MASTER DRAINAGE & DEVELOPMENT PLAN FOR TUSCAN FOOTHILLS VILLAGE AND FINAL DRAINAGE REPORT FOR TUSCAN FOOTHILLS VILLAGE PHASE 1 FILING NO. 1 & PRELIMINARY DRAINAGE REPORT FOR TUSCAN FOOTHILLS VILLAGE PHASE 2 FILING NO. 2

Prepared For:

TFV1, LLC
31 N. Tejon St., Suite 500
Colorado Springs, Colorado 80903

Prepared By:

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Stantec Project Number: 181710238

May 18, 2017

SIGNATURE PAGE

Tuscan Foothills Village

ENGINEER'S STATEMENT:
This report and plan for the drainage design of Tuscan Foothills Village was prepared by me (or under my direct supervision) and is correct to the best of my knowledge and belief. Said report and plan has been prepared in accordance with the City of Colorado Springs Drainage Criteria Manual and is in conformity with the master plan of the drainage basin. I understand that the City of Colorado Springs does not and will not assume liability for drainage facilities designed by others. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

Charlene M. Durham 3/6/18
Charlene M. Durham, Colorado P.E. # 36727 Date:
For and On Behalf of Stantec Consulting, Inc

DEVELOPER'S STATEMENT:
TVF1, LLC hereby certifies that the drainage facilities for Tuscan Foothills Village shall be constructed according to the design presented in this report. I understand that the City of Colorado Springs does not and will not assume liability for the drainage facilities designed and/or certified by my engineer and that are submitted to the City of Colorado Springs pursuant to section 7.7.906 of the City Code; and cannot, on behalf of Tuscan Foothills Village, guarantee that final drainage design review will absolve TVF1, LLC and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the final plat does not imply approval of my engineer's drainage design.

TVF1, LLC
Name of Developer

3/7/2018
Authorized Signature Date

Raymond F. O'Sullivan
Printed Name

Member
Title

31 N. Tejon St., Suite 500 Colorado Springs, CO 80903
Address

COLORADO REGISTERED PROFESSIONAL ENGINEER
CHARLENE M. DURHAM
36727
3/6/18

CITY OF COLORADO SPRINGS STATEMENT:

Filed in accordance with Section 7.7.906 of the Code of the City of Colorado Springs, 2001, as amended.

Ann Bergmark 3/8/18
For the City Engineer Date

Conditions:

TUSCAN FOOTHILLS VILLAGE

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APPENDIX

MDDP FOR TUSCAN FOOTHILLS VILLAGE, FDR FOR TUSCAN FOOTHILLS VILLAGE FILING 1 & PDR FOR TUSCAN FOOTHILLS FILING 2

I. Introduction

This document is a Final Drainage Report for Tuscan Foothills Village Filing No 1, also referred to as the "Bench" Site and a Preliminary Drainage Report for Tuscan Foothills Village Filing No 2, also referred to as the "Hammerhead" Site. Filing No 1 is located along Silverstone Terrace, west of Centennial Boulevard, south of the Mule Deer Drive intersection. Filing No 2 is west and north of the Silverstone Terrace and Mule Deer Drive intersection. The purpose of this document is to identify on and offsite drainage patterns, locate and identify tributary and downstream drainage features and facilities that impact the site. In this document, the location of proposed drainage facilities will be identified and the performance of those facilities will be evaluated to ensure that storm runoff is mitigated safely and in a manner that satisfies City of Colorado Springs Drainage and Development Criteria. Filing No 1 facilities will be designed to a final level. Filing No 2 facilities have only been designed to a preliminary level with general drainage concepts. Final design of these facilities will be done through a Filing No 2 Final Drainage Report (FDR).

II. General Location and Description

Location

Tuscan Foothills Village is a proposed multi-family development located within the northwest quarter of the northwest quarter of Section 23, Township 13 South, Range 67 West of the Sixth Principal Meridian, City of Colorado Springs, County of El Paso, State of Colorado. Filing No 1 consists of approximately 28.36 acres with 15.15 acres being developed. It is adjacent to the westerly right-of-way line for Centennial Boulevard and bounded by Mule Deer Drive to the north, Bed Rock Court to the south and Mountain Shadows Open Space to the west. Filing No 2 is approximately 19.45 acres is bounded by Silverstone Terrace to the east, Filing No 1 to the south, and Mountain Shadows Open Space on the west. See also the attached Vicinity Map located in Appendix A.

Description of Property

The existing site is undeveloped and is comprised of sloping grasslands. The site's soil is comprised of a mix of Chaseville gravelly sandy loam, Chaseville-Midway complex, and Razor-Midway complex. Both Chaseville gravelly sandy loam and Chaseville-Midway complex are a part of the hydrologic soil group Type A as rated by the NRCS and Razor- Midway complex is rated as Type D soil. Type A soils are defined as having a high infiltration rate when thoroughly wet and consist mainly of deep, well drained to excessively drained sands or gravelly soils. Type D soils are defined as having a very slow infiltration rate when thoroughly wet and consist chiefly of clays that have a high shrink-swell potential, have a high water table, have a slay layer near the surface, and are shallow over nearly impervious material. The soils report can be referenced in Appendix A. The existing topography shows a gradient to the east of approximately 1-9%.

