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Final Drainage Report

Nabulsi-Abushaban Subdivision

Project No. 61201

August 16, 2024

PCD File No. MS2211

Final Drainage Report

for

Nabulsi-Abushaban Subdivision

Project No. 61201

August 16, 2024

prepared for

Taher Nabulsi
10650 Black Forest Road
Colorado Springs, CO 80908

prepared by

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Statements and Acknowledgments

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 the County for drainage reports and said report is in conformity with the applicable 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.

COLORADO LICENSED
DAVID RAYMOND GORMAN
8/23/24
31672
PROFESSIONAL ENGINEER

David R. Gorman, P.E.
Colorado No. 31672
For and on Behalf of MVE, Inc.

Developer's Statement

I, the owner/developer have read and will comply with all of the requirements specified in this drainage report and plan.

Taher Nabulsi, Owner

8/23/2024
Date

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.

Joshua Palmer
County Engineer/ECM Administrator

Date

Conditions:

Contents

Final Drainage Report

The purpose of this Final Drainage Report is to identify drainage patterns and quantities within and affecting the proposed Nabulsi-Abushaban Subdivision, a 24.796± acre parcel in El Paso County, Colorado. The report presents the stormwater management issues specific to this site and discusses the aspects of the drainage design that addresses those issues. The report and included maps present results of the final hydrologic and drainage facility sizing and analyses. The report recommends that no additional drainage improvements are needed for the site and identifies drainage requirements relative to the proposed subdivision. This report has been prepared and submitted in accordance with the requirements of the El Paso County Drainage Criteria Manual approval process. An Appendix is included with this report with pertinent calculations and data used in the drainage analysis.

1 General Location and Description

1.1 Location

The Nabulsi-Abushaban Subdivision site is located within the Southeast ¼ of the Southeast ¼ of Section 19, Township 12 South, Range 65 West, of the 6th Principal Meridian in Colorado Springs, Colorado. The site is situated adjacent west of Black Forest Road and adjacent north of Old Ranch Road. The site is made up of a single unplatted parcel having El Paso County Tax Assessor's Schedule Number: 52190-00-101 and address of 10650 Black Forest Road. A Vicinity Map is included in the **Appendix**. This report is submitted in connection with the application for a Minor Subdivision.

1.2 Description of Property

The Nabulsi-Abushaban Subdivision site encompasses 24.796± acres of land zoned currently zoned RR-5 (Rural Residential 5 acres). The parcel currently has multiple buildings within the north ½ of the parcel which includes a single-family residence, detached garage, and a barn/horse stables. Access for this developed area is an existing unpaved driveway along the east property line with direct access to Black Forest Road. The owners intend to subdivide the parcel into four lots. One lot is to be 9.28 acres and will contain the existing buildings. The three remaining lots will be approximately 5 acres each. A private gravel road will be constructed in the southern portion of the property and will provide access to Old Ranch Road.

This parcel is mostly undeveloped with minor grading around the existing buildings. The storm runoff from the site and the offsite basins generally drains from the north to the southeast and southwest. There is an existing livestock pond within the southeast portion of the lots. The drainageways within the property have no improvements or previous stabilization. The drainageways onsite are well vegetated with no indication of erosion and do not require any improvements.

1.3 Soil Description

According to the National Resource Conservation Service, there are two soil types identified at the Nabulsi-Abushaban Subdivision site. Kettle gravelly loamy sand, 8 to 40 percent slopes (map unit 41) makes up the majority of the site and offsite sub-basins which is contained in Hydrologic Soil Group B. This soil is deep and is well drained, permeability is rapid, surface runoff is medium, and the hazard of erosion is moderate.

The secondary soil group is: Pring coarse sandy loam, 3 to 8 percent slopes (map unit 71) which is large portion of the west offsite sub-basins and onsite sub-basin B1. This soil is contained in Hydrologic Soil

Group B. This soil is shallow to deep and well drained, permeability is rapid, surface runoff is medium, and the hazard of erosion is slight to moderate. A portion of the Soil Map and data tables from the National Cooperative Soil Survey and relevant Official Soil Series Descriptions (OSD) are included in the **Appendix**.[1] [2]

Areas of Seasonally Shallow Groundwater and Potentially Seasonal Shallow Groundwater were identified in the Soils and Geology Study prepared by Entech Engineering, Inc. under Job No. 221371 and dated March 22, 2023. Said report details the locations of these areas and outlines appropriate mitigation measures. Mitigation measures for Potentially Seasonally Shallow Groundwater Areas include constructing foundations with sufficient depth for frost protection, installing subsurface perimeter drains, and grading to direct surface flows around structures. Mitigation measures for Seasonally Shallow Groundwater Areas include avoidance of placing structures in obvious ponding areas and observance of the same mitigation measures that apply to the Potentially Seasonal Groundwater Areas.

2 Drainage Basins and Sub-Basins

2.1 Major Basin Descriptions

The Nabulsi-Abushaban Subdivision site is located in the northeast portion of Cottonwood Creek Major Drainage Basin (FOMO2200). El Paso County determined that Cottonwood Creek Major Drainage Basin is a fee basin. Drainage and bridge fees will be due at the time of platting.

The current Flood Insurance Study of the region includes a Flood Insurance Rate Map (FIRM), effective on December 7, 2018.[3] The proposed subdivision is included in Community Panel Numbers 08041C0527G of the Flood Insurance Rate Maps for El Paso County and Incorporated Areas. No portion of the site lies within FEMA designated Special Flood Hazard Areas (SFHA's). An excerpt of the current FEMA Flood Insurance Rate Maps with the site delineated is included in the **Appendix**.

2.2 Sub-Basin Description

The existing drainage patterns of the Nabulsi-Abushaban Subdivision site are described by eleven off-site drainage sub-basins and four on-site drainage sub-basins. The offsite flows mentioned enter the site along all property lines with the majority of flows entering from the north and west offsite sub-basins. Flows from the east and south property lines are from the gravel and paved roadway centerlines. Generally all flows flow to the southwest and southeast portions of the site into two existing Corrugated Metal Pipes (CMPs) which conveys the flows across Old Ranch Road into the south adjacent neighbor. Each existing drainage basin will be described in detail in Sub-Basin Specific Details. The drainage sub-basins are shown on the included **Existing Drainage Map**.

3 Drainage Design Criteria

3.1 Development Criteria Reference

This *Final Drainage Report for Nabulsi-Abushaban Subdivision* has been prepared according to the report guidelines presented in the *El Paso County Drainage Criteria Manual* (DCM)[4]. The hydrologic analysis is based on a collection of data from the DCM, the NCSS Web Soil Survey[5], Topographic mapping by El Paso County, property boundary information and proposed site layout by Eagle Land Surveying, Inc.

3.2 Hydrologic Criteria

For this Final Drainage Report, the Rational Method as described in the *El Paso County Drainage Criteria Manual* has been used for all Storm Runoff calculations, as the development and all sub-basins are less than 130 acres in area. “Colorado Springs Rainfall Intensity Duration Frequency” curves, Figure 6-5 in the

1 WSS
2 OSD
3 FIRM
4 DCM Section 4.3 and Section 4.4
5 WSS

DCM, was used to obtain the design rainfall values; a copy is included in the **Appendix**. The "Overland (Initial) Flow Equation" (Eq. 6-8) in the DCM, and Manning's equation with estimated depths were used in time of concentration calculations. "Runoff Coefficients for Rational Method", Table 6-6 in the DCM, was utilized as a guide in estimating runoff coefficient and Percent Impervious values; a copy is included in the **Appendix**. Peak runoff discharges were calculated for each drainage sub-basin for both the 5-year storm event and the 100-year storm event with the Rational Method formula, (Eq. 6-5) in the DCM.[6]

4 Drainage Facility Design

4.1 General Concept

The intent of the drainage concept presented in this Final Drainage Report is to provide adequate, safe and appropriate storm drainage, in accordance with El Paso County Drainage Criteria, within the proposed development and to the offsite discharge locations. The existing drainage conditions and the proposed drainage concept is described in more detail below. Input data and results for all calculations are included in the **Appendix**. Drainage maps of existing and proposed conditions are also included in the **Appendix**.

4.2 Sub-Basin Specific Details

4.2.1 Offsite Conditions

Offsite sub-basin **OS-A1/ Design Point 1 (DP1)** containing 9.66 ± acres north of the site. This sub-basin contains five RR-5 lots with a single-family residences, detached garages, gravel, and a small portion of paved Black Forest Road. The majority of this sub-basin features moderate slopes of 5% to 25% with steep slopes of > 33% along the west portion of the sub-basin. This sub-basin generates peak flow discharges of Q_5 = 3.4 cfs and Q_{100} = 18.8 cfs (existing flows). This runoff enters onsite sub-basin A1 along the north property line and eventually combines with additional flows at Design Point 2 (DP2).

Offsite sub-basin **OS-A2** containing 1.53 ± acres is located north-northwest of the site. This sub-basin contains a small portion of a single-family residence within the RR-5 lot located to the north-northwest of the site. This sub-basin features moderate slopes of 25% to 33% with steep slopes exceeding 33% found at the north portion of the sub-basin. This sub-basin generates peak flow discharges of Q_5 = 0.6 cfs and Q_{100} = 3.9 cfs (existing flows). This runoff enters on-site sub-basin A1 along the north property line combines with additional flows at DP2.

Offsite sub-basin **OS-A3** containing 2.91 ± acres is located north-northeast of the site. This sub-basin contains a single-family residence along with several small detached buildings. Additionally, the west half of paved Black Forest Road drains into this sub-basin. This majority of this sub-basin features moderate slopes of 25% to 33% with steep slopes exceeding 33% and mild slopes of <10% found at the southeast portion of the sub-basin. This sub-basin generates peak flow discharges of Q_5 = 0.9 cfs and Q_{100} = 6.2 cfs (existing flows). This runoff enters on-site sub-basin A1 along the north property line combines with additional flows at DP2.

Offsite sub-basin **OS-A4** containing 0.07 ± acres is located northeast of the site. This sub-basin contains a small portion of the west half of paved Black Forest Road draining southwest into the site. This sub-basin features mild slopes of 1 – 25%. This sub-basin generates peak flow discharges of Q_5 = < 0.1 cfs and Q_{100} = 0.2 cfs (existing flows). This runoff enters on-site sub-basin A1 along the east property line combines with additional flows at DP2.

Offsite sub-basin **OS-A5** containing 1.14 ± acres is located east of the site. This sub-basin contains the west half of paved Black Forest Road draining southwesterly into the site. The majority of this sub-basin features mild slopes of 1 – 5% with moderate slopes of 25% to 33% found at the roadside ditch at the north portion of this sub-basin. This sub-basin generates peak flow discharges of Q_5 = 1.2 cfs and Q_{100} = 3.7 cfs (existing flows). This runoff enters on-site sub-basin A2 along the east property line combines with additional flows at Design Point 3 (DP3).

6 DCM

Offsite sub-basin **OS-B1** containing 0.15 ± acres is located northwest of the site. This sub-basin contains only pasture meadow with mild slopes of 1 – 25%. This sub-basin generates peak flow discharges of Q_5 = < 0.1 cfs and Q_{100} = 0.4 cfs (existing flows). This runoff enters on-site sub-basin B1 along the north property line combines with additional flows at Design Point 4 (DP4).

Offsite sub-basin **OS-B2** containing 0.69 ± acres is located northwest of the site. This sub-basin contains only pasture meadow with moderate/steep slopes of 25% to > 33% draining southeast into the site. This sub-basin generates peak flow discharges of Q_5 = 0.3 cfs and Q_{100} = 2.0 cfs (existing flows). This runoff enters on-site sub-basin B1 along the west property line combines with additional flows at Design Point 4 (DP4).

Offsite sub-basin **OS-B3** containing 3.25 ± acres is located west of the site. This sub-basin contains pasture meadow and a small portion of an existing single-family residence. This sub-basin features moderate/steep slopes of 25% to > 33% draining southeast and transitions into mild slopes of 1-10% before entering the site. This sub-basin generates peak flow discharges of Q_5 = 1.7 cfs and Q_{100} = 9.1 cfs (existing flows). This runoff enters on-site sub-basin B1 along the west property line combines with additional flows at Design Point 4 (DP4).

Offsite sub-basin **OS-B4** containing 0.38 ± acres is located southwest outside of the site. This sub-basin contains pasture meadow and a small portion of an existing single-family residence. This sub-basin features moderate/steep slopes of 25% to > 33% draining southeast and transitions into mild slopes of 1-10% before entering the site. This sub-basin generates peak flow discharges of Q_5 = 0.4 cfs and Q_{100} = 1.2 cfs (existing flows). This runoff enters on-site sub-basin B1 along the west property line combines with additional flows at Design Point 4 (DP4).

Offsite sub-basin **OS-B5 & PP OS-B5** containing 0.38 ± acres is located center-south of the site. This sub-basin contains a portion of the gravel road on Old Ranch Road and its roadside ditch. In proposed conditions, this sub-basin will contain the gravel apron for the proposed private road. This sub-basin features moderate/steep slopes of 25% to > 33% draining southeast and transitions into mild slopes of 1-10% before entering the site. In existing conditions, this sub-basin generates peak flow discharges of Q_5 = 0.4 cfs and Q_{100} = 1.1 cfs with increase of < 0.1 for the 5-year and 100-year flows. This runoff enters on-site sub-basin B1 along the west property line combines with additional flows at Design Point 4 (DP4).

Offsite sub-basin **OS-C1** containing 0.53 ± acres is located southeast of the site. This sub-basin contains pasture meadow and a small portion of an existing single-family residence. This sub-basin features moderate/steep slopes of 25% to > 33% draining southeast and transitions into mild slopes of 1-10% before entering the site. This sub-basin generates peak flow discharges of Q_5 = 0.8 cfs and Q_{100} = 2.0 cfs. This runoff enters on-site sub-basin B1 along the west property line combines with additional flows at Design Point 4 (DP4).

4.2.2 Existing Onsite Conditions

The existing onsite drainage patterns of the site are described by four sub-basins. The north and west portions of the site feature moderate to steep slopes of 25% to >33% and transitions into mild to moderate slopes within the south half of the site. The south half will feature primarily sheet flow. The majority of runoff within the site will drain into an existing non-jurisdictional livestock pond constructed in 1965 in an existing natural depression located within the southeast portion of the site. No outlet pipes were constructed with this facility as explained in the approved Application for Livestock Water Tank that is included in the **Appendix.** This pond is listed to have a volume of 10.0 acre-feet with a 7.6 feet to the spillway. Any flows that may drain from the pond will drain southerly from the depression wall/tree windbreak area indicated on the **Existing/Proposed Drainage Maps.** Any runoff not captured by the pond will drain toward two existing Corrugated Metal Pipes (CMPs) along the south property line. The majority of runoff not captured by the pond will travel to the 36” CMP located within EX-B1. A minor amount of runoff will be captured by the existing 18” CMP located within EX-C1 at the southeast portion of the site. Currently, the 18” CMP is currently silted and will require maintenance by El Paso County.

Existing onsite sub-basin **EX-A1** containing 7.57 ± acres located within the north ½ of the site. This sub-basin is primarily undeveloped pasture/meadow with an existing single-family residence, detached garage, enclosed pool house, and several horse stables. This sub-basin features steep slopes of 25% to >33% along the north property line and transitions into mild slopes of 1% to 15% sloping toward the

south. This sub-basin generates peak flow discharges of Q_5 = 2.4 cfs and Q_{100} = 16.7 cfs (existing flows). This runoff combines with flows from the offsite sub-basin OSA1-4 at Existing Design Point 2 (EX-DP2).

Existing onsite sub-basin **EX-A2** containing 7.94 ± acres located within the east ½ of the site. This sub-basin is undeveloped pasture/meadow with an existing natural depression and the existing unpaved driveway. This sub-basin features steep slopes of 25% to >33% at the north portion of the sub-basin and the existing depression. There are mild slopes of 1% to 15% that conveys flows to the southwest into the natural depression. This sub-basin accepts flows from EX-DP2 which flows into the existing draiange depression. This sub-basin generates peak flow discharges of Q_5 = 3.0 cfs and Q_{100} = 19.3 cfs (existing flows). This runoff combines with flows from EX-DP2 and OSA5 at Existing Design Point 3 (EX-DP3).

Existing onsite sub-basin **EX-B1** containing 8.86 ± acres located within the west ½ of the site. This sub-basin is undeveloped pasture/meadow with a small corral shed. This sub-basin features steep slopes of 25% to >33% at the north portion of the sub-basin transitioning into mild slopes of 1% to 15% that conveys flows to the south to an existing 36" CMP along the south property line. This sub-basin accepts flows from EX-DP3 and OSB1-5 which flows into the existing depression. This sub-basin generates peak flow discharges of Q_5 = 2.6 cfs and Q_{100} = 19.1 cfs (existing flows). This runoff combines with flows from EX-DP3 and OSB1-5 at Existing Design Point 4 (EX-DP4).

Existing onsite sub-basin **EX-C1** containing 0.41 ± acres located within the southeast portion within the site. This sub-basin is undeveloped pasture/meadow and contains the north roadside ditch of gravel Old Ranch Road and the natural depression wall to the north. This sub-basin features steep slopes of 25% to >33% along the depression wall on the north portion of the sub-basin with mild to moderate slopes along the roadside ditch. This sub-basin accepts flows from OSC1 where all flows are conveyed to an existing 18" CMP. This sub-basin generates peak flow discharges of Q_5 = 0.2 cfs and Q_{100} = 1.1 cfs (existing flows). This runoff combines with flows from OSC1 at Existing Design Point 5 (EX-DP5).

Existing Design Point 2 (EX-DP2) consists of OSA1-4 and EX-A1 with a collective area of 21.74 ± acres. This design point is located at the south portion of EX-A1 with the primary surface type of pasture/meadow. The design point collects peak flow discharges of Q_5 = 6.3 cfs and Q_{100} = 39.0 cfs (existing flows). This runoff drains southeast into sub-basin EX-A2 and combines with additional flows from OSA5 & EX-A2 at Existing Design Point 3 (EX-DP3).

Existing Design Point 3 (EX-DP3) consists of OSA1-5, EX-A1, and EX-A2 with a collective area of 30.83 ± acres. This design point is located at the southwest portion of EX-A2 with the primary surface type of pasture/meadow. The design point collects peak flow discharges of Q_5 = 9.1 cfs and Q_{100} = 54.5 cfs (existing flows). These flows enter the existing natural depression and is infiltrated through the soil.

Existing Design Point 4 (EX-DP4) consists of OSB1-5 and EX-B1 with a collective area of 13.68 ± acres. This design point is located at an existing 36" CMP located within the southwest portion of EX-B1. The design point collects peak flow discharges of Q_5 = 3.9 cfs and Q_{100} = 24.0 cfs (existing flows). This runoff drains through an existing 36" CMP under Old Ranch Road and then flows overland to the south into the adjacent property and eventually into Cottonwood Creek. There is no defined drainage path at the outlet of the pipe and no signs of erosion. Calculations for this existing pipe are included in the **Appendix**.

Existing Design Point 5 (EX-DP5) consists of OSC1 and EX-C1 with a collective area of 0.95 ± acres. This design point is located at an existing 18" CMP located within the southwest portion of EX-C1. The design point collects peak flow discharges of Q_5 = 0.9 cfs and Q_{100} = 3.0 cfs (existing flows). This runoff drains through an existing 18" CMP under Old Ranch Road and then flows overland to the south into the adjacent property and eventually into Cottonwood Creek. There is no defined drainage path at the outlet of the pipe and no signs of erosion. Calculations for this existing pipe are included in the **Appendix**.

4.2.3 Proposed Onsite Conditions

The proposed onsite drainage patterns of the site are described by four sub-basins. The final plat decribes that the subdivision will include a 20 foot Right-of-Way (ROW) dedication on the south property line and a 15 foot Right-of-Way (ROW) dedication along the east property line. The existing delineation lines along said existing property lines will remain the same for proposed drainage conditions.

For the interior onsite sub-basin delineation lines, the drainage paths and sub-basin shapes will change slightly due to the proposed gravel roadway. The shared sub-basin lines for A1, A2, & B2 shall be placed

on the roadway center line. The majority of runoff will continue to drain into the approved livestock pond as in existing conditions with negligible increase in flows. The proposed development calculations included that a proposed lot would contain a collective: 5,000 SF of roof area, 1,000 SF of paved parking area, and a 3,000 SF gravel driveway to connect to the proposed gravel roadway. The drainage sub-basins are shown on the included **Proposed Drainage Map**.

Proposed onsite sub-basin **A1** containing 7.08 ± acres represents the majority of existing sub-basin EX-A1 before entering the east roadside ditch for the proposed gravel roadway. The existing conditions show that this sub-basin is primarily undeveloped pasture/meadow with an existing single-family residence, detached garage, enclosed pool house, and several horse stables. In proposed conditions, 3000 SF of gravel and a collective roof area of 5,000 SF is applied to this sub-basin to mimic fully developed RR-5 lot. This sub-basin features steep slopes of 25% to >33% along the north property line and transitions into mild slopes of 1% to 15% sloping toward the south. In existing conditions, this sub-basin generates a peak flow discharge of Q_5 = 2.4 cfs and Q_{100} = 16.7 cfs (existing flows) and a proposed peak flow discharge of Q_5 = 2.7 cfs and Q_{100} = 16.2 cfs (proposed flows). This results in a negligible increase of Q_5 = 0.3 cfs and a decrease of Q_{100} = 0.5 cfs. The area for A1 has been reduced to accurately depict flows traveling to DP3 & DP4 via the proposed roadside ditches. This flow will combine with additional flows from OSA1-4 at Design Point 2 (DP2).

Proposed onsite sub-basin **A2** containing 7.98 ± acres is located within the east ½ of the site. Currently, this sub-basin is undeveloped pasture/meadow with an existing natural depression and the existing unpaved driveway within the north portion of the sub-basin. In proposed conditions, a 5,000 SF house, 1000 SF paved driveway, and 3,000 SF gravel driveway is added to this sub-basin to simulate developed lot conditions. In addition, the upper east ½ of the proposed road is contained within this sub-basin as the east roadside ditch transitions from fill to cut conditions at the sub-basin delineation line indicated on the proposed drainage map. This sub-basin features steep slopes of 25% to >33% at the north and east portions of the sub-basin and the existing depression. Runoff will travel into the existing pond. In existing conditions,this sub-basin generates a peak flow discharge of Q_5 = 3.0 cfs and Q_{100} = 19.3 cfs (existing flows) and a proposed peak flow discharge of Q_5 = 3.7 cfs and Q_{100} = 20.3 cfs (proposed flows). This results in a negligible increase of Q_5 = 0.7 cfs and Q_{100} = 1.0 cfs. This sub-basin accepts flows from DP2 before entering the existing depression at Design Point 3 (DP3).

Proposed onsite sub-basin **A3** containing 0.46 ± acres is located within the south-center portion of the site. Currently, this sub-basin is undeveloped pasture/meadow draining overland to the southwest toward the existing 36" CMP. In proposed conditions, this sub-basin will contain a small portion of the east side of the proposed gravel road with a typical 2 foot drainage channel. This sub-basin features mild slopes of 5 to 15% with steep slopes of 25% to >33% at the northeast portion of the sub-basin. This sub-basin generates a peak flow discharge of Q_5 = 0.3 cfs and Q_{100} = 1.4 cfs (proposed flows). These flows enter a proposed 14"X23" Reinforced Concrete Elliptical Pipe (RCEP) that will convey flows under the proposed gravel private road. This runoff will combine with additional flows from the west portion of the site at Design Point 4 (DP4)

Proposed onsite sub-basin **B1** containing 8.87 ± acres is located within the west ½ of the site. Currently, this sub-basin is undeveloped pasture/meadow with a small corral shed. In proposed conditions, this sub-basin will contain two proposed lots where both lots will contain a 5,000 SF house, 1000 SF paved driveway, and 3,000 SF gravel driveway is added to this sub-basin to simulate developed lot conditions. In addition, the west half of the proposed road is contained within this sub-basin. This sub-basin features steep slopes of 25% to >33% at the north portion of the sub-basin transitioning into mild slopes of 1% to 15% that conveys flows to the south to an existing 36" CMP along the south property line. In existing conditions, this sub-basin generates a peak flow discharge of Q_5 = 2.6 cfs and Q_{100} = 19.1 cfs (existing flows) and a proposed peak flow discharge of Q_5 = 4.0 cfs and Q_{100} = 20.8 cfs (proposed flows). This results in a negligible increase of Q_5 = 1.4 cfs and Q_{100} = 1.7 cfs. This sub-basin accepts flows from OSB1-5 and combines at Design Point 4 (DP4) located at the existing 36" CMP.

Proposed onsite sub-basin **C1** containing 0.41 ± acres located within the southeast portion of the site. This sub-basin is undeveloped pasture/meadow and contains the north roadside ditch of gravel Old Ranch Road and the natural depression wall to the north. There will be no changes to this sub-basin for proposed conditions. This sub-basin features steep slopes of 25% to >33% along the depression wall on

the north portion of the sub-basin with mild to moderate slopes along the roadside ditch. This sub-basin accepts flows from OSC1 where all flows are conveyed to an existing 18" CMP. This sub-basin generates peak flow discharges of Q_5 = 0.2 cfs and Q_{100} = 1.1 cfs (existing/proposed flows). This runoff combines with flows from OSC1 at Design Point 5 (DP5).

Design Point 2 (DP2) consists of OSA1-4, and A1 with a collective area of 21.25 ± acres. This design point is located at the north portion of the proposed roadway cul-de-sac. This design point represents the flows that will enter the east roadside ditch only. The proposed conditions reflect a proposed lot where an increased collective area of 5,000 SF roof, 1000 SF of pavement, and 3,000 SF gravel is utilized. Design Point 2 has an existing peak discharge of Q_5 = 6.3 cfs and Q_{100} = 39.0 cfs and a proposed peak discharge of Q_5 = 6.5 cfs and Q_{100} = 38.5 cfs. This results in a negligible flow change of Q_5 = 0.2 cfs and Q_{100} = -0.5 cfs. Sub-basin A1 has a reduction of 0.49 ± acres as the proposed roadway changes the sub-basin design within the south portion of the sub-basin. This runoff will continue southerly along the east roadside ditch into sub-basin B1 and combines with additional flows at Design Point 3 (DP3).

