Bradley Crossroads Lot 4A Filing No. 1B
Drainage Letter Report

1830 MAIN STREET
COLORADO SPRINGS, COLORADO
80911

PREPARED FOR: CHARLES HOLLIDAY
WESTERN STATES MANAGEMENT GROUP
13990 BARBWIRE LANE
COLORADO SPRINGS, CO 80930

March 2, 2020

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

PCD File No.: PPR1938

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.

Western States Management Group
Business Name

By: Charles Holliday

Title: General Contractor

Address: 13990 Barbwire Lane

Colorado Springs, Colorado 80930

Date: March 24, 2020

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:

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Appendix D – (PPR1846) Final Drainage Report for The Townhomes at Bradley Crossroads Multifamily Residential Community by MVE, Inc., dated February 14, 2019

Appendix E – (SF 07012) Final Drainage Report for Lincoln Commons prepared for FMI Lincoln Commons, LLC., prepared by WestWorks Engineering (Job #90532), latest revision July 25, 2007, EPC approved July 31,2007

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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 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 July 25, 2007 and approved by El Paso County on July 31, 2007 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 February 14, 2019. 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 February 14, 2019 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:

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

<u>17 to 20-feet</u>: 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} = 0.06 cfs, and Q_{100} = 0.88 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. There is a portion of the parcel to the northwest that flows to a set of two existing private storm sewer inlets (CDOT Type C) designated as Sub-basin E4 which has peak flows of Q_5 = 0.00 cfs, Q_{10} = 0.00 cfs, and Q_{100} = 0.10 cfs. An off-site sub-basin OS-1 is delineated for the surveyed area to show overland flow from the existing undeveloped area that flows over this property and the adjacent north property. This off-site sub-basin has peak flows of Q_5 = 0.02 cfs, Q_{10} = 0.03 cfs, and Q_{100} = 0.43 cfs. Another off-site sub-basin OS-2 is delineated as the paved Service Road portion that flows to the private 42" by 66" storm sewer inlet that the development flows to. This off-site sub-basin has peak flows of Q_5 = 0.21 cfs, Q_{10} = 0.26 cfs, and Q_{100} = 0.46 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. The entire development flows to the private storm sewer system's local inlets into private 30" RCP storm sewer mains which ultimately flow to the pond located within the Lincoln Commons Townhomes (SF07012). The existing storm sewer infrastructure is sized appropriately for the developed conditions.

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 = 3.36 cfs, Q_{10} = 4.14 cfs, and Q_{100} = 8.07 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. As stated previously, the off-site areas are not to be disturbed and as such, the

hydrology remains constant. The off-site sub-basin OS-1 is delineated for the surveyed area to show overland flow from the existing undeveloped area that flows over this property and the adjacent north property and has peak flows of Q_5 = 0.02 cfs, Q_{10} = 0.03 cfs, and Q_{100} = 0.43 cfs. Another off-site sub-basin OS-2 is delineated as the paved Service Road portion that flows to the private 42" by 66" storm sewer inlet that the development flows to and has off-site sub-basin has peak flows of Q_5 = 0.21 cfs, Q_{10} = 0.26 cfs, and Q_{100} = 0.46 cfs.

The storm water volume increases to DP1 are 3.32 cfs for a 5 year storm, 4.08 cfs for a 10 year storm, and 7.19 cfs for a 100 year storm from the existing drainage conditions.

The storm water volume increases to DP2 are 0.19 cfs for a 5 year storm, 0.23 cfs for a 10 year storm, and 0.23 cfs for a 100 year storm from the existing drainage conditions.

The storm water volume decreases to DP3 are 0.02 cfs for a 5 year storm, 0.02 cfs for a 10 year storm, and 0.10 cfs for a 100 year storm from the existing drainage conditions.

The result of development to Lot 4A yields a 5 year storm flow of 3.76 cfs, a 10 year storm flow of 4.64 cfs, and a 100 year storm flow of 9.07 cfs. These are overall increases of 3.51 cfs for a 5 year storm, 4.32 cfs for a 10 year storm, and 7.31 cfs for a 100 year storm from existing conditions.

All of these design points flow into the private storm system within the Bradley Crossroads subdivision which ultimately flows to the pond within the Lincoln Commons Townhomes (SF07012). The developed condition's storm water flow is accounted for in the original pond and private storm sewer system design.

The Final Drainage Report for The Townhomes at Bradley Crossroads by MVE, Inc. dated February 14, 2019 referencing the revised off-site peak flow calculations by Terra Nova Engineering in November 2008 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. The rainfall peak flow rates calculated using current standards for the 78.27 percent imperviousness proposed development at Lot 4A are less than the assumed 95 impervious site by 1.24 cfs for the 5-year storm and 0.23 cfs for the 100-year storm. 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 proposed development is in compliance with the original report's impervious ratio (El Paso County SF 07012) in which the subdivision detention facility was designed for a 95 percent impervious commercial parcel. The entirety of Lot 4A that was assumed to be developed with 95 percent imperviousness is proposed as a 78.27 percent imperviousness development. This is a 16.73 percent imperviousness reduction from the original drainage report. The drainage volumes and flows are accounted for in the private storm sewer system for conveyance as well as the detention facility downstream. The proposed development flows to an existing private storm sewer grate with a private 30" RCP storm sewer pipe. This private system ultimately

flows to the pond at the Lincoln Commons Townhomes through 30" RCP pipe that runs through the Townhomes at Bradley Crossroads and the Lincoln Commons Townhomes private storm sewer system on the south side of their respective subdivision.

The existing downstream pond within the Lincoln Commons Townhomes is functioning as designed and some work will be done as a part of this project to improve its conditions including designating a more appropriate access point, the design and construction of a micropool at the existing outlet structure, and the design and construction of a concrete forebay at one of the pipe inlets that is experiencing erosion.

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 less than downstream facilities had designed for due to the decrease in imperviousness. 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 February 14, 2019.

A Standard Operation Procedures for Inspection and Maintenance of Extended Detention Basins (EDBs) for the Lincoln Commons Townhomes was prepared by WestWorks Engineering and dated January 13, 2016 and was included as a part of SF07012. A Private Detention Basin Construction, Maintenance and Cost Recovery Agreement and Covenants was also included with SF07012 and describes the agreement between LC Partners LLLP and Bradley Crossroads, LLC in which LC Partners LLLP and the Lincoln Commons Townhome Owners Association entered into the Detention Basin Agreement and the Associates takes responsibility for constructing and maintaining a private water runoff detention basin and for properly cleaning, maintaining, inspecting and repairing the detention basin. This agreement document is included in the submittals for EPC file number PPR1938 for Lot 4A of Bradley Crossroads.

The existing downstream pond is functioning as designed and some work will be done as a part of this project to improve its conditions including designating a more appropriate access point, the design and construction of a micropool at the existing outlet structure, and the design and construction of a concrete forebay at one of the pipe inlets that is experiencing erosion.

6.0 References

(EPC VR104) Final Drainage Letter for Bradley Crossroads Filing No. 1 Lot 7 Site Development Plan by Terra Nova Engineering, 10/27/2010

(EPC VR104) Final Drainage Report for Bradley Crossroads Filing No. 1 Lots 1-6 by Terra Nova Engineering, revised November 2008

(PPR 1846) Final Drainage Report for The Townhomes at Bradley Crossroads Multifamily Residential Community by MVE, Inc., dated February 14, 2019

(SF 07012) Final Drainage Report for Lincoln Commons prepared for FMI Lincoln Commons, LLC., prepared by WestWorks Engineering (Job #90532), latest revision July 25, 2007, EPC approved July 31,2007

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

El Paso County Engineering Criteria Manual, Appendix I, July 2019

El Paso County / City of Colorado Springs Drainage Criteria Manuals Volumes I and II, Volume I Chapter 6 & 13, May 2014; Volume II May 2014; Volume I dated 1991 and 1994 revisions.

Appendix A: FEMA Floodplain Map

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)
^{4275000m}N	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 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 for Bradley Crossroads Filing No. 1 Lot 7 Site Development Plan by Terra Nova Engineering dated 10/27/2010 – EPC VR104 / PPR1020

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(

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
ENGINF _RING 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 Engineering 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
Canal Number
8
N
A
0 20 40 80 120 Meters
0 50 100 200 300 Feet

MAP LEGEND

Area of Interest (A01)

C ¯ 1 Area of Interest (A01)

Soils

Soil Map Units

Special Point Features

kt,i Blowout

' Borrow Pit

' Clay Spot

' Closed Depression

X Gravel Pit

' Gravelly Spot

O Landfill

A. Lava Flow

,g, Marsh

5t Mine or Quarry

O Miscellaneous Water

CI Perennial Water

v Rock Outcrop

-I- Saline Spot

Sandy Spot

Severely Eroded Spot

* Sinkhole

3) Slide or Slip

Sodic Spot

= Spoil Area

a Stony Spot

03 Very Stony Spot

t Wet Spot

Other

Special Line Features

LA7 Gully

e g! Short Steep Slope

Other

Political Features

Municipalities

Cities

EI Urban Areas

Water Features

Oceans

Streams and Canals

Transportation

Rails

Roads

Interstate Highways

US Routes

State Highways

WV' 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

RESERVOIR
BRADLEY ROAD
CUNNINGHAM DR
PECOS DRIVE
EL PASO COUI
UNINCORPORATED
080059
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. 0ED080 one F
UNINCOPORAIED AREAS 11035069 0703 F
FOUNTAIN. OTT Of 080001 0703 F
MAP NUMBER
08041C0763 F
EFFECTIVE DA
MARCH 17 97
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 for the Townhomes at Bradley Crossroads Multifamily Residential Community by MVE, Inc., dated 02/14/2019 – EPC PPR1846

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

February 14, 2019

PCD File No. PPR1846

Final Drainage Report

for

The Townhomes at Bradley Crossroads
Multifamily Residential Community

Project No. 61093

February 14, 2019

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

Copyright © MVE, Inc., 2019

Statements and Acknowledgments

Engineer's Statement

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

COLORADO LICENSED
DAVID RAYMOND GORMAN
31672
2/14/19
PROFESSIONAL ENGINEER

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

2/14/2019
Date

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
Title: President
J. Elliott Homes, Inc.
12218 Crystal Downs Road
Peyton, CO 80931

2/14/2019
Date

El Paso County

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

Approved
by Elizabeth Nijkamp
El Paso County Planning and Community Development
on behalf of Jennifer Irvine, County Engineer, ECM Administrator
05/30/2019 6:20:19 PM

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

Date

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1.2 Description of Property 1

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2.2 Sub-Basin Description 3

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4.4 Water Quality Enhancement Best Management Practices 7

5 Opinion of Probable Cost for Drainage Facilities 8

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Appendices

1 General Maps and Supporting Data

2 Hydrologic Calculations

3 Hydraulic Calculations

4 Report Maps

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 1A, Bradley Crossroads Filing No. 1B. This project is the development of the existing platted lot having an area of approximately 5.24± 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 December 7, 2018. [4] [5] The project site is included in Community Panel Number 08041C0763 G 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. 08041C0763 G
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. Existing EDB is in new condition, recently verified by M.V.E, Inc. to be constructed in accordance with the approved construction plans and recently released by El Paso County inspections.

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.

is being provided in the adjacent site, Lincoln Commons Townhomes, EPC file # SF 7-012

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).

NRCS Official Soil Series Descriptions. United States Department of Agriculture, Natural Resources Conservation Service ("http://soils.usda.gov/technical/classification/osd/index.html", accessed Accessed September 2018).

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, December 7, 2018).

Flood Insurance Study for El Paso County, Colorado and incorporated Areas. Federal Emergency Management Agency (Washington D.C.: FEMA, December 7, 2018).

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).

Final Drainage Report for Lincoln Commons. WestWorks Engineering (El Paso County, Colorado: , Revised July 25, 2007).

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 Policies, Procedures and Best Management Practices (BMPs). City of Colorado Springs Engineering Division (Colorado Springs, Colorado: , 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).

Appendices

1 General Maps and Supporting Data

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

VICINITY MAP

N.T.S.

National Flood Hazard Layer FIRMette

FEMA

38°46'22.98"N

104°44'52.53"W

104°44'15.07"W

38°45'54.93"N

Feet 1:6,000

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

Legend

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

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

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

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

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

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 2/14/2019 at 12:54:18 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

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

REEK
00

III

Little
Johnson Re
Canal
(new)
Wide
High

Soil Map—El Paso County Area, Colorado

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

Map Scale: 1:1,020 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 15 30 60 90

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

2 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
Sub-Basin and Design Point Hydrologic Calculations

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		
	Area (Acres)	C_5	C_{100}/CN	% Imp.	L_0 (ft)	S_0 (%)	t_i (min)	L_{0t} (ft)	S_{0t} (ft/ft)	v_{0sc} (ft/s)	t_t (min)	L_{0c} (ft)	S_{0c} (ft/ft)	v_{0c} (ft/s)	t_c (min)	L (min)	$t_{c,alt}$ (min)	t_c (min)
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)

				Direct Runoff				Combined Runoff				Streetflow			Pipe Flow					Travel Time		
DP	Sub-Basin	Area (Acres)	C5	t_c (min)	CA (Acres)	I5 (in/hr)	Q5 (cfs)	t_c (min)	CA (Acres)	I5 (in/hr)	Q5 (cfs)	Slope (%)	Length (ft)	Q (cfs)	Q (cfs)	Slope (%)	Mnngs n	Length (ft)	D_{Pipe} (in)	Length (ft)	V_{0sc} (ft/s)	t_t (min)
	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)

				Direct Runoff				Combined Runoff				Streetflow			Pipe Flow					Travel Time		
DP	Sub-Basin	Area (Acres)	C100	t_c (min)	CA (Acres)	I100 (in/hr)	Q100 (cfs)	t_c (min)	CA (Acres)	I100 (in/hr)	Q100 (cfs)	Slope (%)	Length (ft)	Q (cfs)	Q (cfs)	Slope (%)	Mnngs n	Length (ft)	D_{Pipe} (in)	Length (ft)	v_{Osc} (ft/s)	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)	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

Surface	Area (SF)	Area (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)	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

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	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

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	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

Surface	Area (SF)	Area (Acres)	Runoff Coefficient 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

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	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

Surface	Area (SF)	Area (Acres)	Runoff Coefficient 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.

3 Hydraulic Calculations

Inlet Calculations
Storm Drain Pipe and Culvert Calculations
Channel 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

Version 4.05 Released March 2017

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	0.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	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	2.92	feet
Width of a Unit Grate	W_o =	2.92	2.92	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.70	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	2.41	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.67	0.67	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	N/A	N/A	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	N/A	N/A	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	N/A	N/A	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	N/A	N/A	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	N/A	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	N/A	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	N/A	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. Thursday, Feb 14 2019

DP2 Alley V-Channel 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. Thursday, Feb 14 2019

DP4 Cold Harbor V-Channel 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. Thursday, Feb 14 2019

DP5 Alley V-Channel 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. Thursday, Feb 14 2019

DP6 Alley V-Channel 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

4 Report Maps

Proposed Condition Drainage 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, 1.0 AC, 50% IMP — BASIN LABEL, AREA IN ACRES, PERCENT IMPERVIOUS
- 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 G, EFFECTIVE DECEMBER 7, 2018.