There are no major drainage ways or drainage facilities within the project site. The site is within the Douglas Creek Drainage Basin.

Based on the FEMA FIRM, map number 08041C0511F, dated March 17, 1997, the site lies within Zone X- which is defined as being outside of the 500-year flood zone. The FIRM Map can be referenced in Appendix A.

There are no known irrigation facilities located on the property.

III. Drainage Basins and Sub-basins

Major Basin Descriptions

The site lies within the Douglas Creek master drainage basin based on the 'Douglas Creek Drainage Basin Study' prepared by Leigh Whitehead & Associates dated March 1981. The Douglas Creek Drainage Basin covers approximately 10.1 square miles of mostly residential and commercial land us and is tributary to Douglas Creek which in turn is tributary to Monument Creek.

Sub-basin Description

The runoff from the existing site historically drains to the east onto Centennial Boulevard. The entire project site is covered with sparse vegetation.

Runoff from the proposed development will follow historic drainage patterns draining to the east and conveyed via drainage swales/channel, and curb and gutter to proposed inlets and piped east to on-site water quality and detention ponds. The proposed ponds will detain onsite flow and outfall into existing storm sewer facilities within Centennial Boulevard which convey flows to Douglas Creek.

IV. Drainage Design Criteria

Regulations

Storm Drainage Analysis and Design Criteria for this project were implemented from the City of Colorado Springs "Drainage Criteria Manual Volume 1" (DCM) and "Drainage Criteria Manual Volume 2" both dated May 2017 and the "Urban Storm Drainage Criteria Manual" by Urban Drainage and Flood Control District (USDCM).

Development Criteria Reference and Constraints Hydrologic Criteria

All hydrologic data was obtained from the "City of Colorado Springs Drainage Criteria Manual" Volumes 1 and 2 and the "Urban Drainage and Flood Control District Urban 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 and Figure 6-5 of the Colorado Springs Criteria. 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 of the DCM. Time of concentrations were developed using equations from the DCM. All runoff calculations and applicable charts and graphs are included in Appendix B.

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

Table 1: 1-hr Point Rainfall Data

Hydraulic Criteria

The rational method was used for they hydrologic calculations and Hydraulic Grade Line (HGL) method was used for hydraulic calculations. DCM's forms and equations were used to determine the runoff from the minor and major storms on the site and the UDFCD UD_Detention v3.05 spreadsheet was utilized in the sizing of the proposed ponds. StormCAD was used to determine the HGL's within the storm sewer system.

Storage

The proposed development will provide on-site water quality and detention in the form of two extended detention basins. Chapter 13 of the City of Colorado Springs' design criteria was referenced for designing and calculating the required water quality and detention values for this development. All applicable calculations can be referenced in Appendix C.

Waivers from Criteria

No variances are being requested for this development.

V. Drainage Facility Design

General Concept

Existing drainage patterns will be maintained. Runoff from the proposed development will be conveyed within the site via curb and gutter, collected in sump inlets and piped east towards proposed on-site water quality and detention ponds. The proposed ponds will detain onsite flows and outfall into existing storm sewer facilities within Centennial Boulevard, which convey runoff flows to Douglas Creek.

Previous Reports

Master Development Drainage Plan (MDDP) for Mountain Shadows Centennial Corridor-September 1998 by JR Engineering. This report identified the area tributary to Centennial Boulevard between the north end of Mountain Shadows Filing No. 28 and just to the south of Wickes Road. The report only identified major drainage features with no sizing or location of minor facilities.

Final Drainage Report for Mountain Shadows Filing No. 41-February 2000 by JR Engineering. This report was developed to verify that the street sections of Silverstone Terrace and Terra Cotta Drive (now known as Mule Deer Drive) did not exceed allowable maximum discharges and to size the storm drain system which connects to the existing system in Centennial Boulevard.

Preliminary Drainage Report for Tuscan Foothill Village-October 2006 by JR Engineering. This report was for onsite drainage for the area west of Centennial Boulevard, east of the Mountain Shadows Open Space, between Bedrock Court and south of Centennial Health Subdivision.

Basin Description – Existing Conditions

Basin E-1 is 17.58 acres and begins at the Mountain Shadows Open Space area to the west and continues to Centennial Boulevard on the west along the south boundary of the site. Flows are directed towards an existing 36" rcp stub, DP A. The minor storm event is 20.0 cfs and the major storm is 53.4 cfs. This corresponds to Design Point 1 in the MDDP for Mountain Shadows Centennial Corridor.

Basin E-2 is 27.83 acres and consist of the area north of E-1, also running between the open space area and Centennial Boulevard. Flows are directed towards an existing 30" rcp stub (corresponding to Design Point 2 in the MDDP report), DP B. 5-year storm generates 28.6 cfs and the 100-year storm generates 76.4 cfs.