Design Point 3 (DP3) consists of OSA1-5, A1, and A2 with a collective area of 30.37 ± acres. This design point is located within the southwest portion of A2 at the existing livestock pond. The developed conditions for this lot reflects the increased imperviousness of two proposed lots each containing 5,000 SF roof, 1000 SF of pavement, and 3,000 SF gravel. In addition, this design point accepts flows from the northeast ½ of the proposed gravel roadway. Design Point 3 has an existing peak discharge of Q_5 = 9.1 cfs and Q_{100} = 54.5 cfs and a proposed peak discharge of Q_5 = 9.8 cfs and Q_{100} = 54.2 cfs. This results in a negligible change of Q_5 = +0.7 cfs and Q_{100} = -0.1 cfs. Sub-basin A1 has a reduction of 0.49 ± acres as the proposed roadway changes the sub-basin design within the south portion of the sub-basin. This runoff flows into the existing livestock pond and is slowly released by infiltration.

Design Point 4 (DP4) consists of OSB1-4, PP-OSB5, and B1 with a collective area of 14.14 ± acres. This design point is located at an existing 36" CMP located within the southwest portion of B1. The developed conditions for this design point reflects the increased imperviousness of two proposed lots each containing 5,000 SF roof, 1000 SF of pavement, and 3,000 SF gravel. In addition, this design point accepts flows from the west ½ and southeast ½ of the proposed gravel roadway. The southeast ½ of the gravel roadway drains into a proposed 18" RCP in west direction. This design point has an increase in area of 0.46 ± acres as a result of the proposed cul-de-sac construction. Design Point 4 has an existing peak discharge of Q_5 = 3.9 cfs and Q_{100} = 24.0 cfs and a proposed peak discharge of Q_5 = 5.2 cfs and Q_{100} = 26.2 cfs. This represents a minor and inconsequential increase in flows of 1.3 cfs in the 5-year event (33%) and 2.2 cfs in the 100-year event (9%). The sub-basin runoff drains through an existing 36" CMP under Old Ranch Road and then flows overland to the south into the adjacent property and eventually into Cottonwood Creek. There is no defined drainage path at the outlet of the pipe and no signs of erosion. The increase in flows will not adversely affect this existing condition. Calculations for this existing pipe in the developed condition are included in the **Appendix**.

Existing/Proposed Design Point 5 (DP5) consists of OSC1 and C1 with a collective area of 0.95 ± acres. This design point is located at an existing 18" CMP located within the southwest portion of EX-C1. The design point collects peak flow discharges of Q_5 = 0.9 cfs and Q_{100} = 3.0 cfs (existing/proposed flows). This runoff drains through an existing 18" CMP under Old Ranch Road and then flows overland to the south into the adjacent property and eventually into Cottonwood Creek. There is no defined drainage path at the outlet of the pipe and no signs of erosion. Calculations for this existing pipe are included in the **Appendix**.

4.3 Reseeding and Allowable Ditch Flow Velocities

All disturbed areas that are not access easement surfaces or otherwise protected by riprap shall be reseeded using the El Paso Low Grow Grass Seed Mix suggested by the El Paso County Conservation District. A copy of this recommendation is included in the **Appendix** of this report and on the Grading and Erosion Control Plan for this project. The seed mix contains a mixture of about 24% Western Wheatgrass, about 20% Blue Grama, Native, about 18% Buffalograss, about 13% Sideoats Grama, about 6% Green Needlegrass, and about 1.5% Sand Dropseed. These specific species of native seed are 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

the predominate 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 the predominate species contained in the suggested Seed Mix and is not useful for determining allowable flow velocities with these types of linings. Therefore, a supplemental data table from the "Stability Thresholds for Stream Materials" prepared by U.S. Army Engineer Research and Development Center is 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. Flow velocities on all reseeded areas remain below 5 ft/sec and the native grasses are adequate to withstand to flows. Maximum ditch velocity calculation is included in the **Appendix.**

4.4 Water Quality Enhancement Best Management Practices

The El Paso County Engineering Criteria Manual (Appendix I, Section I.7.2) requires 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 drainage ways, and implementing long term source controls". The Four Step Process is incorporated in this project and the elements are discussed below.

1) Runoff Reduction Practices are employed in this project. Impervious surfaces have been reduced as much as practically possible. There is only minimal concrete or other hard surfaces proposed. Minimized Directly Connected Impervious Areas (MDCIA) is employed on the project because runoff passes through a private roadside ditch and an open space meadow area before leaving the site.

These private roadsides are edged with Receiving Pervious Area (RPA) for the private roadway impervious surfaces as detailed in the **BMP Area ID** map attached in the **Appendix**. The RPA has established vegetation. The slope at the UIA/RPA interface prevents any accumulation of sediment from interfering with runoff entering the existing private roadway ditch. The site is exempted from the use of WQCV BMPs by ECM I.7.1.B.5 by virtue of the large lot rural residential nature of the site having percent imperviousness of less than 10%. The runoff generated from the impervious areas of the gravel road will be treated for water quality by the RPA's.

Areas being used as RPA constitute vegetated areas down-gradient of impervious areas as specified in Water Quality Control Volume reduction procedure detailed in Chapter 4, Fact Sheet T-00 "Quantifying Runoff Reduction" of the Urban Storm Drainage Criteria Manual, Volume 3. Permanent seeding will follow the proposed construction, and temporary irrigation will establish a grass cover. The volume reduction calculation was made with the aid of the "UD-BMP_v3.07" spreadsheet developed by Mile High Flood District and is attached in the **Appendix** showing a WQCV reduction more than 60%.

2) There are no drainage paths on the site that are required to be stabilized as they are well vegetated with no visual erosion. The mild drainage paths have shallow side slopes of >10:1 with 1-3' fescue grass within the channels.

3) The project contains no potentially hazardous uses. The site is exempted from the use of WQCV BMPs by ECM I.7.1.B.5 by virtue of the large lot rural residential nature of the site having actual percent imperviousness of less than 10%. The runoff generated from the impervious areas of the proposed roadway will be treated for water quality by utilizing the runoff reduction standard. Stormwater runoff from the proposed access easements will pass through a strip of RPA edging the impervious areas and will infiltrate into the ground, evaporate, or evapotranspire a quantity of water equal to at least 60% of what the calculated WQCV would be if all impervious area for the applicable development site discharged without infiltration. A uniform strip of at least 4 feet in width along the access easements and 8 foot in width around the cul-de-sacs adjacent to the proposed impervious areas is sufficient to accomplish the necessary 60% reduction minimum and provide for a consistant and manageable shape to the RPA. Runoff Reduction calculations are included in the A**ppendix** that demonstrate the effectiveness of the uniform strip of RPA. The proposed RPAs are considered permanent BMPs and a signed PCM Maintenance Agreement and O&M Manual will prepared and executed.

4) The rural residential lot 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.

5 Drainage Fees

The site is located within the Cottonwood Creek Major Drainage Basin of Monument Creek, El Paso Basin Number FOMO2200, which was last studied in 1994. Fees associated with this basin are Drainage Fees of $23,078 per impervious acre and Bridge Fees of $1,262 per impervious acre. The percent Imperiousness of the 5-acre Rural Residential site is 7% in accordance with El Paso County Engineering Criteria Manual Appendix L Table 3-1. Also, reductions in the per acre Drainage Fee are allowed pursuant to El Paso County Resolution 99-383. A fee reduction in the of 25% for lots 2.5 acres or large is utilized for this project. The Nabulsi-Abushaban Subdivision site contains 23.95 acres. Drainage and Bridge Fees for the site are calculated below:

FEE CALCULATION (Cottonwood Creek 2023 Drainage and Bridge Fees)

Drainage Fee	=	23.95 x $23,078/Imp. Ac x 7% Imp.	=	$38,690
		25% Fee Reduction	=	($ 9,673)
Bridge Fee	=	23.955 x $1,262/Imp. Ac x 7% Imp.	=	$ 2,116
		Grand Total Fees	**=**	**$31,133**

6 Conclusion

This Final Drainage Report presents existing and proposed drainage conditions for the proposed Nabulsi-Abushaban Subdivision project. The development will have negligible and inconsequential effects on the existing site drainage and drainage conditions downstream. With such a negligible increase in stormwater flows from the site detention will not be necessary for the proposed development and will not be provided. The proposed project will not, with respect to stormwater runoff, negatively impact the adjacent properties and downstream properties.

References

NRCS Web Soil Survey. United States Department of Agriculture, Natural Resources Conservation Service ("http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx", accessed October 2016).

NRCS Official Soil Series Descriptions. United States Department of Agriculture, Natural Resources Conservation Service ("http://soils.usda.gov/technical/classification/osd/index.html", accessed October 20165).

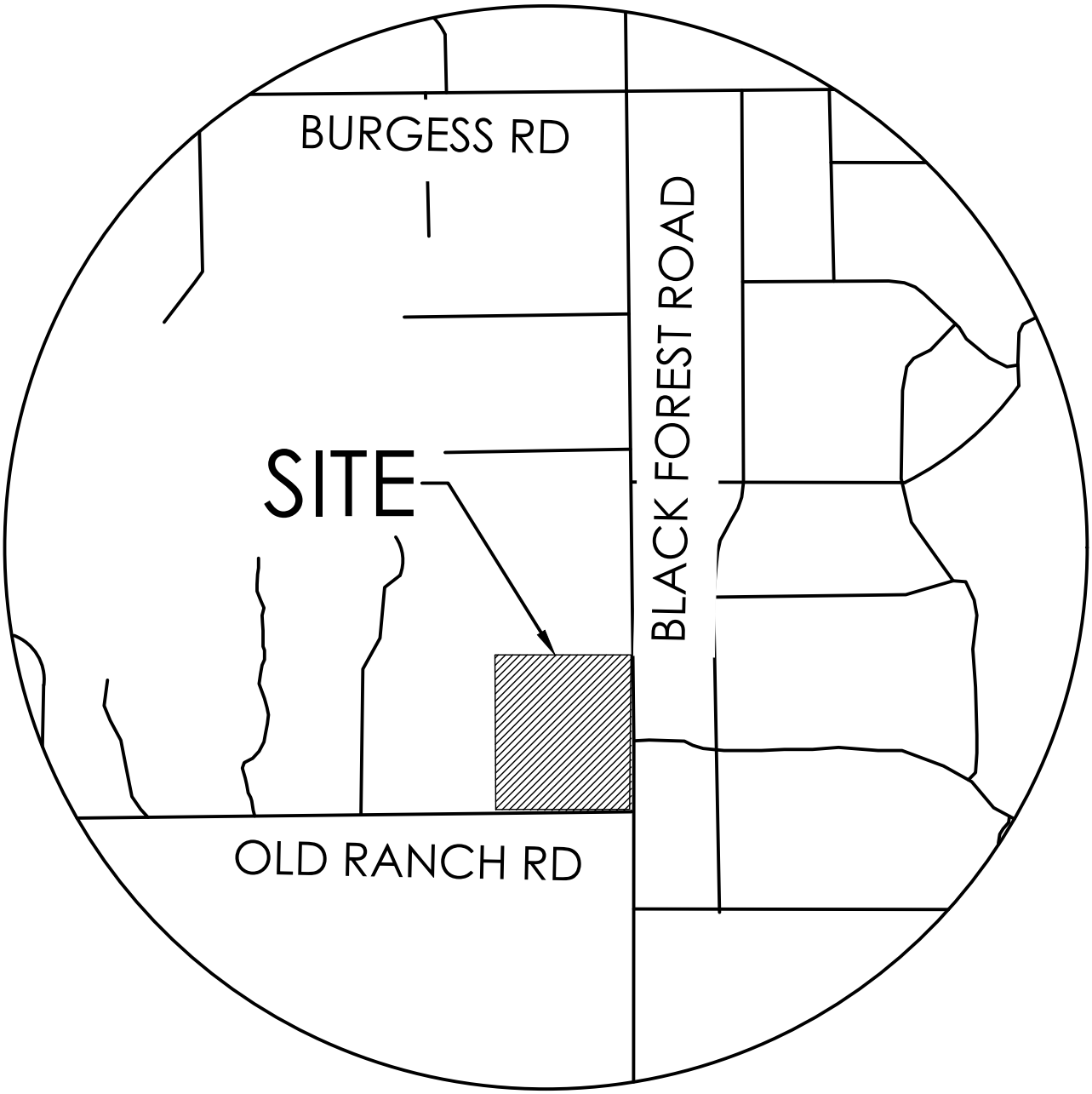
Flood Insurance Rate Map. Federal Emergency Management Agency, National Flood Insurance Program (Washington D.C.: FEMA, December 7, 2018).

City of Colorado Springs Drainage Criteria Manual Volume 1. City of Colorado Springs Engineering Division with Matrix Design Group and Wright Water Engineers (Colorado Springs, Colorado: , May 2014).

Appendices

1 General Maps and Supporting Data

Vicinity Map
Portion of Flood Insurance Rate Map
Soil Type map and Tables
Official Soil Series Descriptions
Hydrologic Soil Group Map and Tables



VICINITY MAP

NOT TO SCALE

National Flood Hazard Layer FIRMette

FEMA

104°42'26"W 38°59'22"N

104°41'49"W 38°58'54"N

Feet

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

1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

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

SPECIAL FLOOD HAZARD AREAS

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

OTHER AREAS OF FLOOD HAZARD

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

OTHER AREAS

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

GENERAL STRUCTURES

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

OTHER FEATURES

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

MAP PANELS

- Digital Data Available
- No Digital Data Available
- Unmapped

N

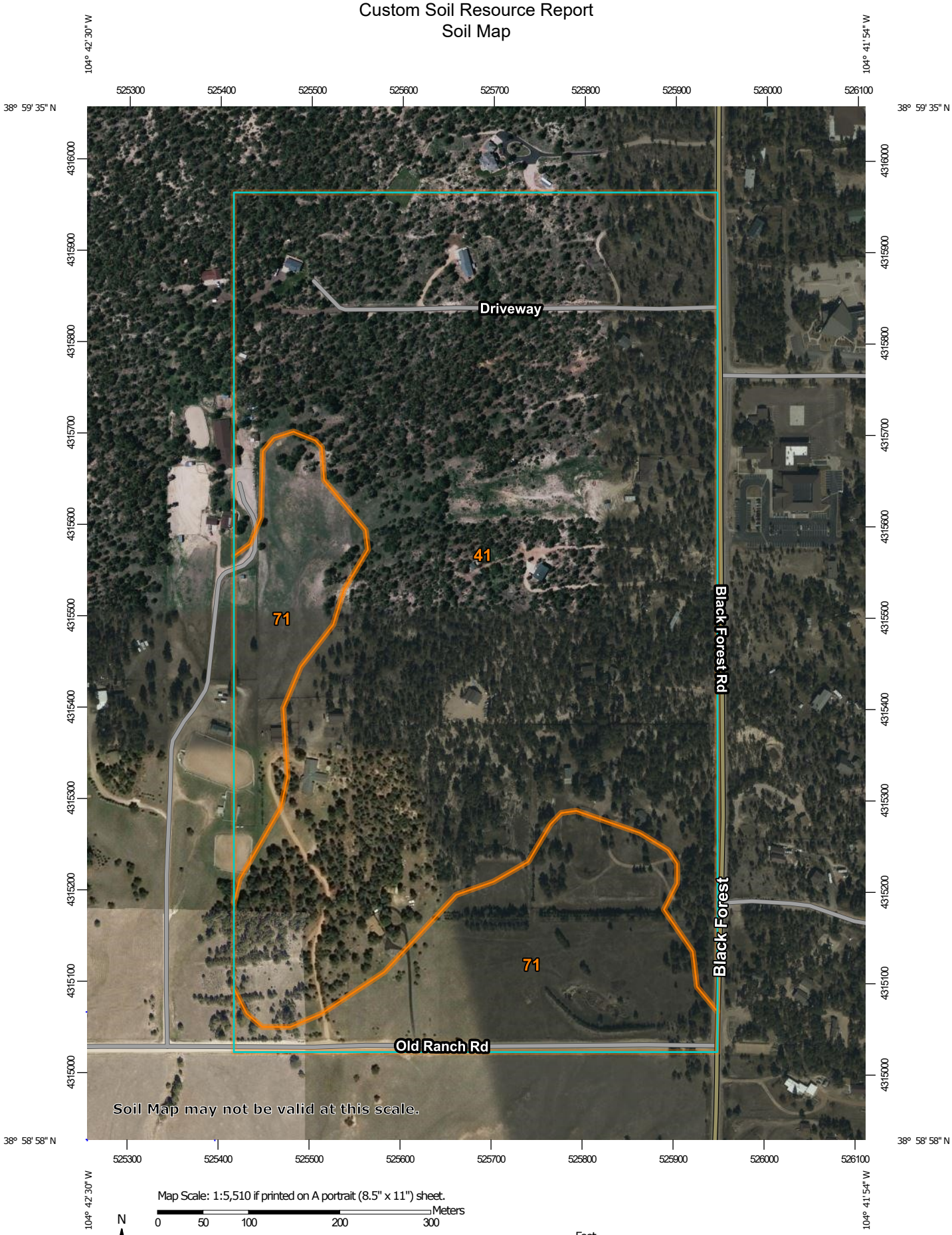
The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 7/31/2023 at 1:08 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.

Custom Soil Resource Report
Soil Map



Map Scale: 1:5,510 if printed on A portrait (8.5" x 11") sheet.

N

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 LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

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 20, Sep 2, 2022

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—Jun 12, 2021

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	96.0	77.4%
71	Pring coarse sandy loam, 3 to 8 percent slopes	28.0	22.6%
Totals for Area of Interest		**124.0**	**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

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

Map Unit Setting

National map unit symbol: 368h
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: 8 to 40 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Medium
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 supply, 0 to 60 inches: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: F048AY908CO - Mixed Conifer
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

71—Pring coarse sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 369k
Elevation: 6,800 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Pring

Setting

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

Typical profile

A - 0 to 14 inches: coarse sandy loam
C - 14 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well 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 supply, 0 to 60 inches: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: R048AY222CO - Loamy Park
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

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

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.

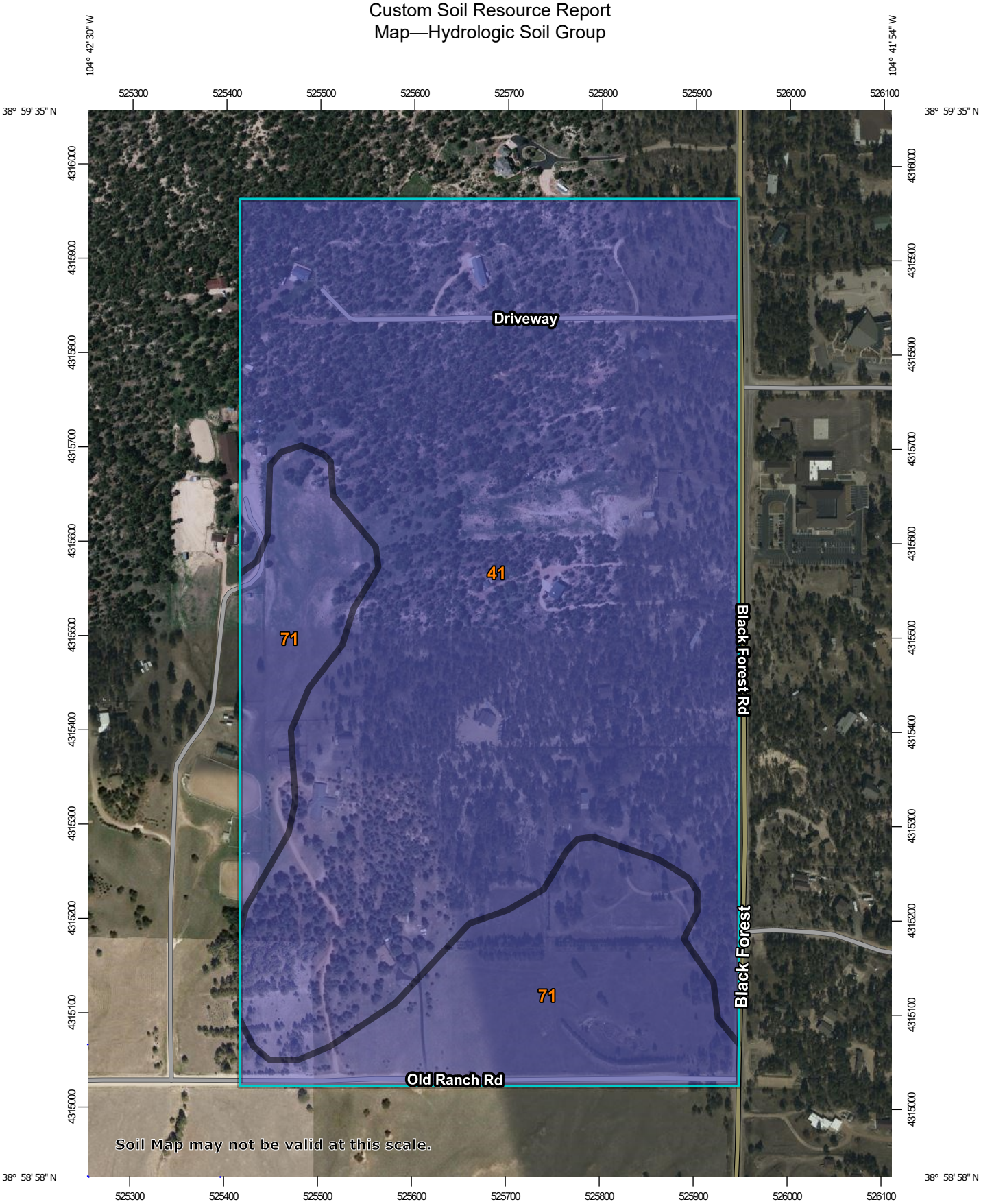
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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.

Map—Hydrologic Soil Group



Map Scale: 1:5,510 if printed on A portrait (8.5" x 11") sheet.

N

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 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.

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Survey Area Data: Version 20, Sep 2, 2022

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—Jun 12, 2021

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

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	B	96.0	77.4%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	28.0	22.6%
Totals for Area of Interest			**124.0**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

pricklypear occur. Ample amounts of litter and forage should be left on the soil because of the high hazard of soil blowing.

Windbreaks and environmental plantings are generally well suited to this soil. Summer fallow a year prior to planting and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, Siberian peashrub, and American plum.

Depending on land use, this soil can produce habitat that is suitable for either rangeland wildlife, such as antelope, or for openland wildlife, such as pheasant, cottontail, and mourning dove. Availability of irrigation water largely determines the land use. Where no irrigation water is available, this soil is mainly used as rangeland, a use that favors rangeland wildlife. If this soil is used as rangeland, fences, livestock water developments, and proper livestock grazing use are practices that enhance habitat for rangeland wildlife. Production of crops such as wheat, corn, and alfalfa provides suitable habitat for openland wildlife, especially pheasant. Among the practices that increase openland wildlife populations are planting trees and shrubs and providing undisturbed nesting cover.

The main limitation of this soil for urban use is shrink-swell potential. Buildings and roads need to be designed to overcome this limitation. Roads need to be designed to minimize frost-heave damage. Capability subclasses IVe, nonirrigated, and IIe, irrigated.

40—Kettle gravelly loamy sand, 3 to 8 percent slopes. This deep, well drained soil formed in sandy arkosic deposits on uplands. Elevation ranges from 7,000 to 7,700 feet. The average annual precipitation is about 18 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 120 days.

Typically, the surface layer is gray gravelly loamy sand about 3 inches thick. The subsurface layer is light gray gravelly loamy sand about 13 inches thick. The subsoil is very pale brown gravelly sandy loam about 24 inches thick. It consists of a matrix of loamy coarse sand that has thin bands of coarse sandy loam or sandy clay loam. The substratum to a depth of 60 inches or more is light yellowish brown extremely gravelly loamy sand.

Included with this soil in mapping are small areas of Alamosa loam, 1 to 3 percent slopes; Elbeth sandy loam, 3 to 8 percent slopes; Pring coarse sandy loam, 3 to 8 percent slopes; Tomah-Crowfoot loamy sands, 3 to 8 percent slopes; and a few rock outcrops.

Permeability of this Kettle soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low to moderate. Surface runoff is slow, and the hazard of erosion is slight to moderate. A few gullies have formed in drainageways.

This soil is used for woodland, livestock grazing, wildlife habitat, recreation, and homesites.

This soil is suited to the production of ponderosa pine. It is capable of producing about 2,240 cubic feet or 4,900 board feet (International rule), of merchantable timber per acre from a fully stocked, even-aged stand of 80-year-old trees. The main limitation for the production or harvesting of timber is the low available water capacity. The low available water capacity also influences seedling survival, especially in areas where understory plants are plentiful. Erosion must be kept to a minimum when harvesting timber.

This soil has good potential for mule deer, tree squirrels, cottontail rabbit, and wild turkey. These animals obtain their food and shelter from pine trees, shrubs, and ground cover, which provide browse, forbs, fruit, and seeds. The presence of ponderosa pine and Gambel oak should encourage wild turkey populations; however, where water is not naturally present, wildlife watering facilities must be provided to attract and maintain wild turkey and other wildlife species. Livestock grazing management is vital on this soil if wildlife populations are to be maintained.

This soil has good potential for use as homesites. Plans for homesite development on this soil should provide for the preservation of as many trees as possible in order to maintain the esthetic value of the sites. During seasons of low precipitation, fire may become a hazard to homesites. This hazard can be minimized by installing firebreaks and reducing the amount of litter on the forest floor. Capability subclass VIe.

41—Kettle gravelly loamy sand, 8 to 40 percent slopes. This deep, well drained soil formed in sandy arkosic deposits on uplands. Elevation ranges from 7,000 to 7,700 feet. The average annual precipitation is about 18 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 120 days.

Typically, the surface layer is gray gravelly loamy sand about 3 inches thick. The subsurface layer is light gray gravelly loamy sand about 13 inches thick. The subsoil is very pale brown gravelly sandy loam about 24 inches thick. It consists of a matrix of loamy coarse sand that has thin bands of coarse sandy loam or sandy clay loam. The substratum to a depth of 60 inches or more is light yellowish brown extremely gravelly loamy sand.

Included with this soil in mapping are small areas of Elbeth sandy loam, 8 to 15 percent slopes; Pring coarse sandy loam, 8 to 15 percent slopes; Tomah-Crowfoot loamy sands, 8 to 15 percent slopes; and a few rock outcrops.

Permeability of this Kettle soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low to moderate. Surface runoff is medium, and the hazard of erosion is moderate. Some gullies have formed in drainageways.

The soil is used for woodland, livestock grazing, wildlife habitat, recreation, and homesites.