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

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

APRIL 26, 2019

SHEET 1 OF 1

Appendix E: Final Drainage Report for Lincoln Commons prepared for FMI Lincoln Commons, LLC. by WestWorks Engineering latest revision 07/25/2007, EPC approved 07/31/2007 – EPC SF07012

NEW DOC

SF-07-012

EPC-DSD-Eng
Library Copy
(submittal 2)

WESTWORKS™
ENGINEERING

RECEIVED
JUL 3 1 2007
EPC DEVELOPMENT SERVICES

FINAL DRAINAGE REPORT
FOR
LINCOLN COMMONS

June 12, 2007
Revised July 25, 2007

VERSION: #2
DATE: 7/31/07

Prepared for:

FMI LINCOLN COMMONS, LLC
3090 Windhover Lane
Colorado Springs, CO 80916
(719) 392-5448

Prepared by:

WestWorks Engineering

WestWorks Job #90532

minor revision on page 3 of 7

1023 W. Colorado Avenue Colorado Springs Co, 80904 Phone (719) 685-1670 Fax (719) 685-1429

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.

David L. Mijares, Colorado PE 40510
For and on behalf of WestWorks Engineering

7/26/07
Date

Developer's Statement:

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

FMI Lincoln Commons
Business Name

By:

Title: Manager

Address: 3090 Windhover Lane
Colo Springs Co 80918

El Paso County, Colorado:

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

for
County Engineer/Director

2-21-08
Date

Conditions:

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- USDA SCS Soil Map
- Detention Pond Maintenance Guidelines
- Hydrologic Calculations
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  - 100-year developed condition
  - 100-year developed pond condition
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  - 100-year historic SCS condition
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  - Final Drainage Report for Bradley Ranch Filing No. 5
  - Drainage Report for Bradley Ranch Filing No. 3 Phase II
  - Final Drainage Report and Plan for Lincoln Plaza Subdivision Filing No. 2
- Developed Condition Drainage Map

Added

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 Commons is a 6 acre site 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 southeast of the intersection of Bradley Road and Lincoln Plaza Drive. The site is bounded by Bradley Road to the north, Lincoln Plaza Subdivision Block 1 Lot 2 (undeveloped ground) to the east, Lincoln Plaza Drive to the west, and Gladiator Drive to the south. Development of the site includes 87 townhome units.

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 Commons and Lincoln Plaza site drains to the southwest over gentle 1%-2% slopes. The Basin has previously been studied in the "Final Drainage Report and Plan for Lincoln Plaza Subdivision Filing No. 2", by Leigh Whitehead and Associates, inc., dated March 2001. The historic analysis from the existing study has been reviewed and found to be in general conformance with our site analysis. **The existing study will be accepted as the basis for the historic comparison of our analysis.** The historic analysis has been included in the appendix of this report.

The site historically outfalls to an existing 10' inlet along the north side of Gladiator Drive east of Lincoln Plaza Drive and an existing 16' along the east side of Lincoln Plaza Drive adjacent to the site. Per the accepted Leigh Whitehead and Associates Study the majority of the flow is collected by the 10' inlet and a very minimal amount of flow enters the 16' inlet along Lincoln Plaza Drive. The runoff generated by this site contributes to the existing storm system within Lincoln Plaza Drive and Gladiator Drive and outfalls to the 36" RCP within Garman Drive.

The existing temporary pond for Bradley Ranch Filing no. 4, Phase I also outfalls to the existing storm system. The Bradley Ranch Pond outfalls to an existing 42" RCP installed within a drainage easement along the Lincoln Plaza Drive Frontage of the Lincoln Commons Development. The 42" outfall was installed with the intent of allowing developed flows to be routed from Bradley Ranch Filing No. 4 upon installation of regional pond improvements and removal of the on-site pond. Regional improvements have not been pursued.

Added to FDR version

The Leigh Whitehead report shows that the overall contribution of the site and surrounding roadways to the 36" RCP Garman Drive is 12.5 cfs in the initial event and 29.6 cfs in the major storm. Including the discharge from the Bradley Ranch Pond (Q_5 = 3.7 cfs and Q_{100} = 9.8 cfs) the total flow in the Garman Drive Outfall at Lincoln Plaza Drive is Q_5 = 16.2 cfs and Q_{100} = 39.4 cfs.

The 36" Outfall continues to the intersection of Garman and Witches Hollow Lane where flows are combined with runoff generated in Bradley Ranch Filing No. 5 and the northerly portion of Bradley Ranch Filing No. 3, phase II. The "Final Drainage report for Bradley Ranch, Filing No. 5", by HMS Group, dated March 1998 states that sites contribution to the Garman Outfall as Q_5 = 4.5 cfs and Q_{100} = 9.8 cfs from basin 1 and Q_5 = 4.4 cfs and Q_{100} = 9.1 cfs from basin 2 both collected in existing 5' sump inlets located at the northeast and northwest corners of the Garman Drive Witches Hollow Drive Intersection. The "Drainage Report for Bradley Ranch Filing No. 3, Phase II", by Weiss Consulting Engineers, Inc. dated April, 1986 states the contribution to the Garman Outfall from basin D-4 as Q_5 = 5.1 cfs and Q_{100} = 20.7 cfs.

The total combined flows delineated in the existing reports at the intersection of Garman and Witches Hollow Drives is 30.2 cfs in the 5-year storm and 79.0 cfs in the 100-year event are conveyed within the 36" outfall ($Q_{capacity}$ = 95 cfs. The existing temporary 18" pipe outfalling to the south in Witches Hollow Drive has a capacity of 21.75. As the pipe exceeds capacity the 15' inlet at the Southwest corner of the intersection overflows and the runoff continues West on Garman Drive to the depression on the adjacent parcel to the east. The westerly extension of Garman Drive has capacity to safely convey the storm to the depression.

Developed Drainage Conditions:

Development of the site includes 87 townhome units. Developed flows will be detained on-site by a privately owned and maintained detention pond and released at or below historic levels prior to discharging off site. The proposed water quality and detention pond to be located on the Lincoln Commons site will be sized to accommodate developed flows from both the Lincoln Commons townhome development, as well as the majority of the future Lincoln Plaza commercial development. This is consistent with the recommendations made in the "Preliminary/Final Drainage Report for Lincoln Plaza Subdivision No. 2," prepared by WestWorks Engineering, dated March 11, 2005 (herein referred to as the PDR).

Basin A consists of 1.7 acres of proposed townhome development. The landscaped areas , 0.4 acres, were removed from the analysis as their inclusion generated lower peak runoff rates due to lengthened times of concentration. The modified Basin A generates runoff of Q_5 = 5 cfs and Q_{100} = 10 cfs. This runoff will be intercepted by a proposed 4' sump inlet at Design Point 1 (DP1). An 18" RCP storm drain (DP101) will route these flows to DP2.

Basin B consists of 0.9 acres of proposed townhome development. The landscaped areas , 0.2 acres, were removed from the analysis as their inclusion generated lower peak runoff rates due to lengthened times of concentration. Basin B generates runoff of Q_5 = 3 cfs and Q_{100} = 5 cfs. A proposed 4' sump inlet at DP2 will collect this flow. A proposed 24" RCP storm drain (DP102) will carry the combined flows of DP1 and DP2 (Q_5 = 7 cfs and Q_{100} = 15 cfs) into proposed water quality and detention Pond 1. The discharge point of DP102 into Pond 1 shall be protected by a 5' wide by 10' long D_{50} = 12" diameter riprap pad 2' thick.

Basin C consists of 1.7 acres of proposed townhome development. The landscaped areas , 0.2 acres, were removed from the analysis as their inclusion generated lower peak runoff rates due to lengthened times of concentration. Basin C generates runoff of Q_5 = 6 cfs and Q_{100} = 11 cfs. A proposed 6' sump inlet at DP3 will collect this flow. A proposed 18" RCP storm drain (DP103) will carry this flow into proposed water quality and detention Pond 1. The discharge point of DP103 into Pond 1 shall be protected by a 5' wide by 6' long D_{50} = 12" diameter riprap pad 2' thick.

Basin D consists of 0.8 acres of mostly Pond 1 itself. Basin D generates runoff of Q_5 = 1 cfs and Q_{100} = 3 cfs directly into Pond 1.

Basin E consists of 0.3 acres of townhome development. Basin E generates runoff of Q_5 = 1 cfs and Q_{100} = 2 cfs. This runoff will sheet flow into Lincoln Plaza Drive where it will combine with flows from off-site Basin OS1. Basin OS1 is the 1.6-acre off-site area of improved Bradley Road and existing Lincoln Plaza Drive. Basin OS1 generates runoff of Q_5 = 5 cfs and Q_{100} = 10 cfs. The combined flow from Basin E and Basin OS1 will collect at DPos1. DPos1 is a proposed 10' sump inlet intended to replace the existing 16' sump inlet. This proposed 10' sump inlet is adequate to collect the combined flows of Q_5 = 6 cfs and Q_{100} = 12 cfs. This flow is also less than the historic flows to DPex1 of Q_5 = 10 cfs and Q_{100} = 24 cfs.

15' on construction plans *

also 15' on construction plans *

Off-site Basin OS2 includes 9.3 acres of future commercial development to the east known as Lincoln Plaza. The landscaped areas , 0.79 acres, were removed from the analysis as their inclusion generated lower peak runoff rates due to lengthened times of concentration. The future layout and drainage basin boundaries are taken from the PDR. Fully developed flows from Basin OS2 are anticipated at Q_5 = 34 cfs and Q_{100} = 68 cfs. A proposed 36" RCP will stubbed at DPos2 for future connection to the east. This 36" RCP will discharge into Pond 1. The discharge point of this 36" RCP into Pond 1 shall be protected by a 10' wide by 20' long D_{50} = 12" diameter riprap pad 2' thick. A temporary diversion will be constructed along the east end of the filing directing interim flows to DP-os2 until the future upstream storm system connection is made.

Off-site Basin OS3 (Q_5 = 2 cfs and Q_{100} = 4 cfs) includes 0.6 acres of existing gladiator drive originally included in Basins A1 and A2 of the Final Drainage Report and Plan for Lincoln Plaza filing 2. This small basin is now the only portion of the site draining to the existing 10' inlet located along the north side of Gladiator Drive.

Developed flows from Basins A, B, C, D, and OS2 will be routed to proposed detention Pond 1. The total combined flows from these basins into Pond 1 is Q_5 = 38 cfs and Q_{100} = 97 cfs. Per the Drainage Criteria Manual method for rational pond sizing various storm intensities were analyzed producing the largest pond storage volume. The modified rational method exhibited a peak inflow rate of Q_{100} = 45 cfs. Pond 1 will release these developed flows at Q_5 = 1 cfs and Q_{100} = 11 cfs. Pond 1 also includes 0.50 ac-ft of water quality capture volume (WQCV). The WQCV is sized to accommodate the impervious area from both the Lincoln Commons townhomes and the Lincoln Plaza commercial developments. A proposed 5.5' tall 4' diameter manhole with holes drilled into the side and a 20" diameter grate on top will serve as the water quality and detention outfall. A proposed 15" RCP storm drain will route Pond 1 discharge into the proposed 15' sump inlet at DPos1 in Lincoln Plaza Drive. The total combined flows from Pond 1, Basin E (undetained), Basin OS1 (undetained)), and Basin OS3 (undetained) as well as existing flows from Basins A3 and A4 as depicted in the "Final Drainage Report and Plan for

* Note: Discussed discrepancy with David Mijares in a meeting on Tuesday, July 17, 2007.
Report was to be revised, but version 2 was not.

Lincoln Plaza Subdivision Filing No. 2 is represented by DPos101. Total combined flows at DPos101 are Q_5 = 11 cfs and Q_{100} = 23 cfs. This is less than the historic flows contributed to the existing storm drain system as presented in the Lincoln Plaza Subdivision Filing No. 2 Final Drainage report of Q_5 = 12.5 cfs and Q_{100} = 29.5 cfs (Basin A).

The combined flows at DPos101 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 (approximately 500' west of DPos1). 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.

If regional Pond B is installed and the storm drain system installed to route developed flows from Lincoln Plaza Drive to Pond B, the upstream private detention pond may be removed. Analysis and improvement of the downstream system including emergency overflow considerations will need to occur prior to removal of the upstream private detention pond and will be the responsibility of the current owner of the property. The Lincoln Commons Development does not propose to install regional improvements at this time.

Although pond outfall failure is not anticipated a fully plugged outfall condition was also analyzed. In the plugged condition the pond discharge through the emergency spillway would peak at 23 cfs during the 100-year event. The emergency outfall will consist of a concrete weir and rip rap protected slope which will outfall directly to Lincoln Plaza Drive. This outflow does not exceed capacity of Garman Drive and would be conveyed to the existing depression at the Westerly terminus of Garman Drive. This analysis also excluded possible inlet capture in Lincoln and Gladiator Drives.

Volume Analysis

An analysis quantifying the effects of the failure of the 18" RCP within Garman Drive is included in the appendix of the report. SCS methodology was utilized to quantify the total 100-yr storm runoff not collected within the 18" RCP at Garman and Witches Hollow Drive. Hydrographs were prepared for analysis of both the existing condition and proposed development. The existing condition creates a runoff volume not captured within the 18" RCP of 1.1 acre feet. The outfall of the proposed private pond was modified to not exceed this volume. Hydrographs are included for the failure at the 18" RCP as well as the excess runoff collected in the depression at the end of Garman Drive.

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:

"Preliminary Drainage Report for Lincoln Commons," prepared by WestWorks Engineering, dated November 2, 2006.

"Little Johnson/Security Creek Drainage Basin Planning Study," prepared by Simons, Li & Associates, Inc., dated April 1988 (referred to as the DBPS).

"Preliminary/Final Drainage Report for Lincoln Plaza Subdivision No. 2," prepared by WestWorks Engineering, dated March 11, 2005 (referred to as the PDR).

"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

"Final Drainage Report for Bradley Ranch Filing No. 5," prepared by HMS Group, dated March 1998.

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 are shown in the Appendix of this report. Detention volume in drainage basin areas less than 100 acres is calculated using the Modified Rational Method. The Modified Rational Method calculations are performed with the aid of HydroCAD version 7.00.

On-site facilities, culverts, and inlets were designed based upon rational method analysis. The proposed pond was sized based on modified rational method analysis, lengthening the time of concentration while reducing the storm intensity to produced the most conservative pond volume. The overall affects of the development on the downstream development requiring hydrograph analysis were produced using TR-20 modeling.

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 Commons site is within a F.E.M.A. designated floodplain per Flood Insurance Rate Map Community Panel No. 08041C0763 F, effective March 17th, 1997.

EROSION CONTROL PLAN

The City of Colorado Springs/El Paso County Drainage Criteria Manual specifies that an Erosion Control Plan and associated cost estimate be submitted in conjunction with the Final Drainage Report. The overlot grading and erosion control plan and cost estimate for the subdivision has been approved by El Paso County.

DRAINAGE FEES

The study area is in the Little Johnson Drainage Basin. Development of this 5.99-acre subdivision includes 87 townhome lots. The average impervious area of this site is approximated at 80% or 4.8 acres of the overall 5.99-acre site. There are no Bridge Fees associated with this basin. Drainage Fees for the site are as follows (due at time of Final Plat recordation):

Drainage Fee:
(5.99 acres) X (80% impervious) X ($7,807/ac) = **$ 37,411**

2007 (FOFO 3200)

OPINION OF PROBABLE COST

(Non-Reimbursable Private Facilities)

Description	Quantity		Unit Cost	Total Cost
1. 18" RCP	200	LF	$ 30/LF	$ 6,000
2. 24" RCP	320	LF	$ 45/LF	$14,400
3. 36" RCP	80	LF	$ 60/LF	$ 4,800
4. 4' Sump Inlet	2	EA	$ 4,000/EA	$ 8,000
5. 6' Sump Inlet	1	EA	$ 4,500/EA	$ 4,500
5. 15' Sump Inlet	1	EA	$ 7,000/EA	$ 7,000
6. Pond Outlet Structure	1	EA	$ 2,500/EA	$ 2,500
7. Riprap	20	CY	$ 50/CY	$ 1,000
		Subtotal		$48,200
		10% Contingency		$ 4,820
		TOTAL		**$ 53,020**

This opinion of probable cost is made on the basis of experience and qualifications and represents WestWorks Engineering's best judgment as an experienced and qualified professional firm, familiar with the construction industry. WestWorks Engineering cannot and will not guarantee that actual construction costs will not vary from this opinion of probable cost.

