PRELIMINARY DRAINAGE REPORT
FOR
RICHMOND HOMES AT FEATHERGRASS

Prepared For:

MDC Holdings – Richmond American Homes
4350 South Monaco Street
Denver, CO 80237
720-977-3827

November, 2019
Project No. 25149.01

Prepared By:
JR Engineering, LLC
5475 Tech Center Drive, Suite 235
Colorado Springs, CO 80919
719-593-2593

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 any negligent acts, errors, or omissions on my part in preparing this report.

_____

Glenn D. Ellis, Colorado P.E. 38861
For and On Behalf of JR Engineering, LLC

DEVELOPER'S STATEMENT:

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

Business Name: MDC Holdings – Richmond American Homes

By: _____

Title: _____

Address: 4350 South Monaco Street
Denver, CO 80237

El Paso County:

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

_____ _____

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

Conditions:

Table of Contents

Purpose 1
General Site Description 1
General Location 1
Description of Property 1
Floodplain statement 2
Existing Drainage Conditions 2
Major Basin Descriptions 2
Existing Sub-basin Drainage 2
Proposed Drainage Conditions 3
Proposed Sub-basin Drainage 3
Drainage Design Criteria 7
Development Criteria Reference 7
Hydrologic Criteria 7
Hydraulic Criteria 7
Drainage Facility Design 8
Four Step Process to Minimize Adverse Impacts of Urbanization 8
Water Quality 8
Erosion Control Plan 9
Operation & Maintenance 9
Drainage and Bridge Fees 10
Summary 10
References 11

APPENDIX

Appendix A – Vicinity Map, Soil Descriptions, FEMA Floodplain Map
Appendix B – Hydrologic Calculations
Appendix C – Hydraulic Calculations
Appendix D – Water Quality & Detention
Appendix E – Reference Material
Appendix F – Drainage Maps

PURPOSE

This document is the Preliminary Drainage Report for Feathergrass Urban Duplexes. The purpose of this report is to identify on-site and off-site drainage patterns, storm sewer, culvert and inlet locations, areas tributary to the site, and to safely route developed storm water to adequate outfall facilities.

GENERAL SITE DESCRIPTION

GENERAL LOCATION

Richmond Homes at Feathergrass (hereby referred to as the "site") is a proposed development on four un-platted parcels with a total area of 10.83 acres. The site is located in the northeast quarter of Section 5, Township 14 South, Range 65 West of the Sixth Principal Meridian in the County of El Paso, State of Colorado. The site is located immediately south of Constitution Avenue on the west and east side of Hannah Ridge Drive. The site is bounded by Constitution Avenue to the north, an unplatted vacant commercial parcel to the east, Jessica Heights Filing No. 1 to the south, and the Cherokee Park Townhomes to the west. The parcels are planned to be platted after approval of the Development Plan. Refer to the vicinity map in Appendix A.

DESCRIPTION OF PROPERTY

A 100-unit residential development is proposed on the four project parcels (totaling 10.83 acres) per the corresponding preliminary Development Plan this drainage report supports. Two parcels are on the east side of Hannah Ridge Drive, and two are on the west side. The existing parcels are undeveloped other than a sanitary sewer easement that follows the eastern border of the two parcels on the east side of Hannah Ridge Drive. The site is comprised of variable sloping grasslands that generally slope east at approximately 3% on the east side of Hannah Ridge Drive. On the west side of Hannah Ridge Drive the land slopes at about 1% to the east, draining into the curb and gutter in Hannah Ridge Drive.

Soil characteristics are comprised of Blakeland loamy sand. NRCS rates this soil designation as Hydrologic Group A. Group A soils exhibit a high infiltration rate when thoroughly wet and consist chiefly of deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a high rate of water transmission. Refer to the soil survey mapping in Appendix A.

There are no major drainageways on the site, although a tributary to the East Fork Sand Creek is immediately to the east of the site.

There are no known irrigation facilities located on the project site. A 12" PVC sanitary sewer runs along the eastern side of the site within an easement.

FLOODPLAIN STATEMENT

Based on the FEMA Firm Map Number 08041C0752G, revised December 7, 2018, the entire development is located within Zone X, or areas area outside the Special Flood Hazard Area (SFHA) and higher than the elevation of the 0.2-percent-annual-chance (or 500-year) flood. The FEMA map containing the site has been presented in Appendix A.

EXISTING DRAINAGE CONDITIONS

MAJOR BASIN DESCRIPTIONS

The site lies within the Sand Creek Drainage Basin based on the "Sand Creek Drainage Basin Planning Study" completed by Kiowa Engineering Corporation in January 1993. The Sand Creek Drainage Basin covers approximately 54 square miles and is divided into five major sub-basins: Sand Creek Mainstem, East Fork Sand Creek, Central Tributary to East Fork, West Fork, and East Fork Subtributary. The site is within the East Fork Sand Creek sub-basin, as shown in Appendix E. The Sand Creek Basin discharges into Fountain Creek approximately 1.5 miles upstream of Academy Boulevard Bridge over Fountain Creek.

As development occurred within the basin, the site was analyzed with the "Jessica Heights Filing No. 1 Final Drainage Report" completed by M.V.E. Inc. in April 2005. The portion of the site west of Hannah Ridge Drive was identified as Basin C1 and the portion of the site east of Hannah Ridge Drive was identified as Basin A2. Basin C1 contributes existing flows of Q_5 = 2.8 cfs and Q_{100} = 6.8 cfs. Basin A2 contributes existing flows of Q_5 = 3.2 cfs and Q_{100} = 7.6 cfs. Runoff from both basins flows east. Basin C1 is captured in Hannah Ridge Drive curb and gutter and is conveyed to Constitution Avenue, while Basin A2 sheet flows off site to the adjacent parcel to the east.

Most recently, the site was analyzed within the "Hannah Ridge at Feathergrass Master Drainage Development Plan" completed by M.V.E. Inc in November 2007. The site was identified as Basin OSA14 with existing flows of Q_5=14 and Q_{100}=27 cfs flowing easterly to Tributary to Sand Creek – East Fork Reach No. 6.

As previously stated, there are no known irrigation facilities within the site that would impact drainage. An existing 12" PVC sanitary sewer runs along the eastern boundary of the site and is contained within a dedicated easement.

EXISTING SUB-BASIN DRAINAGE

The site is bisected by Hannah Ridge Drive, dividing the site into east and west parcels. The east side drains directly into a tributary to the East Fork Sand Creek (Tributary to Sand Creek – East Fork

Reach No. 6). Runoff from the west site sheet flows across the site and is collected in Hannah Ridge Drive curb and gutter and is conveyed north to Constitution Avenue. The west site is comprised of existing Basin EX-W, and the east site is comprised of EX-E. These existing basins correspond to basins C1 and A2, respectively, in the "Jessica Heights Filing No. 1 Final Drainage Report" created by M.V.E., Inc. in April, 2005.

Existing Basin EX-W is approximately 5.59 acres and was modeled in its existing condition. The basin consists of prairie grasses. Flow from this basin sheet flows to the curb and gutter in Hannah Ridge Drive. The flow then is conveyed to the curb and gutter along the south side of Constitution Avenue, where it is conveyed to an inlet and discharges into a tributary to the East Fork Sand Creek. Flows from Basin EX-W were found to be as follows: Q5 = 1.0 cfs, Q100 = 7.4 cfs.

Existing Basin EX-E is approximately 5.25 acres and was modeled in its existing condition. The basin consists of prairie grasses. Flow from this basin sheet flows to the east and enters a tributary to the East Fork Sand Creek. Flows from Basin EX-E were found to be as follows: Q5 = 1.3 cfs, Q100 = 9.6 cfs.

PROPOSED DRAINAGE CONDITIONS

PROPOSED SUB-BASIN DRAINAGE

The proposed site was broken into two major basins: Basin A (west parcels) and Basin B (east parcels). The proposed basin (and sub-basin) delineation is shown on the drainage basin map and is described as follows;

Basin A1 consists of approximately 0.97 acres and includes walks, drives, roofs and landscape areas. Flow from this basin (Q_5=1.9 cfs and Q_{1oo}=4.2 cfs) will be collected and conveyed in a 3.0' concrete pan, that follows the centerline of Road #4, to Design Point #1 (DP1). At DP1, flow enters Type A curb and gutter and is conveyed to an on-grade Double Denver Type 16 Combination Inlet (Double Type 16) at DP3, where it combines with Basin A2 flow. Discussion of DP3 captured flow versus flow-by is presented in the Basin A2 description.

Basin A2 consists of approximately 0.17 acres and includes walks, drives, and landscape areas. Flow from this basin (Q_5=0.6 cfs and Q_{1oo}=1.2 cfs) will be collected and conveyed in Type A curb and gutter in Road #1 to an on-grade Double Type 16 at DP3. Total flows at DP3 are Q_5=2.2 cfs and Q_{1oo}=4.8 cfs. In the 5-year event, 1.8 cfs is captured, and 3.1 cfs is captured in the 100-year event. DP3 flow-by of Q_5=0.4 cfs and Q_{1oo}=1.7 cfs continues in curb and gutter to DP5 where it combines with Basin A5 flow. DP3 captured flows are piped in 18" RCP to DP8.1 before discharging into the pond at DP10.

Basin A3 consists of approximately 0.08 acres and includes walks, drives, and landscape areas. Flow from this basin (Q_5=0.2 cfs and Q_{100}=0.5 cfs) will be collected and conveyed in Type A curb and gutter in Road #1 to an on-grade Double Type 16 at DP4, where it combines with Basin A4 flow. Total flows at DP4 are Q_5=2.0 cfs and Q_{100}=4.0 cfs. In the 5-year event, 1.7 cfs is captured and 2.8 cfs is captured in the 100-year event. DP4 flow-by of Q_5=0.3 cfs and Q_{100}=1.2 cfs continues in curb and gutter to DP6 where it combines with Basin A7 flow. DP4 captured flows are piped in 18" RCP to DP4.1, where it combines with flow from DP3 and ultimately discharges into the pond at DP10.

Basin A4 consists of approximately 0.79 acres and includes walks, drives, roofs and landscape areas. Flow from this basin (Q_5=1.8 cfs and Q_{100}=3.8 cfs) will be collected and conveyed in a 3.0' concrete pan that follows the centerline of Road #6, to DP2. At DP2, flow enters Type A curb and gutter and is conveyed to an on-grade Double Type 16 at DP4, where it combines with Basin A3 flow. Discussion of DP4 captured flow versus flow-by is presented in the Basin A3 description.

Basin A5 consists of approximately 0.87 acres and includes walks, drives, roofs and landscape areas. Flow from this basin (Q_5=1.5 cfs and Q_{100}=3.4 cfs) will be collected and conveyed in a 3.0' concrete pan that follows the centerline of Road #3, to DP5. At DP5, flow enters Type A curb and gutter and combines with DP3 flow-by. The combined flow is conveyed to a sump Double Type 16 at DP8, where it combines with Basin A6 and DP7 flow. Discussion of DP8 captured flow is presented in the Basin A6 description.

Basin A6 consists of approximately 0.26 acres and includes walks, drives, and landscape areas. Flow from this basin (Q_5=0.9 cfs and Q_{100}=1.6 cfs) will be collected and conveyed in Type A curb and gutter in Road #1 to a sump Denver Double Type 16 at DP8. The total combined flow at DP8 from DP5, DP7 and Basin A6 is Q_5=3.7 cfs and Q_{100}=9.2 cfs. All flow at DP8 is captured and piped in a 30" RCP to DP9.1, and discharges into the pond at DP10.

Basin A7 consists of approximately 0.47 acres and includes walks, drives, roofs and landscape areas. Flow from this basin (Q_5=1.1 cfs and Q_{100}=2.2 cfs) will be collected and conveyed in a 3.0' concrete pan that follows the centerline of Road #5, to DP6. At DP6, flow enters Type A curb and gutter and combines with DP4 flow-by. The combined flow is conveyed to a sump Double Type 16 at DP9, where it combines with Basin A9 flow. Discussion of DP9 captured flow is presented in the Basin A9 description.

Basin A8 consists of approximately 0.79 acres and includes walks, drives, roofs and landscape areas. Flow from this basin (Q_5=1.3 cfs and Q_{100}=3.0 cfs) will be collected and conveyed in a 3.0' concrete pan that follows the centerline of Road #2, to DP7. At DP7, flow enters Type A curb and gutter and is conveyed to a sump Denver Double Type 16 at DP8 where it combines with DP5 and Basin A6 flows. Discussion of DP8 captured flow is presented in the Basin A6 description.

Basin A9 consists of approximately 0.64 acres and includes walks, drives, roofs and landscape areas. Flow from this basin (Q_5=1.9 cfs and Q_{100}=3.9 cfs) will be collected and conveyed in Type A curb and gutter in Road #1 to a sump Denver Double Type 16 at DP9. The total combined flow at DP9 from DP6 and Basin A9 is Q_5=2.6 cfs and Q_{100}=6.2 cfs. All flow at DP9 is captured and piped in 30" RCP to DP10.

Basin A10 consists of approximately 0.52 acres of landscaped areas and contains Full Spectrum Water Quality and Detention Pond A. Flow from this basin (Q_5=0.2 cfs and Q_{100}=1.4 cfs) sheet flows directly into Pond A where it combines with flow from Basins A1-A9. A detailed discussion of Full Spectrum Water Quality and Detention Pond A is presented in the Water Quality section later in this report.

Basin B1 consists of approximately 0.75 acres and includes walks, drives, roofs and landscape areas. Flow from this basin (Q_5=1.3 cfs and Q_{100}=3.0 cfs) will be collected and conveyed in a 3.0' concrete pan that follows the centerline of Road #8, to DP15. At DP15, flow enters Type A curb and gutter and is conveyed to an on-grade Double Denver Type 16 Combination Inlet (Double Type 16) at DP17, where it combines with Basin B2 flow. Discussion of DP17 captured flow versus flow-by is presented in the Basin B2 description.

Basin B2 consists of approximately 0.08 acres and includes walks and drives. Flow from this basin (Q_5=0.4 cfs and Q_{100}=0.7 cfs) will be collected and conveyed in Type A curb and gutter in Road #7 to an on-grade Double Type 16 at DP17. Total flows at DP17 from DP15 and Basin B2 are Q_5=1.5 cfs and Q_{100}=3.4 cfs. In the 5-year event, 1.3 cfs is captured and 2.3 cfs is captured in the 100-year event. DP17 flow-by of Q_5=0.2 cfs and Q_{100}=1.1 cfs continues in curb and gutter to DP19 where it combines with Basin B5 flow. DP17 captured flows are piped in 18" RCP to DP18.1, where it combines with flow from DP18, before discharging into the pond at DP24.

Basin B3 consists of approximately 0.11 acres and includes walks, drives, and landscape areas. Flow from this basin (Q_5=0.5 cfs and Q_{100}=0.9 cfs) will be collected and conveyed in Type A curb and gutter in Road #7 to an on-grade Double Type 16 at DP18, where it combines with DP16 flow. Total flows at DP18 from DP16 and Basin B3 are Q_5=2.4 cfs and Q_{100}=4.9 cfs. In the 5-year event, 1.8 cfs is captured and 2.9 cfs is captured in the 100-year event. DP18 flow-by of Q_5=0.6 cfs and Q_{100}=2.0 cfs continues in curb and gutter to DP20 where it combines with Basin B8 flow. DP18 captured flows are piped in 18" RCP to DP18.1 before discharging into the pond at DP24.

Basin B4 consists of approximately 0.95 acres and includes walks, drives, roofs and landscape areas. Flow from this basin (Q_5=2.1 cfs and Q_{100}=4.4 cfs) will be collected and conveyed in a 3.0' concrete pan that follows the centerline of Road #7, to DP16. At DP16, flow enters Type A curb and gutter and is conveyed to an on-grade Double Type 16 at DP18, where it combines with Basin B3 flow. Discussion of DP18 captured flow versus flow-by is presented in the Basin B3 description.

Basin B5 consists of approximately 0.71 acres and includes walks, drives, roofs and landscape areas. Flow from this basin (Q_5=1.3 cfs and Q_{1oo}=2.9 cfs) will be collected and conveyed in a 3.0' concrete pan that follows the centerline of Road #9, to an on-grade Denver Type 16 at DP19, where it combines with DP17 flow-by. Total flows at DP19 from Basin B5 and DP17 flow-by are Q_5=1.6 cfs and Q_{1oo}=4.1 cfs. In the 5-year event, 1.1 cfs is captured and 2.0 cfs is captured in the 100-year event. DP19 flow-by of Q_5=0.5 cfs and Q_{1oo}=2.1 cfs continues in curb and gutter to DP23 where it combines with Basin B6 flow. DP19 captured flow is conveyed to DP19 and piped in 18" RCP to DP 23.1 before discharging into the pond at DP24.

Basin B6 consists of approximately 0.09 acres and includes walks, drives and landscape areas. Flow from this basin (Q_5=0.4 cfs and Q_{1oo}=0.7 cfs) will be collected and conveyed in Type A curb and gutter in Road #7 to a sump Denver Triple Type 16 at DP23. The total combined flow at DP23 from Basin B6 and DP19 flow-by is Q_5=0.7 cfs and Q_{1oo}=2.6 cfs. All flow at DP23 is captured and piped in 30" RCP to DP23.1 before discharging into the pond at DP24.

Basin B7 consists of approximately 0.13 acres and includes walks, drives, and landscape areas. Flow from this basin (Q_5=0.5 cfs and Q_{1oo}=1.0 cfs) will be collected and conveyed in Type A curb and gutter in Road #7 to a sump Denver Double Type 16 at DP22. The total combined flow at DP22 from Basin B7, DP20, and DP21 flow-by is Q_5=3.0 cfs and Q_{1oo}=7.5 cfs. All flow at DP22 is captured and piped to DP22.1 where it combines with flows from DP21 before discharging into the pond at DP24.

Basin B8 consists of approximately 0.85 acres and includes walks, drives, roofs and landscape areas. Flow from this basin (Q_5=1.9 cfs and Q_{1oo}=4.0 cfs) will be collected and conveyed in a 3.0' concrete pan, that follows the centerline of Road #10, to DP20. At DP20, flow enters Type A curb and gutter and combines with DP18 flow-by for a total flow of Q_5=2.3 cfs and Q_{1oo}=5.7 cfs. The combined flow is conveyed to a sump Denver Double Type 16 at DP22, where it combines with Basin B7 and DP21 flow-by flow. Discussion of DP22 captured flow is presented in the Basin B7 description.

Basin B9 consists of approximately 0.67 acres and includes walks, drives, roofs and landscape areas. Flow from this basin (Q_5=1.7 cfs and Q_{1oo}=3.6 cfs) will be collected and conveyed in Type A curb and gutter in Road #11, to DP21. At DP21, flow is captured in a Denver Double Type 16 (Q_5=1.5 cfs and Q_{1oo}=2.6 cfs). DP21 flow-by (Q_5=0.2 cfs and Q_{1oo}=1.0 cfs) continues in Type A curb and gutter to DP22 where it combines with Basin B7 and DP20 flow. Discussion of DP22 captured flow is presented in the Basin B7 description.

Basin B10 consists of approximately 0.56 acres of landscaped areas and contains Full Spectrum Water Quality and Detention Pond B. Flow from this basin (Q_5=0.3 cfs and Q_{1oo}=1.6 cfs) sheet flows directly into Pond B where it combined with flow from Basins B1-B9. A detailed discussion of Full Spectrum Water Quality and Detention Pond B is presented in the Water Quality section later in this report.

Basin B11 consists of approximately 0.35 acres of landscaped areas and contains approximately 1,870 square feet of asphalt roadway. Flow from this basin (Q_5=0.4 cfs and Q_{100}=1.3 cfs) follows existing drainage patterns and sheet flows offsite, along the eastern site boundary, eventually flowing directly into "Tributary to Sand Creek – East Fork Reach No. 6".

DRAINAGE DESIGN CRITERIA

DEVELOPMENT CRITERIA REFERENCE

Storm drainage analysis and design criteria for this project were taken from the "*City of Colorado Springs/El Paso County Drainage Criteria Manual*" Volumes 1 and 2 (EPCDCM), dated October 12, 1994, the "*Urban Storm Drainage Criteria Manual*" Volumes 1 to 3 (USDCM) and Chapter 6 and Section 3.2.1 of Chapter 13 of the "*Colorado Springs Drainage Criteria Manual*" (CSDCM), dated May 2014, as adopted by El Paso County.

HYDROLOGIC CRITERIA

All hydrologic data was obtained from the "*El Paso Drainage Criteria Manual*" Volumes 1 and 2, and the "*Urban Drainage and Flood Control District Urban Storm Drainage Criteria Manual*" Volumes 1, 2, and 3. Onsite drainage improvements were designed based on the 5 year (minor) storm event and the 100-year (major) storm event. Runoff was calculated using the Rational Method, and rainfall intensities for the 5-year and the 100-year storm return frequencies were obtained from Table 6-2 of the CSDCM. One hour point rainfall data for the storm events is identified in the chart below. Runoff coefficients were determined based on proposed land use and from data in Table 6-6 from the CSDCM. Time of concentrations were developed using equations from CSDCM. All runoff calculations and applicable charts and graphs are included in the Appendices.

Table 2 - 1-hr Point Rainfall Data

Storm	Rainfall (in.)
5-year	1.50
100-year	2.52

HYDRAULIC CRITERIA

The Rational Method and USDCM's SF-2 and SF-3 forms were used to determine the runoff from the minor and major storms on the site, and the UDFCD UD-Detention v3.07 spreadsheet was utilized for evaluating proposed detention and water quality pond. Sump and on-grade inlets were sized using UDFCD UD-Inlet v2.07. Manning's equation was used to size the proposed pipes in this report and StormCAD will be used to model the proposed storm sewer system and to analyze the proposed HGL calculations for Construction Drawings.

DRAINAGE FACILITY DESIGN

FOUR STEP PROCESS TO MINIMIZE ADVERSE IMPACTS OF URBANIZATION

In accordance with the El Paso County Drainage Criteria Manual Volume 2, this site has implemented the four step process to minimize adverse impacts of urbanization. The four step process includes reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainage ways, and implementing long-term source controls.

Step 1 – Reducing Runoff Volumes: The Feathergrass Urban Duplexes development project consists of 50 duplex structures with open spaces and lawn areas interspersed within the development which helps disconnect impervious areas and reduce runoff volumes. Roof drains from the structures will discharge to lawn areas, where feasible, to allow for infiltration and runoff volume reduction.

Step 2 – Treat the WQCV: Water Quality treatment for this site is provided in two proposed full spectrum water quality detention ponds: Pond A and Pond B. The runoff from this site will be collected within inlets and conveyed to the proposed ponds via storm sewer. Upon entrance to the ponds, flows will be captured in a forebay designed to promote settlement of suspended solids. A trickle channel is also incorporated into the ponds to minimize the amount of standing water. The outlet structure has been designed to detain the water quality capture volume (WQCV) for 40 hours, and the extended urban runoff volume (EURV) for 72 hours. All flows released from the ponds will be reduced to less than historic rates.

Step 3 – Stabilize Drainageways: The site lies within the Sand Creek Drainage Basin. Basin and bridge fees will be paid at time of platting. These funds will be used on future projects within the basin to stabilize drainageways. The site does not discharge directly into the open drainageway of Sand Creek, therefore no downstream stabilization will be accomplished with this project.

Step 4 – Implement Long Term Source Controls: BMP's will be utilized to minimize off-site contaminants and to protect the downstream receiving waters. Site specific temporary source control BMPs that will be implemented include, but are not limited to, silt fencing placed around downstream areas of disturbance, construction vehicle tracking pads at the entrances, designated concrete truck washout basin, designated vehicle fueling areas, covered storage areas, spill containment and control, etc. The permanent erosion control BMP's include asphalt drives and parking, storm inlets and storm pipe, two full spectrum water quality and detention ponds, and permanent vegetation.

WATER QUALITY

The site is split by Hannah Ridge Drive, therefore; a full spectrum water quality and detention pond is provided on both sides. Basin A, located west of Hannah Ridge Drive, will discharge to Pond A,

while the east side of Hannah Ridge Drive, Basin B, will discharge to Pond B. Both ponds have been designed per Section 13.3.2.1 of Resolution 15-042 of the El Paso County Drainage Criteria Manual.

Pond A is designed for a total contributing acreage of 5.56 acres at 52.2% impervious. The total WQCV is 0.098 ac-ft, the excess urban runoff volume (EURV) is 0.240 ac-ft, and the total required detention volume is 0.532 ac-ft. The WQCV is released over 40 hours, the EURV is released over 67 hours, and the 100-year volume is released over 83 hours. The 100-year discharge of 2.1 cfs is equal to 90% of predevelopment rates. A riprap spillway is provided that conveys the full undetained, peak 100-year flow of 21.5 cfs with a 1.0' freeboard. The spillway has a crest length of 20' and a total depth of 1.50'. The pond outfalls into an 18" RCP that flows along the site's southern property line before discharging into the existing double 10 x 6' RCBC located in the adjacent parcel, east of the eastern parcel. A drainage easement will be provided for both the onsite and offsite portions of this pond outfall. The ultimate discharge of the double 10' x 6' RCBC is the "Tributary to Sand Creek – East Fork Reach No. 6". A drainage map including Pond A and it's outfall has been presented in Appendix F.

Pond B is designed for a total contributing acreage of 4.90 acres at 53.7% impervious. The total WQCV is 0.088 ac-ft, the excess urban runoff volume (EURV) is 0.221 ac-ft and the total required detention volume is 0.483 ac-ft. The WQCV is released over 40 hours, the EURV is released over 71 hours and the 100-year volume is released over 88 hours. The 100-year discharge of 2.2 cfs is equal to 90% of predevelopment rates. A riprap spillway is provided that conveys the full undetained, peak 100-year flow of 20.0 cfs with a 1.0' freeboard. The spillway has a crest length of 20' and a total depth of 1.50'. The pond outfalls into an 18" RCP that flows easterly before discharging into the existing double 10 x 6' RCBC located in the adjacent parcel to the east. A drainage easement will be provided for both the onsite and offsite portions of this pond outfall. The ultimate discharge of the double 10' x 6' RCBC is the" Tributary to Sand Creek – East Fork Reach No. 6". A drainage map including Pond B and it's outfall has been presented in Appendix F.