This soil is suited to the production of ponderosa pine. It is capable of producing 2,240 cubic feet, or 4,900 board

feet (International rule), of merchantable timber per acre from a fully stocked, even-aged stand of 80-year-old trees. The main limitation for this use is the moderate hazard of erosion. Measures must be taken to reduce erosion when harvesting timber, especially on the steeper slopes. The low to moderate available water capacity also influences seedling survival, especially in areas where understory plants are plentiful.

This soil has good potential for mule deer, tree squirrel, cottontail, and wild turkey. These animals obtain their food and shelter from pine trees, shrubs, and ground cover, which provide browse, forbs, fruit, and seeds. The presence of ponderosa pine and Gambel oak should encourage wild turkey populations; however, where water is not naturally present, wildlife watering facilities must be provided to attract and maintain wild turkey and other wildlife species. Livestock grazing management is vital on this soil if wildlife populations are to be maintained.

The moderately sloping to steep slopes limit the suitability of this soil for homesites. Special practices must be provided to minimize surface runoff and thus keep erosion to a minimum. This soil requires special site or building designs because of the slope. Deep cuts, to provide essentially level building sites, may expose bedrock. Access roads must be designed to provide adequate cut-slope grade, and drains must be used to control surface runoff and keep soil losses to a minimum. During seasons of low precipitation, fire may become a hazard to homesites. This hazard can be minimized by installing firebreaks and reducing the amount of litter on the forest floor. Capability subclass VIe.

42—Kettle-Rock outcrop complex. This gently rolling to very steep complex, is mostly on the side slopes of uplands. Slopes range from 8 to 60 percent. Elevation ranges from 6,800 to 7,700 feet. The average annual precipitation is about 18 inches, and average annual air temperature is about 43 degrees F.

The Kettle soil makes up about 60 percent of the complex, Rock outcrop about 20 percent, and other soils about 20 percent.

Included with this complex in mapping are areas of Peyton-Pring complex, 8 to 15 percent slopes; Elbeth sandy loam, 8 to 15 percent slopes; and Elbeth-Pring complex, 5 to 50 percent slopes.

The Kettle soil is deep and well drained. It formed in sandy arkosic deposits, mostly on the lower slopes of the complex. Slope is commonly less than 20 percent. Typically, the surface layer is gray, medium acid or slightly acid gravelly loamy sand about 3 inches thick. The subsurface layer is light gray, medium acid gravelly loamy sand about 13 inches thick. The subsoil is very pale brown, medium acid or slightly acid gravelly sandy loam about 24 inches thick. It consists of loamy coarse sand that has thin bands of coarse sandy loam or sandy clay loam. The substratum to a depth of 60 inches or more is light yellowish brown extremely gravelly loamy sand.

Permeability of the Kettle soil is rapid. Effective rooting depth is more than 60 inches. Available water capacity is low to moderate. Surface runoff is medium to rapid, and the hazard of erosion is slight to high. Soil slippage and deep gullies are common.

Rock outcrop is mostly in the form of vertical cliffs. Large stones are common on the lower slopes of this complex.

This complex is suited to the production of ponderosa pine. It is capable of producing 2,240 cubic feet, or 4,900 board feet (International rule), of merchantable timber per acre from a fully stocked, even-aged stand of 80-year-old trees. The main limitation of this complex for this use is the presence of Rock outcrop and the moderate hazard of erosion on the Kettle soil. Measures must be taken to minimize erosion when harvesting timber, especially on the steeper slopes. The low to moderate available water capacity also influences seedling survival, especially where understory plants are plentiful.

This complex has good potential for producing habitat for mule deer, tree squirrels, cottontail, and wild turkey. These animals obtain their food and shelter from pine trees, shrubs, and ground cover, which provide browse, forbs, fruit, and seeds. The presence of ponderosa pine and Gambel oak should encourage wild turkey populations; however, where water is not naturally present, wildlife watering facilities must be provided to attract and maintain wild turkey and other wildlife species. Livestock grazing management is vital on this soil if wildlife populations are to be maintained.

The moderate to very steep slopes limit the potential of this complex for homesites. Special practices must be provided to minimize surface runoff and thus keep erosion to a minimum. Special site or building designs are required because of the slope. Deep cuts, to provide essentially level building sites, can expose bedrock. The limitation of large stones on the soil surface can be overcome through the use of heavy equipment when preparing building sites. Access roads must be designed to provide adequate cut-slope grade, and drains must be used to control surface runoff and thus keep soil losses to a minimum. Deep cuts along the uphill side of the roads can expose the bedrock. Capability subclass VIIe.

43—Kim loam, 1 to 8 percent slopes. This deep, well drained soil formed in calcareous loamy sediment on fans and uplands. Elevation ranges from 5,300 to 5,600. The average annual precipitation is about 13 inches, the average annual temperature is about 49 degrees F, and the average frost-free period is about 145 days.

Typically, the surface layer is brown loam about 4 inches thick. The substratum is very pale brown loam to a depth of 60 inches or more.

Included with this soil in mapping are small areas of Fort Collins loam, 3 to 8 percent slopes; Midway clay loam, 3 to 25 percent slopes, and Wiley silt loam, 3 to 9 percent slopes.

Permeability of this Kim soil is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is medium, and the hazard of erosion is moderate.

Almost all areas of this soil are used as rangeland.

survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

These soils are suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

These soils have a good potential for homesites. The main limitations, especially on the Peyton soil, are low bearing strength and frost-action potential. Buildings and roads can be designed to overcome these limitations. Access roads should have adequate cut-slope grade and be provided with drains to control surface runoff and keep soil losses to a minimum. Capability subclass VIe.

69—Peyton-Pring complex, 8 to 15 percent slopes. These gently to moderately sloping soils are on valley side slopes and on uplands. Elevation ranges from 6,800 to 7,600 feet. The average annual precipitation is about 17 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 120 days.

The Peyton soil makes up about 40 percent of the complex, the Pring soil about 30 percent, and other soils about 30 percent.

Included with these soils in mapping are areas of Holderness loam, 8 to 15 percent slopes; Tomah-Crowfoot loamy sands, 8 to 15 percent slopes; Kettle gravelly loamy sand, 8 to 40 percent slopes; and a few areas of Rock outcrop.

The Peyton soil is commonly on the less sloping part of the landscape. It is deep, noncalcareous, and well drained. It formed in alluvium and residuum derived from weathered, arkosic, sedimentary rock. Typically, the surface layer is grayish brown sandy loam about 12 inches thick. The subsoil, about 23 inches thick, is pale brown sandy clay loam in the upper 13 inches and pale brown sandy loam in the lower 10 inches. The substratum is pale brown sandy loam to a depth of 60 inches or more.

Permeability of the Peyton soil is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is medium to rapid, and the hazard of erosion is moderate to high. Some gullies have developed along drainageways and livestock trails.

The Pring soil is deep, noncalcareous, and well drained. It formed in sandy sediment derived from weathered, arkosic, sedimentary rock. Typically, the surface layer is dark grayish brown coarse sandy loam about 4 inches thick. The substratum is dark grayish brown coarse sandy loam about 10 inches thick over pale brown gravelly sandy loam that extends to a depth of 60 inches or more.

Permeability of the Pring soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium to rapid, and the hazard of erosion is moderate to high. Some gullies have developed along drainageways and livestock trails.

The soils in this complex are used as rangeland, for wildlife habitat, and for homesites.

These soils are well suited to the production of native vegetation suitable for grazing. The dominant native species are mountain muhly, bluestem grasses, needle-andthread, and blue grama. These soils are subject to invasion of Kentucky bluegrass and Gambel oak. Common forbs are hairy goldenrod, geranium, milkvetch, low larkspur, fringed sage, and buckwheat.

Properly locating livestock watering facilities helps to control grazing. Timely deferment of grazing is needed to protect the plant cover.

Windbreaks and environmental plantings generally are suited to these soils. Soil blowing is the main limitation to the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be needed when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

These soils are well suited to wildlife habitat. They are best suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

These soils have good potential for use as homesites. The main limitations are steepness of slope, limited ability to support a load, and frost-action potential. Buildings and roads can be designed to overcome these limitations. These soils also require special site or building designs because of the slope. Access roads should have adequate cut-slope grade, and drains should be provided to control surface runoff and keep soil losses to a minimum. Capability subclass VIe.

70—Pits, gravel. Gravel pits are in nearly level to rolling areas. They are open excavations several feet deep and commonly 5 acres or less in size.

Gravel pits are very low in natural fertility and are highly susceptible to soil blowing. A cover of weeds or straw helps to control erosion.

Windbreaks and environmental plantings generally are not suited to these areas. Onsite investigation is needed to determine if plantings are feasible. Capability subclass VIIIs.

71—Pring coarse sandy loam, 3 to 8 percent slopes. This deep, noncalcareous, well drained soil formed in sandy sediment derived from arkosic sedimentary rock on valley side slopes and on uplands. Elevation ranges from 6,800 to 7,600 feet. The average annual precipitation is about 17 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 120 days.

Typically, the surface layer is dark grayish brown coarse sandy loam about 4 inches thick. The substratum is dark grayish brown coarse sandy loam about 10 inches thick over pale brown gravelly sandy loam that extends to a depth of 60 inches or more.

Included with this soil in mapping are small areas of Alamosa loam, 1 to 3 percent slopes, along drainageways; Cruckton sandy loam, 1 to 9 percent slopes; Peyton sandy loam, 1 to 5 percent slopes; Peyton sandy loam, 5 to 9 percent slopes; and Tomah-Crowfoot loamy sands, 3 to 8 percent slopes. In some places arkose beds of sandstone and shale are at a depth of 0 to 40 inches.

Permeability of this Pring soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the hazard of erosion is moderate.

Almost all areas of this soil are used as rangeland. Some areas previously cultivated have been reseeded to grass. This soil is also used for wildlife habitat and homesites.

This soil is well suited to the production of native vegetation suitable for grazing by cattle and sheep. Rangeland vegetation is mainly mountain muhly, little bluestem, needleandthread, Parry oatgrass, and junegrass.

Deferment of grazing in spring helps to maintain vigor and production of the cool-season bunchgrasses. Fencing and properly locating livestock watering facilities help to control grazing.

Windbreaks and environmental plantings generally are suited to this soil. The hazard of soil blowing is the main limitation to the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be needed when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

This soil is well suited for use as homesites. Erosion control practices are needed to control soil blowing and water erosion on construction sites where the ground cover has been removed. Capability subclass IVe.

72—Pring coarse sandy loam, 8 to 15 percent slopes. This deep, noncalcareous, well drained soil formed in sandy sediment derived from arkosic sedimentary rock on valley side slopes and on uplands. Elevation ranges from 6,800 to 7,600 feet. The average annual precipitation is about 17 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 120 days.

Typically, the surface layer is dark grayish brown coarse sandy loam about 4 inches thick. The substratum is dark grayish brown coarse sandy loam about 10 inches thick over pale brown gravelly sandy loam that extends to a depth of 60 inches or more.

Included with this soil in mapping are small areas of Cruckton sandy loam, 1 to 9 percent slopes; Peyton sandy loam, 5 to 9 percent slopes; and Tomah-Crowfoot loamy sands, 8 to 15 percent slopes. Arkose beds of sandstone and shale are at a depth of 0 to 40 inches in some places.

Permeability of this Pring soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the hazard of erosion is moderate. Some gullies have developed along drainageways.

Almost all areas of this soil are used as rangeland. Some areas previously cultivated have been reseeded to grass. This soil is also used for wildlife habitat and as homesites.

This soil is well suited to the production of native vegetation suitable for grazing by cattle and sheep. The native vegetation is mainly mountain muhly, little bluestem, needleandthread, Parry oatgrass, and junegrass.

Deferment of grazing in spring helps to maintain the vigor and production of the cool-season bunchgrasses. Fencing and properly locating livestock watering facilities help to control grazing.

Windbreaks and environmental plantings generally are suited to this soil. The hazard of soil blowing is the main limitation to the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be needed when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to habitat for openland and rangeland wildlife habitat. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

This soil has good potential for urban uses. The main limitation is slope. Special site or building designs are needed because of the slope. Access roads must have adequate cut-slope grade and be provided with drains to control surface runoff. Capability subclass VIe.

73—Razor clay loam, 3 to 9 percent slopes. This moderately deep, well drained, clayey soil formed in residuum derived from calcareous shale on uplands. Elevation ranges from 5,300 to 6,100 feet. The average annual precipitation is about 13 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 145 days.

Typically, the surface layer is light brownish gray clay loam about 3 inches thick. The subsoil is grayish brown heavy clay loam or clay about 15 inches thick. The substratum is grayish brown clay that grades to calcareous shale at a depth of about 31 inches. Visible lime is in the lower part of the subsoil and in the substratum.

Included with this soil in mapping are small areas of Midway clay loam, 3 to 25 percent slopes; Heldt clay loam, 0 to 3 percent slopes; and Stoneham sandy loam, 3 to 8 percent slopes.

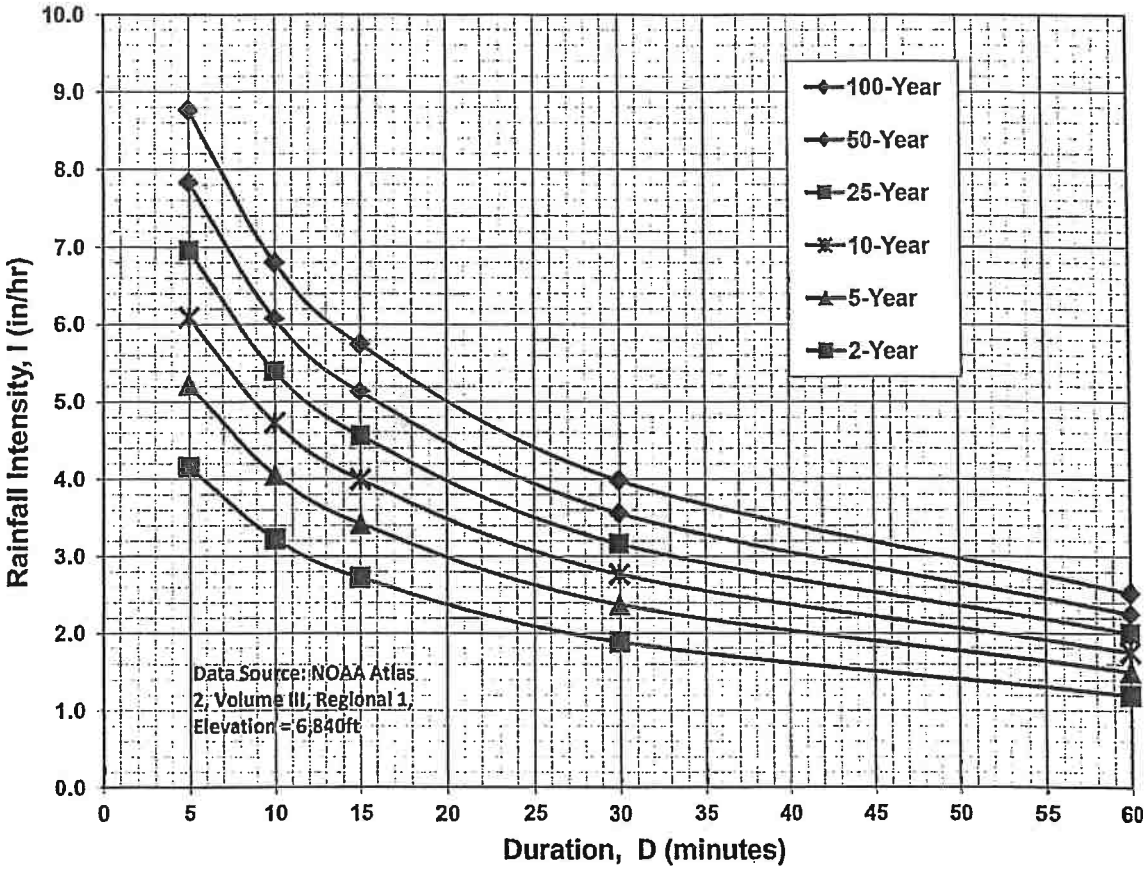
2 Hydrologic Calculations

City of Colorado Springs DCM Runoff Coefficients – Table 6-6
Colorado Springs DCM Rainfall Intensity Duration Frequency – Figure 6-5
Sub-Basin Time of Concentration – Form SF-1
5-yr Sub-Basin and Combined Flows – Form SF-2
100-yr Sub-Basin and Combined Flows – Form SF-2

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

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.

Job No.: **61201**
Project: **Nabulsi-Abushaban Subdivision**

Date: **1/22/2024 9:17**
Calcs By: **JO**
Checked By:

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

Sub-Basin	Sub-Basin Data				Overland			Shallow Channel				Channelized				t_c Check		
	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)
OFFSITE																		
OSA1	9.66	0.11	0.37	4%	85.1	2.3%	12.4	102.9	0.019	1.0	1.8	919.2	0.053	2.8	5.6	1107	N/A	19.7
OSA2	1.53	0.10	0.36	2%	64.4	15.5%	5.9	103.3	0.077	0.7	2.5	134.1	0.082	2.2	1.0	301.8	N/A	9.4
OSA3	2.91	0.08	0.35	1%	57.1	7.0%	7.3	134.2	0.075	0.7	3.3	461.8	0.052	2.1	3.7	653.1	N/A	14.3
OSA4	0.07	0.08	0.35	0%	10.1	9.9%	2.7	8.0	0.125	0.9	0.2	0.0	0.000	0.0	0.0	18.04	N/A	5.0
OSA5	1.14	0.25	0.48	21%	52.0	5.8%	6.2	73.6	0.041	0.5	2.4	233.0	0.077	2.1	1.8	358.6	N/A	10.5
OSB1	0.15	0.08	0.35	0%	58.5	10.2%	6.5	0.0	0.000	0.0	0.0	0.0	0.000	0.0	0.0	58.54	N/A	6.5
OSB2	0.69	0.08	0.35	0%	33.1	15.1%	4.3	68.4	0.146	1.0	1.2	58.7	0.102	2.0	0.5	160.2	N/A	6.0
OSB3	3.25	0.12	0.38	5%	28.4	21.1%	3.5	86.4	0.174	1.0	1.4	522.9	0.067	2.5	3.5	637.8	N/A	8.3
OSB4	0.38	0.22	0.45	19%	60.9	4.9%	7.3	0.0	0.000	0.0	0.0	116.8	0.034	1.2	1.7	177.7	N/A	9.0
OSB5	0.38	0.30	0.50	34%	38.3	2.6%	6.5	74.5	0.013	0.3	4.3	301.1	0.020	0.9	5.4	413.9	N/A	16.2
PP-OSB5	0.38	0.33	0.52	39%	38.3	2.6%	6.3	74.5	0.013	0.3	4.3	301.1	0.020	0.9	5.4	413.9	N/A	15.9
OSC1	0.53	0.37	0.56	42%	33.77	3.0%	5.3	74.0	0.054	4.6	0.3	468.0	0.049	1.5	5.1	575.8	N/A	10.7
EXISTING ONSITE																		
EX-A1	7.57	0.09	0.35	1%	32.04	9.4%	5.0	80.7	0.124	0.9	1.5	1034.6	0.046	2.5	6.8	1147	N/A	13.3
EX-A2	7.94	0.09	0.36	2%	38.99	20.5%	4.2	105.0	0.133	0.9	1.9	787.9	0.057	2.8	4.6	931.9	N/A	10.7
EX-B1	8.86	0.08	0.35	0%	56.69	22.9%	4.9	109.8	0.091	0.8	2.4	1084.9	0.058	2.9	6.3	1251	N/A	13.7
EX-C1	0.41	0.08	0.35	0%	29.41	20.4%	3.7	68.2	0.147	1.0	1.2	165.2	0.073	1.5	1.8	262.8	N/A	6.7
PROPOSED ONSITE																		
A1	7.08	0.10	0.37	3%	32.04	9.4%	4.9	80.7	0.124	0.9	1.5	1034.6	0.046	2.5	6.9	1147	N/A	13.3
A2	7.98	0.11	0.37	5%	38.99	20.5%	4.1	105.0	0.133	0.9	1.9	787.9	0.057	2.9	4.6	931.9	N/A	10.6
A3	0.46	0.17	0.41	14%	100	10.3%	7.8	0.0	0.000	0.0	0.0	41.8	0.096	1.8	0.4	141.8	N/A	8.2
B1	8.87	0.12	0.38	6%	56.69	22.9%	4.7	109.8	0.091	0.8	2.4	1084.9	0.058	2.9	6.2	1251	N/A	13.4
C1	0.41	0.08	0.35	0%	29.41	20.4%	3.7	68.2	0.147	1.0	1.2	165.2	0.073	1.5	1.8	262.8	N/A	6.7

Job No.: **61201**
Project: **Nabulsi-Abushaban Subdivision**
Design Storm: **5-Year Storm** *(20% Probability)*
Jurisdiction: **DCM**

Date: **09/21/2023 17:27**
Calcs By: **JO**
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)	C5	t_c (min)	CA (Acres)	I5 (in/hr)	Q5 (cfs)	t_c (min)	CA (Acres)	I5 (in/hr)	Q5 (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)
OFFSITE																						
DP1	OSA1	9.66	0.11	19.7	1.09	3.11	3.4															
	OSA2	1.53	0.10	9.4	0.15	4.22	0.6															
	OSA3	2.91	0.08	14.3	0.25	3.59	0.9															
	OSA4	0.07	0.08	5.0	0.01	5.17	0.0															
	OSA5	1.14	0.25	10.5	0.29	4.06	1.2															
	OSB1	0.15	0.08	6.5	0.01	4.77	0.1															
	OSB2	0.69	0.08	6.0	0.06	4.89	0.3															
	OSB3	3.25	0.12	8.3	0.38	4.41	1.7															
	OSB4	0.38	0.22	9.0	0.08	4.29	0.4															
	OSB5	0.38	0.30	16.2	0.11	3.40	0.4															
	PP-OSB5	0.38	0.33	15.9	0.13	3.43	0.4															
	OSC1	0.53	0.37	10.7	0.20	4.03	0.8															
EXISTING ONSITE																					######	######
	EX-A1	7.57	0.09	13.3	0.66	3.70	2.4															
	EX-A2	7.94	0.09	10.7	0.74	4.03	3.0															
	EX-B1	8.86	0.08	13.7	0.71	3.66	2.6															
	EX-C1	0.41	0.08	6.7	0.03	4.73	0.2															
EX-DP2	OSA1-4, EX-A1	21.74	0.10					22.1	2.14	2.94	6.3											
EX-DP3	EX-DP2, OSA5, EX-A2	30.83	0.10					23.0	3.17	2.88	9.1											
EX-DP4	OSB1-5, EX-B1	13.71	0.10					23.2	1.36	2.87	3.9											
EX-DP5	OSC1, EX-C1	0.95	0.24					10.7	0.23	4.03	0.9											
PROPOSED ONSITE																					######	######
	A1	7.08	0.10	13.3	0.73	3.71	2.7															
	A2	7.98	0.11	10.6	0.91	4.05	3.7															
	A3	0.46	0.17	8.2	0.08	4.43	0.3															
	B1	8.87	0.12	13.4	1.07	3.70	4.0															
	C1	0.41	0.08	6.7	0.03	4.73	0.2															
DP2	OSA1-4, A1	21.25	0.10					22.1	2.22	2.94	6.5											
DP3	DP2, OSA5, A2	30.37	0.11					23.5	3.42	2.85	9.8											
DP4	OSB1-4,PP-OSB5, A3, B1	14.17	0.13					23.2	1.80	2.87	5.2											
DP5	OSC1, C1	0.95	0.24					10.7	0.23	4.03	0.9											

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

Job No.: **61201**
Project: **Nabulsi-Abushaban Subdivision**
Design Storm: **100-Year Storm** *(1% Probability)*
Jurisdiction: **DCM**

Date: **09/21/2023 17:27**
Calcs By: **JO**
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)
OFFSITE																						
DP1	OSA1	9.66	0.37	19.7	3.61	5.22	18.8															
	OSA2	1.53	0.36	9.4	0.55	7.09	3.9															
	OSA3	2.91	0.35	14.3	1.03	6.03	6.2															
	OSA4	0.07	0.35	5.0	0.02	8.68	0.2															
	OSA5	1.14	0.48	10.5	0.55	6.82	3.7															
	OSB1	0.15	0.35	6.5	0.05	8.00	0.4															
	OSB2	0.69	0.35	6.0	0.24	8.22	2.0															
	OSB3	3.25	0.38	8.3	1.23	7.40	9.1															
	OSB4	0.38	0.45	9.0	0.17	7.20	1.2															
	OSB5	0.38	0.50	16.2	0.19	5.72	1.1															
	PP-OSB5	0.38	0.52	15.9	0.20	5.76	1.1															
	OSC1	0.53	0.56	10.7	0.30	6.76	2.0															
EXISTING ONSITE																					######	######
	EX-A1	7.57	0.35	13.3	2.69	6.22	16.7															
	EX-A2	7.94	0.36	10.7	2.85	6.76	19.3															
	EX-B1	8.86	0.35	13.7	3.10	6.14	19.1															
	EX-C1	0.41	0.35	6.7	0.14	7.95	1.1															
EX-DP2	OSA1-4, EX-A1	21.74	0.36					22.1	7.90	4.93	39.0											
EX-DP3	EX-DP2, OSA5, EX-A2	30.83	0.37					23.0	11.30	4.83	54.5											
EX-DP4	OSB1-5, EX-B1	13.71	0.36					23.2	4.99	4.82	24.0											
EX-DP5	OSC1, EX-C1	0.95	0.47					10.7	0.44	6.76	3.0											
PROPOSED ONSITE																					######	######
	A1	7.08	0.37	13.3	2.60	6.22	16.2															
	A2	7.98	0.37	10.6	2.98	6.79	20.3															
	A3	0.46	0.41	8.2	0.19	7.43	1.4															
	B1	8.87	0.38	13.4	3.36	6.20	20.8															
	C1	0.41	0.35	6.7	0.14	7.95	1.1															
DP2	OSA1-4, A1	21.25	0.37					22.1	7.81	4.93	38.5											
DP3	DP2, OSA5, A2	30.37	0.37					23.5	11.34	4.78	54.2											
DP4	OSB1-4,PP-OSB5, A3, B1	14.17	0.38					23.2	5.43	4.82	26.2											
DP5	OSC1, C1	0.95	0.47					10.7	0.44	6.76	3.0											

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

Offsite Sub-Basin OSA1 Runoff Calculations (DP1)

