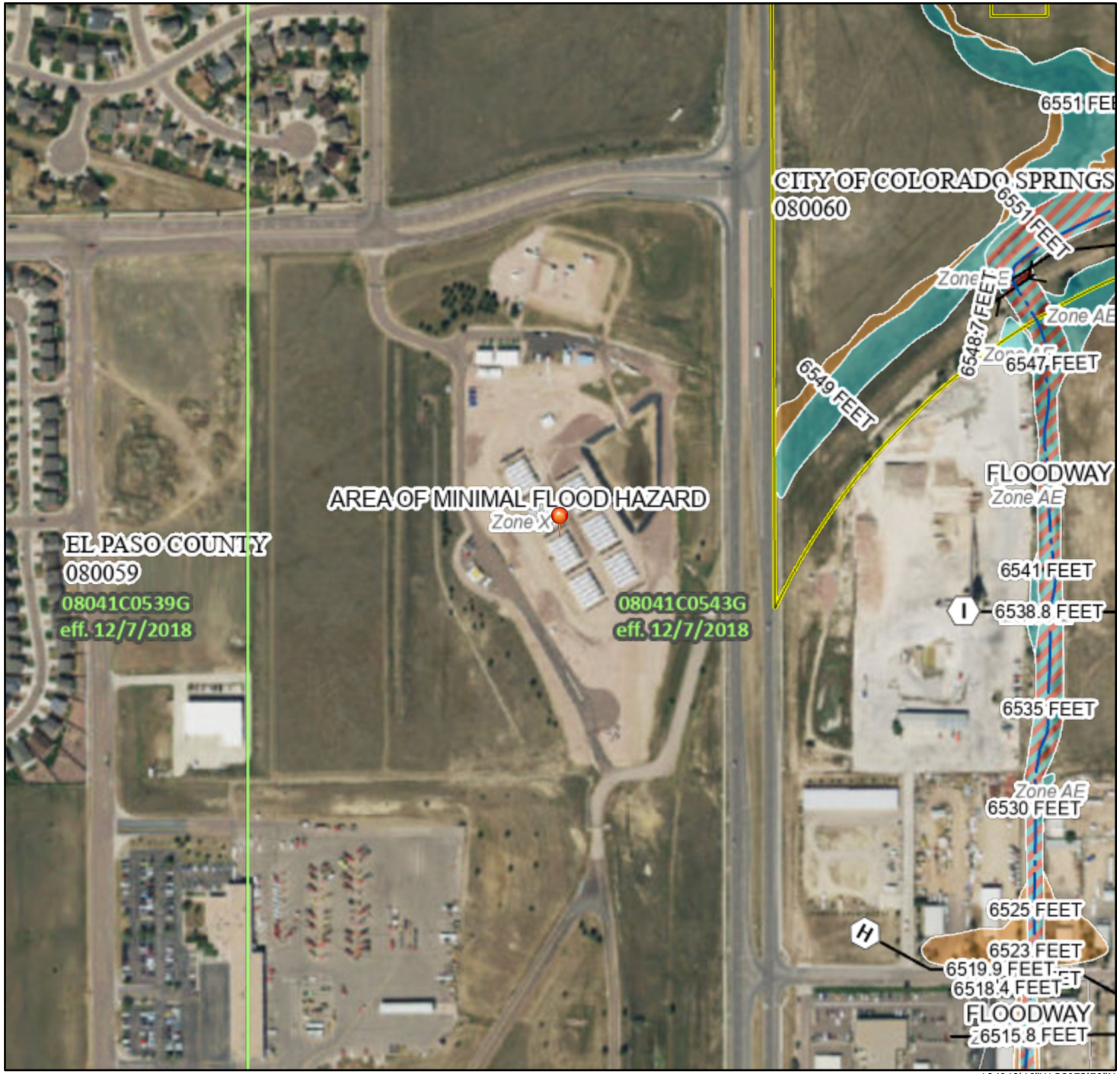
*Tie-break Rule:* Higher

ATTACHMENT 3 – FEMA Flood Map

# National Flood Hazard Layer FIRMette

FEMA

104°41'23"W 38°53'18"N




104°40'46"W 38°52'50"N

Feet 1:6,000

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

*Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020*

## Legend

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

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

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

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

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

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 8/26/2021 at 12:42 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.