EROSION CONTROL PLAN

We respectfully request that the Erosion Control Plan and Cost Estimate be submitted in conjunction with the grading and erosion control plan and construction assurances posted prior to obtaining a grading permit.

OPERATION & MAINTENANCE

In order to ensure the function and effectiveness of the stormwater infrastructure, maintenance activities such as inspection, routine maintenance, restorative maintenance, rehabilitation and repair, are required. The property owner shall be responsible for the inspection, maintenance, rehabilitation and repair of stormwater and erosion control facilities located on the property unless another party accepts such responsibility in writing and responsibility is properly assigned through legal documentation. Access is provided from onsite facilities and easements for proposed infrastructure

located offsite. We respectfully request that the Operation & Maintenance Manual be submitted in conjunction with the construction documents, prior to obtaining a grading permit.

DRAINAGE AND BRIDGE FEES

The site lies within the Sand Creek Drainage Basin. Anticipated drainage and bridge fees are presented below and will be paid at time of platting:

2019 DRAINAGE AND BRIDGE FEES - FEATHERGRASS URBAN DUPLEXES				
Impervious Acres (ac)	Drainage Fee (Per Imp. Acre)	Bridge Fee (Per Imp. Acre	Feathergrass Drainage Fee	Feathergrass Bridge Fee
5.58	$18,940	$5,559	$105,685	$31,019

SUMMARY

The proposed Feathergrass Urban Duplexes development drainage improvements, including storm sewer and two full spectrum water quality and detention ponds were designed to meet or exceed the El Paso County Drainage Criteria. The proposed development will not adversely affect the offsite drainageways or surrounding development. This report is in conformance and meets the latest El Paso County Storm Drainage Criteria requirements for this site.

REFERENCES

1. City of Colorado Springs Drainage Criteria Manual (Volumes I & II), City of Colorado Springs, Colorado, Updated May, 2014.

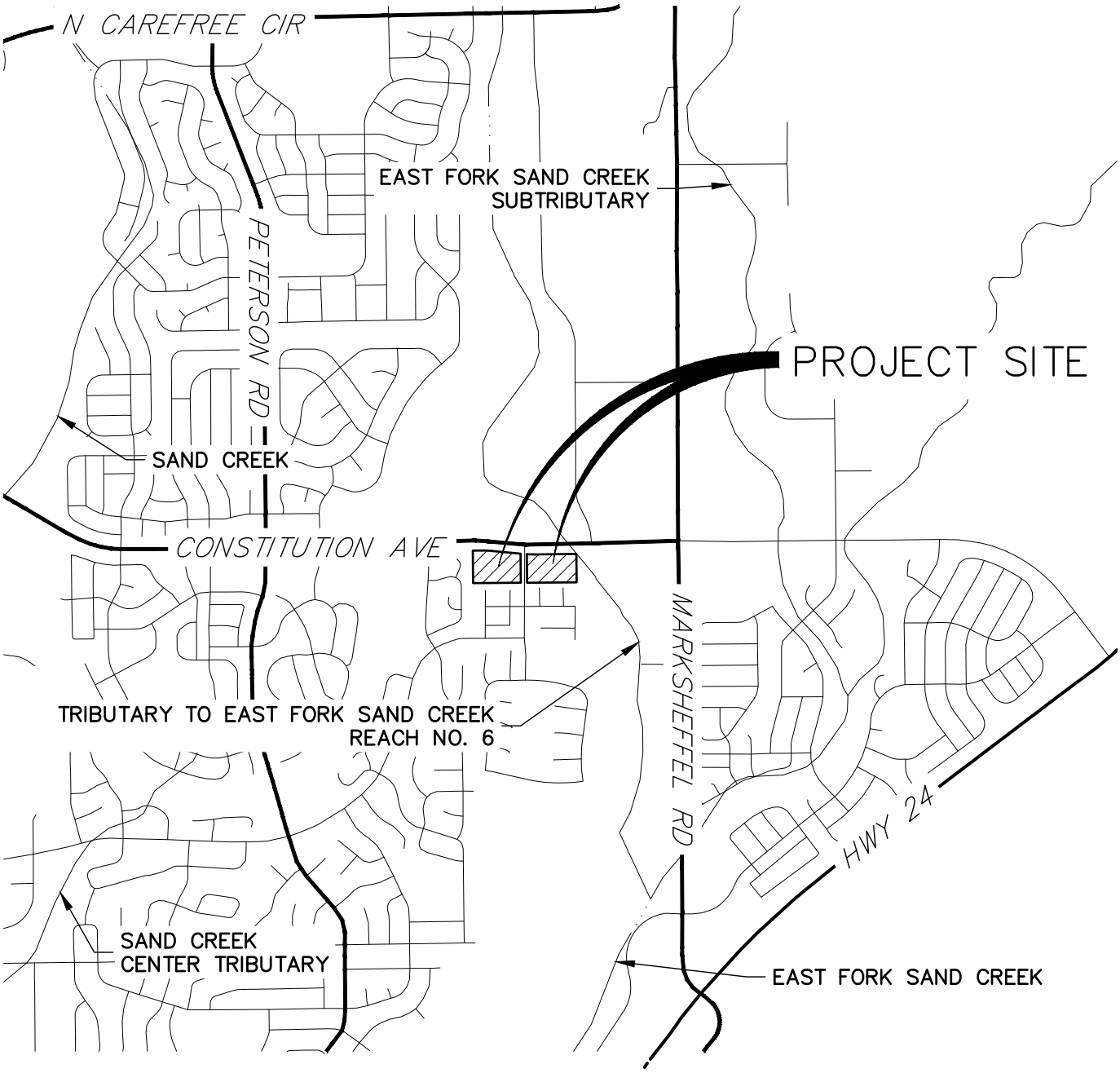
2. Urban Storm Drainage Criteria Manual (Volumes 1, 2, and 3), Urban Drainage and Flood Control District, June 2001.

3. Sand Creek Drainage Basin Planning Study, prepared Kiowa Engineering Corporation, January, 1993.

4. Jessica Heights Filing No. 1 Final Drainage Report, prepared by M.V.E., Inc, April, 2005.

5. Hannah Ridge at Feathergrass Master Drainage Development Plan, prepared by M.V.E., Inc., November 15, 2007.

Appendix A
Vicinity Map, Soil Descriptions, FEMA Floodplain Map



N

2000 1000 0 2000

ORIGINAL SCALE: 1" = 2000'

APPENDIX A: VICINITY MAP
RICHMOND HOMES AT
FEATHERGRASS
JOB NO. 25149.01
10/11/19
SHEET 1 OF 1

J·R ENGINEERING
A Westrian Company

Centennial 303-740-9393 • Colorado Springs 719-593-2593
Fort Collins 970-491-9888 • www.jrengineering.com

X:\2510000.all\2514901\Drawings\Blocks\2514901_VicinityMap.dwg, Drainage, 10/11/2019 11:40:00 AM, CS

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.

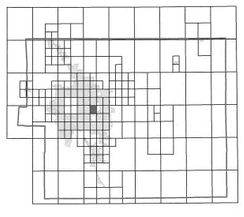
Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this 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

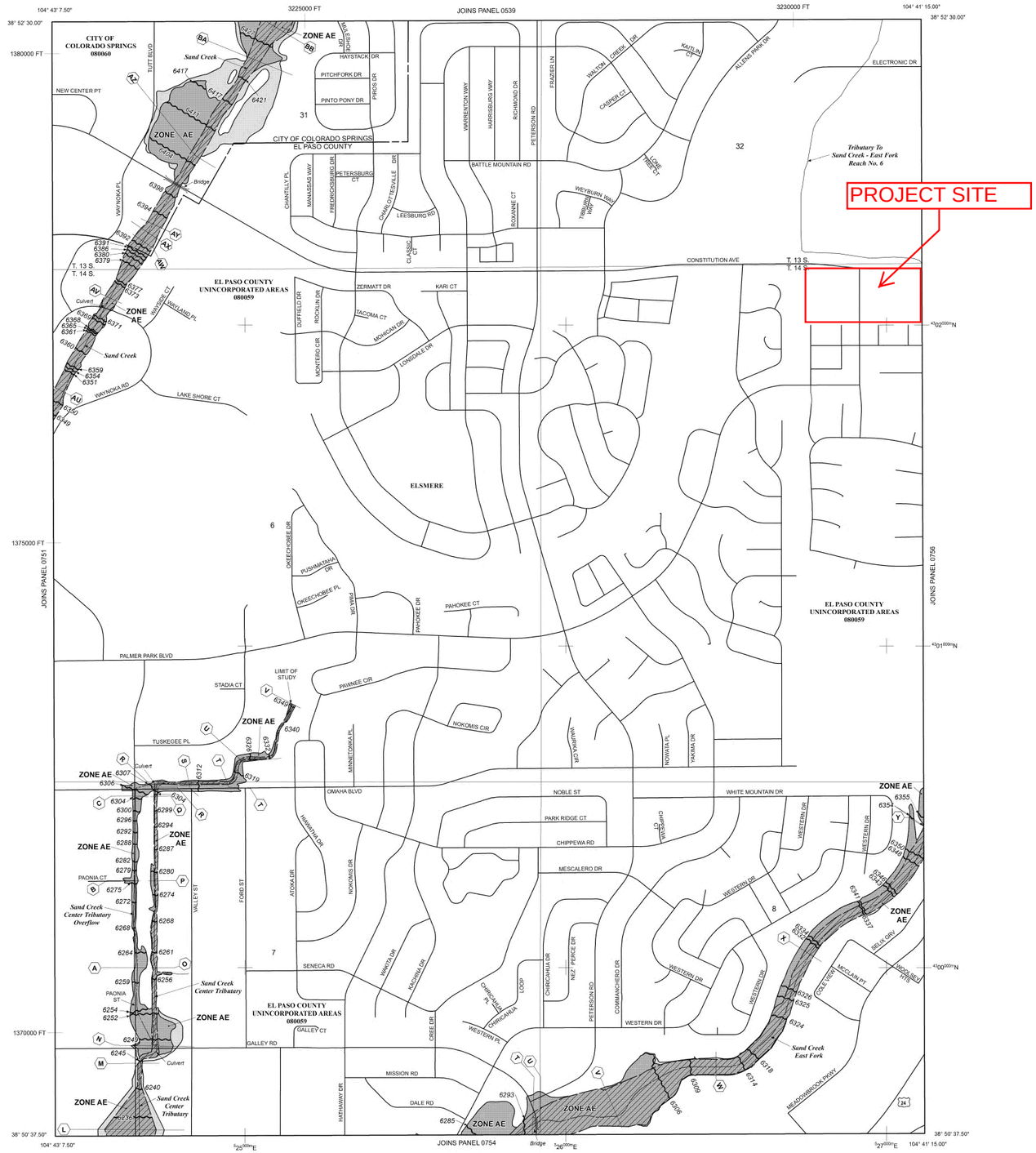
Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

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 13 SOUTH, RANGE 65 WEST, AND TOWNSHIP 14 SOUTH, RANGE 65 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 (EL 987)	Base Flood Elevation line and value; elevation in feet*
	Base Flood Elevation value where uniform within zone; elevation in feet*

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

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

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

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

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

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

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

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0752G

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 752 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0752	G
EL PASO COUNTY	080059	0752	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
08041C0752G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

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.

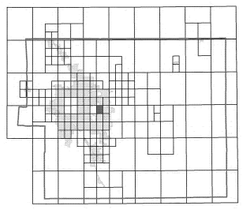
Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this 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

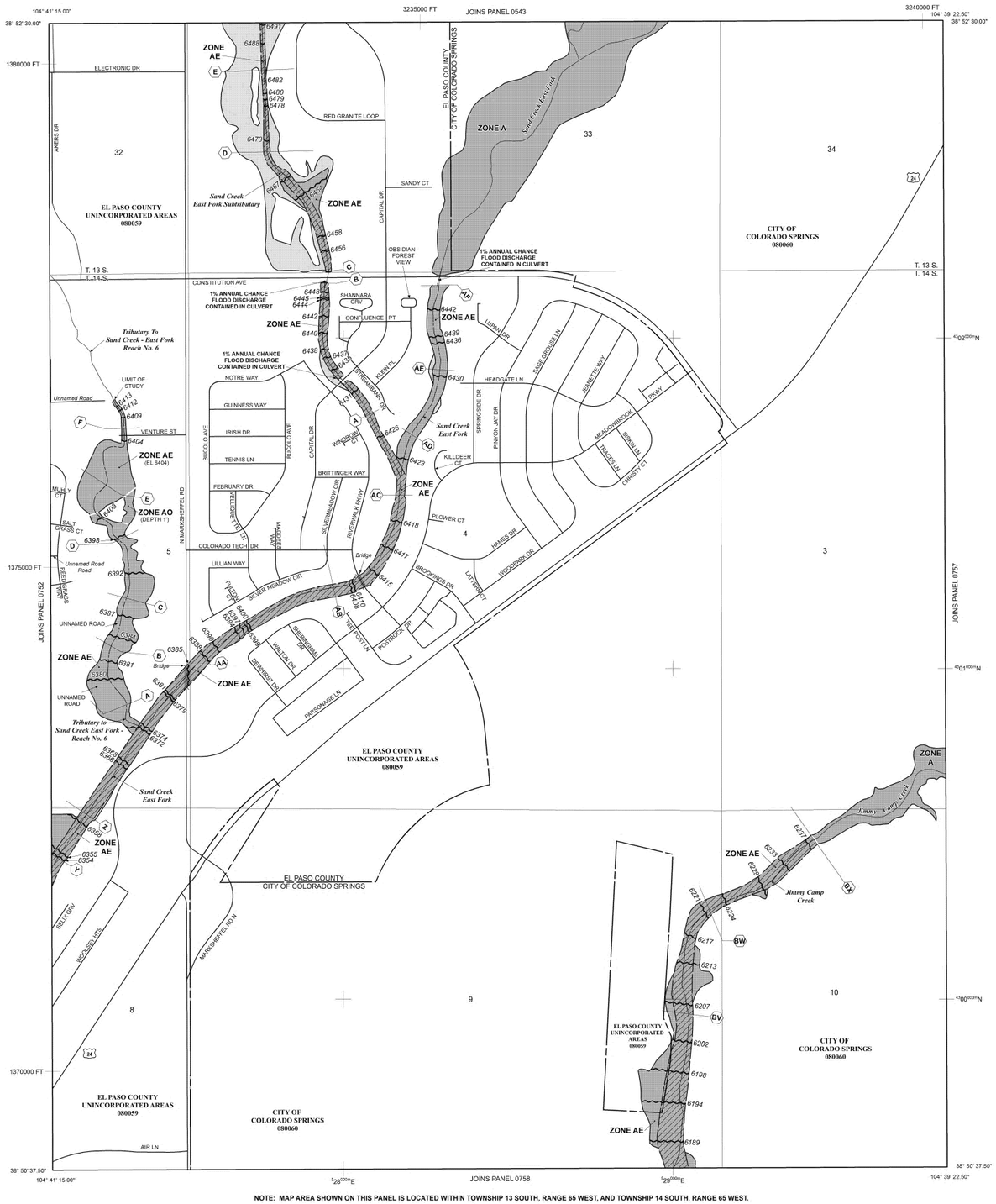
Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

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 13 SOUTH, RANGE 65 WEST, AND TOWNSHIP 14 SOUTH, RANGE 65 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)
$^{4}275^{000m}$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 0756G

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 756 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0756	G
EL PASO COUNTY	080059	0756	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
08041C0756G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

104° 41' 33" W
104° 41' 13" W
38° 52' 7" N
38° 51' 57" N
526690
526740
526790
526840
526890
526940
526990
527040
527090
527140
4302260
4302210
4302160
4302110
4302060
4302010
4301960
Constitution
Constitution Ave
8
Soil Map may not be valid at this scale.
Map Scale: 1:2,200 if printed on A landscape (11" x 8.5") sheet.
N
Meters
0
30
60
120
180
Feet
0
100
200
400
600
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 17, Sep 13, 2019

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

Date(s) aerial images were photographed: Apr 15, 2011—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	11.3	100.0%
Totals for Area of Interest			**11.3**	**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

Appendix B
Hydrologic Calculations

FEATHERGRASS URBAN DUPLEXES - EXISTING
DRAINAGE SUMMARY

BASIN SUMMARY TABLE

Tributary Sub-basin	Area (acres)	Percent Impervious	C_5	C_{100}	t_c (min)	Q_5 (cfs)	Q_{100} (cfs)
EX-W	5.59	0%	0.08	0.35	34.7	1.0	7.4
EX-E	5.25	0%	0.08	0.35	19.6	1.3	9.6

DESIGN POINT SUMMARY TABLE

DP	Q5	Q100
1	1.0	7.4
2	1.3	9.6

COMPOSITE % IMPERVIOUS & COMPOSITE RUNOFF COEFFICIENT CALCULATIONS

Subdivision: Richmond Homes at Feathergrass
Location: Colorado Springs

Project Name: Richmond Homes at Feathergrass
Project No.: 2000-5149.01
Calculated By: RPD
Checked By:
Date: 10/11/19

Basin ID	Total Area (ac)	Hardscape (100% Impervious)				Roofs (90% Impervious)				Gravel (80% Impervious)				Lawns (0% Impervious)				Basins Total Weighted C		Basins Total Weighted % Imp.
		C_5	C_{100}	Area (ac)	Weighted % Imp.	C_5	C_{100}	Area (ac)	Weighted % Imp.	C_5	C_{100}	Area (ac)	Weighted % Imp.	C_5	C_{100}	Area (ac)	Weighted % Imp.	C_5	C_{100}	
EX-W	5.59	0.90	0.96	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.08	0.35	5.59	0.0%	0.08	0.35	0.0%
EX-E	5.25	0.90	0.96	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.08	0.35	5.25	0.0%	0.08	0.35	0.0%
TOTAL	10.84																			0.0%

STANDARD FORM SF-2
TIME OF CONCENTRATION

Subdivision: Richmond Homes at Feathergrass
Location: Colorado Springs

Project Name: Richmond Homes at Feathergrass
Project No.: 2000-5149.01
Calculated By: RPD
Checked By:
Date: 10/11/19

SUB-BASIN DATA						INITIAL/OVERLAND (T_i)			TRAVEL TIME (T_t)					*tc* CHECK (URBANIZED BASINS)			FINAL
BASIN ID	D.A. (ac)	Hydrologic Soils Group	Impervious (%)	C_5	C_{100}	L (ft)	S_o (%)	t_i (min)	L_t (ft)	S_t (%)	K	VEL. (ft/s)	t_t (min)	COMP. t_c (min)	TOTAL LENGTH (ft)	Urbanized t_c (min)	t_c (min)
EX-W	5.59	A	0%	0.08	0.35	50	1.0%	13.0	650	1.0%	5.0	0.5	21.7	34.7	700.0	38.0	34.7
EX-E	5.25	A	0%	0.08	0.35	50	3.0%	9.1	550	3.0%	5.0	0.9	10.6	19.6	600.0	31.9	19.6

NOTES:

$$t_c = t_i + t_t$$ Equation 6-2

Where:

t_c = computed time of concentration (minutes)

t_i = overland (initial) flow time (minutes)

t_t = channelized flow time (minutes).

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_o^{0.33}}$$ Equation 6-3

Where:

t_i = overland (initial) flow time (minutes)
C_5 = runoff coefficient for 5-year frequency (from Table 6-4)
L_i = length of overland flow (ft)
S_o = average slope along the overland flow path (ft/ft).

$$t_t = \frac{L_t}{60K\sqrt{S_o}} = \frac{L_t}{60V_t}$$ Equation 6-4

Where:

t_t = channelized flow time (travel time, min)
L_t = waterway length (ft)
S_o = waterway slope (ft/ft)
V_t = travel time velocity (ft/sec) = $K\sqrt{S_o}$
K = NRCS conveyance factor (see Table 6-2).

$$t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$$ Equation 6-5

Where:

t_c = minimum time of concentration for first design point when less than t_c from Equation 6-1.
L_t = length of channelized flow path (ft)
i = imperviousness (expressed as a decimal)
S_t = slope of the channelized flow path (ft/ft).

Table 6-2. NRCS Conveyance factors, K

Type of Land Surface	Conveyance Factor, K
Heavy meadow	2.5
Tillage/field	5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

Use a minimum t_c value of 5 minutes for urbanized areas and a minimum t_c value of 10 minutes for areas that are not considered urban. Use minimum values even when calculations result in a lesser time of concentration.

STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Richmond Homes at Feathergrass
Location: Colorado Springs
Design Storm: 100-Year

Project Name: Richmond Homes at Feathergrass
Project No.: 2000-5149.
Calculated By: RPD
Checked By:
Date: 10/11/19

Description	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (ac)	Runoff Coeff.	t_c (min)	C*A (ac)	I (in/hr)	Q (cfs)	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Q_{street} (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
	1	EX-W	5.59	0.35	34.7	1.96	3.80	7.4															Surface flow from Basin EX-W to DP-1 (Hannah Ridge Drive curb and gutter).
	2	EX-E	5.25	0.35	19.6	1.84	5.23	9.6															Surface flow from Basin EX-E to DP-2 (adjacent property, then overland into a tributary to East Fork Sand Creek).

STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Richmond Homes at Feathergrass
Location: Colorado Springs
Design Storm: 5-Year

Project Name: Richmond Homes at Feathergrass
Project No.: 2000-5149.
Calculated By: RPD
Checked By:
Date: 10/11/19

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			
		Basin ID	Area (Ac)	Runoff Coeff.	t_c (min)	C*A (Ac)	I (in/hr)	Q (cfs)	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Q_{street} (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	REMARKS
	1	EX-W	5.59	0.08	34.7	0.45	2.26	1.0															Surface flow from Basin EX-W to DP-1 (Hannah Ridge Drive curb and gutter).
	2	EX-E	5.25	0.08	19.6	0.42	3.12	1.3															Surface flow from Basin EX-E to DP-2 (adjacent property, then overland into a tributary to East Fork Sand Creek).

FEATHERGRASS URBAN DUPLEXES -
DRAINAGE SUMMARY

BASIN 'A' SUMMARY TABLE							
Tributary	Area	Percent			t_c	Q_5	Q_{100}
Sub-basin	(acres)	Impervious	C_5	C_{100}	(min)	(cfs)	(cfs)
A1	0.97	55%	0.50	0.65	11.2	1.9	4.2
A2	0.17	71%	0.66	0.78	5.0	0.6	1.2
A3	0.08	63%	0.59	0.73	5.0	0.2	0.5
A4	0.79	63%	0.56	0.70	10.0	1.8	3.8
A5	0.87	49%	0.45	0.62	12.9	1.5	3.4
A6	0.26	83%	0.74	0.84	7.9	0.9	1.6
A7	0.47	63%	0.56	0.70	10.9	1.1	2.2
A8	0.79	45%	0.43	0.60	13.0	1.3	3.0
A9	0.64	64%	0.59	0.73	5.5	1.9	3.9
A10	0.52	0%	0.08	0.35	6.8	0.2	1.4

DESIGN POINT SUMMARY TABLE		
Design Point	Q_5 (cfs)	Q_{100} (cfs)
1	1.9	4.2
2	1.9	3.8
3	2.2	4.8
4	2.0	4.0
4.1	3.4	5.8
5	1.9	5.1
6	0.3	3.3
7	1.3	3.0
8	3.7	9.2
8.1	7.0	14.7
9	2.6	6.2
9.1	9.5	2.4
10	9.6	21.5

BASIN 'B' SUMMARY TABLE							
Tributary	Area	Percent			t_c	Q_5	Q_{100}
Sub-basin	(acres)	Impervious	C_5	C_{100}	(min)	(cfs)	(cfs)
B1	0.75	49%	0.46	0.62	12.3	1.3	3.0
B2	0.08	100%	0.90	0.96	5.0	0.4	0.7
B3	0.11	100%	0.83	0.90	5.0	0.5	0.9
B4	0.95	63%	0.57	0.71	11.6	2.1	4.4
B5	0.71	52%	0.48	0.64	11.7	1.3	3.0
B6	0.09	89%	0.81	0.89	5.0	0.4	0.7
B7	0.13	85%	0.77	0.87	5.0	0.5	1.0
B8	0.85	62%	0.56	0.70	10.9	1.9	4.0
B9	0.67	54%	0.50	0.66	5.9	1.7	3.7
B10	0.56	4%	0.11	0.37	7.4	0.3	1.6
B11	0.35	14%	0.20	0.44	5.0	0.4	1.3

DESIGN POINT SUMMARY TABLE		
Design Point	Q_5 (cfs)	Q_{100} (cfs)
15	1.3	3.0
16	2.1	4.4
17	1.5	3.4
18	2.4	4.9
18.1	3.1	5.2
19	1.6	4.1
20	1.9	5.7
21	1.7	3.6
22	3.0	7.5
22.1	7.1	14.3
23	0.7	2.6
23.1	8.8	18.8
24	9.0	20.0
25	0.4	1.3

COMPOSITE % IMPERVIOUS CALCULATIONS

Subdivision: FEATHERGRASS URBAN DUPLEXES
Location: Colorado Springs

Project Name: FEATHERGRASS URBAN DUPLEXES
Project No.: 2514901
Calculated By: NQJ
Checked By:
Date: 11/11/19