APPENDIX

VICINITY MAP
N.T.S.

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	080091	0763	F

MAP NUMBER
08041C0763 F

EFFECTIVE DATE:
MARCH 17, 1997

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

(Joins sheet 16)
PETERSON FIELD
T. 14 S.
T. 15 S.
LITTLE JOHNSON RESERVOIR
CANAL
SITE
Security

DETENTION POND MAINTENANCE GIUDELINES

Added version 2

Maintenance Recommendations

Extended detention basins have low to moderate maintenance requirements. Routine and Nonroutine maintenance is necessary to assure performance, enhance aesthetics, and protect structural integrity. The dry basins can result in nuisance complaints if not properly designed or maintained. Bio-degradable pesticides may be required to limit insect problems. Frequent debris removal and grass-mowing can reduce aesthetic complaints. If a shallow wetland or marshy area is included, mosquito breeding and nuisance odors could occur if the water becomes stagnant. Access to critical elements of the pond (inlet, outlet, spillway, and sediment collection areas) must be provided. The basic elements of the maintenance requirements are presented in Table EDB-1.

TABLE EDB-1

Extended Detention Basin Maintenance Considerations

Required Action	Maintenance Objective	Frequency of Action
Lawn mowing and lawn care	Occasional mowing to limit unwanted vegetation. Maintain irrigated turf grass as 2 to 4 inches tall and nonirrigated native turf grasses at 4 to 6 inches.	Routine – Depending on aesthetic requirements.
Debris and litter removal	Remove debris and litter from the entire pond to minimize outlet clogging and improve aesthetics.	Routine – Including just before annual storm seasons (that is, April and May) and following significant rainfall events.
Erosion and sediment control	Repair and revegetate eroded areas in the basin and channels.	Nonroutine – Periodic and repair as necessary based on inspection.
Structural Repair	pond inlets, outlets, forebays, low flow channel liners, and energy dissipators whenever damage is discovered.	Nonroutine – Repair as needed based on regular inspections.
Inspections	Inspect basins to insure that the basin continues to function as initially intended. Examine the outlet for clogging, erosion, slumping, excessive sedimentation levels, overgrowth, embankment and spillway integrity, and damage to any structural element.	Routine – Annual inspection of hydraulic and structural facilities. Also check for obvious problems during routine maintenance visits, especially for plugging of outlets.
Nuisance control	Address odor, insects, and overgrowth issues associated with stagnant or standing water in the bottom zone.	Nonroutine – Handle as necessary per inspection or local complaints.
Sediment removal	Remove accumulated sediment from the forebay, micro-pool, and the bottom of the basin.	Nonroutine – Performed when sediment accumulation occupies 20 percent of the WQCV. This may vary considerably, but expect to do this every 10 to 20 years, as necessary per inspection if no construction activities take place in the tributary watershed. More often if they do. The forebay and the micro-pool will require more frequent cleanout than other areas of the basin, say every 1 or 2 years.

HYDROLOGIC CALCULATIONS

Time of Concentration Calcuations

Sub-Basin Area [ac]	Time of Concentration, Tc [min.] Flowline	L [ft.]	H [ft.]	v [ft/s]	Tc [min.]
	overland	30	3.0		1.0
A*	channel	364	3.6	3.48	1.7
1.3				Total Tc =	**2.7**
	overland	70	4.0		1.8
B*	channel	280	4.2	4.29	1.1
0.7				Total Tc =	**2.8**
	overland	41	3.5		1.2
C*	channel	412	4.0	3.45	2.0
1.5				Total Tc =	**3.2**
	overland	30	4.0		3.7
D	channel	220	4.0	4.72	0.8
0.8				Total Tc =	**4.4**
	overland	50	3.0		6.2
E	channel	1	0.0	3.50	0.0
0.3				Total Tc =	**6.2**

Sub-Basin Area [ac]	Time of Concentration, Tc [min.] Flowline	L [ft.]	H [ft.]	v [ft/s]	Tc [min.]
	overland	16	0.3		5.2
OS1	channel	850	9.0	3.60	3.9
1.6				Total Tc =	**9.1**
	overland	50	1.0		2.1
OS2*	channel	747	7.4	3.48	3.6
9.3				Total Tc =	**5.7**

Sub-Basin Area [ac]	Time of Concentration, Tc [min.] Flowline	L [ft.]	H [ft.]	v [ft/s]	Tc [min.]
	overland	16	0.3		5.2
EX-OS1	channel	850	9.0	3.60	3.9
1.5				Total Tc =	**9.1**
	overland	300	3.0		27.5
EX1	channel	620	7.0	3.72	2.8
13.1				Total Tc =	**30.3**

*** EXCLUDING LANDSCAPE AREAS**

WESTWORKS™ ENGINEERING

Project: LINCOLN COMMONS

Job No.: 90532

Engineer: David Mijares

Date: 1-Nov-06

BASIN SUMMARY

BASIN	AREA [acre]	C_5	C_{100}	$I_{5\ [in/hr]}$	I_{100}	Q_5 [cfs]	Q100 [cfs]
historic							
EX-OS1	1.50	0.60	0.70	4.26	7.57	**4**	**8**
EX1	14.42	0.25	0.35	2.19	3.91	**8**	**20**
developed							
A	1.70	0.75	0.85	3.56	6.34	**5**	**9**
B	0.90	0.75	0.85	3.91	6.95	**3**	**5**
C	1.70	0.75	0.85	3.50	6.23	**4**	**9**
D	0.80	0.35	0.45	4.96	8.83	**1**	**3**
E	0.30	0.75	0.85	4.76	8.43	**1**	**2**
OS-1	1.60	0.70	0.80	4.26	7.57	**5**	**10**
OS-2	9.30	0.80	0.90	3.49	6.33	**26**	**53**
OS-3	0.60	0.66	0.75	5.10	9.09	**2**	**4**
A*	1.30	0.75	0.85	4.96	9.09	**5**	**10**
B*	0.70	0.75	0.85	4.97	9.09	**3**	**5**
C*	1.50	0.75	0.85	4.96	9.09	**6**	**11**
OS-2*	8.61	0.80	0.90	4.91	8.65	**34**	**67**

*** EXCLUDING LANDSCAPED AREAS**

WESTWORKS™
ENGINEERING

Project: LINCOLN COMMONS

Job No.: 90532
Engineer: David Mijares
Date: 1-Nov-06

5-YEAR DEVELOPED CONDITION

5-YEAR DEVELOPED CONDITION

Drainage Diagram for 5YR-DEVELOPED
Prepared by WestWorks Engineering 7/20/2006
HydroCAD® 7.00 s/n 002053 © 1986-2003 Applied Microcomputer Systems

Subcatchment A: BASIN A

Runoff = 4.84 cfs @ 0.08 hrs, Volume= 0.034 af, Depth= 0.32"

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=5 min, Inten=5.10 in/hr

Area (ac)	C	Description
1.300	0.75	TOWNHOMES

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

Subcatchment B: BASIN B

Runoff = 2.61 cfs @ 0.08 hrs, Volume= 0.019 af, Depth= 0.32"

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=5 min, Inten=5.10 in/hr

Area (ac)	C	Description
0.700	0.75	TOWNHOMES

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, BASIN B**

Subcatchment C: BASIN C

Runoff = 5.58 cfs @ 0.08 hrs, Volume= 0.040 af, Depth= 0.32"

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=5 min, Inten=5.10 in/hr

Area (ac)	C	Description
1.500	0.75	TOWNHOMES

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, BASIN C**

Link DP1: DP1

Inflow Area = 1.300 ac, Inflow Depth = 0.32" for 5-Year event
Inflow = 4.84 cfs @ 0.08 hrs, Volume= 0.034 af
Primary = 4.84 cfs @ 0.08 hrs, Volume= 0.034 af, Atten= 0%, Lag= 0.0 min

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

Link DP101: DP101

Inflow Area =	1.300 ac,	Inflow Depth =	0.32"	for	5-Year event	
Inflow =	4.84 cfs @	0.08 hrs,	Volume=		0.034 af	
Primary =	4.84 cfs @	0.08 hrs,	Volume=		0.034 af,	Atten= 0%, Lag= 0.0 min

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

Link DP102: DP102

Inflow Area =	2.000 ac,	Inflow Depth =	0.32"	for	5-Year event	
Inflow =	7.44 cfs @	0.08 hrs,	Volume=		0.053 af	
Primary =	7.44 cfs @	0.08 hrs,	Volume=		0.053 af,	Atten= 0%, Lag= 0.0 min

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

Link DP2: DP2

Inflow Area =	0.700 ac,	Inflow Depth =	0.32"	for	5-Year event	
Inflow =	2.61 cfs @	0.08 hrs,	Volume=		0.019 af	
Primary =	2.61 cfs @	0.08 hrs,	Volume=		0.019 af,	Atten= 0%, Lag= 0.0 min

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

Link DP3: DP3

Inflow Area =	1.500 ac,	Inflow Depth =	0.32"	for	5-Year event	
Inflow =	5.58 cfs @	0.08 hrs,	Volume=		0.040 af	
Primary =	5.58 cfs @	0.08 hrs,	Volume=		0.040 af,	Atten= 0%, Lag= 0.0 min

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

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Subcatchment D: BASIN D

Runoff = 1.39 cfs @ 0.08 hrs, Volume= 0.010 af, Depth= 0.15"

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=5 min, Inten=5.10 in/hr

Area (ac)	C	Description
0.800	0.35	POND

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, BASIN D**

Subcatchment E: BASIN E

Runoff = 1.07 cfs @ 0.10 hrs, Volume= 0.009 af, Depth= 0.35"

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=6 min, Inten=4.86 in/hr

Area (ac)	C	Description
0.300	0.75	TOWNHOMES

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

Subcatchment OS1: Basin OS1

Runoff = 4.77 cfs @ 0.15 hrs, Volume= 0.059 af, Depth= 0.44"

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=9 min, Inten=4.27 in/hr

Area (ac)	C	Description
1.600	0.70	Basin OS1

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

Link DPos1: DPos1

Inflow Area = 1.900 ac, Inflow Depth = 0.45" for 5-Year event
Inflow = 5.74 cfs @ 0.15 hrs, Volume= 0.071 af
Primary = 5.74 cfs @ 0.15 hrs, Volume= 0.071 af, Atten= 0%, Lag= 0.0 min

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

Subcatchment OS2: Basin OS2

Runoff = 33.83 cfs @ 0.10 hrs, Volume= 0.279 af, Depth= 0.39"

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 5-Year Duration=6 min, Inten=4.86 in/hr

Area (ac)	C	Description
1.520	0.80	PDR BASIN B
4.000	0.80	PDR BASIN C
3.090	0.80	PDR BASIN D
8.610	0.80	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7					**Direct Entry, PDR BASIN D**

Link DPos2: DPos2

Inflow Area = 8.610 ac, Inflow Depth = 0.39" for 5-Year event
Inflow = 33.83 cfs @ 0.10 hrs, Volume= 0.279 af
Primary = 33.83 cfs @ 0.10 hrs, Volume= 0.279 af, Atten= 0%, Lag= 0.0 min

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

Subcatchment A3: A3

Runoff = 3.00 cfs @ 0.08 hrs, Volume= 0.021 af, Depth= 0.26"

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=5 min, Inten=5.10 in/hr

Area (ac)	C	Description
0.990	0.66	Whitehead Basin A3

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

Subcatchment A3: A3

Subcatchment A4: A4

Runoff = 3.04 cfs @ 0.10 hrs, Volume= 0.025 af, Depth= 0.32"

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=6 min, Inten=4.86 in/hr

Area (ac)	C	Description
0.940	0.66	Whitehead Basin A3

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

Subcatchment 0S3: 0S-3

Runoff = 1.97 cfs @ 0.08 hrs, Volume= 0.014 af, Depth= 0.28"

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=5 min, Inten=5.10 in/hr

Area (ac)	C	Description
0.600	0.66	

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

Pond Pond1: Pond 1

Inflow Area =	14.400 ac,	Inflow Depth =	0.66"	for 5-Year event	
Inflow =	38.40 cfs @	0.25 hrs,	Volume=	0.789 af	
Outflow =	1.02 cfs @	0.47 hrs,	Volume=	0.223 af,	Atten= 97%, Lag= 13.5 min
Primary =	1.02 cfs @	0.47 hrs,	Volume=	0.223 af	
Secondary =	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Peak Elev= 5,835.02' @ 0.47 hrs Surf.Area= 0.326 ac Storage= 0.765 af
Plug-Flow detention time= 86.9 min calculated for 0.223 af (28% of inflow)
Center-of-Mass det. time= 79.8 min (93.9 - 14.1)

#	Invert	Avail.Storage	Storage Description
1	5,831.20'	2.649 af	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
5,831.20	0.005	0.000	0.000
5,832.00	0.133	0.055	0.055
5,834.00	0.247	0.380	0.435
5,836.00	0.403	0.650	1.085
5,838.00	0.557	0.960	2.045
5,839.00	0.650	0.604	2.649

#	Routing	Invert	Outlet Devices
1	Primary	5,831.50'	**17.1" x 170.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 5,829.80' S= 0.0100 '/' n= 0.013 Cc= 0.900
2	Device 1	5,831.20'	**2.0" Vert. WQCV Outlet X 2.00** C= 0.600
3	Device 1	5,832.20'	**2.0" Vert. WQCV Outlet X 2.00** C= 0.600
4	Device 1	5,833.20'	**2.0" Vert. WQCV Outlet X 2.00** C= 0.600
5	Device 1	5,836.70'	**24.0" Horiz. Orifice/Grate** Limited to weir flow C= 0.600
6	Secondary	5,838.00'	**50.0' 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=1.02 cfs @ 0.47 hrs HW=5,835.02' (Free Discharge)
└─**1=Culvert** (Passes 1.02 cfs of 11.34 cfs potential flow)
  ├─**2=WQCV Outlet** (Orifice Controls 0.39 cfs @ 9.0 fps)
  ├─**3=WQCV Outlet** (Orifice Controls 0.35 cfs @ 8.0 fps)
  ├─**4=WQCV Outlet** (Orifice Controls 0.28 cfs @ 6.3 fps)
  └─**5=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,831.20' (Free Discharge)
└─**6=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

✓

Pond Pond1: Pond 1

Link DPos101: DPos101

Inflow Area =	18.830 ac,	Inflow Depth =	0.28"	for	5-Year event	
Inflow	=	11.31 cfs @	0.25 hrs,	Volume=	0.440 af	
Primary	=	11.31 cfs @	0.25 hrs,	Volume=	0.440 af,	Atten= 0%, Lag= 0.0 min

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

Link DPos101: DPos101

100-YEAR DEVELOPED CONDITION

Drainage Diagram for 100YR-DEVELOPED
Prepared by WestWorks Engineering 7/20/2006
HydroCAD® 7.00 s/n 002053 © 1986-2003 Applied Microcomputer Systems

Subcatchment A: BASIN A

Runoff = 9.77 cfs @ 0.08 hrs, Volume= 0.070 af, Depth= 0.64"

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=5 min, Inten=9.09 in/hr

Area (ac)	C	Description
1.300	0.85	TOWNHOMES

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

Subcatchment B: BASIN B

Runoff = 5.26 cfs @ 0.08 hrs, Volume= 0.037 af, Depth= 0.64"

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=5 min, Inten=9.09 in/hr

Area (ac)	C	Description
0.700	0.85	TOWNHOMES

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, BASIN B**

Subcatchment C: BASIN C

Runoff = 11.28 cfs @ 0.08 hrs, Volume= 0.080 af, Depth= 0.64"