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	400,876	9.20	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	9,560	0.22	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	7,396	0.17	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	2,905	0.07	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**420,737**	**9.66**	**0.05**	**0.11**	**0.18**	**0.28**	**0.33**	**0.37**	**4.4%**
	420737								

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	1,107	53	-	-	-	-	
Initial Time	85	2	0.023	-	12.4	N/A	DCM Eq. 6-8
Shallow Channel	103	2	0.019	1.0	1.8	-	DCM Eq. 6-9
Channelized	919	49	0.053	2.8	5.6	-	V-Ditch
				t_c	**19.7 min.**		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.49	3.11	3.63	4.15	4.67	5.22
Runoff (cfs)	1.3	**3.4**	6.3	11.1	14.7	**18.8**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.3	**3.4**	6.3	11.1	14.7	**18.8**

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

Offsite Sub-Basin OSA2 Runoff Calculations

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	65,008	1.49	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	1,540	0.04	0.71	0.73	0.75	0.78	0.8	0.81	90%
Combined	**66,548**	**1.53**	**0.04**	**0.10**	**0.16**	**0.26**	**0.31**	**0.36**	**2.1%**
	66548								

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	302	29	-	-	-	-	
Initial Time	64	10	0.155	-	5.9	N/A	DCM Eq. 6-8
Shallow Channel	103	8	0.077	0.7	2.5	-	DCM Eq. 6-9
Channelized	134	11	0.082	2.2	1.0	-	V-Ditch
				t_c	**9.4**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.37	4.22	4.93	5.63	6.34	7.09
Runoff (cfs)	0.2	**0.6**	1.2	2.3	3.0	**3.9**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.2	**0.6**	1.2	2.3	3.0	**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

Offsite Sub-Basin OSA3 Runoff Calculations

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	126,033	2.89	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	940	0.02	0.71	0.73	0.75	0.78	0.8	0.81	90%
Combined	**126,973**	**2.91**	**0.03**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.7%**
	126973								

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	653	38	-	-	-	-	
Initial Time	57	4	0.070	-	7.3	N/A	DCM Eq. 6-8
Shallow Channel	134	10	0.075	0.7	3.3	-	DCM Eq. 6-9
Channelized	462	24	0.052	2.1	3.7	-	V-Ditch
				t_c	**14.3**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.87	3.59	4.19	4.79	5.39	6.03
Runoff (cfs)	0.2	**0.9**	1.9	3.5	4.8	**6.2**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.2	**0.9**	1.9	3.5	4.8	**6.2**

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

Offsite Sub-Basin OSA4 Runoff Calculations

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	2,879	0.07	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**2,879**	**0.07**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**
	2879								

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	18	2	-	-	-	-	
Initial Time	10	1	0.099	-	2.7	N/A	DCM Eq. 6-8
Shallow Channel	8	1	0.125	0.9	0.2	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				t_c	**5.0**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	4.12	5.17	6.03	6.89	7.75	8.68
Runoff (cfs)	0.0	**0.0**	0.1	0.1	0.2	**0.2**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.0	**0.0**	0.1	0.1	0.2	**0.2**

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

Offsite Sub-Basin OSA5 Runoff Calculations

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	39,239	0.90	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	10,458	0.24	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**49,697**	**1.14**	**0.20**	**0.25**	**0.31**	**0.40**	**0.44**	**0.48**	**21.0%**
	49697								

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	359	24	-	-	-	-	
Initial Time	52	3	0.058	-	6.2	N/A	DCM Eq. 6-8
Shallow Channel	74	3	0.041	0.5	2.4	-	DCM Eq. 6-9
Channelized	233	18	0.077	2.1	1.8	-	V-Ditch
				t_c	**10.5**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.24	4.06	4.74	5.42	6.09	6.82
Runoff (cfs)	0.8	**1.2**	1.7	2.4	3.0	**3.7**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.8	**1.2**	1.7	2.4	3.0	**3.7**

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

Offsite Sub-Basin OSB1 Runoff Calculations

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	6,447	0.15	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**6,447**	**0.15**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**
	6447								

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	59	6	-	-	-	-	
Initial Time	59	6	0.102	-	6.5	N/A	DCM Eq. 6-8
Shallow Channel			0.000	0.0	0.0	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				t_c	**6.5**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.80	4.77	5.56	6.36	7.15	8.00
Runoff (cfs)	0.0	**0.1**	0.1	0.2	0.3	**0.4**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.0	**0.1**	0.1	0.2	0.3	**0.4**

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

Offsite Sub-Basin OSB2 Runoff Calculations

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	30,262	0.69	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**30,262**	**0.69**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**
	30262								

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	160	21	-	-	-	-	
Initial Time	33	5	0.151	-	4.3	N/A	DCM Eq. 6-8
Shallow Channel	68	10	0.146	1.0	1.2	-	DCM Eq. 6-9
Channelized	59	6	0.102	2.0	0.5	-	V-Ditch
				t_c	**6.0**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.90	4.89	5.71	6.53	7.34	8.22
Runoff (cfs)	0.1	**0.3**	0.6	1.1	1.5	**2.0**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.1	**0.3**	0.6	1.1	1.5	**2.0**
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

Offsite Sub-Basin OSB3 Runoff Calculations

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		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.**
Pasture/Meadow	134,963	3.10	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	6,010	0.14	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	500	0.01	0.71	0.73	0.75	0.78	0.8	0.81	90%
Combined	**141,473**	**3.25**	**0.06**	**0.12**	**0.18**	**0.28**	**0.33**	**0.38**	**4.6%**
	141473								

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	638	56	-	-	-	-	
Initial Time	28	6	0.211	-	3.5	N/A	DCM Eq. 6-8
Shallow Channel	86	15	0.174	1.0	1.4	-	DCM Eq. 6-9
Channelized	523	35	0.067	2.5	3.5	-	V-Ditch
				t_c	**8.3**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.51	4.41	5.14	5.87	6.61	7.40
Runoff (cfs)	0.7	**1.7**	3.1	5.4	7.1	**9.1**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.7	**1.7**	3.1	5.4	7.1	**9.1**

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

Offsite Sub-Basin OSB4 Runoff Calculations

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	12,806	0.29	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	2,092	0.05	0.57	0.59	0.63	0.66	0.68	0.7	80%
Paved	1,502	0.03	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**16,400**	**0.38**	**0.17**	**0.22**	**0.28**	**0.37**	**0.41**	**0.45**	**19.4%**
	16400								

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	178	7	-	-	-	-	
Initial Time	61	3	0.049	-	7.3	N/A	DCM Eq. 6-8
Shallow Channel			0.000	0.0	0.0	-	DCM Eq. 6-9
Channelized	117	4	0.034	1.2	1.7	-	V-Ditch
				t_c	**9.0**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.42	4.29	5.01	5.72	6.44	7.20
Runoff (cfs)	0.2	**0.4**	0.5	0.8	1.0	**1.2**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.2	**0.4**	0.5	0.8	1.0	**1.2**

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

Offsite Sub-Basin OSB5 Runoff Calculations

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	9,628	0.22	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	7,042	0.16	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**16,670**	**0.38**	**0.25**	**0.30**	**0.35**	**0.42**	**0.46**	**0.50**	**33.8%**
	16670								

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	414	8	-	-	-	-	
Initial Time	38	1	0.026	-	6.5	N/A	DCM Eq. 6-8
Shallow Channel	75	1	0.013	0.3	4.3	-	DCM Eq. 6-9
Channelized	301	6	0.020	0.9	5.4	-	V-Ditch
				t_c	**16.2**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.72	3.40	3.97	4.54	5.11	5.72
Runoff (cfs)	0.3	**0.4**	0.5	0.7	0.9	**1.1**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.3	**0.4**	0.5	0.7	0.9	**1.1**

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

Proposed Offsite Sub-Basin PP-OSB5 Runoff Calculations

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	8,585	0.20	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	8,084	0.19	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**16,670**	**0.38**	**0.29**	**0.33**	**0.38**	**0.45**	**0.48**	**0.52**	**38.8%**
	16670								

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	414	8	-	-	-	-	
Initial Time	38	1	0.026	-	6.3	N/A	DCM Eq. 6-8
Shallow Channel	75	1	0.013	0.3	4.3	-	DCM Eq. 6-9
Channelized	301	6	0.020	0.9	5.4	-	V-Ditch
				t_c	**15.9**	**min.**	

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	5.76
Runoff (cfs)	0.3	**0.4**	0.6	0.8	1.0	**1.1**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.3	**0.4**	0.6	0.8	1.0	**1.1**

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

Offsite Sub-Basin OSC1 Runoff Calculations

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	11,770	0.27	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	8,361	0.19	0.57	0.59	0.63	0.66	0.68	0.7	80%
Paved	3,069	0.07	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**23,200**	**0.53**	**0.33**	**0.37**	**0.42**	**0.49**	**0.52**	**0.56**	**42.1%**
	23200								

Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$ 300 ft C_v 20

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	576	28	-	-	-	-	
Initial Time	34	1	0.030	-	5.3	N/A	DCM Eq. 6-8
Shallow Channel	74	4	0.054	4.6	0.3	-	DCM Eq. 6-9
Channelized	468	23	0.049	1.5	5.1	-	V-Ditch
				t_c	**10.7**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.21	4.03	4.70	5.37	6.04	6.76
Runoff (cfs)	0.6	**0.8**	1.1	1.4	1.7	**2.0**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.6	**0.8**	1.1	1.4	1.7	**2.0**

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

Existing Sub-Basin EX-A1 Runoff Calculations

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		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.**
Pasture/Meadow	325,778	7.48	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	3,355	0.08	0.57	0.59	0.63	0.66	0.68	0.7	80%
Roofs	806	0.02	0.71	0.73	0.75	0.78	0.8	0.81	90%
Combined	**329,938**	**7.57**	**0.03**	**0.09**	**0.16**	**0.26**	**0.31**	**0.35**	**1.0%**
	329938								

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	1,147	61	-	-	-	-	
Initial Time	32	3	0.094	-	5.0	N/A	DCM Eq. 6-8
Shallow Channel	81	10	0.124	0.9	1.5	-	DCM Eq. 6-9
Channelized	1,035	48	0.046	2.5	6.8	-	V-Ditch
				t_c	**13.3 min.**		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.96	3.70	4.32	4.94	5.56	6.22
Runoff (cfs)	0.6	**2.4**	5.1	9.6	12.8	**16.7**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.6	**2.4**	5.1	9.6	12.8	**16.7**

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

Existing Sub-Basin EX-A2 Runoff Calculations

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		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.**
Pasture/Meadow	337,320	7.74	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	8,723	0.20	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**346,043**	**7.94**	**0.03**	**0.09**	**0.16**	**0.26**	**0.31**	**0.36**	**2.0%**
	346043								

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	932	67	-	-	-	-	
Initial Time	39	8	0.205	-	4.2	N/A	DCM Eq. 6-8
Shallow Channel	105	14	0.133	0.9	1.9	-	DCM Eq. 6-9
Channelized	788	45	0.057	2.8	4.6	-	V-Ditch
				t_c	**10.7**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.21	4.03	4.70	5.37	6.04	6.76
Runoff (cfs)	0.9	**3.0**	6.0	11.1	14.8	**19.3**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.9	**3.0**	6.0	11.1	14.8	**19.3**

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

Existing Sub-Basin EX-B1 Runoff Calculations

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		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.**
Pasture/Meadow	385,963	8.86	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	185	0.00	0.71	0.73	0.75	0.78	0.8	0.81	90%
Combined	**386,148**	**8.86**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**
	386148								

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	1,251	86	-	-	-	-	
Initial Time	57	13	0.229	-	4.9	N/A	DCM Eq. 6-8
Shallow Channel	110	10	0.091	0.8	2.4	-	DCM Eq. 6-9
Channelized	1,085	63	0.058	2.9	6.3	-	V-Ditch
				t_c	**13.7**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	2.92	3.66	4.27	4.88	5.49	6.14
Runoff (cfs)	0.5	**2.6**	5.7	10.8	14.6	**19.1**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.5	**2.6**	5.7	10.8	14.6	**19.1**

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

Existing Sub-Basin EX-C1 Runoff Calculations

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	17,979	0.41	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**17,979**	**0.41**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**
	17979								

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	263	28	-	-	-	-	
Initial Time	29	6	0.204	-	3.7	N/A	DCM Eq. 6-8
Shallow Channel	68	10	0.147	1.0	1.2	-	DCM Eq. 6-9
Channelized	165	12	0.073	1.5	1.8	-	V-Ditch
				t_c	**6.7**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.77	4.73	5.52	6.31	7.10	7.95
Runoff (cfs)	0.0	**0.2**	0.3	0.7	0.9	**1.1**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.0	**0.2**	0.3	0.7	0.9	**1.1**

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

Existing Combined Sub-Basin Runoff Calculations (EX-DP2)

Includes Basins OSA1 OSA2 OSA3 OSA4 EX-A1

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		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.**
Pasture/Meadow	920,575	21.13	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	12,846	0.29	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	7,396	0.17	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	6,260	0.14	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**947,077**	**21.74**	**0.04**	**0.10**	**0.17**	**0.27**	**0.31**	**0.36**	**2.5%**

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	OSA1	-	1,107	53	-	-	-	-	19.7
Channelized-1	V-Ditch	2	698	28	19	0	2	4.9	2.4
Channelized-2									
Channelized-3									
Total			1,806	81					

2 = Natural, Winding, minimal vegetation/shallow grass

t_c (min) **22.1**

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)	2.35	2.94	3.43	3.92	4.41	4.93
Site Runoff (cfs)	2.03	**6.30**	12.47	22.60	30.13	**38.96**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**6.3**	-	-	-	**39.0**

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.

Existing Combined Sub-Basin Runoff Calculations (EX-DP3)

Includes Basins EX-DP2 OSA5 EX-A2

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		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.**
Pasture/Meadow	1,297,134	29.78	0.02	0.08	0.15	0.25	0.3	0.35	0%
Paved	17,854	0.41	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	14,983	0.34	0.57	0.59	0.63	0.66	0.68	0.7	80%
Roofs	12,846	0.29	0.71	0.73	0.75	0.78	0.8	0.81	90%
Combined	**1,342,817**	**30.83**	**0.04**	**0.10**	**0.17**	**0.27**	**0.32**	**0.37**	**3.1%**

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-DP2	-	1,806	81	-	-	-	-	22.1
Channelized-1	V-Ditch	3	161	5	39	0	2	2.9	0.9
Channelized-2									
Channelized-3									
Total			1,967	86					

3 = Natural, Winding, significant vegetation

t_c (min) **23.0**

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)	2.30	2.88	3.36	3.84	4.32	4.83
Site Runoff (cfs)	3.14	**9.12**	17.73	31.79	42.26	**54.54**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**9.1**	-	-	-	**54.5**

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.

Existing Combined Sub-Basin Runoff Calculations (EX-DP4)

Includes Basins OSB1 OSB2 OSB3 OSB4 OSB5 EX-B1

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	580,068	13.32	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	9,134	0.21	0.57	0.59	0.63	0.66	0.68	0.7	80%
Paved	7,512	0.17	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	685	0.02	0.71	0.73	0.75	0.78	0.8	0.81	90%
Combined	**597,399**	**13.71**	**0.04**	**0.10**	**0.17**	**0.27**	**0.31**	**0.36**	**2.6%**

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	OSB1	-	59	6	-	-	-	-	6.5
Channelized-1	V-Ditch	3	1,251	86	0	0	2	1.3	16.6
Channelized-2									
Channelized-3									
Total			1,310	92					

3 = Natural, Winding, significant vegetation

t_c (min) **23.2**

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)	2.30	2.87	3.35	3.83	4.30	4.82
Site Runoff (cfs)	1.26	**3.89**	7.70	13.94	18.57	**24.01**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**3.9**	-	-	-	**24.0**

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.

Existing Combined Sub-Basin Runoff Calculations (EX-DP5)

Includes Basins OSC1 EX-C1

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		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.**
Pasture/Meadow	29,748	0.68	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	8,361	0.19	0.57	0.59	0.63	0.66	0.68	0.7	80%
Paved	3,069	0.07	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**41,179**	**0.95**	**0.20**	**0.24**	**0.30**	**0.38**	**0.43**	**0.47**	**23.7%**

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	OSC1	-	576	28	-	-	-	-	10.7
Channelized-1									
Channelized-2									
Channelized-3									
Total			576	28					
								t_c (min)	**10.7**

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)	3.21	4.03	4.70	5.37	6.04	6.76
Site Runoff (cfs)	0.60	**0.93**	1.35	1.95	2.43	**2.98**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**0.9**	-	-	-	**3.0**

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.

Proposed Sub-Basin A1 Runoff Calculations

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		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.**
Pasture/Meadow	296,229	6.80	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	6,355	0.15	0.57	0.59	0.63	0.66	0.68	0.7	80%
Roofs	5,000	0.11	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	1,000	0.02	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**308,585**	**7.08**	**0.05**	**0.10**	**0.17**	**0.27**	**0.32**	**0.37**	**3.4%**
	308585								

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	1,147	61	-	-	-	-	
Initial Time	32	3	0.094	-	4.9	N/A	DCM Eq. 6-8
Shallow Channel	81	10	0.124	0.9	1.5	-	DCM Eq. 6-9
Channelized	1,035	48	0.046	2.5	6.9	-	V-Ditch
				t_c	**13.3**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.96	3.71	4.32	4.94	5.56	6.22
Runoff (cfs)	1.0	**2.7**	5.3	9.4	12.5	**16.2**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.0	**2.7**	5.3	9.4	12.5	**16.2**

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

Proposed Sub-Basin A2 Runoff Calculations

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	325,924	7.48	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	15,522	0.36	0.57	0.59	0.63	0.66	0.68	0.7	80%
Roofs	5,000	0.11	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	1,000	0.02	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**347,446**	**7.98**	**0.06**	**0.11**	**0.18**	**0.28**	**0.33**	**0.37**	**5.2%**
	347446								

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	932	67	-	-	-	-	
Initial Time	39	8	0.205	-	4.1	N/A	DCM Eq. 6-8
Shallow Channel	105	14	0.133	0.9	1.9	-	DCM Eq. 6-9
Channelized	788	45	0.057	2.9	4.6	-	V-Ditch
				t_c	**10.6**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.23	4.05	4.72	5.39	6.07	6.79
Runoff (cfs)	1.5	**3.7**	6.9	12.0	15.8	**20.3**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.5	**3.7**	6.9	12.0	15.8	**20.3**

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

Proposed Sub-Basin A3 Runoff Calculations

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		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.**
Pasture/Meadow	16,461	0.38	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	3,398	0.08	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**19,859**	**0.46**	**0.11**	**0.17**	**0.23**	**0.32**	**0.37**	**0.41**	**13.7%**

19859.2888

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	142	16	-	-	-	-	
Initial Time	100	10	0.103	-	7.8	N/A	DCM Eq. 6-8
Shallow Channel		2	0.000	0.0	0.0	-	DCM Eq. 6-9
Channelized	42	4	0.096	1.8	0.4	-	V-Ditch
				t_c	**8.2**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.53	4.43	5.16	5.90	6.64	7.43
Runoff (cfs)	0.2	**0.3**	0.5	0.9	1.1	**1.4**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.2	**0.3**	0.5	0.9	1.1	**1.4**

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

Proposed Sub-Basin B1 Runoff Calculations

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	359,485	8.25	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	14,569	0.33	0.57	0.59	0.63	0.66	0.68	0.7	80%
Roofs	10,185	0.23	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	2,000	0.05	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**386,239**	**8.87**	**0.06**	**0.12**	**0.19**	**0.28**	**0.33**	**0.38**	**5.9%**
	386239								

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	1,251	86	-	-	-	-	
Initial Time	57	13	0.229	-	4.7	N/A	DCM Eq. 6-8
Shallow Channel	110	10	0.091	0.8	2.4	-	DCM Eq. 6-9
Channelized	1,085	63	0.058	2.9	6.2	-	V-Ditch
				t_c	**13.4**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.95	3.70	4.31	4.93	5.54	6.20
Runoff (cfs)	1.7	**4.0**	7.2	12.4	16.3	**20.8**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.7	**4.0**	7.2	12.4	16.3	**20.8**

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

Proposed Sub-Basin C1 Runoff Calculations

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	17,979	0.41	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**17,979**	**0.41**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**
	17979								

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	263	28	-	-	-	-	
Initial Time	29	6	0.204	-	3.7	N/A	DCM Eq. 6-8
Shallow Channel	68	10	0.147	1.0	1.2	-	DCM Eq. 6-9
Channelized	165	12	0.073	1.5	1.8	-	V-Ditch
				t_c	**6.7**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.77	4.73	5.52	6.31	7.10	7.95
Runoff (cfs)	0.0	**0.2**	0.3	0.7	0.9	**1.1**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.0	**0.2**	0.3	0.7	0.9	**1.1**

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

Proposed Combined Sub-Basin Runoff Calculations (DP2)

Includes Basins OSA1 OSA2 OSA3 OSA4 A1

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		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.**
Pasture/Meadow	891,027	20.46	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	17,040	0.39	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	9,260	0.21	0.57	0.59	0.63	0.66	0.68	0.7	80%
Paved	8,396	0.19	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**925,723**	**21.25**	**0.05**	**0.10**	**0.17**	**0.27**	**0.32**	**0.37**	**3.4%**

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	OSA1	-	1,107	53	-	-	-	-	19.7
Channelized-1	V-Ditch	2	698	28	19	0	2	4.9	2.4
Channelized-2									
Channelized-3									
Total			1,806	81					

2 = Natural, Winding, minimal vegetation/shallow grass

t_c (min) **22.1**

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)	2.35	2.94	3.43	3.92	4.41	4.93
Site Runoff (cfs)	2.30	**6.53**	12.59	22.49	29.87	**38.52**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**6.5**	-	-	-	**38.5**

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.

Proposed Combined Sub-Basin Runoff Calculations (DP3)

Includes Basins DP2 OSA5 A2

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		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.**
Pasture/Meadow	1,256,190	28.84	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	24,782	0.57	0.57	0.59	0.63	0.66	0.68	0.7	80%
Roofs	22,040	0.51	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	19,854	0.46	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**1,322,866**	**30.37**	**0.05**	**0.11**	**0.18**	**0.28**	**0.33**	**0.37**	**4.50%**

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	DP2	-	1,806	81	-	-	-	-	22.1
Channelized-1	V-Ditch	2	430	14	39	0	2	5.4	1.3
Channelized-2									
Channelized-3									
Total			2,236	95					

2 = Natural, Winding, minimal vegetation/shallow grass

t_c (min) **23.5**

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)	2.28	2.85	3.33	3.80	4.28	4.78
Site Runoff (cfs)	3.80	**9.75**	18.23	31.96	42.23	**54.24**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**9.8**	-	-	-	**54.2**

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.

Proposed Combined Sub-Basin Runoff Calculations (DP4)

Includes Basins OSB1 OSB2 OSB3 OSB4 PP-OSB5 A3 B1

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	569,009	13.06	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	28,143	0.65	0.57	0.59	0.63	0.66	0.68	0.7	80%
Roofs	10,685	0.25	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	9,512	0.22	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**617,350**	**14.17**	**0.07**	**0.13**	**0.19**	**0.29**	**0.34**	**0.38**	**6.7%**

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	OSB1	-	59	6	-	-	-	-	6.5
Channelized-1	V-Ditch	3	1,251	86	0	0	2	1.3	16.6
Channelized-2									
Channelized-3									
Total			1,310	92					

3 = Natural, Winding, significant vegetation

t_c (min) **23.2**

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)	2.30	2.87	3.35	3.83	4.30	4.82
Site Runoff (cfs)	2.29	**5.17**	9.21	15.64	20.50	**26.16**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**5.2**	-	-	-	**26.2**

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.

Proposed Combined Sub-Basin Runoff Calculations (DP5)

Includes Basins OSC1 C1

Job No.:	**61201**	Date:	**09/21/2023 17:27**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		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.**
Pasture/Meadow	29,748	0.68	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	8,361	0.19	0.57	0.59	0.63	0.66	0.68	0.7	80%
Paved	3,069	0.07	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**41,179**	**0.95**	**0.20**	**0.24**	**0.30**	**0.38**	**0.43**	**0.47**	**23.7%**

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	OSC1	-	576	28	-	-	-	-	10.7
Channelized-1									
Channelized-2									
Channelized-3									
Total			576	28					
								t_c (min)	**10.7**

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)	3.21	4.03	4.70	5.37	6.04	6.76
Site Runoff (cfs)	0.60	**0.93**	1.35	1.95	2.43	**2.98**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**0.9**	-	-	-	**3.0**

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.