Basin E-3 is 15.37 acres and consists of the area north of E-2 between the open space area and Silverstone Terrace. Flows are directed towards an existing 24" stub, DP C (which corresponds to DP-3 from the Mountain Shadows Filing No 41 report). The minor 5-year storm is 16.2 cfs and the major 100-year storm is 43.4 cfs.

Basin E-4 is 5.44 acres east of E-3, between basins E-2 to the south and E-5 to the north. Flows from this basin are 7.4 cfs for the 5-year event and 19.7 cfs for the 100-year event.

Basin E-5 is 2.80 acres north of basin E-4, east of E-3 and south of Mule Deer Drive. This area drains to an existing 24" RCP stub (DP D) from the existing system located in Mule Deer Drive. This corresponds to Basin OS-3 in the Filing No. 41 report. The 5-year storm generates 3.9 cfs and the 100-year storm generates 10.5 cfs.

Basin E-6 is 0.32 acres and is the south half of Mule Deer Drive. Flows are directed via curb and gutter to an existing 14' curb inlet in Centennial Drive. This corresponds to Basin E in the Filing No. 41 report. The 5-year storm for this basin is 1.4 cfs and the 100-year storm is 2.9 cfs.

Basin Description – Proposed Conditions

Phase 1 Filing No 1 (Final-Bench Site)

Runoff from the site was calculated through the previously described Rational Method and can be referenced in Appendix B. It is anticipated that all roof drains within the project will be directed/released towards the roadways. The basin delineation is as follows:

Basin D-1 consists of approximately 0.18 and includes the south portion of the west half of Silverstone Terrace. Runoff from the basin will be collected in curb and gutter and conveyed to a low point at the south end of the roadway to a proposed curb cut at Design Point A. The basin runoff is 0.8 cfs in the 5-year minor event and 1.5 cfs for the 100-year major event. Flow from this basin will release into the Filing No 1 Pond 2, at the south end of Silverstone Terrace.

Basin D-2 consists of approximately 0.69 acres and consists of residential lots and the eastern half of the south portion of Silverstone Terrace. It is assumed that the roof drains will release towards the street, therefore the building area has been accounted for in this basin. Runoff from the basin will be collected in curb and gutter and conveyed to a low point at the south end of the roadway to a proposed curb cut at Design Point A. The basin runoff is 2.8 cfs in the 5-year minor event and 5.1

cfs for the 100-year major event. Flow from this basin will release into the Phase 1 Pond 2, at the south end of Silverstone Terrace.

Basin D-3 is approximately 0.96 acres and consists of open space. Flows will be directed towards the east to Centennial Boulevard at Design Point G. The basin runoff is 2.3 cfs for the 5-year minor event and 4.6 cfs for the 100-year major event.

Basin D-4 is approximately 1.61 acres and consists of residential lots and a portion of Silverstone Terrace. Flow is directed, via curb and gutter, towards a proposed channel and pipe under the roadway at Design Point D. The basin runoff is 2.4 cfs for the 5-year minor event and 4.6 cfs for the 100-year major event.

Basin D-5 is approximately 0.73 acres and consists of residential lots and a portion of Silverstone Terrace. Flows are conveyed through curb and gutter to a sump inlet in the roadway at Design Point Y. The basin runoff is 1.4 cfs for the 5-year minor event and 2.6 cfs for the major event.

Basin D-6a is approximately 0.72 acres and consists of residential lots and a portion of Silverstone Terrace. Flow is directed through curb and gutter to an at-grade inlet at Design Point LL on the west side of the roadway. The basin runoff is 1.0 cfs for the 5-year minor event and 2.0 cfs for the 100-year major event.

Basin D-6b is approximately 0.41 acres and consists of residential lots and a portion of Silverstone Terrace. Flow is directed through curb and gutter to an at-grade inlet at Design Point L on the west side of the roadway. The basin runoff is 0.4 cfs for the 5-year minor event and 0.9 cfs for the 100-year major event.

Basin D-7a is approximately 0.30 acres and consists of residential lots and a portion of Silverstone Terrace. Flow is directed through curb and gutter to an at-grade inlet at Design Point MM on the east side of the roadway. The basin runoff is0.8 cfs for the 5-year minor event and 0.9 cfs for the 100-year major event.

Basin D-7b is approximately 0.27 acres and consists of residential lots and a portion of Silverstone Terrace. Flow is directed through curb and gutter to an at-grade inlet at Design Point M on the east side of the roadway. The basin runoff is 0.4 cfs for the 5-year minor event and 0.4 cfs for the 100-year major event.

Basin D-15 is approximately 0.20 acres and consists of residential lots and a portion of Silverstone Terrace. Flows will enter the proposed Filing No 1 Pond 1 at Design Point S. Basin runoff is 0.5 cfs for the 5-year minor event and 0.6 cfs for the 100-year major event.

Basin D-16 is approximately 0.32 acres and consists of open space and the south half of Mule Deer Drive. Flows will be conveyed to the east through curb and gutter to Centennial Boulevard. Basin runoff is 1.1 cfs for the 5-year minor event and 2.0 cfs for the 100-year major event.

Basin D-18 is approximately 1.80 acres and consists of open space between Basins D-3 and D-17, along Centennial Boulevard. Flows will be directed towards the east to Centennial Boulevard at Design Point H. Runoff is 3.5 cfs for the 5-year minor event and 6.9 cfs for the major event.