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=5 min, Inten=9.09 in/hr

Area (ac)	C	Description
1.500	0.85	TOWNHOMES

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, BASIN C**

Link DP1: DP1

Inflow Area = 1.300 ac, Inflow Depth = 0.64" for 100-Year event
Inflow = 9.77 cfs @ 0.08 hrs, Volume= 0.070 af
Primary = 9.77 cfs @ 0.08 hrs, Volume= 0.070 af, Atten= 0%, Lag= 0.0 min

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

Link DP101: DP101

Inflow Area =	1.300 ac,	Inflow Depth =	0.64"	for	100-Year event	
Inflow =	9.77 cfs @	0.08 hrs,	Volume=		0.070 af	
Primary =	9.77 cfs @	0.08 hrs,	Volume=		0.070 af,	Atten= 0%, Lag= 0.0 min

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

Link DP102: DP102

Inflow Area =	2.000 ac,	Inflow Depth =	0.64"	for	100-Year event	
Inflow =	15.04 cfs @	0.08 hrs,	Volume=		0.107 af	
Primary =	15.04 cfs @	0.08 hrs,	Volume=		0.107 af,	Atten= 0%, Lag= 0.0 min

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

Link DP2: DP2

Inflow Area =	0.700 ac,	Inflow Depth =	0.64"	for	100-Year event	
Inflow =	5.26 cfs @	0.08 hrs,	Volume=		0.037 af	
Primary =	5.26 cfs @	0.08 hrs,	Volume=		0.037 af,	Atten= 0%, Lag= 0.0 min

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

Link DP3: DP3

Inflow Area =	1.500 ac,	Inflow Depth =	0.64"	for	100-Year event	
Inflow =	11.28 cfs @	0.08 hrs,	Volume=		0.080 af	
Primary =	11.28 cfs @	0.08 hrs,	Volume=		0.080 af,	Atten= 0%, Lag= 0.0 min

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

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Subcatchment D: BASIN D

Runoff = 3.18 cfs @ 0.08 hrs, Volume= 0.023 af, Depth= 0.34"

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=5 min, Inten=9.09 in/hr

Area (ac)	C	Description
0.800	0.45	POND

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, BASIN D**

Subcatchment E: BASIN E

Runoff = 2.15 cfs @ 0.10 hrs, Volume= 0.018 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 100-Year Duration=6 min, Inten=8.65 in/hr

Area (ac)	C	Description
0.300	0.85	TOWNHOMES

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

Subcatchment OS1: Basin OS1

Runoff = 9.69 cfs @ 0.15 hrs, Volume= 0.120 af, Depth= 0.90"

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=9 min, Inten=7.59 in/hr

Area (ac)	C	Description
1.600	0.80	Basin OS1

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

Link DPos1: DPos1

Inflow Area = 1.900 ac, Inflow Depth = 0.91" for 100-Year event
Inflow = 11.64 cfs @ 0.15 hrs, Volume= 0.144 af
Primary = 11.64 cfs @ 0.15 hrs, Volume= 0.144 af, Atten= 0%, Lag= 0.0 min

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

Subcatchment OS2: Basin OS2

Runoff = 67.74 cfs @ 0.10 hrs, Volume= 0.559 af, Depth= 0.78"

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=6 min, Inten=8.65 in/hr

Area (ac)	C	Description
1.520	0.90	PDR BASIN B
4.000	0.90	PDR BASIN C
3.090	0.90	PDR BASIN D
8.610	0.90	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7					**Direct Entry, PDR BASIN D**

Link DPos2: DPos2

Inflow Area = 8.610 ac, Inflow Depth = 0.78" for 100-Year event
Inflow = 67.74 cfs @ 0.10 hrs, Volume= 0.559 af
Primary = 67.74 cfs @ 0.10 hrs, Volume= 0.559 af, Atten= 0%, Lag= 0.0 min

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

Subcatchment A3: A3

Runoff = 5.35 cfs @ 0.08 hrs, Volume= 0.038 af, Depth= 0.46"

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=5 min, Inten=9.09 in/hr

Area (ac)	C	Description
0.990	0.66	Whitehead Basin A3

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

Subcatchment A4: A4

Runoff = 5.41 cfs @ 0.10 hrs, Volume= 0.045 af, Depth= 0.57"

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=6 min, Inten=8.65 in/hr

Area (ac)	C	Description
0.940	0.66	Whitehead Basin A3

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

Subcatchment 0S3: 0S-3

Runoff = 3.98 cfs @ 0.08 hrs, Volume= 0.028 af, Depth= 0.57"

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=5 min, Inten=9.09 in/hr

Area (ac)	C	Description
0.600	0.75	

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

Pond Pond1: Pond 1

Inflow Area =	12.910 ac,	Inflow Depth =	0.74"	for	100-Year event
Inflow =	97.11 cfs @	0.10 hrs,	Volume=	0.799 af	
Outflow =	8.28 cfs @	0.18 hrs,	Volume=	0.562 af,	Atten= 91%, Lag= 5.2 min
Primary =	8.28 cfs @	0.18 hrs,	Volume=	0.562 af	
Secondary =	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Peak Elev= 5,834.91' @ 0.18 hrs Surf.Area= 0.318 ac Storage= 0.732 af
Plug-Flow detention time= 36.2 min calculated for 0.562 af (70% of inflow)
Center-of-Mass det. time= 35.0 min (40.8 - 5.8)

#	Invert	Avail.Storage	Storage Description
1	5,831.20'	2.649 af	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
5,831.20	0.005	0.000	0.000
5,832.00	0.133	0.055	0.055
5,834.00	0.247	0.380	0.435
5,836.00	0.403	0.650	1.085
5,838.00	0.557	0.960	2.045
5,839.00	0.650	0.603	2.649

#	Routing	Invert	Outlet Devices
1	Primary	5,831.50'	**15.0" x 170.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 5,829.80' S= 0.0100 '/' n= 0.013 Cc= 0.900
2	Device 1	5,831.20'	**2.0" Vert. WQCV Outlet X 2.00** C= 0.600
3	Device 1	5,832.20'	**2.0" Vert. WQCV Outlet X 2.00** C= 0.600
4	Device 1	5,833.20'	**2.0" Vert. WQCV Outlet X 2.00** C= 0.600
5	Device 1	5,833.30'	**24.0" Horiz. Orifice/Grate** Limited to weir flow C= 0.600
6	Secondary	5,838.00'	**50.0' 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=8.28 cfs @ 0.18 hrs HW=5,834.91' (Free Discharge)
└─**1=Culvert** (Barrel Controls 8.28 cfs @ 6.7 fps)
  ├─**2=WQCV Outlet** (Passes < 0.39 cfs potential flow)
  ├─**3=WQCV Outlet** (Passes < 0.34 cfs potential flow)
  ├─**4=WQCV Outlet** (Passes < 0.27 cfs potential flow)
  └─**5=Orifice/Grate** (Passes < 19.20 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,831.20' (Free Discharge)
└─**6=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Pond1: Pond 1

100-YEAR DEVELOPED POND CONDITION

Drainage Diagram for 100YR-DEVELOPED-POND
Prepared by WestWorks Engineering 7/20/2006
HydroCAD® 7.00 s/n 002053 © 1986-2003 Applied Microcomputer Systems

Pond Pond1: Pond 1

Inflow Area =	14.400 ac,	Inflow Depth =	2.10"	for	100-Year event
Inflow =	44.71 cfs @	0.29 hrs,	Volume=	2.525 af	
Outflow =	11.03 cfs @	0.88 hrs,	Volume=	1.977 af,	Atten= 75%, Lag= 35.5 min
Primary =	11.03 cfs @	0.88 hrs,	Volume=	1.977 af	
Secondary =	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Peak Elev= 5,837.91' @ 0.88 hrs Surf.Area= 0.550 ac Storage= 2.001 af
Plug-Flow detention time= 65.5 min calculated for 1.970 af (78% of inflow)
Center-of-Mass det. time= 60.9 min (89.3 - 28.4)

#	Invert	Avail.Storage	Storage Description
1	5,831.20'	2.649 af	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
5,831.20	0.005	0.000	0.000
5,832.00	0.133	0.055	0.055
5,834.00	0.247	0.380	0.435
5,836.00	0.403	0.650	1.085
5,838.00	0.557	0.960	2.045
5,839.00	0.650	0.603	2.649

#	Routing	Invert	Outlet Devices
1	Primary	5,831.50'	**15.0" x 170.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 5,829.80' S= 0.0100 '/' n= 0.013 Cc= 0.900
2	Device 1	5,831.20'	**2.0" Vert. WQCV Outlet X 2.00** C= 0.600
3	Device 1	5,832.20'	**2.0" Vert. WQCV Outlet X 2.00** C= 0.600
4	Device 1	5,833.20'	**2.0" Vert. WQCV Outlet X 2.00** C= 0.600
5	Device 1	5,834.20'	**18.5" Horiz. Orifice/Grate** Limited to weir flow C= 0.600
6	Secondary	5,838.00'	**50.0' 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=11.03 cfs @ 0.88 hrs HW=5,837.91' (Free Discharge)
└─**1=Culvert** (Barrel Controls 11.03 cfs @ 9.0 fps)
  ├─**2=WQCV Outlet** (Passes < 0.53 cfs potential flow)
  ├─**3=WQCV Outlet** (Passes < 0.50 cfs potential flow)
  ├─**4=WQCV Outlet** (Passes < 0.45 cfs potential flow)
  └─**5=Orifice/Grate** (Passes < 17.31 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,831.20' (Free Discharge)
└─**6=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

✓

Pond Pond1: Pond 1

Link DPos101: DPos101

Inflow Area =	18.830 ac,	Inflow Depth =	1.71"	for	100-Year event	
Inflow =	23.02 cfs @	0.68 hrs,	Volume=		2.676 af	
Primary =	23.02 cfs @	0.68 hrs,	Volume=		2.676 af,	Atten= 0%, Lag= 0.0 min

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

100-YEAR DEVELOPED POND
PLUGGED CONDITION

Drainage Diagram for 100YR-DEVELOPED-POND-PLUGGED
Prepared by WestWorks Engineering 7/20/2006
HydroCAD® 7.00 s/n 002053 © 1986-2003 Applied Microcomputer Systems

Pond Pond1: Pond 1

Inflow Area =	14.400 ac,	Inflow Depth =	2.10"	for	100-Year event
Inflow =	44.71 cfs @	0.29 hrs,	Volume=	2.525 af	
Outflow =	22.96 cfs @	0.81 hrs,	Volume=	0.480 af,	Atten= 49%, Lag= 31.1 min
Secondary =	22.96 cfs @	0.81 hrs,	Volume=	0.480 af	

Routing by Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Peak Elev= 5,838.32' @ 0.81 hrs Surf.Area= 0.586 ac Storage= 2.236 af
Plug-Flow detention time= 43.6 min calculated for 0.478 af (19% of inflow)
Center-of-Mass det. time= 25.8 min (54.2 - 28.4)

#	Invert	Avail.Storage	Storage Description
1	5,831.20'	2.649 af	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
5,831.20	0.005	0.000	0.000
5,832.00	0.133	0.055	0.055
5,834.00	0.247	0.380	0.435
5,836.00	0.403	0.650	1.085
5,838.00	0.557	0.960	2.045
5,839.00	0.650	0.603	2.649

#	Routing	Invert	Outlet Devices
1	Secondary	5,838.00'	**50.0' 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

Secondary OutFlow Max=22.83 cfs @ 0.81 hrs HW=5,838.32' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Weir Controls 22.83 cfs @ 1.4 fps)

Pond Pond1: Pond 1

100-YEAR HISTORIC SCS

✓

A3
A3
SCS
A4
A4
DP-1 (BASINS A1 AND A2)
DPos101
DPos101
36 RCP
FILING 5
36" RCP
FILING 5 (BASINS 1 & 2)
CB
15 R
BW
FILING 3
15' TYPE R GARMAN AND WH
GARMAN DEPRESSION
FILING 3-II (BASIN D-4)
18 RCP
18" RCP WITCHES HOLLOW
Subcat
Reach
Pond
Link
Drainage Diagram for 100YR-HISTORIC-SCS
Prepared by WestWorks Engineering 8/8/2006
HydroCAD® 7.00 s/n 002053 © 1986-2003 Applied Microcomputer Systems

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment A3: A3 Runoff Area=0.990 ac Runoff Depth=3.63"
Tc=5.0 min CN=95 Runoff=4.87 cfs 0.299 af

Subcatchment A4: A4 Runoff Area=0.940 ac Runoff Depth=3.63"
Tc=5.0 min CN=95 Runoff=4.63 cfs 0.284 af

Subcatchment FILING 3: FILING 3-II (BASIN D-4) Runoff Area=9.500 ac Runoff Depth=1.15"
Tc=6.0 min CN=65 Runoff=18.59 cfs 0.907 af

Subcatchment FILING 5: FILING 5 (BASINS 1 & 2) Runoff Area=5.200 ac Runoff Depth=2.91"
Tc=20.6 min CN=88 Runoff=18.84 cfs 1.261 af

Subcatchment SCS: DP-1 (BASINS A1 AND A2) Runoff Area=17.160 ac Runoff Depth=1.33"
Tc=17.0 min CN=68 Runoff=28.74 cfs 1.903 af

Reach 36 RCP: 36" RCP Peak Depth=1.25' Max Vel=11.8 fps Inflow=33.16 cfs 2.486 af
D=36.0" n=0.013 L=555.0' S=0.0186 '/' Capacity=90.91 cfs Outflow=32.95 cfs 2.485 af

Pond 15 R: 15' TYPE R GARMAN AND WH Peak Elev=24.67' Inflow=67.72 cfs 4.653 af
Primary=21.75 cfs 3.554 af Secondary=45.97 cfs 1.098 af Outflow=67.72 cfs 4.653 af

Link 18 RCP: 18" RCP WITCHES HOLLOW Inflow=21.75 cfs 3.554 af
Primary=21.75 cfs 3.554 af

Link BW: GARMAN DEPRESSION Inflow=45.97 cfs 1.098 af
Primary=45.97 cfs 1.098 af

Link DPos101: DPos101 Inflow=33.16 cfs 2.486 af
Primary=33.16 cfs 2.486 af

Total Runoff Area = 33.790 ac Runoff Volume = 4.654 af Average Runoff Depth = 1.65"

Subcatchment A3: A3

Runoff = 4.87 cfs @ 6.01 hrs, Volume= 0.299 af, Depth= 3.63"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IIA 24-hr Rainfall=4.20"

Area (ac)	CN	Description
0.990	95	Whitehead Basin A3

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

Subcatchment A4: A4

Runoff = 4.63 cfs @ 6.01 hrs, Volume= 0.284 af, Depth= 3.63"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IIA 24-hr Rainfall=4.20"

Area (ac)	CN	Description
0.940	95	Whitehead Basin A3

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

Subcatchment FILING 3: FILING 3-II (BASIN D-4)

Runoff = 18.59 cfs @ 6.03 hrs, Volume= 0.907 af, Depth= 1.15"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IIA 24-hr Rainfall=4.20"

Area (ac)	CN	Description
9.500	65	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, DIRECT ENTRY FROM WEISS**

Subcatchment FILING 5: FILING 5 (BASINS 1 & 2)

Runoff = 18.84 cfs @ 6.11 hrs, Volume= 1.261 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IIA 24-hr Rainfall=4.20"

✓

Area (ac)	CN	Description
5.200	88	1/8 acre lots, 65% imp, HSG B

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

Subcatchment SCS: DP-1 (BASINS A1 AND A2)

Runoff = 28.74 cfs @ 6.12 hrs, Volume= 1.903 af, Depth= 1.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IIA 24-hr Rainfall=4.20"

Area (ac)	CN	Description
17.160	68	ENTIRE

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.0					**Direct Entry, SCS BASIN**