Basin ID	Total Area (ac)	Drives/Walks			Roofs			Lawns			Basins Total Weighted % Imp.
		% Imp.	Area (ac)	Weighted % Imp.	% Imp.	Area (ac)	Weighted % Imp.	% Imp.	Area (ac)	Weighted % Imp.	
A1	0.97	100%	0.25	25.8%	90%	0.31	28.8%	0%	0.41	0.0%	54.5%
A2	0.17	100%	0.12	70.6%	90%	0.00	0.0%	0%	0.05	0.0%	70.6%
A3	0.08	100%	0.05	62.5%	90%	0.00	0.0%	0%	0.03	0.0%	62.5%
A4	0.79	100%	0.22	27.8%	90%	0.31	35.3%	0%	0.26	0.0%	63.2%
A5	0.87	100%	0.19	21.8%	90%	0.26	26.9%	0%	0.42	0.0%	48.7%
A6	0.26	100%	0.17	65.4%	90%	0.05	17.3%	0%	0.04	0.0%	82.7%
A7	0.47	100%	0.15	31.9%	90%	0.16	30.6%	0%	0.16	0.0%	62.6%
A8	0.79	100%	0.17	21.5%	90%	0.21	23.9%	0%	0.41	0.0%	45.4%
A9	0.64	100%	0.32	50.0%	90%	0.10	14.1%	0%	0.22	0.0%	64.1%
A10	0.52	100%	0.00	0.0%	90%	0.00	0.0%	0%	0.52	0.0%	0.0%
B1	0.75	100%	0.17	22.7%	90%	0.22	26.4%	0%	0.36	0.0%	49.1%
B2	0.08	100%	0.08	100.0%	90%	0.00	0.0%	0%	0.00	0.0%	100.0%
B3	0.11	100%	0.10	90.9%	90%	0.00	0.0%	0%	0.01	0.0%	90.9%
B4	0.95	100%	0.33	34.7%	90%	0.30	28.4%	0%	0.32	0.0%	63.2%
B5	0.71	100%	0.18	25.4%	90%	0.21	26.6%	0%	0.32	0.0%	52.0%
B6	0.09	100%	0.08	88.9%	90%	0.00	0.0%	0%	0.01	0.0%	88.9%
B7	0.13	100%	0.11	84.6%	90%	0.00	0.0%	0%	0.02	0.0%	84.6%
B8	0.85	100%	0.24	28.2%	90%	0.32	33.9%	0%	0.29	0.0%	62.1%
B9	0.67	100%	0.22	32.8%	90%	0.16	21.5%	0%	0.29	0.0%	54.3%
B10	0.56	100%	0.02	3.6%	90%	0.00	0.0%	0%	0.54	0.0%	3.6%
B11	0.35	100%	0.05	14.3%	90%	0.00	0.0%	0%	0.30	0.0%	14.3%
SITE TOTAL	10.81									SITE	51.5%
WEST POND	5.56									WEST POND	52.2%
EAST POND	4.90									EAST POND	53.4%

COMPOSITE RUNOFF COEFFICIENT CALCULATIONS

Subdivision: FEATHERGRASS URBAN DUPLEXES
Location: Colorado Springs

Project Name: FEATHERGRASS URBAN DUPLEXES
Project No.: 2514901
Calculated By: NQJ
Checked By:
Date: 11/11/19

Basin ID	Total Area (ac)	Basins Total Weighted % Imp.	Hydrologic Soil Group			Land Use			Minor Coefficients			Major Coefficients			Basins Total Weighted C_5	Basins Total Weighted C_{100}
			Area A (ac)	Area B (ac)	Area C/D (ac)	Area Walks & Drives (ac)	Area Roofs (ac)	Area Lawns (ac)	$C_{5,A,WALKS\ \&\ DRIVES}$	$C_{5,A,ROOFS}$	$C_{5,A,LAWNS}$	$C_{100,A,WALKS\ \&\ DRIVES}$	$C_{100,A,ROOFS}$	$C_{100,A,LAWNS}$		
A1	0.97	55%	0.97	0.00	0.00	0.25	0.31	0.41	0.90	0.73	0.08	0.96	0.81	0.35	0.50	0.65
A2	0.17	71%	0.17	0.00	0.00	0.12	0.00	0.05	0.90	0.73	0.08	0.96	0.81	0.35	0.66	0.78
A3	0.08	63%	0.08	0.00	0.00	0.05	0.00	0.03	0.90	0.73	0.08	0.96	0.81	0.35	0.59	0.73
A4	0.79	63%	0.79	0.00	0.00	0.22	0.31	0.26	0.90	0.73	0.08	0.96	0.81	0.35	0.56	0.70
A5	0.87	49%	0.87	0.00	0.00	0.19	0.26	0.42	0.90	0.73	0.08	0.96	0.81	0.35	0.45	0.62
A6	0.26	83%	0.26	0.00	0.00	0.17	0.05	0.04	0.90	0.73	0.08	0.96	0.81	0.35	0.74	0.84
A7	0.47	63%	0.47	0.00	0.00	0.15	0.16	0.16	0.90	0.73	0.08	0.96	0.81	0.35	0.56	0.70
A8	0.79	45%	0.79	0.00	0.00	0.17	0.21	0.41	0.90	0.73	0.08	0.96	0.81	0.35	0.43	0.60
A9	0.64	64%	0.64	0.00	0.00	0.32	0.10	0.22	0.90	0.73	0.08	0.96	0.81	0.35	0.59	0.73
A10	0.52	0%	0.52	0.00	0.00	0.00	0.00	0.52	0.90	0.73	0.08	0.96	0.81	0.35	0.08	0.35
B1	0.75	49%	0.75	0.00	0.00	0.17	0.22	0.36	0.90	0.73	0.08	0.96	0.81	0.35	0.46	0.62
B2	0.08	100%	0.08	0.00	0.00	0.08	0.00	0.00	0.90	0.73	0.08	0.96	0.81	0.35	0.90	0.96
B3	0.11	91%	0.11	0.00	0.00	0.10	0.00	0.01	0.90	0.73	0.08	0.96	0.81	0.35	0.83	0.90
B4	0.95	63%	0.95	0.00	0.00	0.33	0.30	0.32	0.90	0.73	0.08	0.96	0.81	0.35	0.57	0.71
B5	0.71	52%	0.71	0.00	0.00	0.18	0.21	0.32	0.90	0.73	0.08	0.96	0.81	0.35	0.48	0.64
B6	0.09	89%	0.09	0.00	0.00	0.08	0.00	0.01	0.90	0.73	0.08	0.96	0.81	0.35	0.81	0.89
B7	0.13	85%	0.13	0.00	0.00	0.11	0.00	0.02	0.90	0.73	0.08	0.96	0.81	0.35	0.77	0.87
B8	0.85	62%	0.85	0.00	0.00	0.24	0.32	0.29	0.90	0.73	0.08	0.96	0.81	0.35	0.56	0.70
B9	0.67	54%	0.67	0.00	0.00	0.22	0.16	0.29	0.90	0.73	0.08	0.96	0.81	0.35	0.50	0.66
B10	0.56	4%	0.56	0.00	0.00	0.02	0.00	0.54	0.90	0.73	0.08	0.96	0.81	0.35	0.11	0.37
B11	0.35	14%	0.35	0.00	0.00	0.05	0.00	0.30	0.90	0.73	0.08	0.96	0.81	0.35	0.20	0.44
TOTAL	10.81	51.5%	10.81	0.00	0.00	2.97	2.30	4.57	---	---	---	---	---	---	0.48	0.64

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

STANDARD FORM SF-2
TIME OF CONCENTRATION

Subdivision: FEATHERGRASS URBAN DUPLEXES
Location: Colorado Springs

Project Name: FEATHERGRASS URBAN DUPLEXES
Project No.: 2514901
Calculated By: NQJ
Checked By:
Date: 11/11/19

SUB-BASIN DATA						INITIAL/OVERLAND (T_i)			TRAVEL TIME (T_t)					*tc* CHECK (URBANIZED BASINS)			FINAL
BASIN ID	D.A. (ac)	Hydrologic Soils Group	Impervious (%)	C_5	C_{100}	L (ft)	S_o (%)	t_i (min)	L_t (ft)	S_t (%)	K	VEL. (ft/s)	t_t (min)	COMP. t_c (min)	TOTAL LENGTH (ft)	Urbanized t_c (min)	t_c (min)
A1	0.97	A	55%	0.50	0.65	87	1.0%	10.1	155	1.4%	20.0	2.4	1.1	11.2	242.0	18.0	11.2
A2	0.17	A	71%	0.66	0.78	20	2.0%	2.8	180	1.0%	20.0	2.0	1.5	4.3	200.0	15.6	5.0
A3	0.08	A	63%	0.59	0.73	12	2.0%	2.5	180	1.0%	20.0	2.0	1.5	4.0	192.0	17.1	5.0
A4	0.79	A	63%	0.56	0.70	87	1.0%	9.0	150	1.6%	20.0	2.5	1.0	10.0	237.0	16.4	10.0
A5	0.87	A	49%	0.45	0.62	99	1.0%	11.6	150	1.0%	20.0	2.0	1.3	12.9	249.0	19.3	12.9
A6	0.26	A	83%	0.74	0.84	99	1.0%	6.4	178	1.0%	20.0	2.0	1.5	7.9	277.0	13.4	7.9
A7	0.47	A	63%	0.56	0.70	99	1.0%	9.6	153	1.0%	20.0	2.0	1.3	10.9	252.0	16.8	10.9
A8	0.79	A	45%	0.43	0.60	99	1.0%	12.0	117	1.1%	20.0	2.1	0.9	13.0	216.0	19.5	13.0
A9	0.64	A	64%	0.59	0.73	14	2.0%	2.7	330	1.0%	20.0	2.0	2.8	5.5	344.0	18.2	5.5
A10	0.52	A	0%	0.08	0.35	25	5.0%	5.4	140	0.8%	20.0	1.7	1.3	6.8	165.0	29.0	6.8
B1	0.75	A	49%	0.46	0.62	97	1.0%	11.4	105	1.0%	20.0	2.0	0.9	12.3	202.0	18.8	12.3
B2	0.08	A	100%	0.90	0.96	12	2.0%	1.0	182	2.3%	20.0	3.1	1.0	2.0	194.0	9.9	5.0
B3	0.11	A	91%	0.83	0.90	12	2.0%	1.4	190	2.3%	20.0	3.0	1.0	2.4	202.0	11.5	5.0
B4	0.95	A	63%	0.57	0.71	120	1.0%	10.5	183	2.0%	20.0	2.8	1.1	11.6	303.0	16.5	11.6
B5	0.71	A	52%	0.48	0.64	97	1.0%	11.0	103	1.6%	20.0	2.5	0.7	11.7	200.0	18.0	11.7
B6	0.09	A	89%	0.81	0.89	12	2.0%	1.4	160	2.5%	20.0	3.2	0.8	2.3	172.0	11.7	5.0
B7	0.13	A	85%	0.77	0.87	12	2.0%	1.6	170	2.5%	20.0	3.2	0.9	2.5	182.0	12.5	5.0
B8	0.85	A	62%	0.56	0.70	97	1.0%	9.7	145	1.0%	20.0	2.0	1.2	10.9	242.0	16.8	10.9
B9	0.67	A	54%	0.50	0.66	30	2.0%	4.7	145	1.0%	20.0	2.0	1.2	5.9	175.0	18.2	5.9
B10	0.56	A	4%	0.11	0.37	47	5.0%	7.2	40	33.0%	7.0	4.0	0.2	7.4	87.0	25.5	7.4
B11	0.35	A	14%	0.20	0.44	20	5.0%	4.3	20	5.0%	10.0	2.2	0.1	4.4	40.0	23.7	5.0

Table 6-2. NRCS Conveyance factors, K

Type of Land Surface	Conveyance Factor, K
Heavy meadow	2.5
Tillage/field	5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

t_t = channelized flow time (minutes).

Equation 6-2

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

Equation 6-3

Where:

t_i = overland (initial) flow time (minutes)
C_5 = runoff coefficient for 5-year frequency (from Table 6-4)
L_i = length of overland flow (ft)
S_o = average slope along the overland flow path (ft/ft).

STANDARD FORM SF-2
TIME OF CONCENTRATION

Subdivision: FEATHERGRASS URBAN DUPLEXES
Location: Colorado Springs

Project Name: FEATHERGRASS URBAN DUPLEXES
Project No.: 2514901
Calculated By: NQJ
Checked By:
Date: 11/11/19

SUB-BASIN DATA						INITIAL/OVERLAND (T_i)			TRAVEL TIME (T_t)					*tc* CHECK (URBANIZED BASINS)			FINAL
BASIN ID	D.A. (ac)	Hydrologic Soils Group	Impervious (%)	C_5	C_{100}	L (ft)	S_o (%)	t_i (min)	L_t (ft)	S_t (%)	K	VEL. (ft/s)	t_t (min)	COMP. t_c (min)	TOTAL LENGTH (ft)	Urbanized t_c (min)	t_c (min)

$$t_t = \frac{L_t}{60K\sqrt{S_o}} = \frac{L_t}{60V_t}$$ Equation 6-4

Where:

t_t = channelized flow time (travel time, min)
L_t = waterway length (ft)
S_o = waterway slope (ft/ft)
V_t = travel time velocity (ft/sec) = $K\sqrt{S_o}$
K = NRCS conveyance factor (see Table 6-2).

$$t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$$ Equation 6-5

Where:

t_c = minimum time of concentration for first design point when less than t_c from Equation 6-1.
L_t = length of channelized flow path (ft)
i = imperviousness (expressed as a decimal)
S_t = slope of the channelized flow path (ft/ft).

Use a minimum t_c value of 5 minutes for urbanized areas and a minimum t_c value of 10 minutes for areas that are not considered urban. Use minimum values even when calculations result in a lesser time of concentration.

STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

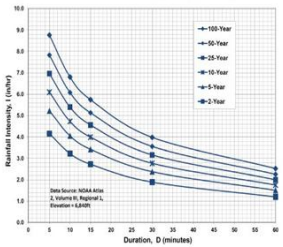
(RATIONAL METHOD PROCEDURE)

odivision: FEATHERGRASS URBAN DUPLEXES
Location: Colorado Springs
gn Storm: 5-Year

Project Name: FEATHERGRASS URBAN DUPLEXES
Project No.: 2514901
Calculated By: NQJ
Checked By:
Date: 11/11/19

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (Ac)	Runoff Coeff.	t_c (min)	C*A (Ac)	I (in/hr)	Q (cfs)	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Q_{street} (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
	1	A1	0.97	0.50	11.2	0.48	3.96	1.9					1.9	0.48	1					170	2.0	1.4	BASIN A1 FLOW @ DP1, C&G FLOW TO DP3
		A2	0.17	0.66	5.0	0.11	5.17	0.6															BASIN A2 FLOW @ DP3 (ROUTED IN SF2)
		A3	0.08	0.59	5.0	0.05	5.17	0.3															BASIN A3 FLOW @ DP4 (ROUTED IN SF2)
	2	A4	0.79	0.56	10.0	0.45	4.12	1.9					1.9	0.45	1					170	2.0	1.4	BASIN A4 FLOW @ DP2, C&G TO DP4
	3								12.6	0.59	3.78	2.2	0.4	0.11	1	1.8	0.48	2.0	18	60 5	2.0 5.5	0.5 0.0	DP3 FLOW-BY, C&G FLOW TO DP5 DP1 & BASIN A2 FLOW CAPTURED IN DBL. DENVER TYPE 16 COMBO INLET, PIPE TO DP4.1
	4								11.5	0.50	3.93	2.0	0.3	0.07	1	1.7	0.43	2.0	18	60 31	2.0 5.4	0.5 0.1	DP4 FLOW-BY, C&G FLOW TO DP6 BASIN A3 & DP2 FLOW CAPTURED IN DBL. DENVER TYPE 16 COMBO INLET, PIPE TO DP4.1
	4.1								12.6	0.91	3.78	3.4				3.4	3.78	2.0	18	123	6.9	0.3	COMBINED DP3&DP4 CAPTURED FLOW, PIPE FLOW TO DP8.1
	5	A5	0.87	0.45	12.9	0.39	3.75	1.5	13.1	0.50	3.72	1.9	1.9	0.50	1					115	2.0	1.0	BASIN A5 & DP3 FLOW @ DP5, C&G FLOW TO DP8
		A6	0.26	0.74	7.9	0.19	4.48	0.9															BASIN A6 FLOW @ DP8 (ROUTED IN SF2)
	6	A7	0.47	0.56	10.9	0.26	4.00	1.0	12.0	0.33	3.86	1.3	1.3	0.33	1					130	2.0	1.1	DP6 FLOW-BY, C&G FLOW TO DP9
	7	A8	0.79	0.43	13.0	0.34	3.74	1.3					1.3	0.34	1					100	2.0	0.8	BASIN A8 FLOW @ DP7, C&G FLOW TO DP8
	8								14.1	1.03	3.62	3.7				3.7	1.03	2.0	30	5	6.6	0.0	BASIN A6, DP5 & DP7 FLOW @ DP8, CAPTURED BY DBL. DENVER TYPE 16 COMBO INLET, PIPE FLOW TO DP9.1
	8.1								14.1	1.94	3.62	7.0				7.0	1.94	2.0	30	55	2.0	0.5	DP4.1 & DP8 FLOW @ DP8.1, PIPE FLOW TO DP9.1
	9	A9	0.64	0.59	5.5	0.38	5.03	1.9	13.0	0.71	3.73	2.6				2.6	0.71	2.0	30	5	5.8	0.0	DP6 & BASIN A9 FLOW @ DP9, CAPTURED BY DBL. DENVER TYPE 16 COMBO INLET, PIPE FLOW TO DP9.1
	9.1								14.5	2.65	3.57	9.5				9.5	2.65	5.0	30	55	11.8	0.1	DP8.1 & DP9 FLOW @ DP9.1, PIPE FLOW TO DP10 (WATER QUALITY POND)
	10	A10	0.52	0.08	6.8	0.04	4.72	0.2	14.6	2.69	3.56	9.6											BASIN A1-10 FLOW @ DP10, TOTAL FLOW ENTERING WATER QUALITY POND
	15	B1	0.75	0.46	12.3	0.34	3.82	1.3					1.3	0.34	2.33					160	3.1	0.9	BASIN B1 FLOW @ DP15, C&G FLOW TO DP17
	17	B2	0.08	0.90	5.0	0.07	5.17	0.4	13.2	0.41	3.71	1.5	0.2	0.06	2.3	1.3	0.35	5.0	18	70 33	3.1 7.1	0.4 0.1	DP17 FLOW-BY, C&G FLOW TO DP19 BASIN B2 AND DP15 FLOW @ DP17, CAPTURED IN DBL. DENVER TYPE 16 COMBO INLET, PIPE TO DP18.1
		B3	0.11	0.83	5.0	0.09	5.17	0.5															BASIN B3 FLOW @ DP18 (ROUTED IN SF2)
	16	B4	0.95	0.57	11.6	0.54	3.91	2.1					2.1	0.54	2.3					185	3.1	1.0	BASIN B4 FLOW @ DP16, C&G FLOW TO DP18
	18								12.6	0.63	3.79	2.4	0.6	0.15	2.3	1.8	0.48	2.0	18	75 5	3.0 5.5	0.4 0.0	DP18 FLOW-BY, C&G FLOW TO DP20 BASIN B3 & DP16 FLOW @ DP18, CAPTURED BY DBL. DENVER TYPE 16 COMBO INLET, PIPE TO DP18.1
	18.1								12.6	0.83	3.78	3.1				3.1	0.83	2.0	18	160	6.6	0.4	DP17 & DP18 CAPTURED FLOW, PIPE FLOW TO DP22.1
	19	B5	0.71	0.48	11.7	0.34	3.89	1.3	11.7	0.40	3.89	1.6	0.5	0.12	2.5	1.1	0.28	2.0	18	103 103	3.2 4.8	0.5 0.4	DP19 FLOW-BY, C&G FLOW TO DP23 BASIN B5 & DP17 FLOW @ DP19, CAPTURED IN SINGLE DENVER TYPE 16 COMBO INLET, PIPE TO DP23.1
		B6	0.09	0.81	5.0	0.07	5.17	0.4															BASIN B6 FLOW AT DP23 (ROUTED IN SF2)
		B7	0.13	0.77	5.0	0.10	5.17	0.5															BASIN B7 FLOW AT DP22 (ROUTED IN SF2)
	20	B8	0.85	0.56	10.9	0.47	4.00	1.9	13.0	0.62	3.74	2.3	2.3	0.62	2.5					125	3.2	0.7	BASIN B8 & DP18 FLOW-BY, C&G FLOW TO DP22
	21	B9	0.67	0.50	5.9	0.34	4.92	1.7					0.2	0.04	1	1.5	0.30	2.0	18	65 45	2.0 5.2	0.5 0.1	DP21 FLOW-BY, C&G FLOW TO DP22 BASIN B9 FLOW CAPTURED BY DBL DENVER TYPE 16 COMBO INLET, PIPE TO DP22.1
	22								11.5	0.76	3.91	3.0				3.0	0.76	5.0	18	33	9.1	0.1	BASIN B7, DP20 FLOW-BY & DP21 FLOW-BY@ DP22, CAPTURED IN DBL. DENVER TYPE 16 COMBO INLET, PIPE TO DP22.1
	22.1								13.0	1.89	3.74	7.1				7.1	1.89	3.0	24	33	9.3	0.1	DP21 & DP22 CAPTURED FLOW, PIPE TO DP23.1
	23								12.3	0.19	3.82	0.7				0.7	0.19	5.0	24	5	5.6	0.0	BASIN B6 & DP19 FLOW-BY, CAPTURED IN TRIPLE DENVER TYPE 16 COMBO INLET, PIPE TO DP23.1
	23.1								13.0	2.36	3.73	8.8				8.8	2.36	5.0	30	55	11.6	0.1	COMBINED DP22.1 & DP23 FLOW, PIPE TO DP24
	24	B10	0.56	0.11	7.4	0.06	4.59	0.3	13.1	2.42	3.72	9.0											DP23.1 AND BASIN B10 FLOW, TOTAL FLOW @ DP24 (FSD WATER QUALITY POND)
	25	B11	0.35	0.20	5.0	0.07	5.17	0.4															BASIN B11 FLOW, FOLLOW EX PATTERNS & FLOWS EAST OFF SITE

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.

Notes:
Street and Pipe C*A values are determined by Q/i using the catchment's intensity value.

STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

sion: FEATHERGRASS URBAN DUPLEXES
tion: Colorado Springs
orm: 100-Year

Project Name: FEATHERGRASS URBAN DUPLEXES
Project No.: 2514901
Calculated By: NQJ
Checked By:
Date: 11/11/19

		DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			
TREE	Design Point	Basin ID	Area (ac)	Runoff Coeff.	t_c (min)	C*A (ac)	*I* (in/hr)	Q (cfs)	t_{tc} (min)	C*A (ac)	*I* (in/hr)	Q (cfs)	Q_{street} (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	REMARKS
	1	A1	0.97	0.65	11.2	0.63	6.65	4.2					4.2	0.63	1					170	2.0	1.4	BASIN A1 FLOW @ DP1, C&G FLOW TO DP3
		A2	0.17	0.78	5.0	0.13	8.68	1.1															BASIN A2 FLOW @ DP3 (ROUTED IN SF2)
		A3	0.08	0.73	5.0	0.06	8.68	0.5															BASIN A3 FLOW @ DP4 (ROUTED IN SF2)
	2	A4	0.79	0.70	10.0	0.55	6.92	3.8					3.8	0.55	1					170	2.0	1.4	BASIN A4 FLOW @ DP2, C&G TO DP4
	3								12.6	0.76	6.35	4.8	1.7	0.27	1	3.1	0.49	2.0	18	60 5	2.0 6.6	0.5 0.0	DP3 FLOW-BY, C&G FLOW TO DP5 DP1 & BASIN A2 FLOW CAPTURED IN DBL. DENVER TYPE 16 COMBO INLET, PIPE TO DP4.1
	4								11.5	0.61	6.59	4.0	1.2	0.19	1	2.8	0.42	2.0	18	60 31	2.0 6.3	0.5 0.1	DP4 FLOW-BY, C&G FLOW TO DP6 BASIN A3 & DP2 FLOW CAPTURED IN DBL. DENVER TYPE 16 COMBO INLET, PIPE TO DP4.1
	4.1								12.6	0.91	6.34	5.8				5.8	6.34	2.0	18	123	7.9	0.3	COMBINED DP3 & DP4 CAPTURED FLOW, PIPE FLOW TO DP8.1
	5	A5	0.87	0.62	12.9	0.54	6.30	3.4	13.1	0.81	6.25	5.1	5.1	0.81	1					115	2.0	1.0	BASIN A5 & DP3 FLOW-BY @ DP5, C&G FLOW TO DP8
		A6	0.26	0.84	7.9	0.22	7.52	1.7															BASIN A6 FLOW @ DP8 (ROUTED IN SF2)
	6	A7	0.47	0.70	10.9	0.33	6.71	2.2	12.0	0.52	6.48	3.3	3.3	0.52	1					130	2.0	1.1	BASIN A7 AND DP4 FLOW-BY FLOW @ DP6, C&G FLOW TO DP9
	7	A8	0.79	0.60	13.0	0.48	6.28	3.0					3.0	0.48	1					100	2.0	0.8	BASIN A8 FLOW @ DP7, C&G FLOW TO DP8
	8								14.1	1.51	6.07	9.2				9.2	1.51	2.0	30	5	8.5	0.0	BASIN A6, DP5 & DP7 FLOW @ DP8, CAPTURED BY DBL. DENVER TYPE 16 COMBO INLET, PIPE FLOW TO DP9.1
	8.1								14.1	2.42	6.07	14.7				14.7	2.42	2.0	30	55	2.0	0.5	DP4.1 & DP8 FLOW @ DP8.1, PIPE FLOW TO DP9.1
	9	A9	0.64	0.73	5.5	0.47	8.45	4.0	13.0	0.99	6.26	6.2				6.2	0.99	2.0	30	5	7.7	0.0	DP6 & BASIN A9 FLOW @DP9, CAPTURED BY DBL. DENVER TYPE 16 COMBO INLET, PIPE FLOW TO DP9.1
	9.1								14.5	3.41	5.99	20.4				20.4	3.41	5.0	30	55	14.8	0.1	DP8.1 & DP9 FLOW @ DP9.1, PIPE FLOW TO DP10 (WATER QUALITY POND)
	10	A10	0.52	0.35	6.8	0.18	7.92	1.4	14.6	3.59	5.98	21.5											BASIN A1-10 FLOW @ DP10, TOTAL FLOW ENTERING WATER QUALITY POND
	15	B1	0.75	0.62	12.3	0.47	6.41	3.0					3.0	0.47	2.33					160	3.1	0.9	BASIN B1 FLOW @ DP15, C&G FLOW TO DP17
	17	B2	0.08	0.96	5.0	0.08	8.68	0.7	13.2	0.55	6.23	3.4	1.1	0.18	2.3	2.3	0.37	5.0	18	70 33	3.1 8.3	0.4 0.1	DP17 FLOW-BY, C&G FLOW TO DP19 BASIN B2 AND DP15 FLOW @ DP17, CAPTURED IN DBL. DENVER TYPE 16 COMBO INLET, PIPE TO DP18.1
		B3	0.11	0.90	5.0	0.10	8.68	0.9															BASIN B3 FLOW @ DP18 (ROUTED IN SF2)
	16	B4	0.95	0.71	11.6	0.67	6.57	4.4					4.4	0.67	2.3					185	3.1	1.0	BASIN B4 FLOW @ DP16, C&G FLOW TO DP18
	18								12.6	0.77	6.36	4.9	2.0	0.31	2.3	2.9	0.46	2.0	18	75 5	3.0 6.5	0.4 0.0	DP18 FLOW-BY, C&G FLOW TO DP20 BASIN B3 & DP16 FLOW @ DP18, CAPTURED BY DBL. DENVER TYPE 16 COMBO INLET, PIPE TO DP18.1
	18.1								12.6	0.83	6.35	5.2				5.2	0.83	2.0	18	160	7.6	0.4	DP17 & DP18 CAPTURED FLOW, PIPE FLOW TO DP22.1
	19	B5	0.71	0.64	11.7	0.45	6.53	2.9	11.7	0.63	6.53	4.1	2.1	0.33	2.5	2.0	0.31	2.0	18	103 103	3.2 5.7	0.5 0.3	DP19 FLOW-BY, C&G FLOW TO DP23 BASIN B5 & DP17 FLOW @ DP19, CAPTURED IN SINGLE DENVER TYPE 16 COMBO INLET, PIPE TO DP23.1
		B6	0.09	0.89	5.0	0.08	8.68	0.7															BASIN B6 FLOW AT DP23 (ROUTED IN SF2)
		B7	0.13	0.87	5.0	0.11	8.68	1.0															BASIN B7 FLOW AT DP22 (ROUTED IN SF2)
	20	B8	0.85	0.70	10.9	0.59	6.72	4.0	13.0	0.90	6.28	5.7	5.7	0.90	2.5					125	3.2	0.7	BASIN B8 & DP18 FLOW-BY, C&G FLOW TO DP22
	21	B9	0.67	0.66	5.9	0.44	8.26	3.6					1.0	0.13	1	2.6	0.31	2.0	18	65 45	2.0 6.2	0.5 0.1	DP21 FLOW-BY, C&G FLOW TO DP22 BASIN B9 FLOW CAPTURED BY DBL DENVER TYPE 16 COMBO INLET, PIPE TO DP22.1
	22								11.5	1.14	6.57	7.5				7.5	1.14	5.0	18	33	11.6	0.0	BASIN B7, DP20 FLOW-BY & DP21 FLOW-BY@ DP22, CAPTURED IN DBL. DENVER TYPE 16 COMBO INLET, PIPE TO DP22.1
	22.1								12.9	2.28	6.28	14.3				14.3	2.28	3.0	24	33	11.4	0.0	DP21 & DP22 CAPTURED FLOW, PIPE TO DP23.1
	23								12.3	0.41	6.42	2.6				2.6	0.41	5.0	24	5	8.4	0.0	BASIN B6 & DP19 FLOW-BY, CAPTURED IN TRIPLE DENVER TYPE 16 COMBO INLET, PIPE TO DP23.1
	23.1								13.0	2.99	6.28	18.8				18.8	2.99	5.0	30	55	14.6	0.1	COMBINED DP22.1 & DP23 FLOW, PIPE TO DP24
	24	B10	0.56	0.37	7.4	0.21	7.70	1.6	13.0	3.20	6.26	20.0											DP23.1 AND BASIN B10 FLOW, TOTAL FLOW @ DP24 (FSD WATER QUALITY POND)
	25	B11	0.35	0.44	5.0	0.15	8.68	1.3															BASIN B11 FLOW, FOLLOW EX PATTERNS & FLOWS EAST OFF SITE

Street and Pipe C*A values are determined by Q/I using the catchment's intensity value.

