Drainage Letter Report

Please provide the plat name on the cover of this document to include the filing number, (lot 4A, filing 1B.

1830 Main Street
Colorado Springs, Colorado
80911

Prepared for: Charles Holliday
Western States Management Group
13990 Barbwire Lane
Colorado Springs, CO 80930

December 2, 2019

Prepared by
Richard Lyon, P.E.
Rocky Mountain Group
2910 Austin Bluffs Parkway | Colorado Springs, CO 80918

PPR1938

PCD File No.: TBD

Drainage Report Statements

1. **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 City/County for drainage reports and said report is in conformity with the master plan for the drainage basin. I accept responsibility for liability caused by negligent acts, errors or omissions on my part in preparing this report:

_____

Richard D. Lyon Colorado P.E. No. 53921

2. **Developer's Statement:**

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

_____

Business Name

By: _____

Title: _____

Address: _____

_____

_____

3. 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.

_____ _____

Jennifer Irvine, P.E. Date
County Engineer / ECM Administrator

Conditions:

Table of Contents

Appendices

which is it? is it split? my map shows that it is in the little Johnson. Please clarify which of these basins or if it is split between the two? or redirected from one to the other? see your text on next page that describes this site accurately.

1.0 Existing Conditions

1.1 Existing Site

Lot 4A of the Bradley Crossroads subdivision is located at the address of 1830 Main Street in Colorado Springs in El Paso County within the northern limits of the census-designated area of Security-Widefield within the Little Johnson/Security Creek Drainage Basin. The 1.50 acre lot is located west of Main Street or the Hancock Expressway, south of Bradley Road, east of Service Road, and north of Gladiator Drive. The parcel number is 6502407105 and is platted as Plat No. 14143 and zoned as CC CAD-O. The parcel is surrounded by commercial development to the south and east and there is residential and school property further south of Gladiator Road. A vicinity map, survey maps with the legal description of the parcel and topography is provided in Appendix A. As part of the development plan, setbacks and adjacent easements are shown.

The property is currently empty for development containing native grasses with surrounding developed right of way such as asphalt paved roads, concrete curb and gutter with curb cuts for designated ingress/egress of the development, and utilities for service line extensions to the development. The site area is generally flat as it flows from its northeast property corner to the southwest at an average grade of 3 percent.

The development plans propose to build a 7,440 square foot commercial building with a concrete foundation and an asphalt and concrete paved parking and driving access area totaling approximately 1.3 acres. As such, a major development plan set and drainage letter are to be submitted to El Paso County. This drainage letter serves as an addendum to the previous Drainage Report developed by Terra Nova Engineering dated September of 2010 which includes information from the Final Drainage Report and Plan for Lincoln Plaza Subdivision Filing No. 2 by Leigh Whitehead & Associates, Inc. dated March 2001; Final Drainage Report for Lincoln Commons Subdivision by WestWorks Engineering, Inc. dated June 12, 2007, revised July 25, 2007 approved May 14, 2008; and Final Drainage Report for Bradley Crossroads by Terra Nova Engineering dated April 2007; and the Final Drainage Report for The Townhomes at Bradley Crossroads Mulitfamily Residential Community by MVE, Inc. dated October 10, 2018. As part of this drainage letter, computations and delineations are updated to reflect current EPC and UDFCD standards and present hydrology and hydraulic analysis for Lot 4A, specifically for the purposes of the major development application. The letter serves to demonstrate that downstream stormwater facilities are sized appropriately for the proposed development.

1.2 Existing Drainage Conditions

The drainage concept of Lot 4A consists of collection of runoff from the site through the main private (subdivision) storm water system via a private storm sewer grated inlet (5.5'x3.5') within Service Road to the west of the property. The private storm water system connects to a joint-use storm water detention pond located within the Lincoln Commons site dedicated to the Bradley Crossroads development sites, including Lot 4A. The Final Drainage Report for The Townhomes at Bradley Crossroads by MVE, Inc. dated October 10, 2018 refers to The Final Drainage Report for Bradley Crossroads Lots 1-6 by Terra Nova Engineering revised November 2008 which includes the capacity of the existing extended detention basin located at the southwest corner of the parcel for the Lincoln Commons Townhomes, schedule number 6502407100.

The site is contained within the Little Johnson Drainage Basin and is part of the Little Johnson/Security Creek Drainage Basin Planning Study dated April 1988 and compiled by Kiowa Engineering Corporation.

According to a subsurface soil investigation report prepared by RMG-Rocky Mountain Group. dated June 27, 2019, "Test Borings performed within the proposed building footprint revealed similar subsurface soil conditions across the site, being primarily silty sand to 17-feet depth (13-feet depth in Test Boring 2). Claystone bedrock was encountered beneath the sand in each Test Boring (sandy clay in Test Boring 4). The soil appears to be native soil in a loose to medium dense state of consolidation. Subsurface soil was classified according the Unified Classification System, and can generally be described as follows:

0 to 17-feet: Brown, moist, loose to medium dense, silty sand. This soil classifies generally as SM, Silty Sand.

17 to 20-feet: Brown with rust staining, moist, firm to hard, sandy claystone."

"Groundwater was not encountered in the Test Borings. While not anticipated to affect foundation design and construction, fluctuations in groundwater and subsurface moisture conditions may occur due to variations in rainfall and other factors not readily apparent at this time. Contractors should, however, always be prepared to control groundwater during construction."

As part of this drainage letter, current criteria will be applied with updated basin and sub-basin delineations for existing conditions. The criteria used to analyze the existing drainage conditions is the rational method for the 5-year and 100-year storm event. The City of Colorado Springs and El Paso County Drainage Criteria Manual, Volumes 1 and 2, were used for hydrologic and hydraulic calculations. FEMA Floodplain maps are provided in Appendix A.

The existing drainage conditions of the lot are presented in the civil exhibit and calculations in the Appendix. The majority of the lot's existing area designated as Sub-basin E-1 has peak flows of Q_5 = 0.04 cfs, Q_{10} = 0.05 cfs, and Q_{100} = 0.98 cfs. The portion of the roadways that flow to the

existing curb and gutter is designated as Sub-basin E-2 has peak flows of Q_5 = 0.20 cfs, Q_{10} = 0.25 cfs, and Q_{100} = 0.73 cfs. A small portion of the lot within the existing landscape/public improvement buffer containing existing sidewalk, landscaping, and curb and gutter that flows to Main Street is designated as Sub-basin E-3 and has peak flows of Q_5 = 0.01 cfs, Q_{10} = 0.01 cfs, and Q_{100} = 0.04 cfs. An off-site sub-basin OS-1 was delineated for the surveyed area to show overland flow from the existing undeveloped area that flows over this property. This off-site sub-basin has peak flows of Q_5 = 0.00 cfs, Q_{10} = 0.00 cfs, and Q_{100} = 0.32 cfs.

All off-site flows are accounted for in the original drainage report for the subdivision and off-site areas are not to be altered as a part of this development, therefore the historical drainage of off-site basins will not be altered.

2.0 Proposed Conditions

The site development includes a 7,440 square foot commercial building, approximately 1.25 acres of concrete and asphalt pavement and curb and gutter as well as landscaped areas within the parking lot. The regrading of the site to conform to parking lot grading standards and vehicle and pedestrian access is generally consistent with the historical drainage pattern. The developed site conveys storm water from the east to the west to the private storm grated inlet within Service Street (Design Point 1), consistent with pre-developed conditions.

The developed drainage concept will be to provide positive drainage away from proposed structure and generally conform to historic drainage patterns by routing the stormwater via the curb and gutter, concrete drainage pans within the parking lot and sheet flow across landscaped area. The development will have minimal impact to downstream facilities as the storm water will drain to the private storm water system and eventually to the joint-use detention facility dedicated for this subdivision for developments consistent with the proposed site. Developed peak flows at Design Point #1 collect storm water from Sub-basin D-1 and Design Point #2 collects storm water from Sub-basin D-2. Sub-basin D-1 has storm water peak flows of Q_5 = 3.68 cfs, Q_{10} = 4.53 cfs, and Q_{100} = 8.67 cfs. Developed peak flows at Sub-basin D-2 are Q_5 = 0.39 cfs, Q_{10} = 0.48 cfs, and Q_{100} = 0.96 cfs. As with the existing conditions, Sub-basin D-3 flows to Main Street and is not to be developed; the peak flows are Q_5 = 0.01 cfs, Q_{10} = 0.01 cfs, and Q_{100} = 0.04 cfs. The off-site sub-basin OS-1 delineates to a smaller sub-basin compared to the existing conditions because the north end of the property will have curb installed above the existing grades which will route stormwater flow from the north around the site and into the existing roadway to the west. Only a small portion of the existing OS-1 flows onto the site from the east side, this delineation has peak flows of Q_5 = 0.00 cfs, Q_{10} = 0.00 cfs, and Q_{100} = 0.01 cfs

The storm water volume increases to DP1 are 3.64 cfs for a 5 year storm, 4.48 cfs for a 10 year storm, and 7.69 cfs for a 100 year storm from the existing drainage conditions. The development is consistent with a typical development for this site/zoning. Commercial developments typically range from 75 percent imperviousness in suburban areas to 95 percent imperviousness in downtown areas for assumed flow conditions in undeveloped parcels such as

this. The proposed development at Lot 4A is approximately 78 percent impervious in total, consistent with typical values for downstream drainage design. The drainage volumes and flows are accounted for in the private storm sewer system for conveyance as well as the detention facility downstream and demonstrated as follows.

Previous drainage studies used DCM Table 6-6 for a typical commercial development with 95 percent imperviousness, yielding flow rates of Q_5 = 5.0 cfs and Q_{100} = 9.3 cfs for Lot 4A, specifically to Design Point #1 as shown on the sub-basin delineation Drainage Map Developed Condition sheet in the Final Drainage Report for The Townhomes at Bradley Crossroads by MVE, Inc. dated October 10, 2018 referencing the revised off-site peak flow calculations by Terra Nova Engineering in November 2008. The rainfall peak flow rates calculated using current standards for the proposed development at Lot 4A are less than predicted by 1.32 cfs for the 5-year storm and 0.63 cfs for the 100-year storm for flows to Design Point #1. Accounting for sub-basin D-2, the current standards calculation comes out to 0.93 cfs less for the 5-year storm and 0.33 cfs additional flow for total on-site peak flow compared to the previous study.

The peak flow to Design Point #1 (private storm sewer inlet in west roadway) is less than the designed capacity. And while the flow from D-2 is slightly more than assumed flows calculated for the existing extended detention basin (EDB) for the subdivision, the EDB was designed for peak flows of Q_5 = 34 cfs and Q_{100} = 68 cfs. To date and after the construction of the Bradley Crossroads Townhomes, the EDB is experiencing a Q_{100} of 62.3 cfs, leaving 5.7 cfs of excess rainfall volume for a 100-year storm. The peak flow from this development does not exceed that limit.

As part of the construction process, proper erosion control measures will be required for development of the site including silt fencing along downstream limits of disturbance to minimize off-site transport of construction sediment and inlet protection of nearby and downstream storm sewer inlets. Other control measures such as rock socks along channelized flow areas, a vehicle tracking pad, a concrete washout area, and erosion blankets are to be installed in appropriate areas. An erosion control plan is provided in the development plan set as a guide to proper control measure placement.

The Developed Drainage Plan includes the following notes for Builders and Property Owners:

1. Proposed site conditions shall not significantly vary from the conditions presented in this report. The degree to which variance from the proposed conditions allowed is at the discretion of the County. The most critical variable is the percent impervious of the site.
2. Individual builders shall provide positive drainage away from structures and account for potential cross-lot drainage impacts within the lot.
3. The builders and property owner shall implement and maintain erosion control best management practices/control measures for protection of downstream properties and facilities.
4. Recognizing the location of this subdivision adjacent to the storm inlets and developed downstream properties, the builders and property owner shall take

extra care in providing and maintaining erosion control BMP's/control measures at downstream property boundaries.

3.0 Floodplain Impacts

According to the FEMA floodplain map for this area, El Paso County FIRM Panel No. 08041C0763G, dated December 7, 2018 (see Appendix A), the entire parcel falls into Zone X, an area of minimal flood hazard.

3.1 Four-Step Process

The selection of appropriate BMPs is based on the characteristics of the site and potential pollutants. The Four-Step Process provides a method of going through the selection process. The following applies the four-step process to the preliminary development plan for the development of Lot 4A:

Step 1: Employ Runoff Reduction Practices

The development plan consists of the minimal area of pavement for ease of access, turnarounds for larges, pedestrian access to the structure, and parking. The remainder of the parcel is to be permanently stabilized with grasses and vegetation to improve percolation and overall drainage.

Step 2: Stabilize Drainageways

Stabilized drainageways via concrete curb and gutter and concrete drainage pans are proposed to ensure proper flows.

Step 3: Provide Water Quality Capture Volume

A storm water facility for water quality capture and detention exists downstream of the development and accounts for this lot's development as well as future development of the subdivision. Water quality capture and release of the stormwater from this site is handled via the extended dentention basin within the Towhomes at Bradley Crossroads development which was designed for water quality capture volume and full detention of the entire subdivision.

Step 4: Consider the Need for Industrial and Commercial BMPs

Since the lot is to be utilized as commercial storefronts, there is no need for industrial BMPs. There will be no storage/handling areas or a need for permanent spill containment and control. The commercial development will have a separate grease sanitary line that goes to a 2,500 gallon two-compartment settling tank to accommodate all of the proposed units within the structure.

4.0 Public Improvements / Drainage Basin Fee

No public drainage improvements are required or proposed for this project. According to El Paso County policies, drainage basin fees are due based on the impervious area projected for the new development but are not applicable with site development plans; therefore, no drainage fees are due. Fees were previously paid at the time this lot was platted.

5.0 Summary

The proposed drainage patterns for the lot will generally remain consistent with historic conditions and the increase in storm water runoff is accounted for in the private storm water system and downstream detention facility for the subdivision. The development results in an increase of storm water volume that is consistent with the type of development designated for this parcel and zoning. The development will have negligible impact to downstream facilities. Should the proposed site plan for this lot vary significantly from the assumptions made in this Drainage Letter Report, a revised report with updated calculations shall be required. Additionally, should the proposed development vary and cause an increase in storm runoff volumes and result in significant impacts to downstream facilities, the proposed development shall be subject to detention and water quality requirements. Installation and maintenance of proper erosion control practices during and after construction will ensure that this developed site will not adversely affect downstream or surrounding areas.

The storm water quality capture volume and full spectrum detention volume for this proposed development are similar to those in the Final Drainage Report for the Townhomes at Bradley Crossroads which reflect the calculations from the Final Drainage Report for Bradley Crossroads Filing No. 1 Lots 1-6, specifically DP2 from the 2008 Terra Nova Report ("2008 BC RPRT DP2" on the Drainage Map Developed Condition sheet for the Townhomes at Bradley Crossroads). The WQCV of the proposed development is slightly less than calculations ultimately used for design of the existing EDB and the full spectrum detention volume is slightly more than the calculations for the predicted lot use, however, the EDB was designed with more overall volume. This proposed development falls within the WQCV and full spectrum detention volume parameters that the EDB was designed for. Drawings containing the subdivision's private storm water facilities are provided as part of the FDR's and letters from previous developments, particularly the developed drainage summary and map (page 80) of the Final Drainage Report for The Townhomes at Bradley Crossroads by MVE, Inc. dated October 10, 2018. As described by Terra Nova in their 2008 report, the subdivision is responsible for the maintenance of the private storm water facilities including the downstream EDB.

EPC # vr104

6.0 References

Final Drainage Letter for Bradley Crossroads Filing No. 1 Lot 7 Site Development Plan by Terra Nova Engineering, 10/27/2010

Final Drainage Report for Bradley Crossroads Filing No. 1 Lots 1-6 by Terra Nova Engineering, revised November 2008

VR104

Final Drainage Report for The Townhomes at Bradley Crossroads Multifamily Residential Community by MVE, Inc., 10/10/2018

Preliminary/Final Drainage Report for Lincoln Plaza Subdivision No. 2 by WestWorks Engineering, August 2004

Little Johnson/Security Creek Drainage Basin Planning Study by Simons, Li & Associates, Inc. in Cooperation with Kiowa Engineering Corporation, April 1988

City of Colorado Springs Drainage Criteria Manual Volumes 1 and 2, May 2014

this is not an approved report. I think you want the Lincoln Commons townhomes site, Maybe? SF07012, ?????

My records indicate that EPC project number SF1837 and PPR1846 shows this date as May 30, 2019 (EPC approval date). i am not sure where you are finding a report dated 2018? Please either change all references within this report to the incorrect date, or provide EPC with a copy of the report you are citing here.

this is not the proper report. You should be using the City/County report from 2002, and the El Paso County Engineering Criteria manual, appendix I (July 2019) version. We did not adopt this report in its entirety, only a couple chapeters.

See comments next page, and drawing on last page of this report.

Appendix A: FEMA Floodplain Map

Previous comments in Blue, 12/30/19 comments in black:

Calculate the SWQCV and FSD volume for this site and show how these volumes are accounted for in the downstream detention facility. Does the downstream facility meet current criteria for SWQCV? does this facility provide the detention required by previous reports and the DBPS?

confirm/state that the existing pond is within today's criteria as well confirm that other lots which drain into the pond have not eaten into the SWQCV and the FSD volume for the existing pond. Or confirm with an overall calculation of existing condition (with allowances for any lots not developed at this time) reference EPC file # SF 07012 in your report and start there please. State that the current pond is functioning as designed or state what work this site should do to get into working order.

Provide a drawing of the storm sewer system that conveys this sites drainage to the detention facility. And describe the detention facility. Show and describe calculations that verify the capacity of these systems.

describe the report(s) that confirms that each leg of the system is adequate to handle the flow you are adding. if you do not show a map, you should describe each leg and which plated lot it goes through.

Who is responsible to maintain the detention facility (Terra nova says on the Lincoln Commons Site?) You indicate the storm sewer system is a Public system?

your added text is incorrect. Please use the agreement in SF07012 to determine who is responsible for maintenance of this pond, unless you find a second agreement in the Bradley crossroads file, i think it is in the Lincoln Commons file.

Rich, confirm that you are in compliance with the original reports impervious ratio and leave it at that. use the SF07012 report to see what your site was designed for. Please still state that the current pond is functioning as designed or state what work this site should do to get into working order (ie clean outlet structure, i do not know this, i am sending someone out to check??). You will also need to state what size the pipe is that transports your flow to the pond, and state that it is adequate. I believe it was designed and installed with the Townhomes at Bradley, VR104 project.

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242 or visit its website at http://www.ngs.noaa.gov/.

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, City of Fountain, Bureau of Land Management, National Oceanic and Atmospheric Administration, United States Geological Survey, and Anderson Consulting Engineers, Inc. These data are current as of 2006.

This map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

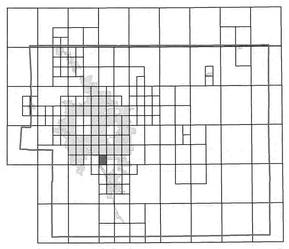
Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

El Paso County Vertical Datum Offset Table

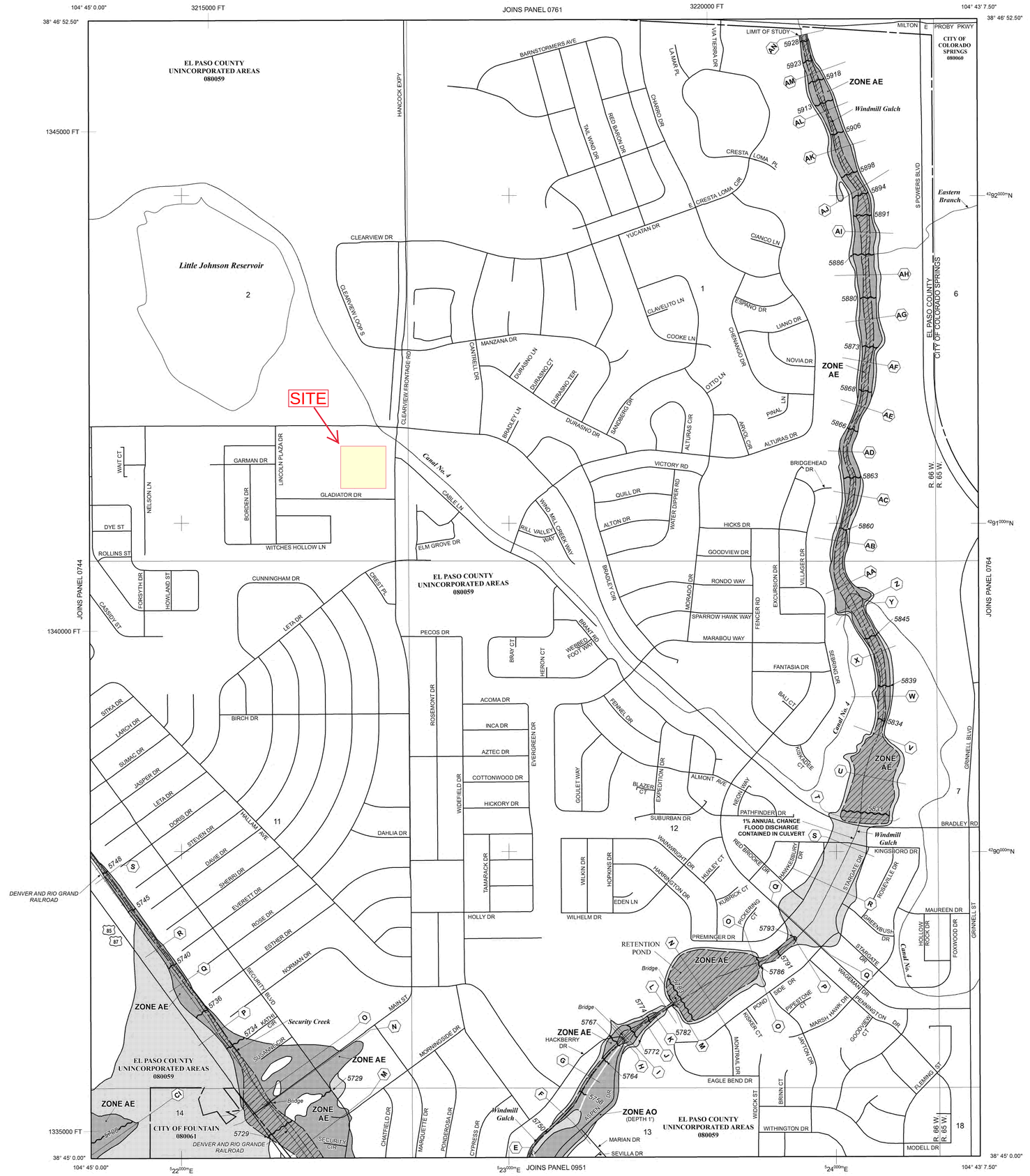
Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

Panel Location Map



This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board (CWCB) and the Federal Emergency Management Agency (FEMA).

Additional Flood Hazard information and resources are available from local communities and the Colorado Water Conservation Board.



NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 15 SOUTH, RANGE 65 WEST, AND TOWNSHIP 15 SOUTH, RANGE 66 WEST.

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.
ZONE AE Base Flood Elevations determined.
ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR Special Flood Hazard Area Formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary
Floodway boundary
Zone D Boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
513 — Base Flood Elevation line and value; elevation in feet*
(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A — Cross section line
23 — 23 — Transect line
97° 07' 30.00" / 32° 22' 30.00" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000mN — 1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 FT — 5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
DX5510 × — Bench mark (see explanation in Notes to Users section of this FIRM panel)
M1.5 ● — River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
MARCH 17, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
DECEMBER 7, 2018 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

For community map revision history prior to countywide mapping, refer to the Community Map History Table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'
250 0 500 1000 FEET
150 0 150 300 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0763G

FIRM
FLOOD INSURANCE RATE MAP
EL PASO COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 763 OF 1300
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0763	G
EL PASO COUNTY	080059	0763	G
FOUNTAIN, CITY OF	080061	0763	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
08041C0763G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

Appendix B: USGS Soils Map

Hydrologic Soil Group—El Paso County Area, Colorado
(1830 Main Street - Hydrologic Soil Group Map)

Map Scale: 1:1,440 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

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

Water Features

Streams and Canals

Transportation

Rails
Interstate Highways
US Routes
Major Roads
Local Roads

Background

Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 16, Sep 10, 2018

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

Date(s) aerial images were photographed: Jun 3, 2014—Jun 17, 2014

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
8	Blakeland loamy sand, 1 to 9 percent slopes	A	8.6	100.0%
Totals for Area of Interest			**8.6**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Appendix C: Final Drainage Letter by Terra Nova Engineering

FINAL DRAINAGE LETTER
FOR
BRADLEY CROSSROADS FILING NO. 1
LOT 7 SITE DEVELOPMENT PLAN

September, 2010

Prepared For:
Bradley Crossroads, LLC
150 Wuthering Heights Ct.
Colorado Springs, CO 80921

Prepared **By:**

TERRA NOVA ENGINEERING, INC.
815 S. 25th Street
Colorado Springs, CO 80904
(719) 635-6422

Job No. 0637.00

RECEIVED
OCT 2 7 2010
EPC DEVELOPMENT SERVICES

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 City/County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

A) 2-6-

entin Armijo, P.E. • 37170

3717(

Seal

Developer's Statement:

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

Bra Crossroads, LLC

By: Mr. Brian Schumann

Title: **WartgaGieia**

Address: 150 Wuthering Heights Court
Colorado Springs, Co 80921

REVIEWED FOR GENERAL COMPLIANCE WITH EL PASO COUNTY ENGINEERING CRITERIA

BY.

DATE: "-HO

May 18, 2010

El Paso County Development Services
c/o Jeffrey D. Rice, P.E.
2880 International Circle, Suite 110
Colorado Springs, CO 80910

Attn: Mr. Jeffrey Rice
RE: Final Drainage Letter for Bradley Crossroads Filing No. 1 — Lot 7

Dear Mr. Rice:

This letter is submitted on behalf of our client, Bradley Crossroads, LLC with regard to the property located as noted above. The overall site is located in Security, Colorado, County of El Paso, State of Colorado. The site is bounded on the east by Main St. (Hancock Expwy.), on the west by Lincoln Commons, on the south by Gladiator Dr., and on the north by Bradley Road. It contains approximately 486,565 square feet or 11.17 acres.

This letter is prepared to accompany the proposed Site Development Plan submittal. The existing overall site consists of seven (7) lots that vary in size from 0.734 acre to 5.577 acres. Lot 7 is 0.764 acre. The impervious and non-impervious areas on the entire site remain relatively unchanged as do the storm water flows for all lots.

Lot 7 will be a combination of self-serve and automatic car wash bays (building 2). The car wash water will be captured in a system that eventually outfalls to the sanitary sewer system via an oil/grease separator sized for this type of facility. The remaining storm water that falls on and around the footprint of the building will be transported to area inlets which are then connected to the existing storm water collection system with in the site.

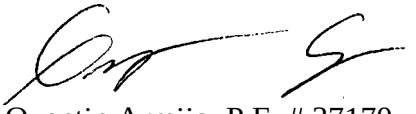
Runoff from the site collects through the main public storm water system running westerly then southwesterly into a junction box at the southwest corner of the overall property. From here it connects to a joint-use storm water detention pond located within the Lincoln Commons site.

The existing site is located on the FEMA FIRM Map number 08041C0763 F dated March 17, 1997. Bradley Crossroads is located outside of the existing floodplain.

As this site was previously platted, no drainage or bridge fees will be required.

The site is contained within the Little Johnson Drainage Basin and is a part of the Little Johnson/Security Creek Drainage Basin Planning Study dated April 1988 and compiled by Kiowa Engineering Corporation. This site has a previously approved Final Drainage Report written by Terra Nova Engineering, Inc. and dated revised November 2008.

Respectfully submitted,
Terra Nova Engineering



Quentin Armijo, P.E. # 37170.
Project Manager

BIBLIOGRAPHY

"El Paso County and City of Colorado Springs Drainage Criteria Manual".

"El Paso County Engineering Criteria Manual"

SCS Soils Map for El Paso County

"USDA Natural Resources Conservation Service"

USGS Topographic Map

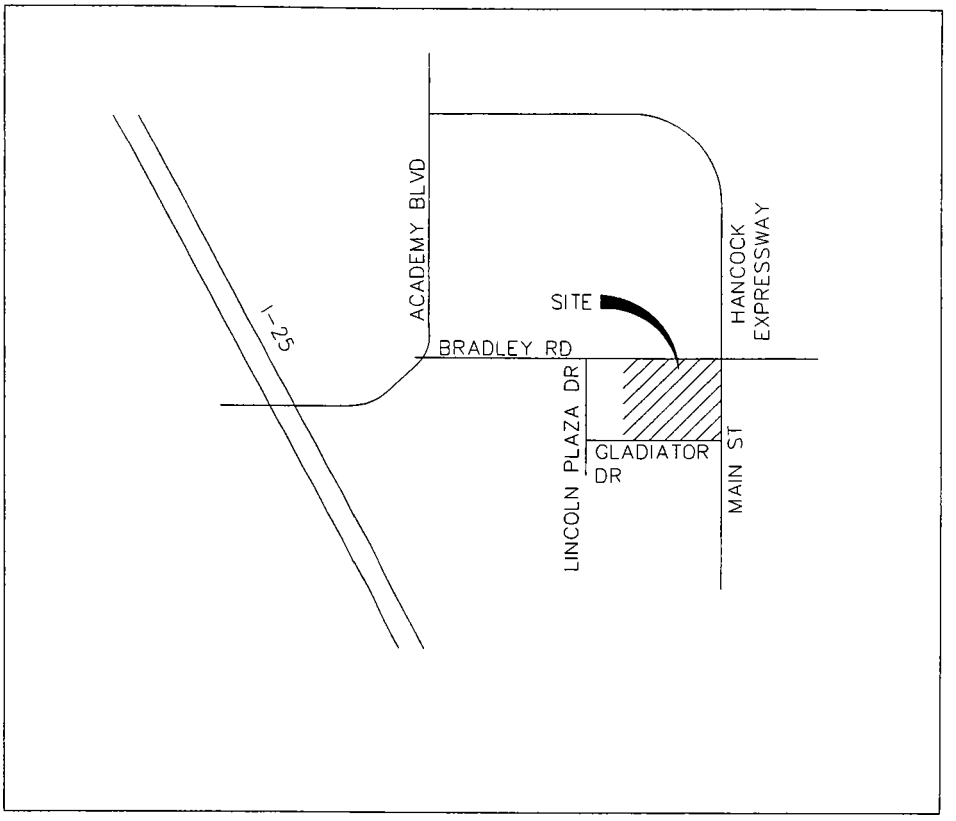
"Little Johnson/Security Creek Drainage Basin Planning Study" by Simons, Li & Associates, Inc. dated April 1988.

"Final Drainage Report and Plan for Lincoln Plaza Subdivision Filing No. 2" by Leigh Whitehead & Associates, Inc dated March, 2001.

"Final Drainage Report for Lincoln Commons Subdivision" by WestWorks Engineering, Inc. dated June 12, 2007, revised July 25, 2007 approved May 14, 2008.

"Final Drainage Report for Bradley Crossroads" by Terra Nova Engineering dated April 2007.

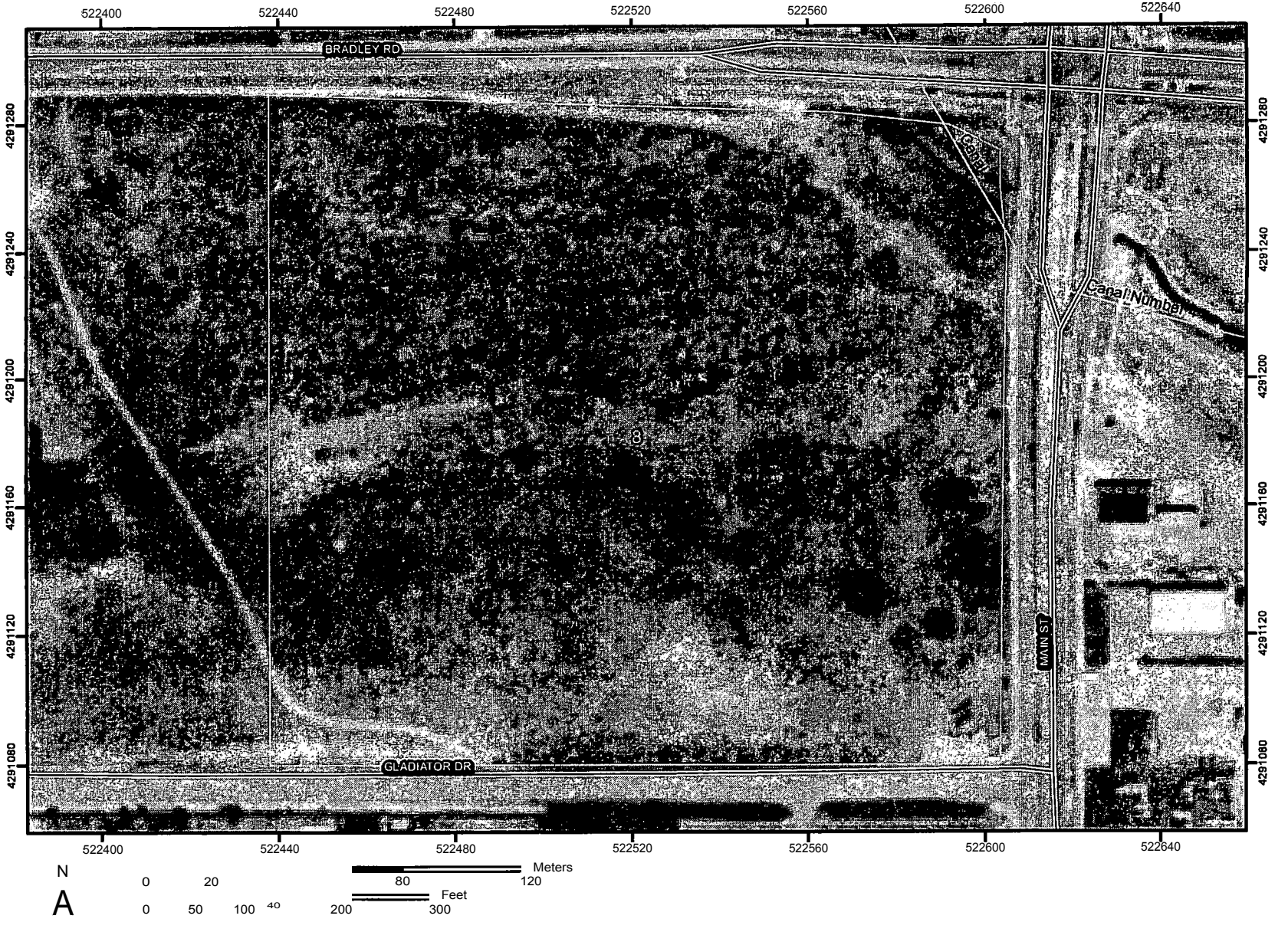
GENERAL LOCATION & SOILS MAP



VICINITY MAP
NTS

315 S. 25TH STREET
20LORADO SPRINGS. CO 80904
OFFICE: 719-635-6422
cAX: 719-635-6426
www.tnesinc.com
Terra Nova
Engineering, Inc.
Civil Engineet it Sok

BRADLEY CROSSROADS
VICINITY MAP
MAY 2010
PROJECT NO. 0637.00


522400
522440
522480
522520
522560
522600
522640
4291280
4291240
4291200
4291160
4291120
4291080
BRADLEY RD
GLADIATOR DR
MAIN ST
Canal Number
3
N
A
0
20
80
120
Meters
0
50
100
40
200
300
Feet

MAP LEGEND

Area of Interest (A01)
- Area of Interest (A01)

Soils
- Soil Map Units

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh
- 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
- Gully
- Short Steep Slope
- Other

Political Features

Municipalities
- Cities
- Urban Areas

Water Features
- Oceans
- Streams and Canals

Transportation
- Rails

Roads
- Interstate Highways
- US Routes
- State Highways
- Local Roads
- Other Roads

MAP INFORMATION

Original soil survey map sheets were prepared at publication scale. Viewing scale and printing scale, however, may vary from the original. Please rely on the bar scale on each map sheet for proper map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 13N

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 6, Aug 21, 2008

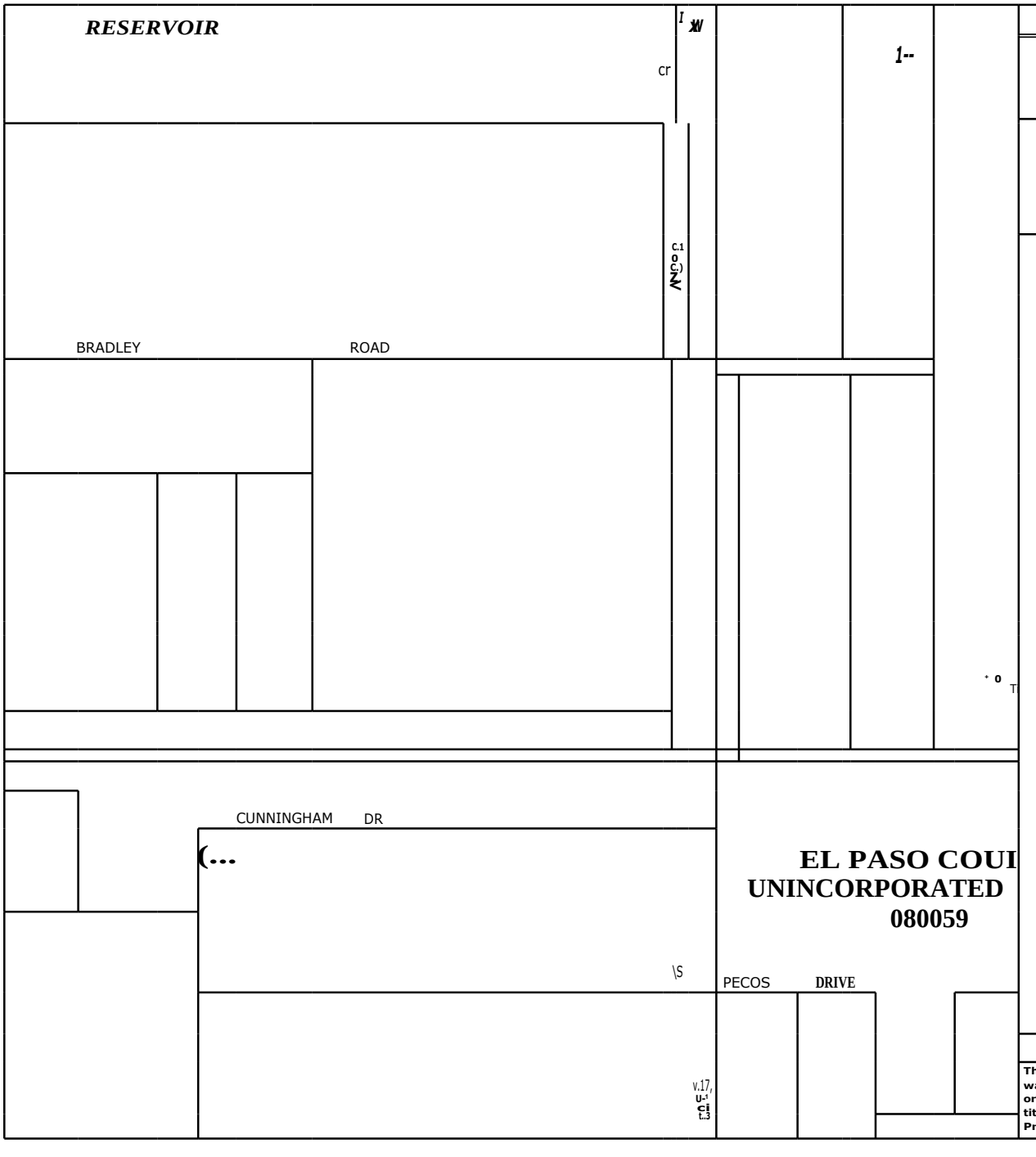
Date(s) aerial images were photographed: 1999

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

! E1 Paso.:County.Area;•Colorado (C0625)			
Map Unit Symbol	**Map Unit Name**	**Acres In A01**	**Percent of A01**
8	Blakeland loamy sand, 1 to **9** percent slopes	11.6	100.0%
Totals for Area of Interest (A01)		11.6	100.0%

FEMA FIRM MAP



APPROXIMATE SCALE IN FEET

500 0 500

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 763 OF 1300

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPAN= OW OF EL PASO COUNTY.	OED080	one	F
UNINCCPORAIED AREAS	11035069	0703	F
FOUNTAIN. OTT Of	080001	0703	F

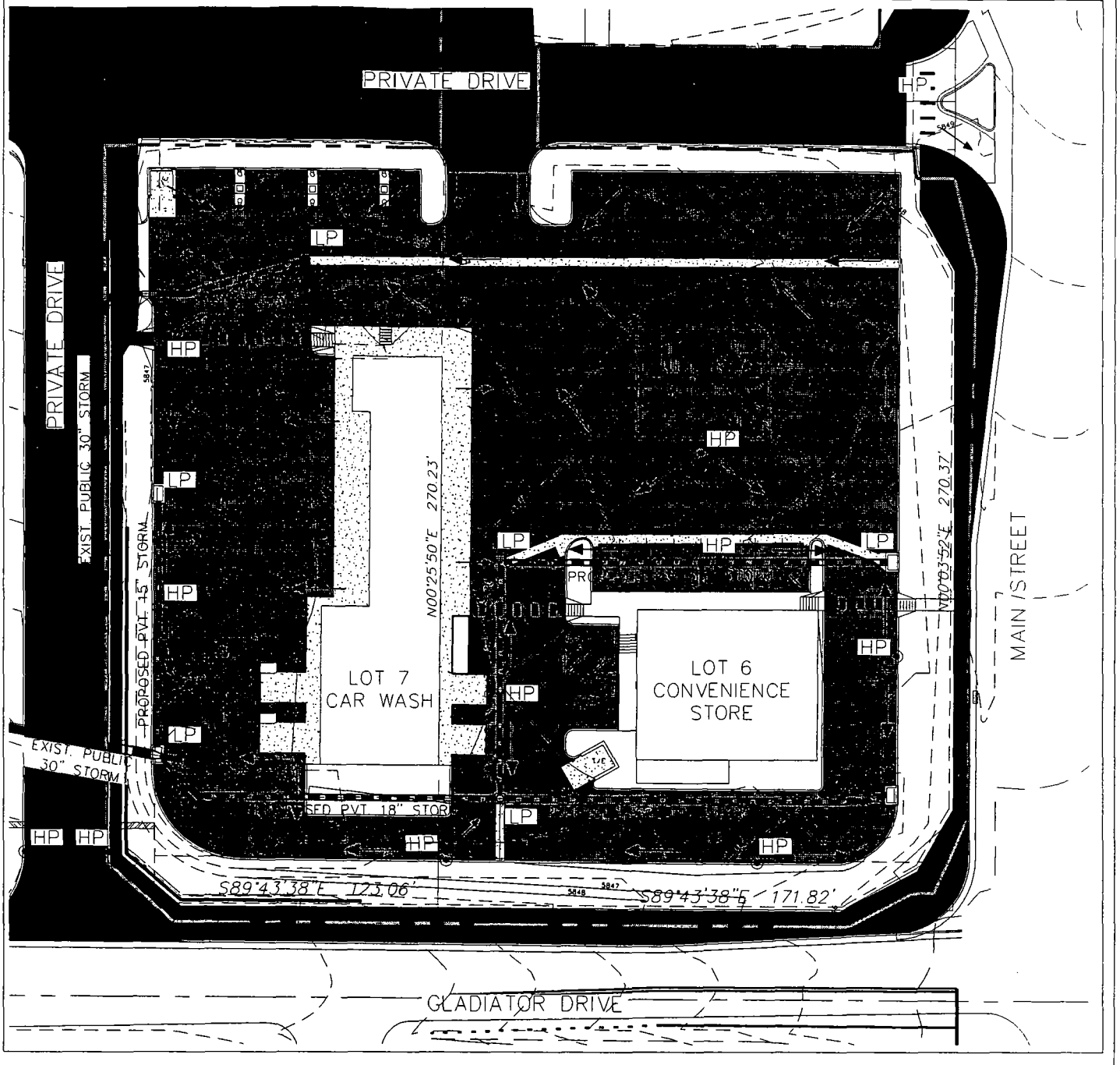
MAP NUMBER
08041C0763 F

EFFECTIVE DA
MARCH 17

Federal Emergency Management Agency

This Is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product Information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

DRAINAGE MAP



SITE MAP

SCALE: 1"=50'

40' 0 40' 80'

N

SCALE: 1"=40'

815 S. 25TH STREET
COLORADO SPRINGS, CO. 80904
OFFICE: 779-635-6422
FAX 719-635-6426
www.tnesinc.com

Terra Nova
Engineering, Inc.

BRADLEY CROSSROADS FILING NO.
LOTS 6 & 7
JUNE 7, 2010
JOB NO. 0637.00

Appendix D: Final Drainage Report by MVE, Inc.

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

Final Drainage Report

The Townhomes at Bradley Crossroads

Project No. 61093

October 10, 2018

PCD File No.

Final Drainage Report

for

The Townhomes at Bradley Crossroads
Multifamily Residential Community

Project No. 61093

October 10, 2018

prepared for

J. Elliott Homes, Inc.
12218 Crystal Downs Road
Peyton, CO 80931
719.499.8214

prepared by

MVE, Inc.
1903 Lelaray Street, Suite 200
Colorado Springs, CO 80909
719.635.5736

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.