3 Hydraulic Calculations

Proposed Nabulsi Roadway West Roadside Ditch Calculations
Proposed Nabulsi Roadway East Roadside Ditch Calculations
Proposed Nabulsi Roadway Culvert Calculations
Proposed Old Ranch Road North Roadside Ditch Calculations
Proposed 5-yr & 100-yr Culvet Calcuations For Existing 18” & 36” CMPs
Proposed Minimum Driveway Culvert Calculations
Reseeding Mix, Grass Characteristics and Allowable Velocities

M.V.E., Inc.
Date: 09/16/2023
Project: 61201
Nabulsi-Abushaban

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:

71 - Pring Coarse Sandy Loam	2.5 fps

Permissible Velocities by Grass Linings:

Grass-legume mixture (0-5%)	4.0 fps
Grass-legume mixture (5-10%)	3.0 fps
> > >	

Sub-basin Designation	Road Name	Stations	Full Sub-Basin Area (Ac)	Full Sub-Basin Q_{100} (cfs)	Partial Sub-Basin Area (Ac)	Ditch Flow Q_{100} (cfs)	Max. Longit. Ditch Slope in Reach (ft/ft)	Ditch Flow Depth (ft)	Ditch Flow Area (ft^2)	**Ditch Flow Velocity (ft/sec)**	Permissible Velocity (ft/sec)	**Ditch Protection Required?**
East Ditch 1	Nabulsi Road	6+45 (0') - 5+95 (62'R)	21.630	39.1	21.321	38.5	0.026	1.4	7.3	**5.3**	4.0	**YES**
East Ditch 1	Nabulsi Road	5+95 (62'R) - 4+37 (24'R)	21.630	39.1	21.630	39.1	0.042	1.3	6.1	**6.4**	4.0	**YES**
West Ditch	Nabulsi Road	5+95 (62'L) - 4+98 (24'L)	0.501	1.5	0.090	0.3	0.074	0.2	0.1	**2.1**	3.0	**NO**
West Ditch	Nabulsi Road	4+98 (24'L) - 2+40 (24'L)	0.501	1.5	0.501	1.5	0.042	0.4	0.5	**2.8**	4.0	**NO**
East Ditch 2	Nabulsi Road	2+05 (24'R) - 0+45 (24'R)	0.191	0.8	0.191	0.8	0.069	0.3	0.3	**2.9**	3.0	**NO**

M.V.E., Inc.
Date: 09/16/2023
Project: 61201
Nabulsi Abushaban

Rock Check Dam Spacing

Check Dam Data
H = 1.5 ft 1.5

Total Rock Checks Required: 5

Road Name	Stations	Max Ditch Slope (%)	Ditch Slope Required for Stabilization (%)	Vertical Distance (ft)	Horizontal Distance (ft)	Vertical Distance Required for Stabilization (ft)	Rock Checks Required (EA)	Rock Check Spacing (ft)
Nabulsi Road	6+45 (0') - 5+95 (62'R)	2.6%	0.56%	2.9	91.1	0.510	2	45.0
Nabulsi Road	5+95 (62'R) - 4+37 (24'R)	4.2%	1.20%	4.0	168.1	2.017	2	85.0
Nabulsi Road	2+05 (24'R) - 0+45 (24'R)	6.90%					1	

Nabulsi Road Sta 6+45 to 4+37 (24'R) Ditch Flow Calculation (East Ditch 1)

Includes Basins OSA1 OSA2 OSA3 OSA4 A1 E-1 ADD AREA

Job No.:	**61201**	Date:	**09/20/2023 9:36**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	897,843	20.61	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	17,040	0.39	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	18,927	0.43	0.57	0.59	0.63	0.66	0.68	0.7	80%
Paved	8,396	0.19	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**942,206**	**21.63**	**0.05**	**0.11**	**0.18**	**0.27**	**0.32**	**0.37**	**4.1%**

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	OSA1	-	1,107	53	-	-	-	-	19.7
Channelized-1	V-Ditch	2	601	29	19	0	2	5.2	1.9
Channelized-2	V-Ditch	2	228.7	5.1	19	0	2	3.9	1.0
Channelized-3									
Total			1,937	87					

2 = Natural, Winding, minimal vegetation/shallow grass

2 = Natural, Winding, minimal vegetation/shallow grass

t_c (min) **22.6**

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)	2.32	2.90	3.39	3.87	4.36	4.87
Site Runoff (cfs)	2.58	**6.87**	13.00	22.95	30.39	**39.09**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**6.9**	-	-	-	**39.1**

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

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

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Sep 20 2023

61201-Nabulsi Road Sta 6+44 to 5+95 (62'R)

Triangular

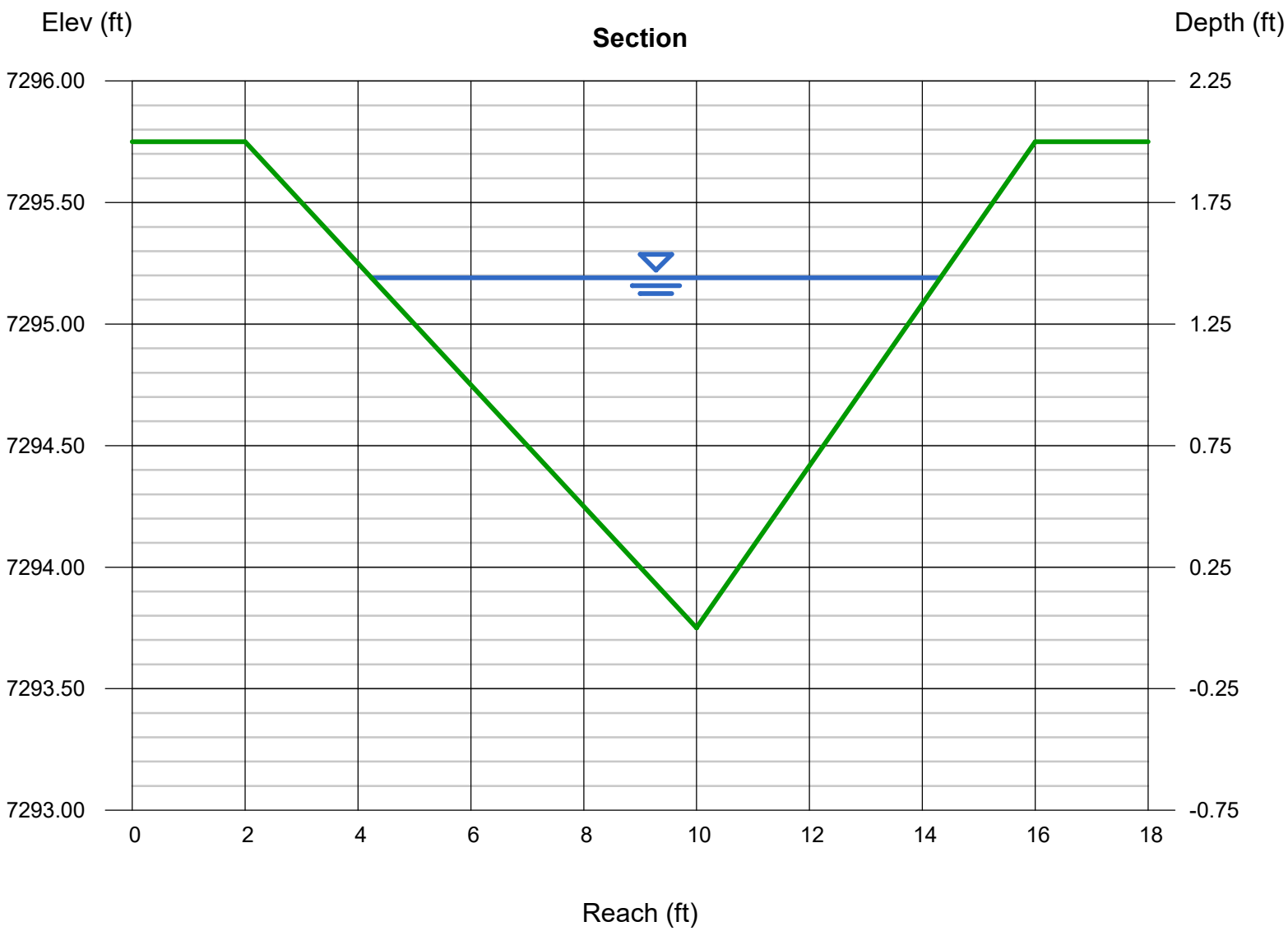
Side Slopes (z:1)	=	4.00, 3.00
Total Depth (ft)	=	2.00
Invert Elev (ft)	=	7293.75
Slope (%)	=	2.63
N-Value	=	0.035

Calculations

Compute by:		Known Q
Known Q (cfs)	=	38.50

Highlighted

Depth (ft)	=	1.44
Q (cfs)	=	38.50
Area (sqft)	=	7.26
Velocity (ft/s)	=	5.30
Wetted Perim (ft)	=	10.49
Crit Depth, Yc (ft)	=	1.50
Top Width (ft)	=	10.08
EGL (ft)	=	1.88



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Sep 20 2023

61201-Nabulsi Road Sta 5+95 (62'R) to 4+37 (24'R)

Triangular

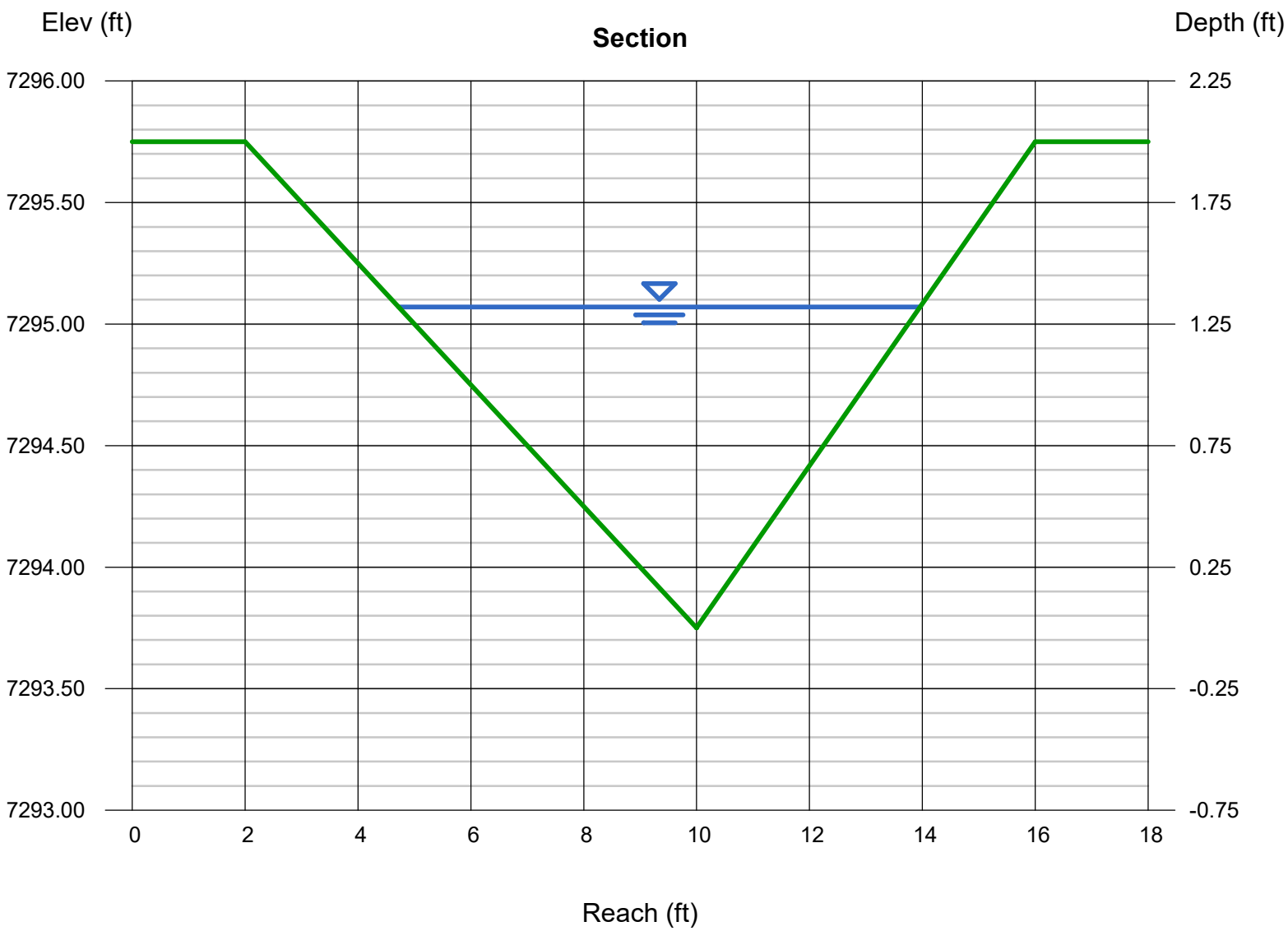
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 7293.75
Slope (%)	= 4.22
N-Value	= 0.035

Calculations

Compute by:	Known Q
Known Q (cfs)	= 39.10

Highlighted

Depth (ft)	= 1.32
Q (cfs)	= 39.10
Area (sqft)	= 6.10
Velocity (ft/s)	= 6.41
Wetted Perim (ft)	= 9.62
Crit Depth, Yc (ft)	= 1.51
Top Width (ft)	= 9.24
EGL (ft)	= 1.96



Nabulsi Road Sta 5+95 (52'L) to 2+40 (24'L) Ditch Flow Calculation (West Ditch)

Job No.:	**61201**	Date:	**09/20/2023 9:36**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	16,437	0.38	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	5,400	0.12	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**21,837**	**0.501**	**0.16**	**0.21**	**0.27**	**0.35**	**0.39**	**0.44**	**19.8%**

21836.9189

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	393	22	-	-	-	-	
Initial Time	90	6	0.066	-	8.2	N/A	DCM Eq. 6-8
Shallow Channel			0.000	0.0	0.0	-	DCM Eq. 6-9
Channelized	303	16	0.052	2.5	2.0	-	V-Ditch
				t_c	**10.3**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.27	4.09	4.77	5.46	6.14	6.87
Runoff (cfs)	0.3	**0.4**	0.6	1.0	1.2	**1.5**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.3	**0.4**	0.6	1.0	1.2	**1.5**

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

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Sep 20 2023

61201-Nabulsi Road Sta 5+95 (62'L) to 4+98 (24'L)

Triangular

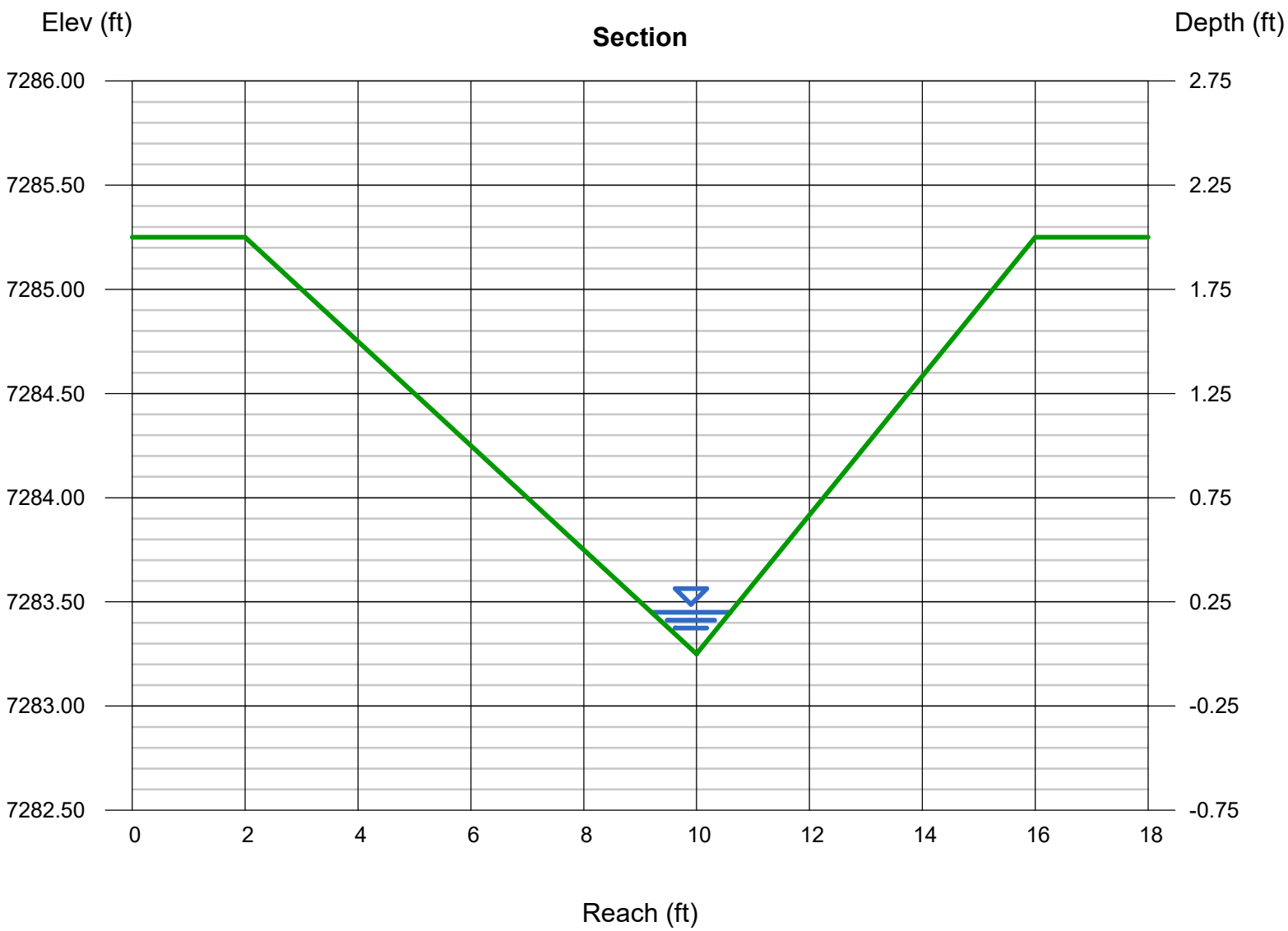
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 7283.25
Slope (%)	= 7.40
N-Value	= 0.035

Calculations

Compute by:	Known Q
Known Q (cfs)	= 0.30

Highlighted

Depth (ft)	= 0.20
Q (cfs)	= 0.300
Area (sqft)	= 0.14
Velocity (ft/s)	= 2.14
Wetted Perim (ft)	= 1.46
Crit Depth, Yc (ft)	= 0.22
Top Width (ft)	= 1.40
EGL (ft)	= 0.27



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Sep 20 2023

61201-Nabulsi Road Sta 4+98 (24'L) to 2+40 (24'L)

Triangular

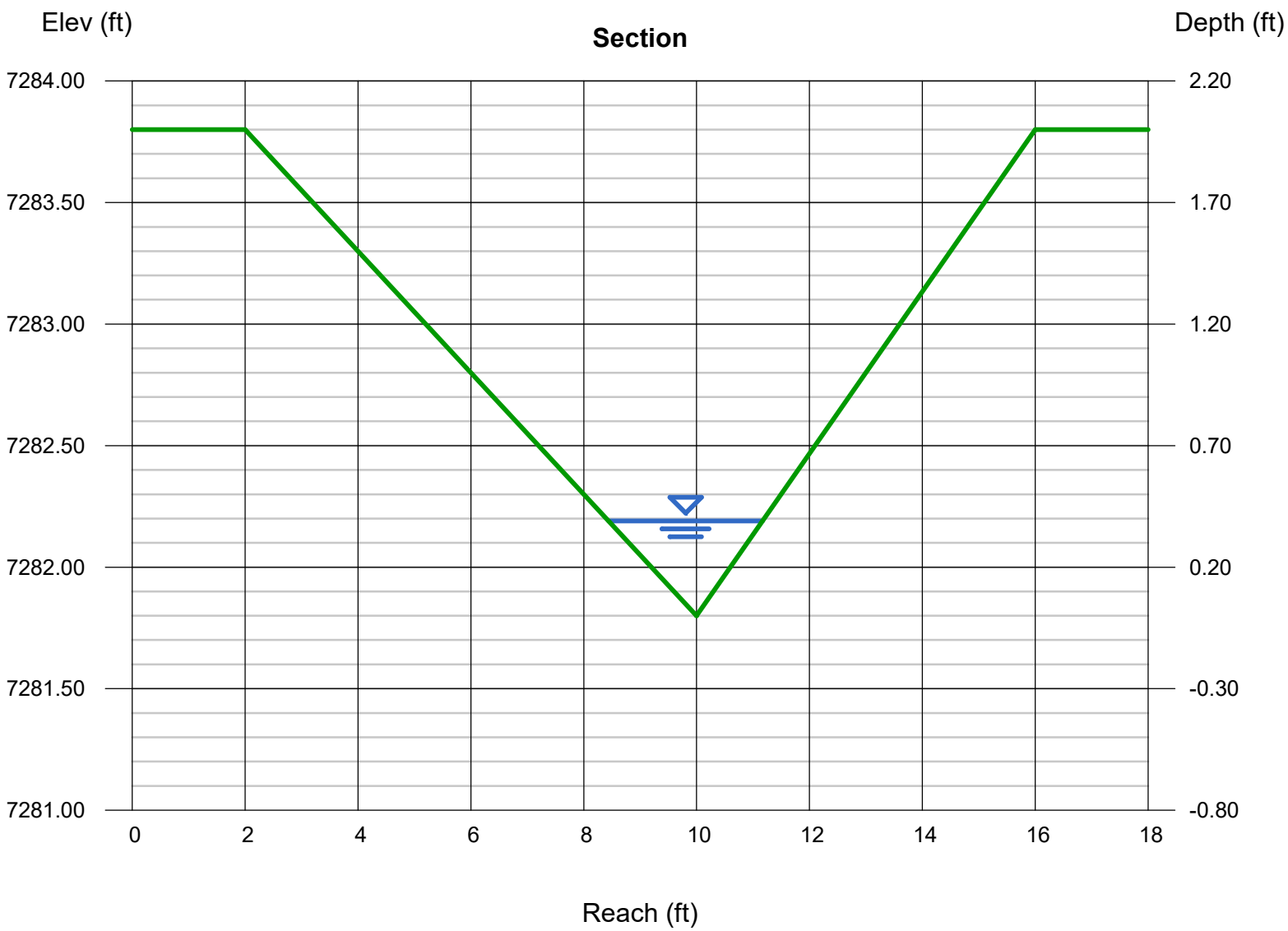
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 7281.80
Slope (%)	= 4.22
N-Value	= 0.035

Calculations

Compute by:	Known Q
Known Q (cfs)	= 1.50

Highlighted

Depth (ft)	= 0.39
Q (cfs)	= 1.500
Area (sqft)	= 0.53
Velocity (ft/s)	= 2.82
Wetted Perim (ft)	= 2.84
Crit Depth, Yc (ft)	= 0.41
Top Width (ft)	= 2.73
EGL (ft)	= 0.51



Nabulsi Road Sta 2+05 (24'R) to 0+45 (24'R) Ditch Flow Calculation (East Ditch 2)

Job No.:	**61201**	Date:	**09/20/2023 9:36**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	5,079	0.12	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	3,248	0.07	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**8,328**	**0.191**	**0.23**	**0.28**	**0.34**	**0.41**	**0.45**	**0.49**	**31.2%**
	8327.5666								

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	167	12	-	-	-	-	
Initial Time	37	5	0.134	-	3.8	N/A	DCM Eq. 6-8
Shallow Channel			0.000	0.0	0.0	-	DCM Eq. 6-9
Channelized	129	7	0.056	2.2	1.0	-	V-Ditch
				t_c	**5.0**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	4.12	5.17	6.03	6.89	7.75	8.68
Runoff (cfs)	0.2	**0.3**	0.4	0.5	0.7	**0.8**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.2	**0.3**	0.4	0.5	0.7	**0.8**

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

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Sep 20 2023

61201-Nabulsi Road 2+05 (24'R) to 0+45 (24'R)

Triangular

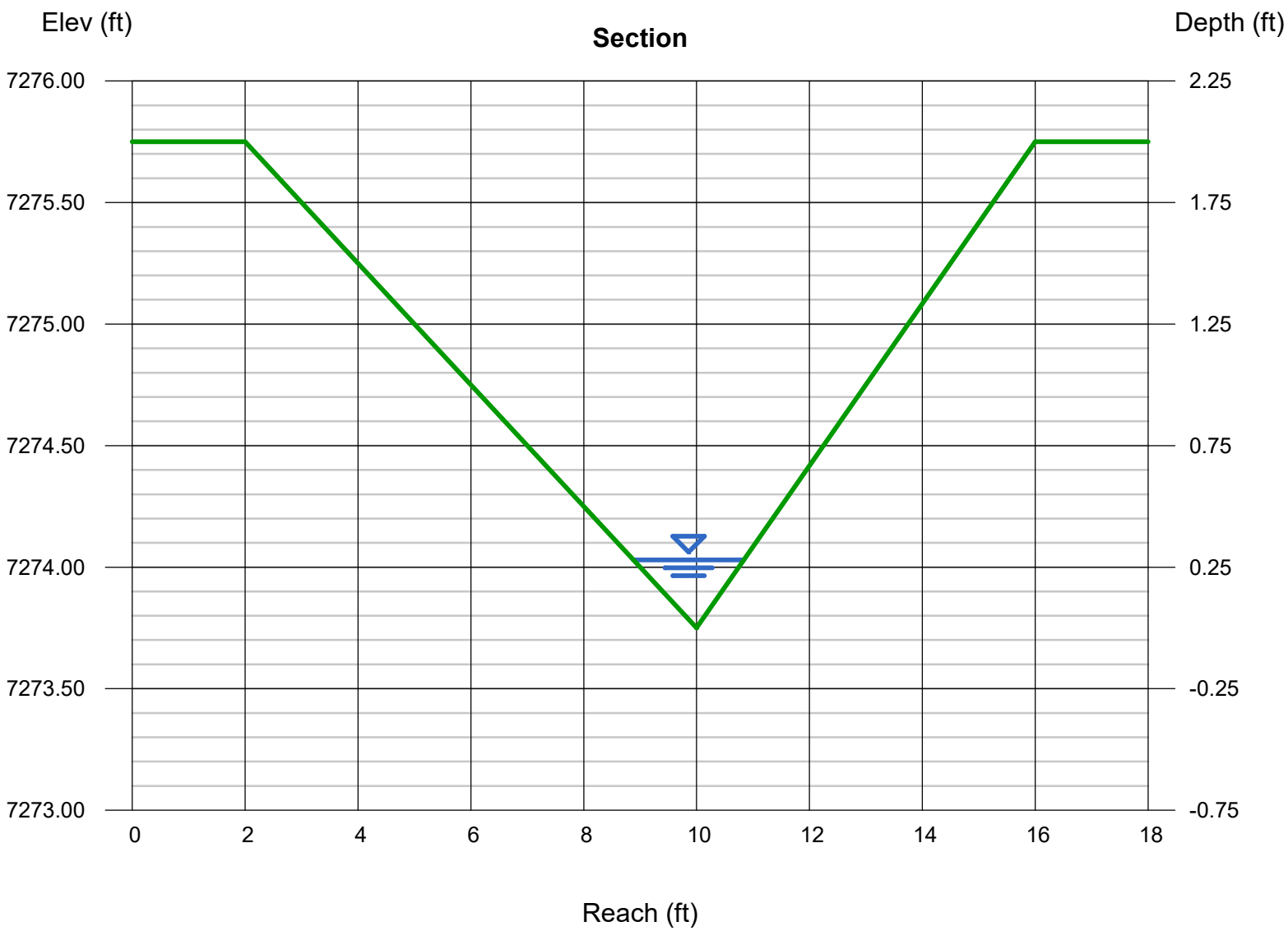
Side Slopes (z:1)	=	4.00, 3.00
Total Depth (ft)	=	2.00
Invert Elev (ft)	=	7273.75
Slope (%)	=	6.90
N-Value	=	0.035

Calculations

Compute by:		Known Q
Known Q (cfs)	=	0.80

Highlighted

Depth (ft)	=	0.28
Q (cfs)	=	0.800
Area (sqft)	=	0.27
Velocity (ft/s)	=	2.92
Wetted Perim (ft)	=	2.04
Crit Depth, Yc (ft)	=	0.32
Top Width (ft)	=	1.96
EGL (ft)	=	0.41