Appendix C
Hydraulic Calculations

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Nov 11 2019

Alley Street Capacity - 1% CL - Allowable Spread - Edge of Pavement

User-defined

Invert Elev (ft)	= 0.36
Slope (%)	= 1.00
N-Value	= 0.016

Calculations

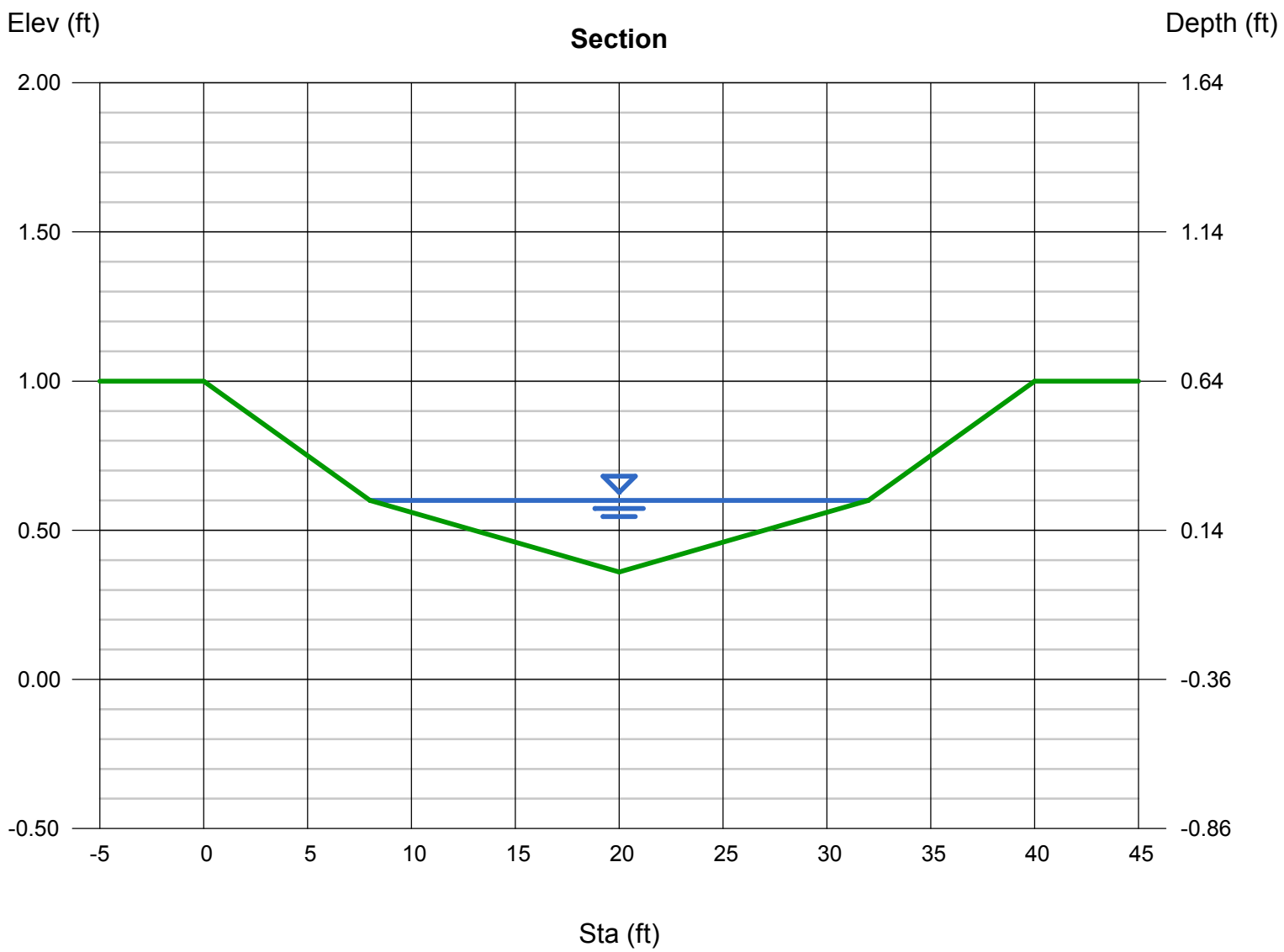
Compute by:	Known Q
Known Q (cfs)	= 6.00

Highlighted

Depth (ft)	= 0.24
Q (cfs)	= 6.000
Area (sqft)	= 2.88
Velocity (ft/s)	= 2.08
Wetted Perim (ft)	= 24.00
Crit Depth, Yc (ft)	= 0.25
Top Width (ft)	= 24.00
EGL (ft)	= 0.31

(Sta, El, n)-(Sta, El, n)...

(0.00, 1.00)-(8.00, 0.60, 0.016)-(20.00, 0.36, 0.016)-(32.00, 0.60, 0.016)-(40.00, 1.00, 0.016)



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Nov 11 2019

Alley Street Capacity - 1.55% CL - Allowable Spread - Edge of Pavement

User-defined

Invert Elev (ft)	= 0.36
Slope (%)	= 1.55
N-Value	= 0.016

Calculations

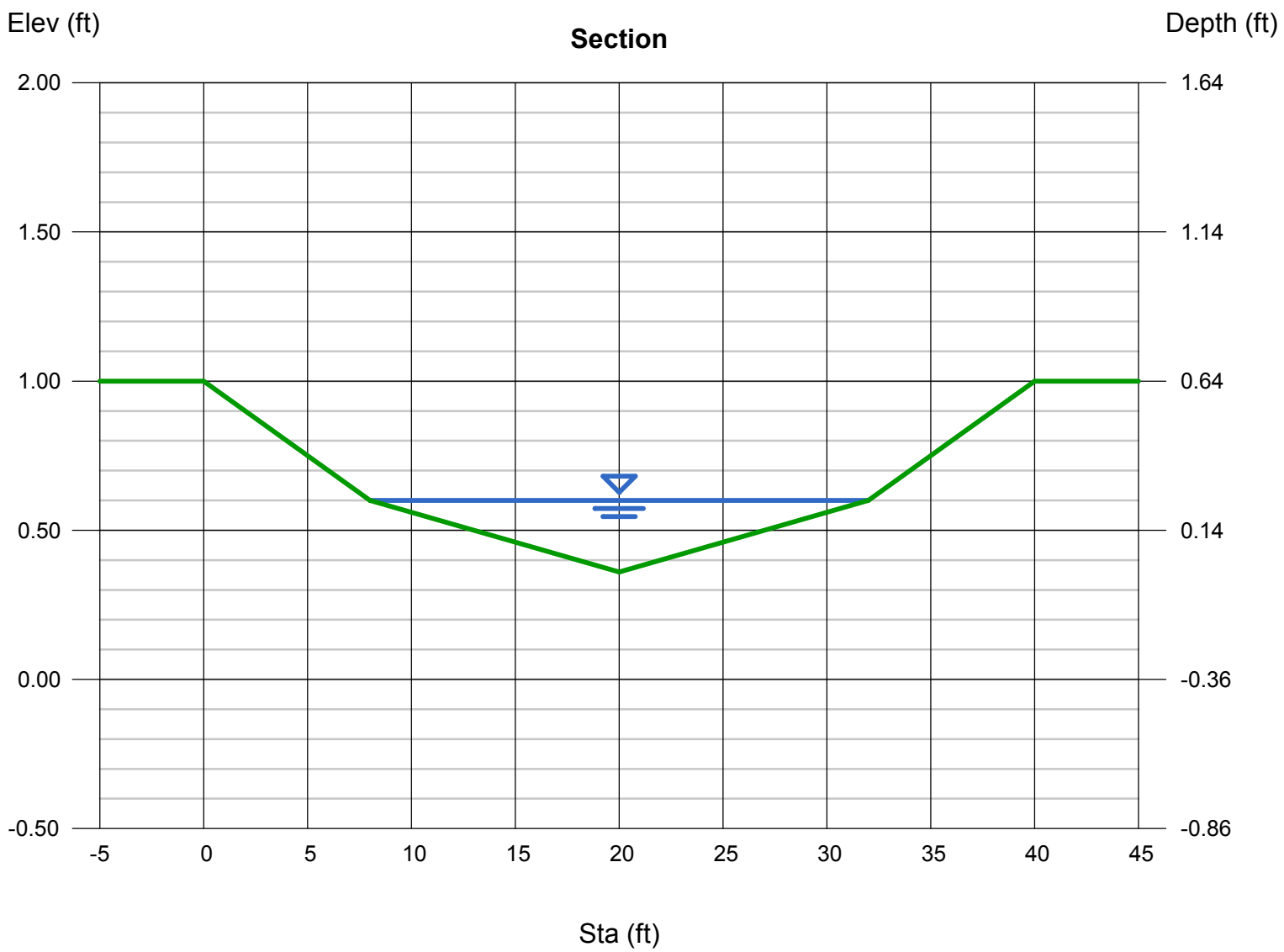
Compute by:	Known Q
Known Q (cfs)	= 8.00

Highlighted

Depth (ft)	= 0.24
Q (cfs)	= 8.000
Area (sqft)	= 2.88
Velocity (ft/s)	= 2.78
Wetted Perim (ft)	= 24.00
Crit Depth, Yc (ft)	= 0.28
Top Width (ft)	= 24.00
EGL (ft)	= 0.36

(Sta, El, n)-(Sta, El, n)...

(0.00, 1.00)-(8.00, 0.60, 0.016)-(20.00, 0.36, 0.016)-(32.00, 0.60, 0.016)-(40.00, 1.00, 0.016)



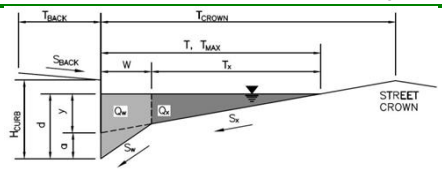
Version 4.05 Released March 2017

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

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

Project: **FEATHERGRASS URBAN DUPLEXES**

Inlet ID: **DP3**



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	7.5	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} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	21.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	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 =	0.010	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.014	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	12.0	21.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	4.4	7.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

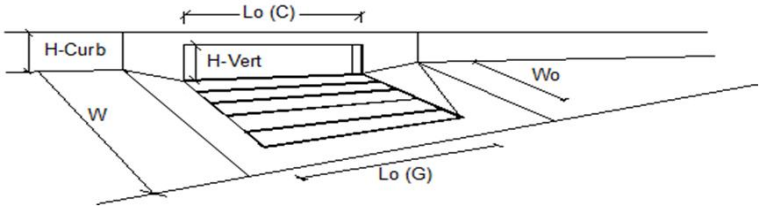
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**5.4**	**21.1**	**cfs**

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'

INLET ON A CONTINUOUS GRADE

Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (Denver No. 16 Combination)	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.8**	**3.1**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.4**	**1.7**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**83**	**65**	**%**

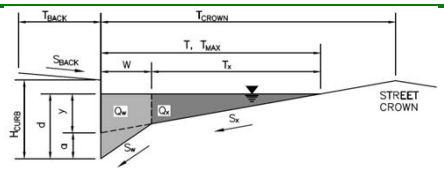
Version 4.05 Released March 2017

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

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

Project: **FEATHERGRASS URBAN DUPLEXES**

Inlet ID: **DP4**



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.5	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} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	12.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	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 =	0.010	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.014	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	12.0	12.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	4.4	6.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

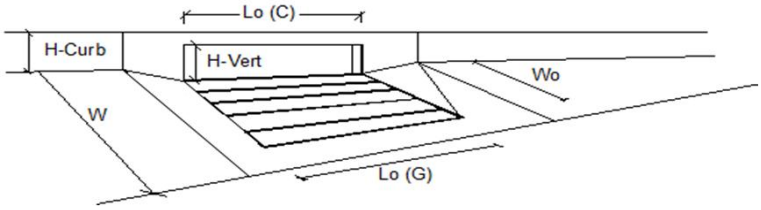
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**5.4**	**5.4**	**cfs**

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'

INLET ON A CONTINUOUS GRADE

Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (Denver No. 16 Combination)	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.7**	**2.8**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.3**	**1.2**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**85**	**69**	**%**

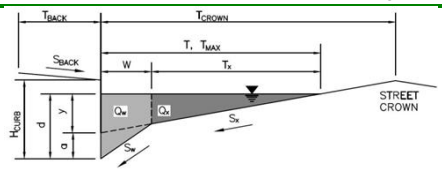
Version 4.05 Released March 2017

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

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

Project: **FEATHERGRASS URBAN DUPLEXES**

Inlet ID: **DP8**



Gutter Geometry (Enter data in the blue cells)

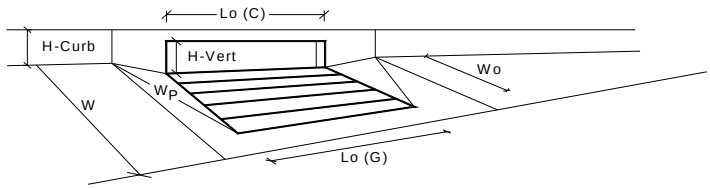
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	30.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	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} =	0.014	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	30.0	30.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	8.0	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



		MINOR	MAJOR	
Design Information (Input)		MINOR	MAJOR	
Type of Inlet (Denver No. 16 Combination)	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	2	2	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	8.0	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Width of a Unit Grate	W_o =	1.73	1.73	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31	
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) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.523	0.689	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.50	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.71	0.94	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.71	0.94	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**6.2**	**12.8**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	3.7	9.2	cfs

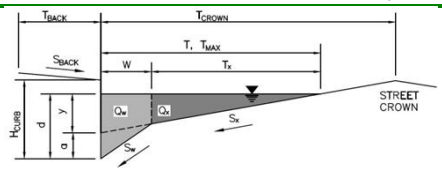
Version 4.05 Released March 2017

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

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

Project: **FEATHERGRASS URBAN DUPLEXES**

Inlet ID: **DP9**



Gutter Geometry (Enter data in the blue cells)

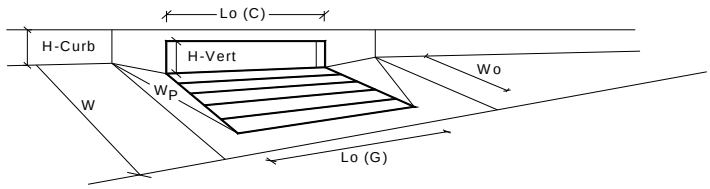
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	21.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	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} =	0.014	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	21.0	21.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	8.0	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 (Denver No. 16 Combination)	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	2	2	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	6.6	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Width of a Unit Grate	W_o =	1.73	1.73	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31	
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) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.523	0.569	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.38	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.71	0.77	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.71	0.77	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**6.2**	**7.9**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	2.6	6.2	cfs

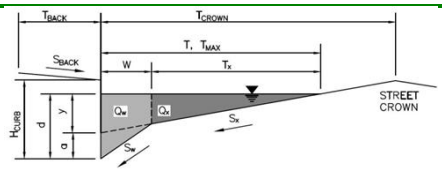
Version 4.05 Released March 2017

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

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

Project: **FEATHERGRASS URBAN DUPLEXES**

Inlet ID: **DP17**



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.0	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} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	12.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	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 =	0.023	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.014	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	12.0	12.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	8.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

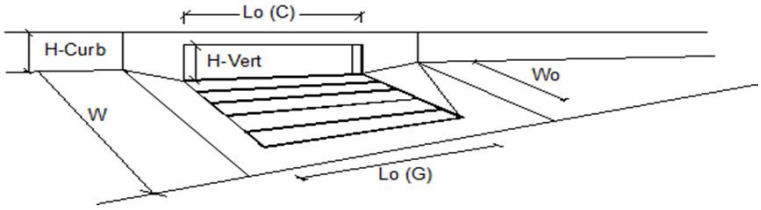
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**8.2**	**8.2**	**cfs**

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'

INLET ON A CONTINUOUS GRADE

Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (Denver No. 16 Combination)	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.3**	**2.3**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.2**	**1.1**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**87**	**67**	**%**

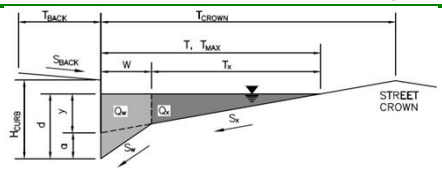
Version 4.05 Released March 2017

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

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

Project: **FEATHERGRASS URBAN DUPLEXES**

Inlet ID: **DP18**



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.0	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} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	21.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	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 =	0.023	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.014	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	21.0	21.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	8.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

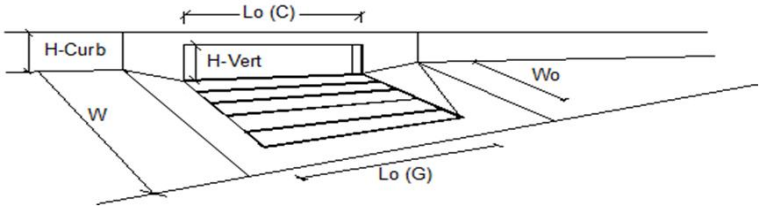
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**22.0**	**32.1**	**cfs**

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'

INLET ON A CONTINUOUS GRADE

Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (Denver No. 16 Combination)	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.8**	**2.9**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.6**	**2.0**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**76**	**58**	**%**

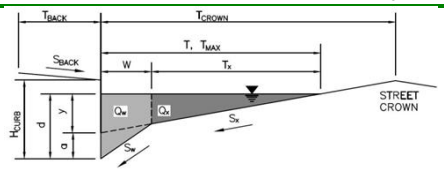
Version 4.05 Released March 2017

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

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

Project: **FEATHERGRASS URBAN DUPLEXES**

Inlet ID: **DP19**



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.0	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} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	12.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	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 =	0.025	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.014	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	12.0	12.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	8.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

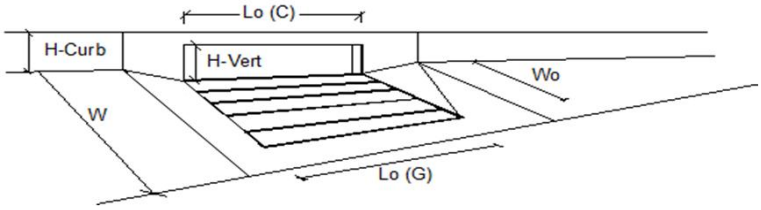
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**8.5**	**8.5**	**cfs**

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'

INLET ON A CONTINUOUS GRADE

Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (Denver No. 16 Combination)	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.1**	**2.0**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.5**	**2.1**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**72**	**49**	**%**

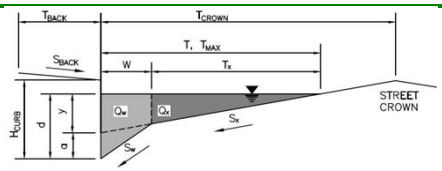
Version 4.05 Released March 2017

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

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

Project: **FEATHERGRASS URBAN DUPLEXES**

Inlet ID: **DP21**



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.0	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} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	12.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	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 =	0.010	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.014	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	12.0	12.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

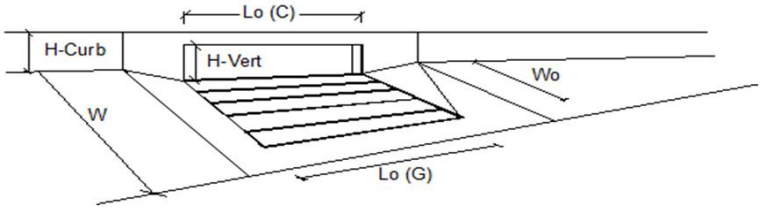
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**5.4**	**5.4**	**cfs**

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'

INLET ON A CONTINUOUS GRADE

Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (Denver No. 16 Combination)	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.5**	**2.6**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.2**	**1.0**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**89**	**71**	**%**

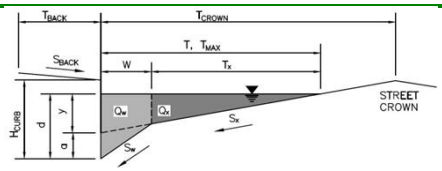
Version 4.05 Released March 2017

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

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

Project: **FEATHERGRASS URBAN DUPLEXES**

Inlet ID: **DP22**



Gutter Geometry (Enter data in the blue cells)

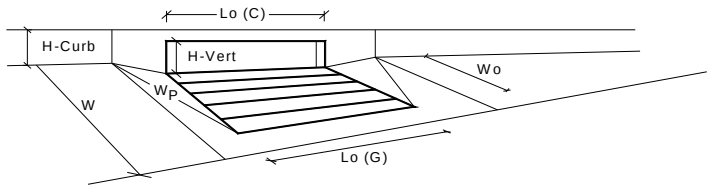
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	21.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	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} =	0.014	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	21.0	21.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	8.0	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



		MINOR	MAJOR	
Design Information (Input)		MINOR	MAJOR	
Type of Inlet (Denver No. 16 Combination)	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	2	2	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	6.6	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Width of a Unit Grate	W_o =	1.73	1.73	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31	
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) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.523	0.569	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.38	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.71	0.77	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.71	0.77	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**6.2**	**7.9**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	3.0	7.5	cfs

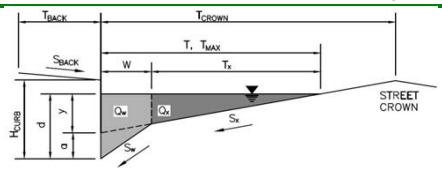
Version 4.05 Released March 2017

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

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

Project: **FEATHERGRASS URBAN DUPLEXES**

Inlet ID: **DP23**



Gutter Geometry (Enter data in the blue cells)

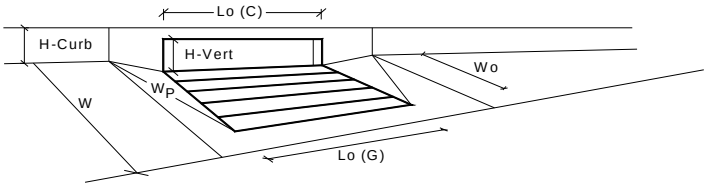
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	12.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	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} =	0.014	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	12.0	12.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	8.0	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



		MINOR	MAJOR	
Design Information (Input)		MINOR	MAJOR	
Type of Inlet (Denver No. 16 Combination)	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	3	3	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4.4	4.4	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Width of a Unit Grate	W_o =	1.73	1.73	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31	
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) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.389	0.389	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.20	0.20	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.41	0.41	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.86	0.86	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.41	0.41	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**3.2**	**3.2**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	1.8	2.6	cfs