ATTACHMENT 4 – Rational Method Calculations

# Hydrograph Report

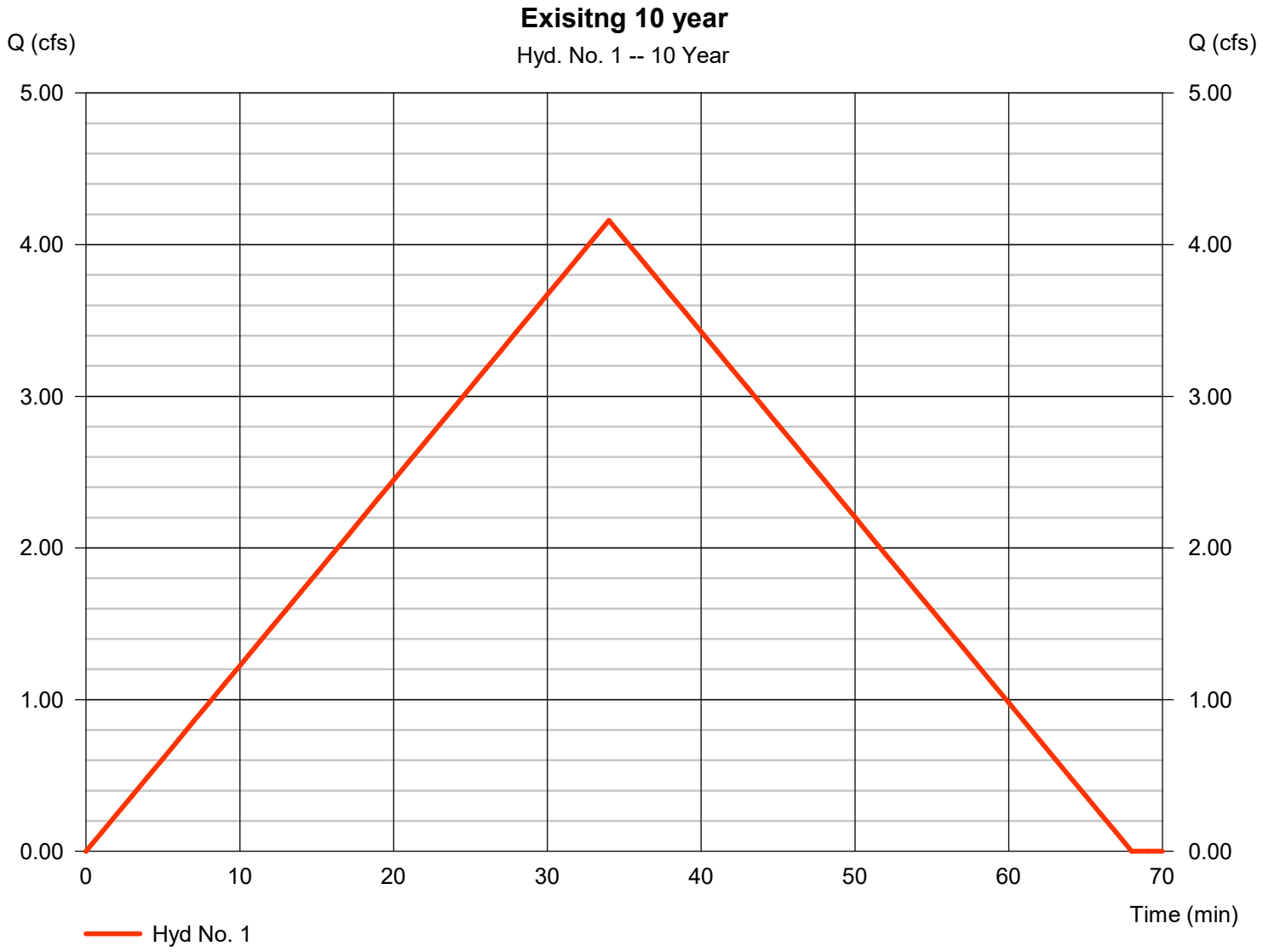
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021 Tuesday, 09 / 7 / 2021