_____ _____

David R. Gorman, P.E. Colorado No. 31672 Date
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.

_____ _____

Printed Name: Jordan Guinane Date
Title: President
J. Elliott Homes, Inc.
12218 Crystal Downs Road
Peyton, CO 80931

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.

_____ _____

Jennifer Irvine, P.E., Date
County Engineer / ECM Administrator

Contents

Final Drainage Report

The purpose of this Final Drainage Report is to identify drainage patterns and quantities within and affecting the proposed The Townhomes at Bradley Crossroads project located in Lot 2, Western Hills Filing No. 2. This project is the development of the existing platted lot having an area of approximately 3.87± Acres with a multi-family use. The report will "identify specific solutions to problems on-site and off-site resulting from the proposed project.[1] The report and included maps present results of hydrologic and drainage facilities analyses. The report will discuss the recommended drainage improvements to the site and identify drainage requirements relative to the proposed project. This report has been prepared and submitted in accordance with the requirements of the El Paso County land development approval process. An Appendix is included with this report with pertinent calculations and graphs used in the drainage analyses and design.

1 General Location and Description

1.1 Location

The proposed The Townhomes at Bradley Crossroads site is located within the southeast one-quarter of Section 2, Township 15 South, Range 66 west of the 6th principal meridian in El Paso County, Colorado. The 5.24± acre site is situated south of Bradley Road and west of Main Street (Hancock Expressway) in the Security-Widefield area. The proposed site is platted as Lot 1A, Bradley Crossroad, Filing No. 1B. A **Vicinity Map** is included in the **Appendix**.

Lincoln Commons Townhomes, zoned PUD CAD-O (Planned Unit Development, Commercial Airport Development District), is adjacent to the property to the west and contains a developed townhome community. Undeveloped Lots 2A, 3A, 4A, 5A, Bradley Crossroads Filing No. 1A, zoned CC CAD-O (Commercial Community, Commercial Airport Development District), are adjacent to the site along the north and east sides. Lot 7A, Bradley Crossroads Filing No. 1A, zoned CC CAD-O (Commercial Community, Commercial Airport Development District), containing a car wash, adjoins the site on the southeast edge. Gladiator Drive is adjacent along the south side of the site. The north and east sides of the site have existing paved private roadways that are shared by the adjoining developed and undeveloped lots.

1.2 Description of Property

The The Townhomes at Bradley Crossroads project contains 5.24± acres and is zoned RM-30 (Residential Multi-Dwelling). The property contains no structures, but has a paved private roadways along the north and east sides for access. Utilities also exist around the perimeter of the site, which are available for extension as part of the development of the site.

The site is covered with native prairie grasses and weeds in fair to good condition. There are also small trees and brush scattered throughout the site. The existing site topography exhibits only a moderate amount of relief, but slopes to the south at grades ranging from 0.5% to 1%. There are areas of small mounds and depressions throughout the site. The south edge of the site is encumbered by utility and drainage easements and contains existing storm drain and water mains.

1 DCM

There are no major drainageways in the The Townhomes at Bradley Crossroads site. All storm runoff flows south and then west to the southwest corner of the site. These flows are captured in existing storm drain inlets and are conveyed by pipe to the existing storm drain detention pond located at the southwest corner of adjacent Lincoln Commons Townhomes. This pond was designed and constructed to accommodate flows from this site.

The site is located in the Little Johnson Basin and is part of the Little Johnson/Security Creek Basin Planning Study by Kiowa Engineering Corporation dated April 1988.

According to the National Resource Conservation Service, the dominant soil in the immediate area of the The Townhomes at Bradley Crossroads site is Blakeland loamy sand (map unit 8). The Blakeland loamy sand is typically deep and somewhat excessively drained. Permeability is rapid, surface runoff is slow, and the hazard of erosion is moderate. Blakeland loamy sand is classified as being part of Hydrologic Soil Group A. 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**.[2] [3]

The current Flood Insurance Study of the region includes Flood Insurance Rate Maps (FIRMs), effective March 17, 1997. [4] [5] The project site is included in Community Panel Number 08041C0763 F of the FIRMs for El Paso County, Colorado. No portion of the site lies within FEMA designated Special Flood Hazard Areas (SFHAs). An excerpt of the current **FEMA Flood Insurance Rate Maps** with the site delineated is included in the **Appendix**.

A new multi-family residential development will be constructed on the site. The proposed buildings will be accessed by paved drives and walkways. The southern portion of the site will remain open space to preserve the existing utility and drainage easements. The development will include a new buildings, paved parking, paved drives, landscaping and recreational open area. The site will drain to the southwest corner of the site, as in existing conditions, and the flows will enter the existing detention pond in the adjacent Lincoln Commons Townhomes site.

2 Drainage Basins and Sub-Basins

2.1 Major Basin Descriptions

The Townhomes at Bradley Crossroads site is located in the Little Johnson Drainage Basin (FOFO3200) in the Security/Widefield area of El Paso County, which contains properties in both City of Colorado Springs and unincorporated El Paso County jurisdictions. The basin is a studied basin with an approved and operative Drainage Basin Planning Study (DBPS). The Basin stretches for approximately 17 miles on the east side of Colorado Springs and drains from northeast to southwest into Fountain Creek at a point just north of the crossing of Interstate 25 and US Highway 85-87. The site is located in the southeastern portion of the Little Johnson Drainage Basin, in the East Fork sub-area and eventually drains into the East Fork of Sand Creek. A copy of a portion of the **"*Drainage Area Identification Study*" map**, showing the site location within the Basin is included in the **Appendix**. [6]

The Drainage Basin Planning Study for the Little Johnson Drainage Basin was completed in 1988 by Kiowa Engineering Corporation.[7] The site is contained within sub-basin 24, located just upstream of Design Point No. 11, as indicated in the 1988 report. There are not drainage improvements noted in the DBPS for the site.

Other previously prepared and approved drainage reports were reviewed in this drainage study and are referenced in this report including:

---

2 WSS
3 OSD
4 FIS
5 FIRM, Map No. 08041C0754 F
6 Drain. Area Ident. Study
7 1988 DBPS

- Final Drainage Report and Plan for Lincoln Plaza Subdivision Filing No. 2 by Leigh Whitehead and Associates, Inc., dated March 2001.[8] This report studied existing conditions for the proposed site and the Lincoln Commons to the west. This report is referenced by later reports for the site by Westworks Engineering and Terra Nova Engineering.
- Preliminary/Final Drainage Report for Lincoln Plaza Subdivision No. 2 by WestWorks Engineering, dated August 2004.[9] This report studied the area of this current site together with the Lincoln Commons area to the west. The site was considered in commercial developed characteristics and to drain to a pond in the Lincoln Commons property.
- Final Drainage Report for Lincoln Commons by WestWorks Engineering revised July 25, 2007. This report included this subject site and adjacent property as an offsite contributing basin in the fully developed condition, generating Q_5=34 cfs and Q_{100}=68 cfs which drains to the Lincoln Common Townhomes water quality and storm detention pond.[10] Construction plans for Lincoln Commons Townhomes were approved and the project was constructed with the pond in 2016-2018.
- Final Drainage Report for Lots1 Thru 6, Bradley Crossroads, El Paso County, Colorado by Terra Nova Engineering, Inc. revised November 2008.[11] This report includes this subject site as mini-storage in a 100% paved condition. Developed flows are shown draining to the southwest corner of the site and entering the existing Stormwater pond in adjacent Lincoln Commons Townhomes.[12]

2.2 Sub-Basin Description

2.2.1 General Existing Conditions

The site and existing sub-basin historically drains from northeast to southwest with slopes of 1% to 2%. The site was studied by Terra Nova Engineering Inc. in previous drainage reports noted above. Historic conditions are documented in those prior reports and incorporated by reference in this analysis.

2.2.2 Existing Drainage Patterns (Off-Site)

Off-site drainage flows enter the north edge of the The Townhomes at Bradley Crossroads property from two off-site drainage basins located north of the site. These are both part of the Bradley Crossroads Filing No. 1A subdivision and both undeveloped at this time. These basins drain into the existing paved private drive located along the north boundary of the site. These flows drain through the site to the southwest corner. An additional offsite basin is located on the east edge of the site and consists of a portion the existing paved drive which currently drains west into the site.

2.2.3 Existing Drainage Patterns (On-Site)

The existing site is undeveloped, except for the existing paved access drives on the north and east edges. The site drains to the southwest corner and the flows are collected and directed to the existing detention pond in Lincoln Commons.

3 Drainage Design Criteria

3.1 Development Criteria Reference

This Final Drainage Report for The Townhomes at Bradley Crossroads has been prepared according to the report guidelines presented in the latest edition of *El Paso County Drainage Criteria Manual* (DCM)[13]. The County has also adopted portions of the City of Colorado Springs Drainage Criteria Manual Volumes 1 and 2, especially concerning the calculation of rainfall runoff flow rates.[14] [15] The

8 LP FDR
9 LP2 FDR
10 LC FDR
11 BC FDR
12 BC FDR
13 DCM Section 4.3 and Section 4.4
14 CS DCM Vol 1
15 CS DCM Vol 2

hydrologic analysis is based on a collection of data from the DCM, the NRCS Web Soil Survey[16], Existing topographic data and proposed site plan by by Land Development Consultants, Inc.

3.2 Hydrologic Criteria

For this Final Drainage Report, the Rational Method as described in the D*rainage 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 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.[17]

4 Drainage Facility Design

4.1 General Concept

The intent of the drainage concept presented in this Final Drainage Report is to maintain the existing drainage patterns on the site which delivers the site flows to the existing detention pond in adjacent Lincoln Commons Townhomes site as determined in the previous drainage reports considering this site and the adjacent properties. Major and minor storm flows will continue to be safely conveyed through the site and downstream. The runoff from all developed areas will drain to the existing Extended Detention Basin (EDB). The existing and proposed private on-site storm drain system will collect the flow from the various developed on-site sub-basins and convey them to the existing EDB. The developed flows will be detained and released to to the downstream drainage system at the historic flow rates.

The proposed drainage hydrologic conditions are described in more detail below. Input data and results for all calculations are included in the **Appendix**. A Drainage Maps for the hydrology are also included in the **Appendix**.

4.2 Specific Details

4.2.1 Proposed Hydrologic Conditions

Design Point 0 (DP0). The off-site drainage basin, OS-1 (0.19 acres), will drain to a low point on the east edge of the site. This flow formerly entered the existing site and continued west into the site. However, in the developed condition, a new grated Type C inlet will collect the flows which will enter the existing 24 inch RC Pipe located in the drive. The developed discharges from sub-basin OS-1 are Q_5 = 0.8 cfs and Q_{100} = 1.4 cfs.

Design Point 1 (DP1). DP1 is the combination of sub-basins OS-1, OS-2, A1 and A2 at the northwest corner of the site where the combined runoff enters the west drain swale from the existing paved north driveway.

Offsite sub-basin OS-2 (1.02 acres) is located adjacent to the northeast corner of the site and drains to the existing paved drive along the north edge of the site. The basin is assumed to be developed in accordance with the commercial zoning. The peak flow rates generated by sub-basin OS-2 are Q_5 = 3.6 cfs and Q_{100} = 6.9 cfs. These flows will travel west in the drive and join additional flows from sub-basin OS-3.

Offsite sub-basin basin OS-3 (0.81 acres) is located adjacent to the northwest edge of the site and will contain offsite commercial development in accordance with the existing zoning. The sub-basin drains to the southwest and flows enter the existing paved drive with peak runoff rates of Q_5 = 3.2 cfs

16 WSS
17 DCM

and Q_{100} = 6.0 cfs. These flows join the runoff from sub-basin OS-2 in the existing paved drive and are directed to a drainage swale located on the west edge of the subject property by way of an existing concrete run-down at Design Point 1 (DP1).

Proposed sub-basin A1 (0.21 acres) consists of half of a proposed townhome building along with sidewalks and landscaping that drains north to the existing paved drive. Sub-basin A1 will produce runoff at peak flow rates of Q_5 = 0.5 cfs and Q_{100} = 1.2 cfs which joins the flows from sub-basin OS-2 and flows west in the drive into sub-basin OS-3.

Proposed sub-basin A2 (0.20 acres) is comprised of building, sidewalk and landscaping area at the northwest edge of the site. The flows of sub-basin A2 are Q_5 = 0.5 cfs and Q_{100} = 1.1 cfs which drain north into the existing paved drive, joining flows from sub-basins OS-2, OS-3 and A1 at DP1. The combined discharges at **DP 1** are Q_5 = 7.3 cfs and Q_{100} = 14.1 cfs. The flows enter a drain swale located along the west edge of the site and continue south through sub-basin A3.

Design Point 2 (DP2). DP2 is the combination of sub-basins A4 and A5 at the west edge of the site where the combined runoff enters the west drain swale in sub-basin A3 from a curb opening in the proposed paved driveway.

Proposed sub-basin A4 (0.34 acres) is comprised of building, drive and landscape area located on the east side of the site, just to the south of A1. The discharges from sub-basin A4 are Q_5 = 1.3 cfs and Q_{100} = 2.5 cfs which drain west into sub-basin A5.

Proposed sub-basin A5 (0.28 acres) consists of building, drive and landscape area located on the east side of the site, just west of A4. The sub-basin generates storm runoff peak discharges of Q_5 = 1.1 cfs and Q_{100} = 2.0 cfs. The sub-basin also accepts the flows from sub-basin A4 and the combined discharges of Q_5 = 2.2 cfs and Q_{100} = 4.2 cfs enter the west drain swale at **DP2** by way of a 2' curb opening.

Design Point 3 (DP3). DP3 is the combination of sub-basins OS-2, OS-3, A3, A4 and A5 at the access road leading to adjacent Lincoln Commons Townhomes to the west in the drain swale at the west edge of the site.

Proposed sub-basin A3 (0.20 acres) will consist of the open channel swale on the west edge of the property. The sub-basin generates peak discharges of Q_5 = 0.1 cfs and Q_{100} = 0.6 cfs, which drain south in the swale to DP3. Sub-basin A3 also collects flows from sub-basins OS-2, OS-3, A4 and A5 with combined discharges of Q_5 = 9.1 cfs and Q_{100} = 17.9 cfs at **DP3** . 5-yer flows cross beneath the access road in 3 private 12" RC Pipes. Overflows greater than the 5-year runoff crosses over the access in a depressed concrete pan and continue south in the drain swale.

Design Point 4 (DP4). DP4 is the combination of sub-basins A6 and A7 at the west edge of the site where the combined runoff enters the west drain swale in sub-basin A12 from the depressed concrete pan in the proposed paved access driveway.

Proposed sub-basin A6 (0.50 acres) is comprised of building, drive and landscape area located on the east side of the site, just to the south of A4. The discharges from sub-basin A6 are Q_5 = 1.9 cfs and Q_{100} = 3.6 cfs which drain west into sub-basin A7.

Proposed sub-basin A7 (0.52 acres) consists of building, drive and landscape area located on the east side of the site, just west of A6. The sub-basin generates storm runoff peak discharges of Q_5 = 1.9 cfs and Q_{100} = 3.7 cfs. The sub-basin also accepts the flows from sub-basin A6 and the combined discharges of Q_5 = 3.6 cfs and Q_{100} = 6.9 cfs enter the west drain swale at **DP4** by way of the depressed concrete pan at the Lincoln Commons Townhomes access.

Design Point 5 (DP5). DP5 is the combination of sub-basins A8 and A9 at the west edge of the site where the combined runoff enters the west drain swale in sub-basin A12 from a curb opening in the proposed paved driveway.

Proposed sub-basin A8 (0.33 acres) is comprised of building, drive and landscape area located on the east side of the site, just to the south of A6. The discharges from sub-basin A8 are Q_5 = 1.3 cfs and Q_{100} = 2.4 cfs which drain west into sub-basin A9.

Proposed sub-basin A9 (0.28 acres) consists of building, drive and landscape area located on the east side of the site, just west of A8. The sub-basin generates storm runoff peak discharges of Q_5 = 1.1 cfs and Q_{100} = 2.0 cfs. The sub-basin also accepts the flows from sub-basin A8 and the combined discharges of Q_5 = 2.2 cfs and Q_{100} = 4.2 cfs enter the west drain swale in sub-basin A12 at **DP5** by way of a 2' curb opening.

Design Point 6 (DP6). DP6 is the combination of sub-basins A10 and A11 at the west edge of the site where the combined runoff enters the west drain swale in sub-basin A12 from a curb opening in the proposed paved driveway.

Proposed sub-basin A10 (0.49 acres) is comprised of building, drive and landscape area located on the east side of the site, just to the south of A8. The discharges from sub-basin A10 are Q_5 = 1.9 cfs and Q_{100} = 3.6 cfs which drain west into sub-basin A11.

Proposed sub-basin A11 (0.38 acres) consists of building, drive and landscape area located on the east side of the site, just west of A10. The sub-basin generates storm runoff peak discharges of Q_5 = 1.5 cfs and Q_{100} = 2.8 cfs. The sub-basin also accepts the flows from sub-basin A10 and the combined discharges of Q_5 = 3.2 cfs and Q_{100} = 6.1 cfs enter the west drain swale in sub-basin A12 at **DP6** by way of a 2' curb opening.

Design Point 7 (DP7). DP7 is the combination of sub-basins OS-1, OS-2, A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A11 and A12 near the southwest corner of the site where the combined runoff enters an existing 24" RC Pipe at the downstream end the west drain swale.

Proposed sub-basin A12 (0.11 acres) will consist of the open channel swale on the west edge of the property. The sub-basin generates peak discharges of Q_5 = 0.1 cfs and Q_{100} = 0.6 cfs, which drains south in the swale to DP7. Sub-basin A3 also collects flows from the upstream sub-basins OS-2, OS-3 and A1 – A11 (DP1-DP6) with combined discharges of Q_5 = 16.4 cfs and Q_{100} = 32.0 cfs at **DP7**. 5-year flows enter the existing 24" RC Pipe. Overflows greater than the 5-year continue south to an existing D-9 grated inlet at DP8 in sub-basin A13. All these flows are collected in the storm drain system and continue west in the existing 36" RC Pipe which drains into the existing Lincoln Commons Townhomes EDB.

Design Point 8 (DP8). DP8 consists of sub-basin A13, which drains by surface flow to the west and is captured in the existing D-9 inlet at the west property boundary. These flows are combined with the flows from DP7 and are conveyed to the west. Proposed sub-basin A13 (0.15 acres) is comprised of building and a significantly sized open landscape area located along the south side of the just to the south of A10 and A11. The discharges from sub-basin A13 are Q_5 = 1.0 cfs and Q_{100} = 3.2 cfs. The combined discharges at **DP8** are Q_5 = 17.4 cfs and Q_{100} = 35.3 cfs.

Existing Extended Detention Basin (EDB).

The development of Lincoln Commons and the construction of Lincoln Commons Townhomes provided for the detention and water quality treatment of the entire Lincoln Commons and Bradley Crossroads developments. The Final Drainage Report for Lincoln Commons by WestWorks Engineering, revised July 25, 2007 calculated the offsite flows from Bradley Crossroads Filing No, 1, Lots 1-6 to have developed flows of Q_5 = 34 cfs and Q_{100} = 68 cfs. Those flows combine with the Lincoln Commons Townhome development, were used to size the detention and water quality basin. The Final Drainage Report for Bradley Crossroads Filing No. 1 Lots 1 – 6 by Terra Nova Engineering, revised November 2008 recalculated the offsite flows going to the EDB to have peak flow rates of Q_5 = 34.2 cfs and Q_{100} = 61.3 cfs, which is less than the overall capacity of the existing facility. This report considers a portion of the Bradley Crossroads site, and revised the developed flows from the Terra Nova report and determines offsite developed flows entering the EDB to be Q_5 = 31.9 cfs and Q_{100} = 62.3 cfs. These revised flows are also lower than the original design flows used to size the existing EDB. The existing EDB will provide adequate storm detention and water quality capacity for the Townhomes at Bradley Crossroads site.

4.2.2 Proposed Drainage Facilities

The proposed on-site storm drain system will be owned and maintained by The Townhomes at Bradley Crossroads. The pipe system will be 6", 12" and 18" HDPE material. The proposed inlets

will be Type 16 combination inlets with concrete boxes and adjustable steel grate and curb openings. The area inlet will be PVC and non-traffic bearing located in landscaped areas. The proposed pipe system discharges into the Full Spectrum Sand Filter Basin, which is designed to detain the WQCV, EURV and 100-year developed runoff volumes. The proposed FS Sand Filter Basin has storage volume of 0.281 acre-feet. The facility is located in Type A soils and will be full-infiltration type. The EURV and 100-year flows will be regulated by a concrete outlet box with steel orifice plate and outlet pipe. The facility will have an emergency spillway with 6' bottom width discharging to Western Drive and protected by riprap lining.

4.3 Erosion Control

During future construction, best management practices (BMP's) for erosion control will be employed based on the previously referenced City of Colorado Springs Drainage Criteria Manual Volume 2 and the Erosion Control Plan to minimize erosion from the site. The BMP's will remain in place until the site is stabilized with the new hard surfacing or landscape seeding, planting and cover materials. Also, BMP's will be utilized as deemed necessary by the contractor, engineer, owner, or County inspector and are not limited to the measures described on the Erosion Control Plan.

4.4 Water Quality Enhancement Best Management Practices

This development will utilize the existing Extended Detention Basin (EDB) west of the site in Lincoln Commons Townhomes. This existing EDB was designed and constructed for this purpose as indicated in the referenced previous drainage reports. The pond adequately sized for this purpose. Other drainage facilities in this project consist of rip rap drainage swale on the west side of the site and minor modifications to the existing surrounding storm drain system. These facilities will be private and will be maintained by the development's homeowners association. A Grading and Erosion Control Plan for the construction of the site has been prepared in accordance with the provisions of the County's Engineering Criteria Manual. Placement of construction stormwater BMP's will as required by the plan will limit soil erosion and deposition by stormwater flowing over the site.

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 drainageways, 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. The parking lot contains landscape islands and a significant portion of the south side of the site will remain as pervious lanscaped open space.

2) All drainage paths on the site are stabilized with pavement or appropriate landscape treatment. The existing EDB will intercept flows from developed areas. Additionally, all inflow points willl be stabilized with rip-rap or concrete protection.

3) The project contains no potentially hazardous uses. All developed areas drain into a proposed a WQCV BMP.

4) The site is residential in nature and contains no storage of potentially harmful substances or use of potentially harmful substances. No Site Specific or Other Source Control BMP's are required.

5 Opinion of Probable Cost for Drainage Facilities

There are no public drainage improvements associated with this project. Costs for the private non-reimbursable drainage improvements for this project are listed in the table below:

The Townhomes at Bradley Crossroads Private Drainage Costs (Non-Reimbursable)				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
Storm Sewer Manhole, Box Base	1	EA	$8,592	$8,592
Reinforced Concrete Pipe - 12""	156	LF	$48	$7,488
Reinforced Concrete Pipe – 36"	4	LF	$124	$496
Flared End Section - 24"	1	EA	$325	$325
Grated Inlet (Type C)	1	EA	$3,270	$3,270
GRAND TOTAL				**$20,171.00**

6 Drainage and Bridge Fees

The site is already platted and replatted. No additional Drainage or Bridge Fees are due for this project.

7 Conclusion

This Final Drainage Report presents existing and proposed drainage conditions for the proposed The Townhomes at Bradley Crossroads project. The development will have negligible and inconsequential effects on the existing site drainage and drainage conditions downstream. Full Spectrum Detention and Water Quality treatment will be provided. The proposed project will not, with respect to stormwater runoff, negatively impact the adjacent properties and downstream properties.

References

City of Colorado Springs/El Paso County Drainage Criteria Manual. City of Colorado Springs, Department of Public Works, Engineering Division; HDR Infrastructure, Inc.; El Paso County, Department of Public Works, Engineering Division (Colorado Springs: City of Colorado Springs, Revised November 1991).

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NRCS Web Soil Survey. United States Department of Agriculture, Natural Resources Conservation Service ("http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx", accessed Accessed September 2018).

Flood Insurance Rate Map. Federal Emergency Management Agency, National Flood Insurance Program (Washington D.C.: FEMA, March 17, 1997).

Flood Insurance Study for El Paso County, Colorado and incorporated Areas. Federal Emergency Management Agency (Washington D.C.: FEMA, March 17, 1997).

Drainage Area Identification Study. Muller Engineering Company, Inc. (Lakewood, CO: , 1986).

Little Johnson/Security Creek Drainage Basin Planning Study. Simons, Li & Associates, Inc. in cooperation with Kiowa Engineering Corporation (Colorado Springs, Colorado: , April, 1988).

Final Drainage Report and Plan for Lincoln Plaza Filing No. 2. Leigh Whitehead & Associates, Inc. (El Paso County, Colorado: , March, 2001).

Preliminary/Final Drainage Report for Lincoln Plaza Subdivision No. 2. WestWorks Engineering (El Paso County, Colorado: , August, 2004).

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Final Drainage Report for Lots 1 Thru 6, Bradley Crossroads. Terra Nova Engineering, Inc. (Revised November 2008: , El Paso County, Colorado).

Drainage Criteria Manual Volume 2, Stormwater Quality Policies, Procedures and Best Management Practices (BMPs). City of Colorado Spring Engineering Division (Colorado Springs: , May 2014).

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

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).

Drainage Criteria Manual (Volume 2). Urban Drainage and Flood Control District (Denver, Colorado: Urban Drainage and Flood Control District, Rev. September 2017).

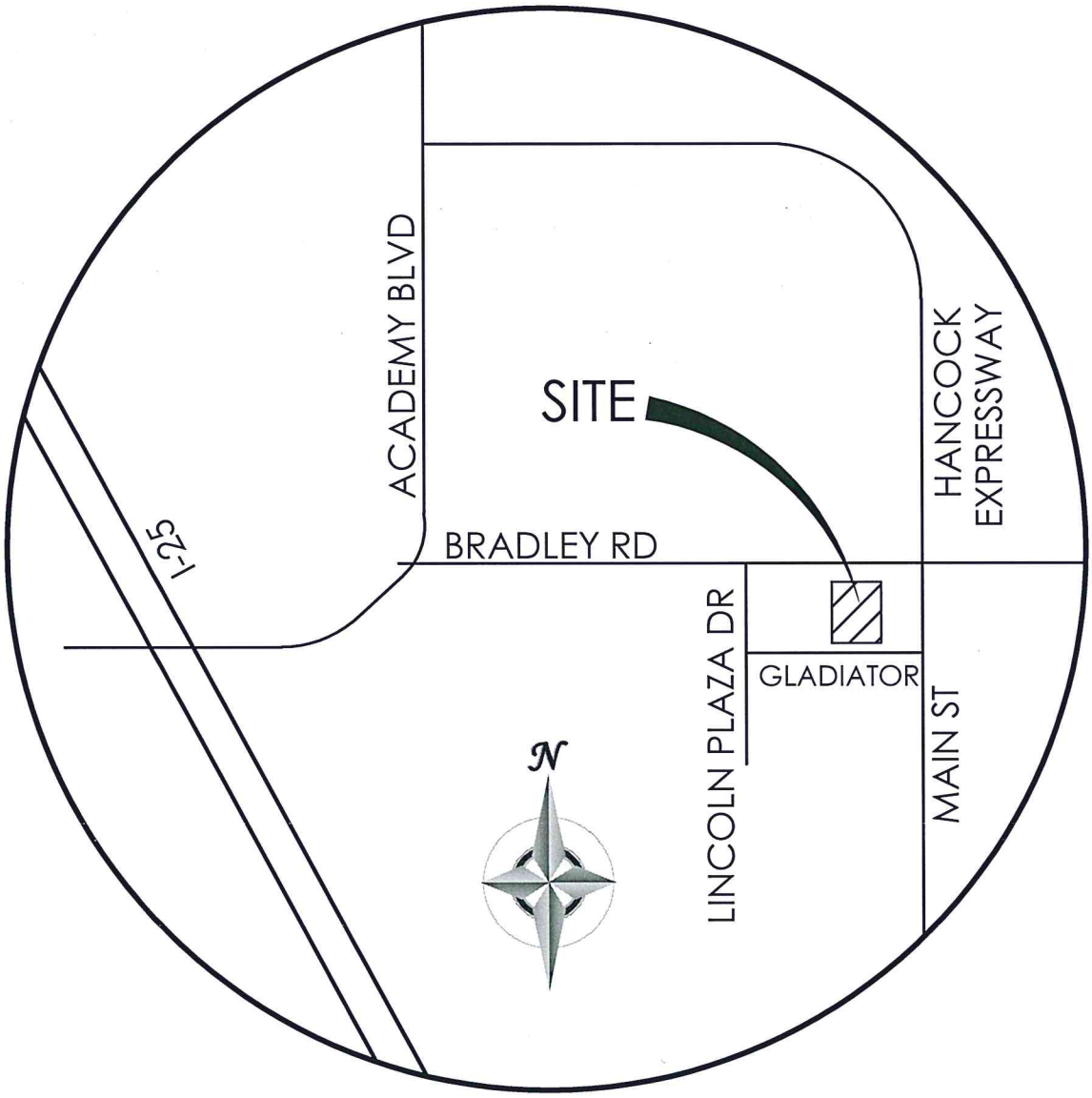
Detention Design Spreadsheet. Urban Drainage and Flood Control District ("http://www.udfcd.org/downloads/software/UD-Detention_v2.2.xls", accessed February 2017).

Urban Storm Drainage Criteria Manual Volume 3. Urban Drainage and Flood Control District (Denver, Colorado: , August, 2011).

Appendices

8 General Maps and Supporting Data

Vicinity Map
Portions of Flood Insurance Rate Map
Portion of Drainage Area Identification Study Map
NRCS Soil Map and Tables
SCS Soil Type Descriptions
Hydrologic Soil Group Map and Tables



VICINITY MAP

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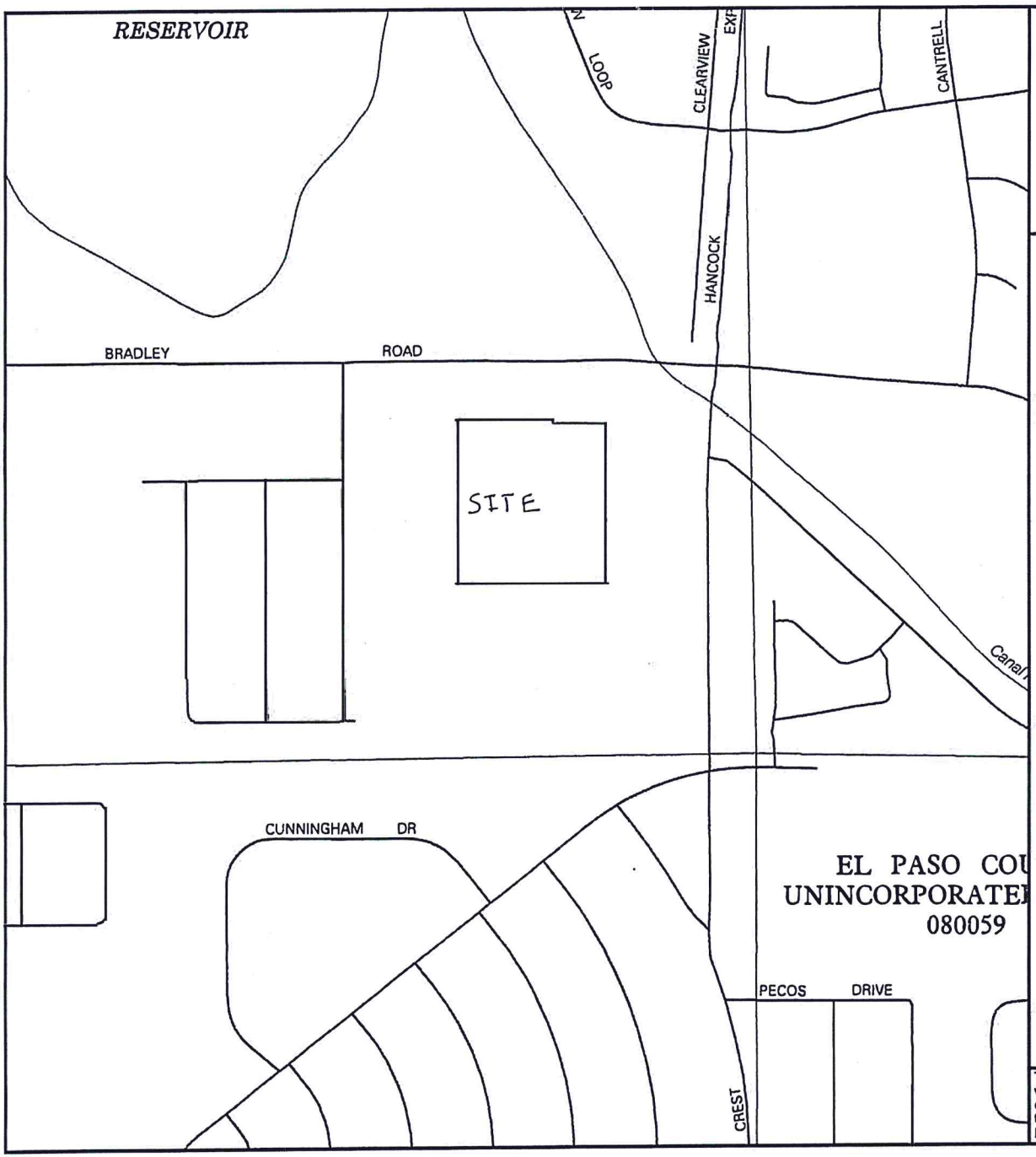

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APPROXIMATE SCALE IN FEET

500 0 500

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 763 OF 1300

(SEE MAP INDEX FOR PANELS NOT PRINTED)

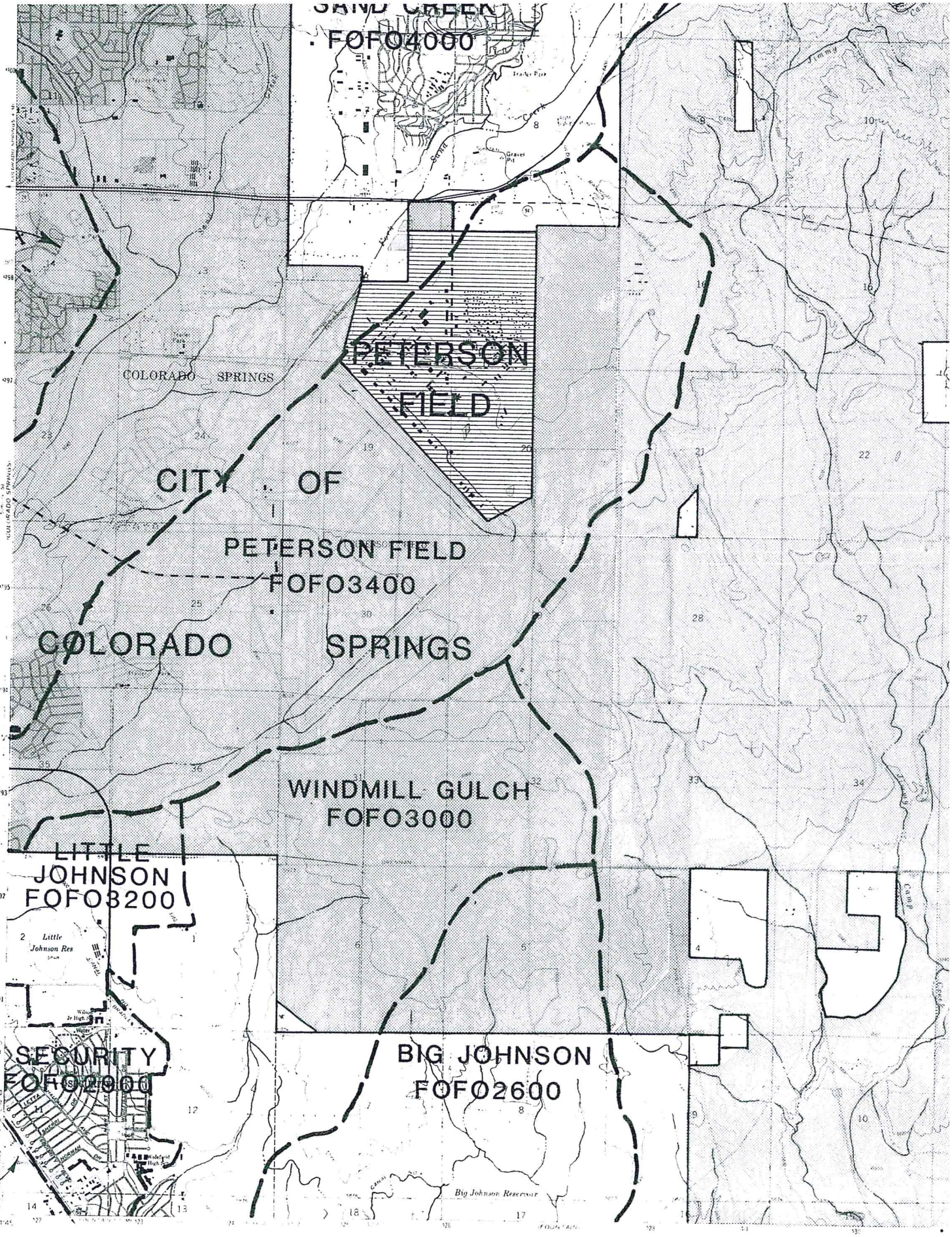
CONTAINS:

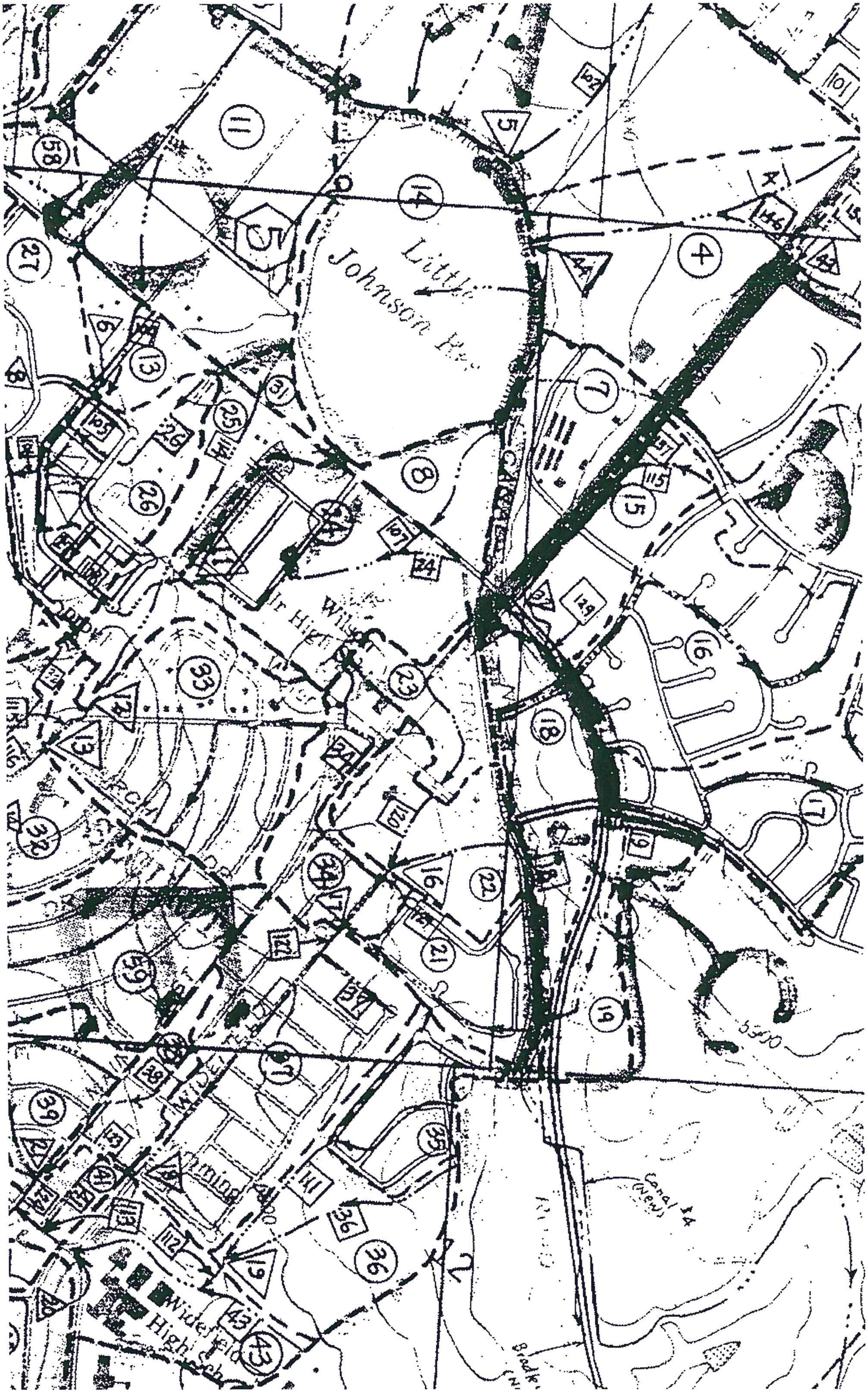
COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0763	F
EL PASO COUNTY, UNINCORPORATED AREAS	080059	0763	F
FOUNTAIN, CITY OF	080081	0763	F

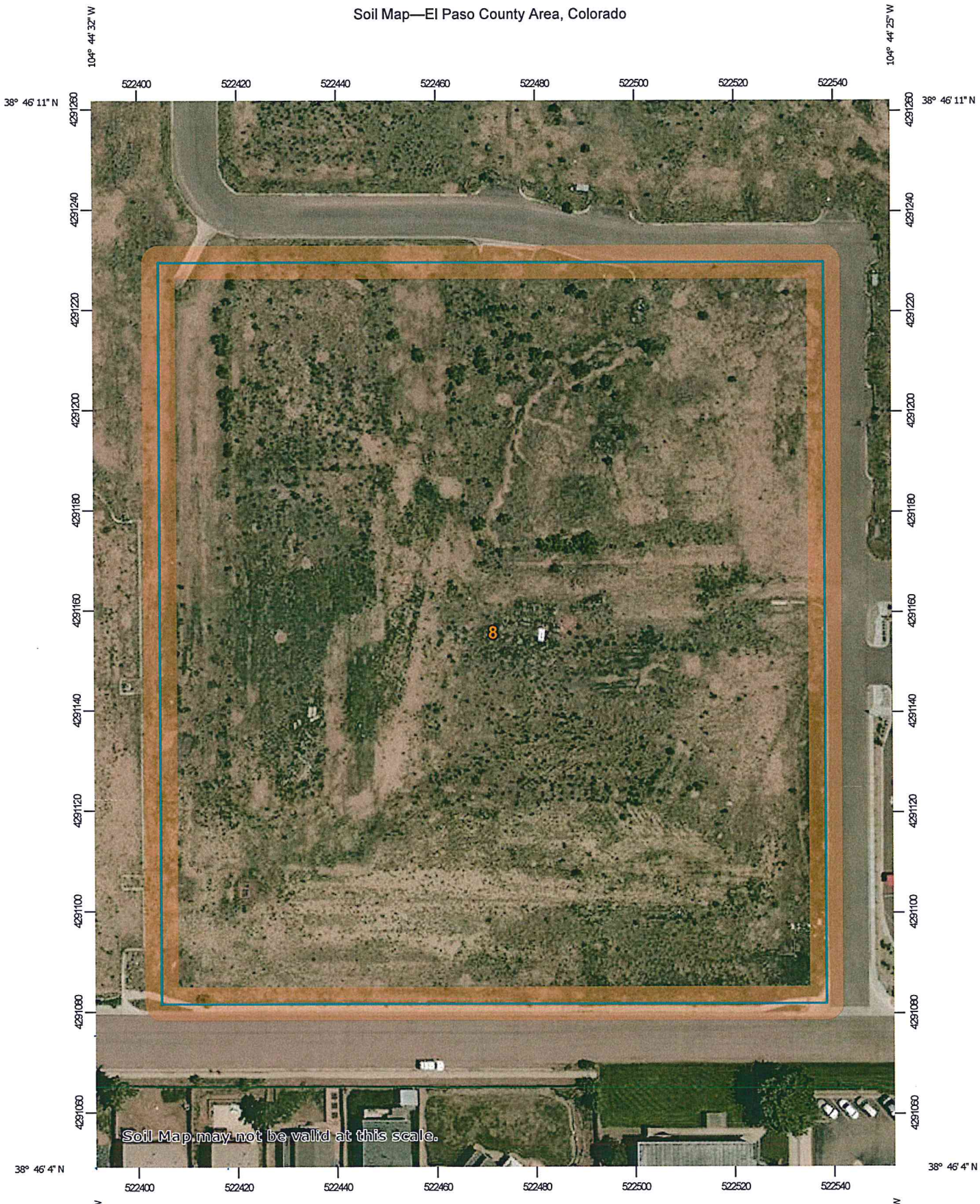
MAP NUMBER
08041C0763 F

EFFECTIVE DATE:
MARCH 17, 1997

Federal Emergency Management Agency


SAND CREEK
FOFO4000
PETERSON
FIELD
COLORADO SPRINGS
CITY OF
PETERSON FIELD
FOFO3400
COLORADO SPRINGS
WINDMILL GULCH
FOFO3000
LITTLE
JOHNSON
FOFO3200
SECURITY
FOFO2900
BIG JOHNSON
FOFO2600


Little
Johnson Res.
Wilder Jr High Sch.
Widefield High Sch.
Canal #4 (New)
5500



Map Scale: 1:1,040 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 15 30 60 90

Feet: 0 50 100 200 300

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
8	Blakeland loamy sand, 1 to 9 percent slopes	4.9	100.0%
Totals for Area of Interest		**4.9**	**100.0%**

is severely eroded and blowouts have developed, the new seeding should be fertilized.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the main limitation for 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 necessary 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 wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. In cropland areas, habitat favorable for ring-necked pheasant, mourning dove, and many nongame species can be developed by establishing areas for nesting and escape cover. For pheasant, the provision of undisturbed nesting cover is vital and should be included in plans for habitat development. 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 use as homesites. Shallow excavation is severely limited because cut banks cave in. This sandy soil requires special management practices to reduce water erosion and soil blowing. Capability subclasses IIIe, irrigated, and IVe, nonirrigated.