Weir Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Nov 18 2019

Pond A Spillway (Q_100 = Peak Undetained Q_100 (SF3 Major) = 21.5 cfs

Trapezoidal Weir

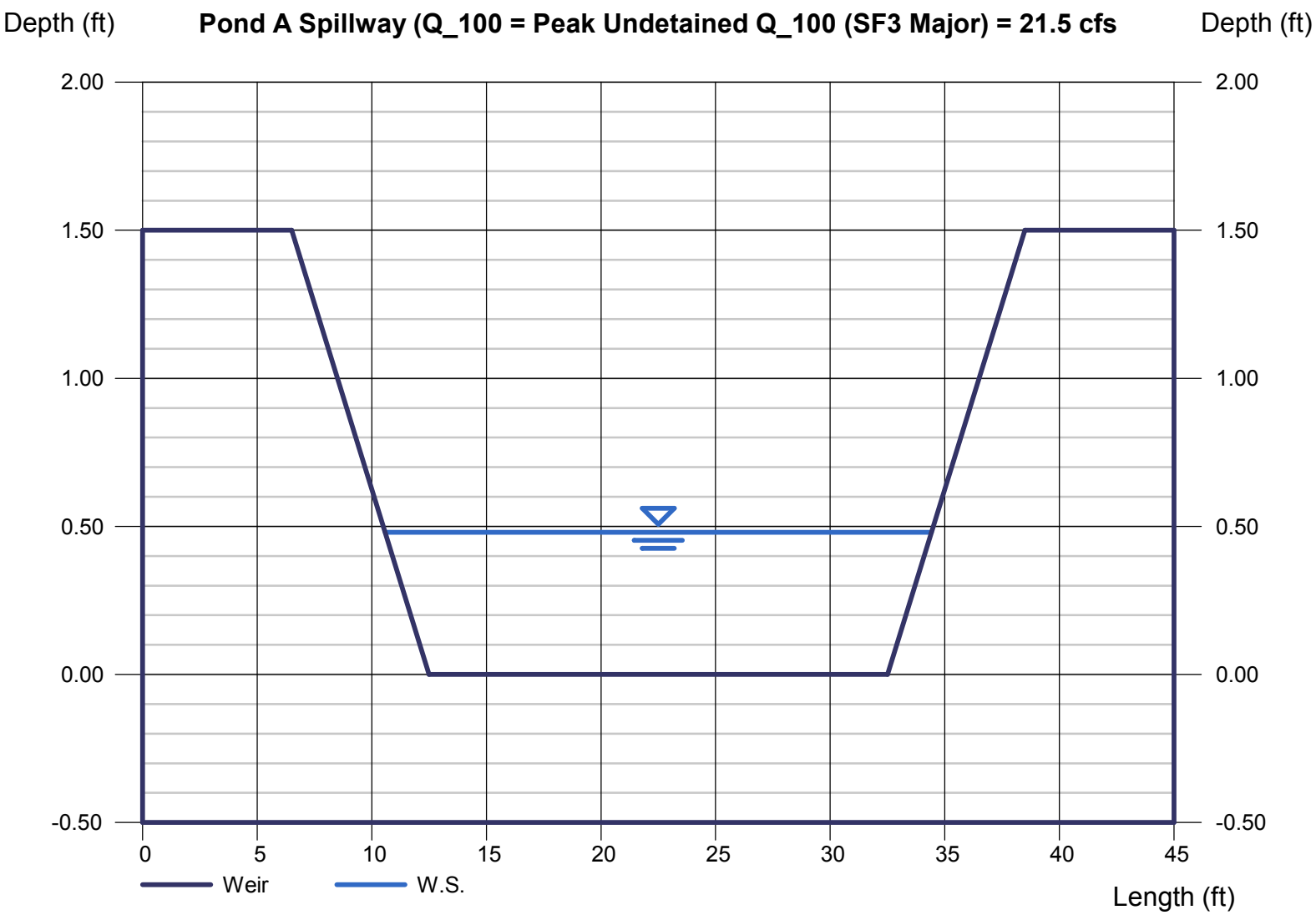
Crest	= Sharp
Bottom Length (ft)	= 20.00
Total Depth (ft)	= 1.50
Side Slope (z:1)	= 4.00

Calculations

Weir Coeff. Cw	= 3.10
Compute by:	Known Q
Known Q (cfs)	= 21.50

Highlighted

Depth (ft)	= 0.48
Q (cfs)	= 21.50
Area (sqft)	= 10.52
Velocity (ft/s)	= 2.04
Top Width (ft)	= 23.84



Weir Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Nov 18 2019

Pond B Spillway (Q_100 = Peak Undetained Q_100 (SF3 Major) = 20.0 cfs

Trapezoidal Weir

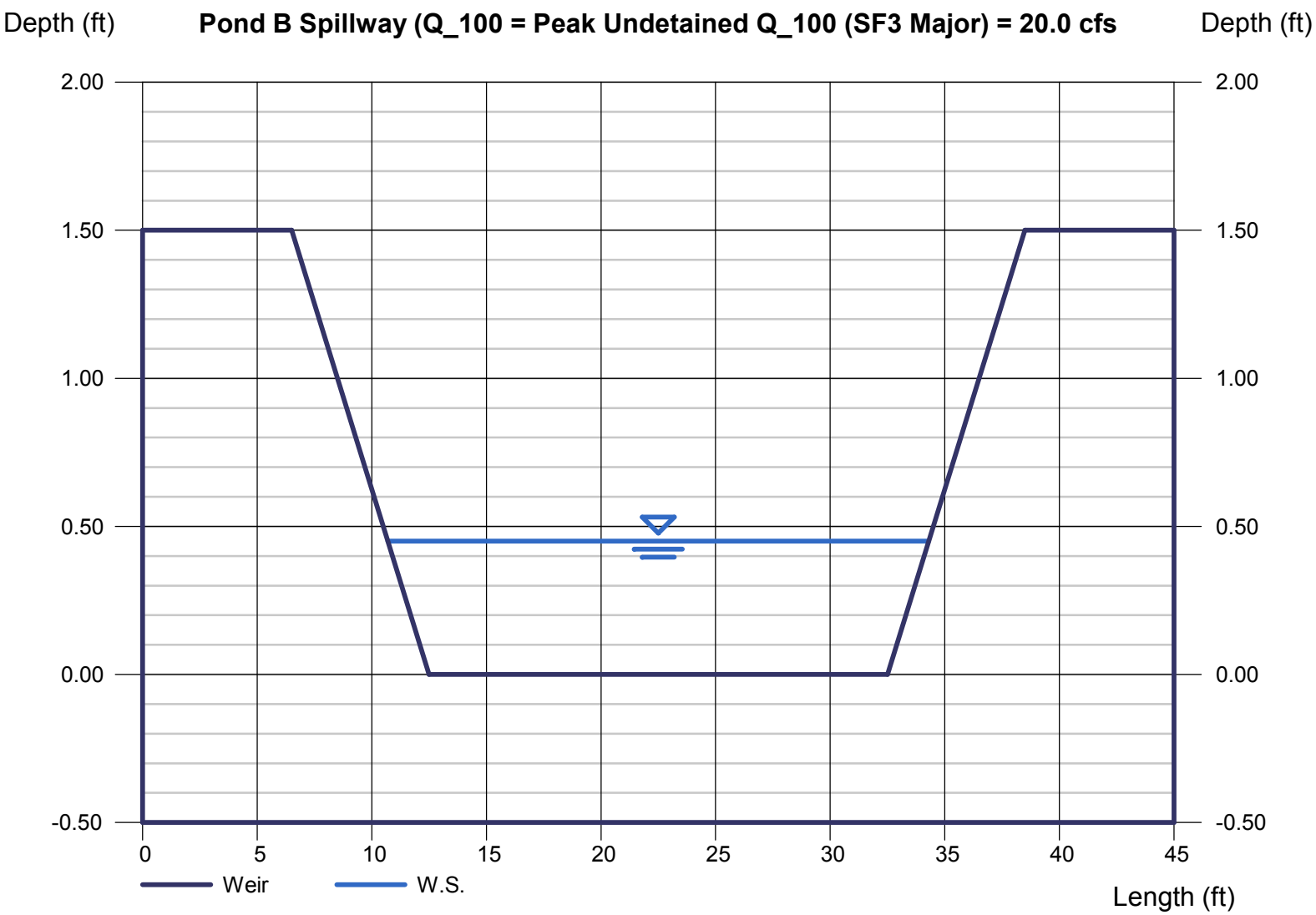
Crest	= Sharp
Bottom Length (ft)	= 20.00
Total Depth (ft)	= 1.50
Side Slope (z:1)	= 4.00

Calculations

Weir Coeff. Cw	= 3.10
Compute by:	Known Q
Known Q (cfs)	= 20.00

Highlighted

Depth (ft)	= 0.45
Q (cfs)	= 20.00
Area (sqft)	= 9.81
Velocity (ft/s)	= 2.04
Top Width (ft)	= 23.60



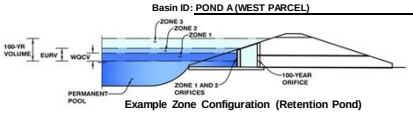
Appendix D
Water Quality & Detention

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: FEATHERGRASS URBAN DUPLEXES

Basin ID: POND A (WEST PARCEL)



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	**EDB**			
Watershed Area =	5.56	acres		
Watershed Length =	700	ft		
Watershed Slope =	0.012	ft/ft		
Watershed Imperviousness =	52.20%	percent		
Percentage Hydrologic Soil Group A =	100.0%	percent		
Percentage Hydrologic Soil Group B =	0.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Desired WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			
Water Quality Capture Volume (WQCV) =	0.098	acre-feet	Optional User Override 1-hr Precipitation	
Excess Urban Runoff Volume (EURV) =	0.339	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.231	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.304	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.373	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.463	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.574	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.703	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 0 in.) =	0.000	acre-feet		inches
Approximate 2-yr Detention Volume =	0.218	acre-feet		
Approximate 5-yr Detention Volume =	0.287	acre-feet		
Approximate 10-yr Detention Volume =	0.349	acre-feet		
Approximate 25-yr Detention Volume =	0.426	acre-feet		
Approximate 50-yr Detention Volume =	0.475	acre-feet		
Approximate 100-yr Detention Volume =	0.532	acre-feet		

Stage-Storage Calculation

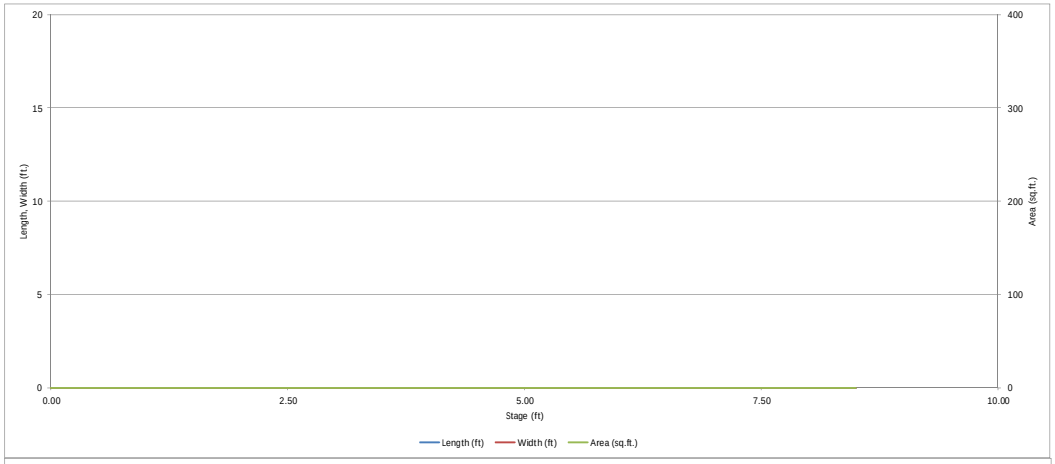
Zone 1 Volume (WQCV) =	0.098	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.240	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.194	acre-feet
Total Detention Basin Volume =	0.532	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

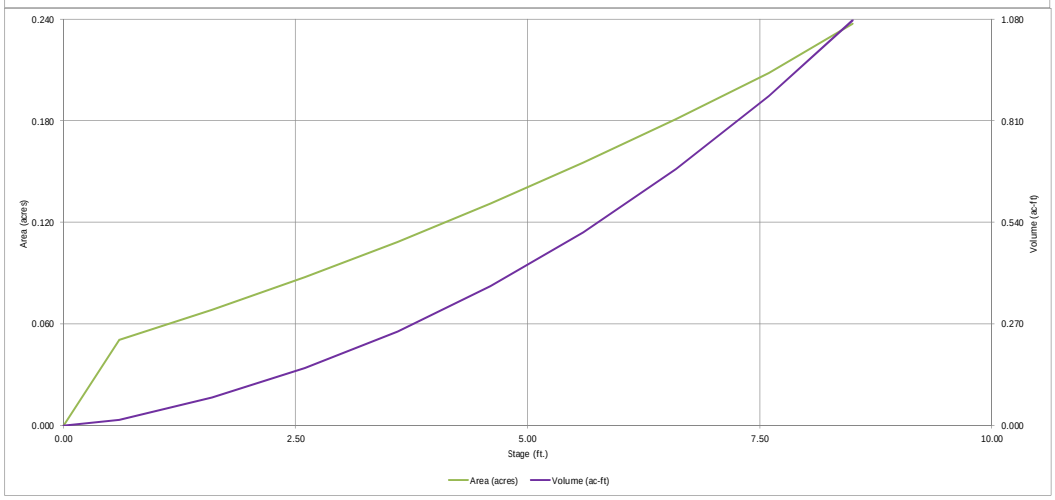
Depth Increment = 0.1 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
6444.4 **Top of Micropool**	--	0.00	--	--	--	0	0.000		
6445	--	0.60	--	--	--	2,202	0.051	639	0.015
6446	--	1.60	--	--	--	2,973	0.068	3,218	0.074
6447	--	2.60	--	--	--	3,813	0.088	6,641	0.152
6448	--	3.60	--	--	--	4,724	0.108	10,909	0.250
6449	--	4.60	--	--	--	5,704	0.131	16,123	0.370
6450	--	5.60	--	--	--	6,755	0.155	22,353	0.513
6451	--	6.60	--	--	--	7,874	0.181	29,667	0.681
6452	--	7.60	--	--	--	9,070	0.208	38,139	0.876
6452.9	--	8.50	--	--	--	10,329	0.237	46,869	1.076

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



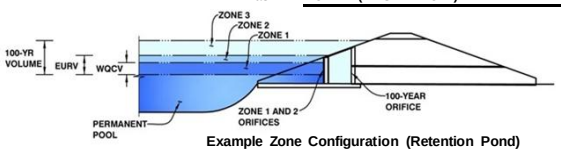


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: FEATHERGRASS URBAN DUPLEXES

Basin ID: POND A (WEST PARCEL)



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.94	0.098	Orifice Plate
Zone 2 (EURV)	4.36	0.240	Circular Orifice
Zone 3 (100-year)	5.73	0.194	Weir&Pipe (Restrict)
		0.532	Total

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	1.94	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	0.68	sq. inches (diameter = 15/16 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row =	4.722E-03	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.75	2.00					
Orifice Area (sq. inches)	0.68	0.68	0.68					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	3.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	4.36	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	0.38	N/A	inches

Calculated Parameters for Vertical Orifice

	Zone 2 Circular	Not Selected	
Vertical Orifice Area =	0.00	N/A	ft^2
Vertical Orifice Centroid =	0.02	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	5.73	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	3.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	3.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	5.73	N/A	feet
Over Flow Weir Slope Length =	3.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	34.18	N/A	should be $\geq$ 4
Overflow Grate Open Area w/o Debris =	6.30	N/A	ft^2
Overflow Grate Open Area w/ Debris =	3.15	N/A	ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	2.90		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.18	N/A	ft^2
Outlet Orifice Centroid =	0.14	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	0.83	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.10	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	20.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

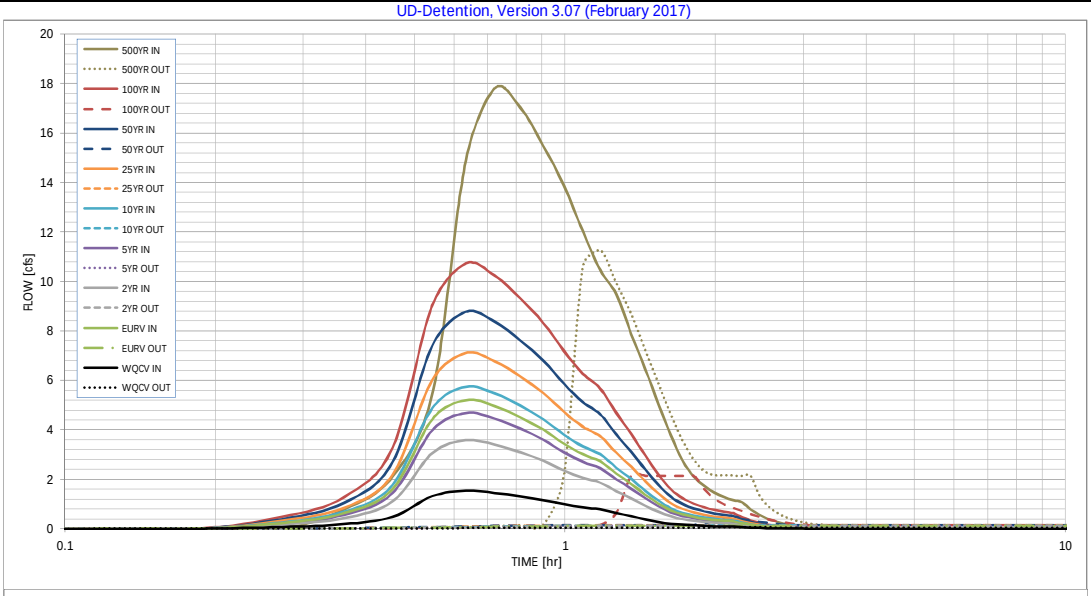
Spillway Design Flow Depth=	0.34	feet
Stage at Top of Freeboard =	7.44	feet
Basin Area at Top of Freeboard =	0.20	acres

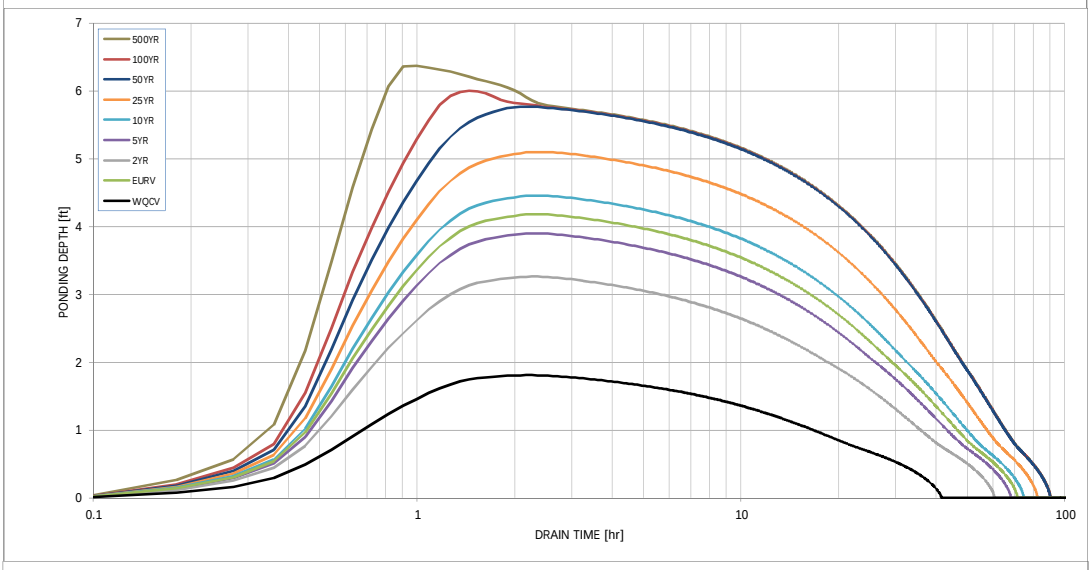
Routed Hydrograph Results

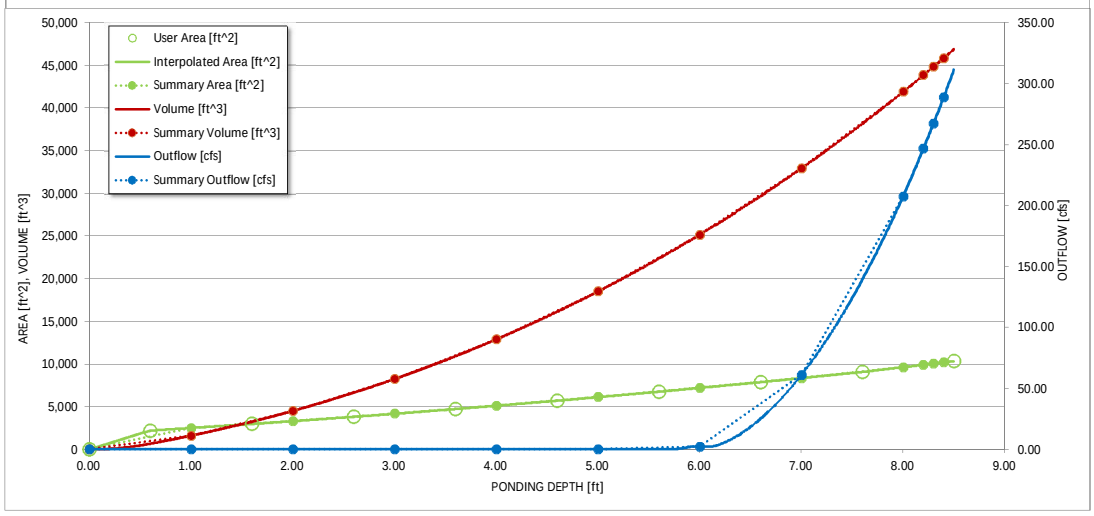
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.68
Calculated Runoff Volume (acre-ft) =	0.098	0.339	0.231	0.304	0.373	0.463	0.574	0.703	1.175
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.098	0.337	0.231	0.303	0.373	0.463	0.573	0.702	1.173
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.00	0.00	0.01	0.02	0.18	0.43	1.15
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.0	0.1	0.1	1.0	2.4	6.4
Peak Inflow Q (cfs) =	1.5	5.2	3.6	4.7	5.7	7.1	8.8	10.7	17.8
Peak Outflow Q (cfs) =	0.1	0.1	0.1	0.1	0.1	0.1	0.4	2.1	11.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	4.7	2.2	1.1	0.4	0.9	1.8
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Grate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	0.0	0.3	0.3
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	61	53	59	64	69	75	73	66
Time to Drain 99% of Inflow Volume (hours) =	40	67	57	64	70	77	84	83	79
Maximum Ponding Depth (ft) =	1.81	4.18	3.26	3.90	4.46	5.10	5.77	6.01	6.38
Area at Maximum Ponding Depth (acres) =	0.07	0.12	0.10	0.12	0.13	0.14	0.16	0.17	0.17
Maximum Volume Stored (acre-ft) =	0.089	0.317	0.215	0.284	0.351	0.439	0.540	0.577	0.640

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename: _____

Storm Inflow Hydrographs UD-Detention, Version 3.07 (February 2017)

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.43 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrograph	0:10:52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant	0:16:17	0.07	0.23	0.16	0.21	0.26	0.32	0.39	0.47	0.78
0.920	0:21:43	0.19	0.63	0.43	0.56	0.69	0.85	1.05	1.28	2.11
	0:27:09	0.48	1.61	1.11	1.45	1.77	2.19	2.69	3.28	5.41
	0:32:35	1.32	4.42	3.05	3.98	4.87	6.01	7.40	9.02	14.87
	0:38:01	1.53	5.20	3.58	4.67	5.74	7.10	8.77	10.72	17.81
	0:43:26	1.45	4.95	3.40	4.45	5.47	6.77	8.37	10.23	17.02
	0:48:52	1.32	4.51	3.10	4.05	4.98	6.16	7.62	9.32	15.50
	0:54:18	1.16	4.01	2.75	3.60	4.43	5.50	6.80	8.33	13.88
	0:59:44	0.99	3.45	2.36	3.09	3.81	4.73	5.87	7.19	12.03
	1:05:10	0.87	3.01	2.06	2.70	3.33	4.13	5.11	6.26	10.46
	1:10:35	0.78	2.72	1.86	2.44	3.01	3.74	4.63	5.68	9.49
	1:16:01	0.63	2.23	1.52	2.00	2.47	3.08	3.82	4.69	7.87
	1:21:27	0.51	1.81	1.23	1.62	2.01	2.50	3.11	3.83	6.46
	1:26:53	0.38	1.38	0.93	1.23	1.53	1.92	2.39	2.96	5.03
	1:32:19	0.27	1.02	0.68	0.91	1.13	1.42	1.78	2.20	3.79
	1:37:44	0.20	0.74	0.50	0.66	0.82	1.03	1.29	1.59	2.75
	1:43:10	0.16	0.58	0.39	0.52	0.64	0.80	1.00	1.23	2.11
	1:48:36	0.13	0.48	0.32	0.43	0.53	0.66	0.82	1.02	1.73
	1:54:02	0.11	0.41	0.27	0.36	0.45	0.56	0.70	0.86	1.46
	1:59:28	0.10	0.36	0.24	0.32	0.40	0.49	0.61	0.76	1.28
	2:04:53	0.09	0.32	0.22	0.29	0.36	0.44	0.55	0.68	1.15
	2:10:19	0.08	0.30	0.20	0.27	0.33	0.41	0.51	0.63	1.06
	2:15:45	0.06	0.22	0.15	0.20	0.24	0.30	0.37	0.46	0.78
	2:21:11	0.05	0.16	0.11	0.14	0.18	0.22	0.27	0.34	0.57
	2:26:37	0.03	0.12	0.08	0.10	0.13	0.16	0.20	0.25	0.42
	2:32:02	0.02	0.09	0.06	0.08	0.09	0.12	0.15	0.18	0.31
	2:37:28	0.02	0.06	0.04	0.05	0.07	0.08	0.11	0.13	0.22
	2:42:54	0.01	0.04	0.03	0.04	0.05	0.06	0.07	0.09	0.16
	2:48:20	0.01	0.03	0.02	0.03	0.03	0.04	0.05	0.07	0.11
	2:53:46	0.00	0.02	0.01	0.02	0.02	0.03	0.03	0.04	0.08
	2:59:11	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.05
	3:04:37	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.02
	3:10:03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	3:15:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:26:20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:31:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:37:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:42:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:48:04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:53:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:58:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:04:21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:09:47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:26:04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:31:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:36:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:42:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:47:47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:53:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:58:39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:04:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:09:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:14:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:31:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:36:40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:42:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:47:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:52:57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:58:23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:03:49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:09:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:14:40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:20:06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:25:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:30:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	0	0.000	0	0.000	0.00
	1.00	2,503	0.057	1,578	0.036	0.03
	2.00	3,301	0.076	4,471	0.103	0.06
	3.00	4,177	0.096	8,239	0.189	0.10
	4.00	5,116	0.117	12,877	0.296	0.12
	5.00	6,124	0.141	18,489	0.424	0.14
	6.00	7,203	0.165	25,144	0.577	2.15
	7.00	8,352	0.192	32,913	0.756	60.93
	8.00	9,630	0.221	41,879	0.961	207.40
	8.20	9,909	0.227	43,833	1.006	246.46
	8.30	10,049	0.231	44,831	1.029	267.24
	8.40	10,189	0.234	45,843	1.052	288.86