Reach 36 RCP: 36" RCP

Inflow Area = 19.090 ac, Inflow Depth = 1.56"
Inflow = 33.16 cfs @ 6.04 hrs, Volume= 2.486 af
Outflow = 32.95 cfs @ 6.07 hrs, Volume= 2.485 af, Atten= 1%, Lag= 1.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 11.8 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 3.9 fps, Avg. Travel Time= 2.4 min

Peak Depth= 1.25' @ 6.05 hrs
Capacity at bank full= 90.91 cfs
Inlet Invert= 28.31', Outlet Invert= 18.00'
36.0" Diameter Pipe n= 0.013 Length= 555.0' Slope= 0.0186 '/'

Pond 15 R: 15' TYPE R GARMAN AND WH

Inflow Area = 33.790 ac, Inflow Depth = 1.65"
Inflow = 67.72 cfs @ 6.04 hrs, Volume= 4.653 af
Outflow = 67.72 cfs @ 6.04 hrs, Volume= 4.653 af, Atten= 0%, Lag= 0.0 min
Primary = 21.75 cfs @ 5.79 hrs, Volume= 3.554 af
Secondary = 45.97 cfs @ 6.04 hrs, Volume= 1.098 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 24.67' @ 6.04 hrs
Plug-Flow detention time= 0.0 min calculated for 4.651 af (100% of inflow)
Center-of-Mass det. time= (not calculated: outflow precedes inflow)

✓

#	Routing	Invert	Outlet Devices
1	Primary	0.00'	**Special (user-defined)** Elev. (feet) 16.73 23.65 Disch. (cfs) 0.00 21.75
2	Secondary	23.65'	**15.0' long x 1.0' 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 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=21.75 cfs @ 5.79 hrs HW=23.70' (Free Discharge)
└─**1=Special (user-defined)** (Custom Controls 21.75 cfs)

Secondary OutFlow Max=45.85 cfs @ 6.04 hrs HW=24.67' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 45.85 cfs @ 3.0 fps)

Link 18 RCP: 18" RCP WITCHES HOLLOW

Inflow Area = 33.790 ac, Inflow Depth = 1.26"
Inflow = 21.75 cfs @ 5.79 hrs, Volume= 3.554 af
Primary = 21.75 cfs @ 5.79 hrs, Volume= 3.554 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link BW: GARMAN DEPRESSION

Inflow = 45.97 cfs @ 6.04 hrs, Volume= 1.098 af
Primary = 45.97 cfs @ 6.04 hrs, Volume= 1.098 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DPos101: DPos101

Inflow Area = 19.090 ac, Inflow Depth = 1.56"
Inflow = 33.16 cfs @ 6.04 hrs, Volume= 2.486 af
Primary = 33.16 cfs @ 6.04 hrs, Volume= 2.486 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Pond 15 R: 15' TYPE R GARMAN AND WH

Link 18 RCP: 18" RCP WITCHES HOLLOW

Link BW: GARMAN DEPRESSION

100-YEAR DEVELOPED SCS

Drainage Diagram for 100YR-DEVELOPED-SCS
Prepared by WestWorks Engineering 11/2/2006
HydroCAD® 7.00 s/n 002053 © 1986-2003 Applied Microcomputer Systems

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 0S3: 0S-3 Runoff Area=0.600 ac Runoff Depth=3.11"
Tc=5.0 min CN=90 Runoff=2.74 cfs 0.155 af

Subcatchment A3: A3 Runoff Area=0.990 ac Runoff Depth=3.63"
Tc=5.0 min CN=95 Runoff=4.87 cfs 0.299 af

Subcatchment A4: A4 Runoff Area=0.940 ac Runoff Depth=3.63"
Tc=5.0 min CN=95 Runoff=4.63 cfs 0.284 af

Subcatchment E: BASIN E Runoff Area=0.300 ac Runoff Depth=2.64"
Tc=6.2 min CN=85 Runoff=1.21 cfs 0.066 af

Subcatchment FILING 3: FILING 3-II (BASIN D-4) Runoff Area=9.500 ac Runoff Depth=1.15"
Tc=6.0 min CN=65 Runoff=18.59 cfs 0.907 af

Subcatchment FILING 5: FILING 5 (BASINS 1 & 2) Runoff Area=5.200 ac Runoff Depth=2.91"
Tc=20.6 min CN=88 Runoff=18.84 cfs 1.261 af

Subcatchment OS1: Basin OS1 Runoff Area=1.600 ac Runoff Depth=2.21"
Tc=9.1 min CN=80 Runoff=5.39 cfs 0.294 af

Subcatchment SCS: SCS BASIN Runoff Area=14.400 ac Runoff Depth=3.01"
Tc=5.0 min CN=89 Runoff=64.39 cfs 3.612 af

Reach 36 RCP: 36" RCP Peak Depth=1.17' Max Vel=11.4 fps Inflow=29.25 cfs 4.392 af
D=36.0" n=0.013 L=555.0' S=0.0186 '/' Capacity=90.91 cfs Outflow=29.15 cfs 4.389 af

Pond 15 R: 15' TYPE R GARMAN AND WH Peak Elev=25.68' Inflow=65.02 cfs 6.557 af
Primary=21.75 cfs 5.529 af Secondary=43.27 cfs 1.028 af Outflow=65.02 cfs 6.557 af

Pond Pond1: Pond 1 Peak Elev=5,837.76' Storage=1.932 af Inflow=64.39 cfs 3.612 af
Primary=10.92 cfs 3.293 af Secondary=0.00 cfs 0.000 af Outflow=10.92 cfs 3.293 af

Link 18 RCP: 18" RCP WITCHES HOLLOW Inflow=21.75 cfs 5.529 af
Primary=21.75 cfs 5.529 af

Link BW: GARMAN DEPRESSION Inflow=43.27 cfs 1.028 af
Primary=43.27 cfs 1.028 af

Link DPos1: DPos1 Inflow=6.58 cfs 0.360 af
Primary=6.58 cfs 0.360 af

Link DPos101: DPos101 Inflow=29.25 cfs 4.392 af
Primary=29.25 cfs 4.392 af

✓

Total Runoff Area = 33.530 ac Runoff Volume = 6.879 af Average Runoff Depth = 2.46"

Subcatchment 0S3: 0S-3

Runoff = 2.74 cfs @ 6.01 hrs, Volume= 0.155 af, Depth= 3.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IIA 24-hr Rainfall=4.20"

Area (ac)	CN	Description
0.600	90	

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

Subcatchment A3: A3

Runoff = 4.87 cfs @ 6.01 hrs, Volume= 0.299 af, Depth= 3.63"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IIA 24-hr Rainfall=4.20"

Area (ac)	CN	Description
0.990	95	Whitehead Basin A3

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

Subcatchment A4: A4

Runoff = 4.63 cfs @ 6.01 hrs, Volume= 0.284 af, Depth= 3.63"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IIA 24-hr Rainfall=4.20"

Area (ac)	CN	Description
0.940	95	Whitehead Basin A3

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

Subcatchment E: BASIN E

Runoff = 1.21 cfs @ 6.01 hrs, Volume= 0.066 af, Depth= 2.64"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IIA 24-hr Rainfall=4.20"

✓

Area (ac)	CN	Description
0.300	85	TOWNHOMES

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

Subcatchment FILING 3: FILING 3-II (BASIN D-4)

Runoff = 18.59 cfs @ 6.03 hrs, Volume= 0.907 af, Depth= 1.15"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IIA 24-hr Rainfall=4.20"

Area (ac)	CN	Description
9.500	65	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, DIRECT ENTRY FROM WEISS**

Subcatchment FILING 5: FILING 5 (BASINS 1 & 2)

Runoff = 18.84 cfs @ 6.11 hrs, Volume= 1.261 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IIA 24-hr Rainfall=4.20"

Area (ac)	CN	Description
5.200	88	1/8 acre lots, 65% imp, HSG B

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

Subcatchment OS1: Basin OS1

Runoff = 5.39 cfs @ 6.04 hrs, Volume= 0.294 af, Depth= 2.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IIA 24-hr Rainfall=4.20"

Area (ac)	CN	Description
1.600	80	

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

Subcatchment SCS: SCS BASIN

Runoff = 64.39 cfs @ 6.01 hrs, Volume= 3.612 af, Depth= 3.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IIA 24-hr Rainfall=4.20"

Area (ac)	CN	Description
14.400	89	ENTIRE

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, SCS BASIN**

Reach 36 RCP: 36" RCP

Inflow Area = 18.830 ac, Inflow Depth = 2.80"
Inflow = 29.25 cfs @ 6.02 hrs, Volume= 4.392 af
Outflow = 29.15 cfs @ 6.04 hrs, Volume= 4.389 af, Atten= 0%, Lag= 1.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 11.4 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 4.7 fps, Avg. Travel Time= 2.0 min

Peak Depth= 1.17' @ 6.02 hrs
Capacity at bank full= 90.91 cfs
Inlet Invert= 28.31', Outlet Invert= 18.00'
36.0" Diameter Pipe n= 0.013 Length= 555.0' Slope= 0.0186 '/'

Pond 15 R: 15' TYPE R GARMAN AND WH

Inflow Area = 33.530 ac, Inflow Depth = 2.35"
Inflow = 65.02 cfs @ 6.03 hrs, Volume= 6.557 af
Outflow = 65.02 cfs @ 6.03 hrs, Volume= 6.557 af, Atten= 0%, Lag= 0.0 min
Primary = 21.75 cfs @ 5.76 hrs, Volume= 5.529 af
Secondary = 43.27 cfs @ 6.03 hrs, Volume= 1.028 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 25.68' @ 6.03 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= (not calculated)

#	Routing	Invert	Outlet Devices
1	Primary	0.00'	**Special (user-defined)** Elev. (feet) 16.73 23.65 Disch. (cfs) 0.00 21.75
2	Secondary	23.65'	**15.0' long Broad-Crested Rectangular Weir** Head (feet) 15.00 Coef. (English) 1.00

✓

Primary OutFlow Max=21.75 cfs @ 5.76 hrs HW=23.84' (Free Discharge)
└─**1=Special (user-defined)** (Custom Controls 21.75 cfs)

Secondary OutFlow Max=43.20 cfs @ 6.03 hrs HW=25.67' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 43.20 cfs @ 1.4 fps)

Pond Pond1: Pond 1

Inflow Area =	14.400 ac,	Inflow Depth =	3.01"		
Inflow =	64.39 cfs @	6.01 hrs,	Volume=	3.612 af	
Outflow =	10.92 cfs @	6.13 hrs,	Volume=	3.293 af,	Atten= 83%, Lag= 7.3 min
Primary =	10.92 cfs @	6.13 hrs,	Volume=	3.293 af	
Secondary =	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 5,837.76' @ 6.13 hrs Surf.Area= 0.539 ac Storage= 1.932 af
Plug-Flow detention time= 182.5 min calculated for 3.291 af (91% of inflow)
Center-of-Mass det. time= 118.7 min (596.5 - 477.8)

#	Invert	Avail.Storage	Storage Description
1	5,831.20'	2.649 af	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
5,831.20	0.005	0.000	0.000
5,832.00	0.133	0.055	0.055
5,834.00	0.247	0.380	0.435
5,836.00	0.403	0.650	1.085
5,838.00	0.557	0.960	2.045
5,839.00	0.650	0.603	2.649

#	Routing	Invert	Outlet Devices
1	Primary	5,831.50'	**15.0" x 170.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 5,829.80' S= 0.0100 '/' n= 0.013 Cc= 0.900
2	Device 1	5,831.20'	**2.0" Vert. WQCV Outlet X 2.00** C= 0.600
3	Device 1	5,832.20'	**2.0" Vert. WQCV Outlet X 2.00** C= 0.600
4	Device 1	5,833.20'	**2.0" Vert. WQCV Outlet X 2.00** C= 0.600
5	Device 1	5,834.50'	**18.5" Horiz. Orifice/Grate** Limited to weir flow C= 0.600
6	Secondary	5,838.00'	**50.0' 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=10.92 cfs @ 6.13 hrs HW=5,837.76' (Free Discharge)
└─**1=Culvert** (Barrel Controls 10.92 cfs @ 8.9 fps)
  ├─**2=WQCV Outlet** (Passes < 0.53 cfs potential flow)
  ├─**3=WQCV Outlet** (Passes < 0.49 cfs potential flow)
  ├─**4=WQCV Outlet** (Passes < 0.44 cfs potential flow)
  └─**5=Orifice/Grate** (Passes < 16.24 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,831.20' (Free Discharge)
└─***6=Broad-Crested Rectangular Weir*** *(Controls 0.00 cfs)*

Link 18 RCP: 18" RCP WITCHES HOLLOW

Inflow Area =	33.530 ac,	Inflow Depth =	1.98"		
Inflow =	21.75 cfs @	5.76 hrs,	Volume=	5.529 af	
Primary =	21.75 cfs @	5.76 hrs,	Volume=	5.529 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link BW: GARMAN DEPRESSION

Inflow =	43.27 cfs @	6.03 hrs,	Volume=	1.028 af	
Primary =	43.27 cfs @	6.03 hrs,	Volume=	1.028 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DPos1: DPos1

Inflow Area =	1.900 ac,	Inflow Depth =	2.27"		
Inflow =	6.58 cfs @	6.03 hrs,	Volume=	0.360 af	
Primary =	6.58 cfs @	6.03 hrs,	Volume=	0.360 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DPos101: DPos101

Inflow Area =	18.830 ac,	Inflow Depth =	2.80"		
Inflow =	29.25 cfs @	6.02 hrs,	Volume=	4.392 af	
Primary =	29.25 cfs @	6.02 hrs,	Volume=	4.392 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

V

Pond 15 R: 15' TYPE R GARMAN AND WH

Link 18 RCP: 18" RCP WITCHES HOLLOW

Link BW: GARMAN DEPRESSION

HYDRAULIC CALCULATIONS

Calculations for Sizing of 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]
1	5	10	0.50	0.69	**4**	**4**
2	3	5	0.50	0.69	**4**	**4**
3	4	11	0.50	0.69	**4**	**5**
OS1	6	12	0.50	0.69	**4**	**6**

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

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

where:

Qi = flow to inlet [cfs]
L_i = length of inlet [ft]
W = width of gutter pan [=2 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 COMMONS

Job No.: 90532
Engineer: David Mijares
Date: 1-Nov-06

Design Procedure Form: Extended Detention Basin (EDB) - Sedimentation Facility

Designer:	**David Mijares**
Company:	**WestWorks Engineering**
Date:	**6-Jul-06**
Project:	**Lincoln Commons**

Pond 1

1. Basin Storage Volume			
A) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	I_a =	82.88	%
	i =	0.83	
B) Contributing Watershed Area (Area)	Area =	14.4	acres
C) Water Quality Capture Volume (WQCV) ($WQCV = 1.0 * (0.91 * I^3 - 1.19 * I^2 + 0.78 * I)$)	WQCV =	0.35	watershed inches
D) Design Volume: Vol = (WQCV / 12) * Area * 1.2	Vol =	0.500	acre-feet
		(0.50 ac-ft provided)	

Pond 1 Tributary Area Summary:

Description	Area [AC]	Imperviousness	Wtd. Avg.
Lincoln Plaza (commercial)	9.3	0.85	0.55
Lincoln Commons (townhomes)	5.1	0.79	0.28

Total Imperviousness: 0.83

✓

Street Capacity

* Q = 0.56/(n*Sx)*S^(0.5)*(T*Sx)^(2.67)

*equation taken from City of Colorado Springs and El Paso County Drainage Criteria Manual Chapter 7.3

where:

Q = flow rate [cfs]
T = width of flow (spread) [ft]
Sx = cross slope [ft/ft]
S = longitudinal slope [ft/ft]
n = Manning's n coeff.