Basin D-17 is approximately 5.10 acres and consists of open space south of Mule Deer Drive between Centennial Boulevard and Silverstone Terrace. The Detention Pond is located in this basin. Runoff is 8.3 cfs for the 5-year minor event and 16.7 cfs for the major event.

Basin OS1 consists of approximately 16.98 acres and is an offsite basin. Runoff from this basin will be directed toward the existing swale just south of the site which is collected by an existing 36" RCP stub from Centennial Boulevard. Detention will not be provided for offsite basin flow as is continues on its existing flow path to the existing culvert under Centennial Boulevard and has no development or passes through any developed area. The basin runoff is 19.5 cfs in the 5-year minor event and 52.1 cfs in the 100- year major event.

Basin OS2 consists of approximately 2.46 acres and is an offsite basin. Runoff from this basin will be collected on the western edge of the site and conveyed through a proposed swale to Design Point C. The basin runoff is 3.5 cfs in the 5-year minor event and 9.4 cfs in the 100- year major event.

Basin OS3 consists of approximately 19.77 acres and is an offsite basin. Runoff from this basin will be collected on the western edge of the site and conveyed through a proposed channel and pipe (Design Point C) to the Detention Pond on the west side of Centennial Boulevard to an existing storm sewer in Centennial Boulevard. The basin runoff is 19.6 cfs in the 5-year minor event and 52.4 cfs in the 100- year major event.

Basin OS4 consists of approximately 2.48 acres and is an offsite basin. Runoff from this basin will be collected on the western edge of the site and conveyed through a proposed swale to Design Point C. The basin runoff is 3.6 cfs in the 5-year minor event and 9.6 cfs in the 100-year major event.

Phase 2 Filing No 2 (Preliminary Design)

Basin D-8 is approximately 0.13 acres and consists of the south half of the turnaround. Flow is conveyed via curb and gutter to Design Point I. The basin runoff is 0.3 cfs for the 5-year minor event and 0.3 cfs for the 100-year major event.

Basin D-9 is approximately 1.01 acres and consists of residential lots and the south portion on the west side of Villa Lorenzo Drive. Flows are conveyed through curb and gutter to the turn around to Design Point J. The basin runoff is 1.7 cfs for the 5-year minor event and 1.9 cfs for the 100-year major event.

Basin D-10 is approximately 0.38 acres and consists of residential lots and the south portion on the east side of Villa Lorenzo Drive. Flows are conveyed via curb and gutter to Design Point J at the turn around. The basin runoff is 0.8 cfs for the 5-year minor event and 1.0 cfs for the major event.

Basin D-11 is approximately 0.90 acres and consists of residential lots and open area where the WQ Pond is located. Basin runoff is 0.7 cfs for the 5-year minor event and 1.0 cfs for the 100-year major event.

Basin D-12 is approximately 1.34 acres and consists of residential lots and the north portion on the west side of Villa Lorenzo Drive. Flow is conveyed through curb and gutter to Silverstone Terrace to Design Point O. The offsite portion of this basin is conveyed through a proposed swale. During final design of this site, a storm system will be designed to intercept this flow and release it into the Phase 2 Pond 1 for treatment. During the "overlot grading" for the preliminary stage of this site, the flow will be released into the over excavated portion of the future road, which acts as a small

drainage swale. The basin runoff is 2.5 cfs for the 5-year minor event and 2.8 cfs for the 100-year major event.

Basin D-13 is approximately 0.41 acres and consists of residential lots and the north portion on the east side of Villa Lorenzo Drive. Flow is conveyed through curb and gutter to Silverstone Terrace to Design Point O. During final design of this site, a storm system will be designed to intercept this flow and release it into the Phase 2 Pond 1 for treatment. The basin runoff is 0.8 cfs for the 5-year minor event and 0.9 cfs for the 100-year major event.

Basin D-14 is approximately 0.82 acres and consists of residential lots and a portion of Silverstone Terrace. Flows are conveyed as gutter flow in Silverstone Terrace to DP P. During final design of this site, a storm system will be designed to intercept this flow and release it into the Phase 2 Pond 1 for treatment. Basin runoff is 1.8 cfs for the 5-year minor event and 2.0 cfs for the 100-year major event.

Basin OS5 consists of approximately 2.11 acres and is an offsite basin. Runoff from this basin will be collected within Silverstone Terrace and enter the proposed pond for Filing No 2. The basin runoff is 22.0 cfs in the 5-year minor event and 35.1 cfs in the 100- year major event.

Basin OS7 consists of approximately 6.60 acres and is an offsite basin. Runoff from this basin will be collected on the western edge of the site and conveyed south through a proposed swale to Design Point I. The basin runoff is 7.8 cfs in the 5-year minor event and 9.0 cfs in the 100- year major event.

Basin OS8 consists of approximately 1.51 acres and is an offsite basin. Runoff from this basin will be collected on the western edge of the site and conveyed through a proposed swale to Design Point N at the northwest corner of Centennial Boulevard and Mule Deer Drive. The basin runoff is 2.0 cfs in the 5-year minor event and 2.4 cfs in the 100- year major event.