## Hyd. No. 1

Existing 10 year

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Rational | Peak discharge | = | 4.160 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 34 min |
| Time interval | = | 1 min | Hyd. volume | = | 8,487 cuft |
| Drainage area | = | 7.950 ac | Runoff coeff. | = | 0.15* |
| Intensity | = | 3.489 in/hr | Tc by TR55 | = | 34.00 min |
| IDF Curve | = | SampleFHA.idf | Asc/Rec limb fact | = | 1/1 |

* Composite (Area/C) = [(7.950 x 0.15)] / 7.950



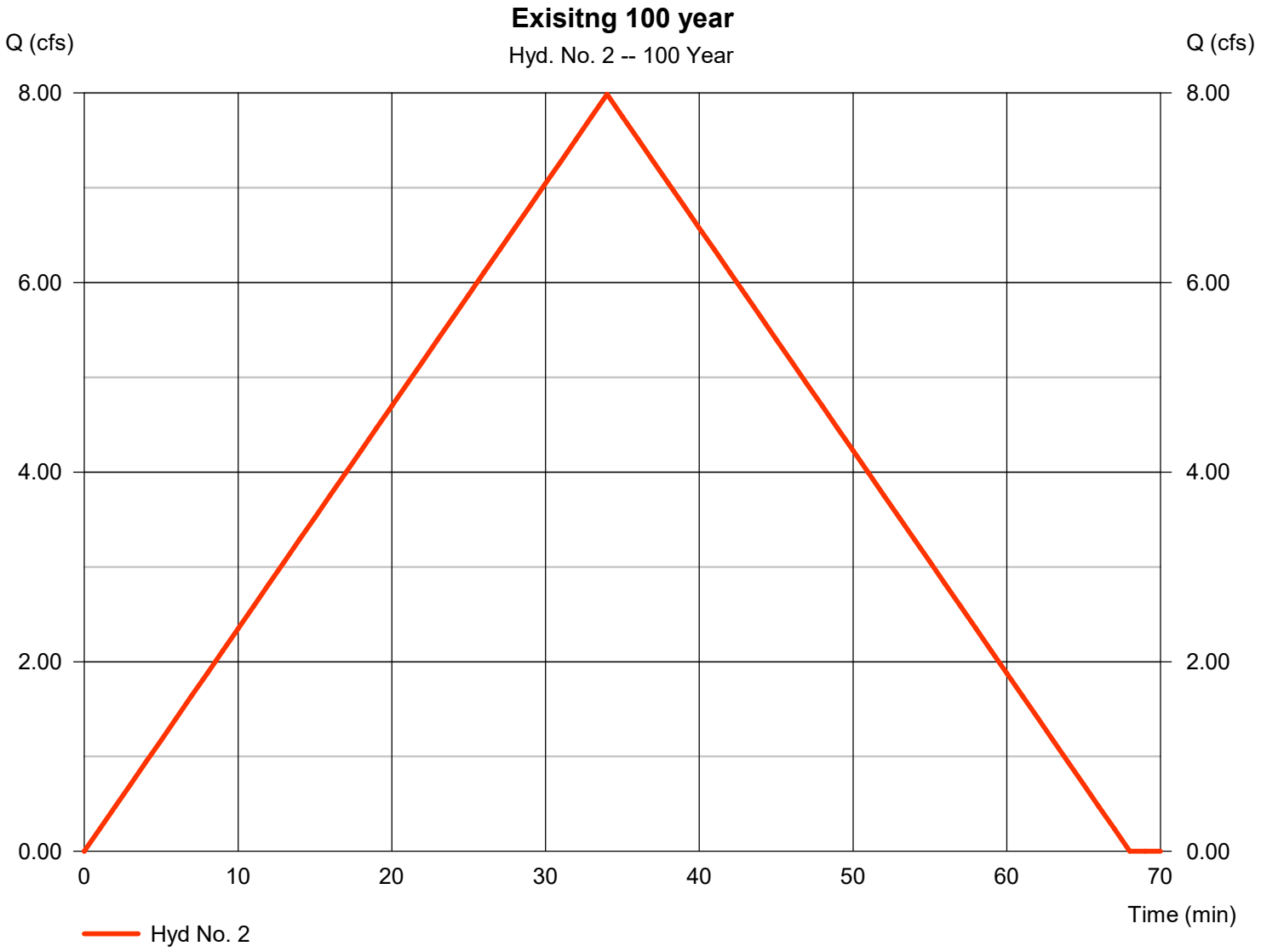
# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021 Tuesday, 09 / 7 / 2021