Height of Curb = 0.67 ft

-- Initial Storm -- d(max) @ flowline = 0.50 ft

Known:

T(initial) = 18.00 ft Sa = 0.02 ft/ft Sb = 0.06 ft/ft n (road) = 0.016
W = 2.00 ft S = 0.06 ft/ft

Solution:

Q(A) = 31.2 cfs Q(B) = 11.6 cfs

Initial Storm Street Capacity, Qcap = Q(A) + Q(B) = **43** cfs/side

-- Major Storm -- d(max) @ flowline = 0.67 ft

Known:

T(major) = 25.00 ft Sa = 0.02 ft/ft Sb = 0.06 ft/ft n (road) = 0.016
W = 2.00 ft S = 0.06 ft/ft Sc = 0.33 ft/ft n (grass)= 0.030

Solution:

Q(A) = 80.0 cfs Q(B) = 20.0 cfs Q(C) = 0.0 cfs

Major Storm St. Capacity, Qcap = Q(A) + Q(B) + Q(C) = **100** cfs/side

RIPRAP SIZING

Channel Section Description	Velocity V [ft/s]	Slope, S [ft/ft]	Specific Gravity	*Channel/Riprap Relationship	Rock Type	Mean Particle Size [in]
DP102	7.6	1.00%	2.5	2.66	VL	***6***
DP103	6.7	1.00%	2.5	2.34	VL	***6***
DPos2	7	1.00%	2.5	2.45	VL	***6***

*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)

90532dr.XLS

CIRCULAR CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

August 11, 2006

DP 101

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)..Q100	10.0
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)	1.17
Flow Velocity (fps)	6.77
Froude Number	1.095
Velocity Head (ft)	0.71
Energy Head (ft)	1.88
Cross-Sectional Area of Flow (sq ft)	1.48
Top Width of Flow (ft)	1.24

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CIRCULAR CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

August 11, 2006

DP 102

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs) Q100	15.0
Channel Bottom Slope (ft/ft)	0.01
Manning's Roughness Coefficient (n-value)	0.013
Channel Diameter (ft)	2.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	1.19
Flow Velocity (fps)	7.7
Froude Number	1.364
Velocity Head (ft)	0.92
Energy Head (ft)	2.11
Cross-Sectional Area of Flow (sq ft)	1.95
Top Width of Flow (ft)	1.96

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CIRCULAR CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

August 11, 2006

DP053

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PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)..Q100	11.0
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)	1.31
Flow Velocity (fps)	6.73
Froude Number	0.931
Velocity Head (ft)	0.7
Energy Head (ft)	2.01
Cross-Sectional Area of Flow (sq ft)	1.63
Top Width of Flow (ft)	1.01

==========

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PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

August 11, 2006

DP052

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Culvert Diameter (ft)	3.0
FHWA Chart Number	1
FHWA Scale Number (Type of Culvert Entrance)	2
Manning's Roughness Coefficient (n-value)	0.013
Entrance Loss Coefficient of Culvert Opening	0.5
Culvert Length (ft)	100.0
Invert Elevation at Downstream end of Culvert (ft)	5,833.9
Invert Elevation at Upstream end of Culvert (ft)	5,834.9
Culvert Slope (ft/ft)	0.01
Starting Flow Rate (cfs)	23.0
Incremental Flow Rate (cfs)	5.0
Ending Flow Rate (cfs)	73.0
Starting Tailwater Depth (ft)	3.0
Incremental Tailwater Depth (ft)	0.0
Ending Tailwater Depth (ft)	3.0

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)
23.0	3.0	2.22	2.37	1.22	1.54	3.0	3.25
28.0	3.0	2.52	2.54	1.36	1.71	3.0	3.96
33.0	3.0	2.81	2.75	1.49	1.86	1.49	9.42
38.0	3.0	3.11	3.0	1.62	2.01	1.62	9.74
43.0	3.0	3.4	3.28	1.75	2.14	1.75	10.03
48.0	3.0	3.61	3.59	1.88	2.26	1.88	10.27
53.0	3.0	3.85	3.94	2.02	2.37	3.0	7.5
58.0	3.0	4.17	4.33	2.16	2.47	3.0	8.21
63.0	3.0	4.52	4.74	2.32	2.55	3.0	8.91
68.0	3.0	4.91	5.2	2.52	2.63	3.0	9.62 ← Q_{100}
73.0	3.0	5.32	5.68	3.0	2.7	3.0	10.33

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DPos/01

CIRCULAR CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

October 28, 2005

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	95.0 ← Q CAPACITY (ESTIMATED)
Channel Bottom Slope (ft/ft)	0.0186
Manning's Roughness Coefficient (n-value)	0.013
Channel Diameter (ft)	3.0 ← EX 36" RCP

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	2.6
Flow Velocity (fps)	14.59
Froude Number	1.438
Velocity Head (ft)	3.31
Energy Head (ft)	5.91
Cross-Sectional Area of Flow (sq ft)	6.51
Top Width of Flow (ft)	2.04

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PIPE CAPACITY & ENTRANCE LOSS

COST DATA

PIPE DIA.	AREA S.F.	Q C.F.S	VEL. F.PS.	ENTRANCE LOSS	n	FRICTION SLOPE	INSTALLATION $/LF	COST/ CFS
18	1.77	12	6.79	1.07	0.013	0.013066	25	2.08
18	1.77	15	8.49	1.68	0.013	0.020415	25	1.67
18	1.77	18	10.19	2.42	0.013	0.029398	25	1.39
18	1.77	21	11.88	3.29	0.013	0.040013	25	1.19
18	1.77	24	13.58	4.30	0.013	0.052262	25	1.04
18	1.77	27	15.28	5.44	0.013	0.066145	25	0.93
18	1.77	30	16.98	6.71	0.013	0.081660	25	0.83
24	3.14	20	6.37	0.94	0.013	0.007810	35	1.75
24	3.14	25	7.96	1.47	0.013	0.012203	35	1.40
24	3.14	30	9.55	2.12	0.013	0.017573	35	1.17
24	3.14	35	11.14	2.89	0.013	0.023918	35	1.00
24	3.14	40	12.73	3.78	0.013	0.031240	35	0.88
24	3.14	45	14.32	4.78	0.013	0.039538	35	0.78
24	3.14	50	15.92	5.90	0.013	0.048813	35	0.70
24	3.14	55	17.51	7.14	0.013	0.059064	35	0.64
24	3.14	60	19.10	8.50	0.013	0.070291	35	0.58
30	4.91	30	6.11	0.87	0.013	0.005337	40	1.33
30	4.91	40	8.15	1.55	0.013	0.009489	40	1.00
30	4.91	50	10.19	2.42	0.013	0.014826	40	0.80
30	4.91	60	12.22	3.48	0.013	0.021350	40	0.67
30	4.91	70	14.26	4.74	0.013	0.029060	40	0.57
30	4.91	80	16.30	6.19	0.013	0.037956	40	0.50
30	4.91	90	18.33	7.83	0.013	0.048037	40	0.44
P101 36	7.07	40	5.66	0.75	0.013	0.003584	50	1.25
36	7.07	50	7.07	1.17	0.013	0.005600	50	1.00
36	7.07	60	8.49	1.68	0.013	0.008064	50	0.83
36	7.07	70	9.90	2.28	0.013	0.010976	50	0.71
36	7.07	80	11.32	2.98	0.013	0.014337	50	0.63
36	7.07	90	12.73	3.78	0.013	0.018145	50	0.56
36	7.07	100	14.15	4.66	0.013	0.022401	50	0.50
36	7.07	110	15.56	5.64	0.013	0.027105	50	0.45
36	7.07	120	16.98	6.71	0.013	0.032257	50	0.42
36	7.07	140	19.81	9.14	0.013	0.043906	50	0.36
42	9.62	60	6.24	0.91	0.013	0.003541	70	1.17
42	9.62	70	7.28	1.23	0.013	0.004819	70	1.00
42	9.62	80	8.32	1.61	0.013	0.006294	70	0.88
42	9.62	90	9.35	2.04	0.013	0.007966	70	0.78
42	9.62	100	10.39	2.52	0.013	0.009835	70	0.70
42	9.62	110	11.43	3.04	0.013	0.011900	70	0.64
42	9.62	120	12.47	3.62	0.013	0.014162	70	0.58
42	9.62	130	13.51	4.25	0.013	0.016621	70	0.54
42	9.62	140	14.55	4.93	0.013	0.019276	70	0.50
42	9.62	150	15.59	5.66	0.013	0.022129	70	0.47
42	9.62	160	16.63	6.44	0.013	0.025177	70	0.44
42	9.62	170	17.67	7.27	0.013	0.028423	70	0.41
42	9.62	180	18.71	8.15	0.013	0.031865	70	0.39

EXISTING 18" RCP
@ WITCHES HOLLOW
AND CARMAN DR.
18" INVERT = 16.73
FL @ INLET = 23.65
AVAILABLE HW = 6.92'

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

July 6, 2006

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Culvert Diameter (ft)	1.5
FHWA Chart Number	1
FHWA Scale Number (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.013
Entrance Loss Coefficient of Culvert Opening	0.5
Culvert Length (ft)	414.62
Invert Elevation at Downstream end of Culvert (ft)	14.66
Invert Elevation at Upstream end of Culvert (ft)	16.78
Culvert Slope (ft/ft)	0.0051
Starting Flow Rate (cfs)	8.0
Incremental Flow Rate (cfs)	1.25
Ending Flow Rate (cfs)	33.0
Starting Tailwater Depth (ft)	1.5
Incremental Tailwater Depth (ft)	0.0
Ending Tailwater Depth (ft)	1.5

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)
8.0	1.5	1.86	2.26	1.35	1.1	1.5	4.53
9.25	1.5	2.09	3.23	1.5	1.18	1.5	5.23
10.5	1.5	2.41	4.35	1.5	1.25	1.5	5.94
11.75	1.5	2.76	5.6	1.5	1.3	1.5	6.65
13.0	1.5	3.16	6.99	1.5	1.35	1.5	7.36
14.25	1.5	3.59	8.53	1.5	1.39	1.5	8.06
15.5	1.5	4.06	10.2	1.5	1.42	1.5	8.77
16.75	1.5	4.58	12.02	1.5	1.44	1.5	9.48
18.0	1.5	5.13	13.97	1.5	1.45	1.5	10.19
19.25	1.5	5.72	16.07	1.5	1.46	1.5	10.89
20.5	1.5	6.36	18.31	1.5	1.47	1.5	11.6
21.75	1.5	7.03	20.69	1.5	1.48	1.5	12.31
23.0	1.5	7.74	23.21	1.5	1.48	1.5	13.02
24.25	1.5	8.5	25.87	1.5	1.48	1.5	13.72
25.5	1.5	9.29	28.67	1.5	1.49	1.5	14.43
26.75	1.5	10.12	31.61	1.5	1.49	1.5	15.14
28.0	1.5	10.99	34.7	1.5	1.49	1.5	15.84
29.25	1.5	11.91	37.92	1.5	1.49	1.5	16.55
30.5	1.5	12.86	41.28	1.5	1.49	1.5	17.26
31.75	1.5	13.85	44.79	1.5	1.49	1.5	17.97
33.0	1.5	14.88	48.43	1.5	1.5	1.5	18.67

21.75 CFS CARRIED IN 18" RCP PRIOR TO CAPACITY FAILURE

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EXCERPTS FROM PREVIOUS DRAINAGE REPORTS

Final Drainage Report

for

Bradley Ranch, Filing No. 5

Prepared For:

Ranch Equities, Ltd.
900 W. Fillmore Street
Colorado Springs, CO 80907
(719) 471-7763

By:

HMS Group
2835 Downhill Drive
Colorado Springs, CO 80918
(719) 528-8554

Job No. COS158

March, 1998

CERTIFICATIONS

The attached drainage plan and report were prepared under my direct supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by El Paso County for drainage reports, and said 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.

Mark E. Heine, Registered Professional Engineer, State of Colorado No. 28953

Date 3/23/98

COLORADO REGISTERED MARK EDWARD HEINE 28953 PROFESSIONAL ENGINEER

DEVELOPER'S STATEMENT

I, the Developer, have read and will comply with all of the requirements specified in this Final Drainage Report.

Business Name: Ranch Equities, Ltd.

By: Darwin L. Faaborg Date: 3/23/98

Darwin L. Faaborg

Title: President

Address: 900 W. Fillmore Street
Colorado Springs, CO 80907

EL PASO COUNTY

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

John A. McCarty Date: 4-23-98

John A. McCarty
County Engineer / Manager

Conditions:

Basin No. 1. Stormwater runoff will be channeled within the proposed curb to the intersection of Garman Drive and the proposed street. At this location runoff from Basin No. 1 will be Q(5) / Q(100) = 4.5 / 9.8 c.f.s. This runoff will collect at the existing five (5) curb inlet. The inlet has an interception capacity of 6.9 c.f.s. which will collect all of the five year flows with 2.9 c.f.s. crossing the road to the existing fifteen (15) foot curb inlet during a 100-yr. storm. Basin No. 2 will drain to the proposed street, collect within the proposed curb which will channel stormwater runoff to the intersection of Garman Drive and the proposed street. At this location runoff from Basin No. 2 will be Q(5) / Q(100) = 4.4 / 9.1 c.f.s. This runoff will collect at the existing five (5) curb inlet. The inlet has an interception capacity of 6.9 c.f.s. which will collect all of the five year flows with 2.2 c.f.s. crossing the road to the existing fifteen (15) foot curb inlet. Stormwater runoff from improvements within Filing No. 5 will be Q(5) / Q(100) = 6.4 / 13.8 c.f.s. at the intersection of the proposed street and Garman Drive. This runoff compares favorably to the previous report which estimated a runoff of Q(5) / Q(100) = 7.8 / 19.0 c.f.s. The outfall for these existing inlets is a 42" R.C.P. storm drain which carries stormwater runoff to the west and discharges to an area designated as a future detention pond.

V. CONCLUSIONS / RECOMMENDATIONS

Proposed improvements within Filing No. 5, indicated as Basins 1 and 2, will generate developed runoff of Q(5) / Q(100) = 6.4 / 13.8 c.f.s. at the intersection of the proposed road and Garman Drive. These flows are less than flows as shown within previously approved drainage reports and will be collected within existing facilities constructed in Garman Drive. These existing improvements consist of two (2) five foot curb inlets which will collect runoff from Filing No. 5, and the additional capacity of the existing fifteen (15) foot curb inlet located at the southwest curb return. Proposed land use for Filing No. 5 will be revised from the previously studied multi-family site to a single-family development with rezoning actions.

Bradley Ranch - Filing No. 5
Job No. COS158
Date: March, 1998

BASIN SUMMARY - DEVELOPED FLOWS

Basin	Area			Overland Flow			Swale / Gutter / Street Flow				Basin				
	(Acres)	C(5)	C(100)	Length (ft.)	Height (ft.)	T(c) (min.)	Length (ft.)	Height (ft.)	Velocity (f.p.s.)	T(c) (min.)	T(c) (min.)	I(5) (in./hr.)	I(100) (in./hr.)	Q(5) (cfs)	Q(100) (cfs)
1	2.9	0.55	0.65	130	1.3	18.1	175	3.5	4.9	0.6	20.6	2.8	5.2	4.5	9.8
							200	5.6	5.9	0.6					
							225	2.5	3.7	1.0					
							90	2.1	5.3	0.3					
2	2.2	0.60	0.70	75	0.8	13.8	175	3.5	4.9	0.6	15.5	3.3	5.9	4.4	9.1
							240	6.7	5.8	0.7					
							140	3.2	5.3	0.4					

Capacity of Existing 5' Sumped Curb Inlets

Q(i) = 1.7 (Li + 1.8W)(d + w/12)^1.85

Q(i) = 1.7 (5 + 1.8*2)(.5 + 2/12)^1.85 = 6.9 c.f.s.