Design Point Description – Phase 1 Filing No 1 (Final – Bench Site)

Design Point A is located at the proposed curb cut located at the south end of Silverstone Terrace. Runoff will release through a riprap rundown to Filing No 1 Pond 2. Flows are 3.6 cfs for the 5-year minor event and 6.6 cfs for the 100-year major event.

Design Point B is the inlet side of an existing storm system in Centennial Boulevard. Flows from OS1 are combined with outlet flow from Phase 1 Pond 2. Flows at this location are 18.1 and 52.5 cfs for the minor and major storm events. Without detention, flows at this location are 21.7 cfs and 56.0 cfs for each of the storm events. This location corresponds to DP-1 from the MDDP report, which had design flows of 26.8 and 52.6 cfs.

Design Point C is on the western edge of the property. It combines the flows from OS2, OS3 and OS4, prior to entering the site. Flows are 24.5 cfs for the 5-year minor event and 65.5 cfs for the 100-year major event.

Design Point D is the inlet end of the proposed storm system at approximately Sta 11+00, which conveys offsite flows through the site. Basin D-4 combines with DP C. Flows are 26.5 cfs for the 5-year minor event and 69.2 cfs for the 100-year major event.

Design Point Y consists of Basin D-5 and is a proposed 6' Type D-10-R sump inlet in Silverstone Terrace. This inlet has the capacity to intercept up 4.2 cfs. If the flow does manage to overtop the back of curb, it would release into the drainage swale at the back of the curb and continue east to Filing No 1 Pond 1. Flows at this location are 1.4 cfs for the minor storm and 2.6 cfs for the major storm.

Design Point F combines Design Points Y and D and releases into the proposed Filing No 1 Pond 1. Flows are 33.4 cfs for the 5-year minor event and 86.4 cfs for the 100-year major event.

Design Point G is Basin D-3 where it enters Centennial Boulevard.

Design Point H is Basin D-18 where it enters Centennial Boulevard.

Design Point LL consists of Basin D-6a and is a 6' at-grade Type D-10-R inlet on the west side of Silverstone Terrace. Flows are 1.0 cfs and 2.0 cfs. An at-grade inlet will be installed at this location. The bypass flows from this inlet are 0.0 and 0.1 cfs, which continue as gutter flow to the at-grade inlet located at Design Point L on the west side of Silverstone Terrace.

Design Point L consists of Basin D-6b and is a 6' at-grade Type D-10-R inlet on the west side of Silverstone Terrace. Flows are 0.9 cfs and 1.5 cfs. An at-grade inlet will be installed at this location. The bypass flows from this inlet are 0.0 and 0.0 cfs, which continue as gutter flow to the north to the existing sump inlet on the west side of Silverstone Terrace. This location corresponds to DP-1 in the Filing 41 report. From this report, the design point had flows of 15 and 33 cfs with flowbys of 3 and 12 cfs headed to the sump inlet.

Design Point MM consists of Basin D-7a and is a 6' at-grade Type D-10- R inlet on the east side of Silverstone Terrace. Flows are 0.8 and 0.9 cfs. An at-grade inlet will be installed at this location. Bypass flows from this inlet are 0.0 and 0.0 cfs, which will continue as gutter flow to the at grade inlet located at Design Point M on the east side of Silverstone Terrace.

Design Point M consists of Basin D-7b and is a 6' at-grade Type D-10- R inlet on the east side of Silverstone Terrace. Flows are 1.7 and 1.9 cfs. An at-grade inlet will be installed at this location. Bypass flows from this inlet are 0.0 and 0.1 cfs, which will continue as gutter flow to the north to the intersection where it will follow the curb and continue to the east in Mule Deer Drive. From the Filing No. 41 report, this basin was part of the Mule Deer Drive basin and all gutter flow was directed towards the existing inlet in Centennial Boulevard.

Design Point Q consists of Basin D-16 and is where the flow enters Centennial Boulevard.

Design Point S combines the flow from Basin D-17 with the flow from DP F as it enters Filing No 1 Pond 1. Flows are 39.4 cfs for the 5-year minor event and 172.9 cfs for the 100-year major event.

Design Point Description – Phase 2 Filing No 2

Design Point J is the flow from Basins D-9 and D-10, which will release into Filing No 2 Pond. Flows are 4.9 cfs for the 5-year minor event and 5.6 cfs for the 100-year major event.

Design Point I is the combined flow of Basin D-8 with the offsite flow of OS5, OS9 and OS7 at the turn around and releases into the area for Filing No 2 Pond. Flows are 54.2 cfs for the 5-year minor event and 70.9 cfs for the 100-year major event.

Design Point N consists of offsite basin OS8. Flows are directed around the site through proposed swales to Design Point N. Flows are 2.0 cfs for the 5-year minor event and 2.4 cfs for the 100-year major event.

Design Point O combines Basins D-12 and D-13 with DP N in Silverstone Terrace. Runoff will continue as curb flow in the roadway. Flows are 8.7 cfs for the 5-year minor event and 9.9 cfs for the 100-year major event.