PP Nabulsi Road, 18" Culvert Runoff Calculations

Job No.:	**61201**	Date:	**07/31/2023 11:01**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	18,926	0.43	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	6,195	0.14	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**25,121**	**0.58**	**0.16**	**0.21**	**0.27**	**0.35**	**0.39**	**0.44**	**19.7%**

25120.6675

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	152	16	-	-	-	-	
Initial Time	26	6	0.229	-	2.9	N/A	DCM Eq. 6-8
Shallow Channel	85	5	0.059	0.6	2.3	-	DCM Eq. 6-9
Channelized	41	5	0.121	2.2	0.3	-	V-Ditch
				t_c	**5.6**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.99	5.00	5.83	6.67	7.50	8.40
Runoff (cfs)	0.4	**0.6**	0.9	1.3	1.7	**2.1**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.4	**0.6**	0.9	1.3	1.7	**2.1**

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

Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Jul 31 2023

61201 - PP Nabulsi Road Sta 0+28, PP 18-inch RCP 5-yr

Invert Elev Dn (ft)	=	7269.25
Pipe Length (ft)	=	79.17
Slope (%)	=	1.01
Invert Elev Up (ft)	=	7270.05
Rise (in)	=	18.0
Shape	=	Circular
Span (in)	=	18.0
No. Barrels	=	1
n-Value	=	0.012
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

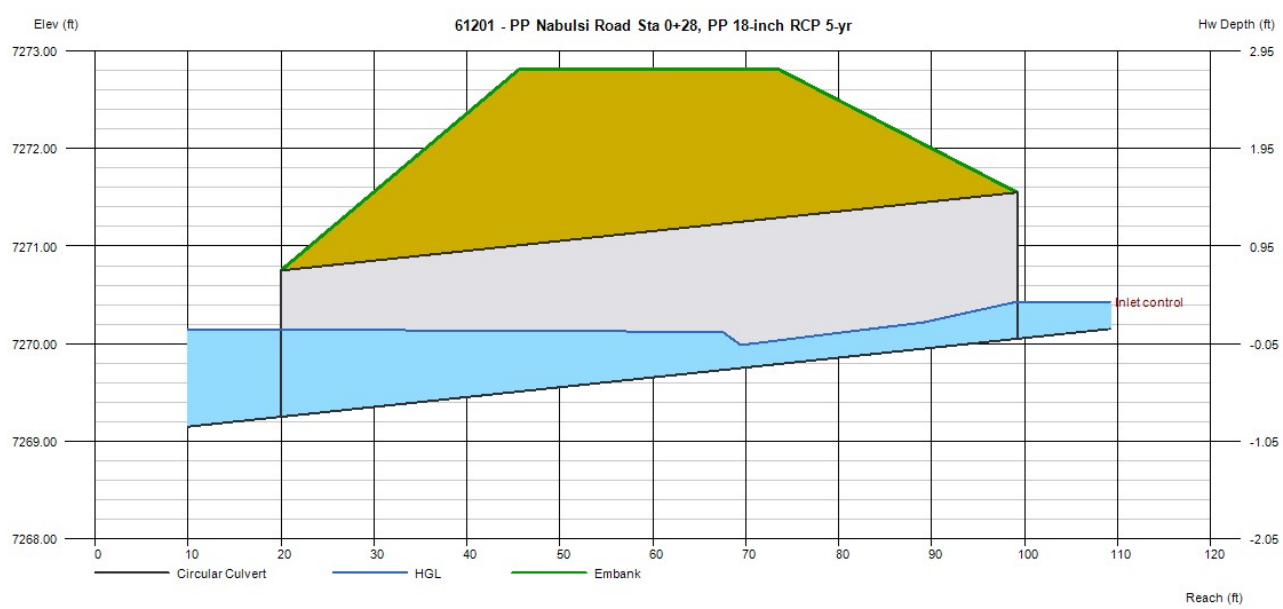
Top Elevation (ft)	=	7272.81
Top Width (ft)	=	28.00
Crest Width (ft)	=	70.00

Calculations

Qmin (cfs)	=	0.60
Qmax (cfs)	=	0.60
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	0.60
Qpipe (cfs)	=	0.60
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	0.55
Veloc Up (ft/s)	=	2.54
HGL Dn (ft)	=	7270.14
HGL Up (ft)	=	7270.34
Hw Elev (ft)	=	7270.43
Hw/D (ft)	=	0.25
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Jul 31 2023

61201 - PP Nabulsi Road Sta 0+28, PP 18-inch RCP

Invert Elev Dn (ft)	=	7269.25
Pipe Length (ft)	=	79.17
Slope (%)	=	1.01
Invert Elev Up (ft)	=	7270.05
Rise (in)	=	18.0
Shape	=	Circular
Span (in)	=	18.0
No. Barrels	=	1
n-Value	=	0.012
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

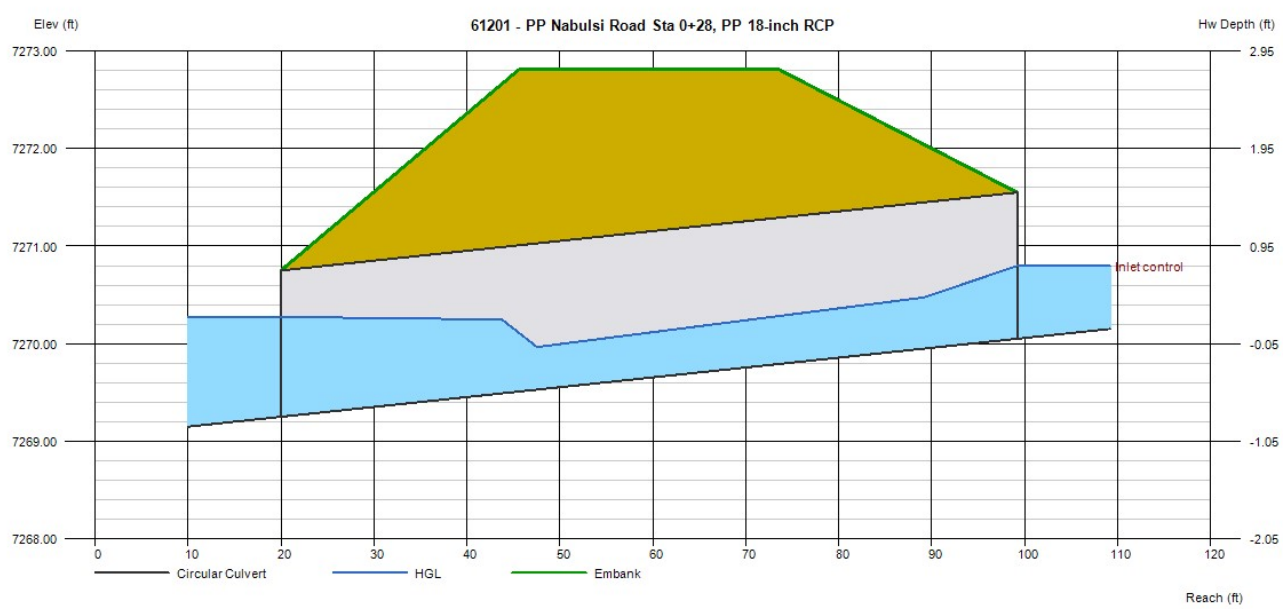
Top Elevation (ft)	=	7272.81
Top Width (ft)	=	28.00
Crest Width (ft)	=	70.00

Calculations

Qmin (cfs)	=	2.10
Qmax (cfs)	=	2.10
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	2.10
Qpipe (cfs)	=	2.10
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	1.63
Veloc Up (ft/s)	=	3.61
HGL Dn (ft)	=	7270.27
HGL Up (ft)	=	7270.60
Hw Elev (ft)	=	7270.80
Hw/D (ft)	=	0.50
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Aug 19 2024

61201 - Nabulsi Road Driveway Culvert Minimum 18-inch RCP - 5-yr (6.5 cfs)

Invert Elev Dn (ft)	=	100.00
Pipe Length (ft)	=	20.00
Slope (%)	=	2.00
Invert Elev Up (ft)	=	100.40
Rise (in)	=	18.0
Shape	=	Circular
Span (in)	=	18.0
No. Barrels	=	1
n-Value	=	0.023
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

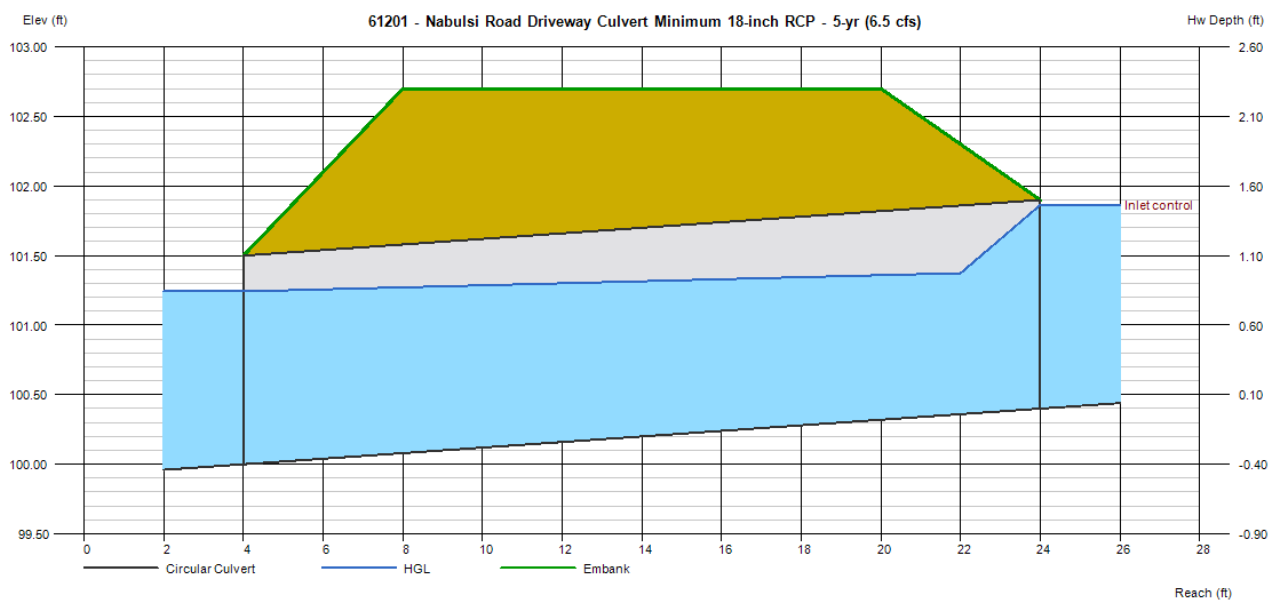
Top Elevation (ft)	=	102.70
Top Width (ft)	=	12.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	6.50
Qmax (cfs)	=	6.50
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	6.50
Qpipe (cfs)	=	6.50
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	4.15
Veloc Up (ft/s)	=	5.26
HGL Dn (ft)	=	101.24
HGL Up (ft)	=	101.39
Hw Elev (ft)	=	101.86
Hw/D (ft)	=	0.98
Flow Regime	=	Inlet Control



PP Old Ranch Roadside Ditch Runoff Calculations

Includes Basins pp orr roadside ditch A3 PP-OSB5

Job No.:	**61201**	Date:	**09/21/2023 17:43**
Project:	**Nabulsi-Abushaban Subdivision**	Calcs by:	**JO**
		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.**
Pasture/Meadow	94,879	2.18	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	20,051	0.46	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**114,930**	**2.64**	**0.12**	**0.17**	**0.23**	**0.32**	**0.37**	**0.41**	**14.0%**

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	orr roadside ditch	-	854	32	-	-	-	-	12.6
Channelized-1									
Channelized-2									
Channelized-3									
Total			854	32					
								t_c (min)	**12.6**

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)	3.02	3.79	4.42	5.05	5.68	6.36
Site Runoff (cfs)	0.93	**1.69**	2.72	4.28	5.49	**6.90**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**1.7**	-	-	-	**6.9**

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.

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Jan 18 2024

61201-Old Ranch Road Roadside Ditch to Existing 36-inch CMP - 5yr (DP4)

Triangular

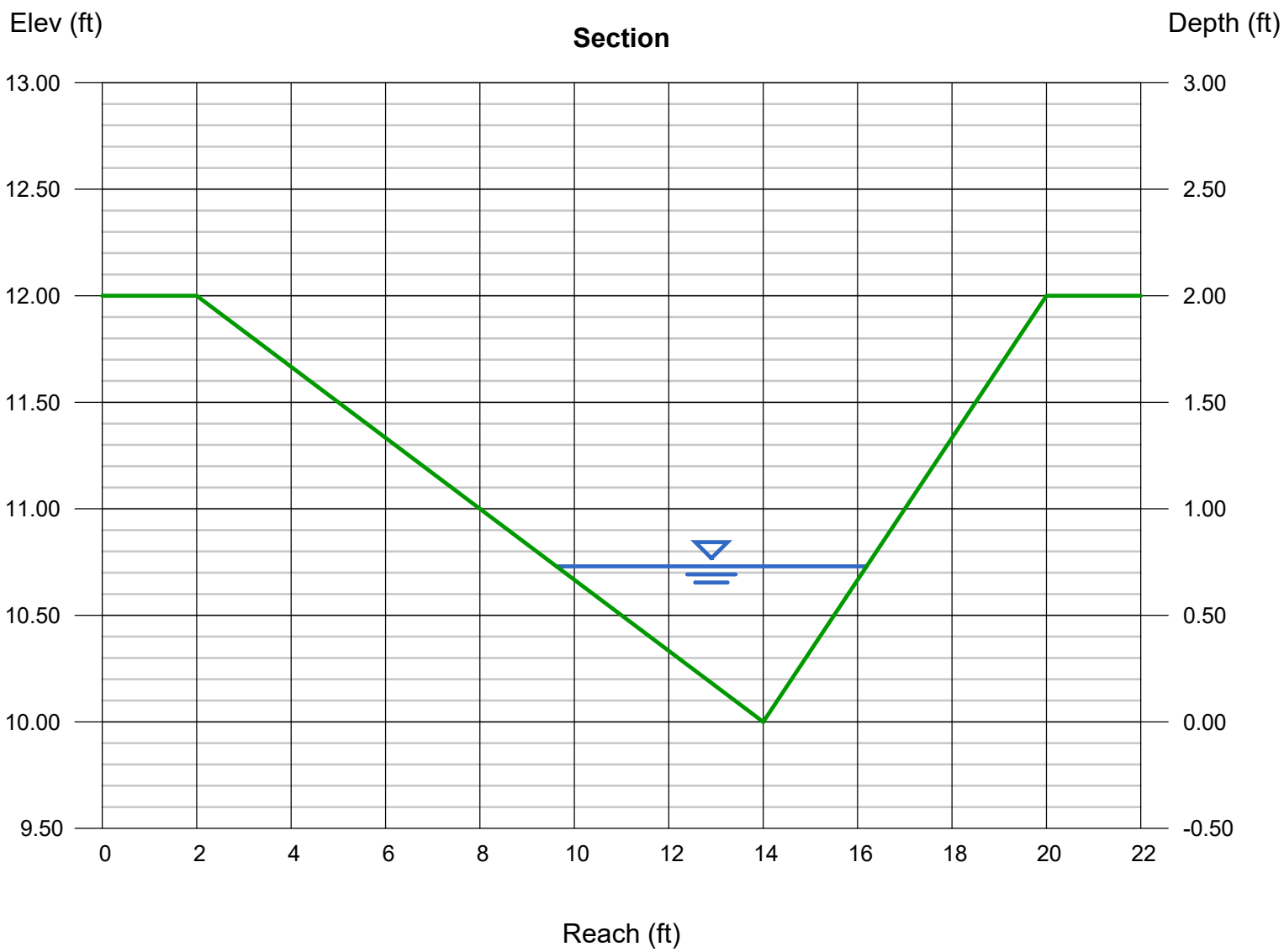
Side Slopes (z:1)	= 6.00, 3.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 10.00
Slope (%)	= 1.05
N-Value	= 0.035

Calculations

Compute by:	Known Q
Known Q (cfs)	= 5.20

Highlighted

Depth (ft)	= 0.73
Q (cfs)	= 5.200
Area (sqft)	= 2.40
Velocity (ft/s)	= 2.17
Wetted Perim (ft)	= 6.75
Crit Depth, Yc (ft)	= 0.61
Top Width (ft)	= 6.57
EGL (ft)	= 0.80



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Jan 18 2024

61201-Old Ranch Road Roadside Ditch to Existing 36-inch CMP - 100yr (DP4)

Triangular

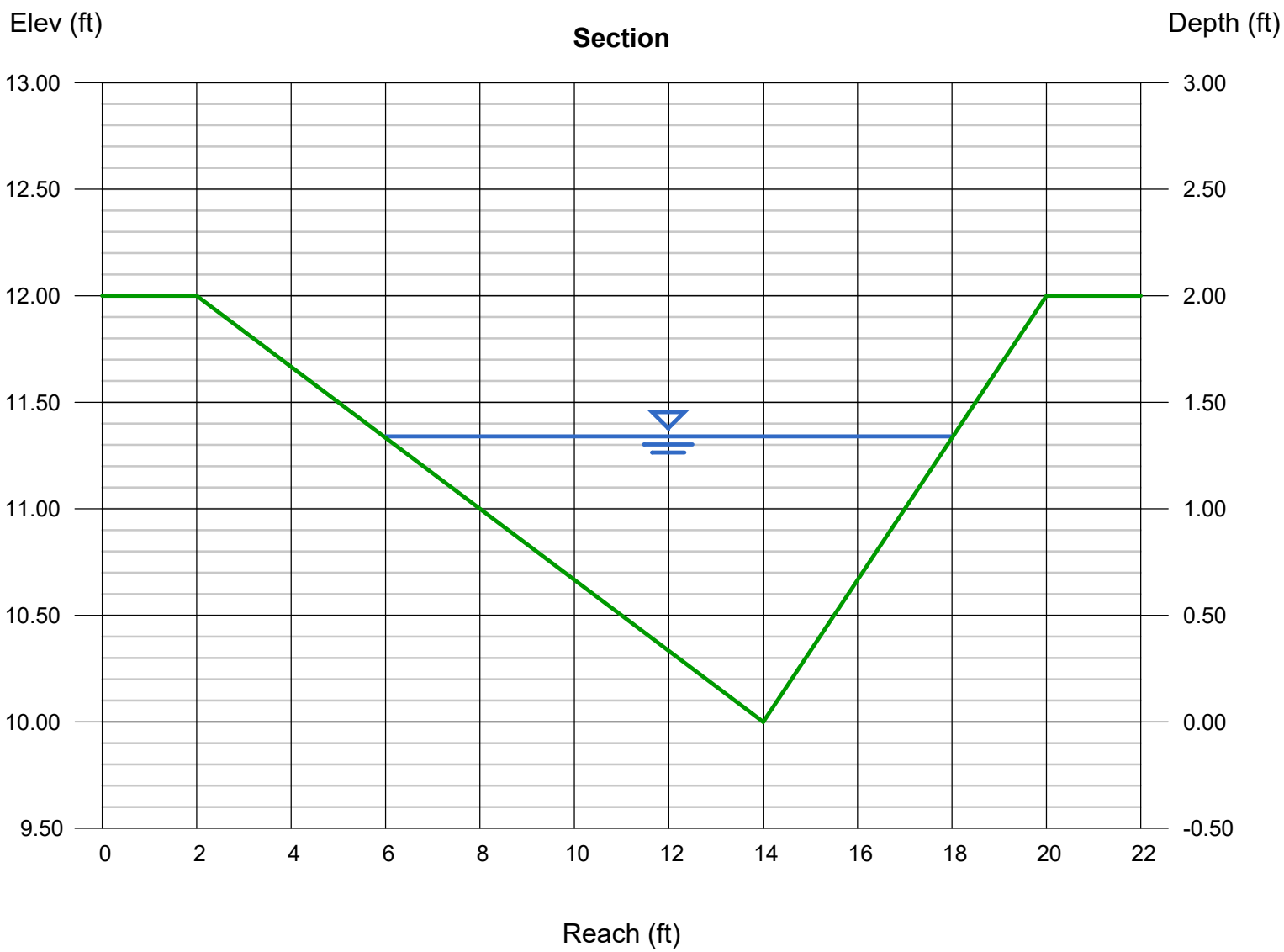
Side Slopes (z:1)	= 6.00, 3.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 10.00
Slope (%)	= 1.05
N-Value	= 0.035

Calculations

Compute by:	Known Q
Known Q (cfs)	= 26.20

Highlighted

Depth (ft)	= 1.34
Q (cfs)	= 26.20
Area (sqft)	= 8.08
Velocity (ft/s)	= 3.24
Wetted Perim (ft)	= 12.39
Crit Depth, Yc (ft)	= 1.17
Top Width (ft)	= 12.06
EGL (ft)	= 1.50



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Sep 21 2023

61201 - Old Ranch Road Existing 36-inch CMP (DP4), Proposed 5 yr

Invert Elev Dn (ft)	=	7265.20
Pipe Length (ft)	=	54.22
Slope (%)	=	2.18
Invert Elev Up (ft)	=	7266.38
Rise (in)	=	36.0
Shape	=	Circular
Span (in)	=	36.0
No. Barrels	=	1
n-Value	=	0.022
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

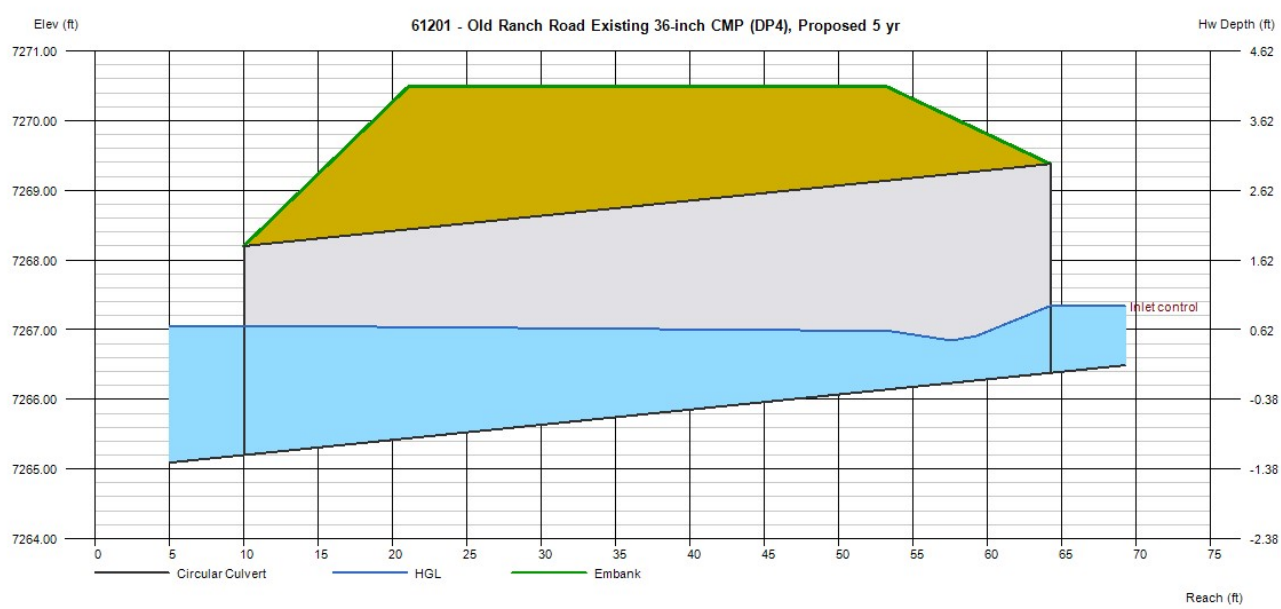
Top Elevation (ft)	=	7270.50
Top Width (ft)	=	32.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	5.20
Qmax (cfs)	=	5.20
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	5.20
Qpipe (cfs)	=	5.20
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	1.13
Veloc Up (ft/s)	=	4.04
HGL Dn (ft)	=	7267.06
HGL Up (ft)	=	7267.09
Hw Elev (ft)	=	7267.34
Hw/D (ft)	=	0.32
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Sep 21 2023

61201 - Old Ranch Road Existing 36-inch CMP (DP4), Proposed 100 yr

Invert Elev Dn (ft)	=	7265.20
Pipe Length (ft)	=	54.22
Slope (%)	=	2.18
Invert Elev Up (ft)	=	7266.38
Rise (in)	=	36.0
Shape	=	Circular
Span (in)	=	36.0
No. Barrels	=	1
n-Value	=	0.022
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

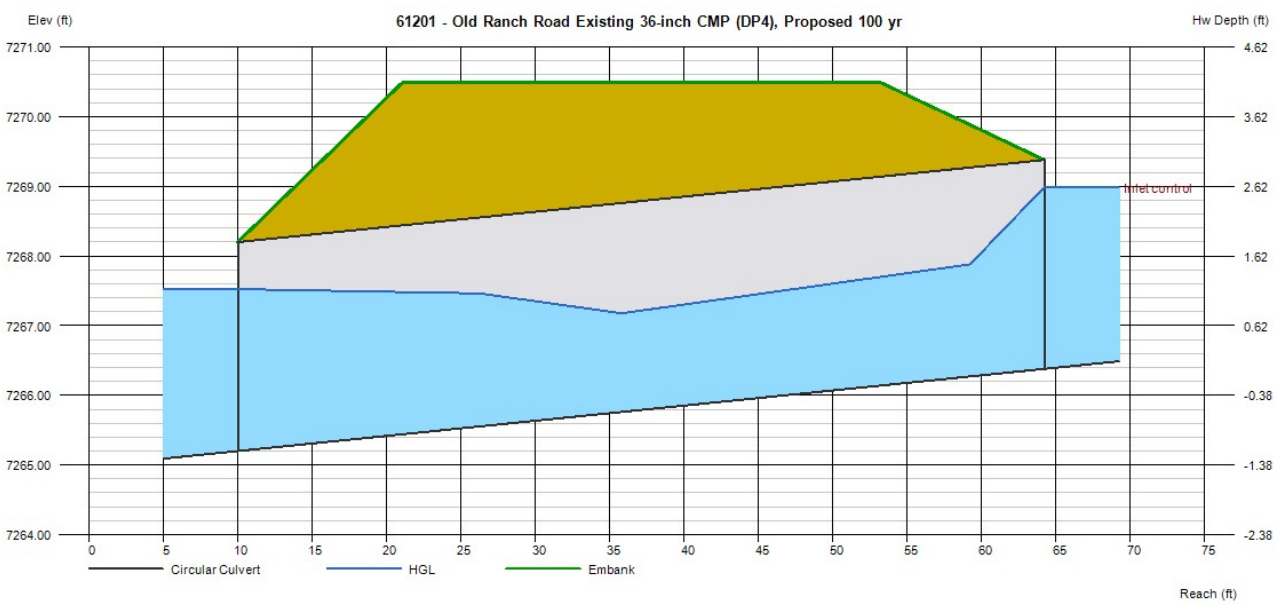
Top Elevation (ft)	=	7270.50
Top Width (ft)	=	32.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	26.20
Qmax (cfs)	=	26.20
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	26.20
Qpipe (cfs)	=	26.20
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	4.46
Veloc Up (ft/s)	=	6.57
HGL Dn (ft)	=	7267.53
HGL Up (ft)	=	7268.03
Hw Elev (ft)	=	7268.99
Hw/D (ft)	=	0.87
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Jul 31 2023