VICINITY MAP
NOT TO SCALE

SECTION 60' RIGHT-OF-WAY
NOT TO SCALE

NOTES: 1) TYPICAL SECTION FOR THE FOLLOWING STREETS
-FLOW NO. 8 STREET
-FLOW NO. 6 STREETS

HMS GROUP
Civil Engineering & Design

DRAINAGE PLAN
BRADLEY RANCH - FIL. NO. 5
EL PASO COUNTY, COLORADO

DRAINAGE REPORT

FOR

BRADLEY RANCH

FILING NO. 3

PHASE II

WE SS CONSULT NG ENGINEERS, INC.
Professional Engineer and Land Surveyor

April 16, 1986

Mr. Max Rothschild
County Engineer
El Paso County
3170 Century Street
Colorado Springs, Colorado 80907

Dear Mr. Rothschild:

Transmitted herewith is the drainage report for Bradley Ranch Filing No. 3, Phase II. This subdivision is located south of Bradley Road and west of Lincoln Plaza Drive on the north boundary of Security, Colorado.

If you have any questions on this report, please let me know.

Sincerely,

WEISS CONSULTING ENGINEERS, INC.

G. J. Weiss PE LS 4124

1815 North Tejon • Colorado Springs, CO 80907 • (303) 634-0373

DRAINAGE REPORT STATEMENT

Engineer's Statement:

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

Gerald J. Weiss

Gerald J. Weiss PE 4124

Seal

Developer's Statement

The developer has read and will comply with all of the requirements specified in this drainage report.

Business Name

By: _____

Title: _____

Address: _____

_____

EL PASO COUNTY

_____ County Engineer

_____ Date

Conditions:

manual for El Paso County. The calculations were made using a 5 year frequency, 24 hour duration storm using 2.6 inches of precipitation. The 100 year storm was also calculated for informational purposes. The Soil Conservation Service Manual and the P.P.A.C.G. Areawide Urban Runoff Control Manual were also used for design information.

The S.C.S. Soils Map No. 17 lists the soil classification on this site as the Blakeland Series. It is a loamy sand and falls in Hydrologic Group A.

EXTERNAL FLOWS

Basins D-1, D-2 and D-3 discharge 35 C.F.S., 51.6 C.F.S. and 7.8 C.F.S. respectively into this subdivision using the proposed development flows. This water will be diverted to the proposed Detention Storage Pond lying west of this subdivision.

INTERNAL FLOWS

Basin D-4 generates 5.1 C.F.S. and outfalls into the detention pond system. Basin D-5 generates 2.8 C.F.S. and discharges into the 24" R.C.P. outfall line.

DRAINAGE FACILITIES

The 24" R.C.P. from Bradley Ranch Filing 2, Phase II, will need to be extended into the subdivision

MAJOR BASIN	SUB BASIN	AREA Planim. Read.	AREA MILE	BASIN LENGTH	BASIN HEIGHT	Tc	K	SOIL GROUP	DEV. TYPE	CURVE NO.	FLOW Q 5	FLOW Q 100	FLOW qp	q 5	q 100
D	1	16.8	0.026625	1000	12	0.17		A	COMM	89	1.55	3.39	860	35	76.5
	2	26.0	0.0406	1200	10	0.20		"	COMM	89	1.55	3.39	820	51.6	113
	3	5.2	0.008125	700	20	0.08		"	M.F.	80	0.96	2.55	1000	7.8	19
	4	9.5	0.014915	1200	12	0.10		"	S.F.	65	0.34	1.39	1000	5.1	20.7
	5	5.3	0.00829	700	15	0.10		"	S.F.	65	0.34	1.39	1000	2.8	11.5

HYDROLOGIC COMPUTATION - BASIC DATA

PROJ: BRADLEY RANCH FILING 3 PHASE II

By: BJ Weiss

Date: 4-16-86

WEISS CONSULTING ENGINEERS, INC.

BRADLEY RANCH FILING NO. 3
PHASE II

EL PASO COUNTY, COLORADO

FINAL
DRAINAGE REPORT AND PLAN
FOR
LINCOLN PLAZA SUBDIVISION FILING NO. 2

March, 2001

RECEIVED
MAR 6 2001

EL PASO COUNTY REVIEW SET
TO BE RETURNED

12650

Leigh
& Whitehead
Associates, Inc.
CONSULTING CIVIL ENGINEERS & SURVEYORS
2720 EAST YAMPA STREET, SUITE 1
COLORADO SPRINGS, CO 80909-5061

LWA Project No. 00083.62

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ZONING MAP

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CONDITIONS OF DEVELOPMENT LETTER

EXISTING CONDITIONS DRAINAGE PLAN (ENVELOPE)

PROPOSED CONDITIONS DRAINAGE PLAN (ENVELOPE)

Sample Calculations are included for reference, but are "not required" for addition by the applicant.

Leigh Whitehead & Associates, Inc.
ENGINEERS, SURVEYORS & PLANNERS

2720 EAST YAMPA STREET, SUITE 1
COLORADO SPRINGS, CO 80909-5061
TELEPHONE 719-636-5179 / FAX 719-636-5199

March, 2001

El Paso County
Public Works Department
Engineering Division
3460 Marksheffel Road
Colorado Springs, CO 80922

RE: Lincoln Plaza Subdivision Filing No. 2

Dear Representative:

In accordance with the requirements of the El Paso County Subdivision Ordinance, a drainage report and plan has been prepared for the proposed Lincoln Plaza Subdivision Filing No. 2.

This report has been prepared under the current City of Colorado Springs and County Drainage Criteria.

Seven (7) complete copies of the drainage report and plan are hereby transmitted for your review and approval. If there are any questions or comments concerning this report, please contact the undersigned.

Sincerely,

Leonard A. Beasley
Project Engineer

Date

Reviewed by:

David J. Whitehead, P.E.

cc: Client

LWA #00183.02

SIGNATURES AND STATEMENTS

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 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 J. Whitehead, P.E. (Colo. 25118)

Developer's Statement:

The Developer has read and will comply with all the requirements specified in this drainage report and plan.

By:_____ Darwin L. Faaborg, General Partner
(signature) Printed Name

Lincoln Equities, L.L.L.P.
900 W. Fillmore Street
Colorado Springs, CO 80907

El Paso County, Colorado:

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

John A. McCarty, P.E., County Eng./Director Date

Conditions: Construction documents to be submitted to El Paso County Department of Transportation. When the site layout is completed.

Floodplain Statement:

Lincoln Plaza Subdivision Filing No. 2 is not located in a F.E.M.A. designated 100-year floodplain, as shown on F.I.R.M. Panel No. 08041C0763 F, dated March 17, 1997.

Soils:

The soils across the site consist of Blakeland Loamy Sand, a deep, somewhat excessively drained soil, formed in alluvial and eolian material, derived from arkosic sedimentary rock on uplands. Also with this soil are small areas of Bresser Sandy Loam, Truckton Sandy Loam, and Stapleton Sandy Loam. Permeability of the Blakeland Soil is rapid which gives it a Hydrologic Group A rating. For the purpose of this report, Hydrologic Group B will be used. Surface runoff is slow, the hazard of erosion is moderate, and the hazard of soil blowing is severe.

Existing Conditions:

The site drains in a westerly to southwesterly direction with slopes ranging from 1.0 to 2.0%. Vegetation across the site consists mainly of grasses native to the area. No shrubs or trees are located on the site. The property to the east in the northeast corner has an existing irrigation canal that flows under Bradley Road and Main Street.

The property was divided into two major drainage basins and four sub-basins along with a design point. The locations are shown on the attached Existing Conditions Drainage Plan. Basin A was divided into four sub-basins and one design point. Sub-basin A1 contains 10.55 acres and consists of the property within Lot 2, Lincoln Plaza Subdivision, located immediately east of this property. This sub-basin generates a peak flow of 6.7 cfs for the 5-year event and 16.4 cfs for the 100-year event. Sub-basin A2 consists of the Lincoln Plaza Subdivision Filing No. 2 boundaries and includes a portion of Lincoln Plaza Drive, Bradley Road and Gladiator Drive. This sub-basin contains 6.61 acres and generates a peak flow of 5.0 cfs for the 5-year event and 12.3 cfs for the 100-year event. Sub-basin A3 consists of the southerly half of Gladiator Drive and the northerly half of the single family residential properties located to the south of this project. These flows are directed to Gladiator Drive and an existing 5' Type R inlet. This sub-

basin contains 0.99 acres and generates a peak flow of 3.3 cfs for the 5-year event and 6.7 cfs for the 100-year event. Sub-basin A4 consists of all of the portion of Lincoln Plaza Drive and the easterly half of the single family residences located on the west side of Lincoln Plaza Drive. Runoff from this area is directed easterly to Lincoln Plaza Drive and then routed to an existing 10' Type R inlet located on the east side of Lincoln Plaza Drive immediately north of Gladiator Drive. Peak flow generated from Sub-basin A4 which contains 0.94 acres is 2.9 cfs for the 5-year event and 6.0 cfs for the 100-year event.

Design Point 1 (DP-1), which contains 17.16 acres, consists of Sub-basins A1 and A2. These flows are directed to an existing 10' Type R inlet located on the north side of Gladiator Drive approximately 100' east of Lincoln Plaza Drive. Peak flow generated at DP-1 is 10.0 cfs for the 5-year event and 24.9 cfs for the 100-year event. Basin A contains 19.09 acres and generates a peak flow of 12.5 cfs for the 5-year event and 29.6 cfs for the 100-year event. Located within Lincoln Plaza Drive across from Garman Drive is an existing 16' Type R inlet. This inlet collects street flows from Lincoln Plaza Drive. A very minimal amount of flow enters this inlet from this site. A majority of the flow is directed to the previously mentioned 10' Type R inlet located in Gladiator Drive.

15

Not 16'; please revise

ok

B ok

Basin D is located on the southeast corner of the drainage area studied. This basin contains 2.64 acres and generates a peak flow of 1.5 cfs for the 5-year event and 3.9 cfs for the 100-year event. These flows are directed southerly and southeasterly to Gladiator Drive and then to Main Street. Located across from Lincoln Plaza Subdivision Filing No. 2 on the south side of Gladiator Drive is an existing detention pond. This facility is a temporary structure only and the runoff from Bradley Ranch Filing No. 4, Phase I, is directed to it. Flows in are 13.5 cfs for the 5-year event and 27.6 cfs for the 100-year event. Release rates for this detention pond are 3.7 cfs for the 5-year event and 9.8 cfs for the 100-year event. These runoff flows were obtained from a drainage report prepared for Bradley Ranch Filing No. 4, Phase I, by Jeffries Engineering and approved by El Paso County Department of Transportation in ~~April~~ June 1995. Runoff from this detention facility is directed to an existing storm drain system in Lincoln Plaza Drive and Garman Drive.

... along Lincoln Plaza
does not include a 18" pipe. Please revise.

Incorrect

This system consists of 18", 36", and 42" R.C.P.s along with 5', 10' and 16' Type R inlets. This system routes flows westerly within Garman Drive. This pipe discharges to an area designated as a future detention pond. The location is shown on the attached Existing Conditions Drainage Plan.

Proposed Conditions:

The overall drainage pattern remained somewhat the same as the existing drainage patterns. Basin A was slightly reduced in size and Basin B became slightly larger. Sub-basin A1 was used to determine flow that would enter Lincoln Plaza Subdivision Filing No. 2. For the purpose of this report, the calculations were based on a commercial development which would give peak flows utilizing a C-factor of 0.9 and 0.95. Currently, there is not available a site layout for this development. Although the layout may change and flow routing may deviate slightly, the peak flows should not change from what has been calculated for this report. Therefore, peak flows from this report can be used for the final design of this storm system. All flows except historic runoff will be directed to an underground storm system within the property. Following is a brief description of the basins and sub-basins.

Basin A was divided into four sub-basins and one design point. Sub-basin A1 which is a property immediately east of this subdivision contains 8.40 acres and generates a peak flow of 36.6 cfs for the 5-year event and 70.0 cfs for the 100-year event. Sub-basin A2 consists of the Lincoln Plaza Subdivision Filing No. 2 site. It contains 6.61 acres which includes a portion of Bradley Road, Lincoln Plaza Drive, and Gladiator Drive. Peak flow generated from this sub-basin is 30.6 cfs for the 5-year event and 56.5 cfs for the 100-year event. Design Point 1 (DP-1), which consists of Sub-basins A1 and A2, contains 15.01 acres and generates a peak flow of 56.3 cfs for the 5-year event and 106.9 cfs for the 100-year event. Sub-basins A3 and A4 were discussed in detail in the Existing Conditions portion of this report. These basin areas and peak flow have not changed, therefore, no further discussion is necessary.

Peak flow generated from Basin A, which contains 16.94 acres, is 61.5 cfs for the 5-year event

RUNOFF COMPUTATIONS
RATIONAL METHOD

LINCOLN PLAZA SUBDIVISION No 2
LINCOLN PLAZA Dr & BRADLEY Rd
SECURITY EL PASO COUNTY, COLORADO

TABLE A
EXISTING CONDITIONS

LWA # 00083 02

LEIGH WHITEHEAD & ASSOCIATES, INC
Engineers Surveyors & Planners
2720 EAST YAMPA STREET SUITE 1
COLORADO SPRINGS COLORADO
(719) 636-5179

SHEET 1 OF 2

BASIN	AREA	SOIL TYPE	C5 / C100	GEOMETRY LENGTH	SLOPE	HEIGHT	Ti5 / Ti100	V / Tt	tc5 / tc100	i5 / i100	Q5	Q100	COMMENTS
A1	10.55	A	0.31	830.0		13.3	36.43		36.43	2.06	6.7		
		B	0.40		1.60		32.28		32.28	3.88		16.4	
A2	6.61	A	0.32	630.0		4.7	29.37		29.37	2.35	5.0		
		B	0.42		1.09		25.61		25.61	4.44		12.3	
OP-1	17.16	A	0.31	1000.0		16.0	40.00	1.75	42.47	1.87	10.0		A1 & A2
		B	0.41		1.60		34.34	2.47	37.43	3.54		24.9	
A3	0.89	B	0.66	80.0		9.0	3.31	4.04	5.41	5.00	3.3		
		B	0.75		11.25		2.63	2.10	4.73	5.00		6.7	
A4	0.94	B	0.66	50.0		3.0	4.63	Varies	6.93	4.66	2.9		
		B	0.75		2.00		3.68	2.30	5.98	6.57		9.0	
A	15.09	A / B	0.35	1000.0		16.0	37.98	Varies	52.78	1.66	12.5		
		B	0.44		1.60		33.42	4.30	37.72	3.52		26.6	
B	3.64	A	0.29	750.0		10.0	37.72		37.72	2.02	1.5		
		B	0.39		1.33		33.07		33.07	3.87		3.5	

RUNOFF COMPUTATIONS
WEIGHTED RUNOFF COEFFICIENT (C)

LINCOLN PLAZA SUBDIVISION No. 2
LINCOLN PLAZA Dr. & BRADLEY Rd.
SECURITY, EL PASO COUNTY, COLORADO

TABLE A
EXISTING CONDITIONS

LEIGH WHITEHEAD & ASSOCIATES, INC.
Engineers, Surveyors & Planners
2720 EAST VAMPA STREET, SUITE
COLORADO SPRINGS, COLORADO
719) 536 5179