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

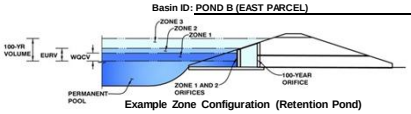
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: FEATHERGRASS URBAN DUPLEXES

Basin ID: POND B (EAST PARCEL)



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	4.90	acres
Watershed Length =	700	ft
Watershed Slope =	0.028	ft/ft
Watershed Imperviousness =	53.70%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	0.088	acre-feet
Excess Urban Runoff Volume (EURV) =	0.310	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.212	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.278	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	0.341	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	0.422	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	0.519	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	0.634	acre-feet
500-yr Runoff Volume (P1 = 0 in.) =	0.000	acre-feet
Approximate 2-yr Detention Volume =	0.200	acre-feet
Approximate 5-yr Detention Volume =	0.262	acre-feet
Approximate 10-yr Detention Volume =	0.319	acre-feet
Approximate 25-yr Detention Volume =	0.389	acre-feet
Approximate 50-yr Detention Volume =	0.432	acre-feet
Approximate 100-yr Detention Volume =	0.483	acre-feet

Optional User Override 1-hr Precipitation

1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
	inches

Stage-Storage Calculation

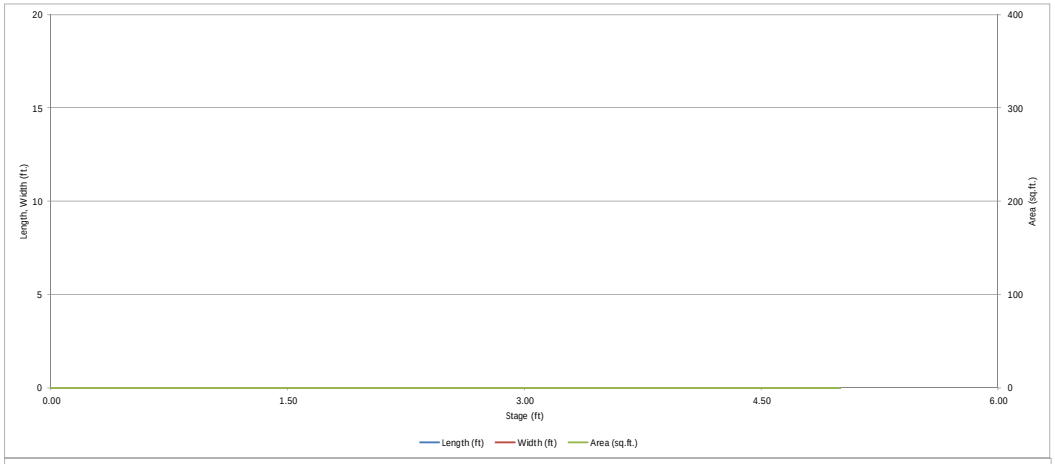
Zone 1 Volume (WQCV) =	0.088	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.221	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.173	acre-feet
Total Detention Basin Volume =	0.483	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

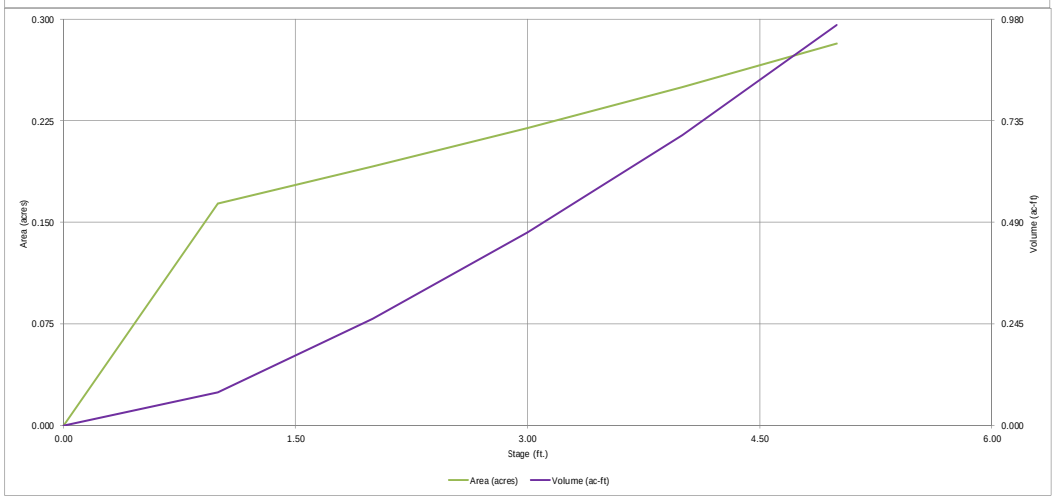
Depth Increment = 0.1 ft

	Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
6433	**Top of Micropool**	--	0.00	--	--	--	0	0.000		
	6434	--	1.00	--	--	--	7,145	0.164	3,501	0.080
	6435	--	2.00	--	--	--	8,322	0.191	11,223	0.258
	6436	--	3.00	--	--	--	9,570	0.220	20,252	0.465
	6437	--	4.00	--	--	--	10,888	0.250	30,481	0.700
	6438	--	5.00	--	--	--	12,278	0.282	42,064	0.966

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



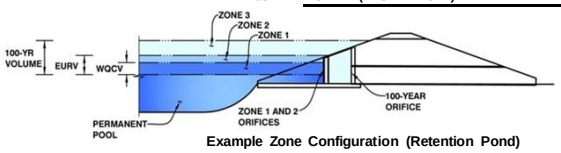


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: FEATHERGRASS URBAN DUPLEXES

Basin ID: POND B (EAST PARCEL)



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.04	0.088	Orifice Plate
Zone 2 (EURV)	2.26	0.221	Circular Orifice
Zone 3 (100-year)	3.09	0.173	Weir&Pipe (Restrict)
		0.483	Total

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	1.04	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	5.20	inches
Orifice Plate: Orifice Area per Row =	0.64	sq. inches (diameter = 7/8 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row =	4.444E-03	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.35	0.69					
Orifice Area (sq. inches)	0.64	0.64	0.64					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	1.04	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	2.26	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	0.69	N/A	inches

Calculated Parameters for Vertical Orifice

	Zone 2 Circular	Not Selected	
Vertical Orifice Area =	0.00	N/A	ft^2
Vertical Orifice Centroid =	0.03	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.10	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	3.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	3.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.10	N/A	feet
Over Flow Weir Slope Length =	3.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	26.07	N/A	should be $\geq$ 4
Overflow Grate Open Area w/o Debris =	6.30	N/A	ft^2
Overflow Grate Open Area w/ Debris =	3.15	N/A	ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	3.50		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.24	N/A	ft^2
Outlet Orifice Centroid =	0.17	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	0.91	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.50	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	20.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

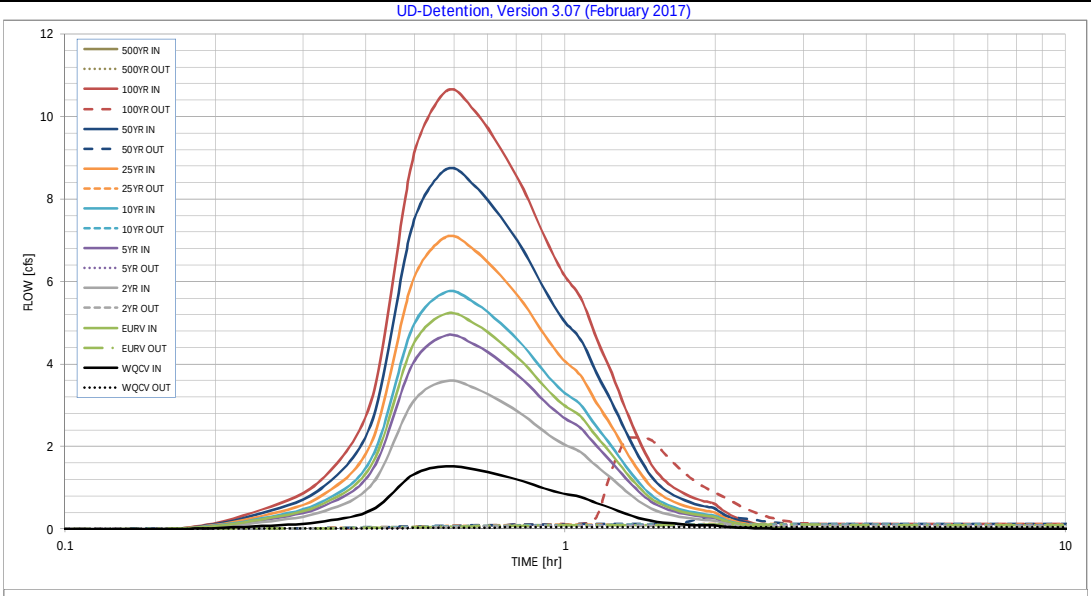
Spillway Design Flow Depth=	0.30	feet
Stage at Top of Freeboard =	4.80	feet
Basin Area at Top of Freeboard =	0.28	acres

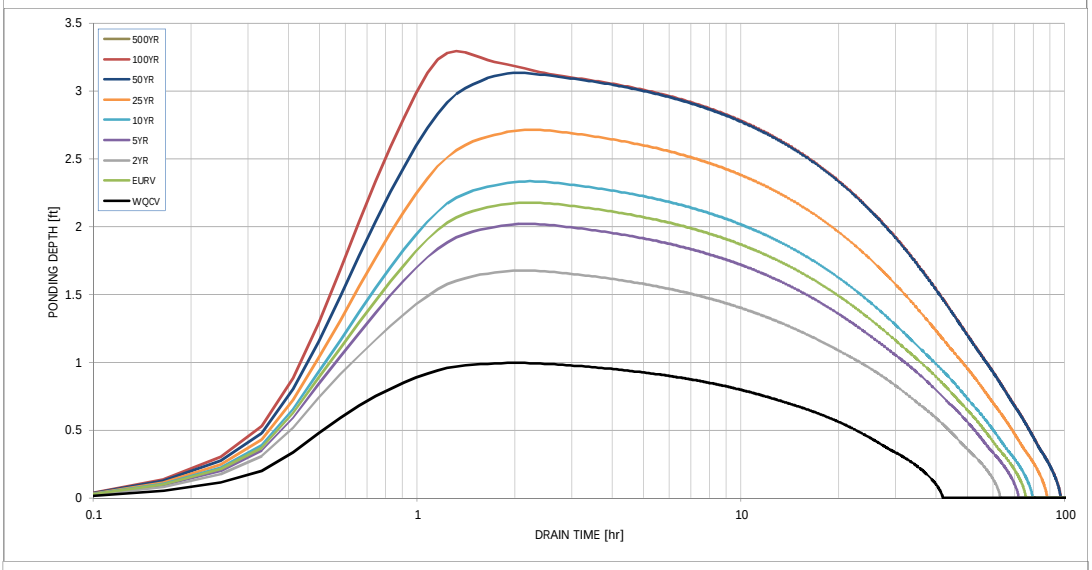
Routed Hydrograph Results

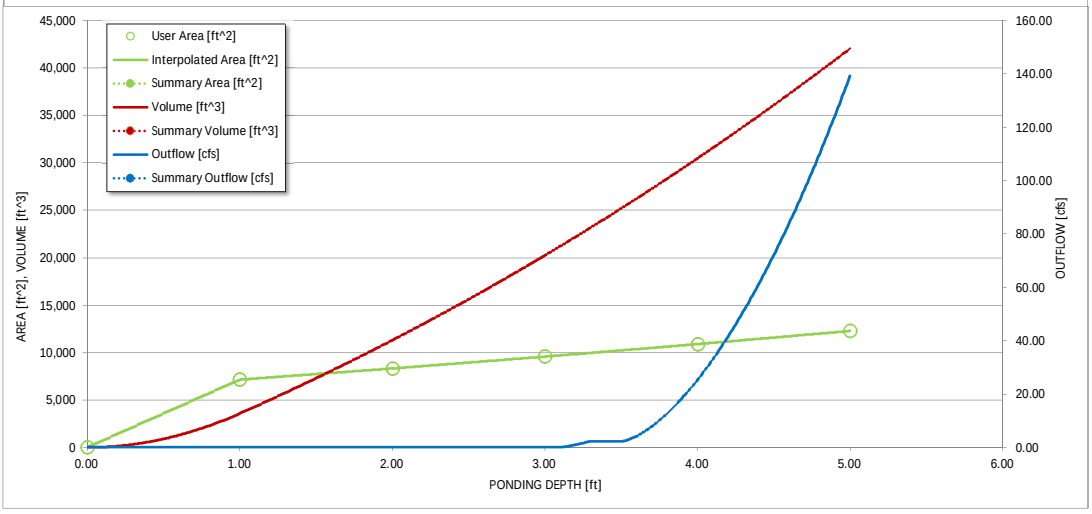
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	0.00
Calculated Runoff Volume (acre-ft) =	0.088	0.310	0.212	0.278	0.341	0.422	0.519	0.634	0.000
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.088	0.309	0.211	0.277	0.341	0.421	0.520	0.634	#N/A
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.00	0.01	0.01	0.03	0.20	0.48	0.00
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.0	0.1	0.1	1.0	2.4	0.0
Peak Inflow Q (cfs) =	1.5	5.2	3.6	4.7	5.7	7.1	8.7	10.6	#N/A
Peak Outflow Q (cfs) =	0.1	0.1	0.1	0.1	0.1	0.1	0.3	2.2	#N/A
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	3.8	1.8	0.9	0.3	0.9	#N/A
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Grate 1	Outlet Plate 1	#N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	0.0	0.3	#N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	#N/A
Time to Drain 97% of Inflow Volume (hours) =	37	64	54	61	67	73	80	79	#N/A
Time to Drain 99% of Inflow Volume (hours) =	40	71	59	67	74	82	89	88	#N/A
Maximum Ponding Depth (ft) =	1.00	2.18	1.68	2.02	2.33	2.71	3.14	3.29	#N/A
Area at Maximum Ponding Depth (acres) =	0.16	0.20	0.18	0.19	0.20	0.21	0.22	0.23	#N/A
Maximum Volume Stored (acre-ft) =	0.080	0.292	0.198	0.261	0.324	0.402	0.494	0.530	#N/A

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

Storm Inflow Hydrographs UD-Detention, Version 3.07 (February 2017)

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	#N/A
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
4.96 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	0:04:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
Hydrograph	0:09:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
Constant	0:14:53	0.07	0.24	0.16	0.21	0.26	0.32	0.39	0.47	#N/A
1.009	0:19:50	0.19	0.63	0.43	0.57	0.69	0.85	1.04	1.27	#N/A
	0:24:48	0.48	1.61	1.11	1.45	1.78	2.18	2.68	3.25	#N/A
	0:29:46	1.31	4.44	3.06	4.00	4.88	6.00	7.37	8.94	#N/A
	0:34:43	1.52	5.22	3.59	4.69	5.75	7.08	8.72	10.61	#N/A
	0:39:41	1.44	4.97	3.41	4.47	5.48	6.75	8.31	10.13	#N/A
	0:44:38	1.31	4.52	3.10	4.06	4.98	6.14	7.57	9.22	#N/A
	0:49:36	1.15	4.02	2.75	3.61	4.44	5.47	6.75	8.23	#N/A
	0:54:34	0.98	3.46	2.36	3.10	3.81	4.71	5.82	7.11	#N/A
	0:59:31	0.86	3.02	2.06	2.71	3.33	4.11	5.08	6.19	#N/A
	1:04:29	0.78	2.73	1.86	2.45	3.01	3.72	4.60	5.61	#N/A
	1:09:26	0.63	2.24	1.52	2.00	2.47	3.06	3.79	4.63	#N/A
	1:14:24	0.50	1.81	1.23	1.62	2.01	2.49	3.09	3.78	#N/A
	1:19:22	0.37	1.38	0.93	1.23	1.53	1.90	2.37	2.91	#N/A
	1:24:19	0.27	1.01	0.68	0.90	1.13	1.41	1.76	2.17	#N/A
	1:29:17	0.20	0.74	0.50	0.66	0.82	1.02	1.28	1.57	#N/A
	1:34:14	0.16	0.58	0.39	0.52	0.64	0.80	0.99	1.22	#N/A
	1:39:12	0.13	0.48	0.32	0.43	0.53	0.66	0.82	1.00	#N/A
	1:44:10	0.11	0.41	0.27	0.36	0.45	0.56	0.69	0.85	#N/A
	1:49:07	0.10	0.36	0.24	0.32	0.39	0.49	0.61	0.75	#N/A
	1:54:05	0.09	0.32	0.22	0.29	0.36	0.44	0.55	0.67	#N/A
	1:59:02	0.08	0.30	0.20	0.27	0.33	0.41	0.51	0.62	#N/A
	2:04:00	0.06	0.22	0.15	0.20	0.24	0.30	0.37	0.45	#N/A
	2:08:58	0.04	0.16	0.11	0.14	0.18	0.22	0.27	0.33	#N/A
	2:13:55	0.03	0.12	0.08	0.11	0.13	0.16	0.20	0.24	#N/A
	2:18:53	0.02	0.09	0.06	0.08	0.09	0.12	0.15	0.18	#N/A
	2:23:50	0.02	0.06	0.04	0.05	0.07	0.08	0.10	0.13	#N/A
	2:28:48	0.01	0.04	0.03	0.04	0.05	0.06	0.07	0.09	#N/A
	2:33:46	0.01	0.03	0.02	0.03	0.03	0.04	0.05	0.06	#N/A
	2:38:43	0.00	0.02	0.01	0.02	0.02	0.03	0.03	0.04	#N/A
	2:43:41	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.03	#N/A
	2:48:38	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.01	#N/A
	2:53:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	2:58:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:03:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:08:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:13:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:18:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:23:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:28:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:33:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:38:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:43:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:48:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:53:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:58:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:03:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:08:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:12:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:17:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:22:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:27:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:32:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:37:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:42:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:47:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:52:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:57:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:02:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:07:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:12:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:17:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:22:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:27:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:32:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:37:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:42:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:47:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:52:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:57:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

Appendix E
Reference Material

El Paso County Drainage Basin Fees

Resolution No. 18-470

Basin Number	Receiving Waters	Year Studied	Drainage Basin Name	2019 Drainage Fee (per Impervious Acre)	2019 Bridge Fee (per Impervious Acre)
Drainage Basins with DBPS's:					
CHMS0200	Chico Creek	2013	Haegler Ranch	$10,324	$1,524
CHWS1200	Chico Creek	2001	Bennett Ranch	$11,558	$4,433
CHWS1400	Chico Creek	2013	Falcon	$29,622	$4,069
FOFO2000	Fountain Creek	2001	West Fork Jimmy Camp Creek	$12,564	$3,717
FOFO2600	Fountain Creek	1991*	Big Johnson / Crews Gulch	$18,350	$2,370
FOFO2800	Fountain Creek	1988*	Widefield	$18,350	$0
FOFO2900	Fountain Creek	1988*	Security	$18,350	$0
FOFO3000	Fountain Creek	1991*	Windmill Gulch	$18,350	$275
FOFO3100 / FOFO3200	Fountain Creek	1988*	Carson Street / Little Johnson	$11,192	$0
FOFO3400	Fountain Creek	1984*	Peterson Field	$13,235	$1,004
FOFO3600	Fountain Creek	1991*	Fisher's Canyon	$18,350	$0
FOFO4000	Fountain Creek	1996	Sand Creek	$18,940	$5,559
FOFO4200	Fountain Creek	1977	Spring Creek	$9,517	$0
FOFO4600	Fountain Creek	1984*	Southwest Area	$18,350	$0
FOFO4800	Fountain Creek	1991	Bear Creek	$18,350	$1,004
FOFO5400	Fountain Creek	1977	21st Street	$5,521	$0
FOFO5600	Fountain Creek	1964	19th Street	$3,611	$0
FOFO5800	Fountain Creek	1964	Camp Creek	$2,033	$0
FOMO0400	Monument Creek	1986*	Mesa	$9,598	$0
FOMO1000	Monument Creek	1981	Douglas Creek	$11,540	$255
FOMO1200	Monument Creek	1977	Templeton Gap	$11,847	$275
FOMO1400	Monument Creek	1976	Pope's Bluff	$3,676	$627
FOMO1600	Monument Creek	1976	South Rockrimmon	$4,314	$0
FOMO1800	Monument Creek	1973	North Rockrimmon	$5,521	$0
FOMO2000	Monument Creek	1971	Pulpit Rock	$6,085	$0
FOMO2200	Monument Creek	1994	Cottonwood Creek / S. Pine	$18,350	$1,004
FOMO2400	Monument Creek	1966	Dry Creek	$14,486	$524
FOMO3600	Monument Creek	1989*	Black Squirrel Creek	$8,331	$524
FOMO3700	Monument Creek	1987*	Middle Tributary	$15,312	$0
FOMO3800	Monument Creek	1987*	Monument Branch	$18,350	$0
FOMO4000	Monument Creek	1996	Smith Creek	$7,481	$1,004
FOMO4200	Monument Creek	1989*	Black Forest	$18,350	$500
FOMO5200	Monument Creek	1993*	Dirty Woman Creek	$18,350	$1,004
FOMO5300	Fountain Creek	1993*	Crystal Creek	$18,350	$1,004
Miscellaneous Drainage Basins: [1]					
CHBS0800	Chico Creek		Book Ranch	$17,217	$2,492
CHEC0400	Chico Creek		Upper East Chico	$9,380	$272
CHWS0200	Chico Creek		Telephone Exchange	$10,306	$241
CHWS0400	Chico Creek		Livestock Company	$16,976	$202
CHWS0600	Chico Creek		West Squirrel	$8,849	$3,672
CHWS0800	Chico Creek		Solberg Ranch	$18,350	$0
FOFO1200	Fountain Creek		Crooked Canyon	$5,540	$0
FOFO1400	Fountain Creek		Calhan Reservoir	$4,625	$270
FOFO1600	Fountain Creek		Sand Canyon	$3,342	$0
FOFO2000	Fountain Creek		Jimmy Camp Creek[3]	$18,350	$858
FOFO2200	Fountain Creek		Fort Carson	$14,486	$524
FOFO2700	Fountain Creek		West Little Johnson	$1,209	$0
FOFO3800	Fountain Creek		Stratton	$8,801	$394
FOFO5000	Fountain Creek		Midland	$14,486	$524
FOFO6000	Fountain Creek		Palmer Trail	$14,486	$524
FOFO6800	Fountain Creek		Black Canyon	$14,486	$524
FOMO4600	Monument Creek		Beaver Creek	$10,970	$0
FOMO3000	Monument Creek		Kettle Creek	$9,909	$0
FOMO3400	Monument Creek		Elkhorn	$1,665	$0
FOMO5000	Monument Creek		Monument Rock	$7,953	$0
FOMO5400	Monument Creek		Palmer Lake	$12,717	$0
FOMO5600	Monument Creek		Raspberry Mountain	$4,278	$0
PLPL0200	Monument Creek		Bald Mountain	$9,116	$0
Interim Drainage Basins: [2]					
FOFO1800	Fountain Creek		Little Fountain Creek	$2,346	$0
FOMO4400	Monument Creek		Jackson Creek	$7,263	$0
FOMO4800	Monument Creek		Teachout Creek	$5,044	$758

1. The miscellaneous drainage fee previous to September 1999 resolution was the average of all drainage fees for basins with Basin Planning Studies perform

2. Interim Drainage Fees are based upon draft Drainage Basin Planning Studies or the Drainage Basin Identification and Fee Estimation Report. (Best availabl

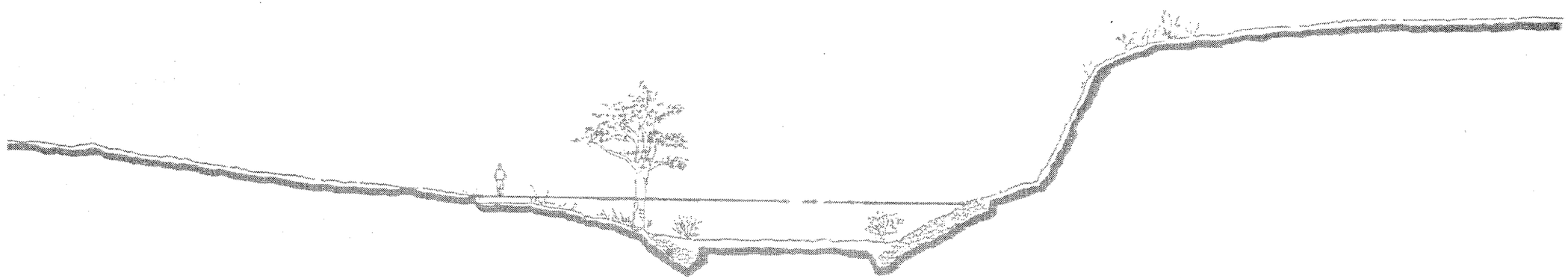
3. This is an interim fee and will be adjusted when a DBPS is completed. In addition to the Drainage Fee a surety in the amount of $7,285 per impervious acre sh the DBPS results in a fee greater than the current fee. Fees paid in excess of the future revised fee will be reimbursed. See Resolution 06-326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

EPC Stormwater Management *Jennifer Irvine, P.E.*

SAND CREEK DRAINAGE BASIN PLANNING STUDY

PRELIMINARY DESIGN REPORT

CITY OF COLORADO SPRINGS, EL PASO COUNTY, COLORADO



PREPARED FOR:

City of Colorado Springs
Department of Comprehensive Planning, Development and Finance
Engineering Division
30 S. Nevada
Colorado Springs, Colorado 80903

PREPARED BY:

Kiowa Engineering Corporation
1011 North Weber
Colorado Springs, CO 80903

II. STUDY AREA DESCRIPTION

The Sand Creek drainage basin is a left-bank tributary to the Fountain Creek lying in the west-central portions of El Paso County. Sand Creek's drainage area at Fountain Creek is approximately 54 square miles of which approximately 18.8 square miles are inside the City of Colorado Springs corporate limits. The basin is divided into five major sub-basins, the Sand Creek mainstem, the East Fork Sand Creek, the Central Tributary to East Fork, the West Fork, and the East Fork Subtributary. Figure II-1 shows the location of the Sand Creek basin.