## Hyd. No. 2

Existing 100 year

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Rational | Peak discharge | = | 7.986 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 34 min |
| Time interval | = | 1 min | Hyd. volume | = | 16,291 cuft |
| Drainage area | = | 7.950 ac | Runoff coeff. | = | 0.2 |
| Intensity | = | 5.022 in/hr | Tc by TR55 | = | 34.00 min |
| IDF Curve | = | SampleFHA.idf | Asc/Rec limb fact | = | 1/1 |



# Hydrograph Report

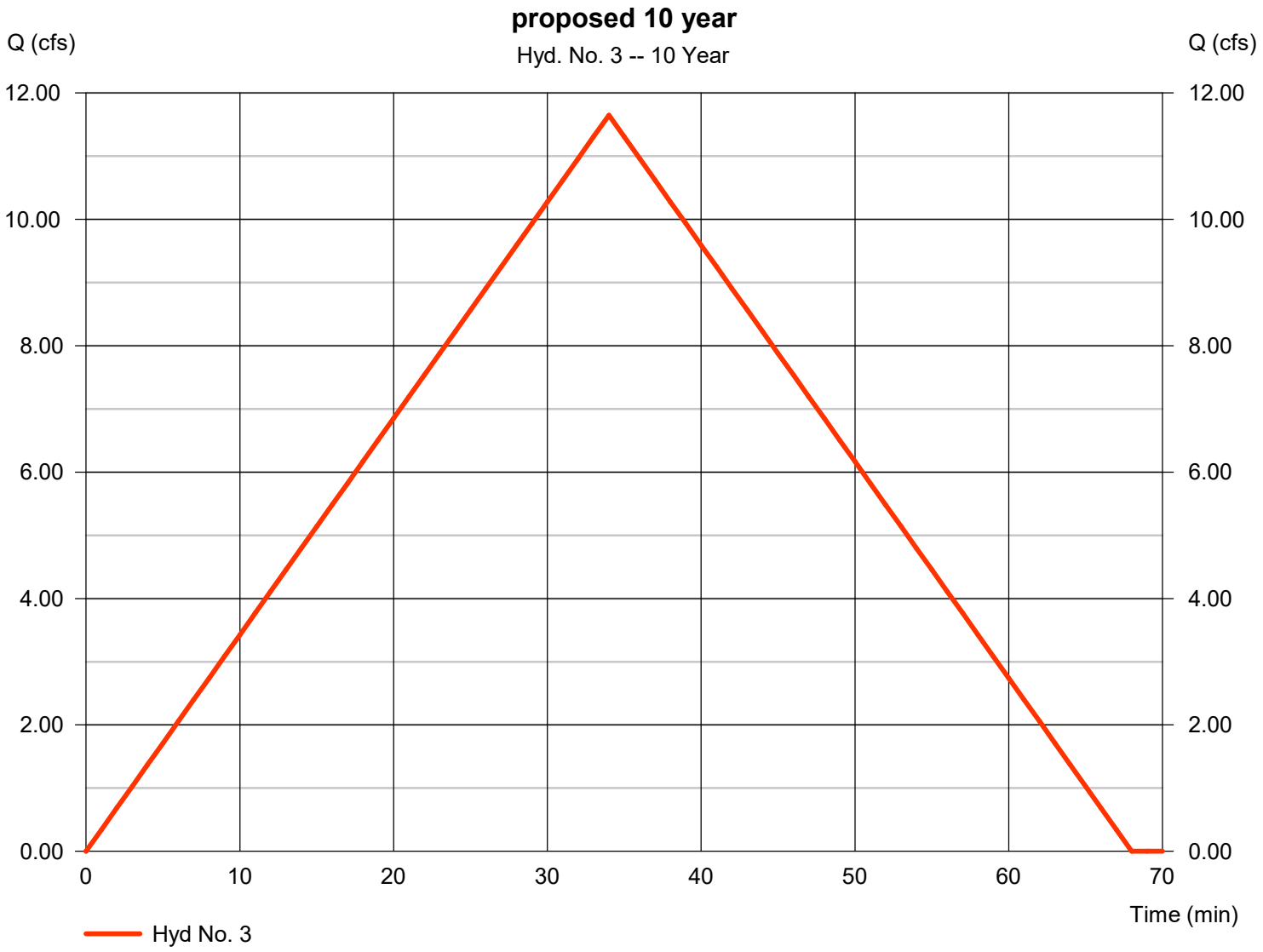
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021 Tuesday, 09 / 7 / 2021