61201 - Old Ranch Road Existing 18-inch CMP (DP5) 5-yr

Invert Elev Dn (ft)	=	7271.52
Pipe Length (ft)	=	50.50
Slope (%)	=	2.65
Invert Elev Up (ft)	=	7272.86
Rise (in)	=	18.0
Shape	=	Circular
Span (in)	=	18.0
No. Barrels	=	1
n-Value	=	0.022
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

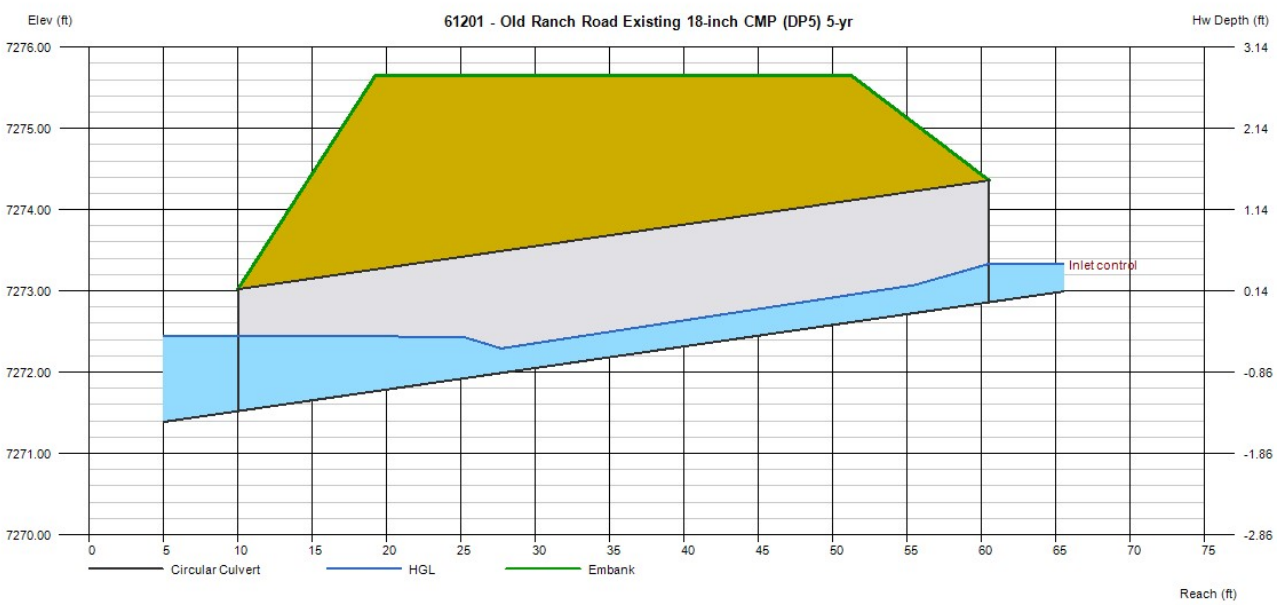
Top Elevation (ft)	=	7275.65
Top Width (ft)	=	32.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	0.90
Qmax (cfs)	=	0.90
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	0.90
Qpipe (cfs)	=	0.90
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	0.79
Veloc Up (ft/s)	=	2.84
HGL Dn (ft)	=	7272.45
HGL Up (ft)	=	7273.21
Hw Elev (ft)	=	7273.33
Hw/D (ft)	=	0.31
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Jul 31 2023

61201 - Old Ranch Road Existing 18-inch CMP (DP5)

Invert Elev Dn (ft)	=	7271.52
Pipe Length (ft)	=	50.50
Slope (%)	=	2.65
Invert Elev Up (ft)	=	7272.86
Rise (in)	=	18.0
Shape	=	Circular
Span (in)	=	18.0
No. Barrels	=	1
n-Value	=	0.022
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

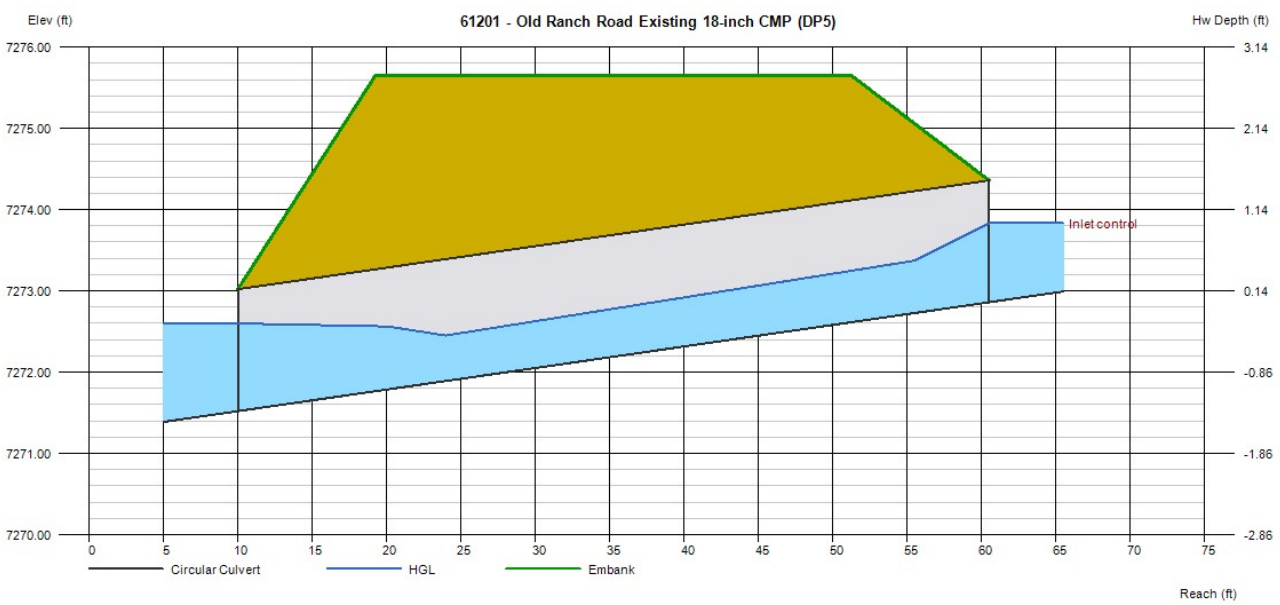
Top Elevation (ft)	=	7275.65
Top Width (ft)	=	32.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	3.00
Qmax (cfs)	=	3.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	3.00
Qpipe (cfs)	=	3.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	2.20
Veloc Up (ft/s)	=	4.02
HGL Dn (ft)	=	7272.60
HGL Up (ft)	=	7273.52
Hw Elev (ft)	=	7273.83
Hw/D (ft)	=	0.65
Flow Regime	=	Inlet Control



Design Procedure Form: Runoff Reduction

UD-BMP (Version 3.07, March 2018)

Designer:	**TJW**
Company:	**M.V.E., Inc.**
Date:	**August 16, 2024**
Project:	**Nabulsi-Abushaban Subdivision**
Location:	**Typical Roadside RPA (100' Long Section of 1/2 Roadway UIA + 6' Wide RPA allowing for a 20' wide driveway)**

SITE INFORMATION (User Input in Blue Cells)

WQCV Rainfall Depth	0.60	inches
Depth of Average Runoff Producing Storm, d_6 =	0.43	inches (for Watersheds Outside of the Denver Region, Figure 3-1 in USDCM Vol. 3)

Area Type	UIA:RPA											
Area ID	Slope											
Downstream Design Point ID	None											
Downstream BMP Type	None											
DCIA (ft^2)	--											
UIA (ft^2)	1,600											
RPA (ft^2)	480											
SPA (ft^2)	--											
HSG A (%)	0%											
HSG B (%)	100%											
HSG C/D (%)	0%											
Average Slope of RPA (ft/ft)	0.250											
UIA:RPA Interface Width (ft)	80.00											

CALCULATED RUNOFF RESULTS

Area ID	Slope											
UIA:RPA Area (ft^2)	2,080											
L / W Ratio	0.33											
UIA / Area	0.7692											
Runoff (in)	0.15											
Runoff (ft^3)	25											
Runoff Reduction (ft^3)	41											

CALCULATED WQCV RESULTS

Area ID	Slope											
WQCV (ft^3)	67											
WQCV Reduction (ft^3)	41											
WQCV Reduction (%)	62%											
Untreated WQCV (ft^3)	25											

CALCULATED DESIGN POINT RESULTS (sums results from all columns with the same Downstream Design Point ID)

Downstream Design Point ID	None											
DCIA (ft^2)	0											
UIA (ft^2)	1,600											
RPA (ft^2)	480											
SPA (ft^2)	0											
Total Area (ft^2)	2,080											
Total Impervious Area (ft^2)	1,600											
WQCV (ft^3)	67											
WQCV Reduction (ft^3)	41											
WQCV Reduction (%)	62%											
Untreated WQCV (ft^3)	25											

CALCULATED SITE RESULTS (sums results from all columns in worksheet)

Total Area (ft^2)	2,080
Total Impervious Area (ft^2)	1,600
WQCV (ft^3)	67
WQCV Reduction (ft^3)	41
WQCV Reduction (%)	62%
Untreated WQCV (ft^3)	25

Design Procedure Form: Runoff Reduction

UD-BMP (Version 3.07, March 2018)

Designer:	**TJW**
Company:	**M.V.E., Inc.**
Date:	**August 16, 2024**
Project:	**Nabulsi-Abushhaban Subdivision**
Location:	**Total Roadway & RPA Reduction accounting for four driveways**

SITE INFORMATION (User Input in Blue Cells)

WQCV Rainfall Depth: 0.60 inches

Depth of Average Runoff Producing Storm, d_6 = 0.43 inches (for Watersheds Outside of the Denver Region, Figure 3-1 in USDCM Vol. 3)

Area Type	UIA:RPA											
Area ID	Slope											
Downstream Design Point ID	None											
Downstream BMP Type	None											
DCIA (ft^2)	--											
UIA (ft^2)	24,157											
RPA (ft^2)	7,092											
SPA (ft^2)	--											
HSG A (%)	0%											
HSG B (%)	100%											
HSG C/D (%)	0%											
Average Slope of RPA (ft/ft)	0.250											
UIA:RPA Interface Width (ft)	104.00											

CALCULATED RUNOFF RESULTS

Area ID	Slope											
UIA:RPA Area (ft^2)	31,249											
L / W Ratio	2.89											
UIA / Area	0.7730											
Runoff (in)	0.14											
Runoff (ft^3)	367											
Runoff Reduction (ft^3)	639											

CALCULATED WQCV RESULTS

Area ID	Slope											
WQCV (ft^3)	1007											
WQCV Reduction (ft^3)	639											
WQCV Reduction (%)	64%											
Untreated WQCV (ft^3)	367											

CALCULATED DESIGN POINT RESULTS (sums results from all columns with the same Downstream Design Point ID)

Downstream Design Point ID	None											
DCIA (ft^2)	0											
UIA (ft^2)	24,157											
RPA (ft^2)	7,092											
SPA (ft^2)	0											
Total Area (ft^2)	31,249											
Total Impervious Area (ft^2)	24,157											
WQCV (ft^3)	1,007											
WQCV Reduction (ft^3)	639											
WQCV Reduction (%)	64%											
Untreated WQCV (ft^3)	367											

CALCULATED SITE RESULTS (sums results from all columns in worksheet)

Total Area (ft^2)	31,249
Total Impervious Area (ft^2)	24,157
WQCV (ft^3)	1,007
WQCV Reduction (ft^3)	639
WQCV Reduction (%)	64%
Untreated WQCV (ft^3)	367

LEGEND

PROPERTY LINE

EASEMENT LINE

EXISTING

5985 INDEX CONTOUR

84 INTERMEDIATE CONTOUR

PROPOSED

5985 INDEX CONTOUR

84 INTERMEDIATE CONTOUR

AREA BOUNDARY

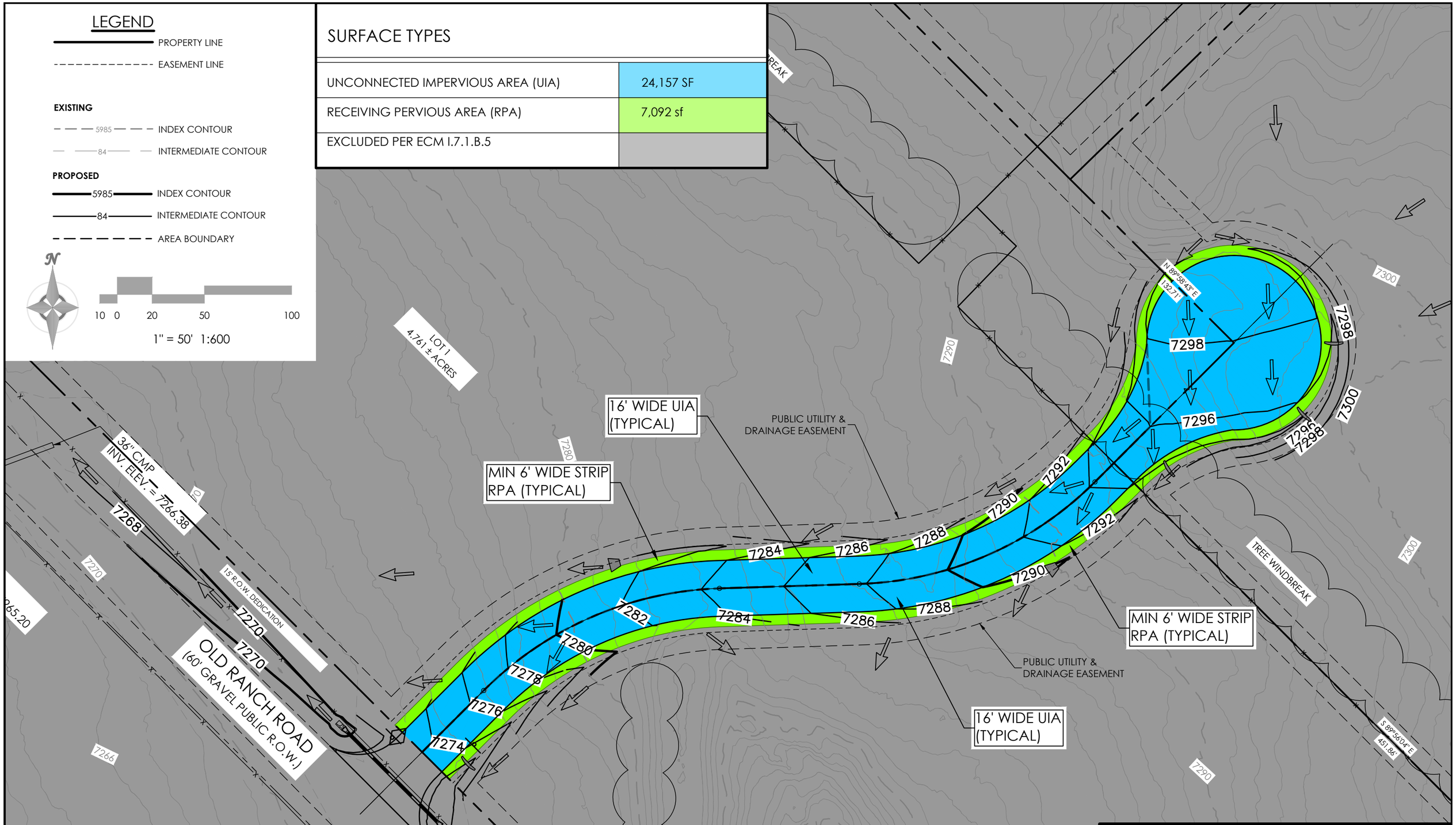
N

10 0 20 50 100

1" = 50' 1:600

SURFACE TYPES

UNCONNECTED IMPERVIOUS AREA (UIA)	24,157 SF
RECEIVING PERVIOUS AREA (RPA)	7,092 sf
EXCLUDED PER ECM I.7.1.B.5	



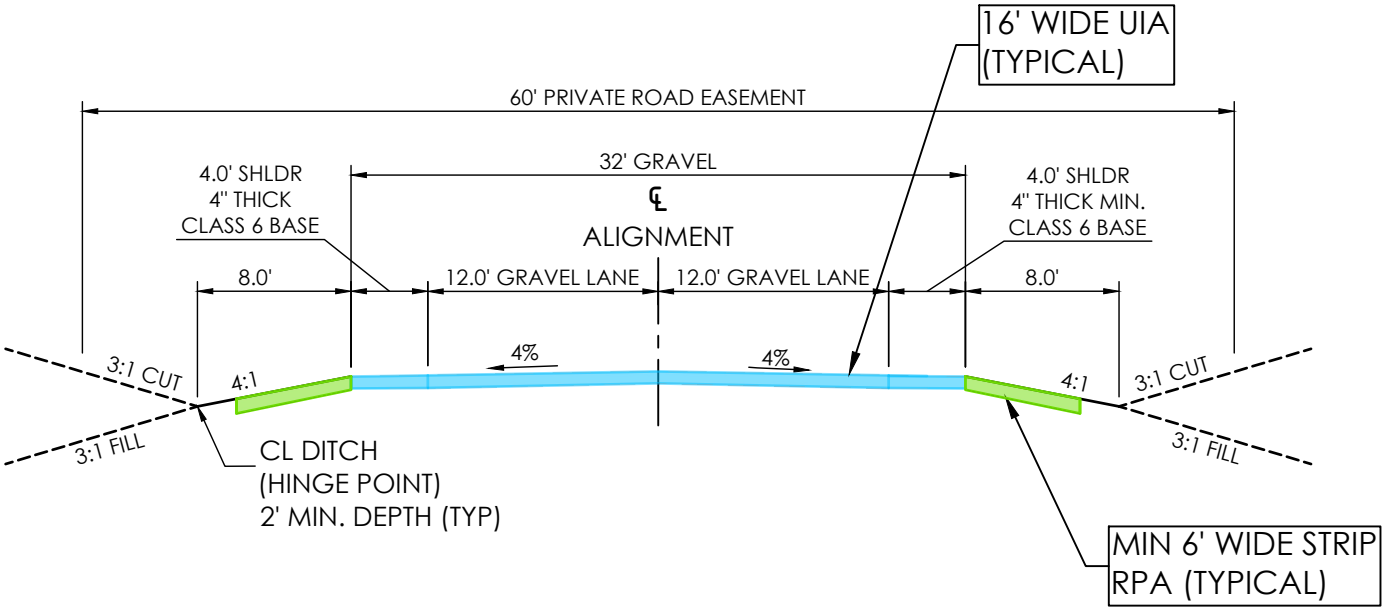
MONUMENT VALLEY ENGINEERS INC.

*** ENGINEERS *** SURVEYORS ***

1903 LELARAY ST., COLORADO SPRINGS, COLORADO 80909

(719) 635-5736

NABULSI–ABUSHABAN_SUBDIVISION



RURAL GRAVEL LOCAL (PRIVATE) ROADWAY

SCALE: 1" = 10'

RPA REQUIREMENTS:

6' OF RPA MINIMUM ALONG EACH SIDE OF THE ENTIRE LENGTH OF ACCESS EASEMENT TRAVEL WAY.

6' OF RPA MINIMUM AROUND PERIMETER OF CUL-DE-SAC BULB GRADING.

NO DROP AT THE UIA / RPA INTERFACE FOR SAFETY.

RPA SHALL VEGETATED AND HAVE A UNIFORM DENSITY OF AT LEAST 80%.

RPAs SHALL BE MAINTAINED PER THE APPROVED O&M MANUAL AND ADMINISTERED PER THE PCM MAINTENANCE AGREEMENT.

MVE, INC.
ENGINEERS SURVEYORS
1903 lelaray street
colorado springs
719.635.5736
suite 200
co 80909
www.mvecivil.com

El Paso County Conservation District

5610 Industrial Pl #100
Colorado Springs, CO 80916

719-600-4706

districtmanager@epccd.org

https://epccd.org

The El Paso County Conservation District serves landowners, land users, and partners to champion the responsible management and conservation of our finite natural resources.

To Whom It May Concern,

The El Paso County Conservation District (EPCCD) Board of Supervisors recommendations are as follows:

Ground Disturbance: If the ground is disturbed, it should be mulched or revegetated within **45 days of disturbance**. It is generally important that some type of native grass should be planted for the protection of natural resources, erosion control, native vegetation preservation, sedimentation prevention, habitat protection, stormwater management, and soil health. Please make sure the "native" grasses and plants already in place are in fact native to the area. The EPCCD store inventory generally includes both our Shotgun Native Grass Seed Mix as well as the El Paso Low Grow Grass Seed Mix; these are our recommendations should grass seed need to be implemented.

- Our **Shotgun Native Grass Seed Mix** is formulated specifically for the Pikes Peak Front Range by our NRCS District Conservationist and Rangeland Management partners. It is drought-tolerant and includes: about 20% each of Big Bluestem Native and Wheatgrass, Western Native, and about 10% each of Grama, Sideoats Native, Green Needlegrass Native, Little Bluestem Native, Prairie Sandreed Native, Switchgrass Native, and Yellow Indiangrass Native.
- The **El Paso Low Grow Grass Seed Mix** is a great drought-tolerant and low-grow grass seed mix designed for the Pikes Peak Front Range; it includes: about 24% Western Wheatgrass, about 20% Blue Grama, Native, about 18% Buffalograss, about 13% Sideoats Grama, about 6% Green Needlegrass, and about 1.5% Sand Dropseed.

More information about these grass seed mixes, as well as clover, cover crop, and wildflower seeds, and many waterwise/Coloradoscape plants, is available on our website at https://epccd.org/

Integrated Noxious Weed Management: Early intervention and integrated control measures are generally important, especially in areas where the ground is disturbed or undergoing development for: preservation of native vegetation, protection of land and soil, fire risk reduction, maintenance of water quality, cost savings, and long-term health and sustainability. An integrated noxious weed control plan typically includes a combination of prevention, mechanical, biological, and/or chemical control, and ongoing assessment and monitoring. It is a proactive approach to address the threat posed by invasive weeds and protect the ecological and economic health of the region. If there is no integrated noxious weed control plan in place, we recommend a weed program be reviewed and approved by the NRCS, Colorado Department of Agriculture, Colorado State University Extension - El Paso County, El Paso County Environmental Services Department, or a qualified weed management professional *prior* to the land use authority approval.

If you have any questions regarding these remarks please call us at 719-600-4706 or email districtmanager@epccd.org

Thank you,

Kenneth Barker

Kenneth Barker, Board President
El Paso County Conservation District

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

[1] Ranges of values generally reflect multiple sources of data or different testing conditions.

A. Chang, H.H. (1988).
B. Florineth. (1982)
C. Gerstgraser, C. (1998).
D. Goff, K. (1999).
E. Gray, D.H., and Sotir, R.B. (1996).
F. Julien, P.Y. (1995).
G. Kouwen, N.; Li, R. M.; and Simons, D.B., (1980).
H. Norman, J. N. (1975).
I. Schiechtl, H. M. and R. Stern. (1996).
J. Schoklitsch, A. (1937).
K. Sprague, C.J. (1999).
L. Temple, D.M. (1980).
M. TXDOT (1999)
N. Data from Author (2001)
O. USACE (1997).

Fischenich, C. (2001). "Stability Thresholds for Stream Restoration Materials," EMRRP Technical Notes Collection (ERDC TN-EMRRP-SR-29), U.S. Army Engineer Research and Development Center, Vicksburg, MS. www.wes.army.mil/el/emrrp

REFERENCES

Chang, H.H. (1988). *Fluvial Processes in River Engineering*, John Wiley and Sons, New York and other cities, citing Fortier, S., and Scobey, F.C. (1926). "Permissible canal velocities," *Transactions of the ASCE*, 89:940-984.

Fischenich and Allen (2000). "Stream management," Water Operations Technical Support Program Special Report ERDC/EL SR-W-00-1, Vicksburg, MS.

Florineth, F., (1982). Begrünungen von Erosionszonen im Bereich über der Waldgrenze. Zeitschrift für Vegetationstechnik 5, S. 20-24 (In German).

Gerstgraser, C. (1998). "Bioengineering methods of bank stabilization," GARTEN & LANDSCHAFT, Vol. 9, September 1998, 35-37.

Goff, K. (1999). "Designer linings," *Erosion Control*, Vol. 6, No. 5.

Gray, D.H., and Sotir, R.B. (1996). *Biotechnical and soil bioengineering: a practical guide for erosion control*. John Wiley and Sons, New York.

Julien, P.Y. (1995). *Erosion and sedimentation.* Cambridge University Press, New York.

Kouwen, N.; Li, R.-M.; and Simons, D.B. (1980). "A stability criteria for vegetated Waterways." *Proceedings, International Symposium on Urban Storm Runoff*. University of Kentucky, Lexington, KY, 28-31 July 1980, 203-210.

Norman, J. N. (1975). "Design of stable channels with flexible linings," Hydraulic Engineering Circular 15, U.S. Dept. of Transportation, Federal Highway Adm., Washington, DC.

Schiechtl, H. M., and Stern, R. (1996). *Water Bioengineering Techniques for Watercourse Bank and Shoreline Protection*. Blackwell Science, Inc. 224 pp.

Schoklitsch, A. (1937). *Hydraulic structures; a text and handbook*. Translated by Samuel Shulits. The American Society of Mechanical Engineers, New York.