Basin Description

The Sand Creek basin covers a total of 54 square miles in unincorporated El Paso County and Colorado Springs, Colorado. Of this total, approximately 28 square miles is encompassed by the Sand Creek basin, and 26 square miles for the East Fork Sand Creek basin. The basin trends in generally a south to southwesterly direction, entering the Fountain Creek approximately two miles upstream of the Academy Boulevard bridge over Fountain Creek. Two main tributaries drain the basin, those being the mainstem of Sand Creek and East Fork Sand Creek. Development presence in most evident along the mainstream. At this time, approximately 25 percent of the basin is developed. This alternative evaluation focuses upon the Sand Creek basin only.

The maximum basin elevation is approximately 7,620 feet above mean sea level, and falls to approximately 5,790 feet at the confluence with Fountain Creek. The headwaters of the basin originate in the conifer covered areas of The Black Forest. The middle eastern portions of the basin are typified by rolling range land with fair to good vegetative cover associated with semi-arid climates.

Climate

This area of El Paso County can be described, in general as high plains, with total precipitation amounts typical of a semi-arid region. Winters are generally cold and dry. Precipitation ranges from 14 to 16 inches per year, with the majority of this precipitation occurring in spring and summer in the form of rainfall. Thunderstorms are common during the summer months, and are typified by quick-moving low pressure cells which draw moisture from the Gulf of Mexico into the region. Average temperatures range from about 30°F in the winter to 75° in the summer. The relative humidity ranges from about 25 percent in the summer to 45 percent in the winter.

Soils and Geology

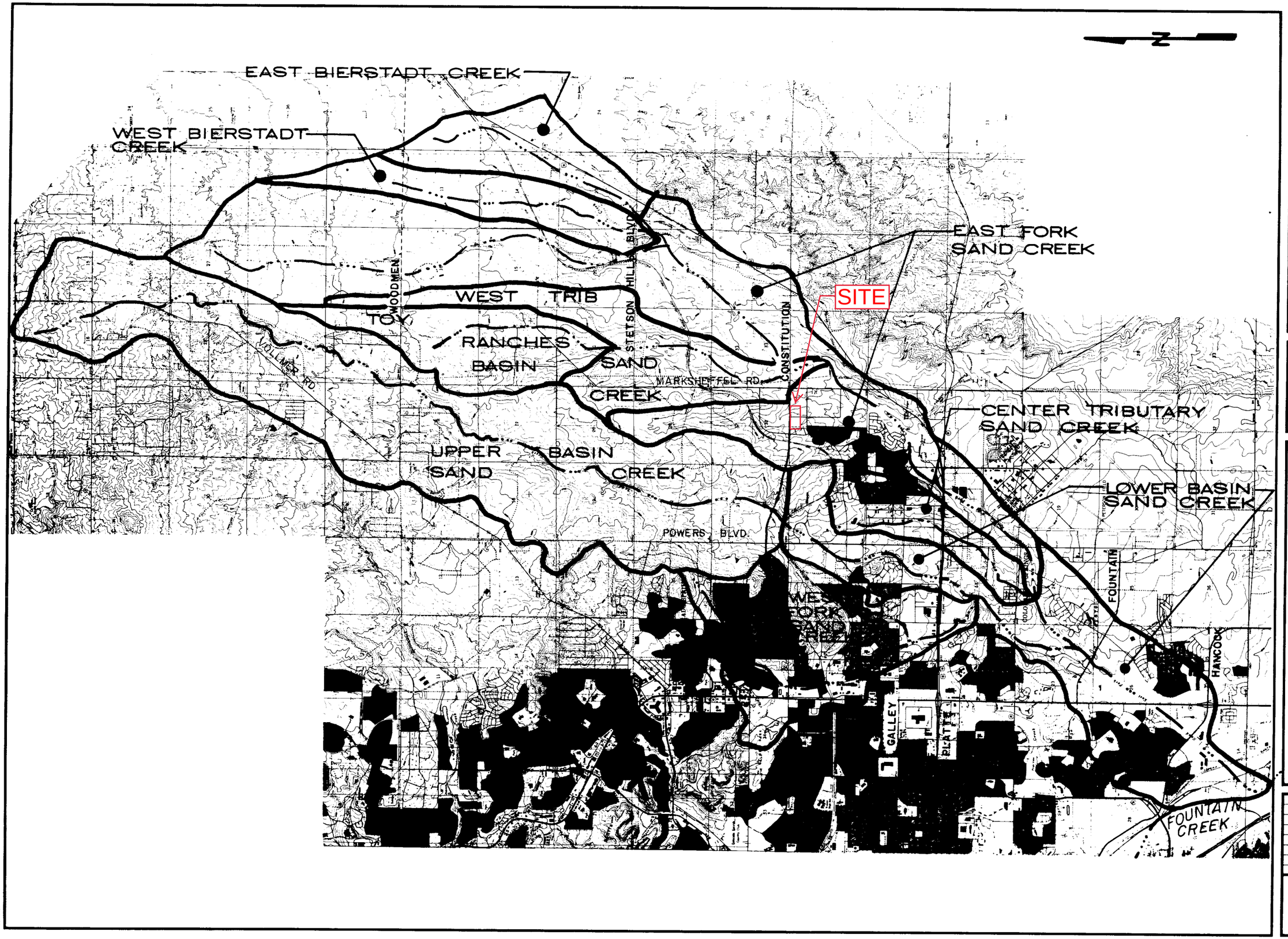
Soils within the Sand Creek basin vary between soil types A through D, as identified by the U. S. Department of Agriculture, Soil Conservation Service. The predominant soil groupings are in the Truckton and Bresser soil associations. The soils consist of deep, well drained soils that formed in alluvium and residium, derived from sedimentary rock. The soils have high to moderate infiltration rates, and are extremely susceptible to wind and water erosion where poor vegetation cover exists. In undeveloped areas, the predominance of Type A and B soils give this basin a lower runoff per unit area as compared to basins with soils dominated by Types C and D. Presented on Figure II-2 is the Hydrologic Soil distribution map for the Sand Creek basin.

Property Ownership and Impervious Land Densities

Property ownership along the major drainageway within the Sand Creek basin vary from public to private. Along the developed reaches, drainage right-of-ways and greenbelts have been dedicated during the development of the adjacent residential and commercial land. Where development has not occurred, the drainageways remain under private ownership with no delineated drainage right-of-way or easements. There are several public parks which abut the mainstem of Sand Creek. Roadway and utility easements abutting or crossing the major drainageways occur most frequently in the developed portions of the basin.

Land use information for the existing and future conditions were reviewed as part of the planning effort. This information is used in the hydrologic analysis to predict runoff rates and volumes for the purposes of facility evaluation. The identification of land uses abutting the drainageways is also useful in the identification of feasible plans for stabilization and aesthetic treatment of the creek. Presented on Figure II-3 is the proposed land use map used in the evaluation of impervious land densities discussed in the hydrologic section of this report. Figure II-3 is not intended to reflect the future zoning or land use policies of the City or the County.

The land use information within the Banning-Lewis Ranch property was obtained from Aries Properties during the time the draft East Fork Sand Creek Drainage Basin Planning Study was being prepared. The land use information was again reviewed with the City of Colorado Springs Department of Planning and was found to be appropriate for use in the estimation of hydrology for the East Fork Basin. The location of future arterial streets and roadways within



Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

SAND CREEK DRAINAGE BASIN PLANNING STUDY

REGIONAL SUB-BASINS

Project No	90-04-09
Date:	11/90
Design:	
Drawn:	EAK
Check:	
Revisions:	

11

FIG. III-1

RECEIVED
Mar 20, 2008
EPC DEVELOPMENT SERVICES

NEW DOC

HANNAH RIDGE AT FEATHERGRASS
MASTER DRAINAGE DEVELOPMENT PLAN

November 15, 2007
Project No. 60754

PREPARED FOR:

FEATHERGRASS INVESTMENTS, LLC
4715 North Chestnut Street
Colorado Springs, CO 80907
(719) 593-8367

Kenneth P. Driscoll, Manager

PREPARED BY:

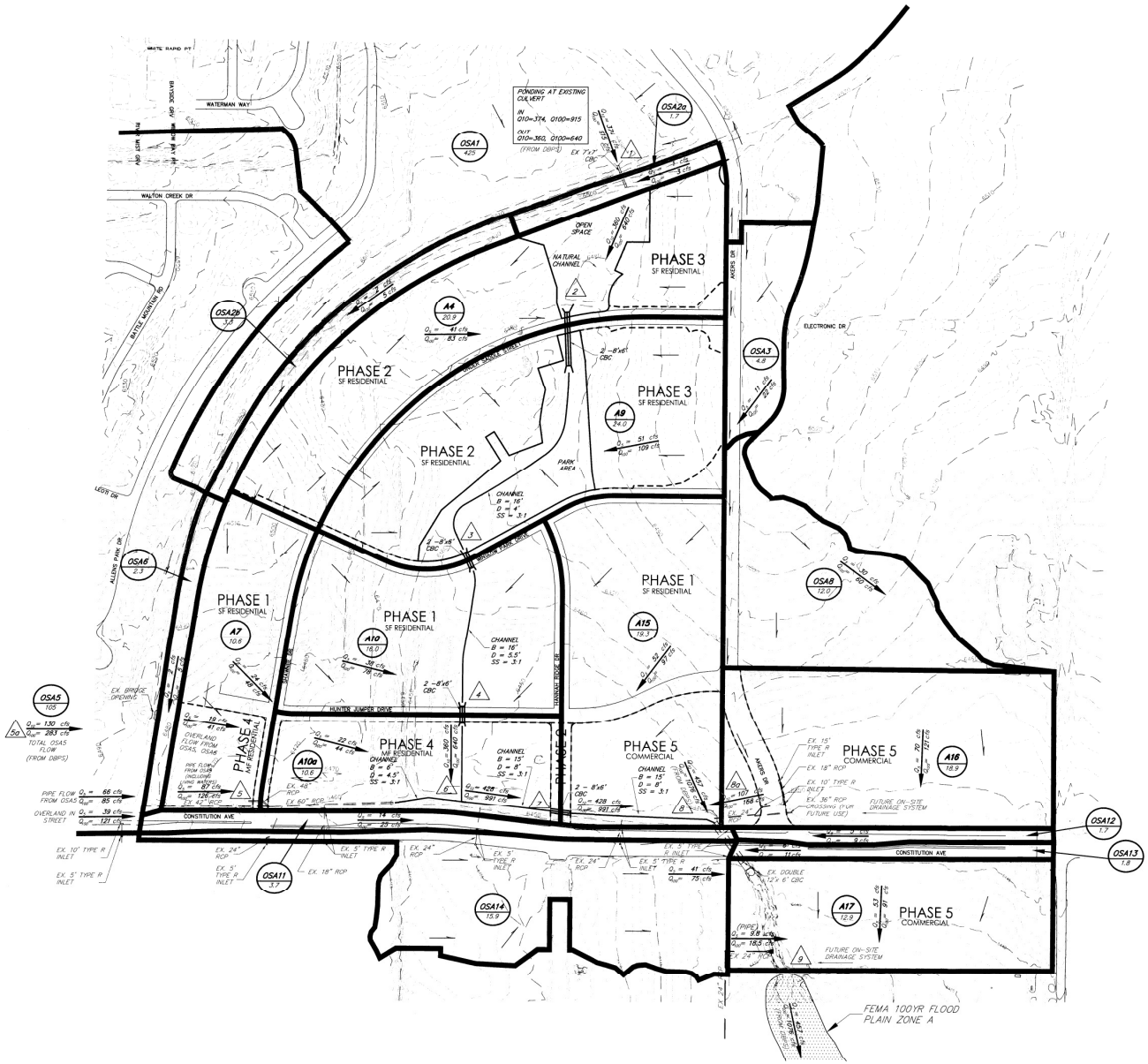
M.V.E., Inc.
1903 Lelaray Street, Suite 200
Colorado Springs, CO 80909
(719) 635-5736

discharges of $Q_5 = 2$ cfs and $Q_{100} = 5$ cfs. Basin OSA8, on the east side of Akers Drive, drains south onto the eastern section of the property with peak discharges of $Q_5 = 30$ cfs and $Q_{100} = 60$ cfs. Flows from Basin OSA3 and a portion of Basin OSA8 enters Akers Drive. The existing Akers Drive and Akers drainage improvements were designed by M.V.E., Inc. and approved by El Paso County D.O.T. in September 2006. The system was designed to capture and convey developed flows in Akers Drive. One 10 ft Type R inlet and one 15 ft Type R inlet, connected by an 18" RCP are installed on the east side of Akers, just north of the Constitution intersection. A 10 ft Type R inlet is located on the west side of Akers. The flows collected by the inlets are discharged at the CBC opening, just to the west, with a 24" RCP. The inlets and connecting pipes are adequate to collect and route developed 100 year flows of 20.9 cfs to the creek. In the 100-year event, bypass flows of 5.1 cfs reaches Constitution and travels west to the sump inlet at the CBC crossing. Off-site basins OSA11, OSA12, and OSA13 contain portions of Constitution Avenue. These basins drain to the existing double 12' x 6' CBC under Constitution Avenue. Runoff from Basin OSA14 drains easterly onto the southern portion of the proposed project located on the south side of Constitution Avenue with flows of $Q_5 = 14$ cfs and $Q_{100} = 27$ cfs. Basin OSA14 is currently undeveloped commercial property, just north of the Jessica Heights Filing Nol. 1 residential subdivision. A storm drain pipe from Jessica Heights delivers an additional $Q_5 = 9.8$ cfs and $Q_{100} = 18.5$ cfs to the Tributary 6 channel. These flow enter the property and then travel to the creek flowing to the south.

IV. ON-SITE DRAINAGE BASINS

The existing site drains southerly and easterly from the old Rock Island Railroad that bounds the property on the north and west. Tributary 6 to the East Fork of Sand Creek runs north to south through the property to Constitution Avenue. Offsite storm discharges from the Tributary enter onsite Basin A4 at Design Point 1 (the existing 7'x7' CBC). The existing channel area from the railroad culvert to existing Electronic Drive will be maintained in nearly existing condition. Basin A4 will contain single family residential development with open space components and produce runoff quantities of $Q_5 = 41$ cfs and $Q_{100} = 83$ cfs. Flows from Basin A4, along with the Tributary flows will drain to Design Point 2 at proposed Under Saddle Street. A new CBC beneath the street will allow runoff into Basin A9, where flows will enter a park area by way of an improved channel from the DP 2 culvert. Basin A9 contains single family residential development and open space. Developed runoff discharges of $Q_5 = 51$ cfs and $Q_{100} = 109$ cfs are generated by the basin. A storm

MASTER DEVELOPMENT DRAINAGE PLAN



SCALE

200' 100' 0 100' 200' 400'
150' 50'
1" = 200' 1:2400

NORTH

DEVELOPED SITE HYDROLOGY DATA

DESIGN POINT	AREA (Ac)	Q_{10} (cfs)	Q_{100} (cfs)	INCL. BASINS
1	425.0 (Q_{10})	360	640	OSA1
2	450.9 (Q_{10})	360	640	OSA1, OSA2a, OSA2b, A4
3	474.9 (Q_{10})	360	640	OSA1, OSA2, OSA2b, A4, A9
4	490.9 (Q_{10})	360	640	OSA1, OSA2, A4, A9, A10
5a	105.0 (Q_{10})	130	283	OSA5
5	117.9 (Q_{10})	130	283	OSA5, OSA6, A7
6	619.4 (Q_{10})	428	991	OSA1, OSA2, OSA3, A4, OSA5, OSA6, A7, A9, A10
7	619.4 (Q_{10})	428	991	OSA1, OSA2, OSA3, A4, OSA5, OSA6, A7, A9, A10
8a	35.7 (Q_{10})	107	168	OSA3, OSA8, A16
8	679.8 (Q_{10})	457	1076	OSA1, OSA2, OSA3, A4, OSA5, OSA6 A7, OSA8, A9, A10, A10a, OSA11, OSA12 A15, A16
9	710.4 (Q_{10})	457	1076	OSA1, OSA2, OSA3, A4, OSA5, OSA6 A7, OSA8, A9, A10, A10a, OSA11, OSA12 OSA13, OSA14, A15, A16, A17

LEGEND

- 7,300 — EXISTING INDEX CONTOUR
- EXISTING INTERMEDIATE CONTOUR
- EXISTING STORM DRAIN CURB INLET
- EX 24" RCP — EXISTING STORM DRAIN LINE
- EXISTING PROPERTY LINE
- EXISTING ROAD
- PROPOSED CULVERT W/ RIPRAP APRON
- PROPOSED DRAINAGE CHANNEL
- PROPOSED PROJECT PHASE LINE
- DRAINAGE BASIN BOUNDARY
- OSA2 14.9 — DRAINAGE BASIN DESIGNATION
- A5 2.56 — DRAINAGE BASIN AREA
- Q_{10} = 3.3 cfs, Q_{100} = 7.4 cfs — FLOW DIRECTION AND QUANTITIES
- FLOW DIRECTION
- 8 — DESIGN POINT DESIGNATION

PROJECT: HANNAH RIDGE

TITLE: MDDP DEVELOPED MAP

MONUMENT VALLEY ENGINEERS INC.
ENGINEERS • SURVEYORS
3570 LAKEWOOD DRIVE
COLORADO SPRINGS, COLORADO 80909
PHONE (719) 635-5736

DISK NO.
XREF'S

PROJ. NO. 60754
DRAWN: DRG
ENGINEER: DRG
CHECKED:
SCALE: 1" = 200'
DATE: 11/15/07
REVISIONS:

NO.:	DATE:	ITEM

SHEET 1 OF 1

DRAWING NO. 60754077

JESSICA HEIGHTS FILING NO. 1
FINAL DRAINAGE REPORT

April 27, 2005
Project No. 60742

PREPARED FOR:

Sand Creek Investments South, LLC
%
Equity Investments
90 South Cascade, Suite 1500
Colorado Springs, CO 80903

PREPARED BY:

M.V.E., Inc.
1903 Lelaray Street, Suite 200
Colorado Springs, CO 80909
(719) 635-5736

roads will be paved county streets within 50 to 80 foot of right-of-ways. Curb & gutter will be constructed on the streets and route storm water flows to storm water inlets. Grading operations will be done in order to improve drainage conditions and to direct runoff to a desired location. Overlot grading will be necessary for subdivision development.

The included **Drainage Map - Developed Condition** shows the proposed road scheme, lot layout, and developed drainage basins with basin designations. The basin sizes and estimated peak storm runoff flows are shown in the table below and on the included map.

Table 3.1 - Developed Condition Hydrologic Data

Design Point or Basin		Cumulative Drainage Area (Ac)	5-yr Discharge (cfs)	100-yr Discharge (cfs)
	OSA	0.15	0.6	1.1
	OSB	0.46	1.8	3.3
	OSC	0.88	3.3	6.0
	A1	0.96	2.0	4.0
	A2	5.25	3.2	7.6
	A3	0.51	1.4	2.8
	A4	O.32	1.3	2.3
	B1	2.27	4.1	8.2
DP 2	B2	0.70	2.0	3.8
DP 3a	B3a	0.77	1.7	3.4
DP 3b	B3b	2.53	4.8	9.6
	B3c	1.35	3.2	6.6
DP3	B3+3b+3c	4.65	8.4	16.9
	B4	0.51	1.4	2.7
	B5	1.06	2.5	5.0
DP5	B6	0.53	1.4	2.6
DP6	B8	1.98	3.9	7.8

Table 3.1 - Developed Condition Hydrologic Data				
Design Point or Basin		Cumulative Drainage Area (Ac)	5-yr Discharge (cfs)	100-yr Discharge (cfs)
DP7	B9	1.29	3.3	6.3
DP8	B10	1.75	3.7	7.6
	B11	1.88	3.9	7.9
DP10	B12	2.48	4.9	9.8
DP11	B13	2.30	5.1	10.2
	B14	0.98	2.4	4.9
	B15	0.24	1.1	2.1
	C1	5.99	2.8	6.8
	OSA+OSB+C1	6.19	3.6	8.1
DP1	OSC+B1	3.15	6.6	12.8
	OSC1+B1+B2+B4	4.36	8.7	17.1
DP4	OSC1+B1+B2+B4+B5	5.42	10.3	20.3
	OSC1+B1+B2+B4+B5+B8	7.40	14.0	27.6
	OSC1+B1+B2+B4+B5+B8+B9	8.69	15.2	30.5
DP9	B10+B11	3.63	7.5	15.2
	A1+A2	6.21	4.6	10.6
	B10+B11+B13+B15+A3	6.68	13.8	27.9

The future lot owners in Jessica Heights Filing No. 1 will adhere to proper construction technics and erosion control. The recommendations within this report need to be followed by the new lot owners. We also recommend that the existing down gradient lot owners not construct their homes in existing drainage swales or flow paths.

The developed conditions will route storm water flows over the site in sheet flow and shallow concentrated flow, depending on the topography and the contributing flow areas. These flows will be routed to the streets. The five and one hundred year frequency storm water flows will be collected and routed to the offsite earthen channel.

The nature of this development dictates that some lots will contribute storm flows onto other lots. This cross-lot drainage cannot be avoided. It is the responsibility of the individual lot owners and the building contractors to locate new structures on each lot so that the structures do not interfere with the proposed drainage pathways. The individual lot owners and contractors should provide positive drainage away from all structures. Individual lot owners are also responsible for maintaining their properties in such a manner that does not allow soil movement from one lot to another.

3.2 Offsite

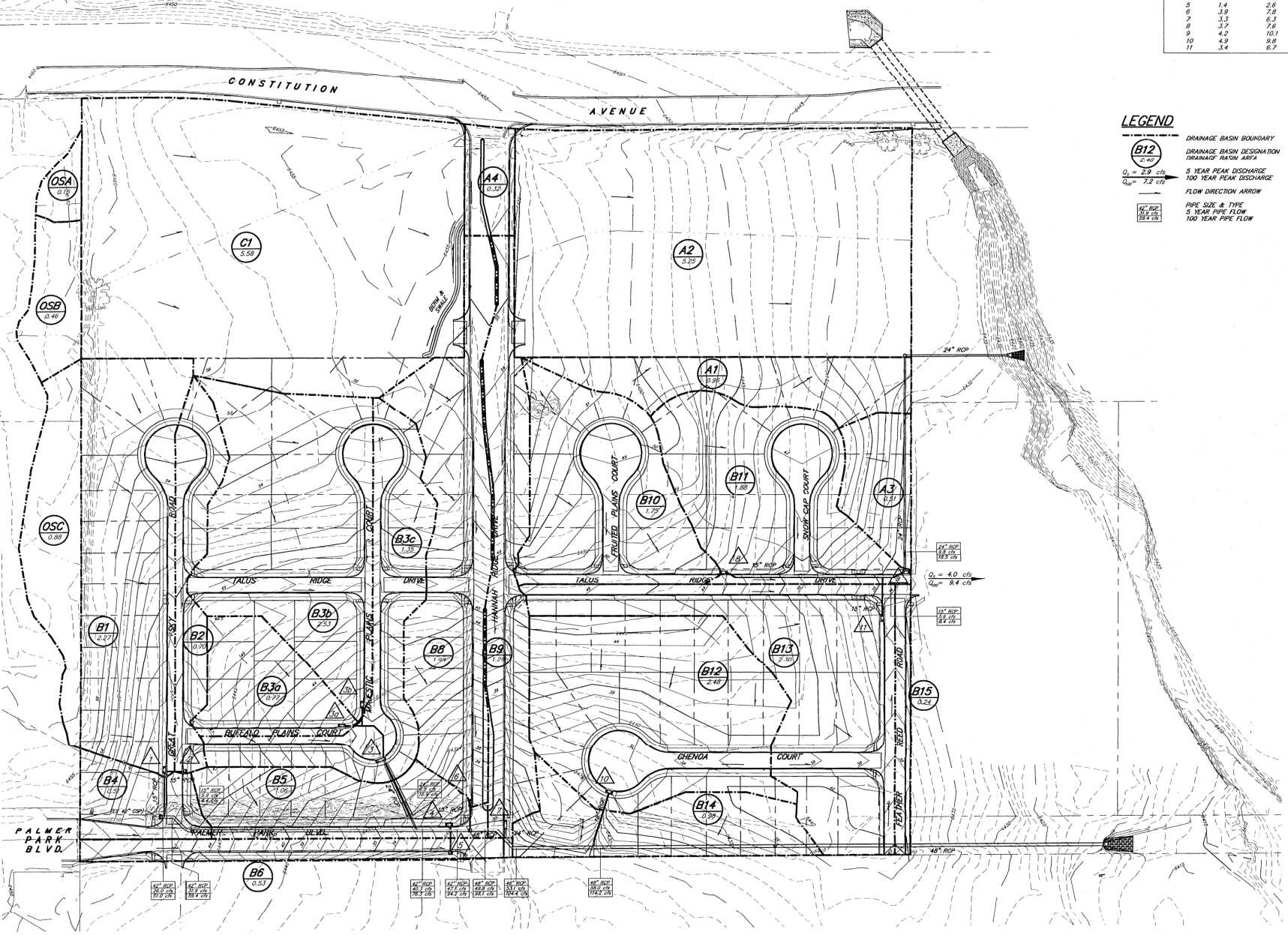
The offsite pipe flow will continue to drain easterly. The pipe will be extended easterly and shall, in addition to the offsite flow, carry the proposed pipe flows from Jessica Heights. The small strip of land adjacent to the west boundary of the site shall continue to drain onto the site as defined by Basin OSC to the north and Basin OSB to the south. Basin C1, which is not being developed at this time, will continue to drain to the east. A berm and swale will direct runoff to the northeast where the flow will enter Hannah Ridge Drive and flow north. When Basin C1 is developed, all flows will be collected and piped to the east. Basin A2 is also not to be developed at this time. Basin A2 will continue to drain to the east.