## Hyd. No. 3

Proposed 10 year

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Rational | Peak discharge | = | 11.65 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 34 min |
| Time interval | = | 1 min | Hyd. volume | = | 23,763 cuft |
| Drainage area | = | 7.950 ac | Runoff coeff. | = | 0.42* |
| Intensity | = | 3.489 in/hr | Tc by User | = | 34.00 min |
| IDF Curve | = | SampleFHA.idf | Asc/Rec limb fact | = | 1/1 |

* Composite (Area/C) = [(3.330 x 0.80) + (4.620 x 0.15)] / 7.950



# Hydrograph Report

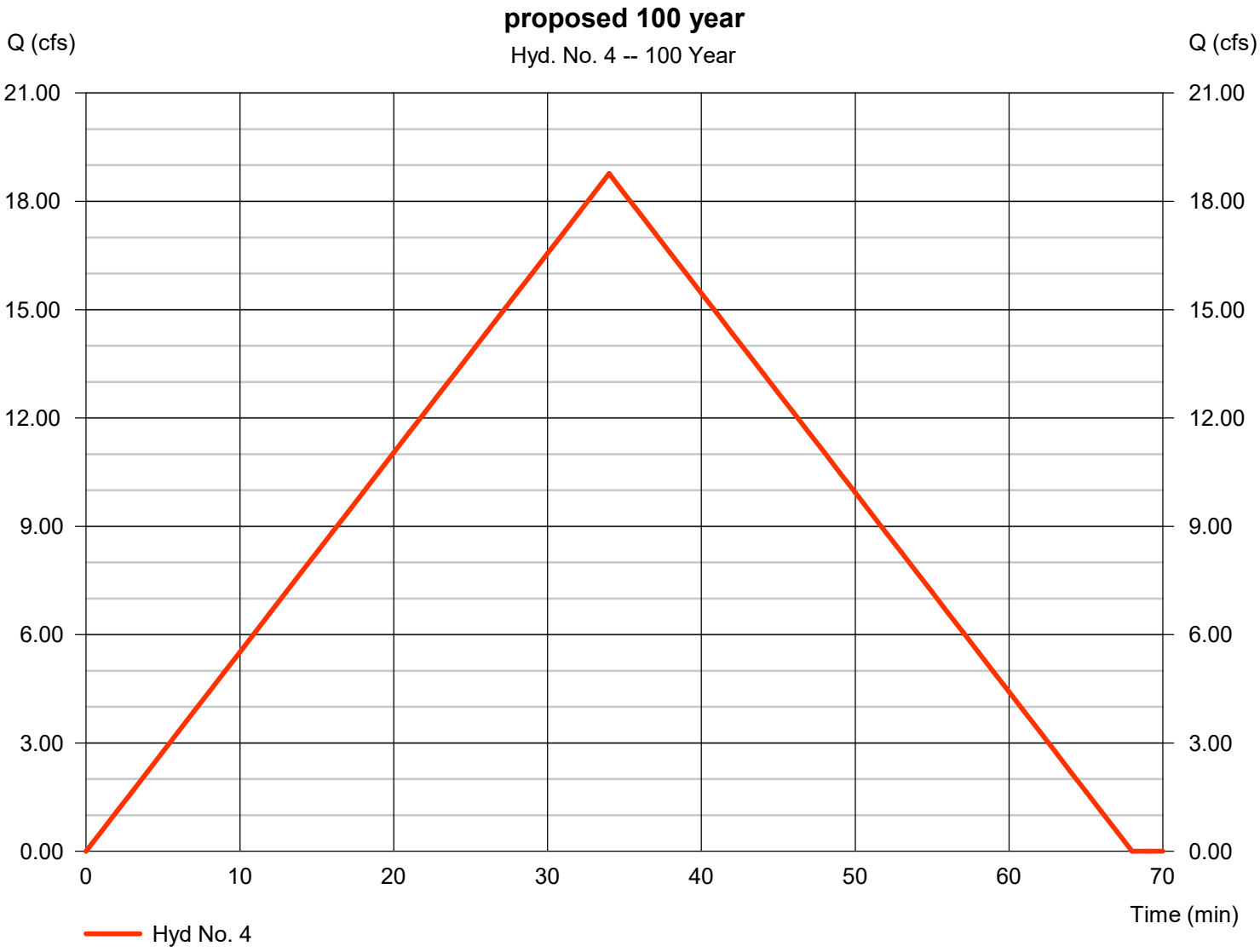
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021 Tuesday, 09 / 7 / 2021