Shields, A. (1936). "Anwendung der ahnlichkeits-mechanik und der turblenz-forschung auf die geschiebebewegung," *Mitt. Preuss. Versuchsanst. Wasser. Schiffsbau*, 26, 1-26 (in German).

Sprague, C.J. (1999). "Green engineering: Design principles and applications using rolled erosion control products," *CE News Online*, downloaded from http://www.cenews.com/edecp0399.html.

Temple, D.M. (1980). "Tractive force design of vegetated channels, *Transactions of the ASAE*, 23:884-890.

TXDOT (1999). "Field Performance Testing of Selected Erosion Control Products," TXDOT / TTI Hydraulics and Erosion Control Laboratory, Bryan, TX.

USACE TR EL 97-8

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>

Plant Fact Sheet

BLUE GRAMA

Bouteloua gracilis (Willd. ex Kunth.) Lag. ex Griffiths

Plant Symbol = BOGR2

Contributed by: USDA NRCS Plant Materials Program

© W. L. Wagner
Smithsonian Institution
@USDA NRCS PLANTS

Uses

Livestock: In southern states, blue grama grows as a bunchgrass; in northern states or areas of heavy grazing pressure, it is a sod former.

Erosion control: Blue grama is suitable for mixtures of grasses used in erosion control, low maintenance turf plantings, and surface mine revegetation.

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

Bouteloua gracilis, blue grama, is a major warm season grass found throughout the Great Plains. The plant is fairly short, reaching 10 to 20 inches with narrow basal leaves of 3 to 6 inches. Blue grama grows in definite bunches and reproduces by tillering and by seed. Mature seed heads are curved, resembling a human eyebrow. Blue grama can be found growing in association with buffalograss, western wheatgrass, needlegrasses and in some areas the bluegrasses.

Adaptation and Distribution

Blue grama demonstrates good drought, fair salinity, and moderate alkalinity tolerances. In its dormant state, it will also tolerate burning. Blue grama will not tolerate dense shade, flooding, a high water table, or acid soils.

Blue grama is distributed throughout the western United States. For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

Establishment

As with all native grasses, proper ground preparation is one of the most important considerations. The seedbed should be firm but not solid; cultivation to kill the roots of cool-season grasses is essential. Planting may be done by either drilling or broadcasting, with the seed being sown no more than 1/4 to 1/2 inches deep at a rate of 1 to 3 pounds PLS/acre. Seeding in late spring is recommended in the Great Plains; earlier seeding is recommended in areas further south. In the Southwest, seeding should be done during the period from June 15 to July 15. Mulching and irrigation is recommended on harsh sites. Soil tests should be made to test the soils for deficiencies. Blue grama will tolerate low-nutrient soils better than acidic conditions. Planting should be done by a native grass seed drill. In western areas plant blue grama in a sorghum cover crop, stubble, or in with the crop itself.

Management

Once the grass is established, it is very palatable to livestock all year long. Since growing points are at or near the ground surface, the grass withstands fairly close grazing. For best yields, defer grazing during the growing season every 2 to 3 years. Blue grama cures well on stem, making it a good grass for grazing during the dormant season. Renovation of sodbound stands is also recommended. Weeds can be controlled by use of herbicides, mowing or controlled grazing.

Pests and Potential Problems

There are no known serious pests of blue grama grass.

Cultivars, Improved, and Selected Materials (and area of origin)

Improved materials include the cultivars 'Lovington' (NM), 'Hachita' (NM), and 'Alma' (NM) and the selected class release Bad River Ecotype (SD). Seeds are available at most commercial seed sources.

Prepared By & Species Coordinator:

USDA NRCS Plant Materials Program

Edited: 01Feb2002 JLK; 31may06jsp

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

BUFFALOGRASS
Buchloe dactyloides (Nutt.) Engelm.

Plant Symbol = BUDA

Contributed by: USDA NRCS Plant Materials Program

Hitchcock 1950
Manual of the Grasses of the U.S.

Alternate Names
Bouteloua dactyloides (Nutt.) J.T. Columbus

Uses
Erosion control: Buffalograss can be used on areas that do not receive a lot of rain but are affected by wind erosion, such as roadside cuts.

Recreation and beautification: This grass can be used in parks and on school grounds, golf course roughs, and open lawns.

Livestock: This is an important pasture grass for native and introduced animals.

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
Buchloe dactyloides (Nutt.) Engelm., buffalograss, is a perennial, native, low-growing, warm-season grass. Leaf blades are 10 to12 inches long, but they fall over and give the turf a short appearance. Staminate plants have 2 to 3 flag-like, one-sided spikes on a seedstalk 4 to 6 inches long. Spikelets, usually 10, are 1/8 inch long in two rows on one side of the rachis. Pistillate spikelets are in a short spike or head and included in the inflated sheaths of the upper leaves. Both male and female plants have stolons from several inches to several feet in length, internodes 2 to 3 inches long, and nodes with tufts on short leaves.

Adaptation and Distribution
This grass occurs naturally and grows best on clay loam to clay soils. It requires little mowing to achieve a uniform appearance. It has a low fertility requirement and it often will maintain good density without supplemental fertilization. Buffalograss is well suited for sites with 10 to 25 inches of annual precipitation. It is not adapted to shaded sites.

Buffalograss is distributed throughout the Midwest. For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

Establishment
Buffalograss is propagated by seed and vegetatively. Establishment can be accomplished by seeding, solid sodding, or sprigging rooted and unrooted plugs. If seeds are used, drill at 1/2 inch deep and provide firm contact between the seed and moist soil. The seed may also be broadcast. When broadcasting seed, harrow or rake the area in two directions immediately after seeding to work the seeds into the soil. Broadcast seed must be covered with soil for the seeding to be successful. With any method, the soil must be firmed against the seed. Seedlings begin to appear 14 to 21 days after planting when moisture is available for germination. The amount of seed needed to ensure a stand at the end of the first year will depend on the method of seeding, the quality of seedbed preparation, the availability of water for

establishment, and certain climatic uncertainties. All planting should be delayed until the danger of frost has past. The time of planting depends upon the latitude of the location, and may extend to August 1 in lower latitudes.

Buffalograss can be established from pieces of sod or sod plugs. Sod should be planted on a well prepared seedbed in 18-inch rows. Sod should be spaced from 6 inches to 2 feet apart; plugs should be planted on 12 to 24 inch centers depending on how quickly a complete cover is desired. When planting, dig a hole deep enough to set a plant in with the grass blades above the ground. Pack soil around the sod making sure not to cover with soil because the plant will die. Once planted, the sod should be watered for about 3 weeks to ensure root establishment.

Sprigs should be planted into soil that has been tilled to a depth of 4 to 6 inches. Sprigging rate should be approximately 240 bushels of sprigs per acre, planted to a depth of 1 inch or less. A planted site should be rolled to ensure good sprig-soil contact and irrigated within 3 hours after planting. Newly planted areas will also require irrigation for several weeks to maintain a moist environment for root establishment.

Proper seedbed preparation for planting a home lawn is essential. Buffalograss will grow on heavy and compacted soils, but it is easier to start and maintain on good loam soils. Heavy soils may be improved by applying good quality organic matter such as peat moss, aged manure, or compost. Applying a phosphorus fertilizer stimulates seedling root growth, even on soils testing high in phosphorus. Work the soil to a depth of 4 to 6 inches. This may require plowing, discing, or tilling. The seedbed should be uniform, friable, and well-packed. Use tillage methods to control any weeds that may develop before seeding.

Management

Buffalograss is only recommended for low maintenance and low use turfgrass areas. Mowing height and frequency depend on grass use, amount of irrigation, and time of year. Care must be taken when mowing not to cut shorter than 2 to 3 inches to avoid other grasses from out-competing the buffalograss. Buffalograss responds well to light applications of nitrogen. Over- fertilization will promote undesirable grasses within the planted area. Buffalograss is excellent for people who want a large, attractive lawn during the summer with a minimum of work involved. Other advantages of buffalograss for lawns is that it withstands heavy usage and has good drought tolerance. However, potential lawn growers should note that buffalograss is a warm-season grass, it turns brown with fall's first freezing weather, and will not green-up until warm weather returns; it will be brown and unattractive when the neighbor's Kentucky Bluegrass is brilliant green. During extended dry periods in the summer months, buffalograss will go brown and become dormant if no supplemental water is provided. Because of aggressive runners, buffalograss can require edging along walks, driveway, and flower beds.

Pests and Potential Problems

Buffalograss has no serious pests.

Cultivars, Improved, and Selected Materials (and area of origin)

'Bison', 'Plains', 'Texoka', and 'Topgun' (cultivars); Bismarck Ecotype (selected class release). Seeds are available at most Midwestern commercial seed sources. Sod, sod plugs, and sprigs can be obtained from sod farms.

Prepared By & Species Coordinator:

USDA NRCS Plant Materials Program

Edited: 01Feb2002 JLK; 31may06jsp

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

SIDEOATS GRAMA

Bouteloua curtipendula (Michx.) Torr.

Plant Symbol = BOCU

Contributed by: USDA NRCS Plant Materials Program

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Smithsonian Institution
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Uses

Erosion Control: This grass is adapted to most soil conditions. Successful seedings are obtained in rocky, stony, or shallow soils. It is a fair to good erosion control plant when mixed with the other plants naturally associated with it.

Grazing: This is one of the most important range grasses. Although not as palatable as some of the smaller gramas, e.g. blue grama, it is more palatable than many of the other grass species. It produces a much greater volume of forage than blue grama, and this tends to make up for its slightly lower palatability. It remains green later in the fall and usually begins growth in the spring before other gramas. It cures well, and maintains a fairly high feeding value throughout the year.

Wildlife: Furnishes some forage for deer and antelope when green. Elk use this plant throughout the year.

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). It is considered threatened in several states.

Description

Bouteloua curtipendula, sideoats grama, is a medium-size perennial bunchgrass, 15 to 30 inches tall or occasionally taller. This is the largest and most coarse of the grama grasses. It has a bluish-green color, sometimes with a purplish cast (especially in the spring), and cures to a reddish-brown or straw color. Leaves are coarser than other species of gramas, straight, comparatively stiff, and mostly basal. Ten to thirty small, non-comb-like spikes are borne mostly along one side of each central seed stalk. These spikes drop when mature, leaving a long zigzag stalk.

Adaptation and Distribution

Sideoats grama is found on rocky open slopes, woodlands, and forest openings up to an elevation of about 7,000 feet.

Sideoats grama is distributed throughout most of the United States. For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

Establishment

Seeding of improved strains of this grass is accomplished by drilling in firm, weed-free seedbeds at the rate of 2-1/2 to 5 pounds (or more) pure live seed per acre. Protect from grazing from date of seeding through the second growing season. Seedings should be delayed until good soil moisture is present.

Management

Sideoats grama is not as resistant to grazing as blue grama because of its taller growth habit, but sideoats grama stays green longer and can be grazed for a longer period. Reduced forage production, carrying capacity, and loss in cattle weight is a direct result of overgrazing. Sideoats grama is a normal component of a large number of range sites. The grass lengthens

the grazing season and increases forage production, in addition to providing variety in the feed. Sideoats grama will return to most ranges under good management. Practices that will bring the grass back include proper grazing use, planned grazing systems, and brush control.

Pests and Potential Problems
There are no serious pests of sideoats grama.

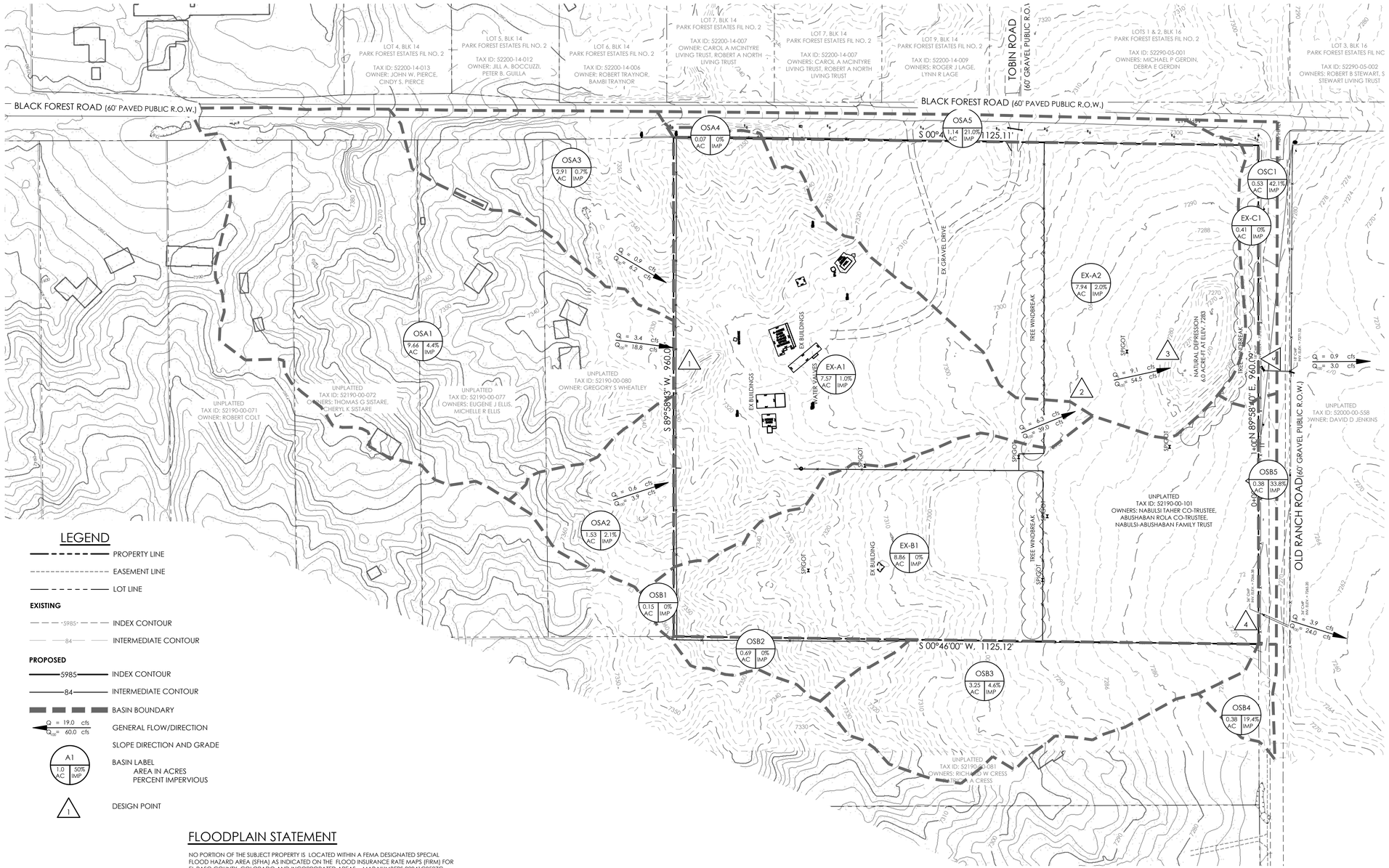
Cultivars, Improved, and Selected Materials (and area of origin)
Released cultivars include'Butte' (NE), 'El Reno' (OK), 'Haskell' (TX), 'Niner' (NM), 'Premier' (Mexico), 'Trailway' (NE), and 'Vaughn' (NM); informal releases include Killdeer (ND) and Pierre (SD); and source identified releases include Northern Iowa Germplasm, Central Iowa Germplasm, Southern Iowa Germplasm (all from IA). Seeds are available at most western commercial seed sources.

Prepared By & Species Coordinator:
USDA NRCS Plant Materials Program

Edited: 01Feb2002 JLK: 31may06jsp

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>

4 Drainage Maps



LEGEND

- PROPERTY LINE
- EASEMENT LINE
- LOT LINE

EXISTING

- 5985 — INDEX CONTOUR
- 84 — INTERMEDIATE CONTOUR

PROPOSED

- 5985 — INDEX CONTOUR
- 84 — INTERMEDIATE CONTOUR
- BASIN BOUNDARY
- Q = 19.0 cfs, Q100 = 60.0 cfs — GENERAL FLOW/DIRECTION
- SLOPE DIRECTION AND GRADE
- A1: 1.0 AC, 50% IMP — BASIN LABEL: AREA IN ACRES, PERCENT IMPERVIOUS
- 1 — DESIGN POINT

FLOODPLAIN STATEMENT

NO PORTION OF THE SUBJECT PROPERTY IS LOCATED WITHIN A FEMA DESIGNATED SPECIAL FLOOD HAZARD AREA (SFHA) AS INDICATED ON THE FLOOD INSURANCE RATE MAPS (FIRM) FOR EL PASO COUNTY, COLORADO AND INCORPORATED AREAS - MAP NUMBERS 08041C0527G, EFFECTIVE DECEMBER 7, 2018.

EXISTING DRAINAGE SUMMARY

OFFSITE DRAINAGE SUMMARY TABLE

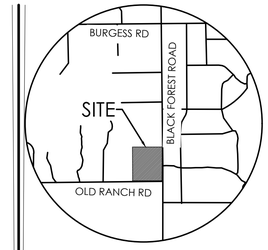
DESIGN POINTS	INCLUDED BASINS	AREA (AC)	Tc (MIN.)	RUNOFF Q5 (CFS)	RUNOFF Q100 (CFS)	METHOD
DP1 (1)	OSA1	9.66	19.7	3.4	18.8	RATIONAL
	OSA2	1.53	9.4	0.6	3.9	RATIONAL
	OSA3	2.91	14.3	0.9	6.2	RATIONAL
	OSA4	0.07	5.0	< 0.1	0.2	RATIONAL
	OSA5	1.14	10.5	1.2	3.7	RATIONAL
	OSB1	0.15	6.5	0.1	0.4	RATIONAL
	OSB2	0.69	6.0	0.3	2.0	RATIONAL
	OSB3	3.25	8.3	1.7	9.1	RATIONAL
	OSB4	0.38	9.0	0.4	1.2	RATIONAL
	OSB5	0.38	16.2	0.4	1.1	RATIONAL
	OSC1	0.53	10.7	0.8	2.0	RATIONAL

ONSITE DRAINAGE SUMMARY TABLE

DESIGN POINTS	INCLUDED BASINS	AREA (AC)	Tc (MIN.)	RUNOFF Q5 (CFS)	RUNOFF Q100 (CFS)	METHOD
	EX-A1	7.57	13.3	2.4	16.7	RATIONAL
	EX-A2	7.94	10.7	3.0	19.3	RATIONAL
	EX-B1	8.86	13.7	2.6	19.1	RATIONAL
	EX-C1	0.41	6.7	0.2	1.1	RATIONAL

DESIGN POINTS SUMMARY TABLE

DESIGN POINTS	INCLUDED BASINS	AREA (AC)	Tc (MIN.)	RUNOFF Q5 (CFS)	RUNOFF Q100 (CFS)	METHOD
EX-DP2	OSA1-4, EX-A1	21.74	22.1	6.3	39.0	RATIONAL
EX-DP3	EX-DP2, OSA5, EX-A2	30.83	23.0	9.1	54.5	RATIONAL
EX-DP4	OSB1-5, EX-B1	13.71	23.2	3.9	24.0	RATIONAL
EX-DP5	OSC1, EX-C1	0.95	10.7	0.9	3.0	RATIONAL



VICINITY MAP
NOT TO SCALE

BENCHMARK

N

10 0 50 100 200
1" = 100' 1:1,200

MVE, INC. ENGINEERS / SURVEYORS
1903 lelaray street, suite 200 colorado springs co 80909 719.635.5736

REVISIONS

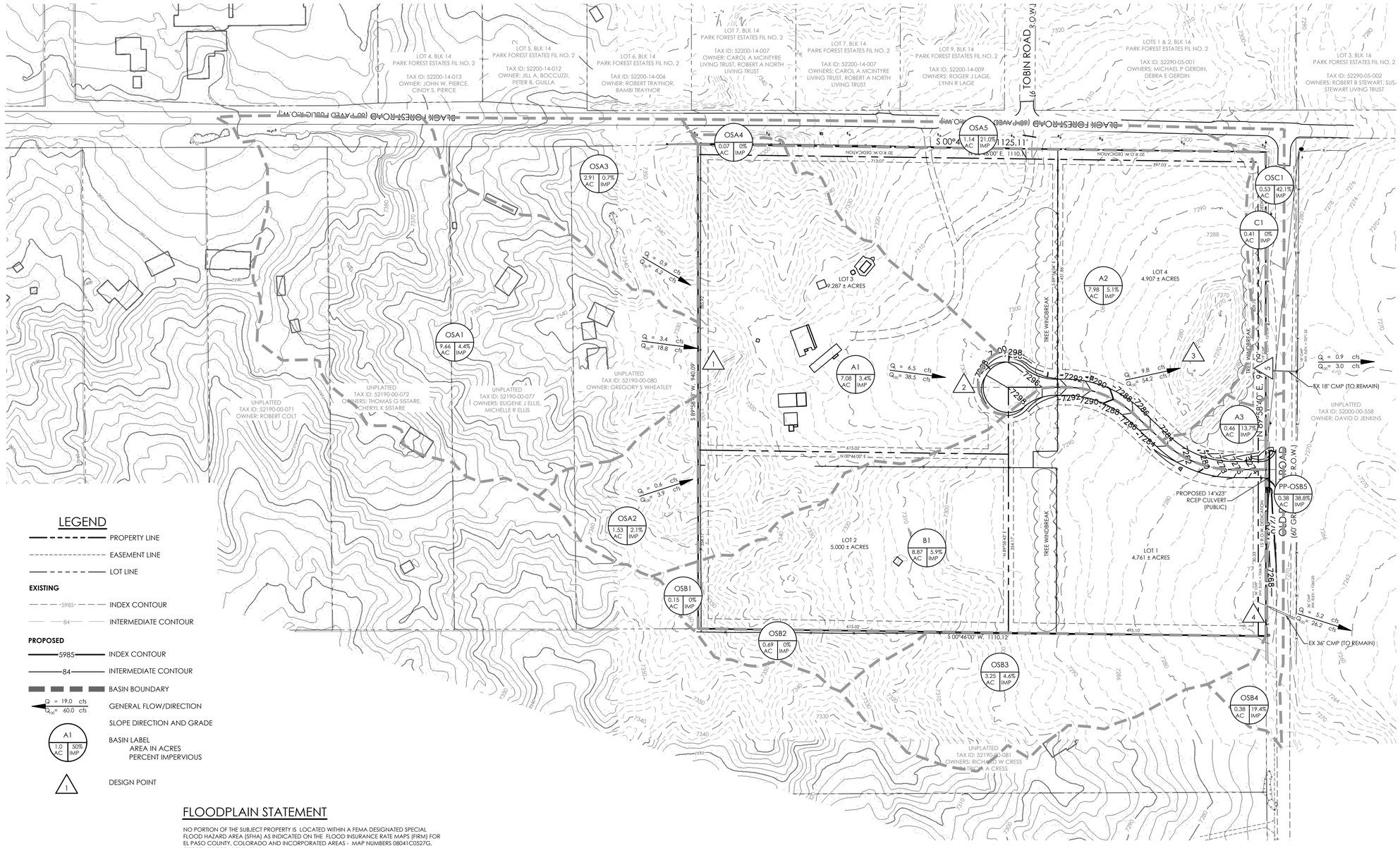
DESIGNED BY
DRAWN BY JO
CHECKED BY
AS-BUILTS BY
CHECKED BY

NABULSI-ABUSHABAN SUBDIV. FIL NO. 1

EXISTING DRAINAGE MAP

MVE PROJECT **61201**
MVE DRAWING **EX-DRN**

SEPTEMBER 21, 2023
SHEET 1 OF 1



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PROPERTY LINE
EASEMENT LINE
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PROPOSED DRAINAGE CONDITIONS

OFFSITE DRAINAGE SUMMARY TABLE

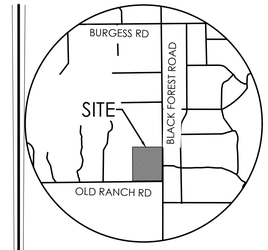
DESIGN POINTS	INCLUDED BASINS	AREA (AC)	Tc (MIN.)	RUNOFF Q5 (CFS)	RUNOFF Q100 (CFS)	METHOD
DP1 (1)	OSA1	9.66	19.7	3.4	18.8	RATIONAL
	OSA2	1.53	9.4	0.6	3.9	RATIONAL
	OSA3	2.91	14.3	0.9	6.2	RATIONAL
	OSA4	0.07	5.0	< 0.1	0.2	RATIONAL
	OSA5	1.14	10.5	1.2	3.7	RATIONAL
	OSB1	0.15	6.5	0.1	0.4	RATIONAL
	OSB2	0.69	6.0	0.3	2.0	RATIONAL
	OSB3	3.25	8.3	1.7	9.1	RATIONAL
	OSB4	0.38	9.0	0.4	1.2	RATIONAL
	PP-OSB5	0.38	15.9	0.4	1.1	RATIONAL
	OSC1	0.53	10.7	0.8	2.0	RATIONAL

ONSITE DRAINAGE SUMMARY TABLE

DESIGN POINTS	INCLUDED BASINS	AREA (AC)	Tc (MIN.)	RUNOFF Q5 (CFS)	RUNOFF Q100 (CFS)	METHOD
	A1	7.08	13.3	2.7	16.2	RATIONAL
	A2	7.98	10.6	3.7	20.3	RATIONAL
	A3	0.46	8.2	0.3	1.4	RATIONAL
	B1	8.87	13.4	4.0	20.8	RATIONAL
	C1	0.41	6.7	0.2	1.1	RATIONAL

DESIGN POINTS SUMMARY TABLE

DESIGN POINTS	INCLUDED BASINS	AREA (AC)	Tc (MIN.)	RUNOFF Q5 (CFS)	RUNOFF Q100 (CFS)	METHOD
DP2	OSA1-4, A1	21.25	22.1	6.5	38.5	RATIONAL
DP3	DP2, OSA5, A2	30.37	23.5	9.8	54.2	RATIONAL
DP4	OSB1-4, PP-OSB5 A3, B1	14.17	23.2	5.2	26.2	RATIONAL
DP5	OSC1, C1	0.95	10.7	0.9	3.0	RATIONAL



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REVISIONS

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DRAWN BY JO
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CHECKED BY

NABULSI-ABUSHABAN SUBDIVISION

PROPOSED DRAINAGE MAP

MVE PROJECT **61201**
MVE DRAWING **PP-DRN**

SEPTEMBER 21, 2023
SHEET 1 OF 1