7—Bijou sandy loam, 3 to 8 percent slopes. This deep, well drained soil is on flood plains, terraces, and uplands. It formed in sandy alluvium and eolian material derived from arkose deposits. Elevation ranges from 5,400 to 6,200 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 brown sandy loam about 4 inches thick. The subsoil is brown or grayish brown sandy loam about 24 inches thick. The substratum is pale brown loamy coarse sand.

Included with this soil in mapping are small areas of Olney sandy loam, 3 to 5 percent slopes; Valent sand, 1 to 9 percent slopes; Vona sandy loam, 3 to 9 percent slopes; and Wigton loamy sand, 1 to 8 percent slopes.

Permeability of this Bijou soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Organic matter content of the surface layer is low. Surface runoff is slow, and the hazards of erosion and soil blowing are moderate.

Almost all areas of this soil are used for range.

This soil is suited to the production of native vegetation suitable for grazing. Because of the hazards of water erosion and soil blowing, the soil is not suited to nonirrigated crops.

Native vegetation is dominantly blue grama, sand dropseed, needleandthread, side-oats grama, and buckwheat.

Seeding is a suitable practice if the range has deteriorated. Seeding the native grasses is a good practice. If the range is severely eroded and blowouts have developed, the new seeding should be fertilized. Brush control and grazing management may be needed to improve the depleted range. Grazing should be managed so that enough forage is left standing to protect the soil from blowing, to increase infiltration of water, and to catch and hold snow.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the main limitation for 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 wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, by properly managing livestock grazing, and by reseeding range where needed.

This soil has good potential for use as homesites. Shallow excavation is severely limited because cut banks cave in. This soil requires special management practices to reduce water erosion and soil blowing. Capability subclass VIe.

8—Blakeland loamy sand, 1 to 9 percent slopes. This deep, somewhat excessively drained soil formed in alluvial and eolian material derived from arkosic sedimentary rock on uplands. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 135 days.

Typically, the surface layer is dark grayish brown loamy sand about 11 inches thick. The substratum, to a depth of 27 inches, is brown loamy sand; it grades to pale brown sand that extends to a depth of 60 inches.

Included with this soil in mapping are small areas of Bresser sandy loam, 0 to 3 percent slopes; Bresser sandy loam, 3 to 5 percent slopes; Truckton sandy loam, 0 to 3 percent slopes; Truckton sandy loam, 3 to 9 percent slopes; and Stapleton sandy loam, 3 to 8 percent slopes. In some areas, mainly north of Colorado Springs in the Cottonwood Creek area, arkosic beds of sandstone and shale are at a depth of 0 to 40 inches.

Permeability of this Blakeland soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low to moderate. Organic matter content of the surface layer is medium. Surface runoff is slow, the hazard of erosion is moderate, and the hazard of soil blowing is severe.

Most areas of this soil are used for range, homesites, and wildlife habitat.

Native vegetation is dominantly western wheatgrass, side-oats grama, and needleandthread. This soil is best suited to deep-rooted grasses.

Proper range management is necessary to prevent excessive removal of plant cover from the soil. Interseeding improves the existing vegetation. Deferment of grazing in spring increases plant vigor and soil stability. Proper location of livestock watering facilities helps to control grazing.

Windbreaks and environmental plantings are fairly well suited to this soil. Blowing sand and low available water capacity are the main limitations for the establishment of trees and shrubs. The soil is so loose that trees need to be planted in shallow furrows and plant cover needs to be maintained between the rows. Supplemental irrigation may be needed to insure survival. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, and Siberian elm. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to wildlife habitat. It is 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.

This soil has good potential for urban development. Soil blowing is a hazard if protective vegetation is removed. Special erosion control practices must be provided to minimize soil losses. Capability subclass VIe.

9—Blakeland complex, 1 to 9 percent slopes. This complex is on uplands, mostly in the Falcon area. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the frost-free period is about 135 days.

This complex is about 60 percent Blakeland loamy sand, about 30 percent Fluvaquentic Haplaquolls, and 10 percent other soils.

Included with these soils in mapping are areas of Columbine gravelly sandy loam, 0 to 3 percent slopes, Ellicott loamy coarse sand, 0 to 5 percent slopes, and Ustic Torrifluvents, loamy.

The Blakeland soil is in the more sloping areas. It is deep and somewhat excessively drained. It formed in sandy alluvium and eolian material derived from arkosic sedimentary rock. Typically, the surface layer is dark grayish brown loamy sand about 11 inches thick. The substratum, to a depth of 27 inches, is brown loamy sand; it grades to pale brown sand that extends to a depth of 60 inches or more.

Permeability of the Blakeland soil is rapid. The effective rooting depth is more than 60 inches. The available water capacity is moderate to low. Surface runoff is slow, and the hazard of erosion is moderate.

The Fluvaquentic Haplaquolls are in swale areas. They are deep, poorly drained soils. They formed in alluvium derived from arkosic sedimentary rock. Typically, the surface layer is brown. The texture is variable throughout. The water table is at a depth of 0 to 3 feet.

The Blakeland soil is well suited to deep-rooted grasses. Native vegetation is dominantly western wheatgrass, side-oats grama, and needleandthread. Rangeland vegetation on the Fluvaquentic Haplaquolls is dominantly tall grasses, including sand bluestem, switchgrass, prairie cordgrass, little bluestem, and sand reedgrass. Cattails and bulrushes are common in the swampy areas.

Proper range management is needed to prevent excess removal of plant cover from these soils. It is also needed to maintain the productive grasses. Interseeding improves the existing vegetation. Deferment of grazing during the growing season increases plant vigor and soil stability, and it helps to maintain and improve range condition. Proper location of livestock watering facilities helps to control grazing of animals.

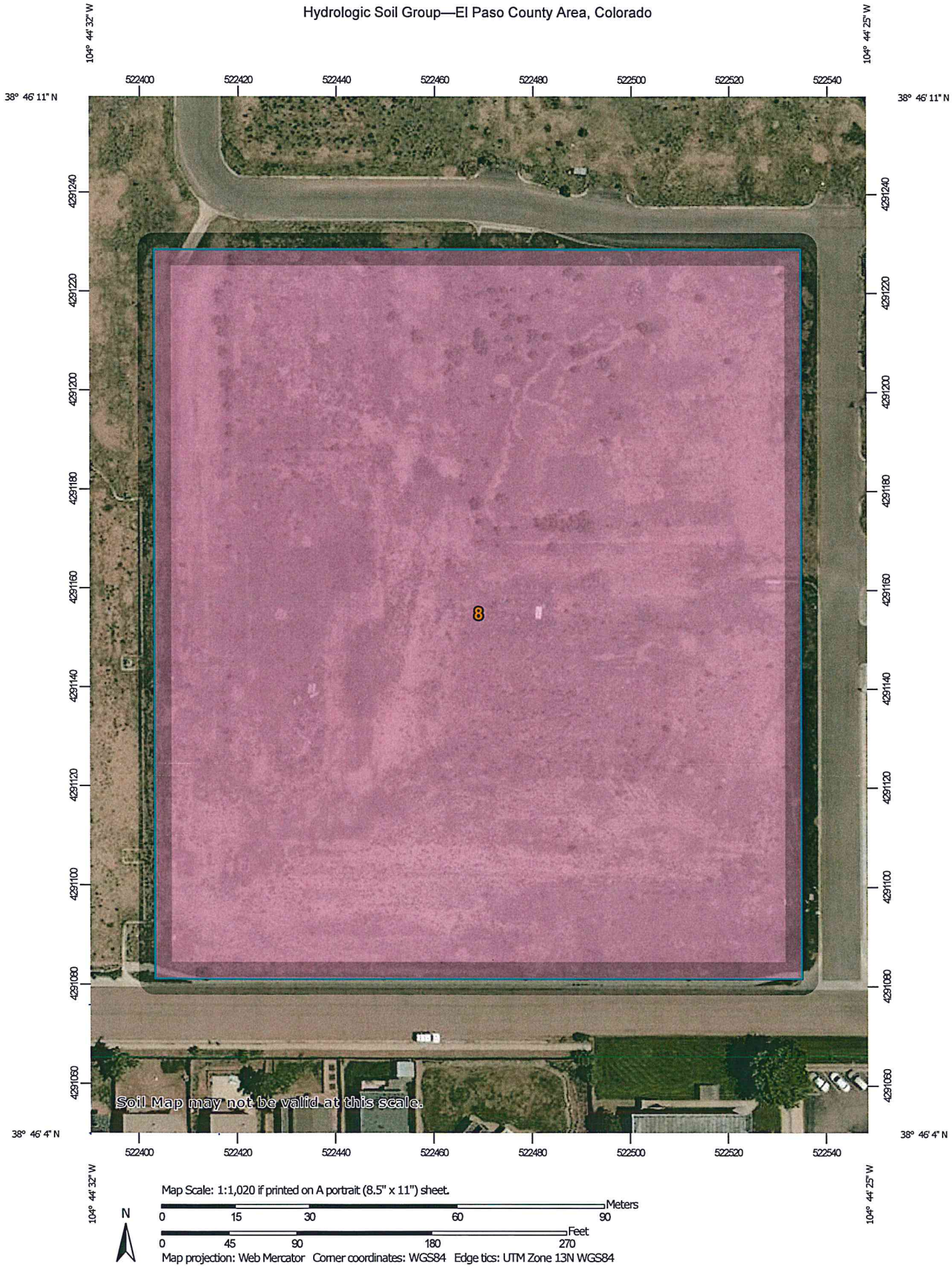
Windbreaks and environmental plantings are fairly well suited to these soils. Blowing sand and low available water capacity are the main limitations to the establishment of trees and shrubs. The soils are so loose that trees need to be planted in shallow furrows and plant cover needs to be maintained between the rows. Supplemental irrigation may be needed to insure survival. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, and Siberian elm. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

The Blakeland soil is well suited to wildlife habitat. It is 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. Wetland wildlife can be attracted to the Fluvaquentic Haplaquolls and the wetland habitat can be enhanced by several means. Shallow water developments can be created by digging or by blasting potholes to create open-water areas. Fencing to control livestock grazing is beneficial, and it allows wetland plants such as cattails, reed canarygrass, and rushes to grow. Control of unplanned burning and prevention of drainage that would remove water from the wetlands are good practices. Openland wildlife use the vegetation on these soils for nesting and escape cover. These shallow marsh areas are especially important for winter cover if natural vegetation is allowed to grow.

The Blakeland soil has good potential for homesites, roads, and streets. It needs to be protected from erosion when vegetation has been removed from building sites. The Fluvaquentic Haplaquolls have poor potential for homesites. Their main limitations for this use are the high water table and the hazard of flooding. Capability subclass VIe.

10—Blendon sandy loam, 0 to 3 percent slopes. This deep, well drained soil formed in sandy arkosic alluvium on alluvial fans and terraces. The average annual precipitation is about 15 inches, the mean annual air temperature is about 47 degrees F, and the average frost-free period is about 135 days.

Hydrologic Soil Group—El Paso County Area, Colorado



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Feet: 0 45 90 180 270

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

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

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

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 15, Oct 10, 2017

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

Date(s) aerial images were photographed: Jun 3, 2014—Jun 17, 2014

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
8	Blakeland loamy sand, 1 to 9 percent slopes	A	4.8	100.0%
Totals for Area of Interest			**4.8**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

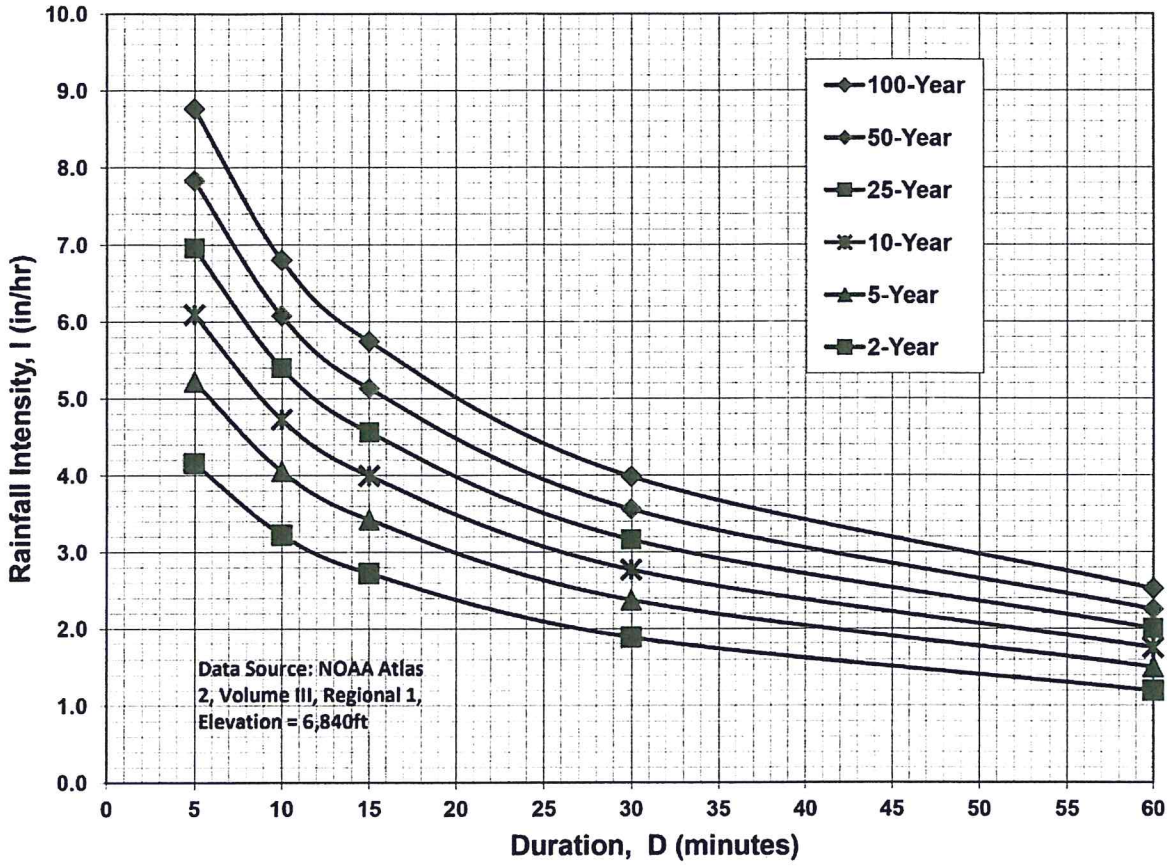
9 Hydrologic Calculations

Runoff Coefficients and Percent Imperviousness Table 6-6
Colorado Springs Rainfall Intensity Duration Frequency Table 6-5
Hydrologic Calculations Summary Form SF-1 for Existing & Developed Conditions
Hydrologic Calculations Summary 5-yr Form SF-2 for Existing & Developed Conditions
Hydrologic Calculations Summary 100-yr Form SF-2 for Existing & Developed Conditions

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.: **61093**
Project: **Townhomes at Bradley Crossroads**

Date: **10/19/18 3:06**
Calcs By: **TJW**
Checked By:

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

Sub-Basin	Sub-Basin Data				Overland			Shallow Channel				Channelized				t_c Check		t_c
	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)	(min)
A1	0.21	0.49	0.65	55%	23	1%	5.3	25	0.060	4.9	0.1	0	0.000	0.0	0.0	48	10.3	5.4
A2	0.20	0.50	0.65	56%	23	1%	5.2	25	0.060	4.9	0.1	0	0.000	0.0	0.0	48	10.3	5.3
A3	0.20	0.13	0.39	6%	39	8%	5.6	0	0.000	0.0	0.0	135	0.010	0.6	3.6	174	11.0	9.2
A4	0.34	0.75	0.84	87%	23	1%	3.0	95	0.010	2.0	0.8	130	0.010	1.5	1.4	248	11.4	5.2
A5	0.28	0.77	0.84	91%	23	1%	2.9	95	0.010	2.0	0.8	88	0.010	1.4	1.0	206	11.1	5.0
A6	0.50	0.74	0.84	85%	23	1%	3.1	140	0.014	2.4	1.0	98	0.015	1.9	0.8	261	11.5	5.0
A7	0.52	0.71	0.81	80%	23	1%	3.4	118	0.019	2.8	0.7	80	0.009	1.6	0.9	221	11.2	5.0
A8	0.33	0.77	0.85	90%	23	1%	2.8	115	0.011	2.1	0.9	106	0.009	1.5	1.2	244	11.4	5.0
A9	0.28	0.77	0.84	91%	23	1%	2.9	98	0.014	2.4	0.7	79	0.009	1.4	1.0	200	11.1	5.0
A10	0.49	0.76	0.85	87%	23	1%	3.0	138	0.013	2.3	1.0	102	0.012	1.8	1.0	263	11.5	5.0
A11	0.38	0.76	0.85	88%	23	1%	2.9	118	0.015	2.5	0.8	83	0.014	1.8	0.8	224	11.2	5.0
A12	0.21	0.09	0.36	2%	20	15%	3.3	0	0.000	0.0	0.0	230	0.007	0.7	5.7	250	11.4	9.0
A13	1.09	0.24	0.46	21%	100	1%	17.6	113	0.014	0.8	2.3	201	0.015	2.4	1.4	414	12.3	12.3
OS-1	0.19	0.77	0.86	84%	24	2%	2.3	0	0.000	0.0	0.0	196	0.031	2.9	1.1	220	11.2	5.0
OS-2	1.02	0.72	0.82	78%	45	2%	3.7	137	0.011	2.1	1.1	238	0.011	2.8	1.4	420	12.3	6.2
OS-3	0.81	0.78	0.87	85%	48	1%	4.1	49	0.031	3.5	0.2	146	0.010	2.6	0.9	243	11.4	5.2

Job No.: **61093**
Project: **Townhomes at Bradley Crossroads**
Design Storm: **5-Year Storm** *(20% Probability)*
Jurisdiction: **DCM**

Date: **10/19/18 13:45**
Calcs By: **TJW**
Checked By:

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

DP	Sub-Basin	Area (Acres)	C5	Direct Runoff t_c (min)	Direct Runoff CA (Acres)	Direct Runoff I5 (in/hr)	Direct Runoff Q5 (cfs)	Combined Runoff t_c (min)	Combined Runoff CA (Acres)	Combined Runoff I5 (in/hr)	Combined Runoff Q5 (cfs)	Streetflow Slope (%)	Streetflow Length (ft)	Streetflow Q (cfs)	Pipe Flow Q (cfs)	Pipe Flow Slope (%)	Pipe Flow Mnngs n	Pipe Flow Length (ft)	Pipe Flow D_{Pipe} (in)	Travel Time Length (ft)	Travel Time v_{Osc} (ft/s)	Travel Time t_t (min)
	OS-1	0.19	0.77	5.0	0.15	5.17	0.8															
	OS-2	1.02	0.72	6.2	0.73	4.85	3.6															
	OS-3	0.81	0.78	5.2	0.63	5.11	3.2															
	A1	0.21	0.49	5.4	0.10	5.06	0.5															
	A2	0.20	0.50	5.3	0.10	5.09	0.5															
DP1	OS-2,OS-3,A1,A2	2.25	0.70					7.1	1.57	4.64	7.3											
	A3	0.20	0.13	9.2	0.03	4.26	0.1															
	A4	0.34	0.75	5.2	0.26	5.10	1.3															
	A5	0.28	0.77	5.0	0.21	5.17	1.1															
DP2		0.62	0.76					6.4	0.47	4.80	2.2											
DP3		3.07	0.67					8.2	2.06	4.43	9.1											
	A6	0.50	0.74	5.0	0.37	5.17	1.9															
	A7	0.52	0.71	5.0	0.37	5.17	1.9															
DP4		1.02	0.73					6.1	0.74	4.88	3.6											
	A8	0.33	0.77	5.0	0.25	5.17	1.3															
	A9	0.28	0.77	5.0	0.21	5.17	1.1															
DP5		0.60	0.77					6.2	0.46	4.84	2.2											
	A10	0.49	0.76	5.0	0.37	5.17	1.9															
	A11	0.38	0.76	5.0	0.29	5.17	1.5															
DP6		0.88	0.76					6.1	0.67	4.88	3.2											
	A12	0.21	0.09	9.0	0.02	4.29	0.1															
DP7		5.78	0.68					9.8	3.95	4.15	16.4											
	A13	1.09	0.24	12.3	0.26	3.82	1.0															
DP8		6.87	0.61					9.9	4.21	4.14	17.4											

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

Job No.: **61093**
Project: **Townhomes at Bradley Crossroads**
Design Storm: **100-Year Storm** *(1% Probability)*
Jurisdiction: **DCM**

Date: **10/19/18 13:45**
Calcs By: **TJW**
Checked By:

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

DP	Sub-Basin	Area (Acres)	C100	Direct Runoff t_c (min)	Direct Runoff CA (Acres)	Direct Runoff I100 (in/hr)	Direct Runoff Q100 (cfs)	Combined Runoff t_c (min)	Combined Runoff CA (Acres)	Combined Runoff I100 (in/hr)	Combined Runoff Q100 (cfs)	Streetflow Slope (%)	Streetflow Length (ft)	Streetflow Q (cfs)	Pipe Flow Q (cfs)	Pipe Flow Slope (%)	Pipe Flow Mnngs n	Pipe Flow Length (ft)	Pipe Flow D_{Pipe} (in)	Travel Time Length (ft)	Travel Time v_{Osc} (ft/s)	Travel Time t_t (min)
	OS-1	0.19	0.86	5.0	0.17	8.68	1.4															
	OS-2	1.02	0.82	6.2	0.84	8.15	6.9															
	OS-3	0.81	0.87	5.2	0.70	8.58	6.0															
	A1	0.21	0.65	5.4	0.14	8.50	1.2															
	A2	0.20	0.65	5.3	0.13	8.54	1.1															
DP1	OS-2,OS-3,A1,A2	2.25	0.81					7.1	1.81	7.78	14.1											
	A3	0.20	0.39	9.2	0.08	7.15	0.6															
	A4	0.34	0.84	5.2	0.29	8.57	2.5															
	A5	0.28	0.84	5.0	0.23	8.68	2.0															
DP2		0.62	0.84					6.4	0.52	8.06	4.2											
DP3		3.07	0.79					8.2	2.41	7.44	17.9											
	A6	0.50	0.84	5.0	0.42	8.68	3.6															
	A7	0.52	0.81	5.0	0.42	8.68	3.7															
DP4		1.02	0.82					6.1	0.84	8.19	6.9											
	A8	0.33	0.85	5.0	0.28	8.68	2.4															
	A9	0.28	0.84	5.0	0.23	8.68	2.0															
DP5		0.60	0.85					6.2	0.51	8.13	4.2											
	A10	0.49	0.85	5.0	0.42	8.68	3.6															
	A11	0.38	0.85	5.0	0.33	8.68	2.8															
DP6		0.88	0.85					6.1	0.74	8.19	6.1											
	A12	0.21	0.36	9.0	0.08	7.20	0.6															
DP7		5.78	0.79					9.8	4.58	6.97	32.0											
	A13	1.09	0.46	12.3	0.50	6.41	3.2															
DP8		6.87	0.74					9.9	5.09	6.95	35.3											

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

Sub-Basin OS-1 Runoff Calculations

Job No.:	61093	Date:	10/19/18 3:06
Project:	Townhomes at Bradley Crossroads	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Roofs			0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	6,973	0.16	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	1,376	0.03	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**8,349**	**0.19**	**0.75**	**0.77**	**0.80**	**0.83**	**0.84**	**0.86**	**83.8%**
	8349								

Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$ = 100 ft C_v = 20

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	220	6	-	-	-	-	
Initial Time	24	0	0.020	-	2.3	11.2	DCM Eq. 6-8
Shallow Channel			0.000	0.0	0.0	-	DCM Eq. 6-9
Channelized	196	6	0.031	2.9	1.1	-	C&G
				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)	0.6	**0.8**	0.9	1.1	1.3	**1.4**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.6	**0.8**	0.9	1.1	1.3	**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

Sub-Basin OS-2 Runoff Calculations

Job No.:	61093	Date:	10/19/18 3:06
Project:	Townhomes at Bradley Crossroads	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	Imperv.
Roofs			0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	34,551	0.79	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	10,072	0.23	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**44,623**	**1.02**	**0.70**	**0.72**	**0.75**	**0.79**	**0.81**	**0.82**	**77.9%**
	44623								

Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$: 100 ft C_v: 20

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	420	5	-	-	-	-	
Initial Time	45	1	0.020	-	3.7	12.3	DCM Eq. 6-8
Shallow Channel	137	2	0.011	2.1	1.1	-	DCM Eq. 6-9
Channelized	238	3	0.011	2.8	1.4	-	C&G
				t_c	**6.2 min.**		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.87	4.85	5.66	6.47	7.28	8.15
Runoff (cfs)	2.8	**3.6**	4.4	5.2	6.0	**6.9**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	2.8	**3.6**	4.4	5.2	6.0	**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

Sub-Basin OS-3 Runoff Calculations

Job No.:	61093	Date:	10/19/18 3:06
Project:	Townhomes at Bradley Crossroads	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Roofs			0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	29,931	0.69	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	5,399	0.12	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**35,330**	**0.81**	**0.76**	**0.78**	**0.81**	**0.84**	**0.85**	**0.87**	**85.0%**
	35330								

Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$ 100 ft C_v 20

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	243	3	-	-	-	-	
Initial Time	48	0	0.010	-	4.1	11.4	DCM Eq. 6-8
Shallow Channel	49	2	0.031	3.5	0.2	-	DCM Eq. 6-9
Channelized	146	1	0.010	2.6	0.9	-	C&G
				t_c	**5.2 min.**		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	4.07	5.11	5.96	6.81	7.66	8.58
Runoff (cfs)	2.5	**3.2**	3.9	4.6	5.3	**6.0**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	2.5	**3.2**	3.9	4.6	5.3	**6.0**
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin A1 Runoff Calculations

Job No.:	61093	Date:	10/19/18 3:06
Project:	Townhomes at Bradley Crossroads	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Roofs	3,864	0.09	0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	1,458	0.03	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	3,807	0.09	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**9,129**	**0.21**	**0.46**	**0.49**	**0.54**	**0.59**	**0.62**	**0.65**	**54.9%**
	9129								

Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$ 100 ft C_v 20

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	48	2	-	-	-	-	
Initial Time	23	0	0.010	-	5.3	10.3	DCM Eq. 6-8
Shallow Channel	25	2	0.060	4.9	0.1	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				t_c	**5.4 min.**		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	4.04	5.06	5.91	6.75	7.60	8.50
Runoff (cfs)	0.4	**0.5**	0.7	0.8	1.0	**1.2**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.4	**0.5**	0.7	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

Sub-Basin A2 Runoff Calculations

Job No.:	61093	Date:	10/19/18 3:06
Project:	Townhomes at Bradley Crossroads	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Roofs	3,864	0.09	0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	1,352	0.03	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	3,497	0.08	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**8,713**	**0.20**	**0.47**	**0.50**	**0.54**	**0.60**	**0.63**	**0.65**	**56.2%**

8713

Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$ 100 ft C_v 20

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	48	2	-	-	-	-	
Initial Time	23	0	0.010	-	5.2	10.3	DCM Eq. 6-8
Shallow Channel	25	2	0.060	4.9	0.1	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				t_c	**5.3 min.**		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	4.05	5.09	5.93	6.78	7.63	8.54
Runoff (cfs)	0.4	**0.5**	0.6	0.8	1.0	**1.1**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.4	**0.5**	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

Sub-Basin A3 Runoff Calculations

Job No.:	61093	Date:	10/19/18 3:06
Project:	Townhomes at Bradley Crossroads	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Roofs	-	0.00	0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	393	0.01	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	8,514	0.20	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**8,907**	**0.20**	**0.07**	**0.13**	**0.20**	**0.29**	**0.34**	**0.39**	**6.3%**
	8907								

Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$: 100 ft C_v: 20

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	174	4	-	-	-	-	
Initial Time	39	3	0.077	-	5.6	11.0	DCM Eq. 6-8
Shallow Channel			0.000	0.0	0.0	-	DCM Eq. 6-9
Channelized	135	1	0.010	0.6	3.6	-	Trap Ditch
				t_c	**9.2 min.**		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.40	4.26	4.97	5.68	6.39	7.15
Runoff (cfs)	0.0	**0.1**	0.2	0.3	0.4	**0.6**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.0	**0.1**	0.2	0.3	0.4	**0.6**
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin A4 Runoff Calculations

Job No.:	61093	Date:	10/19/18 3:06
Project:	Townhomes at Bradley Crossroads	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Roofs	6,762	0.16	0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	6,817	0.16	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	1,269	0.03	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**14,848**	**0.34**	**0.73**	**0.75**	**0.78**	**0.81**	**0.83**	**0.84**	**87.1%**
	14848								

Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$: 100 ft C_v: 20

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	248	2	-	-	-	-	
Initial Time	23	0	0.010	-	3.0	11.4	DCM Eq. 6-8
Shallow Channel	95	1	0.010	2.0	0.8	-	DCM Eq. 6-9
Channelized	130	1	0.010	1.5	1.4	-	V-Ditch
				t_c	**5.2 min.**		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	4.07	5.10	5.95	6.80	7.66	8.57
Runoff (cfs)	1.0	**1.3**	1.6	1.9	2.2	**2.5**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.0	**1.3**	1.6	1.9	2.2	**2.5**
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

Sub-Basin A5 Runoff Calculations

Job No.:	61093	Date:	10/19/18 3:06
Project:	Townhomes at Bradley Crossroads	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Roofs	7,728	0.18	0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	3,884	0.09	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	368	0.01	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**11,980**	**0.28**	**0.75**	**0.77**	**0.79**	**0.82**	**0.83**	**0.84**	**90.5%**
	11980								

Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$ 100 ft C_v 20

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	206	2	-	-	-	-	
Initial Time	23	0	0.010	-	2.9	11.1	DCM Eq. 6-8
Shallow Channel	95	1	0.010	2.0	0.8	-	DCM Eq. 6-9
Channelized	88	1	0.010	1.4	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)	0.8	**1.1**	1.3	1.5	1.8	**2.0**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.8	**1.1**	1.3	1.5	1.8	**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

Sub-Basin A6 Runoff Calculations

Job No.:	61093	Date:	10/19/18 3:06
Project:	Townhomes at Bradley Crossroads	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Roofs	6,762	0.16	0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	12,186	0.28	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	2,729	0.06	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**21,677**	**0.50**	**0.73**	**0.74**	**0.77**	**0.80**	**0.82**	**0.84**	**84.5%**

21677

Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$ 100 ft C_v 20

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	261	4	-	-	-	-	
Initial Time	23	0	0.010	-	3.1	11.5	DCM Eq. 6-8
Shallow Channel	140	2	0.014	2.4	1.0	-	DCM Eq. 6-9
Channelized	98	2	0.015	1.9	0.8	-	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)	1.5	1.9	2.3	2.8	3.2	3.6
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.5	1.9	2.3	2.8	3.2	3.6
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin A7 Runoff Calculations

Job No.:	61093	Date:	10/19/18 3:06
Project:	Townhomes at Bradley Crossroads	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Roofs	7,728	0.18	0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	11,300	0.26	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	3,749	0.09	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**22,777**	**0.52**	**0.69**	**0.71**	**0.74**	**0.77**	**0.79**	**0.81**	**80.5%**

22777

Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$ = 100 ft C_v = 20

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	221	3	-	-	-	-	
Initial Time	23	0	0.010	-	3.4	11.2	DCM Eq. 6-8
Shallow Channel	118	2	0.019	2.8	0.7	-	DCM Eq. 6-9
Channelized	80	1	0.009	1.6	0.9	-	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)	1.5	1.9	2.3	2.8	3.2	3.7
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.5	1.9	2.3	2.8	3.2	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

Sub-Basin A8 Runoff Calculations

Job No.:	61093	Date:	10/19/18 3:06
Project:	Townhomes at Bradley Crossroads	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Roofs	7,728	0.18	0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	5,922	0.14	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	640	0.01	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**14,290**	**0.33**	**0.75**	**0.77**	**0.79**	**0.82**	**0.84**	**0.85**	**90.2%**
	14290								

Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$ = 100 ft C_v = 20

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	244	3	-	-	-	-	
Initial Time	23	0	0.010	-	2.8	11.4	DCM Eq. 6-8
Shallow Channel	115	1	0.011	2.1	0.9	-	DCM Eq. 6-9
Channelized	106	1	0.009	1.5	1.2	-	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)	1.0	**1.3**	1.6	1.9	2.1	**2.4**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.0	**1.3**	1.6	1.9	2.1	**2.4**
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin A9 Runoff Calculations

Job No.:	61093	Date:	10/19/18 3:06
Project:	Townhomes at Bradley Crossroads	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Roofs	7,728	0.18	0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	3,884	0.09	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	368	0.01	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**11,980**	**0.28**	**0.75**	**0.77**	**0.79**	**0.82**	**0.83**	**0.84**	**90.5%**
	11980								

Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$: 100 ft C_v: 20

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	200	2	-	-	-	-	
Initial Time	23	0	0.010	-	2.9	11.1	DCM Eq. 6-8
Shallow Channel	98	1	0.014	2.4	0.7	-	DCM Eq. 6-9
Channelized	79	1	0.009	1.4	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)	0.8	**1.1**	1.3	1.5	1.8	**2.0**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.8	**1.1**	1.3	1.5	1.8	**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

Sub-Basin A10 Runoff Calculations

Job No.:	61093	Date:	10/19/18 3:06
Project:	Townhomes at Bradley Crossroads	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Roofs	7,728	0.18	0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	11,558	0.27	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	2,127	0.05	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**21,413**	**0.49**	**0.74**	**0.76**	**0.78**	**0.81**	**0.83**	**0.85**	**86.7%**
	21413								

Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$: 100 ft C_v: 20

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	263	3	-	-	-	-	
Initial Time	23	0	0.010	-	3.0	11.5	DCM Eq. 6-8
Shallow Channel	138	2	0.013	2.3	1.0	-	DCM Eq. 6-9
Channelized	102	1	0.012	1.8	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)	1.5	1.9	2.3	2.8	3.2	3.6
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.5	1.9	2.3	2.8	3.2	3.6
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin A11 Runoff Calculations

Job No.:	61093	Date:	10/19/18 3:06
Project:	Townhomes at Bradley Crossroads	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Roofs	7,728	0.18	0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	7,780	0.18	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	1,232	0.03	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**16,740**	**0.38**	**0.74**	**0.76**	**0.79**	**0.82**	**0.83**	**0.85**	**88.2%**
	16740								

Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$ 100 ft C_v 20

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	224	3	-	-	-	-	
Initial Time	23	0	0.010	-	2.9	11.2	DCM Eq. 6-8
Shallow Channel	118	2	0.015	2.5	0.8	-	DCM Eq. 6-9
Channelized	83	1	0.014	1.8	0.8	-	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)	1.2	**1.5**	1.8	2.2	2.5	**2.8**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.2	**1.5**	1.8	2.2	2.5	**2.8**
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin A12 Runoff Calculations

Job No.:	61093	Date:	10/19/18 3:06
Project:	Townhomes at Bradley Crossroads	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Roofs			0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks			0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	9,251	0.21	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**9,251**	**0.21**	**0.03**	**0.09**	**0.17**	**0.26**	**0.31**	**0.36**	**2.0%**
	9251								

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$ = 100 ft C_v = 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	250	5	-	-	-	-	
Initial Time	20	3	0.150	-	3.3	11.4	DCM Eq. 6-8
Shallow Channel			0.000	0.0	0.0	-	DCM Eq. 6-9
Channelized	230	2	0.007	0.7	5.7	-	Trap 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	5.00	5.72	6.43	7.20
Runoff (cfs)	0.0	**0.1**	0.2	0.3	0.4	**0.6**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.0	**0.1**	0.2	0.3	0.4	**0.6**
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin A13 Runoff Calculations

Job No.:	61093	Date:	10/19/18 3:06
Project:	Townhomes at Bradley Crossroads	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Roofs	7,728	0.18	0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	2,409	0.06	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	37,250	0.86	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**47,387**	**1.09**	**0.18**	**0.24**	**0.30**	**0.38**	**0.42**	**0.46**	**21.3%**
	47387								

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$: 100 ft C_v: 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	414	5	-	-	-	-	
Initial Time	100	1	0.007	-	17.6	12.3	DCM Eq. 6-8
Shallow Channel	113	2	0.014	0.8	2.3	-	DCM Eq. 6-9
Channelized	201	3	0.015	2.4	1.4	-	V-Ditch
				t_c	**12.3 min.**		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.05	3.82	4.46	5.09	5.73	6.41
Runoff (cfs)	0.6	**1.0**	1.5	2.1	2.6	**3.2**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.6	**1.0**	1.5	2.1	2.6	**3.2**
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

Combined Sub-Basin Runoff Calculations (DP1)

Includes Basins A1 A2 OS-2 OS-3

Job No.:	**61093**	Date:	**10/19/18 3:26**
Project:	**Townhomes at Bradley Crossroads**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Roofs	7,728	0.18	0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	67,292	1.54	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	22,775	0.52	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**97,795**	**2.25**	**0.68**	**0.70**	**0.73**	**0.77**	**0.79**	**0.81**	**76.4%**

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	OS-2	-	420	5	-	-	-	-	6.2
Channelized-1	C&G	Concrete	154	1	7	0	0	2.7	1.0
Channelized-2									
Channelized-3									
Total			574	6					
								t_c (min)	**7.1**

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)	3.70	4.64	5.41	6.18	6.95	7.78
Site Runoff (cfs)	5.61	**7.26**	8.89	10.67	12.32	**14.12**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**7.3**	-	-	-	**14.1**
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.

Combined Sub-Basin Runoff Calculations (DP2)

Includes Basins A4 A5

Job No.:	61093	Date:	10/19/18 3:26
Project:	Townhomes at Bradley Crossroads	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	Imperv.
Roofs	14,490	0.33	0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	10,701	0.25	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	1,637	0.04	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**26,828**	**0.62**	**0.74**	**0.76**	**0.78**	**0.81**	**0.83**	**0.84**	**88.6%**

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	A4	-	248	2	-	-	-	-	5.2
Channelized-1	V-Ditch	1	180	2	2	0	2	2.5	1.2
Channelized-2									
Channelized-3									
Total			428	4					

1 = Man-made, Smooth, Straight

t_c (min) **6.4**

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)	3.83	4.80	5.60	6.40	7.20	8.06
Site Runoff (cfs)	1.74	**2.24**	2.70	3.20	3.68	**4.18**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**2.2**	-	-	-	**4.2**
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

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

Combined Sub-Basin Runoff Calculations (DP3)

Includes Basins DP1 DP2 A3

Job No.:	61093	Date:	10/19/18 3:26
Project:	Townhomes at Bradley Crossroads	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	Imperv.
Roofs	22,218	0.51	0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	78,386	1.80	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	32,926	0.76	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**133,530**	**3.07**	**0.65**	**0.67**	**0.71**	**0.75**	**0.77**	**0.79**	**74.2%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	DP1	-	574	6	-	-	-	-	7.1
Channelized-1	Trap Ditch	4	172	1	14	2	2	2.7	1.1
Channelized-2									
Channelized-3									
Total			746	8					

4 = Riprap

t_c (min) **8.2**

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)	3.53	4.43	5.17	5.91	6.64	7.44
Site Runoff (cfs)	7.02	**9.12**	11.20	13.50	15.63	**17.94**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**9.1**	-	-	-	**17.9**
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

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

Combined Sub-Basin Runoff Calculations (DP4)

Includes Basins A6 A7

Job No.:	61093	Date:	10/19/18 3:26
Project:	Townhomes at Bradley Crossroads	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Roofs	14,490	0.33	0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	23,486	0.54	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	6,478	0.15	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**44,454**	**1.02**	**0.71**	**0.73**	**0.76**	**0.79**	**0.81**	**0.82**	**82.5%**

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	A6	-	261	4	-	-	-	-	5.0
Channelized-1	V-Ditch	1	180	2	4	0	2	2.8	1.1
Channelized-2									
Channelized-3									
Total			441	6					

1 = Man-made, Smooth, Straight

t_c (min) **6.1**

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)	3.89	4.88	5.69	6.50	7.32	8.19
Site Runoff (cfs)	2.80	**3.62**	4.39	5.23	6.03	**6.88**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**3.6**	-	-	-	**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.

Combined Sub-Basin Runoff Calculations (DP5)

Includes Basins A8 A9

Job No.:	61093	Date:	10/19/18 3:26
Project:	Townhomes at Bradley Crossroads	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Roofs	15,456	0.35	0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	9,806	0.23	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	1,008	0.02	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**26,270**	**0.60**	**0.75**	**0.77**	**0.79**	**0.82**	**0.84**	**0.85**	**90.4%**

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	A8	-	244	3	-	-	-	-	5.0
Channelized-1	V-Ditch	1	180	2	2	0	2	2.5	1.2
Channelized-2									
Channelized-3									
Total			424	4					

1 = Man-made, Smooth, Straight

t_c (min) **6.2**

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)	3.86	4.84	5.65	6.46	7.27	8.13
Site Runoff (cfs)	1.75	**2.25**	2.70	3.19	3.67	**4.16**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**2.2**	-	-	-	**4.2**
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

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

Combined Sub-Basin Runoff Calculations (DP6)

Includes Basins A10 A11

Job No.:	**61093**	Date:	**10/19/18 3:26**
Project:	**Townhomes at Bradley Crossroads**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Roofs	15,456	0.35	0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	19,338	0.44	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	3,359	0.08	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**38,153**	**0.88**	**0.74**	**0.76**	**0.79**	**0.82**	**0.83**	**0.85**	**87.3%**

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	A10	-	263	3	-	-	-	-	5.0
Channelized-1	V-Ditch	1	185	2	4	0	2	2.9	1.1
Channelized-2									
Channelized-3									
Total			448	5					

1 = Man-made, Smooth, Straight

t_c (min) **6.1**

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)	3.89	4.88	5.69	6.50	7.32	8.19
Site Runoff (cfs)	2.53	**3.25**	3.91	4.64	5.34	**6.07**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**3.2**	-	-	-	**6.1**
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.

Combined Sub-Basin Runoff Calculations (DP7)

Includes Basins DP3 DP4 DP5 DP6 A12

Job No.:	**61093**	Date:	**10/19/18 3:26**
Project:	**Townhomes at Bradley Crossroads**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Roofs	67,620	1.55	0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	131,016	3.01	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	53,022	1.22	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**251,658**	**5.78**	**0.66**	**0.68**	**0.72**	**0.75**	**0.77**	**0.79**	**76.7%**

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	DP3	-	746	8	-	-	-	-	8.2
Channelized-1	Trap Ditch	4	265	3	18	5	3	2.7	1.6
Channelized-2									
Channelized-3									
Total			1,011	11					
		4 = Riprap						t_c (min)	**9.8**

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

Contributing Basins/Areas

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

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

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.31	4.15	4.85	5.54	6.23	6.97
Site Runoff (cfs)	12.65	**16.41**	20.06	24.12	27.90	**31.97**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**16.4**	-	-	-	**32.0**
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.