Design Point P combines flow from DP O with Basin D-14. Flows are 3.3 cfs for the 5-year minor event and 3.7 cfs for the 100-year major event. Flow will release into the Filing No 2 pond.

Design Point R combines flow from DP P, I and J with D-11 and enters Filing No 2 Pond. Flows are 45.2 cfs for the 5-year minor event and 60.7 cfs for the 100-year major event.

Street Capacities

Street capacity for Silverpoint Terrace was checked using the UDFCD Allowable capacity for one-half of street (Q-Allow) spreadsheet. Calculations are provided in the appendix along with corresponding inlet calculation worksheets. Allowable street capacity was designed based on limitations for velocity, flow depth and spread. For Basins D-6 and D-7, street capacity spreadsheets determined that the major storm flow was able to be handled within the gutter but the minor flow was larger than the ability for the curb to carry the flow, therefore on-grade inlets were installed in each of these basins to intercept flows.

Storm Systems

There are three separate storm systems for this site. The first system is located at approximately Sta 11+00 in Silverstone Terrace. A proposed ditch will collect offsite basin flows which will combine with street flow at Design Point D. A Type D area inlet will intercept this flow. On the east side of Silverstone Terrace, a sump inlet will intercept the gutter flow and connect with the rcp in the roadway. The system will release directly into Filing No 1 Pond 1.

The second system, located at approximate Sta 14+50, is a set of (2) 6’ Type D-10-R inlets (at-grade) at DP LL and DP MM, which will also release into Phase 1 Pond 1.

The third system, located at approximate Sta 16+50, is a set of (2) 6’ Type D-10-R inlets (at-grade) at DP L and DP M, which will also release into Phase 1 Pond 1.

Swales & Ditches

None of the designed swales fill within the “hazard” areas denoted in the geologic hazard report and meet the criteria recommended of maximum 100 year velocity of 5.0 fps on erosive soils and 7.0 fps on non-erosive soils, in grass-lined channels. All channels shall have a 1’ freeboard . However, the channels do not meet the maximum longitudinal slope of 0.60%, therefore they will be riprap lined.

There are two offsite swales designed for this project. These are to help direct the offsite flows through and around the site. The first swale directs flows from OS2 along the western boundary to DP C. The swale will be a minimum of 2.0% grade with a 10’ bottom width, 1.75’ depth and 3:1

side slopes. It will have a velocity of 2.65 fps with a flow depth of 0.32 feet. This will allow for a freeboard of 1.43'. The channel will be lined with Type VL (D50=6") riprap.

The second swale is to direct flows from OS4 to DP C. The swale will be a minimum of 5.0% grade with a 5' bottom width, 2.0' depth and 3:1 side slopes. It will have a velocity of 4.30 fps with a flow depth of 0.37 feet. This will allow for a freeboard of 1.63'. The channel will be lined with Type VL (D50=6") riprap.

There are three ditches designed as part of this project. One is upstream of the proposed Area D inlet and 30" rcp in the Silverstone Terrace at DP C and the second is at the outlet side of the system at DP F and the third is at the rundown from the curb cut at DP A. The ditch for DP C will have a 0.60% grade with a 10' bottom width, 2.5' depth and 3:1 side slopes. It will have a velocity of 3.37 fps with a flow depth of 1.37 feet. This allows for a freeboard of 1.13'. The channel will be lined with Type VL (D50=6") riprap.

The ditch (overflow riprap rundown) for DP F, on the outlet side of the storm system, will have a 3:1 slope, as it comes down the catch slope into Filing No 1 Pond 1, with a 10' bottom width, 2.0' depth and 3:1 side slopes. It will have a velocity of 9.18 fps with a flow depth of 0.77 feet. With the steep slope into the pond, the ditch does not meet the velocity constraint, therefore it will be lined with type H (D50 = 18") riprap.

The ditch (riprap rundown) for DP A, located at the curb cut at the south end of Silverstone Terrace, will have a 4:1 slope, as it comes down the catch slope into Filing No 1 Pond 2, with a 2' bottom width, 1.5' depth and 3:1 side slopes. It will have a velocity of 4.49 fps with a flow depth of 0.37 feet. It will be lined with type VL (D50 = 6") riprap.

On-Site Water Quality & Detention

Phase 1 Pond 1 (Final – Bench Site)

There are two proposed water quality/detention ponds on site that will provide water quality and detention for proposed improvements in Filing No 1, Bench Site. The Phase 1 Pond 1 provides the majority of the detention for Filing No 1, with flows being released at less than historic levels, as the system ties into the existing drainage facilities in Centennial Boulevard. The pond will treat Basins OS-2, OS-3 and OS-4, D-4, D-5, D-6, D-7, D-17 and D-18, for a total of 37.9. acres.