3.3 Onsite

Basin OSC overland storm water flows enter the subdivision along the western boundary of Basin B1 and travel easterly overland to Great Sky Road. These flows then travel southerly in the street section of said Great Sky Road to a 10' inlet at Design Point No.1. The inlet intercepts Q_5 = 4.5 cfs / Q_{100}= 6.5 cfs of the calculated storm water runoff.

Basin B2 overland storm water flows enter Great Sky Road from the adjacent lots and travel southerly in the street section of said Great Sky Road to a 5' inlet at Design Point No. 2. The inlet intercepts Q_5 = 1.4 cfs / Q_{100}= 1.9 cfs of the calculated storm water runoff. This collected inlet runoff flows via a 15" reinforced concrete pipe (RC Pipe) to the 10' inlet at Design Point No. 1. The combined collected flows of Design Point No's 1 & 2 then flow in a 24" RC Pipe which connects to a Type I Manhole along with the extended existing 42" corrugated metal pipe in Palmer Park Boulevard. A 42" RC Pipe continues east in Palmer Park Boulevard.

Basins B3a, B3b and B3c overland storm water flows enter Buffalo Plains Court, Majestic plains Court, and Talus Ridge Drive. These flows travel via street section easterly, westerly, and



PROPOSED DRAINAGE INLET DATA

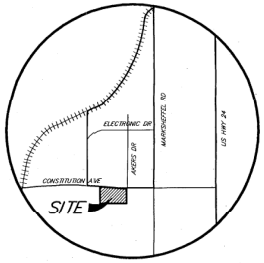
POINT OF INTEREST	Q5 W/ INLETS	Q100 W/ INLETS	INLET SIZE	Q5 INTERCEPTED	Q5 BYPASS	Q100 INTERCEPTED	Q100 BYPASS
1	6.6	12.8	10	4.5	2.1	6.5	6.3
2	2.0	3.8	5	1.4	0.6	1.9	1.9
3a	1.7	3.4	10	1.6	0.1	2.6	0.8
3b	4.8	9.6	10	3.1	1.7	4.5	5.1
3	1.7	9.4	15 (SUMP)	1.7	0.0	9.4	0.0
4	5.4	15.3	10 (SUMP)	5.4	0.0	15.3	0.0
5	1.4	2.6	5 (SUMP)	1.4	0.0	2.6	0.0
6	3.9	7.8	10	2.7	1.2	3.9	3.9
7	3.3	6.3	15 (SUMP)	3.3	0.0	6.3	0.0
8	3.7	7.6	10	2.3	1.4	3.3	4.3
9	4.2	10.1	10 (SUMP)	4.2	0.0	10.1	0.0
10	4.9	9.8	10 (SUMP)	4.9	0.0	9.8	0.0
11	3.4	6.7	10	3.3	0.1	5.1	1.6

LEGEND

- DRAINAGE BASIN BOUNDARY
- B12 / 2.40 — DRAINAGE BASIN DESIGNATION / DRAINAGE BASIN AREA
- Q_5 = 2.9 cfs, Q_{100} = 7.2 cfs — 5 YEAR PEAK DISCHARGE / 100 YEAR PEAK DISCHARGE
- FLOW DIRECTION ARROW
- 42" RCP, 5.8 cfs, 59.4 cfs — PIPE SIZE & TYPE / 5 YEAR PIPE FLOW / 100 YEAR PIPE FLOW

DEVELOPED DRAINAGE BASIN DATA

	BASIN	AREA	Q5	Q100
	OSA	0.15	0.6	1.1
	OSB	0.46	1.8	3.3
	OSC	0.88	3.3	6.0
	A1	0.96	2.0	4.0
	A2	5.25	3.2	7.6
	A3	0.51	1.4	2.8
	A4	0.32	1.3	2.3
	B1	2.27	4.1	8.2
2	B2	0.70	2.0	3.8
3a	B3a	0.77	1.7	3.4
3b	B3b	2.53	4.8	9.6
	B3c	1.35	3.2	6.6
	B4	0.51	1.4	2.7
	B5	1.06	2.5	5.0
5	B6	0.53	1.4	2.6
6	B8	1.98	3.9	7.8
7	B9	1.29	3.3	6.3
8	B10	1.75	3.7	7.6
	B11	1.88	3.9	7.9
10	B12	2.48	4.9	9.8
11	B13	2.30	5.1	10.2
	B14	0.98	2.4	4.9
	B15	0.24	1.1	2.1
	C1	5.99	2.8	6.8
	OSA+OSB+C1	6.19	3.6	8.1
3 / 1	B3a+B3b+B3c	4.65	8.4	16.9
	OSC+B1	3.15	6.6	12.8
	OSC+B1+B2+B4	4.36	8.7	17.1
4	OSC+B1+B2+B4+B5	5.42	10.3	20.3
	OSC+B1+B2+B4+B5+B8	7.40	14.0	27.6
	OSC+B1+B2+B4+B5+B8+B9	8.69	15.2	30.5
9	B10+B11	3.63	7.5	15.2
	A1+A2	6.21	4.6	10.6
	B10+B11+B13+B15+A3	6.68	13.8	27.9



VICINITY MAP
N.T.S.

NORTH

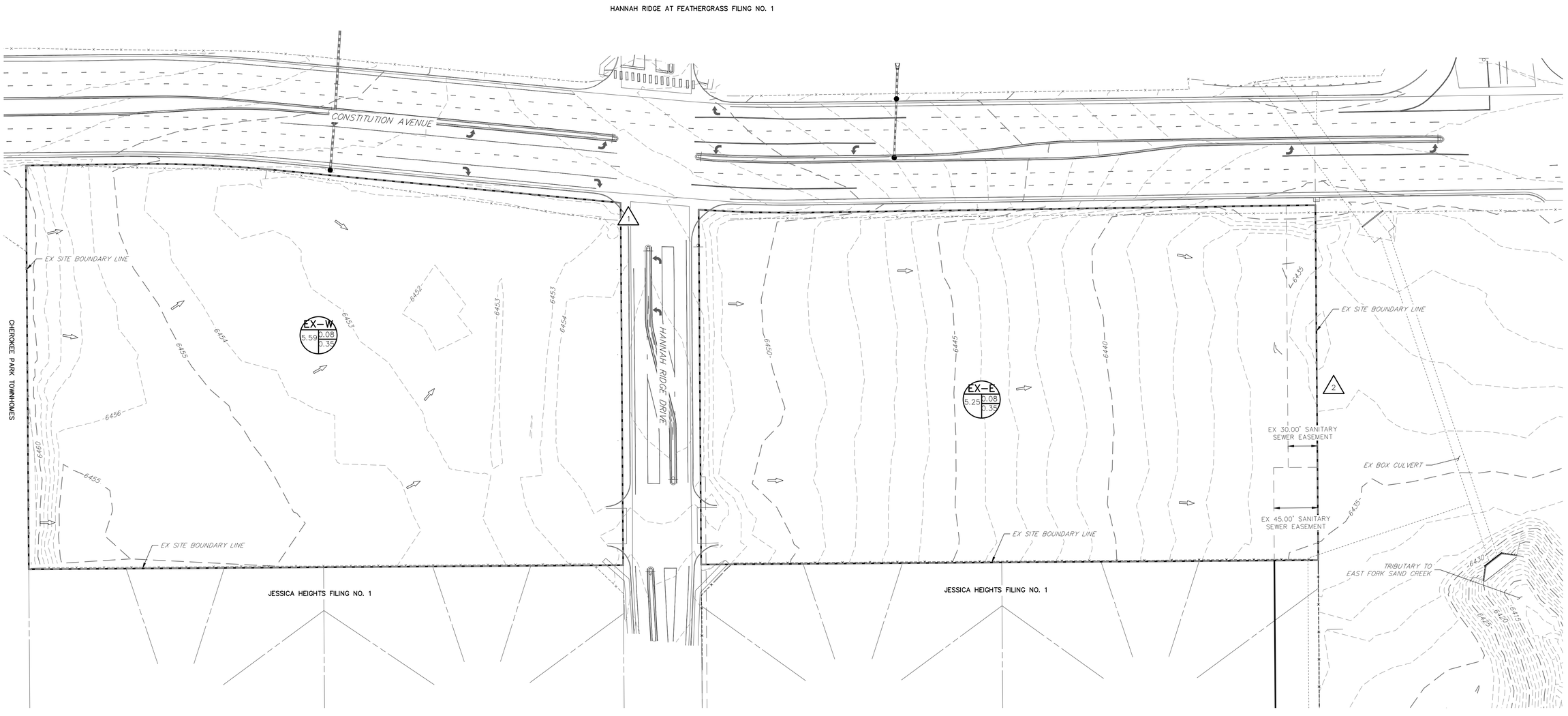
SCALE

80' 40' 0 40' 80' 160'
60' 20'
1"=80' 1:960

Appendix F
Drainage Maps

RICHMOND HOMES AT FEATHERGRASS

EXISTING DRAINAGE MAP



BASIN SUMMARY TABLE

Tributary Sub-basin	Area (acres)	Percent Impervious	C_5	C_{100}	t_c (min)	Q_5 (cfs)	Q_{100} (cfs)
EX-W	5.59	0%	0.08	0.35	34.7	1.0	7.4
EX-E	5.25	0%	0.08	0.35	19.6	1.3	9.6

DESIGN POINT SUMMARY TABLE

DP	Q5	Q100
1	1.0	7.4
2	1.3	9.6

N

50 25 0 50

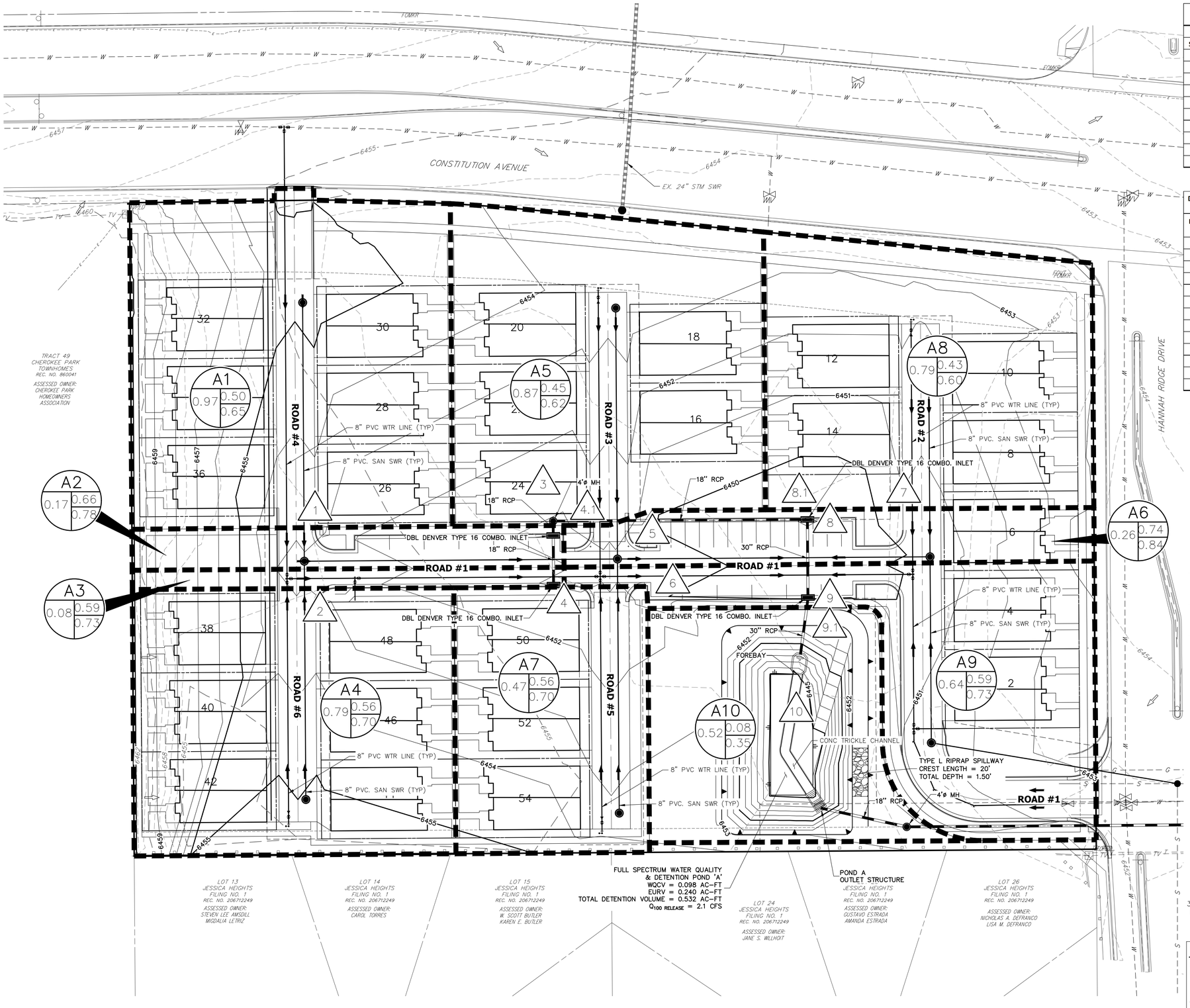
ORIGINAL SCALE: 1" = 50'

EXISTING DRAINAGE MAP
RICHMOND HOMES AT FEATHERGRASS
JOB NO. 25149.01
10/11/19
SHEET 1 OF 1

J·R ENGINEERING
A Westrian Company

Centennial 303-740-9393 • Colorado Springs 719-593-2593
Fort Collins 970-491-9888 • www.jrengineering.com

X:\2510000.all\2514901\Drawings\Sheet Dwgs\Drainage\Existing\DrainageMap.dwg, 24x36 Title Landscape, 10/11/2019 2:57:44 PM, CS



BASIN 'A' SUMMARY TABLE

Tributary Sub-basin	Area (acres)	Percent Impervious	C_5	C_{100}	t_c (min)	Q_5 (cfs)	Q_{100} (cfs)
A1	0.97	55%	0.50	0.65	11.2	1.9	4.2
A2	0.17	71%	0.66	0.78	5.0	0.6	1.2
A3	0.08	63%	0.59	0.73	5.0	0.2	0.5
A4	0.79	63%	0.56	0.70	10.0	1.8	3.8
A5	0.87	49%	0.45	0.62	12.9	1.5	3.4
A6	0.26	83%	0.74	0.84	7.9	0.9	1.6
A7	0.47	63%	0.56	0.70	10.9	1.1	2.2
A8	0.79	45%	0.43	0.60	13.0	1.3	3.0
A9	0.64	64%	0.59	0.73	5.5	1.9	3.9
A10	0.52	0%	0.08	0.35	6.8	0.2	1.4

DESIGN POINT SUMMARY TABLE

Design Point	Q_5 (cfs)	Q_{100} (cfs)
1	1.9	4.2
2	1.9	3.8
3	2.2	4.8
4	2.0	4.0
4.1	3.4	5.8
5	1.9	5.1
6	0.3	3.3
7	1.3	3.0
8	3.7	9.2
8.1	7.0	14.7
9	2.6	6.2
9.1	9.5	2.4
10	9.6	21.5

LEGEND

- I.D. (A / B / C) — BASIN DESIGNATION
  - I.D.: BASIN IDENTIFIER
  - A: BASIN AREA
  - B: C_5
  - C: C_{100}
- X — DESIGN POINT
- BASIN DELINEATION
- 6100 — EXISTING INDEX CONTOURS
- EXISTING INTERMEDIATE CONTOURS
- 6100 — PROPOSED INDEX CONTOURS
- PROPOSED INTERMEDIATE CONTOURS
- PROPOSED SANITARY SEWER
- PROPOSED STORM SEWER
- PROPOSED WATER LINE
- EXISTING FLOW DIRECTION
- PROPOSED FLOW DIRECTION

30 15 0 30 60

ORIGINAL SCALE: 1" = 30'

Know what's below. Call before you dig.

ENGINEER'S STATEMENT

PREPARED UNDER MY DIRECT SUPERVISION AND ON BEHALF OF JR ENGINEERING

GLENN D. ELLIS, P.E.
COLORADO P.E. 38861
FOR AND ON BEHALF OF JR ENGINEERING, LLC

DATE

COLORADO GLENN D. ELLIS 38861 REGISTERED PROFESSIONAL ENGINEER

UNTIL SUCH TIME AS THESE DRAWINGS ARE APPROVED BY THE APPROPRIATE REVIEWING AGENCIES, JR ENGINEERING APPROVES THEIR USE ONLY FOR THE PURPOSES DESIGNATED BY WRITTEN AUTHORIZATION.

PREPARED FOR
RICHMOND AMERICAN HOMES
4350 S. MONACO STREET
DENVER, CO 80237
(720) 977-3827
JASON.POCK@MDCH.COM

J·R ENGINEERING
A Westrian Company
Centennial 303-740-9393 • Colorado Springs 719-593-2593
Fort Collins 970-491-9888 • www.jrengineering.com

No.	REVISION	BY	DATE

H-SCALE	1" = 30'
V-SCALE	N/A
DATE	11/22/19
DESIGNED BY	NQJ
DRAWN BY	NQJ
CHECKED BY	

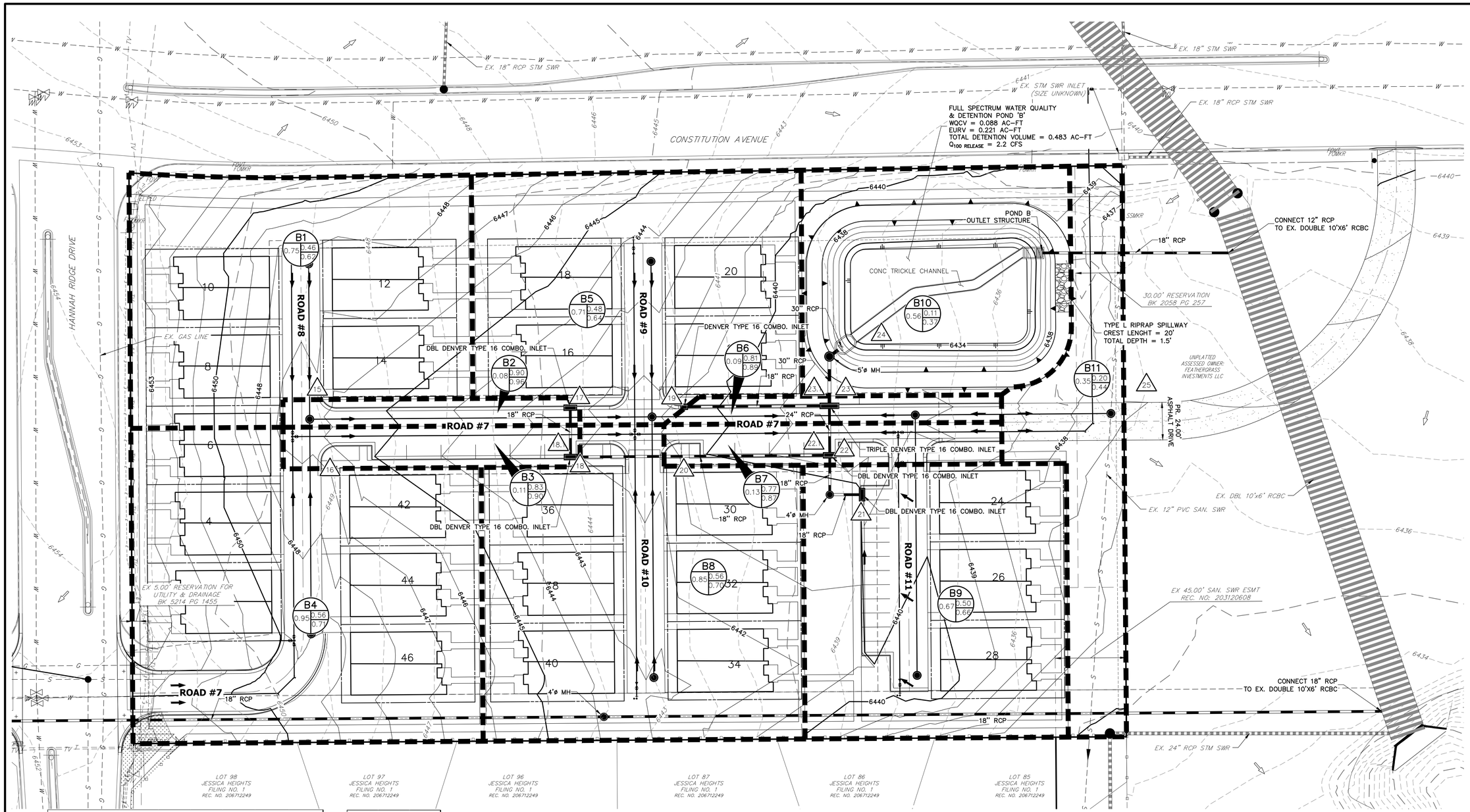
FEATHERGRASS URBAN DUPLEXES

WEST DRAINAGE MAP

SHEET 1 OF 2

JOB NO. 25149.01

X:\25100.00 all\25149.01\Drawings\sheet dwgs\Drainage\25149.01_Pr.Drainage Map.dwg, DR01, 11/20/2019 12:33:33 PM, CS



BASIN 'B' SUMMARY TABLE

Tributary Sub-basin	Area (acres)	Percent Impervious	C_5	C_{100}	t_c (min)	Q_5 (cfs)	Q_{100} (cfs)
B1	0.75	49%	0.46	0.62	12.3	1.3	3.0
B2	0.08	100%	0.90	0.96	5.0	0.4	0.7
B3	0.11	100%	0.83	0.90	5.0	0.5	0.9
B4	0.95	63%	0.57	0.71	11.6	2.1	4.4
B5	0.71	52%	0.48	0.64	11.7	1.3	3.0
B6	0.09	89%	0.81	0.89	5.0	0.4	0.7
B7	0.13	85%	0.77	0.87	5.0	0.5	1.0
B8	0.85	62%	0.56	0.70	10.9	1.9	4.0
B9	0.67	54%	0.50	0.66	5.9	1.7	3.7
B10	0.56	4%	0.11	0.37	7.4	0.3	1.6
B11	0.35	14%	0.20	0.44	5.0	0.4	1.3

DESIGN POINT SUMMARY TABLE

Design Point	Q_5 (cfs)	Q_{100} (cfs)
15	1.3	3.0
16	2.1	4.4
17	1.5	3.4
18	2.4	4.9
18.1	3.1	5.2
19	1.6	4.1
20	1.9	5.7
21	1.7	3.6
22	3.0	7.5
22.1	7.1	14.3
23	0.7	2.6
23.1	8.8	18.8
24	9.0	20.0
25	0.4	1.3

LEGEND

- I.D. (A / B / C): BASIN DESIGNATION
  - I.D.: BASIN IDENTIFIER
  - A: BASIN AREA
  - B: C_5
  - C: C_{100}
- X: DESIGN POINT
- BASIN DELINEATION
- 6100: EXISTING INDEX CONTOURS
- EXISTING INTERMEDIATE CONTOURS
- 6100: PROPOSED INDEX CONTOURS
- PROPOSED INTERMEDIATE CONTOURS
- PROPOSED SANITARY SEWER
- PROPOSED STORM SEWER
- PROPOSED WATER LINE
- EXISTING FLOW DIRECTION
- PROPOSED FLOW DIRECTION

30 15 0 30 60
ORIGINAL SCALE: 1" = 30'

Know what's below. Call before you dig.

ENGINEER'S STATEMENT

PREPARED UNDER MY DIRECT SUPERVISION AND ON BEHALF OF JR ENGINEERING

GLENN D. ELLIS, P.E.
COLORADO P.E. 38861
FOR AND ON BEHALF OF JR ENGINEERING, LLC

DATE

GLENN D. ELLIS 38861 COLORADO PROFESSIONAL ENGINEER

UNTIL SUCH TIME AS THESE DRAWINGS ARE APPROVED BY THE APPROPRIATE REVIEWING AGENCIES, JR ENGINEERING APPROVES THEIR USE ONLY FOR THE PURPOSES DESIGNATED BY WRITTEN AUTHORIZATION.

PREPARED FOR
RICHMOND AMERICAN HOMES
4350 S. MONACO STREET
DENVER, CO 80237
(720) 977-3827
JASON.POCK@MDCH.COM

J·R ENGINEERING
A Westrian Company
Centennial 303-740-9393 • Colorado Springs 719-593-2593
Fort Collins 970-491-9888 • www.jrengineering.com

No.	REVISION	BY	DATE

H-SCALE	1"=30'
V-SCALE	N/A
DATE	11/22/19
DESIGNED BY	NQJ
DRAWN BY	NQJ
CHECKED BY	

FEATHERGRASS URBAN DUPLEXES

EAST DRAINAGE MAP

SHEET 2 OF 2

JOB NO. 25149.01

x:\2510000.all\25149\01\Drawing\sheet dwgs\Drainage\25149\01_Pr Drainage Map.dwg, DR02, 11/20/2019 12:32:35 PM, CS