Combined Sub-Basin Runoff Calculations (DP8)

Includes Basins A13

Job No.:	61093	Date:	10/19/18 3:26
Project:	Townhomes at Bradley Crossroads	Calcs by:	TJW
		Checked by:	
Jurisdiction	DCM	Soil Type	B
Runoff Coefficient	Surface Type	Urbanization	Urban

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Roofs	7,728	0.18	0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	2,409	0.06	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	37,250	0.86	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**47,387**	**1.09**	**0.18**	**0.24**	**0.30**	**0.38**	**0.42**	**0.46**	**21.3%**

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	A13	-	414	5	-	-	-	-	12.3
Channelized-1									
Channelized-2									
Channelized-3									
Total			414	5					
								t_c (min)	12.3

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)	3.05	3.82	4.46	5.09	5.73	6.41
Site Runoff (cfs)	0.61	**0.98**	1.47	2.10	2.63	**3.24**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**1.0**	-	-	-	**3.2**
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

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

Combined Sub-Basin Runoff Calculations (DP8)

Includes Basins DP7 A13

Job No.:	**61093**	Date:	**10/19/18 13:45**
Project:	**Townhomes at Bradley Crossroads**	Calcs by:	**TJW**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Roofs	75,348	1.73	0.71	0.73	0.75	0.78	0.8	0.81	90%
Driveways & Walks	133,425	3.06	0.89	0.9	0.92	0.94	0.95	0.96	100%
Landscaping	90,272	2.07	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**299,045**	**6.87**	**0.59**	**0.61**	**0.65**	**0.69**	**0.72**	**0.74**	**67.9%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	DP7	-	1,011	11	-	-	-	-	9.8
Channelized-1	Pipe	RCP	55	1	32	2	0	8.4	0.1
Channelized-2									
Channelized-3									
Total			1,066	12					
								t_c (min)	**9.9**

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)	3.30	4.14	4.83	5.52	6.21	6.95
Site Runoff (cfs)	13.26	**17.40**	21.57	26.30	30.64	**35.34**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**17.4**	-	-	-	**35.3**
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

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

10 Hydraulic Calculations

Inlet Calculations
Storm Drain Pipe Calculations
Detention Pond Calculations

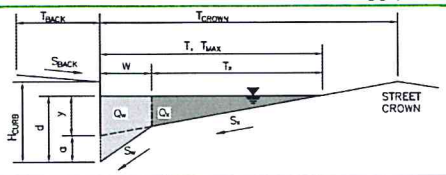
Version 4.05 Released March 2017

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: 61093 - The Townhomes at Bradley Crossroads

Inlet ID: OS-1



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	14.0	ft
Gutter Width	W =	4.00	ft
Street Transverse Slope	S_x =	0.040	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_w =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_o =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	6.0	14.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

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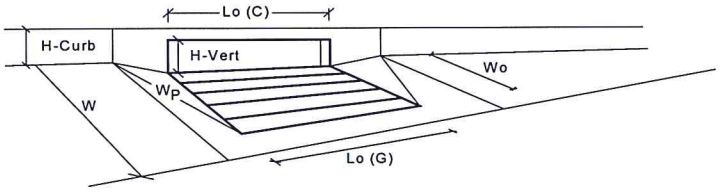

Design Information (Input)		MINOR	MAJOR	
Type of Inlet	CDOT Type C Grate	Type =	CDOT Type C Grate	
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local} =	0.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	4.9	6.0 inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate		L_o (G) =	2.92	feet
Width of a Unit Grate		W_o =	2.92	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A_{ratio} =	0.70	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C_f (G) =	0.50	0.50
Grate Weir Coefficient (typical value 2.15 - 3.60)		C_w (G) =	2.41	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C_o (G) =	0.67	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening		L_o (C) =	N/A	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	N/A	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	N/A	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	N/A	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W_p =	N/A	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		C_f (C) =	N/A	N/A
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C_w (C) =	N/A	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C_o (C) =	N/A	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth		d_{Grate} =	0.291	0.379 ft
Depth for Curb Opening Weir Equation		d_{Curb} =	N/A	N/A ft
Combination Inlet Performance Reduction Factor for Long Inlets		$RF_{Combination}$ =	N/A	N/A
Curb Opening Performance Reduction Factor for Long Inlets		RF_{Curb} =	N/A	N/A
Grated Inlet Performance Reduction Factor for Long Inlets		RF_{Grate} =	0.78	0.95
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)		Q_a =	1.1	2.0 **cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)		$Q_{PEAK\ REQUIRED}$ =	0.8	1.4 cfs

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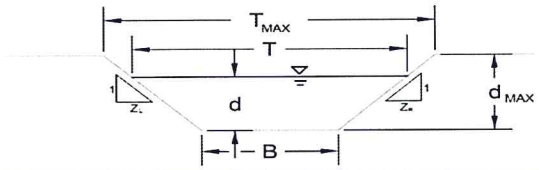
AREA INLET IN A SWALE

61093 - The Townhomes at Bradley Crossroads

DP8 Area Inlet



This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D or E	C	
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	see details below	
Channel Invert Slope	S_O =	0.0200	ft/ft
Bottom Width	B =	10.00	ft
Left Side Slope	Z1 =	50.00	ft/ft
Right Side Slope	Z2 =	4.00	ft/ft

Check one of the following soil types:

Soil Type:	Max. Velocity (V_{MAX})	Max Froude No. (F_{MAX})
Non-Cohesive	5.0 fps	0.60
Cohesive	7.0 fps	0.80
Paved	N/A	N/A

Choose One:
- (•) **Non-Cohesive**
- ( ) **Cohesive**
- ( ) **Paved**

		Minor Storm	Major Storm	
Max. Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	40.00	50.00	feet
Max. Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	0.50	1.00	feet

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	2.7	12.7	cfs
MAJOR STORM Allowable Capacity is based on Top Width Criterion	d_{allow} =	0.50	0.74	ft

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	1.0	3.2	cfs
Water Depth	d =	0.31	0.54	feet

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Version 4.05 Released March 2017

AREA INLET IN A SWALE

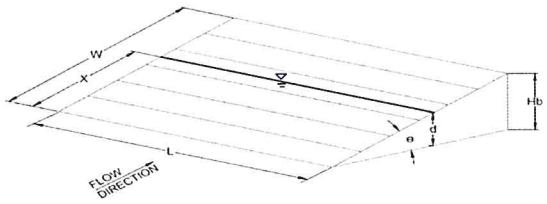
61093 - The Townhomes at Bradley Crossroads

DP8 Area Inlet

Inlet Design Information (Input)

Type of Inlet: User-Defined

Inlet Type = User-Defined



Angle of Inclined Grate (must be <= 30 degrees)	θ =	0.00 degrees
Width of Grate	W =	3.00 feet
Length of Grate	L =	10.00 feet
Open Area Ratio	A_{RATIO} =	0.70
Height of Inclined Grate	H_B =	0.00 feet
Clogging Factor	C_f =	0.50
Grate Discharge Coefficient	C_d =	N/A
Orifice Coefficient	C_o =	0.64
Weir Coefficient	C_w =	2.05

		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	0.31	0.54	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**7.5**	**17.4**	**cfs**
	Bypassed Flow, Q_b =	**0.0**	**0.0**	**cfs**
	Capture Percentage = Q_a/Q_o = C%	**100**	**100**	**%**

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Oct 19 2018

North Curb flowing to DP1 (14.1 cfs)

Gutter

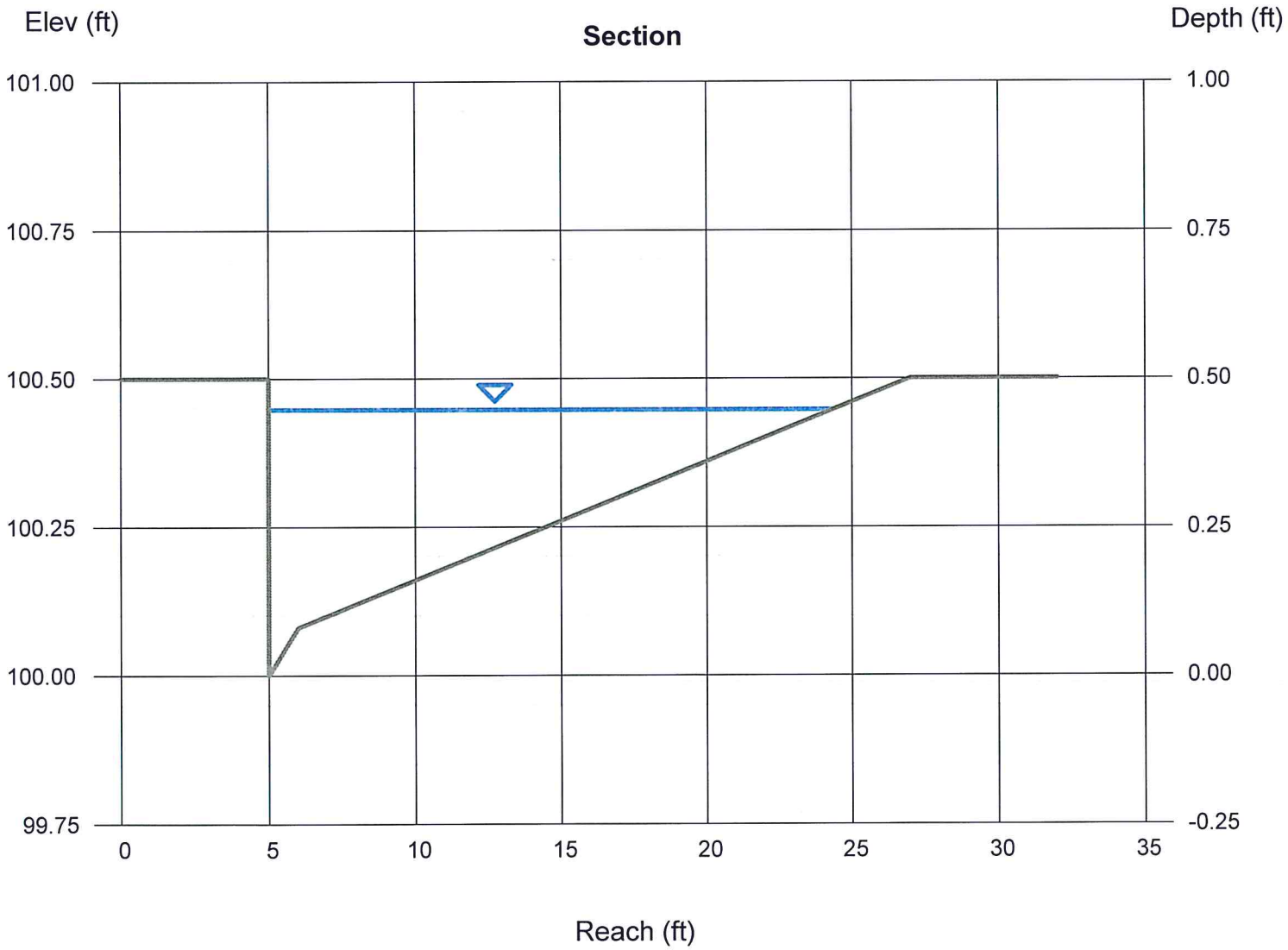
Cross Sl, Sx (ft/ft)	= 0.020
Cross Sl, Sw (ft/ft)	= 0.080
Gutter Width (ft)	= 1.00
Invert Elev (ft)	= 100.00
Slope (%)	= 1.00
N-Value	= 0.016

Calculations

Compute by:	Known Q
Known Q (cfs)	= 14.10

Highlighted

Depth (ft)	= 0.45
Q (cfs)	= 14.10
Area (sqft)	= 3.77
Velocity (ft/s)	= 3.74
Wetted Perim (ft)	= 19.80
Crit Depth, Yc (ft)	= 0.52
Spread Width (ft)	= 19.35
EGL (ft)	= 0.66



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Oct 19 2018

DP1 - Concrete Pan 100 YR Flow (17.9 cfs)

Trapezoidal

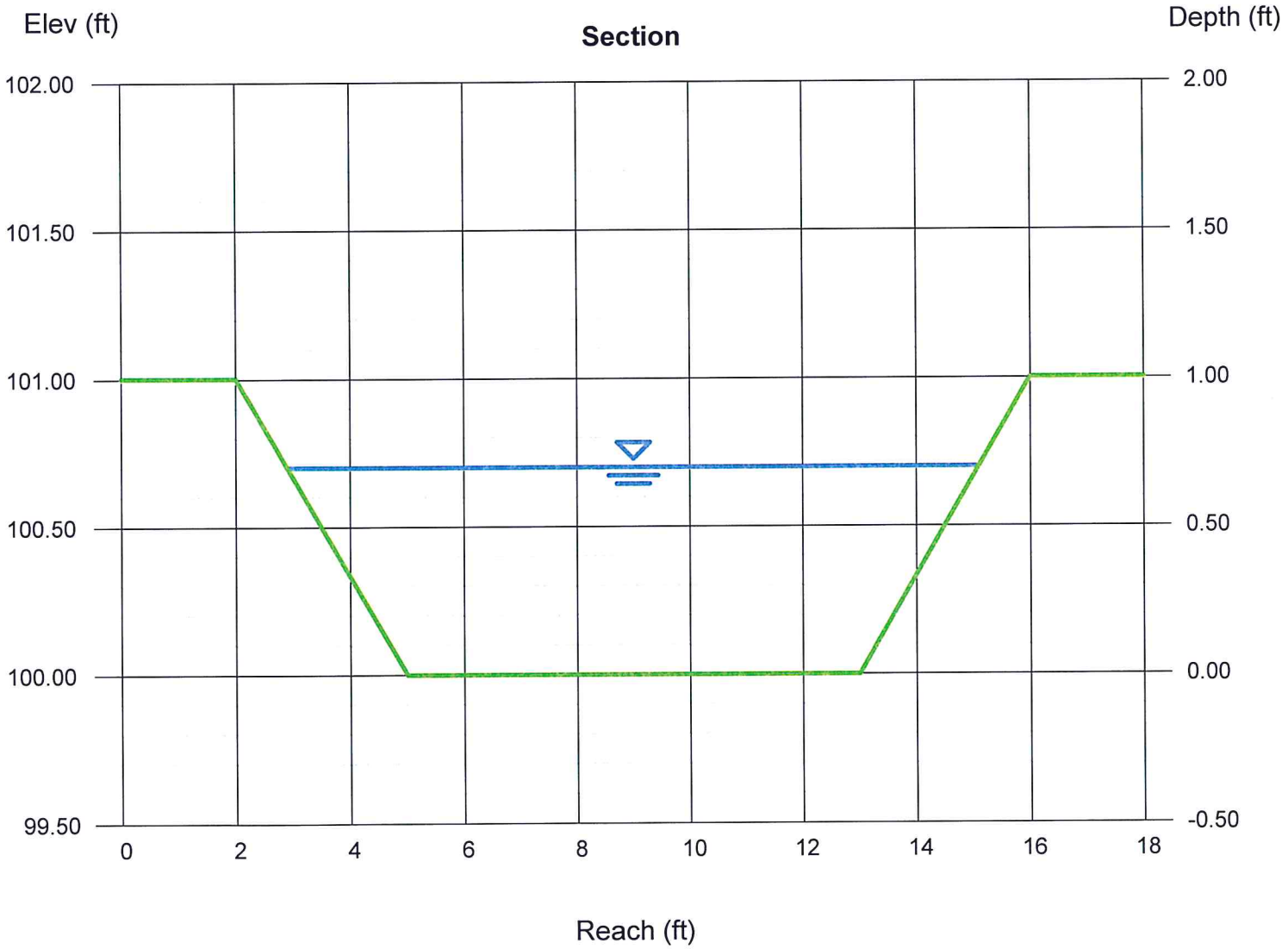
Bottom Width (ft)	= 8.00
Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 1.00
Invert Elev (ft)	= 100.00
Slope (%)	= 1.00
N-Value	= 0.040

Calculations

Compute by:	Known Q
Known Q (cfs)	= 17.90

Highlighted

Depth (ft)	= 0.70
Q (cfs)	= 17.90
Area (sqft)	= 7.07
Velocity (ft/s)	= 2.53
Wetted Perim (ft)	= 12.43
Crit Depth, Yc (ft)	= 0.51
Top Width (ft)	= 12.20
EGL (ft)	= 0.80



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Oct 19 2018

DP2 Alley Trapazoidal Ditch 100 YR Flow (4.2 cfs)

Triangular

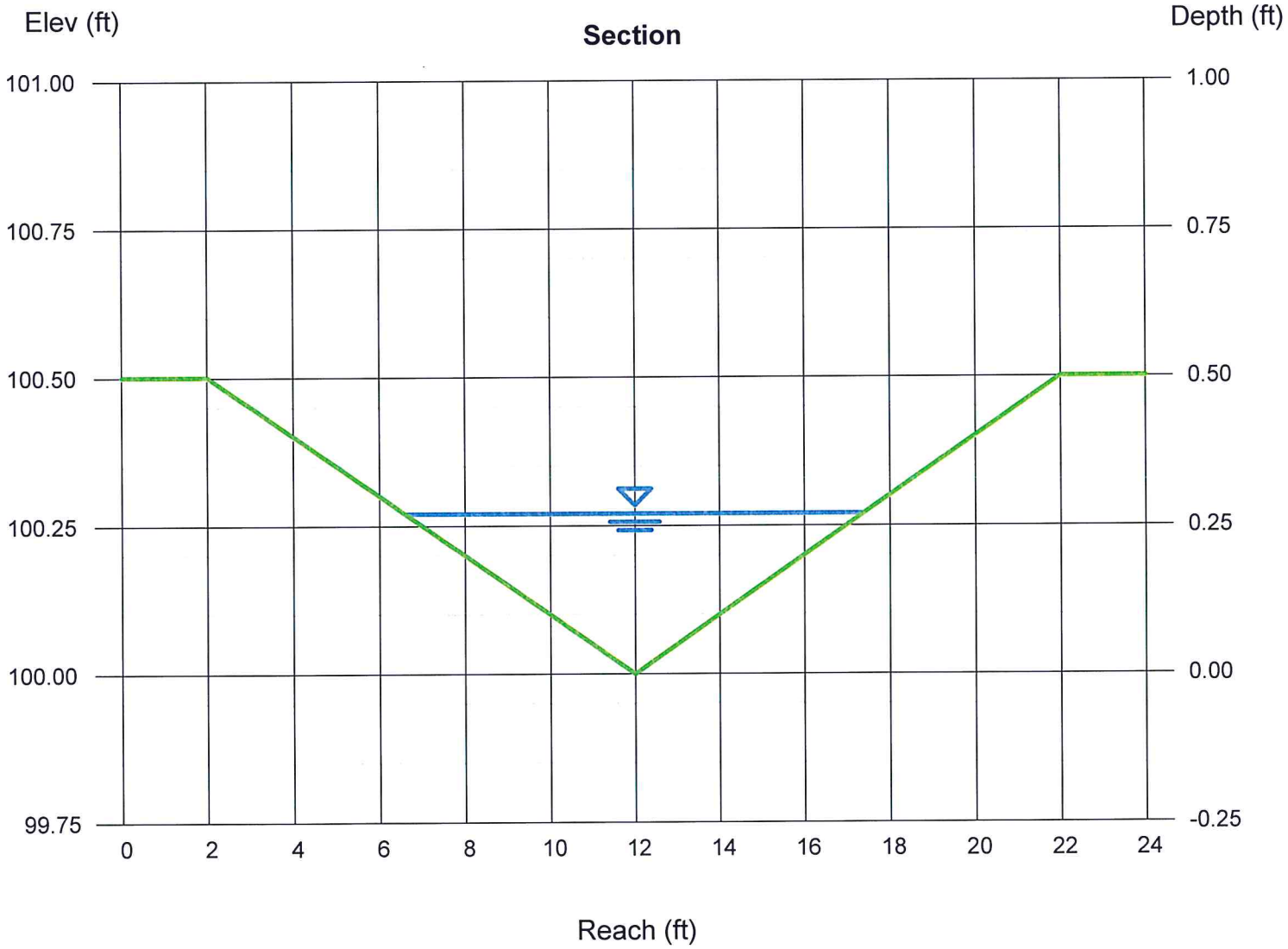
Side Slopes (z:1)	= 20.00, 20.00
Total Depth (ft)	= 0.50
Invert Elev (ft)	= 100.00
Slope (%)	= 0.80
N-Value	= 0.011

Calculations

Compute by:	Known Q
Known Q (cfs)	= 4.20

Highlighted

Depth (ft)	= 0.27
Q (cfs)	= 4.200
Area (sqft)	= 1.46
Velocity (ft/s)	= 2.88
Wetted Perim (ft)	= 10.81
Crit Depth, Yc (ft)	= 0.31
Top Width (ft)	= 10.80
EGL (ft)	= 0.40



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Oct 19 2018

DP2 Alley Curb Opening 100 YR Flow (4.2 cfs)

Trapezoidal

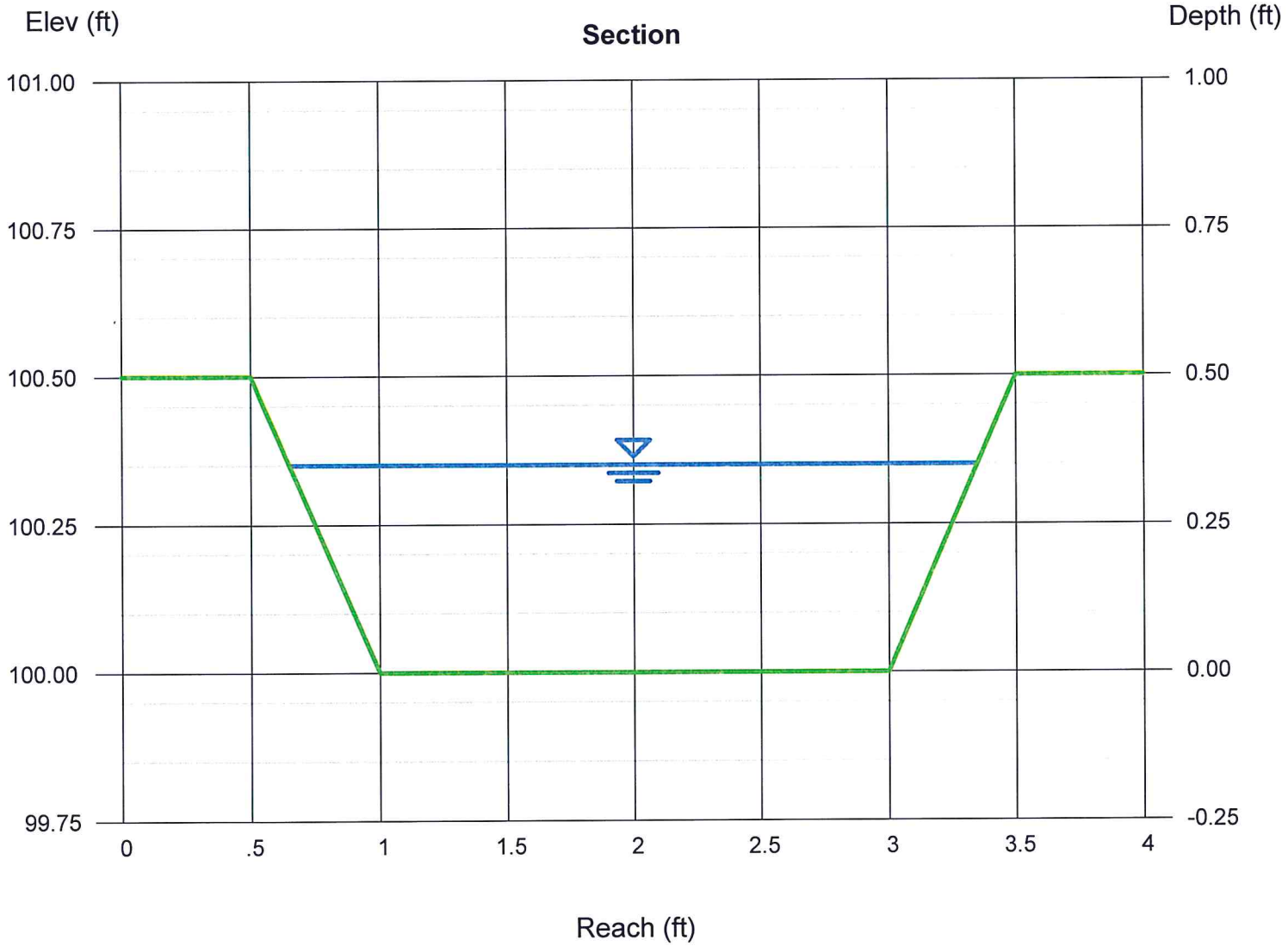
Bottom Width (ft)	= 2.00
Side Slopes (z:1)	= 1.00, 1.00
Total Depth (ft)	= 0.50
Invert Elev (ft)	= 100.00
Slope (%)	= 0.80
N-Value	= 0.011

Calculations

Compute by:	Known Q
Known Q (cfs)	= 4.20

Highlighted

Depth (ft)	= 0.35
Q (cfs)	= 4.200
Area (sqft)	= 0.82
Velocity (ft/s)	= 5.11
Wetted Perim (ft)	= 2.99
Crit Depth, Yc (ft)	= 0.48
Top Width (ft)	= 2.70
EGL (ft)	= 0.76



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Oct 19 2018

Basin A3 Trapazoidal Ditch 100 YR Flow (17.9 cfs)

Trapezoidal

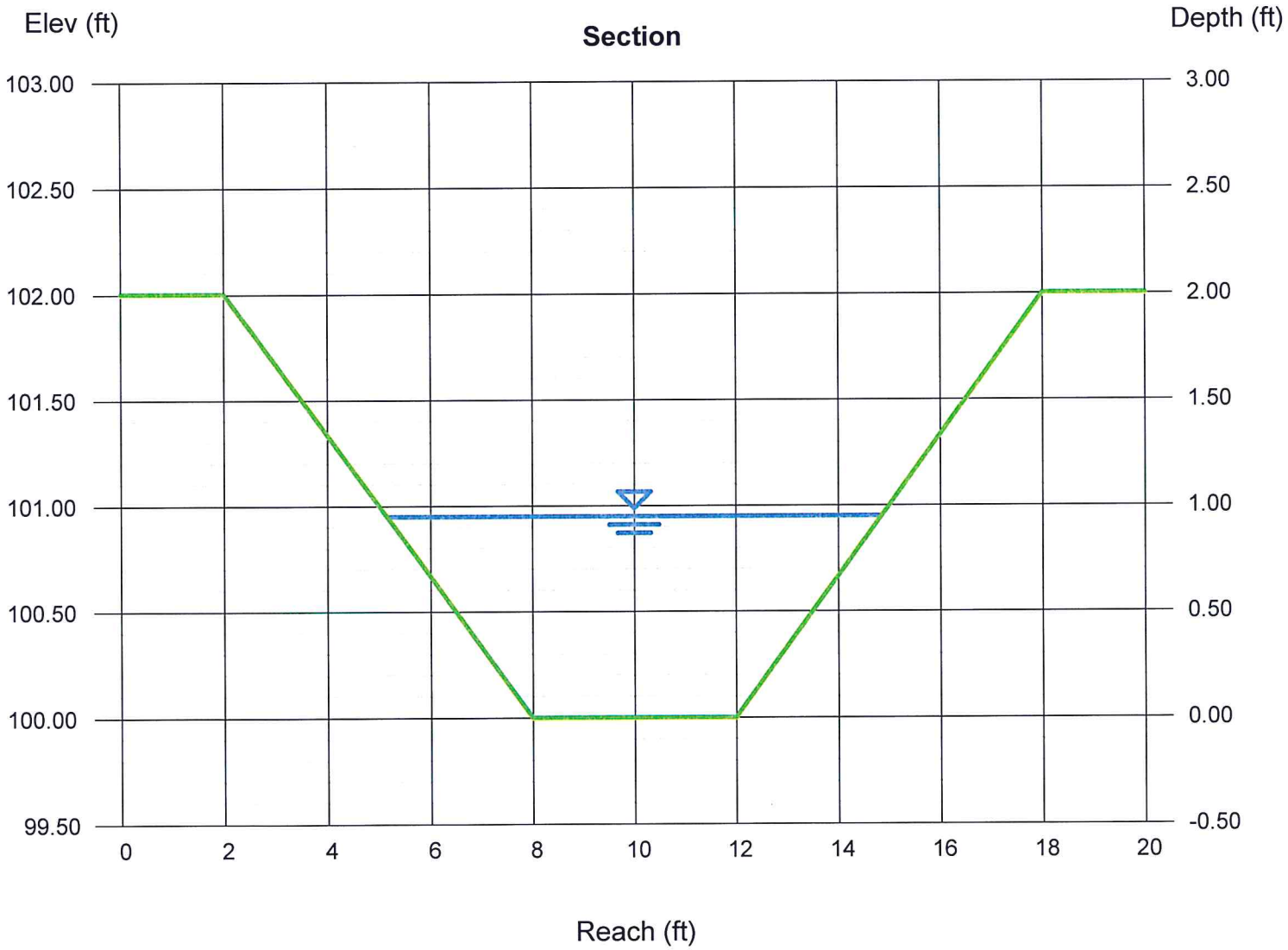
Bottom Width (ft)	= 4.00
Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 1.00
N-Value	= 0.040

Calculations

Compute by:	Known Q
Known Q (cfs)	= 17.90

Highlighted

Depth (ft)	= 0.95
Q (cfs)	= 17.90
Area (sqft)	= 6.51
Velocity (ft/s)	= 2.75
Wetted Perim (ft)	= 10.01
Crit Depth, Yc (ft)	= 0.71
Top Width (ft)	= 9.70
EGL (ft)	= 1.07



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Oct 19 2018

DP6 Cold Harbor Trapazoidal Ditch 100 YR Flow (6.9 cfs)

Triangular

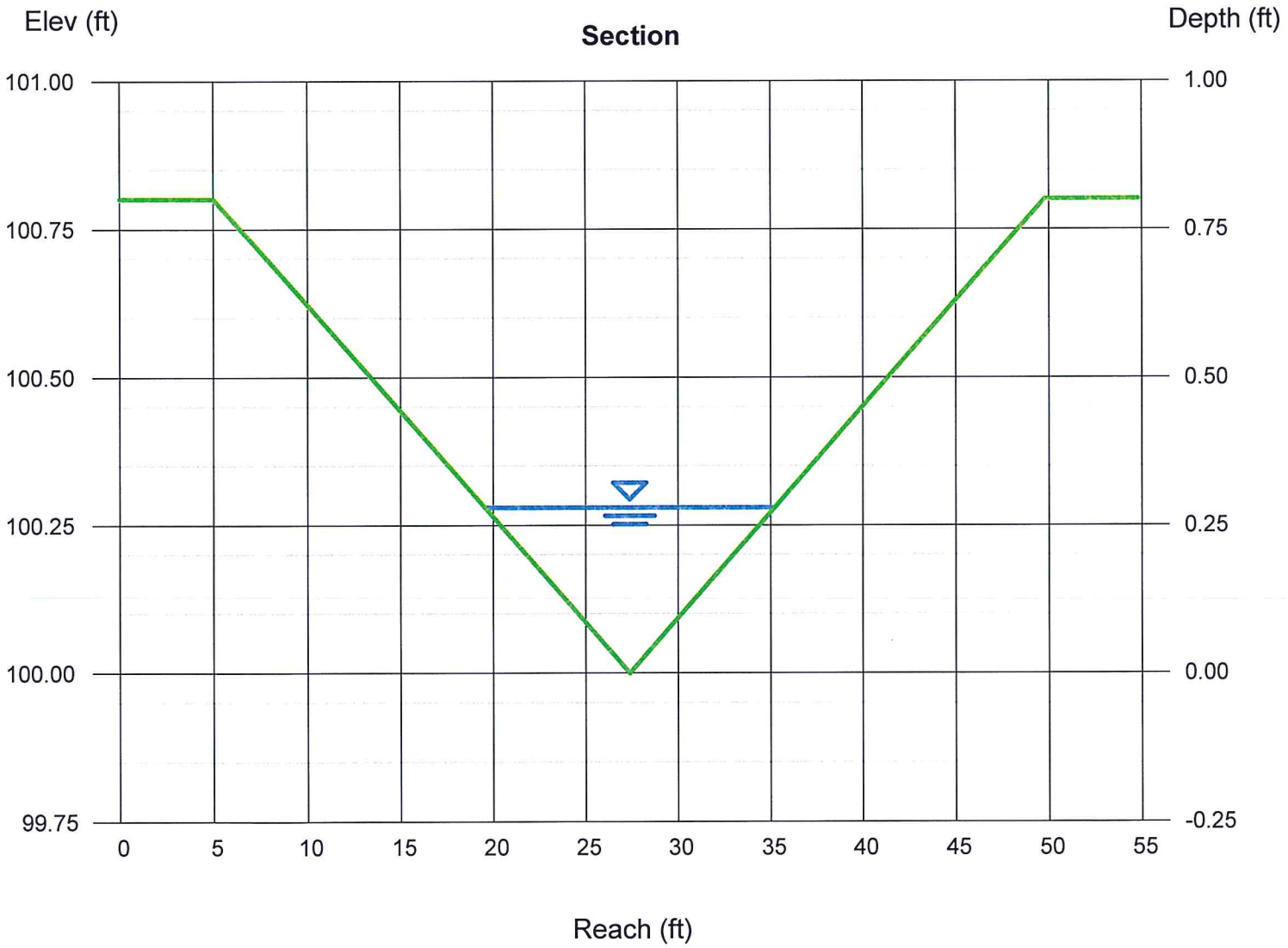
Side Slopes (z:1)	= 28.00, 28.00
Total Depth (ft)	= 0.80
Invert Elev (ft)	= 100.00
Slope (%)	= 0.80
N-Value	= 0.011

Calculations

Compute by:	Known Q
Known Q (cfs)	= 6.90

Highlighted

Depth (ft)	= 0.28
Q (cfs)	= 6.900
Area (sqft)	= 2.20
Velocity (ft/s)	= 3.14
Wetted Perim (ft)	= 15.69
Crit Depth, Yc (ft)	= 0.33
Top Width (ft)	= 15.68
EGL (ft)	= 0.43



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Oct 19 2018

DP3 - Texas Crossing 100 YR Flow (17.9 cfs)

Trapezoidal

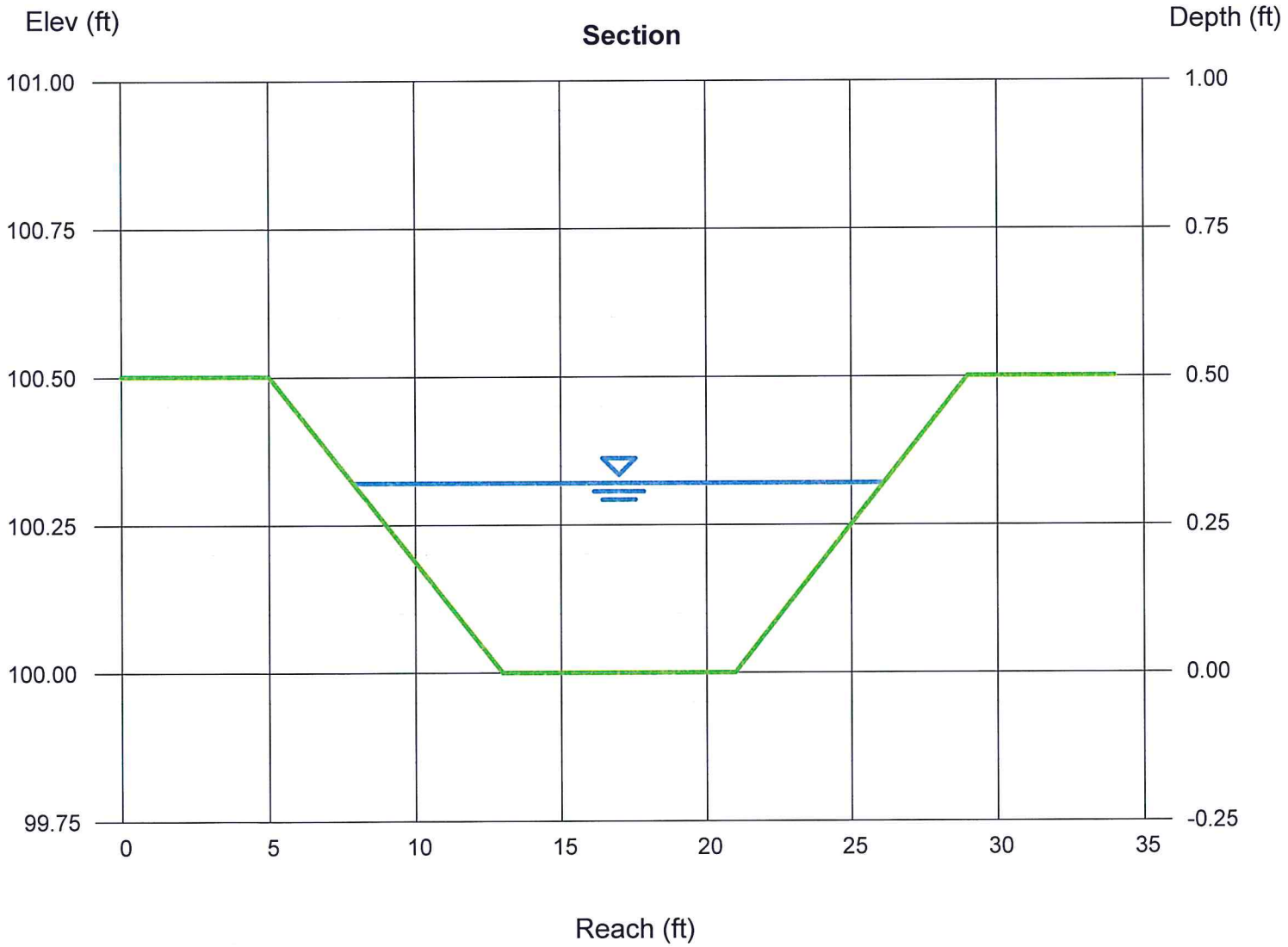
Bottom Width (ft)	= 8.00
Side Slopes (z:1)	= 16.00, 16.00
Total Depth (ft)	= 0.50
Invert Elev (ft)	= 100.00
Slope (%)	= 1.00
N-Value	= 0.013

Calculations

Compute by:	Known Q
Known Q (cfs)	= 17.90

Highlighted

Depth (ft)	= 0.32
Q (cfs)	= 17.90
Area (sqft)	= 4.20
Velocity (ft/s)	= 4.26
Wetted Perim (ft)	= 18.26
Crit Depth, Yc (ft)	= 0.41
Top Width (ft)	= 18.24
EGL (ft)	= 0.60



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Oct 19 2018

DP3 culvert entrance

Invert Elev Dn (ft)	= 39.13
Pipe Length (ft)	= 45.00
Slope (%)	= 1.02
Invert Elev Up (ft)	= 39.59
Rise (in)	= 12.0
Shape	= Circular
Span (in)	= 12.0
No. Barrels	= 3
n-Value	= 0.013
Culvert Type	= Circular Concrete
Culvert Entrance	= Square edge w/headwall (C)
Coeff. K,M,c,Y,k	= 0.0098, 2, 0.0398, 0.67, 0.5

Embankment

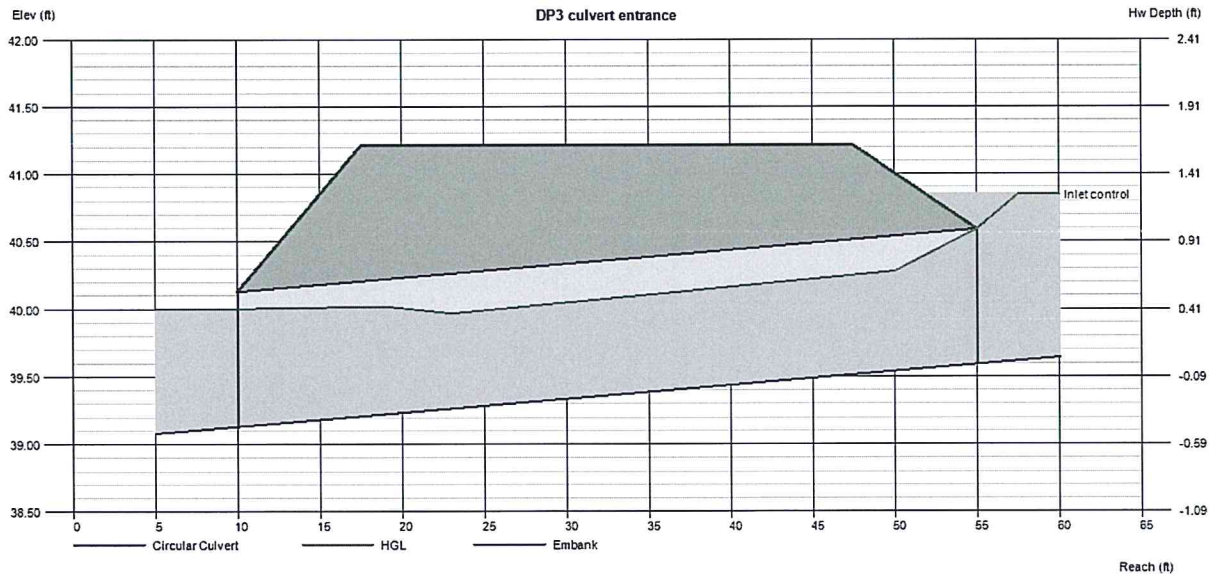
Top Elevation (ft)	= 41.21
Top Width (ft)	= 30.00
Crest Width (ft)	= 30.00

Calculations

Qmin (cfs)	= 9.10
Qmax (cfs)	= 18.10
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 9.10
Qpipe (cfs)	= 9.10
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 4.17
Veloc Up (ft/s)	= 4.83
HGL Dn (ft)	= 40.00
HGL Up (ft)	= 40.34
Hw Elev (ft)	= 40.85
Hw/D (ft)	= 1.26
Flow Regime	= Inlet Control



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Oct 19 2018

DP5 Alley Trapazoidal Ditch 100 YR Flow (4.2 cfs)

Triangular

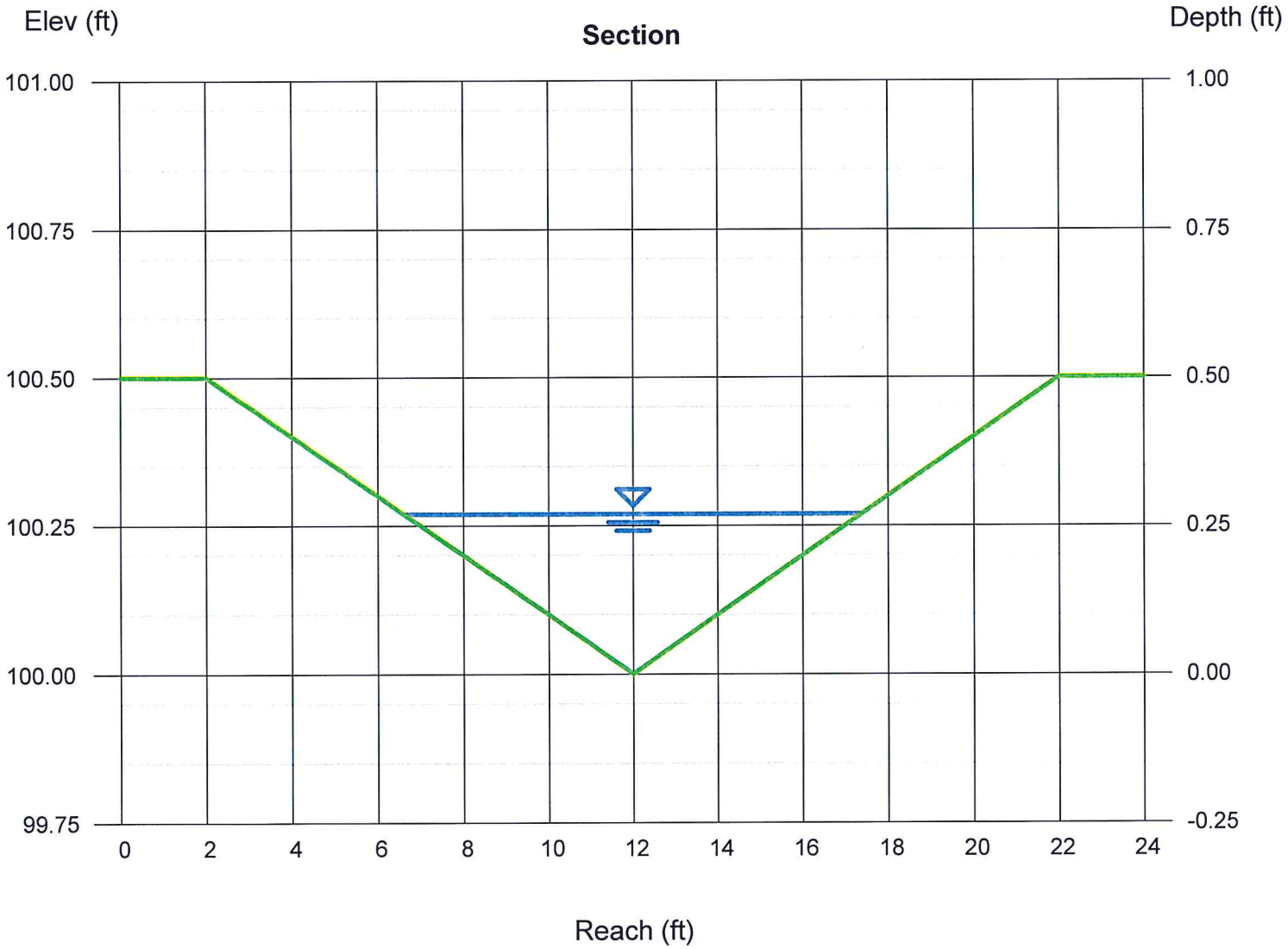
Side Slopes (z:1)	= 20.00, 20.00
Total Depth (ft)	= 0.50
Invert Elev (ft)	= 100.00
Slope (%)	= 0.80
N-Value	= 0.011

Calculations

Compute by:	Known Q
Known Q (cfs)	= 4.20

Highlighted

Depth (ft)	= 0.27
Q (cfs)	= 4.200
Area (sqft)	= 1.46
Velocity (ft/s)	= 2.88
Wetted Perim (ft)	= 10.81
Crit Depth, Yc (ft)	= 0.31
Top Width (ft)	= 10.80
EGL (ft)	= 0.40



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Oct 19 2018

DP5 Alley Curb Opening 100 YR Flow (4.2 cfs)