The pond is designed as a Full Spectrum Detention Facility (FSD) using the UDFCD UD-Detention worksheet. It was determined that the water quality volume needed is 0.317 ac-ft, 5-year volume is 0.586 ac-ft and the 100-year volume is 1.646 ac-ft. Impervious area for the site was determined to be 16.5% (refer to the impervious spreadsheet in the appendix). The outlet structures of the ponds will be designed to detain onsite flows and release at 90% of predevelopment flows plus the contributing offsite flows from the west. The emergency spillway was determined to be 20' wide by 1.4' deep with a flow depth of 1.12'. It will be lined with Type VL (D50=6") riprap. The emergency spillway will release into Centennial Boulevard where it will be collected by the existing storm system. Pond sizing calculations are provided in Appendix E. The overall depth of the pond is 7.25' with a top embankment elevation of 6508.75. Max stage elevation in the pond is 7.22'.

The Phase 1 Pond 2 provides detention and water quality for south portion of the project which does not reach Pond 1. The pond will treat Basins D-1 and D-2. Basin D-2 includes the flow from the roof drains in the area for a total area of 0.82 acres to be treated. Basin OS-1 is routed around the pond and continues to the existing channel where it will exit the site at the existing 36" culvert.

The pond is designed as a Full Spectrum Detention Facility (FSD) using the UDFCD UD-Detention worksheet. It was determined that the water quality volume needed is 0.029 ac-ft, 5-year volume is 0.092 ac-ft and the 100-year volume is 0.143 ac-ft. Impervious area for the site was determined to be 90%, as the basins are completely developed with roads, sidewalks and buildings. The outlet structure of the pond is designed to detain onsite flows and release at 90% of predevelopment flows. The emergency spillway was determined to be 20' wide by 1.1' deep with a flow depth of 0.11'. It will be lined with Type L (D50=9") riprap. The emergency spillway will release into an existing ditch, south of the property and exit the site via an existing 36" rcp in Centennial Boulevard. The overall depth of the pond is 3.5' with a top embankment elevation of 6529.0. Max stage elevation in the pond is 3.5'. Pond sizing calculations are provided in Appendix E.

Phase 2 Filing No 2 (Preliminary – Hammerhead Site)

There is one proposed water quality/detention pond on site that will provide water quality and detention for proposed improvements in Filing No 2, Hammerhead Site. Phase 2 Pond 1, located between Villa Lorenzo Drive and Silverstone Terrace, will be Full Spectrum Detention, with flows being released at less than historic levels, as the system ties into the existing drainage facilities in Centennial Boulevard. This pond is designed to treat flows from Basins D-8 thru D-14. Basins D-12 thru D-14 will have a storm system designed to capture flows and release into this facility. The outlet structure of the pond will be designed to detain onsite flows and release at 90% of predevelopment flows plus the contributing offsite flows from the west. Preliminary pond sizing calculations are provided in Appendix E. Final design for this facility will be done with the Final Drainage report for Phase 2.

Four Step Process

In accordance with the City of Colorado Springs Drainage Criteria Manual, Volume 2 this site has implemented the four step process to minimize adverse impacts of urbanization and helps with the management of smaller, frequently occurring events. The four step process includes reducing runoff volumes, treating and slowly releasing the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls.

In order to reduce runoff volume, the new impervious area for the site was minimized, including minimizing the driveway areas. Existing features will be preserved as all of the offsite basins are undeveloped open space and will continue to be, due to the design constraints presented by the existing terrain and soil types. Existing drainage paths have been maintained as much as possible to also help reduce overall impacts from the site.

The WQCV is treated through extended detention basins. The outlet structures for Filing No 1 have been designed according to the FSD spreadsheet by UDFCD to ensure the release times of the facilities meet the requirements. The Filing No 2 pond will also be designed accordingly.

There are no proposed major drainageways for the site that would need to be stabilized. Existing drainageways will be maintained in their current condition to help with overall site impacts. These

facilities are upstream of the development, so there are no impacts to these channels due to the development of this project. Downstream of the project, all flows enter into existing storm systems, which have been designed for this site to be developed. Therefore, those downstream channel/facilities would also, not see any increase or adverse effects to their functionality.

Some site-specific 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.

Drainage and Bridge Fees

(Douglass Creek Drainage Basin, based on 2018 Drainage, Bridge and Pond Fees City of Colorado Springs, Effective January 1, 2018)

Item	Cost/Acres	Acres	Cost
Drainage	$11,929	15.146	$180,676.63
Bridge	$267	15.146	$4,043.98
		TOTAL	***$184,720.61***

Construction Cost Opinion

Public Storm System (For Information Only) (Non-Reimbursable)

Item	Quantity	Unit	Unit Cost	Cost
18" RCP	191	LF	$90	$1,719
30" RCP	115	LF	$175	$20,200
36" RCP	101	LF	$200	$20,200
18" FES	1	EA	$1,000	$1,000
36" FES	1	EA	$1,500	$1,500
Inlet (6' Type D-10-R)	3	EA	$5,000	$15,000
Inlet (Type D)	1	EA	$6,000	$6,000
Storm Manhole (4')	1	EA	$5,000	$5,000
Riprap (6")	843.5	CY	$125	$105,438
Riprap (18")	492.2	CY	$100	$49,520
			Sub-total	**$225,502**
15% Contingency				$33,825.00
			TOTAL	***$259,327.00***

Stantec cannot and does not guarantee that the construction cost will not vary from these opinions of probable construction costs. These opinions represent our best judgment as design professionals familiar with the construction industry and this development in particular.