Basin	Area	Total Area	Percent Cover	C5	Wtd. C5	C100	Wtd. C100	Type Of Cover
A1	9.64	10.55	91.37%	0.25	0.23	0.35	0.32	Native Grasses
	0.91	10.55	8.63%	0.90	0.08	0.95	0.08	Pavement
	10.55		100.00%		0.31		0.40	
A2	5.89	6.61	89.11%	0.25	0.22	0.35	0.31	Native Grasses
	0.72	6.61	10.89%	0.90	0.10	0.95	0.10	Pavement
	6.61		100.00%		0.32		0.41	
DP-1	15.53	17.16	90.50%	0.25	0.23	0.35	0.32	Native Grasses
	1.63	17.16	9.50%	0.90	0.09	0.95	0.09	Pavement
	17.16		100.00%		0.31		0.41	
A3	0.80	0.99	80.81%	0.60	0.48	0.70	0.57	Existing Single Family Residential
	0.19	0.99	19.19%	0.90	0.17	0.95	0.18	Pavement
	0.99		100.00%		0.66		0.75	
A4	0.59	0.94	62.77%	0.60	0.38	0.70	0.44	Existing Single Family Residential
	0.35	0.94	37.23%	0.90	0.34	0.95	0.35	Pavement
	0.94		100.00%		0.71		0.75	
A	15.53	19.09	81.35%	0.25	0.20	0.35	0.28	Native Grasses
	1.39	19.09	7.28%	0.60	0.04	0.70	0.05	Existing Single Family Residential
	2.17	19.09	11.37%	0.90	0.10	0.95	0.11	Pavement
	19.09		100.00%		0.35		0.44	
B	2.48	2.64	93.94%	0.25	0.23	0.35	0.33	Native Grasses
	0.16	2.64	6.06%	0.90	0.05	0.95	0.06	Pavement
	2.64		100.00%		0.29		0.39	

PROPOSED CONDITIONS

A	13.38	16.94	78.98%	0.90	0.71	0.95	0.75	Commercial Area
	1.39	16.94	8.21%	0.60	0.05	0.70	0.06	Existing Single Family Residential
	2.17	16.94	12.81%	0.90	0.12	0.95	0.12	Pavement
	16.94		100.00%		0.88		0.93	

TABLE 2

RUNOFF COMPUTATIONS
TRAVEL TIME CALCULATIONS

LINCOLN PLAZA SUBDIVISION No. 2
LINCOLN PLAZA Dr. & BRADLEY Rd
SECURITY, EL PASO COUNTY, COLORADO

TABLE A
EXISTING CONDITIONS

LEIGH WHITEHEAD & ASSOCIATES, INC
Engineers, Surveyors & Planners
2720 EAST YAMPA STREET, SUITE 1
COLORADO SPRINGS, COLORADO
(719) 536-5175

BASIN	"P" or "K" (TR-55)	"n"	Area	"WP" or "Pipe Dia"	HIGH ELEV	LOW ELEV	LENGTH	HEIGHT	SLOPE	"V"	"TT" (min)	COMMENTS
DP-1	2.0				5840.0	5838.0	260	2.0	0.77%	1.75	2.47	Overland / Sheet Flow
A3		0.016	2.65	16.42	5848.0	5837.0	510	11.0	2.16%	4.04	2.10	Residential Sheet Flow
A4		0.016	2.65	16.42	5838.5	5837.3	240	1.2	0.50%	1.95	2.05	Residential Sheet Flow
		0.013	0.75	8.02	5837.3	5837.0	38	0.3	0.79%	2.53	0.25	Cross Pan
							278				2.30	
A	2.0				5840.0	5838.0	260	2.0	0.77%	1.75	2.47	Overland / Sheet Flow
		0.013		1.5	5833.0	5831.0	440	2.0	0.45%	4.01	1.83	18" Dia RCP
							700				4.30	
PROPOSED CONDITIONS												
A1	2.0				5850.0	5841.5	540	8.4	1.56%	2.49	3.61	
A2	2.0				5846.0	5838.0	500	8.0	1.60%	2.53	3.29	
DP-1	2.0				5850.0	5838.0	920	12.0	1.30%	2.28	6.71	
A3		0.016	2.65	16.42	5848.0	5837.0	510	11.0	2.16%	4.04	2.10	Residential Sheet Flow
A4		0.016	2.65	16.42	5838.5	5837.3	240	1.2	0.50%	1.95	2.05	Residential Sheet Flow
		0.013	0.75	8.02	5837.3	5837.0	38	0.3	0.79%	2.53	0.25	Cross Pan
							278				2.30	
A	2.0				5850.0	5838.0	920	12.0	1.30%	2.28	6.71	
B	2.0				5850.0	5845.7	600	4.3	0.72%	1.69	5.91	

SAMPLE CALCS FOR BASIN A2

$V = K S^{1/2}$

K = 2 (paved area / sheet flow)

S = 1.6

V = 2.53

$$TT = \frac{L}{V} = \frac{500 \text{ ft}}{2.53 \frac{\text{ft}}{\text{sec}} \times \frac{60 \text{ sec}}{1 \text{ min}}} = 3.29 \text{ min}$$

$V = \frac{1.486}{n} R^{2/3} S^{1/2}$

HERTORIA
LINCOLN PLAZA
FUND #2 SITE
10.85 Ac.
6.7
16.4
L= 830'
TC= 32.3 MIN
TC= 25.6 MIN
L= 1280'
TC= 37.4 MIN
NOTE: ALL EXISTING INLETS SHOWN ARE CDOT TYPE "R" INLETS
L= 750'
TC= 33.1 MIN
GLADIATOR DRIVE

DRAINAGE MAP
(DEVELOPED CONDITIONS)

LINCOLN COMMONS
DEVELOPED CONDITIONS DRAINAGE MAP
EL PASO COUNTY, COLORADO

All figures appear to match approved Preliminary Drainage Report

BASIN	Q5 [CFS]	Q100 [CFS]
A	5	10
B	3	5
C	6	11
D	1	3
E	1	2
OS1	5	10
OS2	34	68
OS3	2	4

DESIGN POINT	Q5 [CFS]	Q100 [CFS]	DESCRIPTION
1	5	10	4' SUMP INLET
2	3	5	4' SUMP INLET
3	6	11	6' SUMP INLET
os1	6	12	10' SUMP INLET
os2	34	68	36" RCP
101	5	10	18" RCP
102	7	15	24" RCP
103	4	9	18" RCP
os101	11	23*	EX 36" RCP

*CALCULATED FROM MODIFIED RATIONAL METHOD PRODUCING GREATEST POND VOLUME

POND 1	Q5 [CFS]	Q100 [CFS]	Q100 [CFS]
INFLOW	38	97	45*
OUTFLOW	1	8	11*

*CALCULATED FROM MODIFIED RATIONAL METHOD PRODUCING GREATEST POND VOLUME
100-YEAR PONDING VOLUME=2.00 AC-FT
WQCV=0.50 AC-FT

LEGEND

- BASIN IDENTIFIER / BASIN AREA [AC] — A / 1.0
- SURFACE DESIGN POINT IDENTIFIER — 1
- STORM DRAIN DESIGN POINT IDENTIFIER — 101
- DRAINAGE BASIN BOUNDARY
- SURFACE FLOW DIRECTION
- EXISTING MAJOR CONTOUR (5') — 100
- EXISTING MINOR CONTOUR (1')
- PROPOSED MAJOR CONTOUR (10') — 100
- PROPOSED MINOR CONTOUR (2')
- DRAINAGE PATH USED IN Tc CALCULATION
- LANDSCAPE AREAS EXCLUDED FROM ANALYSIS

REV.	DESCRIPTION	DATE

REVIEW:

PREPARED FOR:
FMI LINCOLN COMMONS, LLC
3090 WINDHOVER LANE
COLORADO SPRINGS, CO 80916
(719) 392-5448

WESTWORKS ENGINEERING
1023 W. COLORADO COLORADO SPRINGS, CO 80904 (719) 685-1670

LINCOLN COMMONS

DEVELOPED CONDITIONS DRAINAGE MAP

DRAWN BY: DLM	
SCALE: 1"=50'	DATE: 06/11/07
JOB NUMBER	SHEET
90532	1 OF 1

Appendix F: Rational Method Drainage Calculations

Calculation of Peak Runoff using Rational Method

Designer: Richard Lyon
Company: RMG-Rocky Mountain Group
Date: 2/5/2020
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
Rainfall Intensity Equation Coefficients =	a	b	c				
	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	1.02	A	3.80	0.012	0.013	0.016	0.022	0.057	0.140	0.279	110.00	104.70	98.81	0.054	11.83	240.00	98.81	94.37	0.019	10	1.36	2.94	14.77	28.44	14.77	2.28	2.93	3.52	4.48	5.31	6.20	8.62	0.03	0.04	0.06	0.10	0.31	0.88	2.45
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
E-4	0.15	A	2.0	0.005	0.006	0.007	0.011	0.042	0.126	0.267	150.00	98.60	95.70	0.019	19.46	0.01	0.00	0.00	0.000	10	0.03	0.01	19.47	25.67	19.47	1.99	2.55	3.07	3.91	4.63	5.41	7.52	0.00	0.00	0.00	0.01	0.03	0.10	0.30
OS-1	0.41	A	3.9	0.01	0.01	0.02	0.02	0.06	0.14	0.28	110.00	106.00	95.70	0.094	9.83	0.01	0.00	0.00	0.000	10	0.03	0.01	9.84	25.35	10.00	2.70	3.46	4.17	5.30	6.28	7.33	10.20	0.01	0.02	0.03	0.05	0.15	0.43	1.18
OS-2	0.06	A	100.0	0.84	0.86	0.87	0.88	0.88	0.89	0.90	110.00	96.30	94.40	0.017	3.78	0.01	0.00	0.00	0.000	10	0.03	0.01	3.78	9.00	5.00	3.39	4.34	5.22	6.65	7.87	9.19	12.79	0.16	0.21	0.26	0.33	0.39	0.46	0.65

Calculation of Peak Runoff using Rational Method

Designer: Richard Lyon
Company: RMG-Rocky Mountain Group
Date: 2/5/2020
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

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

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

$$\text{Computed } t_c = t_i + t_t$$

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

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

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

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
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Rainfall Intensity Equation Coefficients =	a	b	c				
	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	1.29	A	79.87	0.627	0.646	0.662	0.687	0.707	0.732	0.769	110.00	104.70	98.81	0.054	4.94	240.00	98.81	94.37	0.019	20	2.72	1.47	6.41	13.88	6.41	3.16	4.05	4.87	6.20	7.33	8.57	11.92	2.55	3.36	4.14	5.47	6.67	8.07	11.79
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
D-4	0.007	A	2.0	0.005	0.006	0.007	0.011	0.042	0.126	0.267	25.00	97.40	95.65	0.070	5.19	0.01	0.00	0.00	0.000	20	0.06	0.00	5.19	25.67	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
OS-1	0.41	A	3.9	0.01	0.01	0.02	0.02	0.06	0.14	0.28	7.00	106.30	95.65	1.521	0.99	0.01	0.00	0.00	0.000	20	0.06	0.00	0.99	25.34	10.00	2.70	3.46	4.17	5.30	6.28	7.33	10.20	0.01	0.02	0.03	0.05	0.15	0.42	1.16
OS-2	0.06	A	100.0	0.84	0.86	0.87	0.88	0.88	0.89	0.90	110.00	96.30	94.40	0.017	3.78	0.01	0.00	0.00	0.000	20	0.06	0.00	3.78	9.00	5.00	3.39	4.34	5.22	6.65	7.87	9.19	12.79	0.16	0.21	0.26	0.33	0.39	0.46	0.65

Appendix G: Sub-Basin Delineation Exhibits

Slope Arrows Table			
Number	Minimum Slope	Maximum Slope	Color
1	0.00%	10.00%	
2	10.00%	25.00%	
3	25.00%	100.00%	

ROCKY MOUNTAIN GROUP
Architectural Structural Forensics
Geotechnical Materials Testing Civil Planning
ARCHITECTS RMG ENGINEERS
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ESTABLISHED 1992
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(719) 488-2145 ~ WWW.RMGENGINEERS.COM
SOUTHERN COLORADO, DENVER METRO, NORTHERN COLORADO

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BRADLEY CROSSROADS LOT 4A DEVELOPMENT

1830 MAIN STREET
COLORADO SPRINGS, CO

CHARLES HOLLIDAY

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SHEET NAME
EXISTING SUB-BASIN DELINEATION

PROJECT STATUS
COUNTY REVIEW

ENG:	RDL
DRAWN:	RDL
CHECKED:	RDL
DATE	02/04/20

#	REVISION	DATE
	DD	07/18/19
	CNTY. REV. 1	08/06/19
	CNTY. REV. 2	12/02/19
	UT-2 REVISION	12/18/19
	CNTY. REV. 3	02/04/20
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JOB NO.
170736

SHEET NO.
C-EX-01
of 20

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Slope Arrows Table			
Number	Minimum Slope	Maximum Slope	Color
1	0.00%	5.00%	
2	5.00%	10.00%	
3	10.00%	100.00%	

ROCKY MOUNTAIN GROUP

Architectural Structural Mechanical Plumbing Forensics

Geotechnical Materials Testing Civil Planning

RMG ARCHITECTS ENGINEERS

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1830 MAIN STREET
COLORADO SPRINGS, CO

CHARLES HOLLIDAY

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SHEET NAME:
DEVELOPED SUB-BASIN DELINEATION

PROJECT STATUS:
COUNTY REVIEW

ENG:	RDL
DRAWN:	RDL
CHECKED:	RDL
DATE	02/04/20

#	REVISION	DATE
	DD	07/16/19
	CNTY. REV. 1	08/06/19
	CNTY. REV. 2	12/02/19
	UT-2 REVISION	12/18/19
	CNTY. REV. 3	02/04/20
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JOB NO.
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of 20

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Appendix G: Sub-Basin Delineation Exhibits, Pond Details

DETAIL A - EXISTING EXTENDED DETENTION BASIN FOR LINCOLN COMMONS TOWNHOMES

N.T.S.

DETAIL 02 - PROPOSED MICRO-POOL PLAN VIEW

N.T.S.

VICINITY MAP

N.T.S.

*SLOPE FOREBAY BOTTOM TO NOTCH AT 2% MIN. SLOPE
*FOREBAY TO HAVE 4" THICK CONCRETE SLAB ON TOP OF COMPACTED BASE (95% OF MAXIMUM DRY DENSITY FOR ASTM D698 STANDARD PROTECT OR 90% FOR ASTM D1557 MODIFIED PROCTOR.)

DETAIL 01 - PROPOSED CONCRETE FOREBAY

N.T.S.

*FOREBAY DESIGNED FOR 1% OF WQCV FROM DESIGN POINT 3 OF SF07012 DRAINAGE REPORT.

DETAIL 03 - PROPOSED MICRO-POOL RETROFIT FOR EXISTING EDB OUTLET STRUCTURE

N.T.S.

NOTE: DETAILS FROM ORIGINAL LINCOLN COMMONS TOWNHOMES (SF07012) PROVIDED FOR REFERNCE. OUTLET STRUCTURE NOT BUILT TO DIMENSIONS SHOWN. FIELD MEASUREMENTS ARE USED FOR PROPOSED STRUCTURE(S).

ROCKY MOUNTAIN GROUP
Architectural Structural Forensics
ARCHITECTS RMG ENGINEERS
Geotechnical Materials Testing Civil Planning
SOUTHERN COLORADO
2910 Austin Bluffs Parkway, Colorado Springs, CO. 80918
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Southern Colorado, Denver Metro, Northern Colorado

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1830 MAIN STREET
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WESTERN MANAGEMENT GROUP

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SHEET NAME:
POND DETAILS

PROJECT STATUS
PERMIT REVIEW

ENG:	RDL
DRAWN:	RDL
CHECKED:	RDL
DATE	03/02/20

#	REVISION	DATE
	GEC REV. 1	08/26/19
	CNTY REV. 2	12/02/19
	CNTY REV. 3	02/05/20
	CNTY REV. 4	03/02/20
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170736

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CV-1
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