Trapezoidal

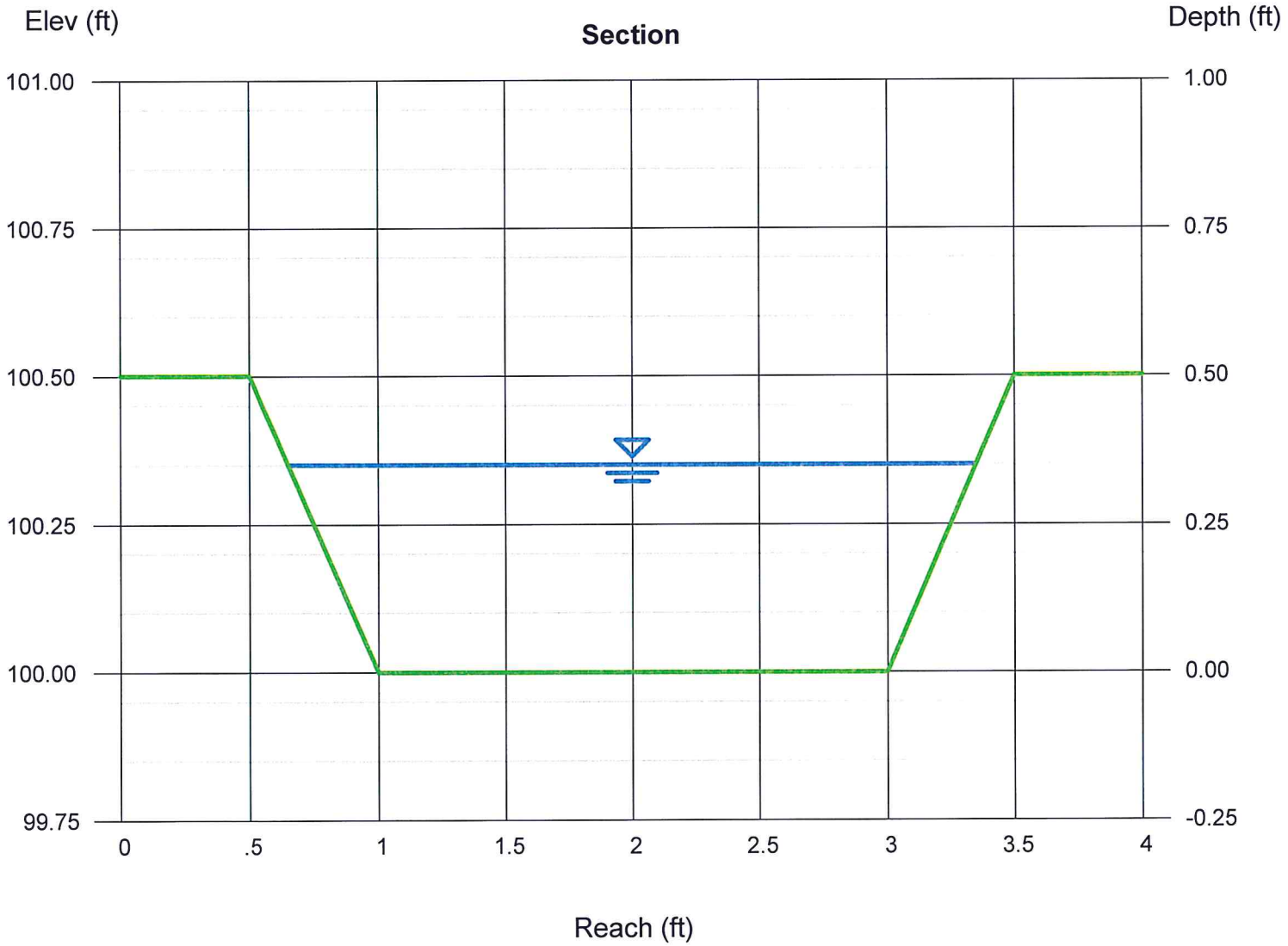
Bottom Width (ft)	= 2.00
Side Slopes (z:1)	= 1.00, 1.00
Total Depth (ft)	= 0.50
Invert Elev (ft)	= 100.00
Slope (%)	= 0.80
N-Value	= 0.011

Calculations

Compute by:	Known Q
Known Q (cfs)	= 4.20

Highlighted

Depth (ft)	= 0.35
Q (cfs)	= 4.200
Area (sqft)	= 0.82
Velocity (ft/s)	= 5.11
Wetted Perim (ft)	= 2.99
Crit Depth, Yc (ft)	= 0.48
Top Width (ft)	= 2.70
EGL (ft)	= 0.76



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Oct 19 2018

DP6 Alley Trapazoidal Ditch 100 YR Flow (6.1 cfs)

Triangular

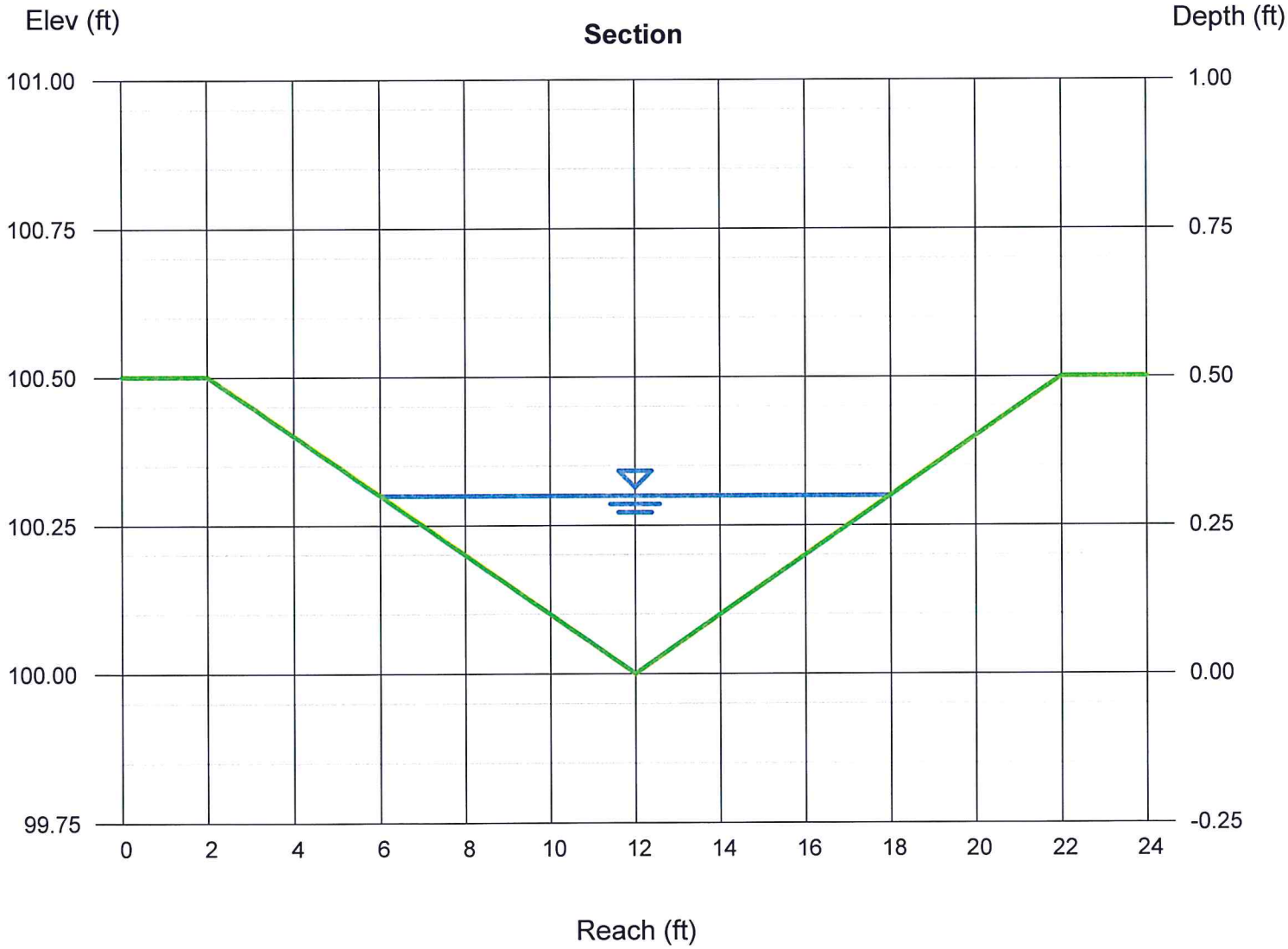
Side Slopes (z:1)	= 20.00, 20.00
Total Depth (ft)	= 0.50
Invert Elev (ft)	= 100.00
Slope (%)	= 0.80
N-Value	= 0.011

Calculations

Compute by:	Known Q
Known Q (cfs)	= 6.10

Highlighted

Depth (ft)	= 0.30
Q (cfs)	= 6.100
Area (sqft)	= 1.80
Velocity (ft/s)	= 3.39
Wetted Perim (ft)	= 12.01
Crit Depth, Yc (ft)	= 0.36
Top Width (ft)	= 12.00
EGL (ft)	= 0.48



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Oct 19 2018

DP6 Alley Curb Opening 100 YR Flow (4.2 cfs)

Trapezoidal

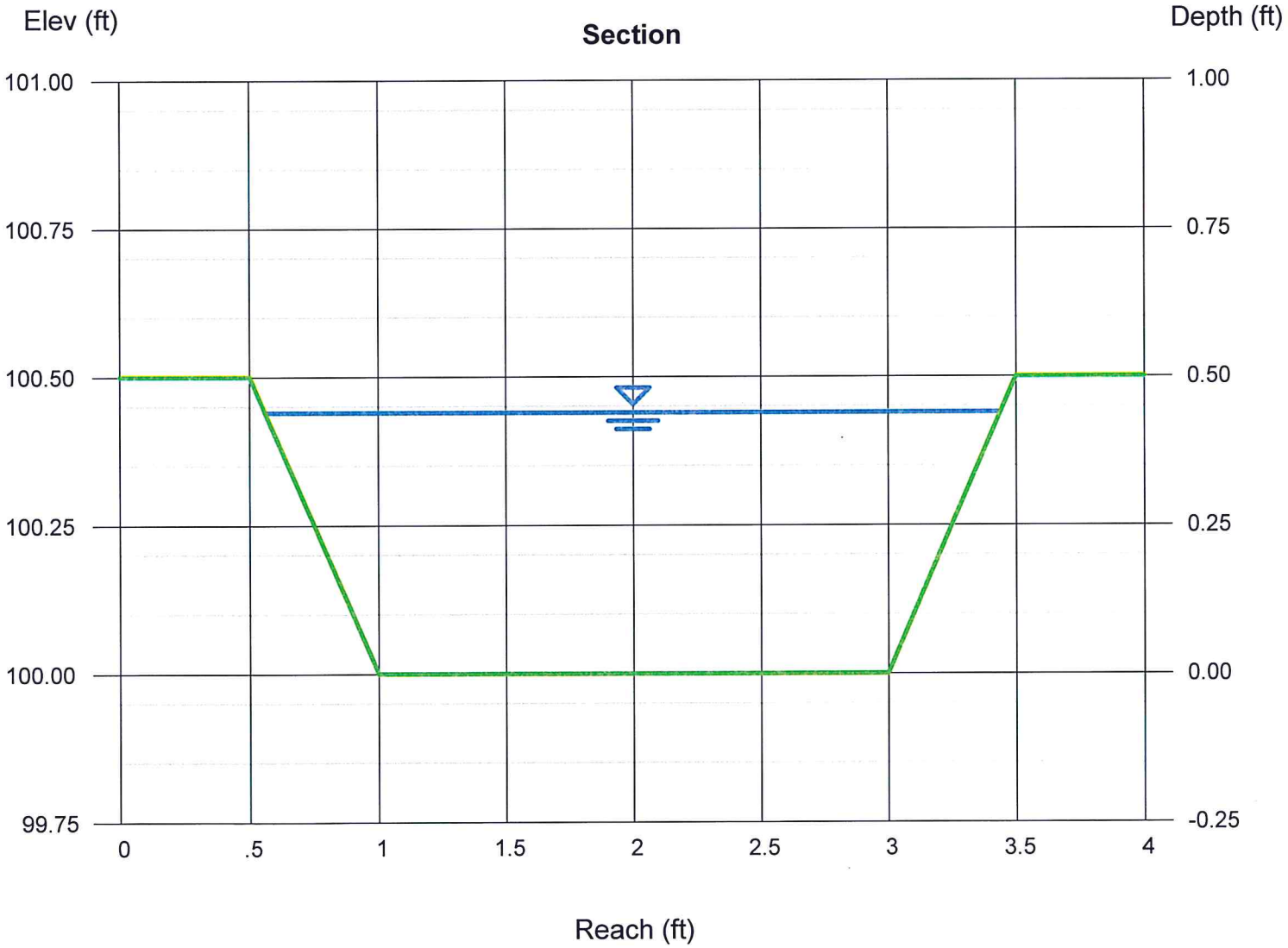
Bottom Width (ft)	= 2.00
Side Slopes (z:1)	= 1.00, 1.00
Total Depth (ft)	= 0.50
Invert Elev (ft)	= 100.00
Slope (%)	= 0.80
N-Value	= 0.011

Calculations

Compute by:	Known Q
Known Q (cfs)	= 6.10

Highlighted

Depth (ft)	= 0.44
Q (cfs)	= 6.100
Area (sqft)	= 1.07
Velocity (ft/s)	= 5.68
Wetted Perim (ft)	= 3.24
Crit Depth, Yc (ft)	= 0.50
Top Width (ft)	= 2.88
EGL (ft)	= 0.94



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Oct 19 2018

DP7 Trapazoidal Ditch 100 YR Flow (32.0 cfs)

Trapezoidal

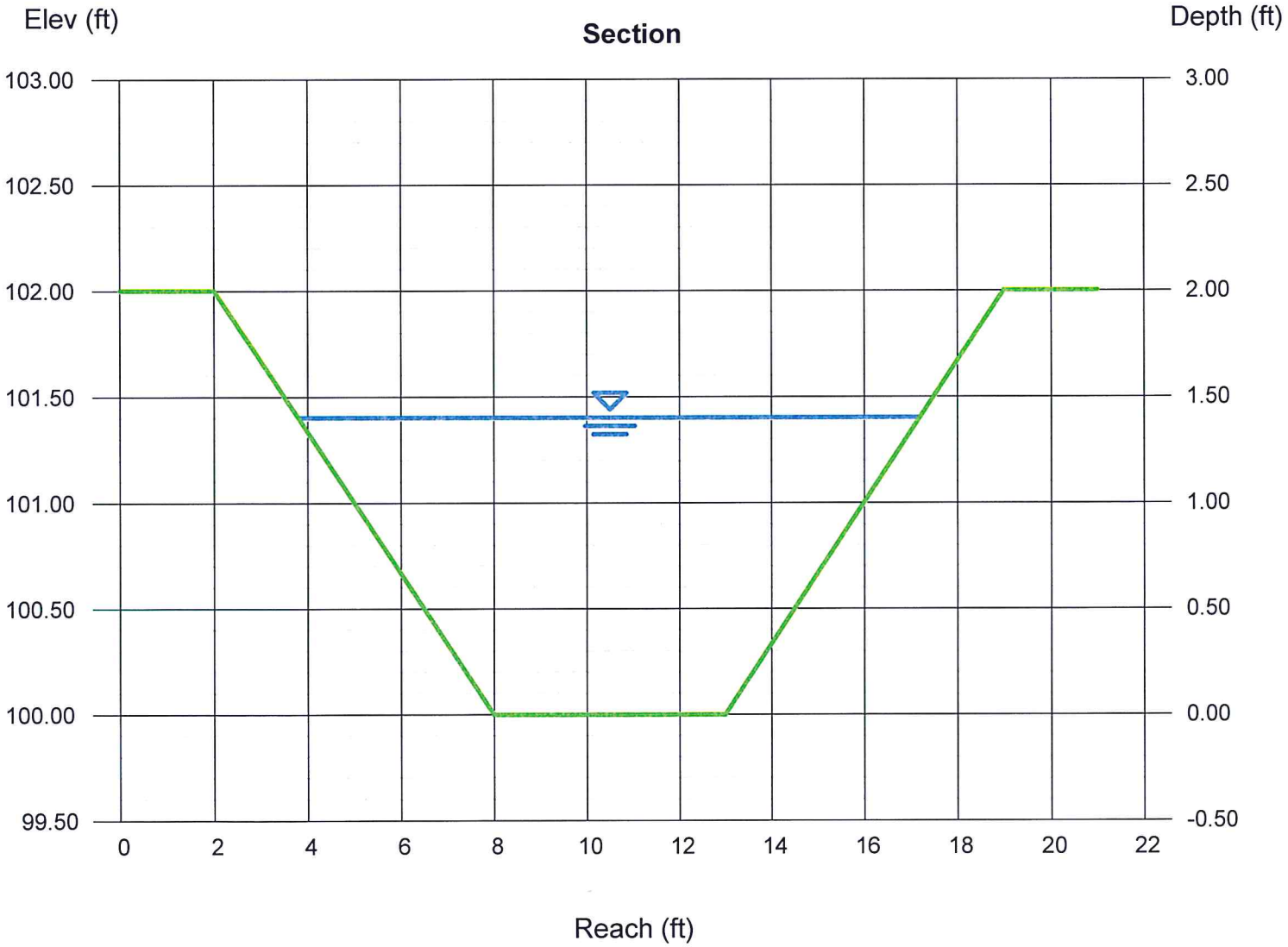
Bottom Width (ft)	= 5.00
Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 0.50
N-Value	= 0.040

Calculations

Compute by:	Known Q
Known Q (cfs)	= 32.00

Highlighted

Depth (ft)	= 1.40
Q (cfs)	= 32.00
Area (sqft)	= 12.88
Velocity (ft/s)	= 2.48
Wetted Perim (ft)	= 13.85
Crit Depth, Yc (ft)	= 0.90
Top Width (ft)	= 13.40
EGL (ft)	= 1.50



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Oct 19 2018

DP7 24in RCP Pipe 5 YR Flow (16.4 cfs)

Circular

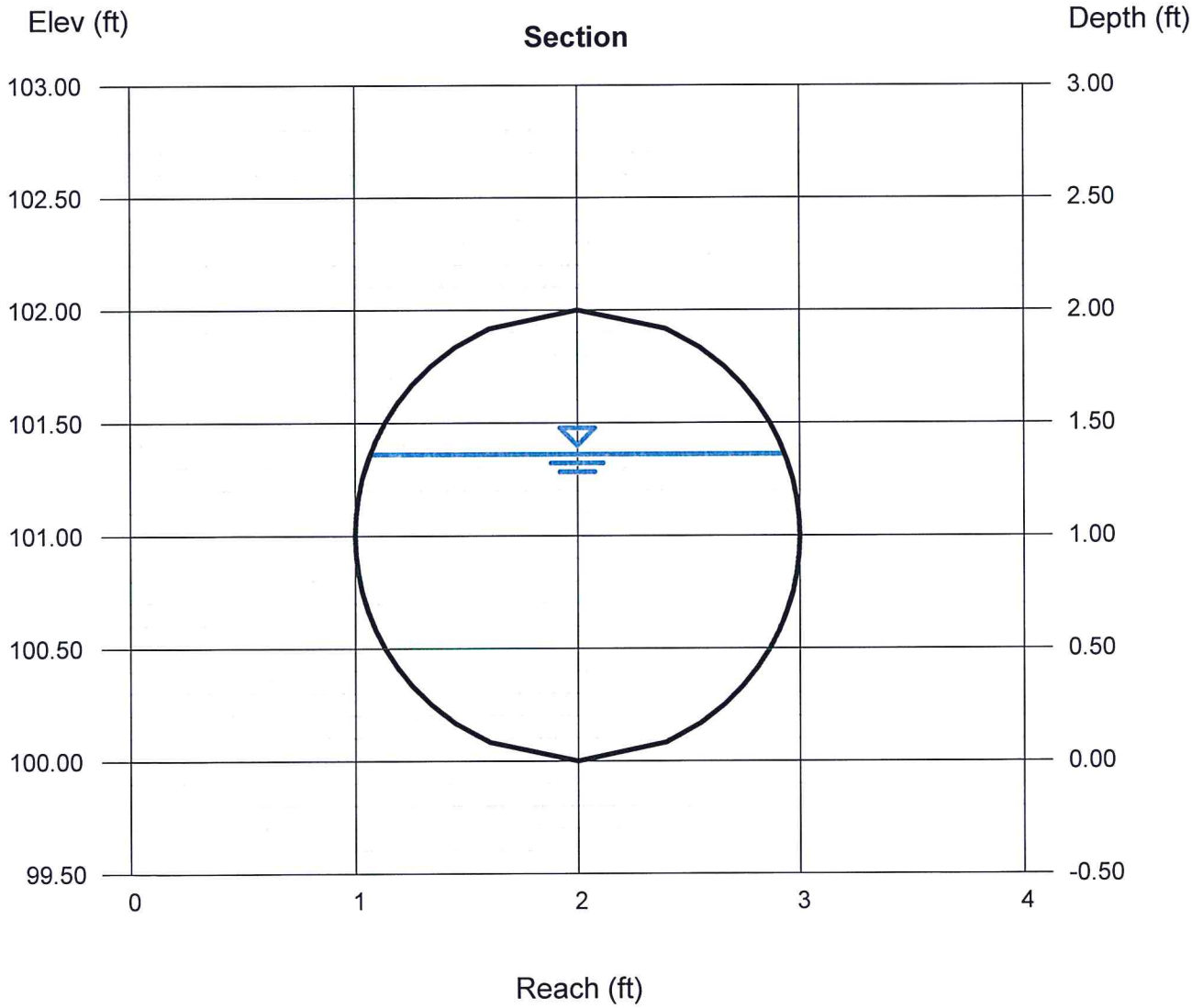
Diameter (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 0.82
N-Value	= 0.013

Calculations

Compute by:	Known Q
Known Q (cfs)	= 16.40

Highlighted

Depth (ft)	= 1.36
Q (cfs)	= 16.40
Area (sqft)	= 2.28
Velocity (ft/s)	= 7.20
Wetted Perim (ft)	= 3.88
Crit Depth, Yc (ft)	= 1.46
Top Width (ft)	= 1.87
EGL (ft)	= 2.17



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Oct 19 2018

DP7 culvert entrance

Invert Elev Dn (ft)	= 37.14
Pipe Length (ft)	= 47.00
Slope (%)	= 1.81
Invert Elev Up (ft)	= 37.99
Rise (in)	= 24.0
Shape	= Circular
Span (in)	= 24.0
No. Barrels	= 1
n-Value	= 0.013
Culvert Type	= Circular Concrete
Culvert Entrance	= Square edge w/headwall (C)
Coeff. K,M,c,Y,k	= 0.0098, 2, 0.0398, 0.67, 0.5

Embankment

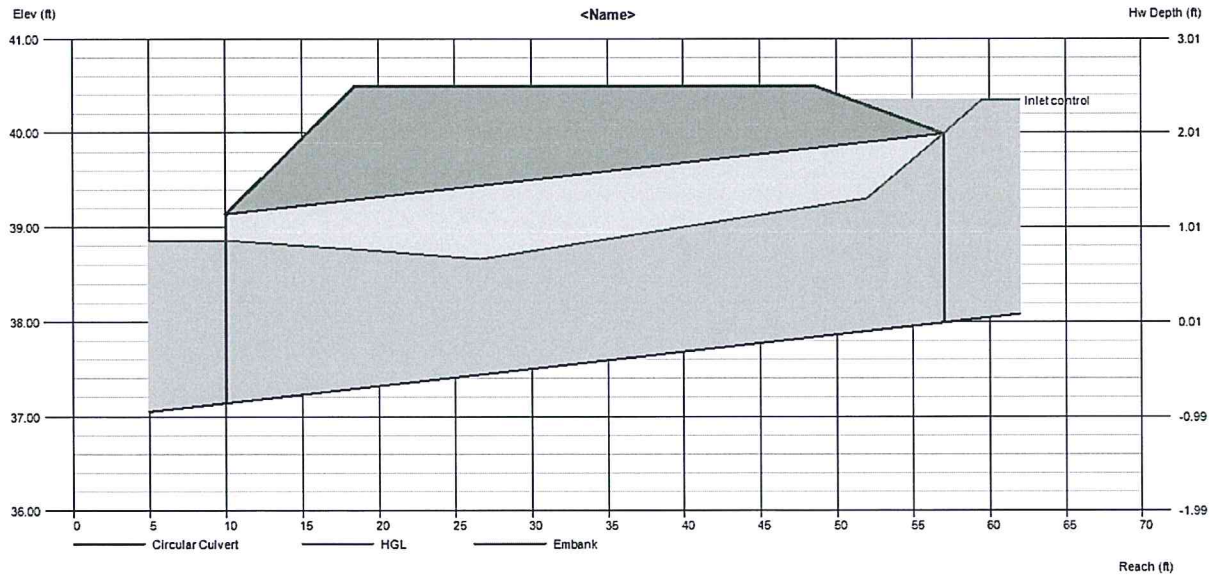
Top Elevation (ft)	= 40.50
Top Width (ft)	= 30.00
Crest Width (ft)	= 30.00

Calculations

Qmin (cfs)	= 16.20
Qmax (cfs)	= 32.20
Tailwater Elev (ft)	= (dc+D)/2

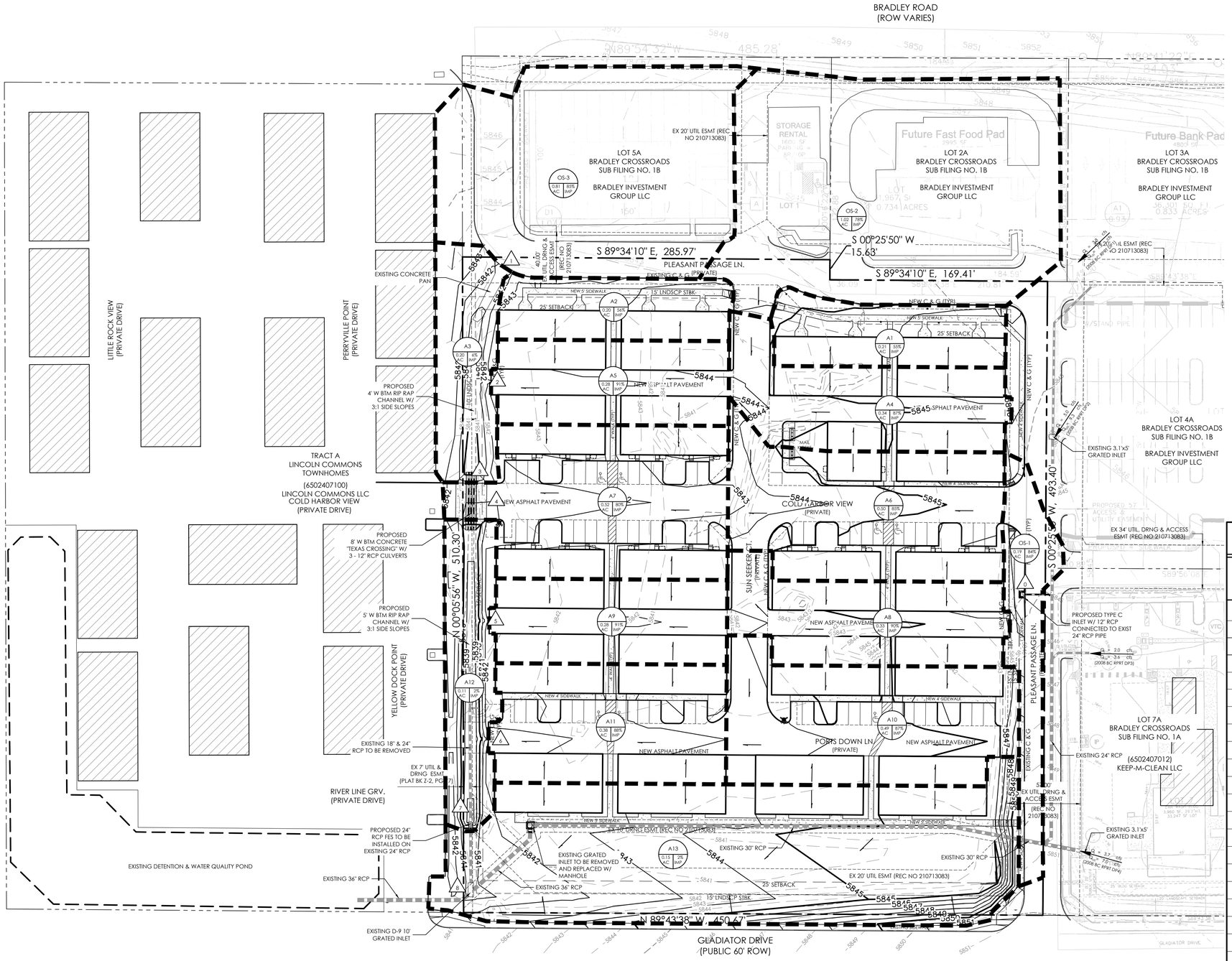
Highlighted

Qtotal (cfs)	= 16.20
Qpipe (cfs)	= 16.20
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 5.62
Veloc Up (ft/s)	= 6.64
HGL Dn (ft)	= 38.86
HGL Up (ft)	= 39.44
Hw Elev (ft)	= 40.37
Hw/D (ft)	= 1.19
Flow Regime	= Inlet Control



11 Report Maps

Existing Condition Hydraulic Analysis Map (Map Pocket)
Proposed Condition Hydraulic Analysis Map (Map Pocket)



LEGEND

- PROPERTY LINE
- EASEMENT LINE
- LOT LINE

EXISTING

- 5985 — INDEX CONTOUR
- 84 — INTERMEDIATE CONTOUR

PROPOSED

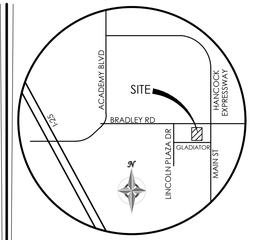
- 5985 — INDEX CONTOUR
- 84 — INTERMEDIATE CONTOUR
- BASIN BOUNDARY
- Q = 19.0 cfs, Q_{100} = 60.0 cfs — GENERAL FLOW/DIRECTION
- 1.5% — SLOPE DIRECTION AND GRADE
- A1 | 0.7 AC | 50% IMP — BASIN LABEL: AREA IN ACRES, PERCENT IMPERVIOUS
- 1 — POINT OF INTEREST

FLOODPLAIN STATEMENT:

NO PORTION OF THE SUBJECT PROPERTY IS NOT LOCATED WITHIN A FEMA DESIGNATED SPECIAL FLOOD HAZARD AREA (SFHA) AS INDICATED ON THE FLOOD INSURANCE RATE MAP (FIRM) FOR EL PASO COUNTY, COLORADO AND INCORPORATED AREAS - MAP NUMBER 08041C0763 F, EFFECTIVE MARCH 17, 1997.

DEVELOPED DRAINAGE SUMMARY TABLE

POINT OF INTEREST/ BASIN(S)	AREA (AC)	Tc (MIN.)	RUNOFF Q5 (CFS)	RUNOFF Q100 (CFS)
OS-1	0.19	5.0	0.8	1.4
OS-2	1.02	6.2	3.6	6.9
OS-3	0.81	5.2	3.2	6.0
A1	0.21	5.4	0.5	1.2
A2	0.20	5.3	0.5	1.1
DP1 (A1, A2, OS-2, OS-3)	2.25	7.1	7.3	14.1
A3	0.20	9.2	0.1	0.6
A4	0.34	5.2	1.3	2.5
A5	0.28	5.0	1.1	2.0
DP2 (A4, A5)	0.62	6.4	2.2	4.2
DP3 (DP1, DP2, A3)	3.07	8.2	9.1	17.9
A6	0.50	5.0	1.9	3.6
A7	0.52	5.0	1.9	3.7
DP4 (A6, A7)	1.02	6.1	3.6	6.9
A8	0.33	5.0	1.3	2.4
A9	0.28	5.0	1.1	2.0
DP5 (A8, A9)	0.60	6.2	2.2	4.2
A10	0.49	5.0	1.9	3.6
A11	0.38	5.0	1.5	2.8
DP6 (A10, A11)	0.88	6.1	3.2	6.1
A12	0.21	9.0	0.1	0.6
DP7 (DP1-6, A12)	5.78	9.8	16.4	32.0
A13	1.09	12.3	1.0	3.2
DP8 (DP1-7, A13)	6.87	9.9	17.4	35.3



VICINITY MAP
N.T.S.

BENCHMARK

N

10 0 20 40 80

1" = 40' 1:480

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

REVISIONS

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

THE TOWNHOMES AT BRADLEY CROSSROADS

Drainage Map
Developed Condition

MVE PROJECT 61093
MVE DRAWING -DRAIN-PP

October 10, 2018
SHEET 1 **OF** 1

Z:\61093_Sheet Dwgs\61093-DRAIN-PP.dwg, 10/19/18 2:26:31 PM, DRG

Appendix E: Preliminary/Final Drainage Report by WestWorks Engineering

PRELIMINARY/FINAL DRAINAGE REPORT FOR LINCOLN PLAZA SUBDIVISION NO. 2

AUGUST 2004

Prepared for:

Lincoln Equities, LLLP
2928 Straus Lane, Suite 210
Colorado Springs, CO 80907
(719) 473-7763

Prepared by:

WestWorks Engineering

WestWorks Job #90419

945 OSAGE AVENUE MANITOU SPRINGS, CO 80829 • PHONE: (719) 685-1670 • FAX: (719) 685-9538

PRELIMINARY/FINAL DRAINAGE REPORT FOR LINCOLN PLAZA SUBDIVISION NO. 2

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 the criteria established by the City/County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors, or omissions on my part in preparing this report.

_____ _____

Chad D. Kuzbek, Colorado PE #35751 Date

For and on behalf of WestWorks Engineering

Developer's Statement:

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

_____

Business Name

By: _____

Title: _____

Address: _____

_____

El Paso County, Colorado:

Filed in accordance with Section 51.1 of the El Paso County Land Development Code, as amended.

_____ _____

For the County Engineer Date

Conditions:

PRELIMINARY/FINAL DRAINAGE REPORT FOR LINCOLN PLAZA SUBDIVISION NO. 2

PURPOSE

The purpose of this drainage report is to identify specific solutions to problems on site and off-site resulting from the development of this subdivision.

GENERAL LOCATION AND DESCRIPTION

Lincoln Plaza Subdivision No. 2 is located within a portion of the southeast quarter of Section 2, Township 15 South, Range 66 West of the 6th P.M. in El Paso County, Colorado. More specifically, the site is located southwest of the intersection of Bradley Road and Main Street. The site is bounded by Bradley Road to the north, Main Street to the east, Lincoln Plaza Drive to the west, and Gladiator Drive to the south. Development of the site includes commercial.

The existing site is covered mostly with native grasses and slopes gently from northeast to southwest. Existing soils in the study area consist mostly of Blakeland loamy sand, as shown on the USDA NRCS soil survey of El Paso County, Colorado, Sheet 17, map symbol '8'. Permeability of the soil is rapid, giving it the designation of Hydrologic Soil Group 'A'. However, for calculation purposes in this study all runoff coefficients are based on HSG 'B'. Other characteristics of this soil, as determined by the USDA NRCS, are slow surface runoff, a moderate hazard of erosion, and a severe hazard of soil blowing. The study area is in the Little Johnson Drainage Basin.

DRAINAGE BASINS AND SUB-BASINS

Historic Drainage Conditions:

The majority of the Lincoln Plaza site (Basin EX1) drains to the west over gentle 1%-2% slopes. A portion of the site (Basin EX2) drains to the southeast. Basin EX2 generates flows of $Q_5 = 3$ cfs and $Q_{100} = 6$ cfs. An existing inlet at the southwest corner of Main Street and Gladiator Drive collects this flow (DPex2). Basin EX1 generates flows of $Q_5 = 9$ cfs and $Q_{100} = 21$ cfs. This flow discharges along the east side of Lincoln Plaza Drive where it is intercepted by an existing 16' sump inlet (DPex1). Also discharging to DPex1 is Basin EX-OS1. Basin EX-OS1 is the off-site area of existing Bradley Road and Lincoln Plaza Drive. Basin EX-OS1 generates runoff of $Q_5 = 2$ cfs and $Q_{100} = 4$ cfs. The total combined flow at DPex1 is $Q_5 = 11$ cfs and $Q_{100} = 25$ cfs. The capacity of the existing 16' inlet at DPex1 is estimated at approximately 50 cfs. The off-site area north of Bradley Road does not drain across this site.

Developed Drainage Conditions:

Development of the site includes commercial. Developed flows will be detained on-site by privately owned and maintained detention ponds and released at or below historic levels prior to discharging off site.

Basin A consists of 2.0 acres of proposed commercial development. Basin A generates runoff of Q_5 = 5 cfs and Q_{100} = 10 cfs. This flow will discharge into proposed detention Pond 2 at DP1. Pond 2 is intended to detain developed flows and release them at Q_5 = 3 cfs and Q_{100} = 7 cfs. This is essentially equal to historic flows at this point (Q_5 = 3 cfs and Q_{100} = 6 cfs – DPex2). The outfall structure for Pond 2 is an 18" RCP culvert. Discharge from Pond 2 will enter Gladiator Drive through a proposed 1.5' wide curb chase under the proposed sidewalk. These flows will cross Gladiator Drive to the south to an existing inlet at the southwest corner of Gladiator Drive and Main Street.

Basin B consists of 1.8 acres of proposed commercial development. Basin B generates runoff of Q_5 = 5 cfs and Q_{100} = 9 cfs. A proposed 5' sump inlet at DP2 will collect this flow. A proposed 18" RCP storm drain will carry this flow to DP3.

Basin C consists of 4.9 acres of proposed commercial development. Basin C generates runoff of Q_5 = 13 cfs and Q_{100} = 25 cfs. A proposed 15' sump inlet at DP3 will collect this flow. The combined flows of DP2 and DP3 (Q_5 = 21 cfs and Q_{100} = 41 cfs) will be carried by a proposed 30" RCP to a proposed swale west of DP3.

Basin D consists of 3.2 acres of proposed commercial development. Basin D generates runoff of Q_5 = 8 cfs and Q_{100} = 16 cfs. This flow will discharge into the proposed swale through a proposed 10' curb opening at DP4. The total combined flow from Basins B, C, and D (Q_5 = 25 cfs and Q_{100} = 50 cfs) will travel under a future access road through a proposed 36" RCP culvert at DP6.

Basin E consists of 5.5 acres of future development. Development of this lot was not known at the time this report was written. The lot is currently zoned for commercial, therefore runoff is calculated based on future commercial development. Basin G generates runoff of Q_5 = 14 cfs and Q_{100} = 28 cfs. This flow will need to be routed to Pond 1 via a future storm drain collection system. This report recommends that a Final Drainage Report be prepared for this Basin to design a storm drain collection system once the future layout is known.

Flows from Basins B, C, D, and E will be routed to proposed detention Pond 1. The total combined flows from these basins is Q_5 = 40 cfs and Q_{100} = 78 cfs. Pond 1 will release these developed flows at Q_5 = 8 cfs and Q_{100} = 15 cfs prior to discharging into the existing 16' inlet at DPos1 (same as historic condition DPex1). The Pond 1 outfall structure consists of a 12" RCP culvert at the bottom of the pond going into a 7' tall inlet box with an 18" diameter grate on top. An 18" RCP will connect this proposed inlet box to the existing 16" inlet in Lincoln Plaza Drive.

Basin OS1 is the off-site area of improved Bradley Road and existing Lincoln Plaza Drive. Basin OS1 generates runoff of Q_5 = 3 cfs and Q_{100} = 6 cfs. Including the discharge from Pond 1, the total combined flow at DPos1 is Q_5 = 10 cfs and Q_{100} = 16 cfs. This is less than the total combined historic condition at DPex1 (Q_5 = 11 cfs and Q_{100} = 25 cfs).

The flows at DPos1 combine with flows from Bradley Ranch Filing No. 4 and travel west in Garman Drive via an existing 36" RCP storm drain. It is anticipated that this existing 36" RCP has adequate capacity to carry these flows. Additional flows enter the existing drainage system

at the intersection of Garman Drive and Witches Hollow Lane. This drainage system is intended to discharge into a future regional detention facility as described in the DBPS. This corresponds with Pond B recommended in DBPS Alternative 1-3. The existing interim condition is to carry drainage south in Witches Hollow Lane in an existing 18" RCP. This off-site downstream system will remain undersized until the future regional Pond B is installed. For this reason, an on-site privately owned and maintained detention system is proposed to detain developed flows and release them at or below historic rates prior to discharging off-site.

DRAINAGE DESIGN CRITERIA

This drainage report was prepared in accordance to the criteria established in the City of Colorado Springs and El Paso County Drainage Criteria Manual, updated in October 1994. This report has taken into the account the results and recommendations of the following previous drainage studies:

"Little Johnson/Security Creek Drainage Basin Planning Study," prepared by Simons, Li & Associates, Inc., dated April 1988.

"Preliminary Drainage Report for Storage Time – Bradley Road," prepared by WestWorks Engineering, dated September 2003 (not yet approved).

"Drainage Report for Bradley Ranch Filing No. 2, Phase II," prepared by Weiss Consulting Engineers, Inc., dated April 1986.

"Drainage Report for Bradley Ranch Filing No. 3, Phase II," prepared by Weiss Consulting Engineers, Inc., dated April 1986.

"Preliminary and Final Drainage Report, Bradley Ranch Filing No. 4, Phase 1," prepared by Jeffries Engineering, dated May 1995.

"Fountain Mutual Irrigation Final Ditch Report, Prepared For Windmill Mesa," prepared by JR Engineering, dated April 1999

WestWorks Engineering uses the rational method for drainage basin study areas of less than 100 acres. This methodology is implemented in accordance with the City/County Drainage Criteria Manual Guidelines.

For the Rational Method, flows are calculated for the 5-year and 100-year recurrence intervals. The average runoff coefficients, 'C' values, are taken from Table 5-1 and the Intensity-Duration-Frequency curves are taken from Figure 5-1 of the City/County Drainage Criteria Manual. Time of concentration for overland flow and storm drain or gutter flow are calculated per Section 5.2.3 of the City/County Drainage Criteria Manual. Calculations for the Rational Method, if used, are shown in the Appendix of this report. Any detention volume, if required, in drainage basin areas less than 100 acres are calculated using the Modified Rational Method. The Modified Rational Method calculations are performed with the aid of HydroCAD version 7.00.

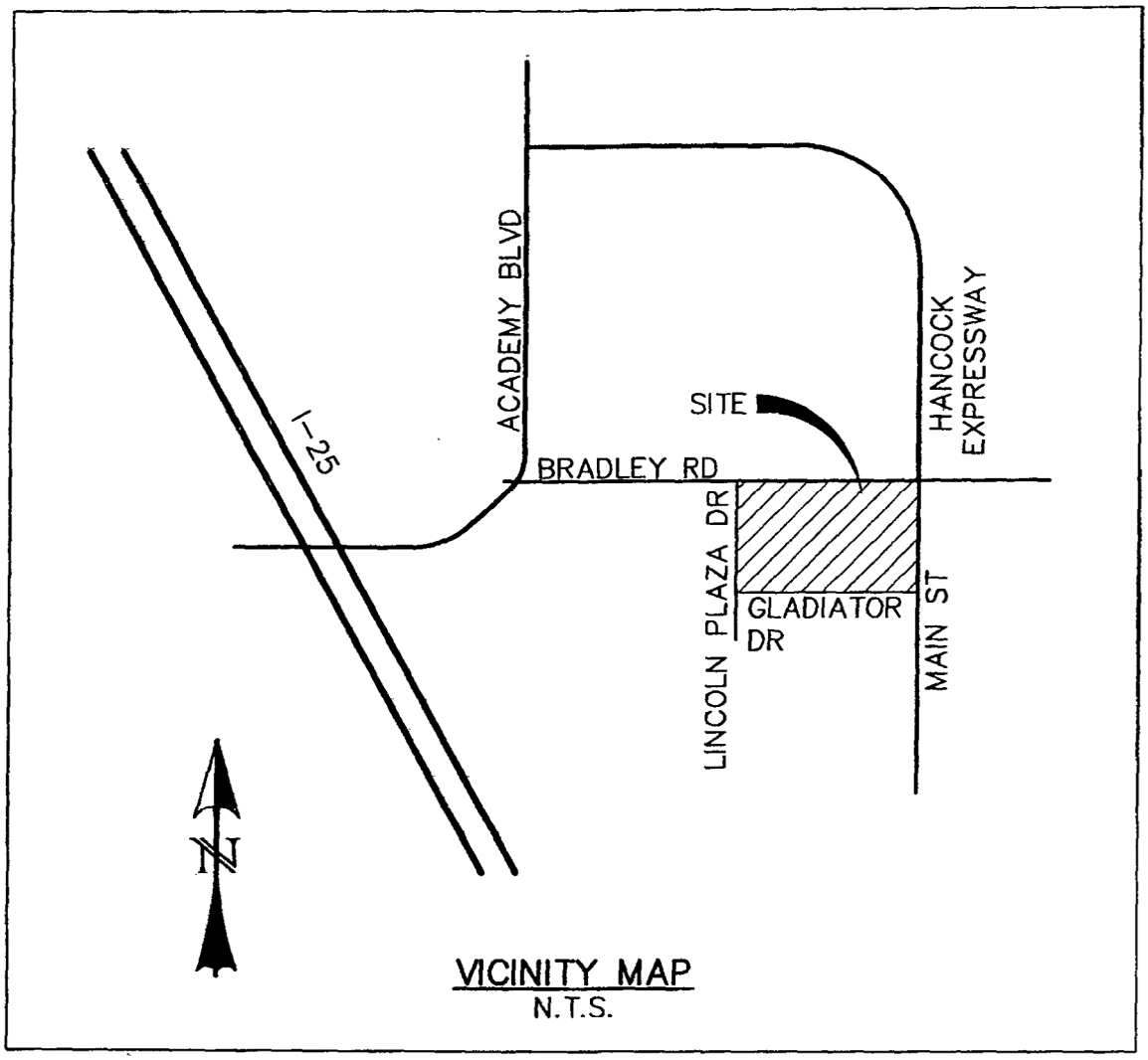
DRAINAGE FACILITY DESIGN

All inlets, storm drains, culverts, and open channels are sized using the procedures outlined in the City/County Drainage Criteria Manual Chapters 7, 8, 9, and 10 respectively. All of the drainage systems, including the streets, are designed to safely route the 5-year and 100-year storm flows.