## Hyd. No. 4

Proposed 100 year

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Rational | Peak discharge | = | 18.77 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 34 min |
| Time interval | = | 1 min | Hyd. volume | = | 38,283 cuft |
| Drainage area | = | 7.950 ac | Runoff coeff. | = | 0.47* |
| Intensity | = | 5.022 in/hr | Tc by User | = | 34.00 min |
| IDF Curve | = | SampleFHA.idf | Asc/Rec limb fact | = | 1/1 |

* Composite (Area/C) = [(3.330 x 0.85) + (4.620 x 0.20)] / 7.950



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

## Hyd. No. 1

Existing 10 year

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.240 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 300.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.96 | | 0.00 | | 0.00 | | |
| Land slope (%) | = 4.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 33.28** | **+** | **0.00** | **+** | **0.00** | **=** | **33.28** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =0.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 27.00 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 19.00 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 3.00 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.025 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =13.06 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})550.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 0.70** | **+** | **0.00** | **+** | **0.00** | **=** | **0.70** |

**Total Travel Time, Tc ..... 34.00 min**

ATTACHMENT 5 – Culvert Analysis

# Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Sep 8 2021

## Existing 12-inch Culvert

**Circular**

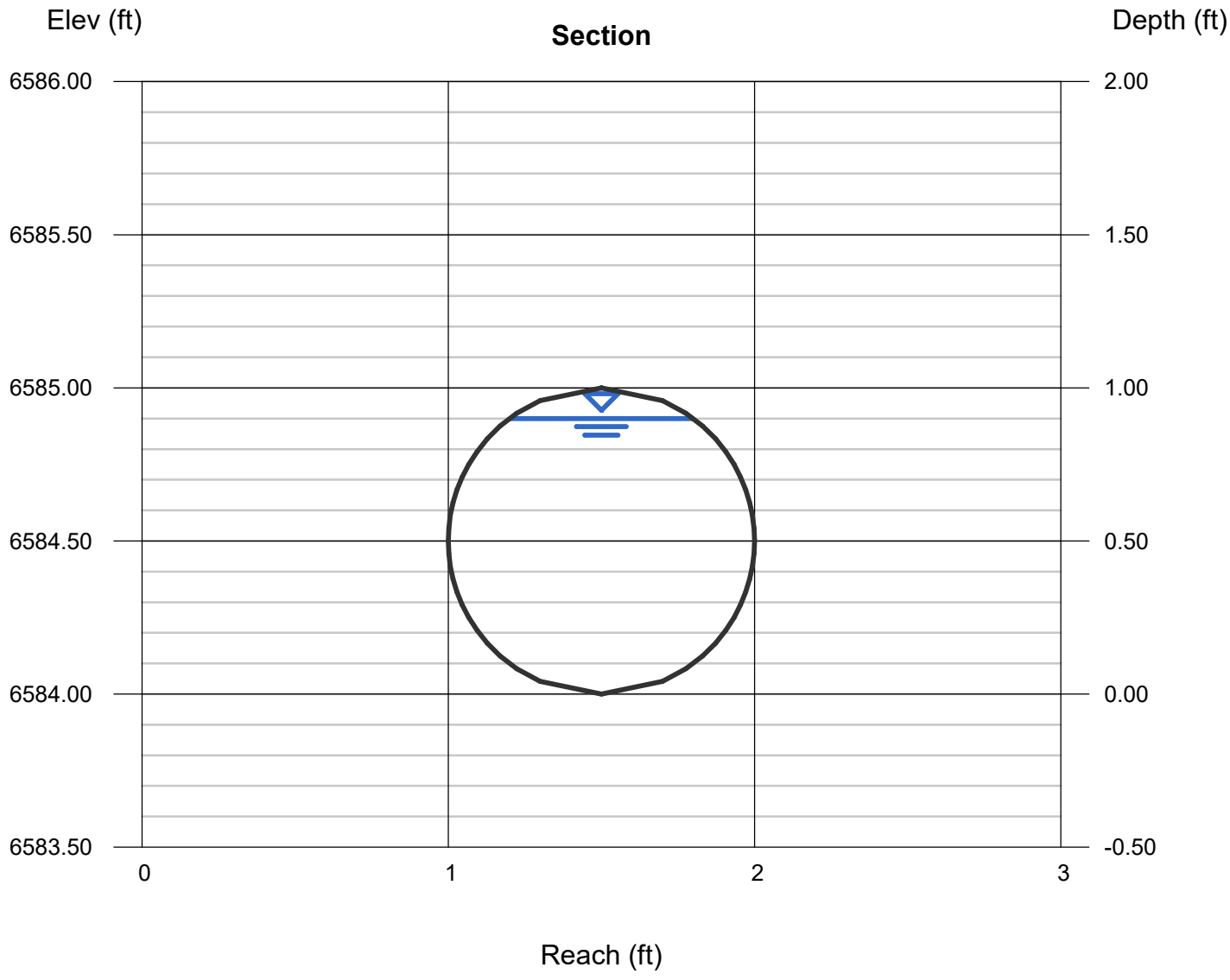
| | |
|---|---|
| Diameter (ft) | = 1.00 |
| Invert Elev (ft) | = 6584.00 |
| Slope (%) | = 1.00 |
| N-Value | = 0.012 |

**Calculations**

| | |
|---|---|
| Compute by: | Q vs Depth |
| No. Increments | = 10 |

**Highlighted**

| | |
|---|---|
| Depth (ft) | = 0.90 |
| Q (cfs) | = 4.113 |
| Area (sqft) | = 0.74 |
| Velocity (ft/s) | = 5.52 |
| Wetted Perim (ft) | = 2.50 |
| Crit Depth, Yc (ft) | = 0.86 |
| Top Width (ft) | = 0.60 |
| EGL (ft) | = 1.37 |



# Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Sep 8 2021

## Proposed 18-inch Culvert

**Circular**

| | |
|---|---|
| Diameter (ft) | = 1.50 |
| Invert Elev (ft) | = 6584.00 |
| Slope (%) | = 1.00 |
| N-Value | = 0.012 |

**Calculations**

| | |
|---|---|
| Compute by: | Known Q |
| Known Q (cfs) | = 11.65 |

**Highlighted**

| | |
|---|---|
| Depth (ft) | = 1.27 |
| Q (cfs) | = 11.65 |
| Area (sqft) | = 1.60 |
| Velocity (ft/s) | = 7.29 |
| Wetted Perim (ft) | = 3.51 |
| Crit Depth, Yc (ft) | = 1.30 |
| Top Width (ft) | = 1.08 |
| EGL (ft) | = 2.10 |