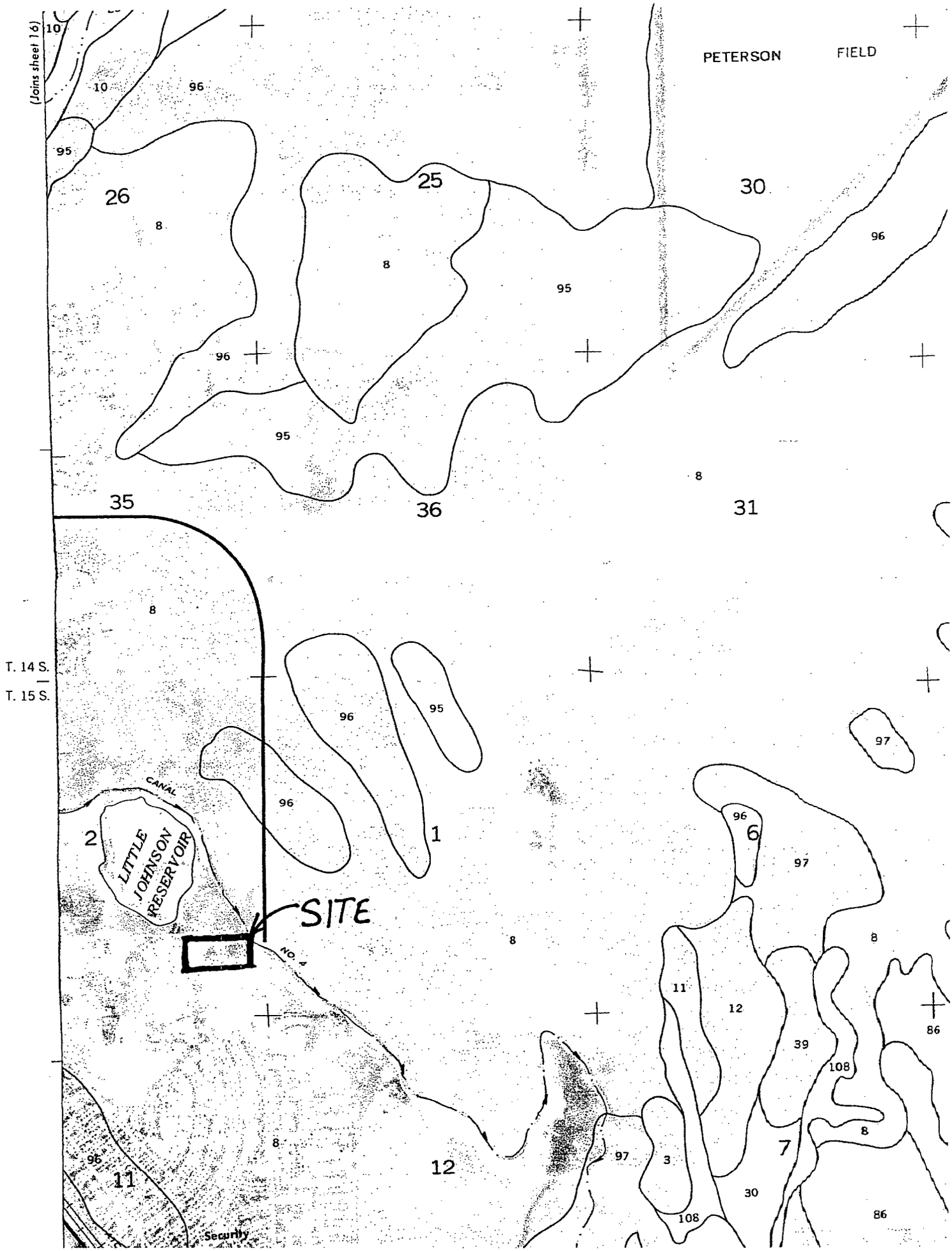
FLOODPLAIN STATEMENT

No portion of the Lincoln Plaza Subdivision is within a F.E.M.A. designated floodplain per Flood Insurance Rate Map Community Panel No. 08041C0763 F, effective March 17th, 1997.

APPENDIX



VICINITY MAP
N.T.S.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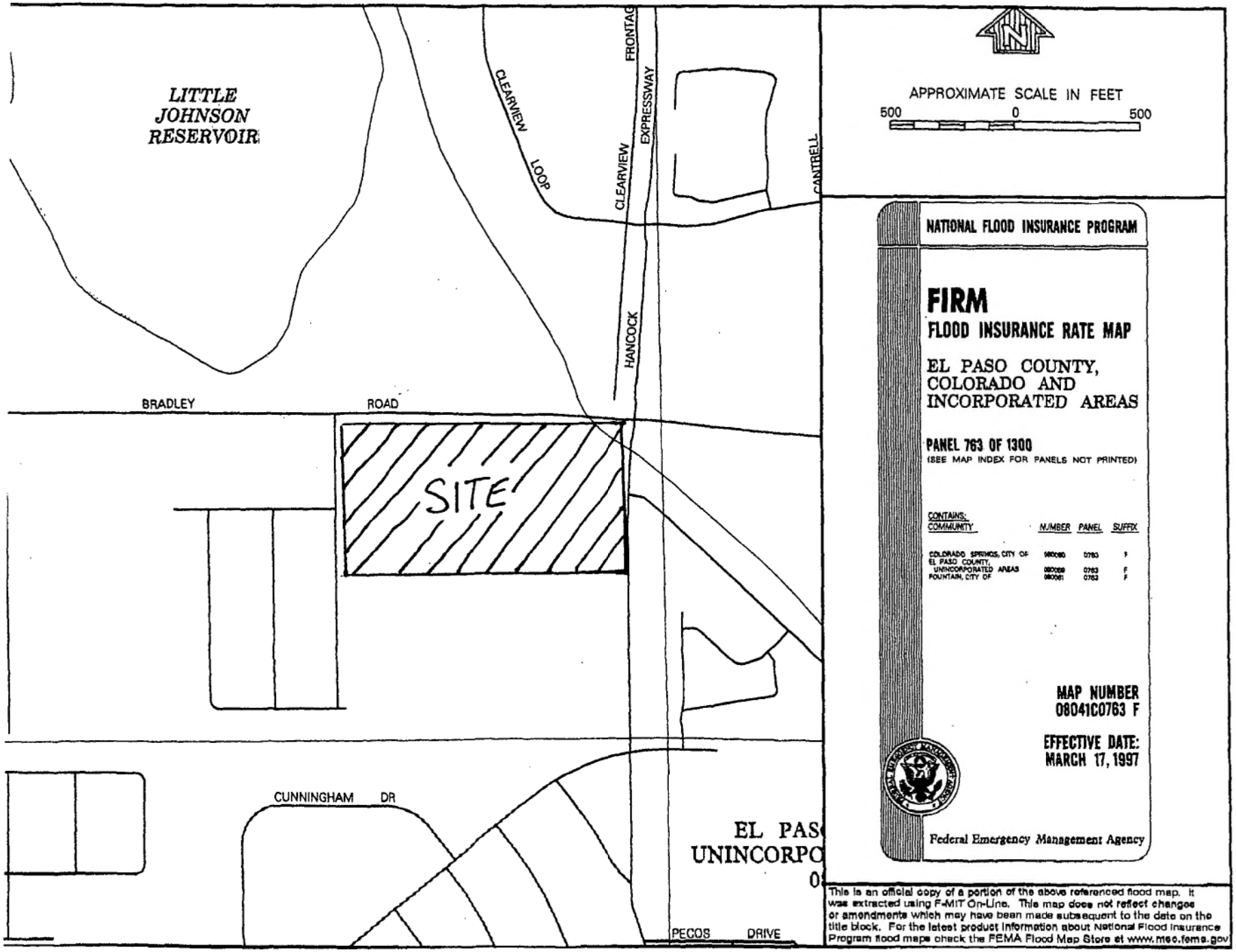
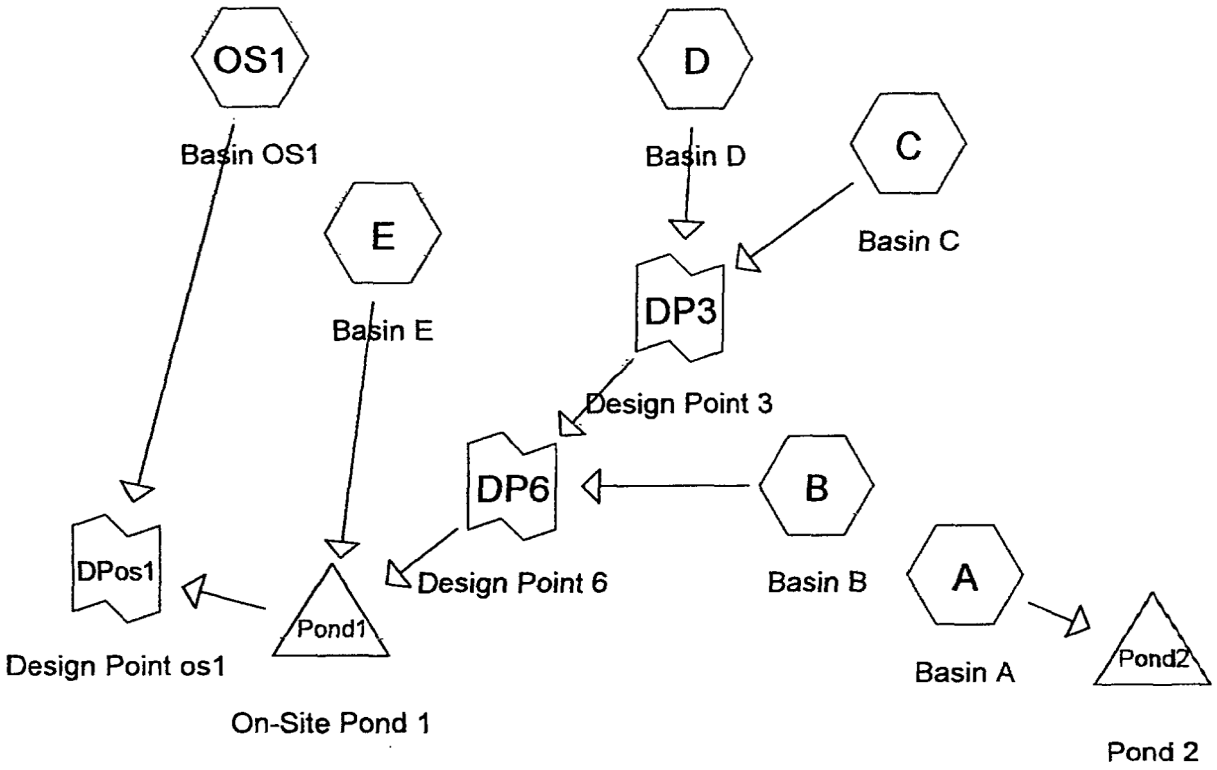
PETERSON FIELD
T. 14 S.
T. 15 S.
LITTLE JOHNSON RESERVOIR
CANAL
SITE
NO. 4
Security



This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



Subcat Reach Pond Link

Drainage Diagram for 5YR-DEVELOPED
Prepared by WestWorks Engineering 8/30/2004
HydroCAD® 7.00 s/n 002053 © 1986-2003 Applied Microcomputer Systems

Time span=0.00-3.00 hrs, dt=0.01 hrs, 301 points
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment A: Basin A Runoff Area=2.000 ac Runoff Depth=0.63"
Tc=11.4 min C=0.70 Runoff=4.52 cfs **0.106 af**

Subcatchment B: Basin B Runoff Area=1.800 ac Runoff Depth=0.73"
Tc=11.1 min C=0.80 Runoff=4.65 cfs **0.109 af**

Subcatchment C: Basin C Runoff Area=4.900 ac Runoff Depth=0.73"
Tc=13.9 min C=0.80 Runoff=12.65 cfs 0.296 af

Subcatchment D: Basin D Runoff Area=3.200 ac Runoff Depth=0.71"
Tc=17.4 min C=0.80 Runoff=7.99 cfs 0.189 af

Subcatchment E: Basin E Runoff Area=5.500 ac Runoff Depth=0.73"
Tc=12.0 min C=0.80 Runoff=14.20 cfs 0.332 af

Subcatchment OS1: Basin OS1 Runoff Area=1.300 ac Runoff Depth=0.63"
Tc=10.0 min C=0.70 Runoff=2.94 cfs 0.069 af

Pond Pond1: On-Site Pond 1 Peak Elev=5,835.44' Storage=0.689 af Inflow=39.53 cfs **0.926** af
Outflow=7.99 cfs 0.923 af

Pond Pond2: Pond 2 Peak Elev=5,846.34' Storage=0.048 af Inflow=4.52 cfs 0.106 af
Outflow=3.31 cfs 0.095 af

Link DP3: Design Point 3 Inflow=20.63 cfs **0.485** af
Primary=20.63 cfs **0.485** af

Link DP6: Design Point 6 Inflow=25.29 cfs 0.594 af
Primary=25.29 cfs 0.594 af

Link DPos1: Design Point os1 Inflow=10.19 cfs **0.992** af
Primary=10.19 cfs **0.992** af

Total Runoff Area = 18.700 ac Runoff Volume = 1.101 af Average Runoff Depth = 0.71"

Subcatchment A: Basin A

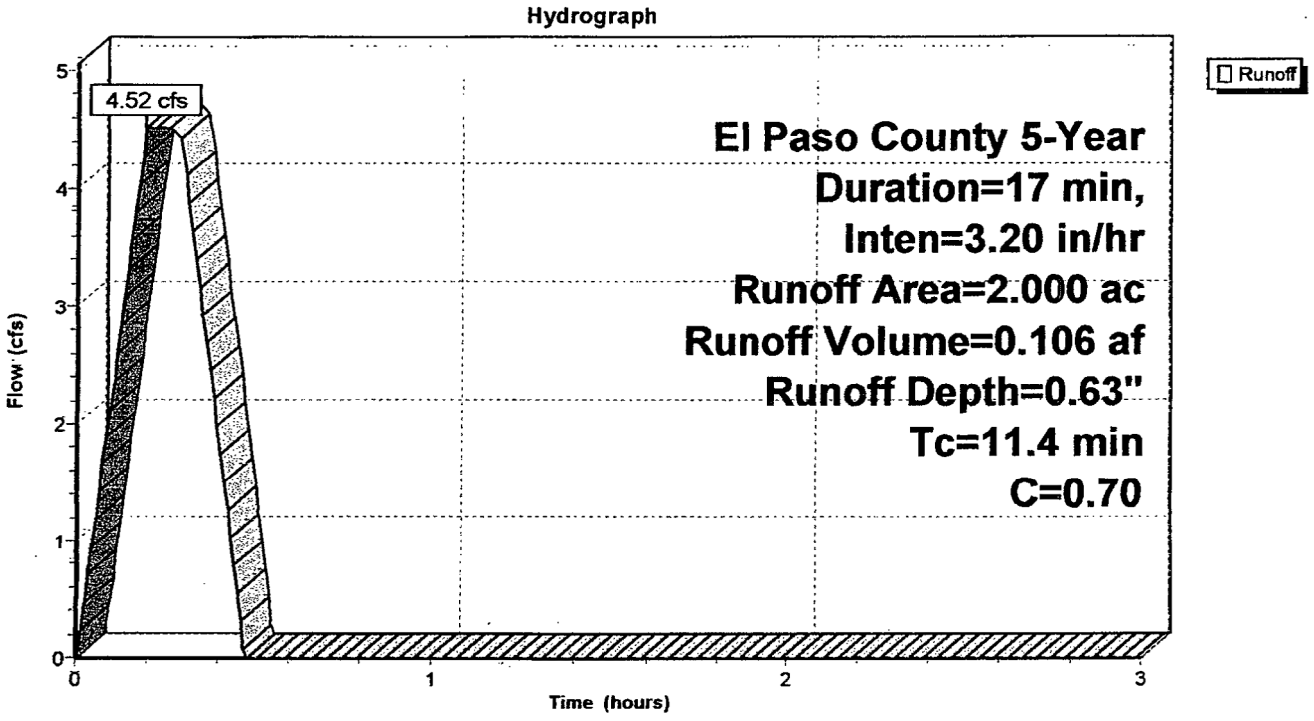
Runoff = 4.52 cfs @ 0.19 hrs, Volume= 0.106 af, Depth= 0.63"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
El Paso County 5-Year Duration=17 min, Inten=3.20 in/hr

Area (ac)	C	Description
2.000	0.70	Commercial

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.4					Direct Entry, Basin A

Subcatchment A: Basin A



Subcatchment B: Basin B

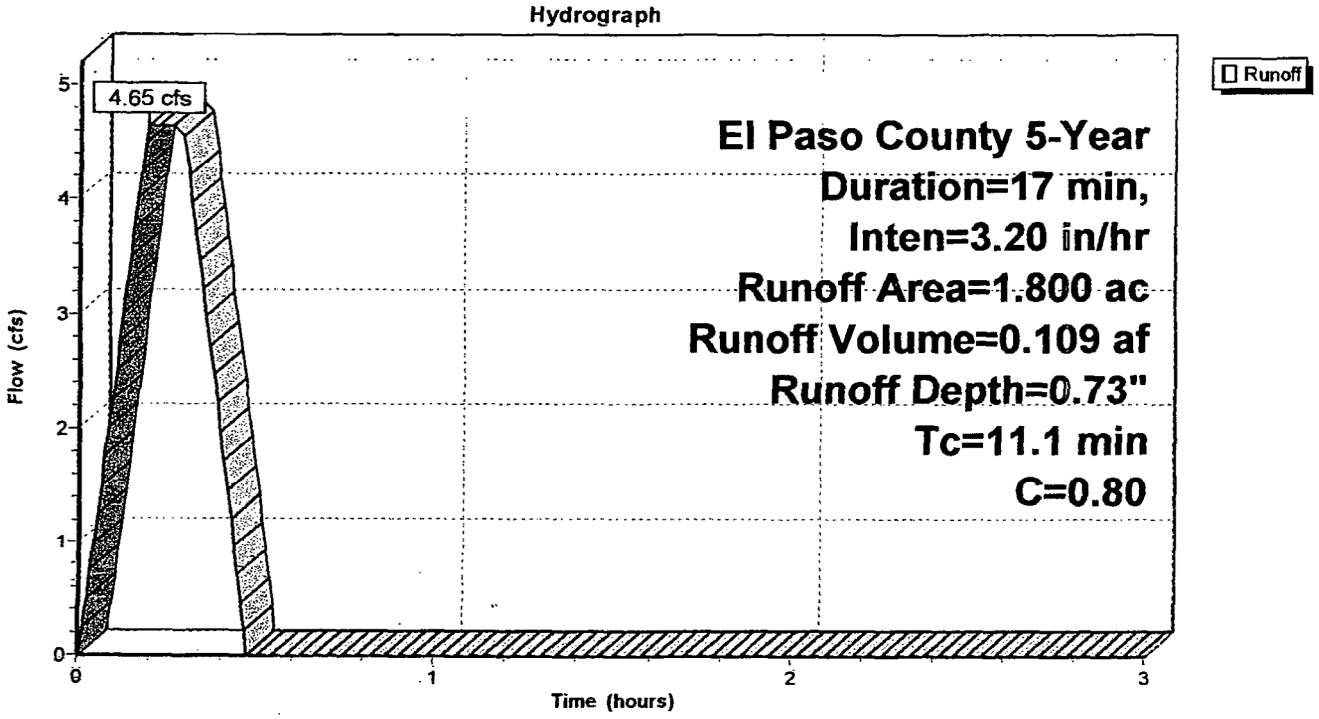
Runoff = 4.65 cfs @ 0.19 hrs, Volume= 0.109 af, Depth= 0.73"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
El Paso County 5-Year Duration=17 min, Inten=3.20 in/hr

Area (ac)	C	Description
1.800	0.80	Basin B

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1					Direct Entry, Basin B

Subcatchment B: Basin B



Subcatchment C: Basin C

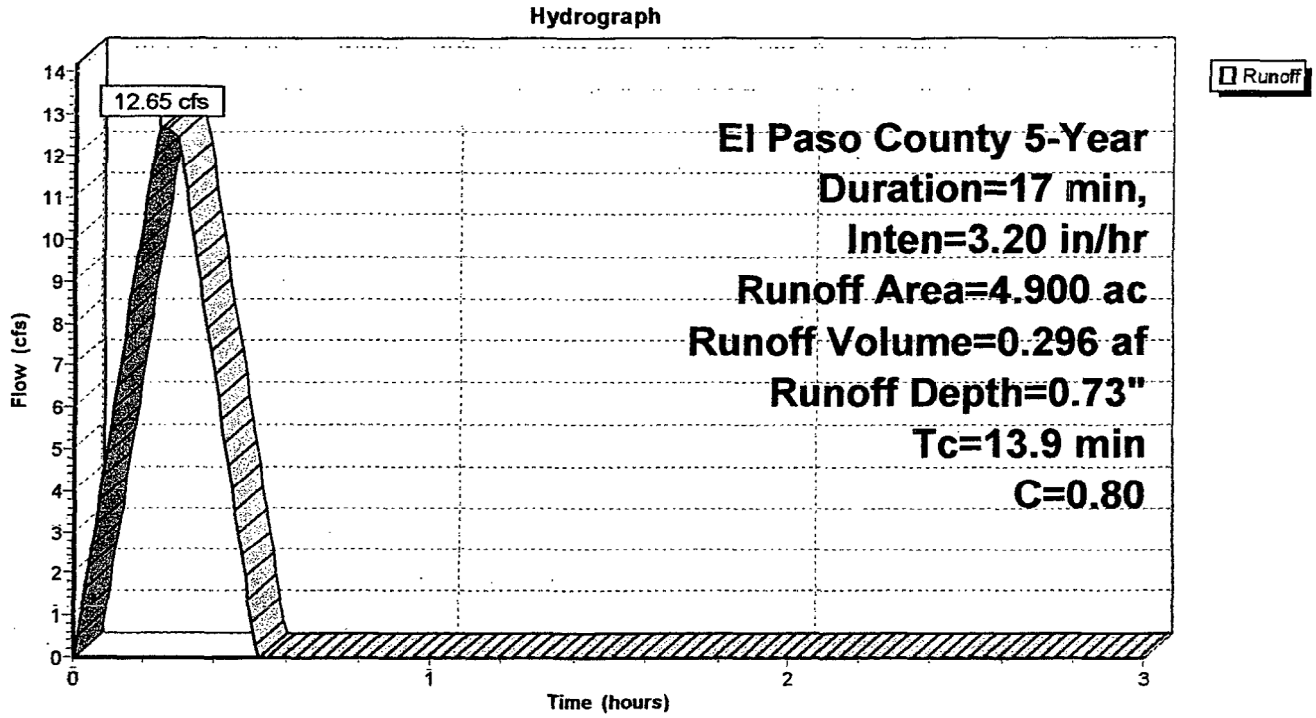
Runoff = 12.65 cfs @ 0.24 hrs, Volume= 0.296 af, Depth= 0.73"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
El Paso County 5-Year Duration=17 min, Inten=3.20 in/hr

Area (ac)	C	Description
4.900	0.80	Basin C

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.9					Direct Entry, Basin C

Subcatchment C: Basin C



Subcatchment D: Basin D

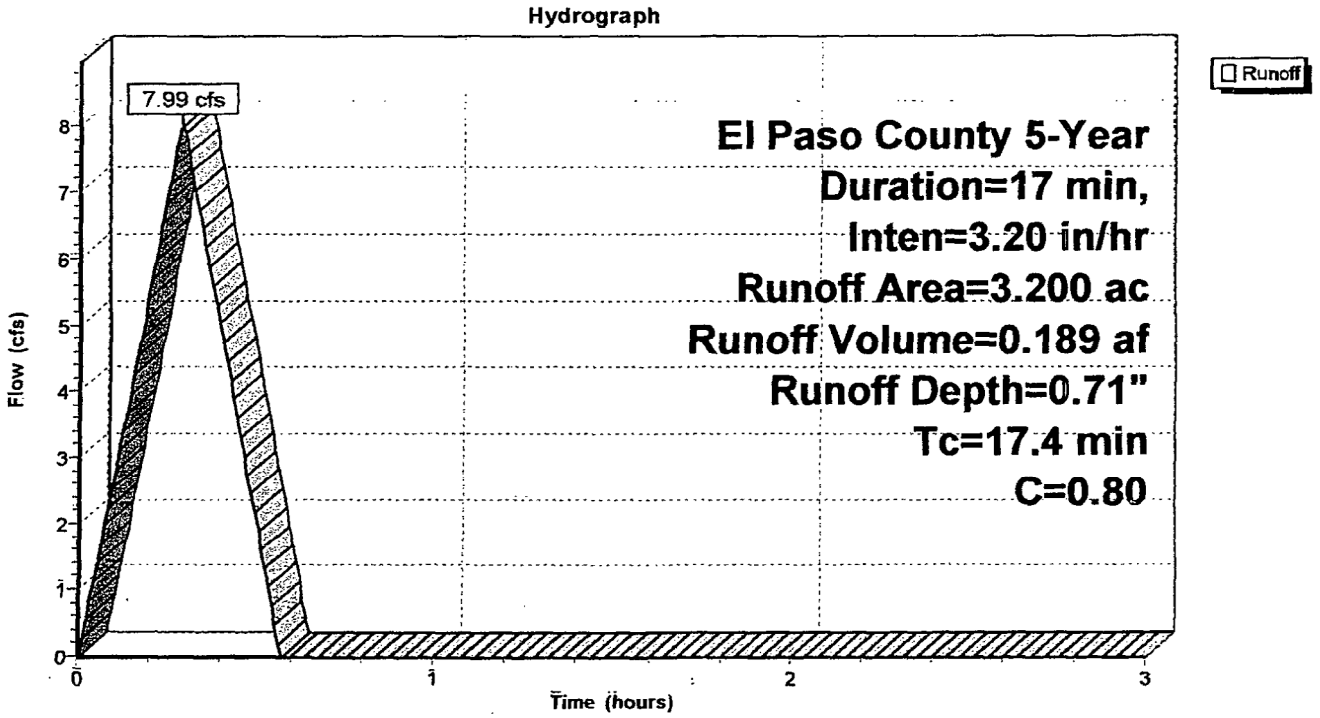
Runoff = 7.99 cfs @ 0.28 hrs, Volume= 0.189 af, Depth= 0.71"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
El Paso County 5-Year Duration=17 min, Inten=3.20 in/hr

Area (ac)	C	Description
3.200	0.80	Basin D

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.4					Direct Entry, Basin D

Subcatchment D: Basin D



Subcatchment E: Basin E

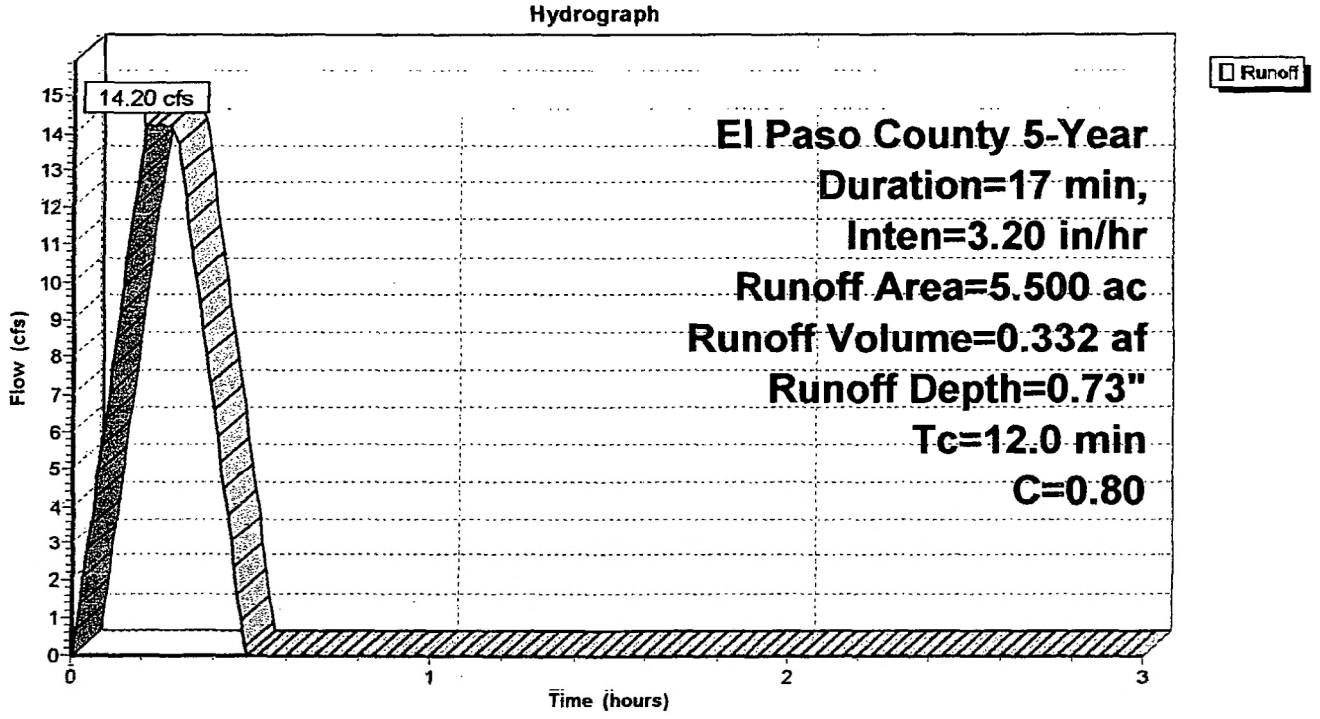
Runoff = 14.20 cfs @ 0.20 hrs, Volume= 0.332 af, Depth= 0.73"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
El Paso County 5-Year Duration=17 min, Inten=3.20 in/hr

Area (ac)	C	Description
5.500	0.80	Basin E

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0					**Direct Entry, Basin E**

Subcatchment E: Basin E



Subcatchment OS1: Basin OS1

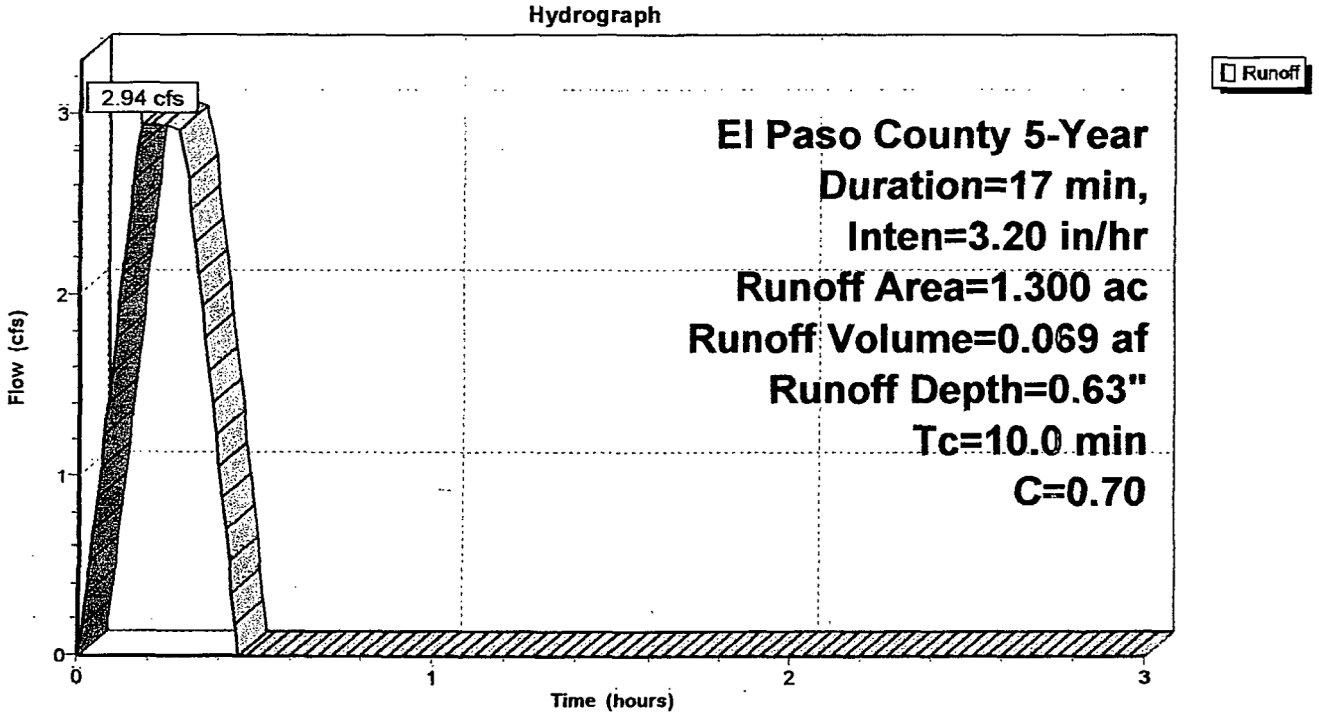
Runoff = 2.94 cfs @ 0.17 hrs, Volume= 0.069 af, Depth= 0.63"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
El Paso County 5-Year Duration=17 min, Inten=3.20 in/hr

Area (ac)	C	Description
1.300	0.70	Basin OS1

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Basin OS1**

Subcatchment OS1: Basin OS1



Pond Pond1: On-Site Pond 1

Inflow Area = 15.400 ac, Inflow Depth = 0.72" for 5-Year event
Inflow = 39.53 cfs @ 0.28 hrs, Volume= 0.926 af
Outflow = 7.99 cfs @ 0.46 hrs, Volume= 0.923 af, Atten= 80%, Lag= 11.0 min
Primary = 7.99 cfs @ 0.46 hrs, Volume= 0.923 af

Routing by Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Peak Elev= 5,835.44' @ 0.46 hrs Surf.Area= 0.283 ac Storage= 0.689 af
Plug-Flow detention time= 38.1 min calculated for 0.923 af (100% of inflow)
Center-of-Mass det. time= 38.0 min (53.3 - 15.3)

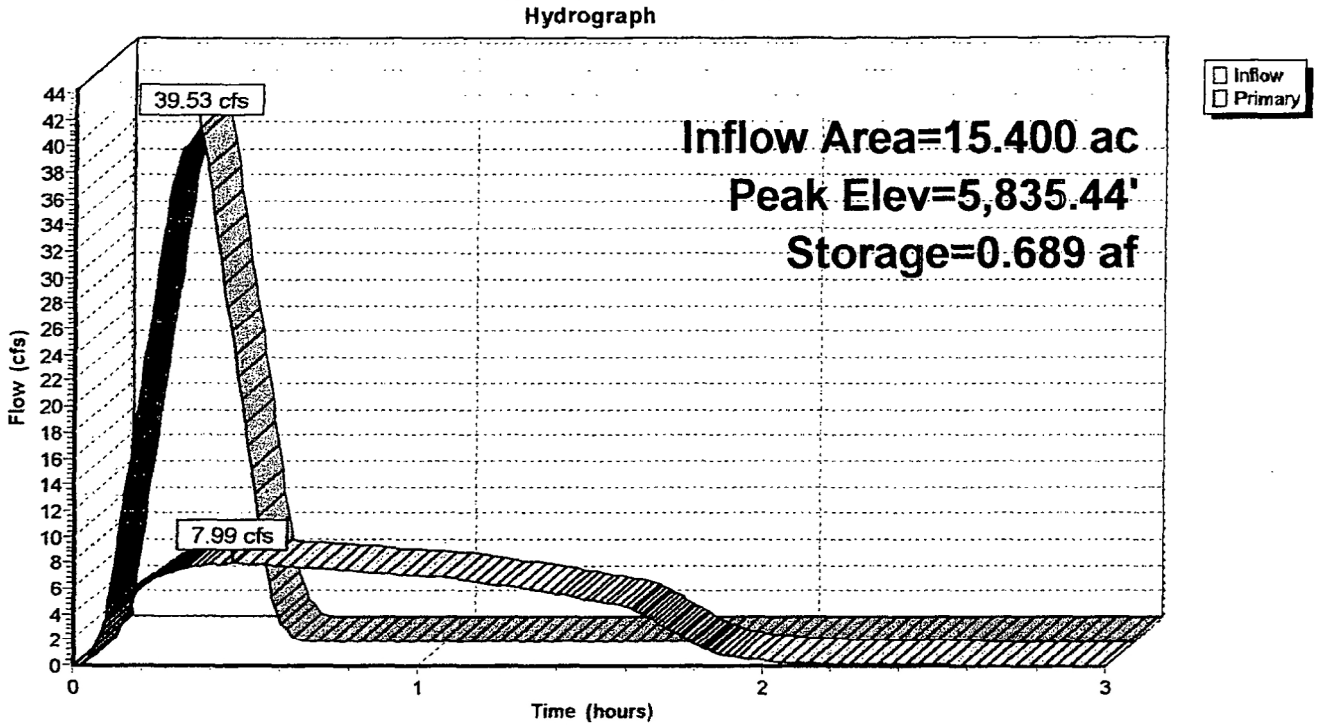
#	Invert	Avail.Storage	Storage Description
1	5,830.00'	1.681 af	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
5,830.00	0.003	0.000	0.000
5,832.00	0.075	0.078	0.078
5,834.00	0.176	0.251	0.329
5,836.00	0.324	0.500	0.829
5,838.00	0.529	0.852	1.681

#	Routing	Invert	Outlet Devices
1	Primary	5,830.00'	**12.0" x 60.0' long Culvert** RCP, sq.cut end projecting, Ke= 0.500 Outlet Invert= 5,829.00' S= 0.0167 '/' n= 0.013 Cc= 0.900
2	Primary	5,837.00'	**18.0" Horiz. Orifice/Grate** Limited to weir flow C= 0.600
3	Primary	5,839.00'	**30.0' long x 2.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32

Primary OutFlow Max=7.99 cfs @ 0.46 hrs HW=5,835.44' (Free Discharge)
- **1=Culvert** (Barrel Controls 7.99 cfs @ 10.2 fps)
- **2=Orifice/Grate** (Controls 0.00 cfs)
- **3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Pond1: On-Site Pond 1



Pond Pond2: Pond 2

Inflow Area = 2.000 ac, Inflow Depth = 0.63" for 5-Year event
Inflow = 4.52 cfs @ 0.19 hrs, Volume= 0.106 af
Outflow = 3.31 cfs @ 0.33 hrs, Volume= 0.095 af, Atten= 27%, Lag= 8.6 min
Primary = 3.31 cfs @ 0.33 hrs, Volume= 0.095 af

Routing by Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Peak Elev= 5,846.34' @ 0.33 hrs Surf.Area= 0.062 ac Storage= 0.048 af
Plug-Flow detention time= 10.8 min calculated for 0.095 af (90% of inflow)
Center-of-Mass det. time= 10.1 min (24.3 - 14.2)

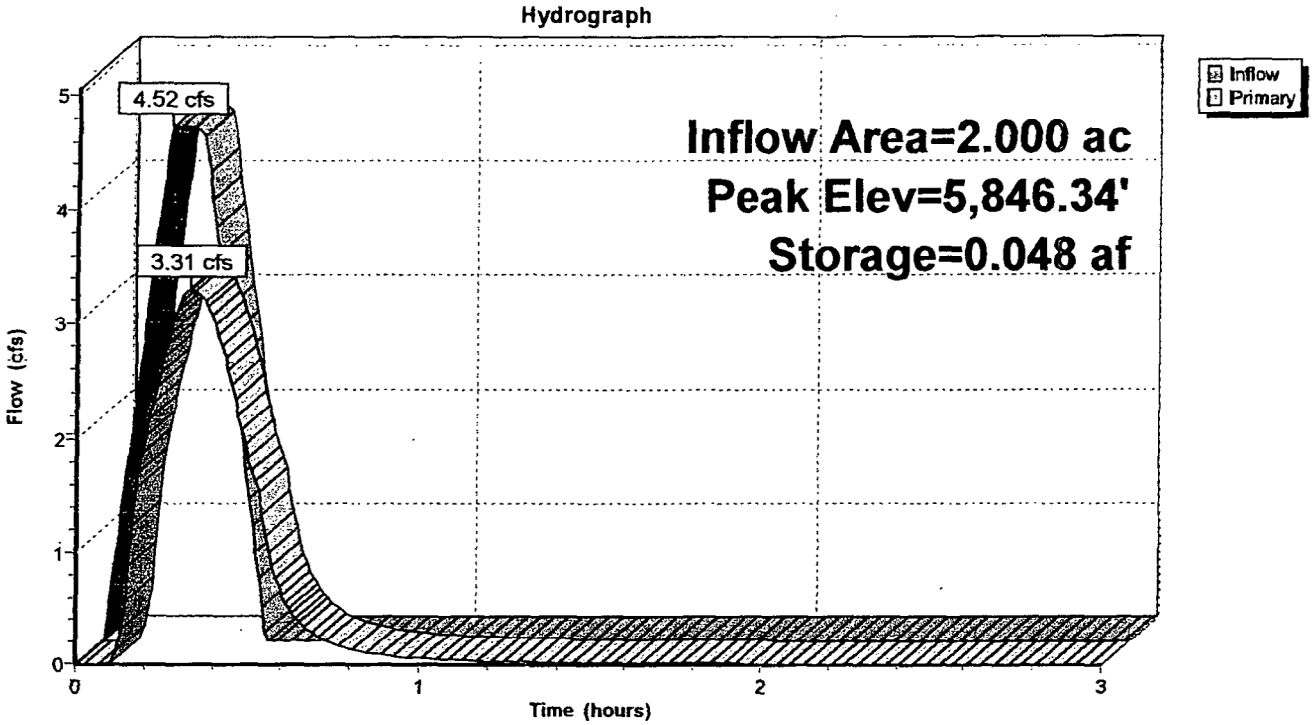
#	Invert	Avail.Storage	Storage Description
1	5,845.00'	0.092 af	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
5,845.00	0.000	0.000	0.000
5,846.00	0.049	0.025	0.025
5,847.00	0.087	0.068	0.092

#	Routing	Invert	Outlet Devices
1	Primary	5,845.40'	**18.0" x 40.0' long Culvert** RCP, mitered to conform to fill, Ke= 0.700 Outlet Invert= 5,845.00' S= 0.0100 '/' n= 0.013 Cc= 0.900
2	Primary	5,847.00'	**10.0' long x 2.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32

Primary OutFlow Max=3.31 cfs @ 0.33 hrs HW=5,846.34' (Free Discharge)
├─**1=Culvert** (Barrel Controls 3.31 cfs @ 4.1 fps)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Pond2: Pond 2

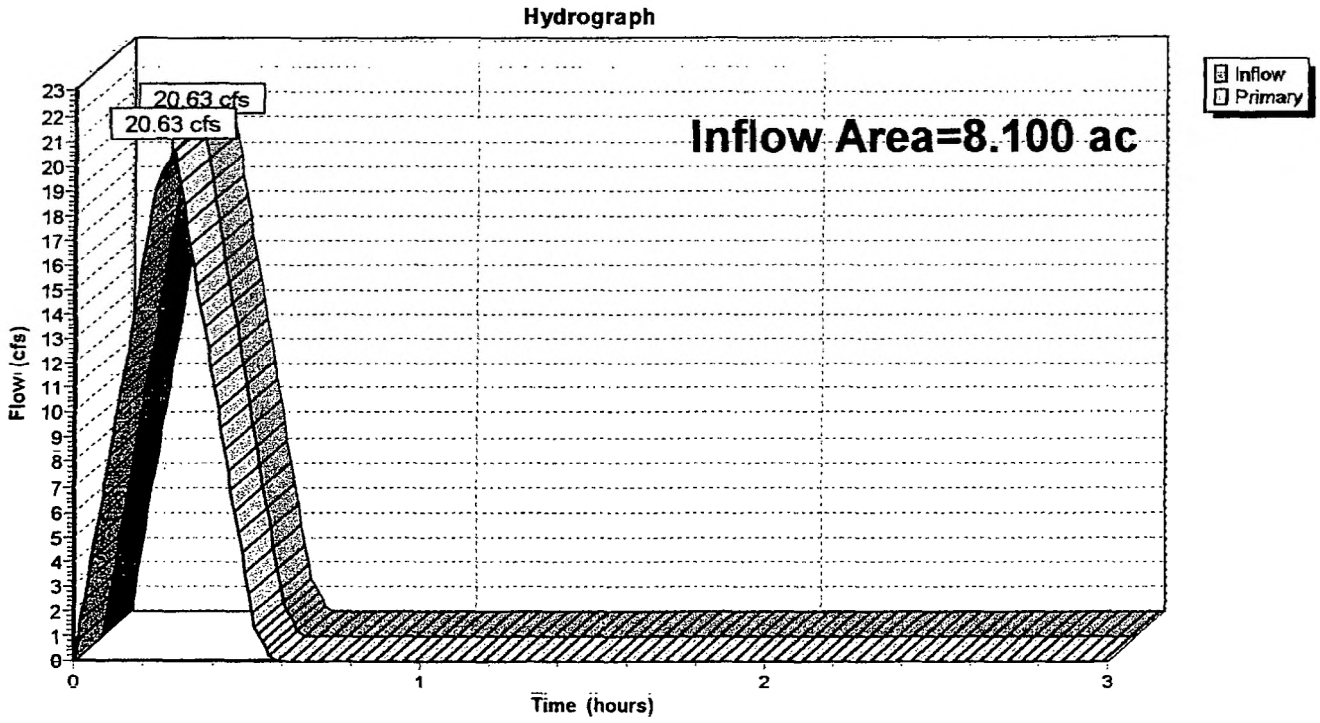


Link DP3: Design Point 3

Inflow Area = 8.100 ac, Inflow Depth = 0.72" for 5-Year event
Inflow = 20.63 cfs @ 0.28 hrs, Volume= 0.485 af
Primary = 20.63 cfs @ 0.28 hrs, Volume= 0.485 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs

Link DP3: Design Point 3

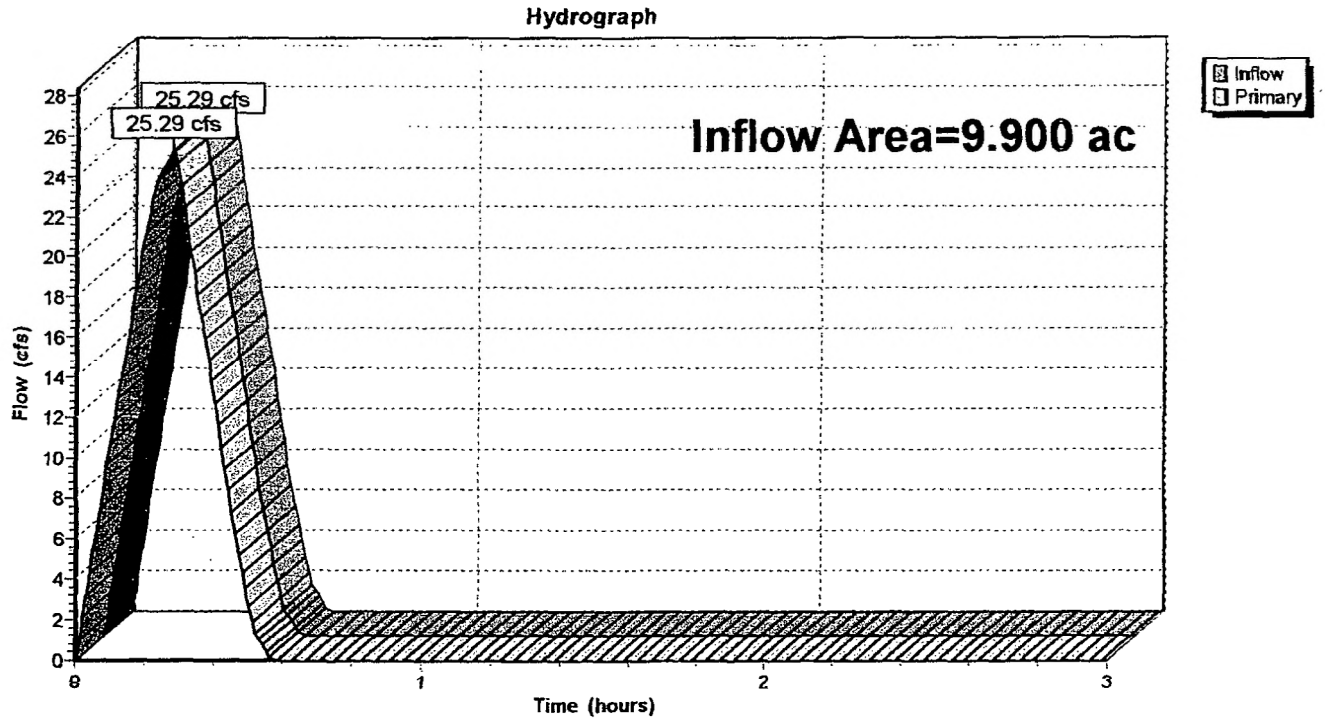


Link DP6: Design Point 6

Inflow Area = 9.900 ac, Inflow Depth = 0.72" for 5-Year event
Inflow = 25.29 cfs @ 0.28 hrs, Volume= 0.594 af
Primary = 25.29 cfs @ 0.28 hrs, Volume= 0.594 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs

Link DP6: Design Point 6

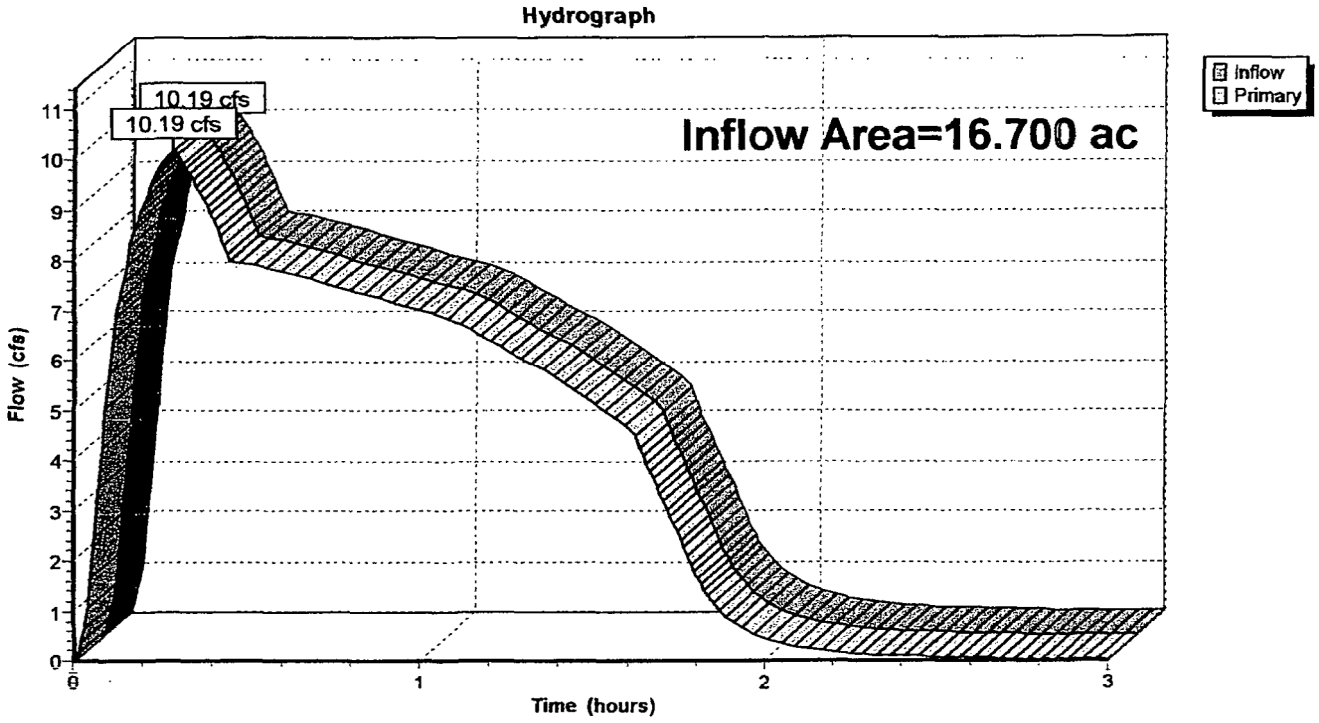


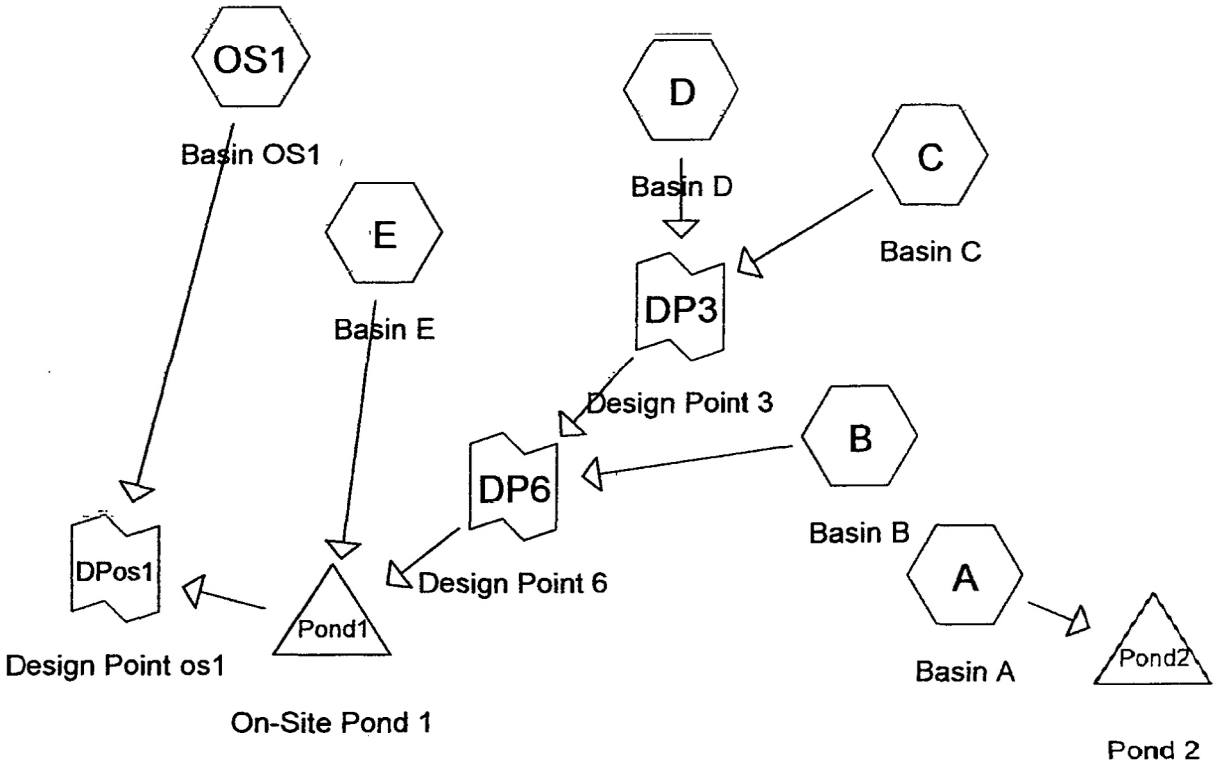
Link DPos1: Design Point os1

Inflow Area = 16.700 ac, Inflow Depth = 0.71" for 5-Year event
Inflow = 10.19 cfs @ 0.28 hrs, Volume= 0.992 af
Primary = 10.19 cfs @ 0.28 hrs, Volume= 0.992 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs

Link DPos1: Design Point os1





Subcat Reach Pond Link

Drainage Diagram for 100YR-DEVELOPED
Prepared by WestWorks Engineering 8/30/2004
HydroCAD® 7.00 s/n 002053 © 1986-2003 Applied Microcomputer Systems

Time span=0.00-3.00 hrs, dt=0.01 hrs, 301 points
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment A: Basin A Runoff Area=2.000 ac Runoff Depth=1.27"
Tc=11.4 min C=0.80 Runoff=9.03 cfs 0.212 af

Subcatchment B: Basin B Runoff Area=1.800 ac Runoff Depth=1.43"
Tc=11.1 min C=0.90 Runoff=9.15 cfs 0.214 af

Subcatchment C: Basin C Runoff Area=4.900 ac Runoff Depth=1.43"
Tc=13.9 min C=0.90 Runoff=24.90 cfs 0.583 af

Subcatchment D: Basin D Runoff Area=3.200 ac Runoff Depth=1.39"
Tc=17.4 min C=0.90 Runoff=15.72 cfs 0.372 af

Subcatchment E: Basin E Runoff Area=5.500 ac Runoff Depth=1.43"
Tc=12.0 min C=0.90 Runoff=27.95 cfs 0.655 af

Subcatchment OS1: Basin OS1 Runoff Area=1.300 ac Runoff Depth=1.27"
Tc=10.0 min C=0.80 Runoff=5.87 cfs 0.137 af

Pond Pond1: On-Site Pond 1 Peak Elev=5,837.54' Storage=1.483 af Inflow=77.82 cfs 1.824 af
Outflow=15.39 cfs 1.810 af

Pond Pond2: Pond 2 Peak Elev=5,846.93' Storage=0.088 af Inflow=9.03 cfs 0.212 af
Outflow=6.65 cfs 0.201 af

Link DP3: Design Point 3 Inflow=40.61 cfs 0.955 af
Primary=40.61 cfs 0.955 af

Link DP6: Design Point 6 Inflow=49.78 cfs 1.169 af
Primary=49.78 cfs 1.169 af

Link DPos1: Design Point os1 Inflow=15.56 cfs 1.947 af
Primary=15.56 cfs 1.947 af

Total Runoff Area = 18.700 ac Runoff Volume = 2.173 af Average Runoff Depth = 1.39"

Subcatchment A: Basin A

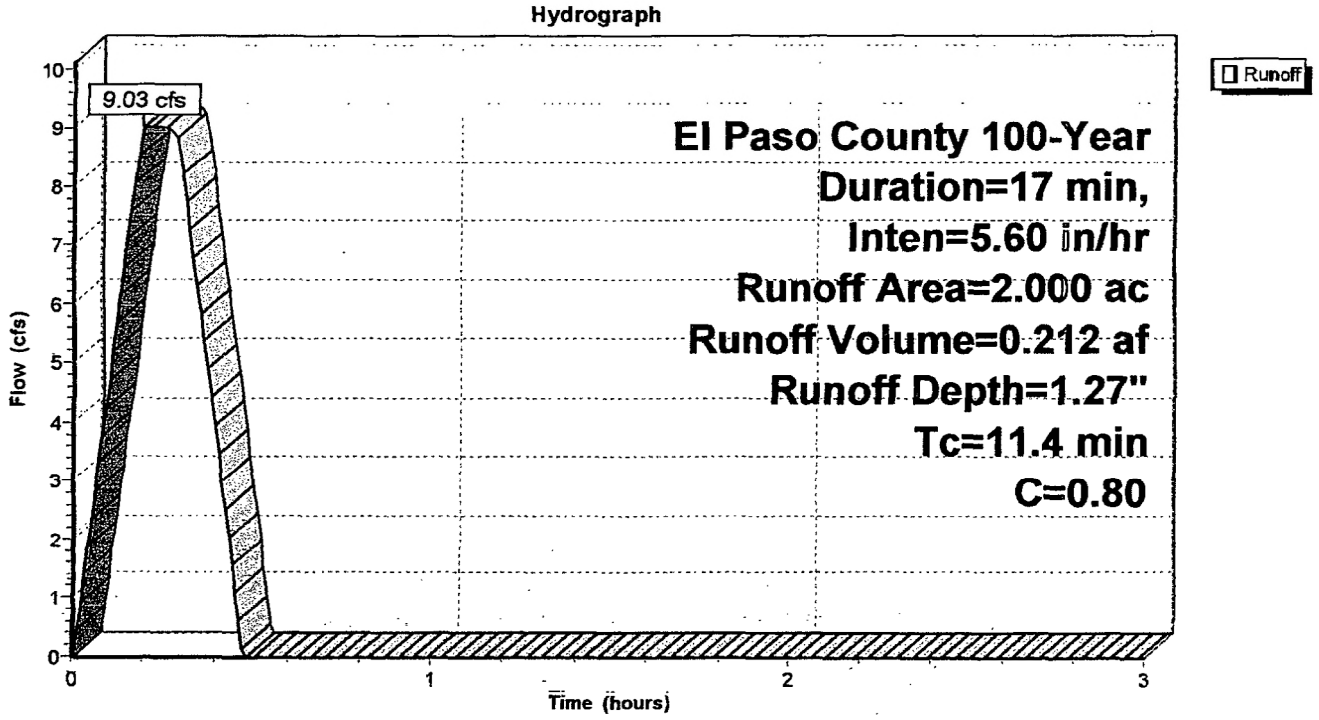
Runoff = 9.03 cfs @ 0.19 hrs, Volume= 0.212 af, Depth= 1.27"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
El Paso County 100-Year Duration=17 min, Inten=5.60 in/hr

Area (ac)	C	Description
2.000	0.80	Commercial

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.4					**Direct Entry, Basin A**

Subcatchment A: Basin A



Subcatchment B: Basin B

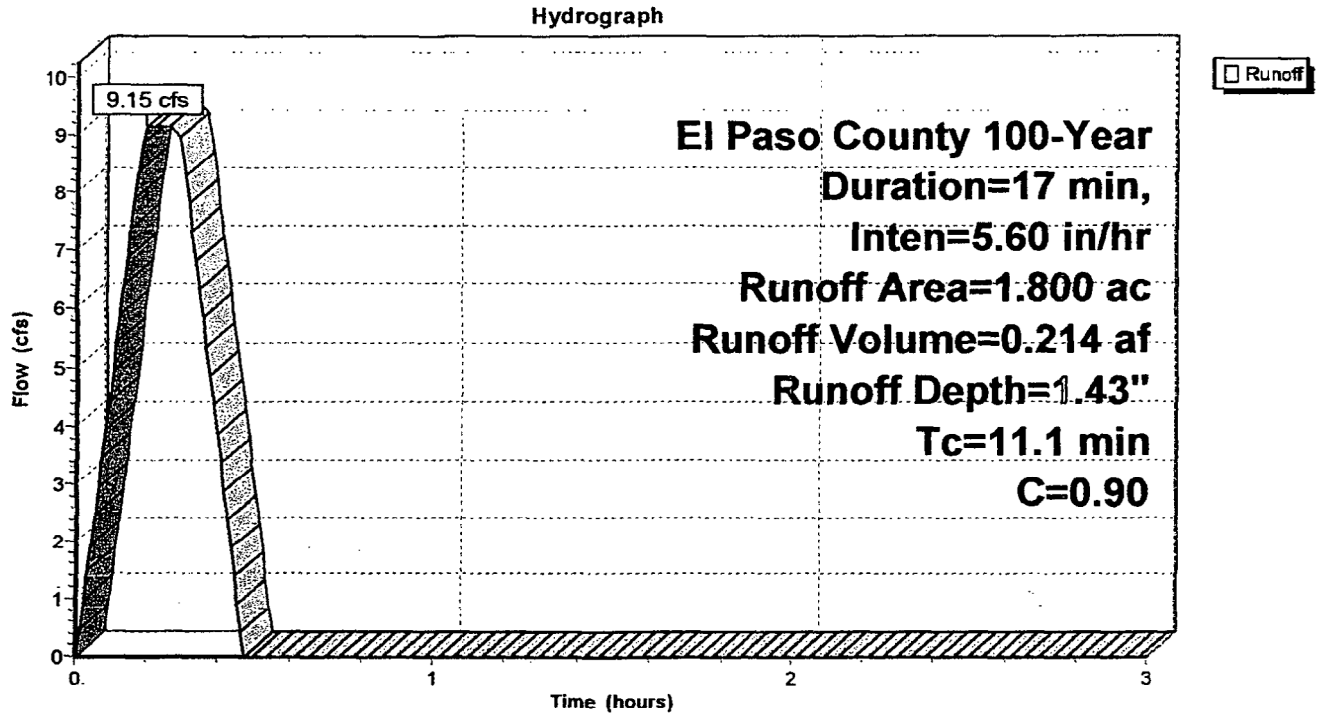
Runoff = 9.15 cfs @ 0.19 hrs, Volume= 0.214 af, Depth= 1.43"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
El Paso County 100-Year Duration=17 min, Inten=5.60 in/hr

Area (ac)	C	Description
1.800	0.90	Basin B

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1					Direct Entry, Basin B

Subcatchment B: Basin B



Subcatchment C: Basin C

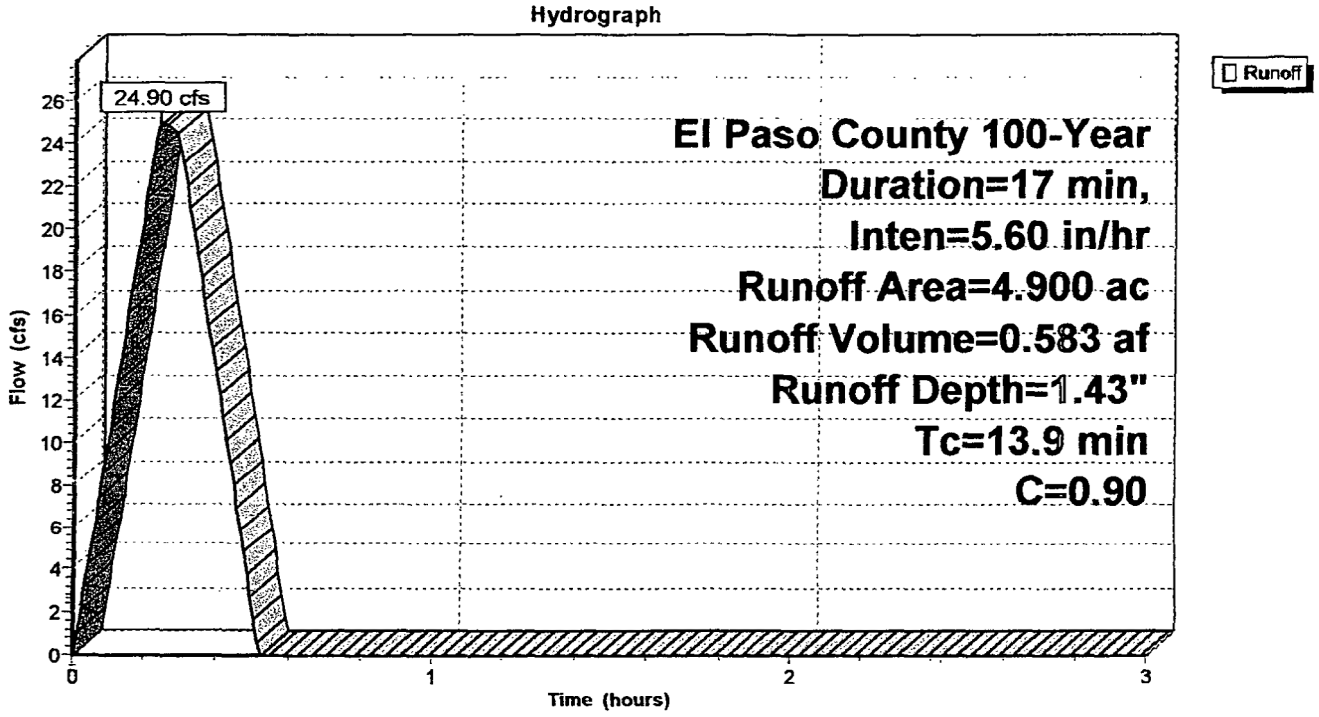
Runoff = 24.90 cfs @ 0.24 hrs, Volume= 0.583 af, Depth= 1.43"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
El Paso County 100-Year Duration=17 min, Inten=5.60 in/hr

Area (ac)	C	Description
4.900	0.90	Basin C

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.9					Direct Entry, Basin C

Subcatchment C: Basin C



Subcatchment D: Basin D

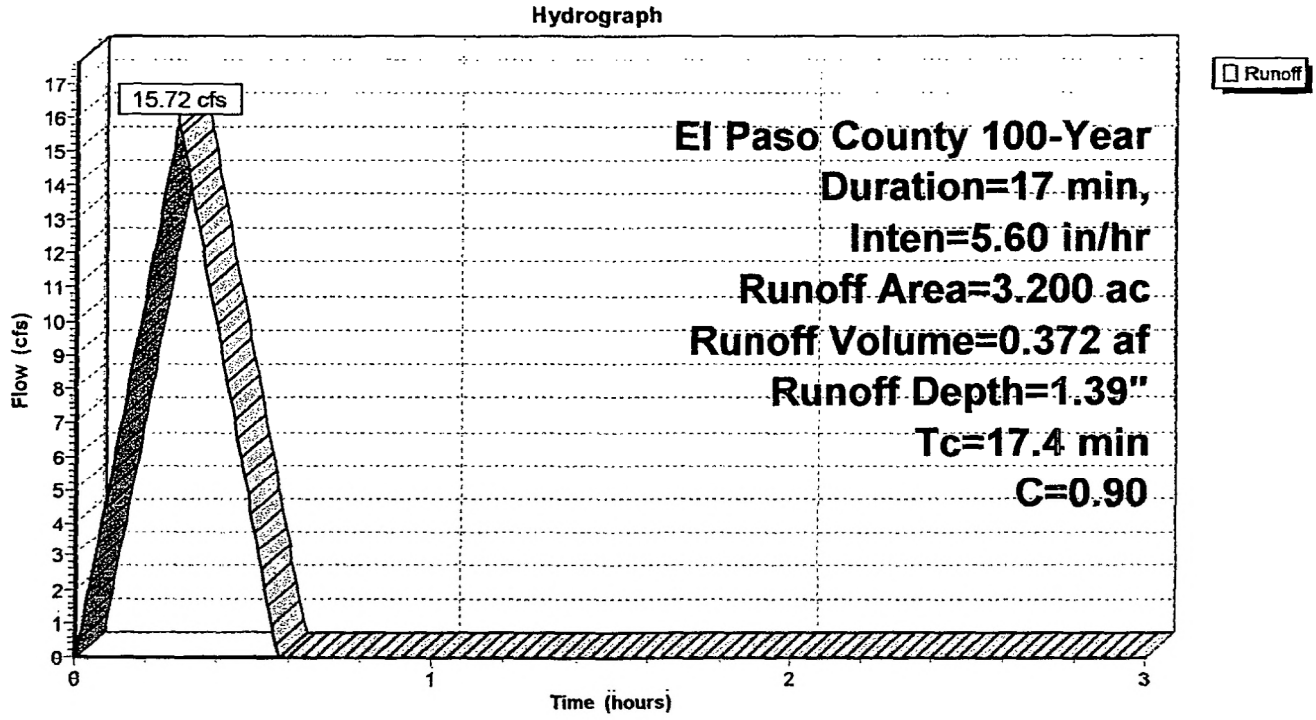
Runoff = 15.72 cfs @ 0.28 hrs, Volume= 0.372 af, Depth= 1.39"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
El Paso County 100-Year Duration=17 min, Inten=5.60 in/hr

Area (ac)	C	Description
3.200	0.90	Basin D

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.4					Direct Entry, Basin D

Subcatchment D: Basin D



Subcatchment E: Basin E

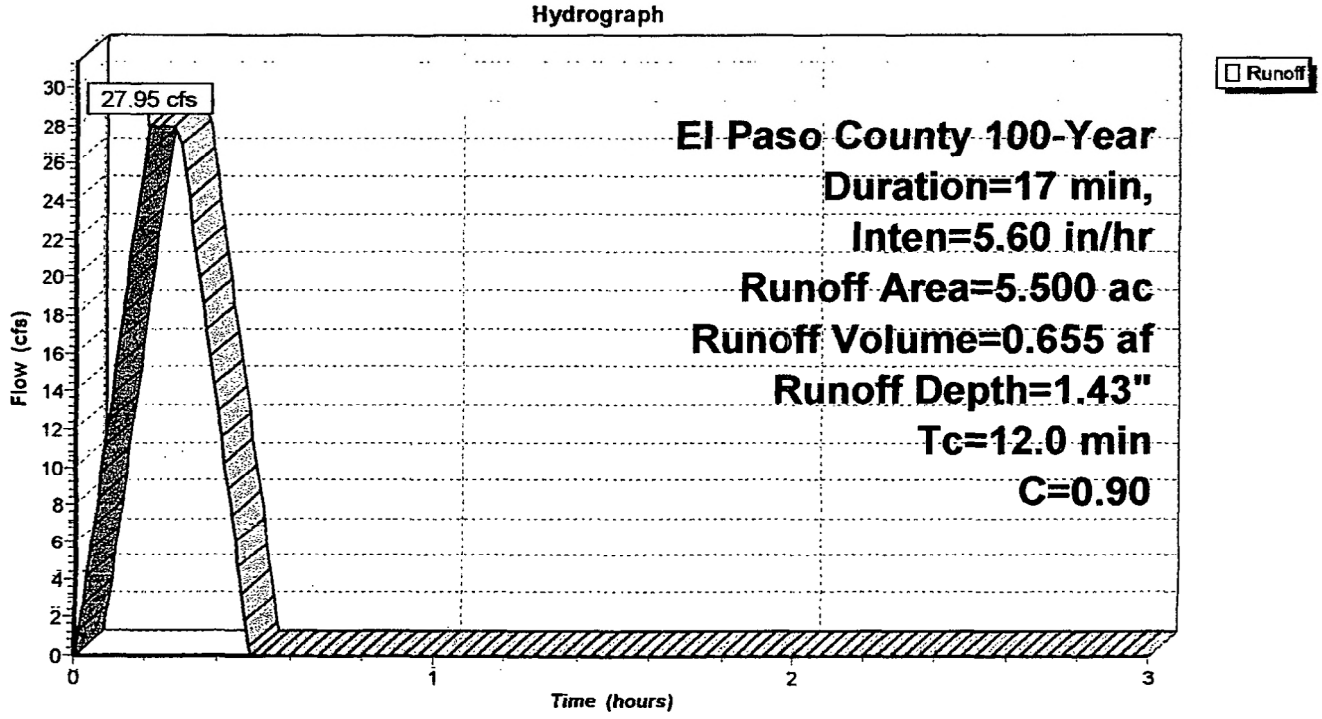
Runoff = 27.95 cfs @ 0.20 hrs, Volume= 0.655 af, Depth= 1.43"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
El Paso County 100-Year Duration=17 min, Inten=5.60 in/hr

Area (ac)	C	Description
5.500	0.90	Basin E

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0					Direct Entry, Basin E

Subcatchment E: Basin E



Subcatchment OS1: Basin OS1

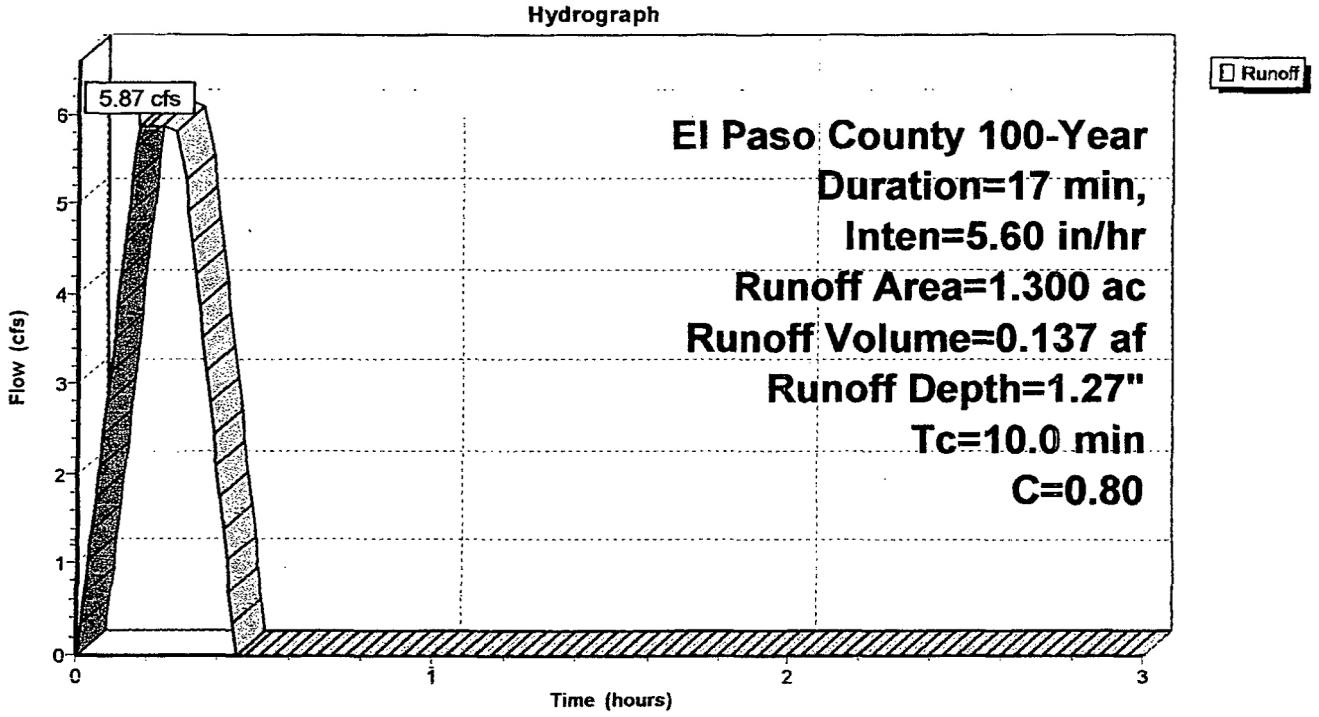
Runoff = 5.87 cfs @ 0.17 hrs, Volume= 0.137 af, Depth= 1.27"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
El Paso County 100-Year Duration=17 min, Inten=5.60 in/hr

Area (ac)	C	Description
1.300	0.80	Basin OS1

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Basin OS1**

Subcatchment OS1: Basin OS1



Pond Pond1: On-Site Pond 1

Inflow Area = 15.400 ac, Inflow Depth = 1.42" for 100-Year event
Inflow = 77.82 cfs @ 0.28 hrs, Volume= 1.824 af
Outflow = 15.39 cfs @ 0.46 hrs, Volume= 1.810 af, Atten= 80%, Lag= 11.0 min
Primary = 15.39 cfs @ 0.46 hrs, Volume= 1.810 af

Routing by Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Peak Elev= 5,837.54' @ 0.46 hrs Surf.Area= 0.481 ac Storage= 1.483 af
Plug-Flow detention time= 61.5 min calculated for 1.810 af (99% of inflow)
Center-of-Mass det. time= 61.4 min (76.7 - 15.3)

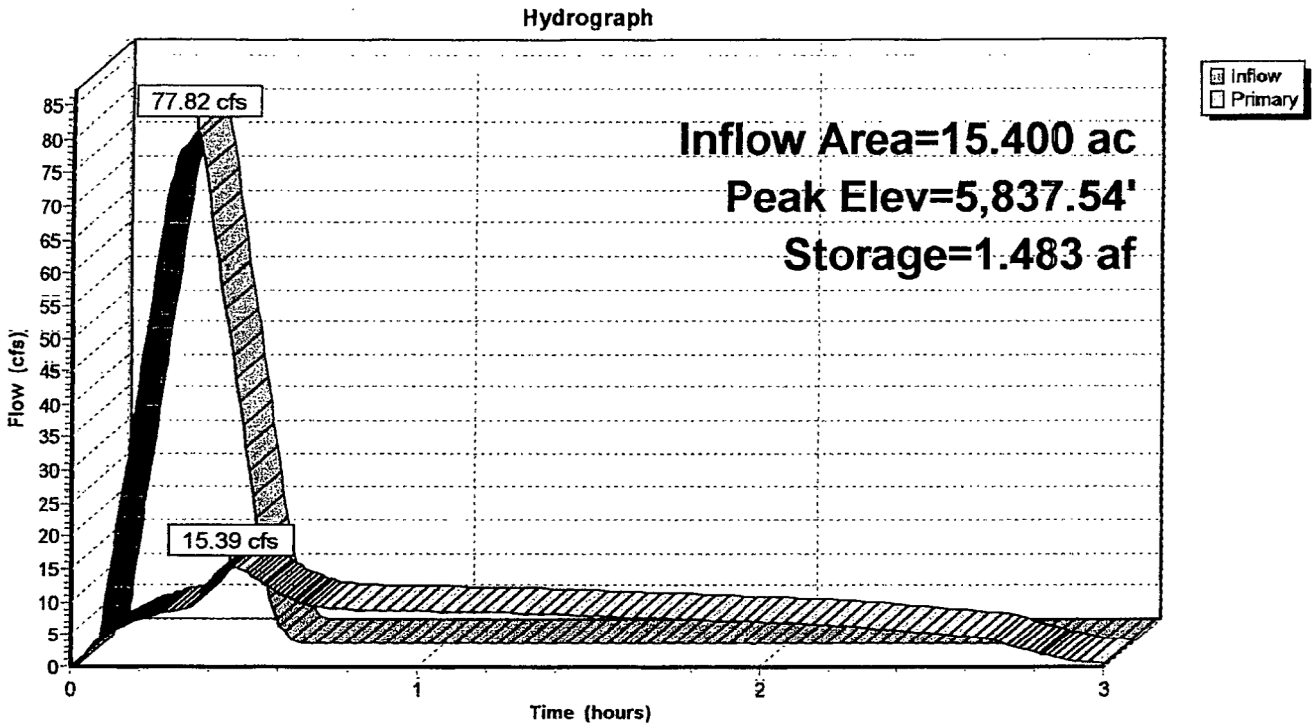
#	Invert	Avail.Storage	Storage Description
1	5,830.00'	1.681 af	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
5,830.00	0.003	0.000	0.000
5,832.00	0.075	0.078	0.078
5,834.00	0.176	0.251	0.329
5,836.00	0.324	0.500	0.829
5,838.00	0.529	0.852	1.681

#	Routing	Invert	Outlet Devices
1	Primary	5,830.00'	**12.0" x 60.0' long Culvert** RCP, sq.cut end projecting, Ke= 0.500 Outlet Invert= 5,829.00' S= 0.0167 '/' n= 0.013 Cc= 0.900
2	Primary	5,837.00'	**18.0" Horiz. Orifice/Grate** Limited to weir flow C= 0.600
3	Primary	5,839.00'	**30.0' long x 2.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32

Primary OutFlow Max=15.44 cfs @ 0.46 hrs HW=5,837.54' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 9.41 cfs @ 12.0 fps)
—**2=Orifice/Grate** (Weir Controls 6.03 cfs @ 2.4 fps)
└—**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Pond1: On-Site Pond 1



Pond Pond2: Pond 2

Inflow Area = 2.000 ac, Inflow Depth = 1.27" for 100-Year event
Inflow = 9.03 cfs @ 0.19 hrs, Volume= 0.212 af
Outflow = 6.65 cfs @ 0.33 hrs, Volume= 0.201 af, Atten= 26%, Lag= 8.6 min
Primary = 6.65 cfs @ 0.33 hrs, Volume= 0.201 af

Routing by Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Peak Elev= 5,846.93' @ 0.33 hrs Surf.Area= 0.084 ac Storage= 0.088 af
Plug-Flow detention time= 9.5 min calculated for 0.200 af (95% of inflow)
Center-of-Mass det. time= 9.2 min (23.4 - 14.2)

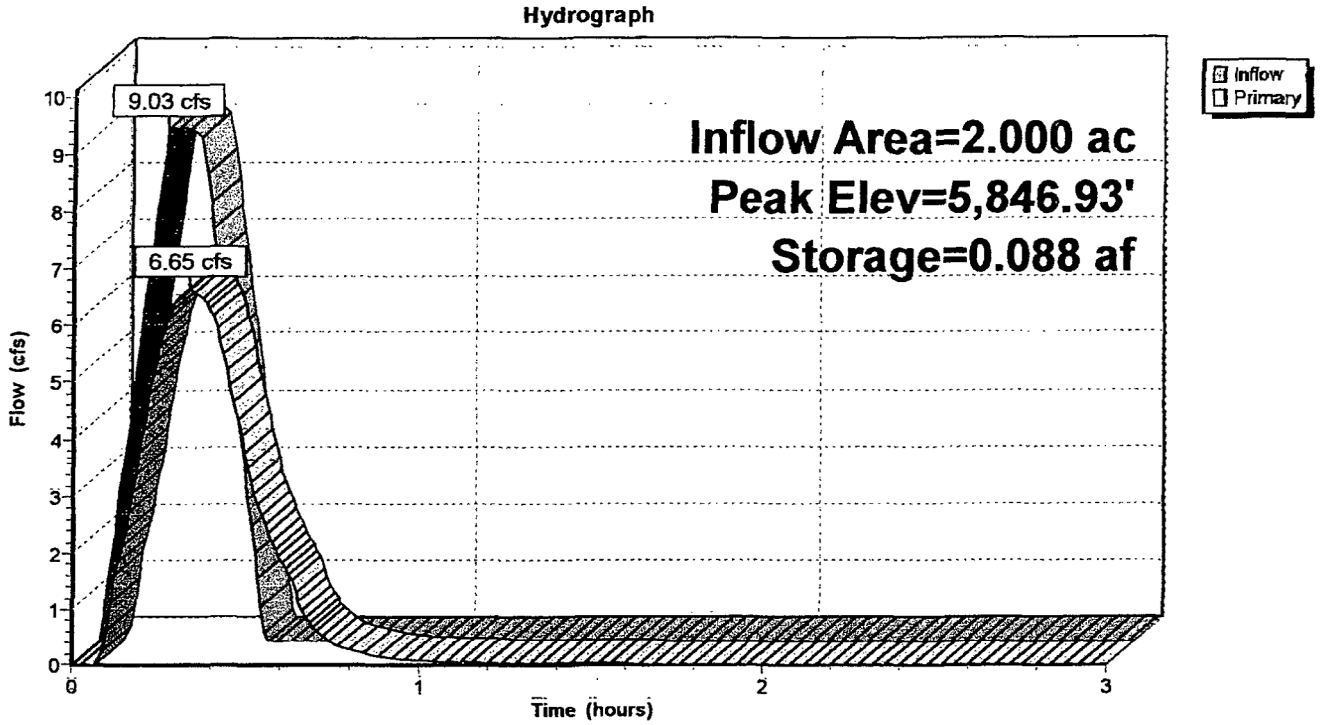
#	Invert	Avail.Storage	Storage Description
1	5,845.00'	0.092 af	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
5,845.00	0.000	0.000	0.000
5,846.00	0.049	0.025	0.025
5,847.00	0.087	0.068	0.092

#	Routing	Invert	Outlet Devices
1	Primary	5,845.40'	**18.0" x 40.0' long Culvert** RCP, mitered to conform to fill, Ke= 0.700 Outlet Invert= 5,845.00' S= 0.0100 '/' n= 0.013 Cc= 0.900
2	Primary	5,847.00'	**10.0' long x 2.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32

Primary OutFlow Max=6.65 cfs @ 0.33 hrs HW=5,846.93' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 6.65 cfs @ 3.8 fps)
└—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Pond2: Pond 2

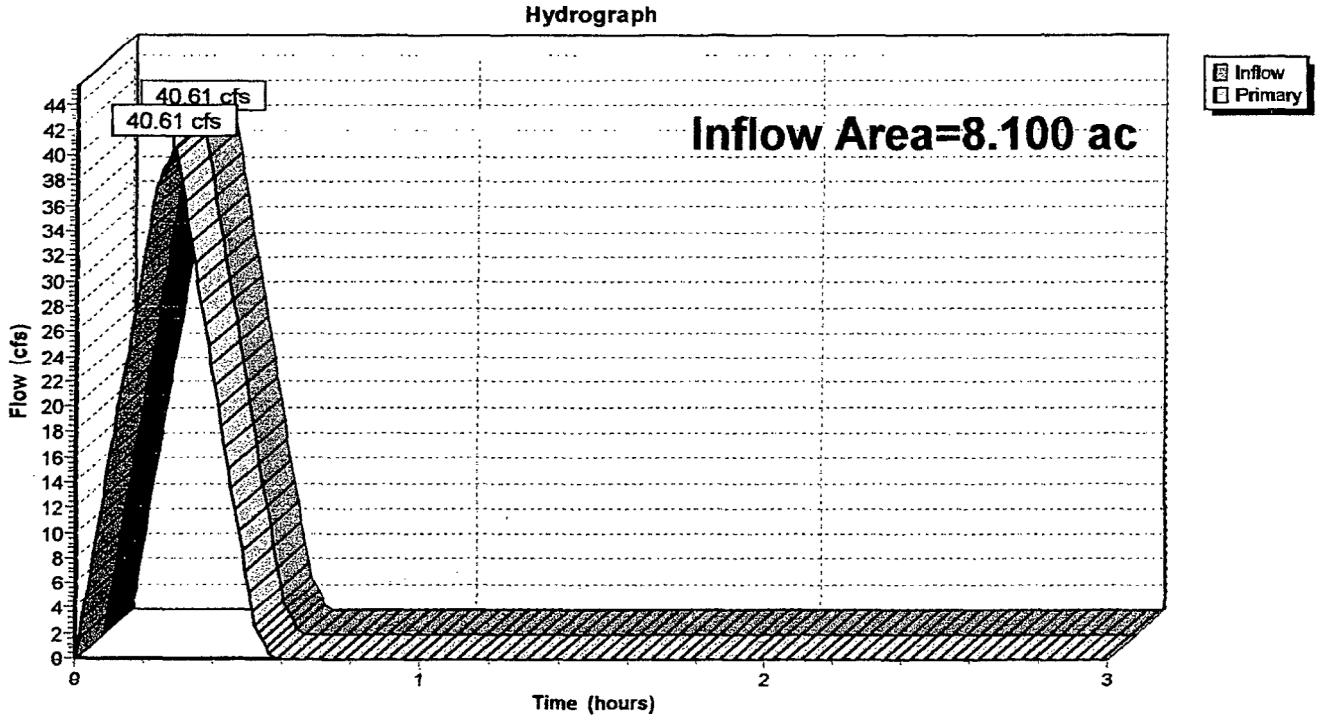


Link DP3: Design Point 3

Inflow Area = 8.100 ac, Inflow Depth = 1.41" for 100-Year event
Inflow = 40.61 cfs @ 0.28 hrs, Volume= 0.955 af
Primary = 40.61 cfs @ 0.28 hrs, Volume= 0.955 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs

Link DP3: Design Point 3

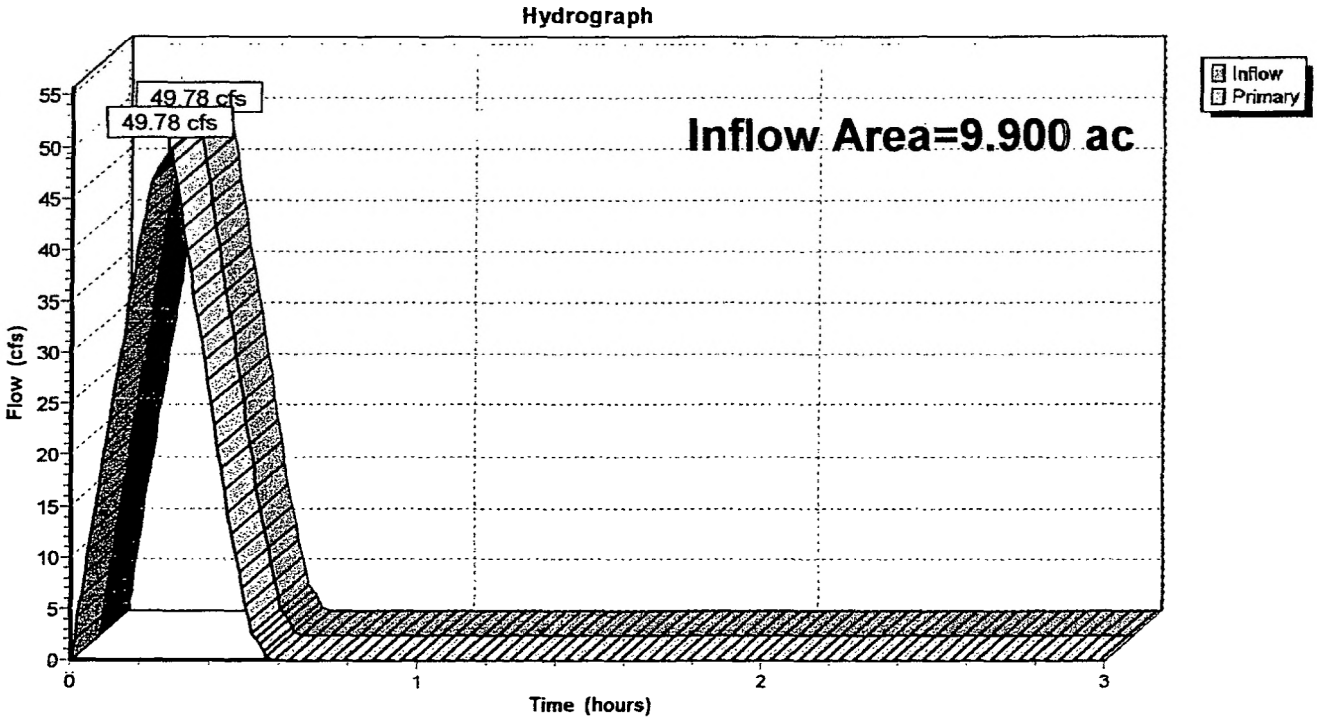


Link DP6: Design Point 6

Inflow Area = 9.900 ac, Inflow Depth = 1.42" for 100-Year event
Inflow = 49.78 cfs @ 0.28 hrs, Volume= 1.169 af
Primary = 49.78 cfs @ 0.28 hrs, Volume= 1.169 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs

Link DP6: Design Point 6

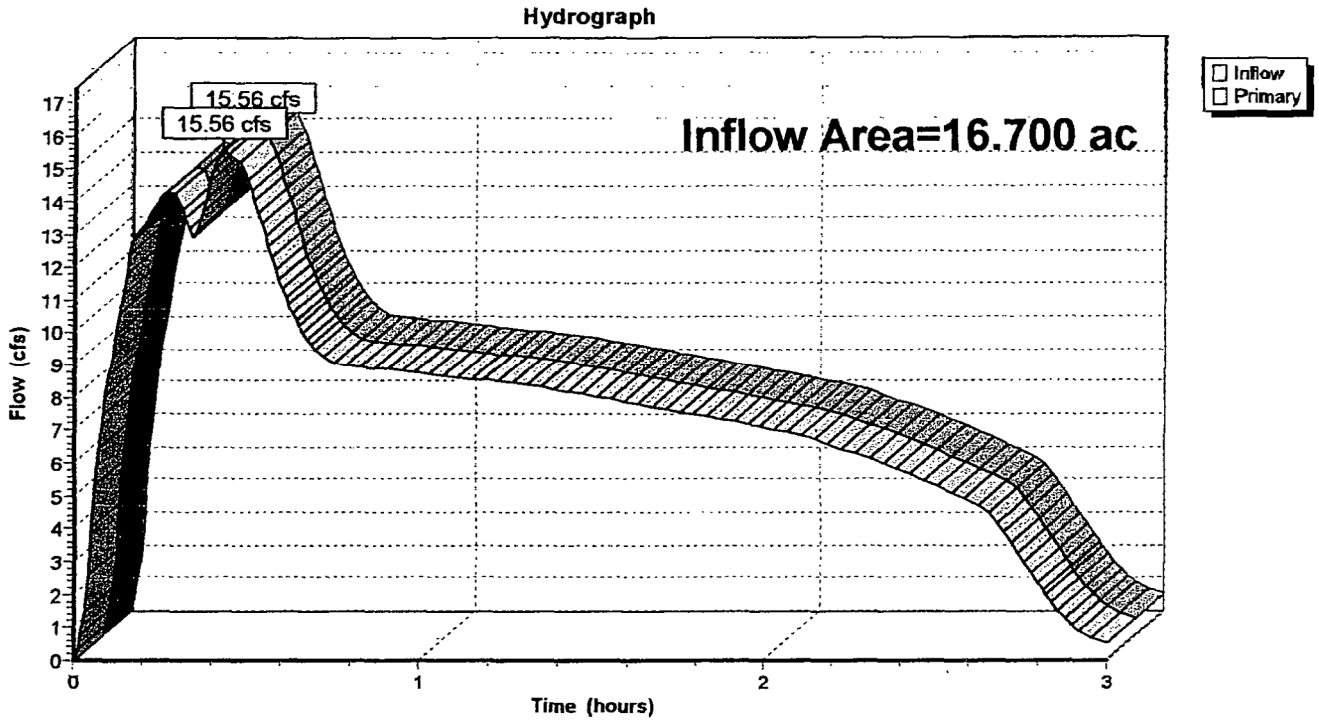


Link DPos1: Design Point os1

Inflow Area = 16.700 ac, Inflow Depth = 1.40" for 100-Year event
Inflow = 15.56 cfs @ 0.43 hrs, Volume= 1.947 af
Primary = 15.56 cfs @ 0.43 hrs, Volume= 1.947 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs

Link DPos1: Design Point os1



DP1
5' CURB OPENING

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

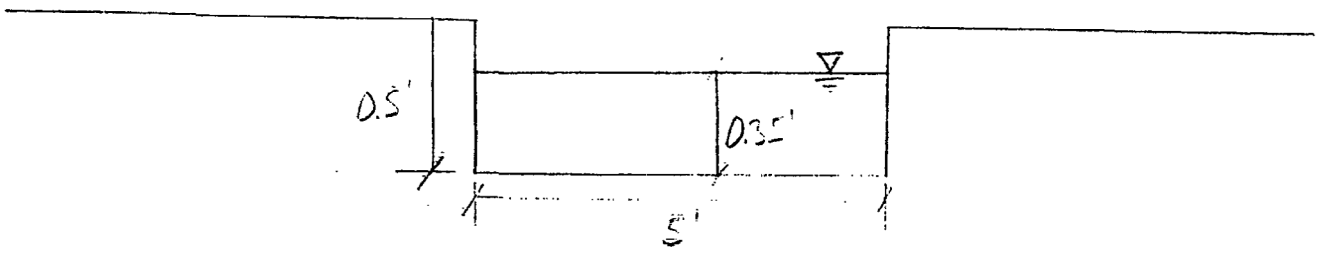
August 30, 2004

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	9.0
Channel Bottom Slope (ft/ft)	0.01
Manning's Roughness Coefficient (n-value)	0.013
Channel Left Side Slope (horizontal/vertical)	0.01
Channel Right Side Slope (horizontal/vertical)	0.01
Channel Bottom Width (ft)	5.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	0.35
Flow Velocity (fps)	5.19
Froude Number	1.553
Velocity Head (ft)	0.42
Energy Head (ft)	0.76
Cross-Sectional Area of Flow (sq ft)	1.74
Top Width of Flow (ft)	5.01



TYPICAL SECTION
N.T.S.

STORM Drain @ DA2
18" RCP

CIRCULAR CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

August 30, 2004

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	9.0 ← Q₁₀
Channel Bottom Slope (ft/ft)	0.01
Manning's Roughness Coefficient (n-value)	0.013
Channel Diameter (ft)	1.5

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	1.07
Flow Velocity (fps)	6.68
Froude Number	1.181
Velocity Head (ft)	0.69
Energy Head (ft)	1.76
Cross-Sectional Area of Flow (sq ft)	1.35
Top Width of Flow (ft)	1.36

STORM DRAIN @ DP3

30" RCP

CIRCULAR CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

August 30, 2004

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	34.0 ← Q_{100}
Channel Bottom Slope (ft/ft)	0.01
Manning's Roughness Coefficient (n-value)	0.013
Channel Diameter (ft)	2.5

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	1.74
Flow Velocity (fps)	9.35
Froude Number	1.311
Velocity Head (ft)	1.36
Energy Head (ft)	3.09
Cross-Sectional Area of Flow (sq ft)	3.64
Top Width of Flow (ft)	2.3

DP 4

10' CURB OPENING

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

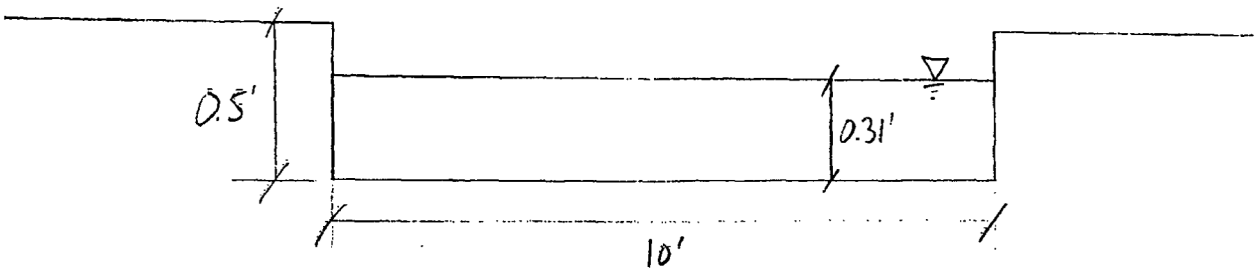
August 30, 2004

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	16.0 ← Q_{100}
Channel Bottom Slope (ft/ft)	0.01
Manning's Roughness Coefficient (n-value)	0.013
Channel Left Side Slope (horizontal/vertical)	0.01
Channel Right Side Slope (horizontal/vertical)	0.01
Channel Bottom Width (ft)	10.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	0.31
Flow Velocity (fps)	5.08
Froude Number	1.599
Velocity Head (ft)	0.4
Energy Head (ft)	0.72
Cross-Sectional Area of Flow (sq ft)	3.15
Top Width of Flow (ft)	10.01



TYPICAL SECTION
N.T.S

CULVERT @ LP6

36" RCP

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

August 30, 2004

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Culvert Diameter (ft)	3.0
FHWA Chart Number	1
FHWA Scale Number (Type of Culvert Entrance)	3
Manning's Roughness Coefficient (n-value)	0.013
Entrance Loss Coefficient of Culvert Opening	0.5
Culvert Length (ft)	70.0
Invert Elevation at Downstream end of Culvert (ft)	5,835.0
Invert Elevation at Upstream end of Culvert (ft)	5,835.7
Culvert Slope (ft/ft)	0.01
Starting Flow Rate (cfs)	24.0
Incremental Flow Rate (cfs)	2.0
Ending Flow Rate (cfs)	54.0
Starting Tailwater Depth (ft)	0.2
Incremental Tailwater Depth (ft)	0.1
Ending Tailwater Depth (ft)	1.7

COMPUTATION RESULTS

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)	
24.0	0.2	2.25	0.0	1.24	1.58	1.24	8.66	
26.0	0.3	2.36	0.0	1.3	1.65	1.3	8.85	25
28.0	0.4	2.47	0.0	1.36	1.71	1.36	9.03	
30.0	0.5	2.58	0.0	1.41	1.77	1.41	9.19	
32.0	0.6	2.69	0.0	1.46	1.84	1.46	9.34	
34.0	0.7	2.8	0.0	1.52	1.89	1.52	9.48	
36.0	0.8	2.9	0.0	1.57	1.95	1.57	9.62	
38.0	0.9	3.01	0.0	1.62	2.01	1.62	9.74	
40.0	1.0	3.12	0.0	1.67	2.06	1.67	9.86	
42.0	1.1	3.23	0.0	1.73	2.11	1.73	9.97	
44.0	1.2	3.37	0.0	1.78	2.16	1.78	10.08	
46.0	1.3	3.5	0.0	1.83	2.21	1.83	10.18	
48.0	1.4	3.57	0.0	1.88	2.26	1.88	10.27	
50.0	1.5	3.64	0.0	1.94	2.3	1.94	10.35	Q_{100}
52.0	1.6	3.77	0.0	1.99	2.34	1.99	10.44	
54.0	1.7	3.91	0.0	2.05	2.39	2.05	10.5	

SWALE FROM AP3 TO AP5

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

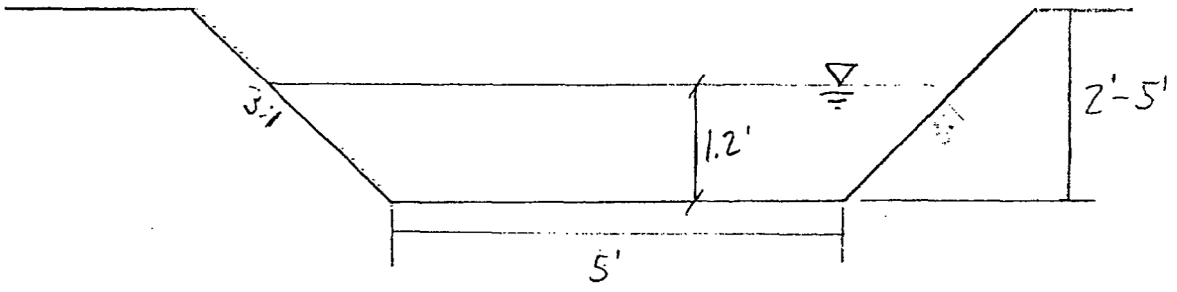
August 30, 2004

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	50.0 ← Q_{100}
Channel Bottom Slope (ft/ft)	0.01
Manning's Roughness Coefficient (n-value)	0.027
Channel Left Side Slope (horizontal/vertical)	3.0
Channel Right Side Slope (horizontal/vertical)	3.0
Channel Bottom Width (ft)	5.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	1.2
Flow Velocity (fps)	4.83
Froude Number	0.924
Velocity Head (ft)	0.36
Energy Head (ft)	1.57
Cross-Sectional Area of Flow (sq ft)	10.36
Top Width of Flow (ft)	12.22



TYPICAL SECTION
N.T.S.

Calculations for Sizing of Standard D-10-R Sump Inlets

Design Point	Q_5 [cfs]	Q_{100} [cfs]	$d_{5\text{-yr.}}$ [ft]	$d_{100\text{-yr.}}$ [ft]	Length of Inlet, L_i [ft]	
					$L_{i\text{-}5yr}$ [ft]	$L_{i\text{-}100yr}$ [ft]
2	5	9	0.50	0.70	**4**	**5**
3	13	26	0.50	0.70	**10**	**13**

$$*Q_i = F[1.7(L_i+1.8W)(d_{max}+w/12)^{1.85}]$$

*Equation taken from Figure 7-11 of the City of Colorado Springs Drainage Criteria Manual

where:

Q_i = flow to inlet [cfs]

L_i = length of inlet [ft]

W = width of gutter pan [=3 ft]

d_{max} = ponding depth [0.94 ft max.]

w = depth of depressed area at inlet [3 in]

F = clogging factor [1.25]

WESTWORKS™ ENGINEERING

Project: Lincoln Plaza

Job No.: 90417

Engineer: Chad Kuzbek

Date: August 30, 2004

RIPRAP SIZING

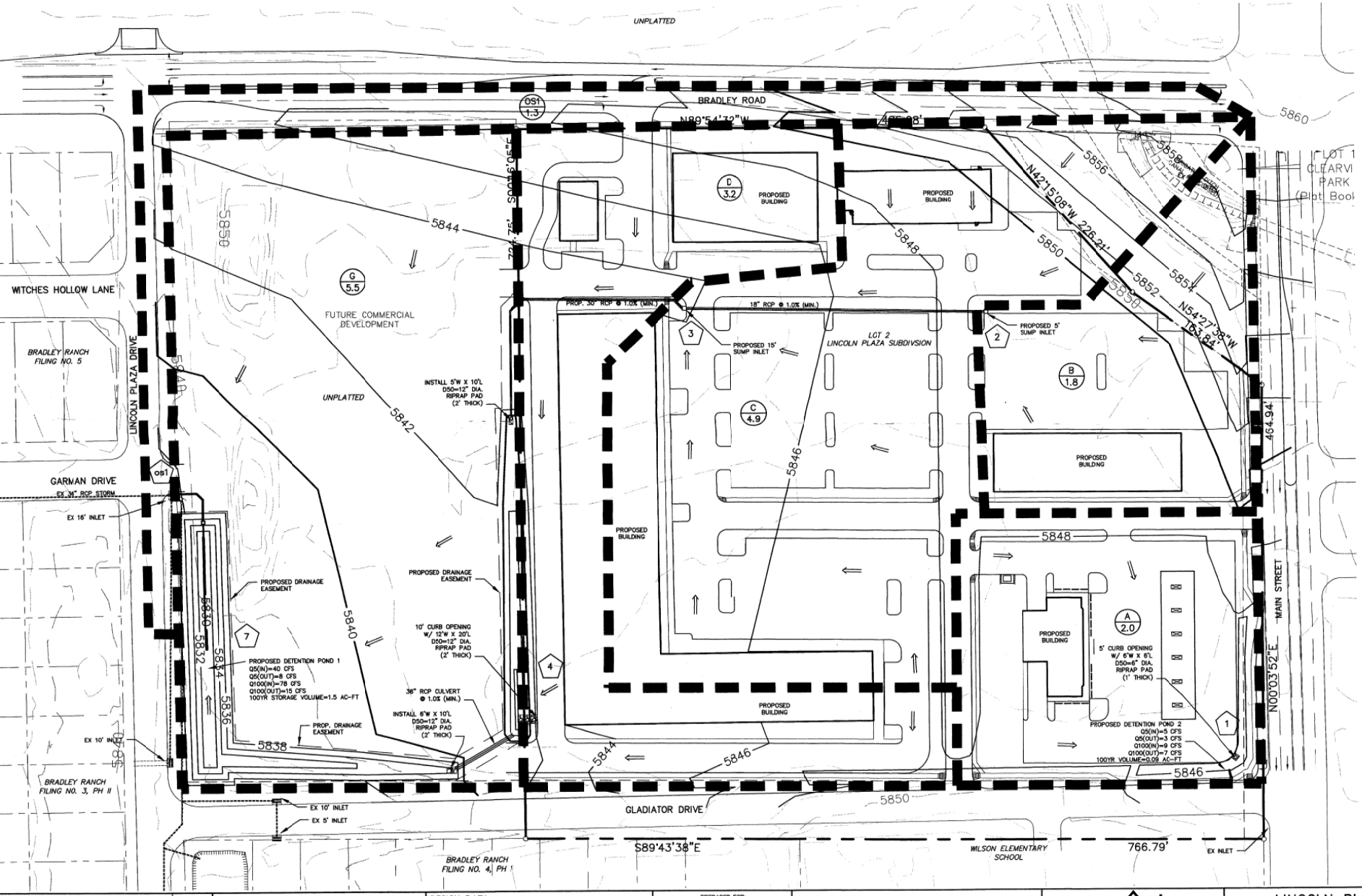
Channel Section Description	Velocity V [ft/s]	Slope, S [ft/ft]	Specific Gravity	*Channel/Riprap Relationship	Rock Type	Mean Particle Size [in]
DP1	5.2	1.00%	2.5	1.82	VL	6
DP3 Discharge	9.4	1.00%	2.5	3.29	VL	6
DP4	5.1	1.00%	2.5	1.78	VL	6
DP6	10.4	1.00%	2.5	3.64	L	9

*Channel/Riprap Relationship = $\frac{V*S^{0.17}}{(S_S - 1)^{0.66}}$

*taken from El Paso County Drainage Criteria Manual Section 10.10

where: V = mean channel flow velocity [ft/sec]
S = longitudinal channel slope [ft/ft]
S_S = specific gravity of stone (min = 2.5)

LINCOLN PLAZA SUBDIVISION NO. 2
DEVELOPED CONDITIONS DRAINAGE MAP
EL PASO COUNTY, COLORADO



BASIN	Q5 [CFS]	Q1
A	5	
B	5	
C	13	
D	8	
E	14	
OS1	3	

DESIGN POINT	Q5 [CFS]	Q1
1	5	
2	5	
3	13	
4	8	
5	14	
6	25	
os1	10	

LEGEND
- BASIN IDENTIFIER / BASIN AREA [AC] — A / 1.0
- DESIGN POINT IDENTIFIER — 1
- DRAINAGE BASIN BOUNDARY
- SURFACE FLOW DIRECTION
- EXISTING MAJOR CONTOUR (10')
- EXISTING MINOR CONTOUR (2')
- PROPOSED MAJOR CONTOUR (10')
- PROPOSED MINOR CONTOUR (2')

N

0 50 100
HORIZONTAL SCALE: 1"=

DESCRIPTION	DATE
ER EL PASO COUNTY DCT COMMENTS	8/30/04

REVIEW:
STREET DESIGN:
ROUGH CUT REVIEW _____ DATE _____
FINAL REVIEW _____ DATE _____
DRAINAGE DESIGN:
_____ DATE _____

DESIGN DATA:
SIDEWALKS: WIDTH: _____ LOCATION: ☐ Attached ☐ Detached
CURB TYPE: ☐1 ☐2 ☐3
R/W WIDTH: _____ F/C-F/C _____
STREET TYPE: _____ HVEEM _____
ASPHALT THICKNESS: AC Surface _____ AC Base _____
AGG. BASE THICKNESS: Class 6 _____ Class 5 _____ Class 2 _____

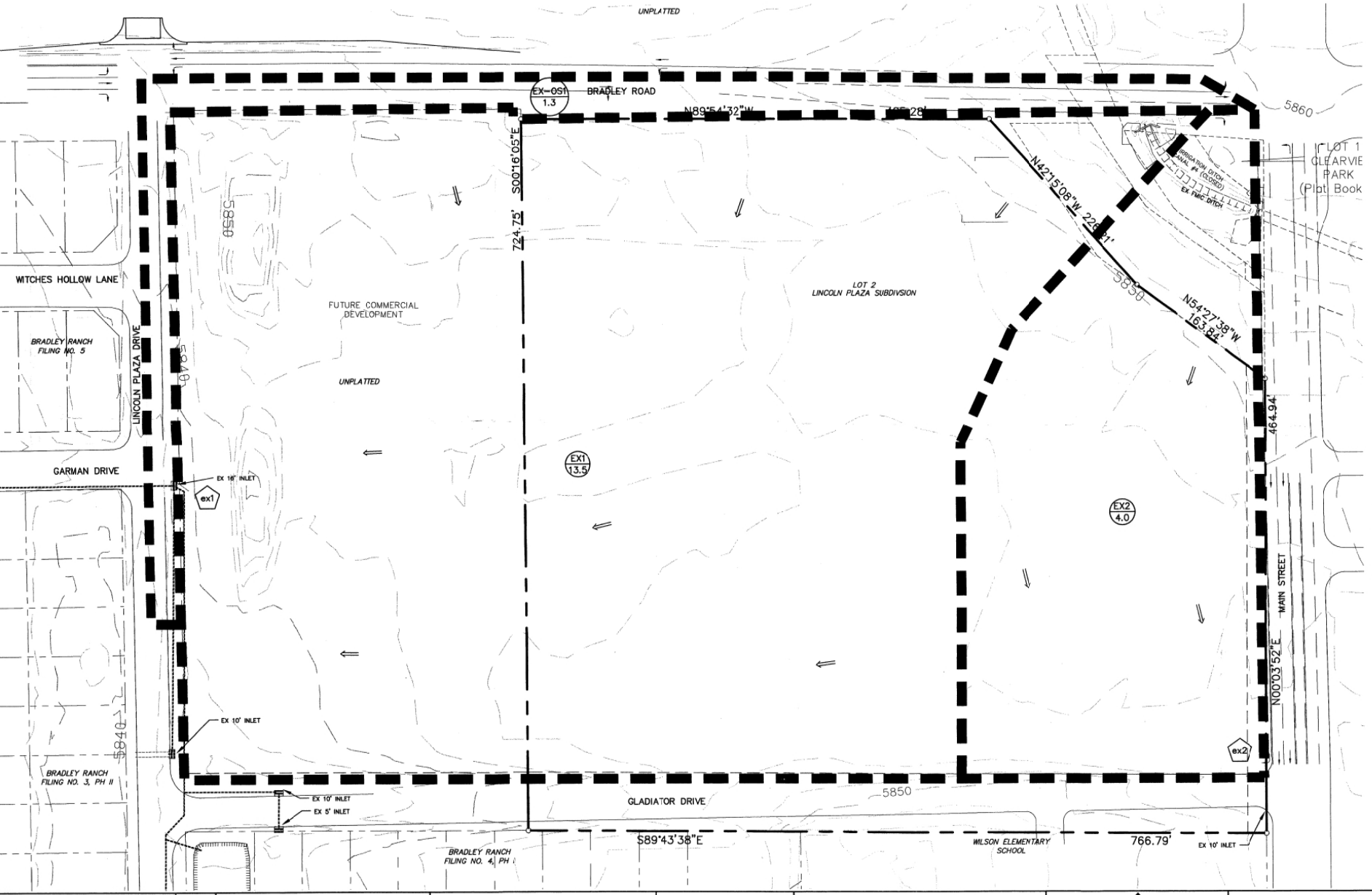
PREPARED FOR:
LINCOLN EQUITIES, LLLP
2928 STRAUS LANE, SUITE 210
COLORADO SPRINGS, CO 80907
(719) 473-7763

WESTWORKS ENGINEERING
945 OSAGE AVENUE MANITOU SPRINGS, CO 80829 (719) 685-1678

LINCOLN PLAZA SUBDIVISION NO. 2
DEVELOPED CONDITIONS DRAINAGE MAP

DRAWN BY: CDK
SCALE: 1"=50'
JOB NUMBER 90417

LINCOLN PLAZA SUBDIVISION NO. 2
HISTORIC CONDITIONS DRAINAGE MAP
EL PASO COUNTY, COLORADO



BASIN	Q5 [CFS]	Q10
EX1	9	
EX2	3	
EX-OS1	2	

DESIGN POINT	Q5 [CFS]	Q10
ex1	11	
ex2	3	

LEGEND

BASIN IDENTIFIER / BASIN AREA [AC] — A / 1.0

DESIGN POINT IDENTIFIER — 1

DRAINAGE BASIN BOUNDARY

SURFACE FLOW DIRECTION

EXISTING MAJOR CONTOUR (10')

EXISTING MINOR CONTOUR (2')

PROPOSED MAJOR CONTOUR (10')

PROPOSED MINOR CONTOUR (2')

N

0 50 100

HORIZONTAL SCALE: 1"=5

DESCRIPTION	DATE
PER EL PASO COUNTY DOT COMMENTS	8/30/04

REVIEW:
STREET DESIGN:
ROUGH CUT REVIEW _____ DATE _____
FINAL REVIEW _____ DATE _____
DRAINAGE DESIGN:
FILED IN ACCORDANCE WITH SECTION 15-3-906 OF THE CODE OF COLORADO SPRINGS 1980, AS AMENDED:
_____ DATE _____

DESIGN DATA:
SIDEWALKS: WIDTH: _____ LOCATION: ☐ Attached ☐ Detached
CURB TYPE: ☐1 ☐2 ☐3
R/W WIDTH: _____ F/C-F/C _____
STREET TYPE: _____ HVEEM _____
ASPHALT THICKNESS: AC Surface _____ AC Base _____
AGG. BASE THICKNESS: Class 6 _____ Class 5 _____ Class 2 _____

PREPARED FOR:
LINCOLN EQUITIES, LLLP
2928 STRAUS LANE, SUITE 210
COLORADO SPRINGS, CO 80907
(719) 473-7763

WESTWORKS ENGINEERING
845 OSAGE AVENUE MANITOU SPRINGS, CO 80829 (719) 685-1676

LINCOLN PLAZA SUBDIVISION NO. 2
HISTORIC CONDITIONS DRAINAGE MAP

DRAWN BY: CDK
SCALE: 1"=50'
JOB NUMBER 90417

Appendix F: Rational Method Drainage Calculations

Calculation of Peak Runoff using Rational Method

Designer: Richard Lyon
Company: RMG-Rocky Mountain Group
Date: 12/2/2019
Project: 1830 Main Street - Existing Conditions
Location: Colorado Springs, CO

Version 2.00 released May 2017

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

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

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

Computed $t_c = t_i + t_t$

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

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

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

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

	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
1-hour rainfall depth, P1 (in) =	1.00	1.28	1.54	1.96	2.32	2.71	3.77
	a	b	c				
Rainfall Intensity Equation Coefficients =	28.50	10.00	0.786				

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

$$Q(cfs) = CIA$$

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C							Overland (Initial) Flow Time					Channelized (Travel) Flow Time							Time of Concentration			Rainfall Intensity, I (in/hr)							Peak Flow, Q (cfs)						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)	Overland Flow Time t_i (min)	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)	Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
E-1	1.17	A	3.32	0.010	0.011	0.013	0.019	0.053	0.136	0.275	110.00	104.70	98.81	0.054	11.85	240.00	98.81	94.37	0.019	10	1.36	2.94	14.79	28.54	14.79	2.28	2.92	3.52	4.48	5.30	6.19	8.61	0.03	0.04	0.05	0.10	0.33	0.98	2.77
E-2	0.31	A	32.5	0.195	0.205	0.219	0.250	0.303	0.363	0.464	97.00	102.30	99.96	0.024	11.90	267.00	99.96	95.00	0.019	20	2.73	1.63	13.53	22.88	13.53	2.38	3.05	3.67	4.67	5.52	6.45	8.98	0.14	0.20	0.25	0.37	0.52	0.73	1.30
E-3	0.02	A	33.3	0.201	0.212	0.225	0.257	0.309	0.369	0.469	67.00	101.20	99.57	0.024	9.79	0.01	0.00	0.00	0.000	20	0.06	0.00	9.79	20.35	9.79	2.72	3.49	4.20	5.35	6.33	7.39	10.28	0.01	0.01	0.01	0.02	0.03	0.04	0.08
OS-1	0.42	A	0.0	0.000	0.000	0.000	0.000	0.025	0.110	0.254	110.00	106.00	98.81	0.065	11.21	0.01	0.00	0.00	0.000	10	0.03	0.01	11.22	26.01	11.22	2.58	3.31	3.98	5.06	5.99	7.00	9.74	0.00	0.00	0.00	0.00	0.06	0.32	1.04

Calculation of Peak Runoff using Rational Method

Designer: Richard Lyon
Company: RMG-Rocky Mountain Group
Date: 12/2/2019
Project: 1830 Main Street
Location: Colorado Springs, CO

Version 2.00 released May 2017

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

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

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

Computed $t_c = t_i + t_t$

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

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

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

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

	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
1-hour rainfall depth, P1 (in) =	1.00	1.28	1.54	1.96	2.32	2.71	3.77
	a	b	c				
Rainfall Intensity Equation Coefficients =	28.50	10.00	0.786				

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

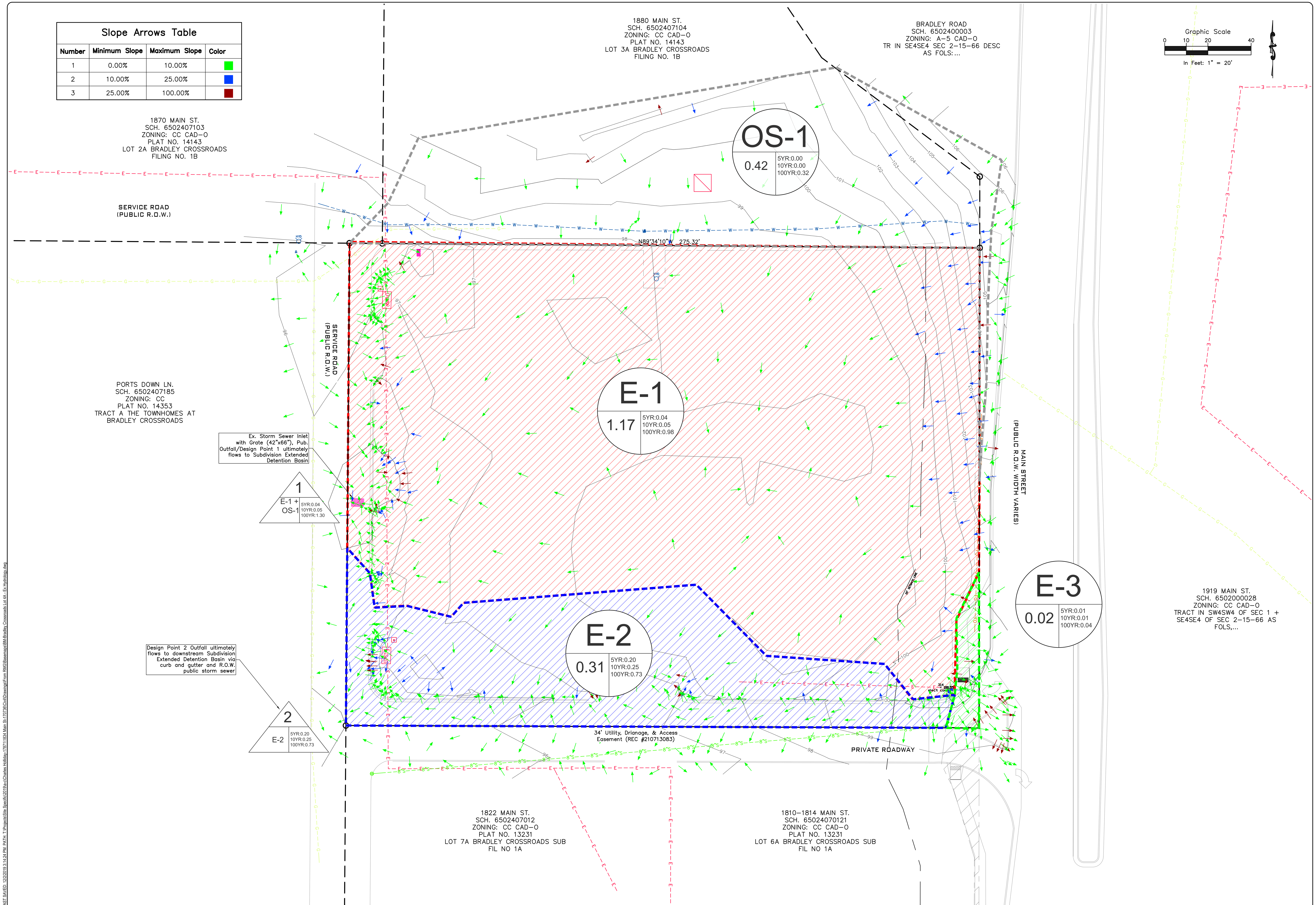
$$Q(cfs) = CIA$$

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C							Overland (Initial) Flow Time					Channelized (Travel) Flow Time							Time of Concentration			Rainfall Intensity, I (in/hr)							Peak Flow, Q (cfs)						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)	Overland Flow Time t_i (min)	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)	Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
D-1	1.31	A	83.46	0.664	0.684	0.699	0.721	0.738	0.760	0.792	110.00	104.70	98.81	0.054	4.53	240.00	98.81	94.37	0.019	20	2.72	1.47	6.00	13.23	6.00	3.22	4.13	4.96	6.32	7.48	8.74	12.15	2.79	3.68	4.53	5.95	7.20	8.67	12.57
D-2	0.18	A	74.8	0.576	0.595	0.611	0.638	0.664	0.693	0.737	97.00	102.30	99.96	0.024	6.72	267.00	99.96	95.00	0.019	20	2.73	1.63	8.35	14.95	8.35	2.89	3.71	4.46	5.67	6.72	7.84	10.91	0.29	0.39	0.48	0.64	0.79	0.96	1.42
D-3	0.02	A	33.3	0.201	0.212	0.225	0.257	0.309	0.369	0.469	67.00	101.20	99.57	0.024	9.79	0.01	0.00	0.00	0.000	20	0.06	0.00	9.79	20.34	9.79	2.72	3.49	4.20	5.35	6.33	7.39	10.28	0.01	0.01	0.01	0.02	0.03	0.04	0.08
OS-1	0.008	A	0.0	0.000	0.000	0.000	0.000	0.025	0.110	0.254	7.00	105.57	104.70	0.124	2.29	0.01	0.00	0.00	0.000	20	0.06	0.00	2.29	26.01	10.00	2.70	3.46	4.17	5.30	6.28	7.33	10.20	0.00	0.00	0.00	0.00	0.00	0.01	0.02

Appendix G: Sub-Basin Delineation Exhibits

Slope Arrows Table

Number	Minimum Slope	Maximum Slope	Color
1	0.00%	10.00%	green
2	10.00%	25.00%	blue
3	25.00%	100.00%	red



ROCKY MOUNTAIN GROUP
RMG ARCHITECTS ENGINEERS

NOT FOR CONSTRUCTION
FOR CIVIL ONLY

BRADLEY CROSSROADS LOT 4A DEVELOPMENT
1830 MAIN STREET
COLORADO SPRINGS, CO
CHARLES HOLLIDAY

SHEET NAME: EXISTING SUB-BASIN DELINEATION

PROJECT STATUS: COUNTY REVIEW

ENG: RDL
DRAWN: RDL
CHECKED: RDL

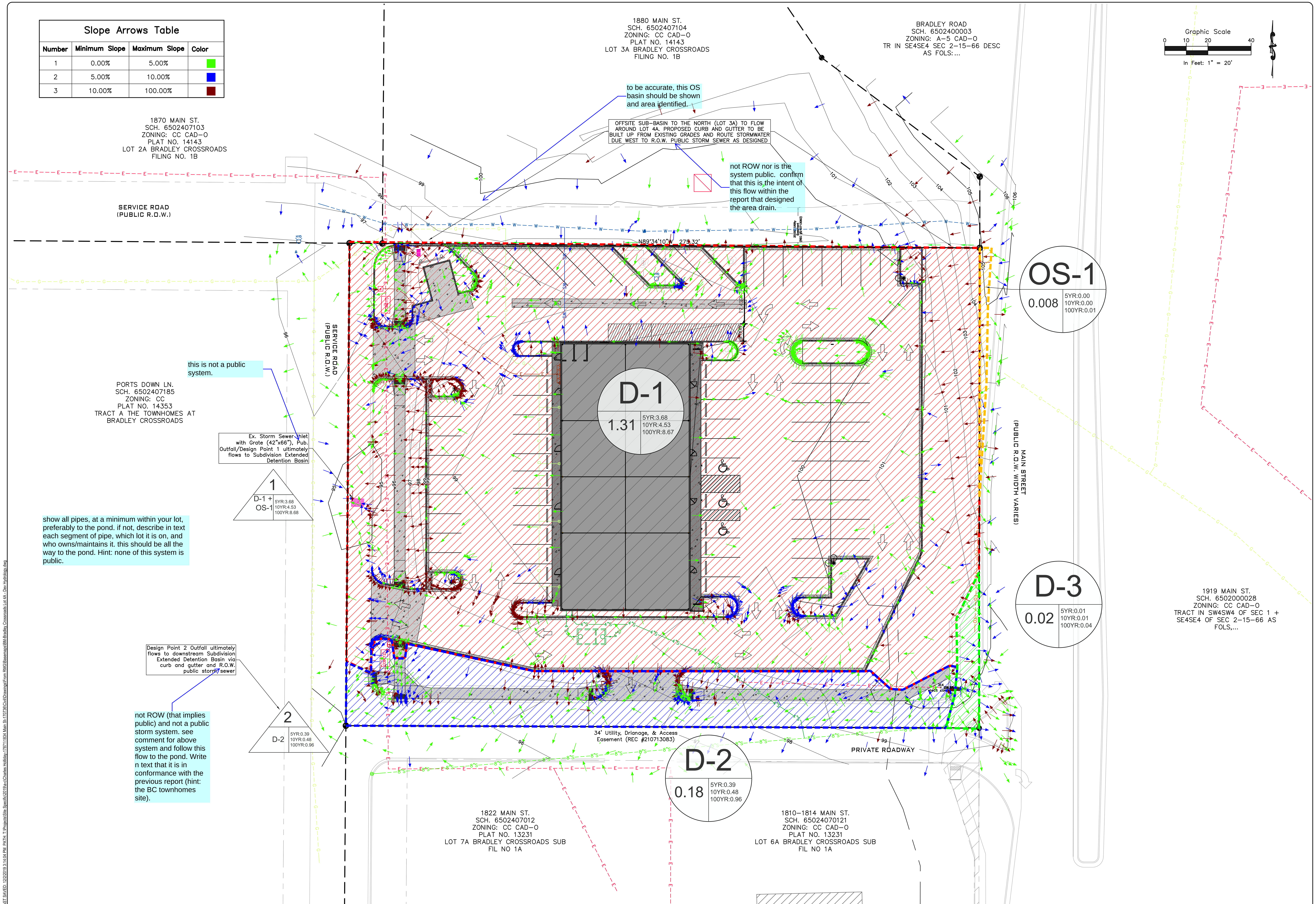
DATE: 12/02/19

#	REVISION	DATE
	DD	07/18/19
	CNTY. REV. 1	08/06/19
	CNTY. REV. 2	12/02/19

JOB NO. 170736

SHEET NO. C-EX-01

Slope Arrows Table			
Number	Minimum Slope	Maximum Slope	Color
1	0.00%	5.00%	(green)
2	5.00%	10.00%	(blue)
3	10.00%	100.00%	(dark red)



1880 MAIN ST. SCH. 6502407104 ZONING: CC CAD-O PLAT NO. 14143 LOT 3A BRADLEY CROSSROADS FILING NO. 1B
BRADLEY ROAD SCH. 6502400003 ZONING: A-5 CAD-O TR IN SE4SE4 SEC 2-15-66 DESC AS FOLS:...
Graphic Scale
In Feet: 1" = 20'
to be accurate, this OS basin should be shown and area identified.
OFFSITE SUB-BASIN TO THE NORTH (LOT 3A) TO FLOW AROUND LOT 4A. PROPOSED CURB AND GUTTER TO BE BUILT UP FROM EXISTING GRADES AND ROUTE STORMWATER DUE WEST TO R.O.W. PUBLIC STORM SEWER AS DESIGNED
not ROW nor is the system public. confirm that this is the intent of this flow within the report that designed the area drain.
1870 MAIN ST. SCH. 6502407103 ZONING: CC CAD-O PLAT NO. 14143 LOT 2A BRADLEY CROSSROADS FILING NO. 1B
SERVICE ROAD (PUBLIC R.O.W.)
N89°34'10"W 279.32'
OS-1
0.008
5YR:0.00 10YR:0.00 100YR:0.01
D-1
1.31
5YR:3.68 10YR:4.53 100YR:8.67
this is not a public system.
PORTS DOWN LN. SCH. 6502407185 ZONING: CC PLAT NO. 14353 TRACT A THE TOWNHOMES AT BRADLEY CROSSROADS
Ex. Storm Sewer Inlet with Grate (42"x66"), Pub. Outfall/Design Point 1 ultimately flows to Subdivision Extended Detention Basin
1
D-1 + OS-1
5YR:3.68 10YR:4.53 100YR:8.68
show all pipes, at a minimum within your lot, preferably to the pond. if not, describe in text each segment of pipe, which lot it is on, and who owns/maintains it. this should be all the way to the pond. Hint: none of this system is public.
MAIN STREET (PUBLIC R.O.W. WIDTH VARIES)
D-3
0.02
5YR:0.01 10YR:0.01 100YR:0.04
1919 MAIN ST. SCH. 6502000028 ZONING: CC CAD-O TRACT IN SW4SW4 OF SEC 1 + SE4SE4 OF SEC 2-15-66 AS FOLS,...
Design Point 2 Outfall ultimately flows to downstream Subdivision Extended Detention Basin via curb and gutter and R.O.W. public storm sewer
not ROW (that implies public) and not a public storm system. see comment for above system and follow this flow to the pond. Write n text that it is in conformance with the previous report (hint: the BC townhomes site).
2
D-2
5YR:0.39 10YR:0.48 100YR:0.96
34' Utility, Drainage, & Access Easement (REC #210713083)
PRIVATE ROADWAY
D-2
0.18
5YR:0.39 10YR:0.48 100YR:0.96
1822 MAIN ST. SCH. 6502407012 ZONING: CC CAD-O PLAT NO. 13231 LOT 7A BRADLEY CROSSROADS SUB FIL NO 1A
1810-1814 MAIN ST. SCH. 65024070121 ZONING: CC CAD-O PLAT NO. 13231 LOT 6A BRADLEY CROSSROADS SUB FIL NO 1A

ROCKY MOUNTAIN GROUP

Architectural
Structural
Forensics

ARCHITECTS RMG ENGINEERS

Geotechnical
Materials, Testing
Civil, Planning

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SOUTHERN COLORADO, DENVER METRO, NORTHERN COLORADO

NOT FOR CONSTRUCTION
FOR CIVIL ONLY

BRADLEY CROSSROADS LOT 4A DEVELOPMENT

1830 MAIN STREET
COLORADO SPRINGS, CO

CHARLES HOLLIDAY

SHEET NAME
DEVELOPED SUB-BASIN DELINEATION

PROJECT STATUS
COUNTY REVIEW

ENG: RDL
DRAWN: RDL
CHECKED: RDL

DATE
12/02/19

#	REVISION	DATE
	DD	07/18/19
	CNTY. REV. 1	08/06/19
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JOB NO.
170736

SHEET NO.
C-EX-02
of 16