VI. Conclusions

The proposed development will not adversely affect the offsite major drainageways or surrounding developments and public infrastructure. Water quality will be provided for the site in the form of two water quality/ detention ponds in Filing No 1 and one water quality/detention pond in Filing No 2. Final design of the Filing No 2 pond will be completed in a separate Final Drainage Report for

the site. The proposed drainage facilities meet the requirements of the City of Colorado Springs "Drainage Criteria Manual" revised 2014. This report and its findings are in conformance with the previously approved reports for this area.

VII. References

Drainage Criteria Manual Volume 1 and Volume 2, City of Colorado Springs, Revised 2014.

Douglas Creek Drainage Basin, Leigh Whitehead & Associates, March 1981.

Urban Storm Drainage Criteria Manual, Urban Drainage and Flood Control District, Latest Edition.

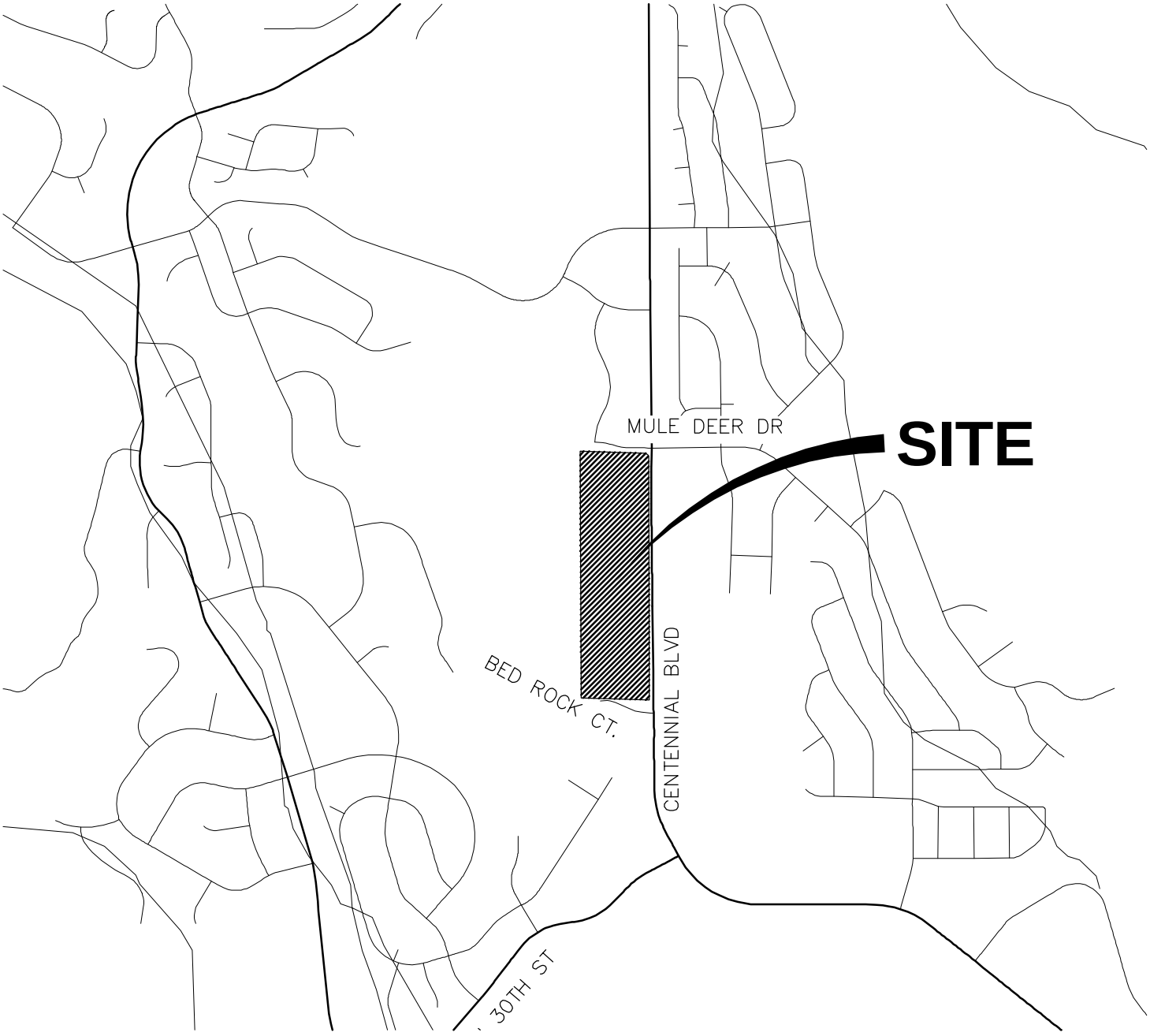
Master Development Drainage Plan (MDDP) for Mountain Shadows Centennial Corridor, JR Engineering, September 1998.

Final Drainage Report for Mountain Shadows Filing No. 41, JR Engineering, February 2000.

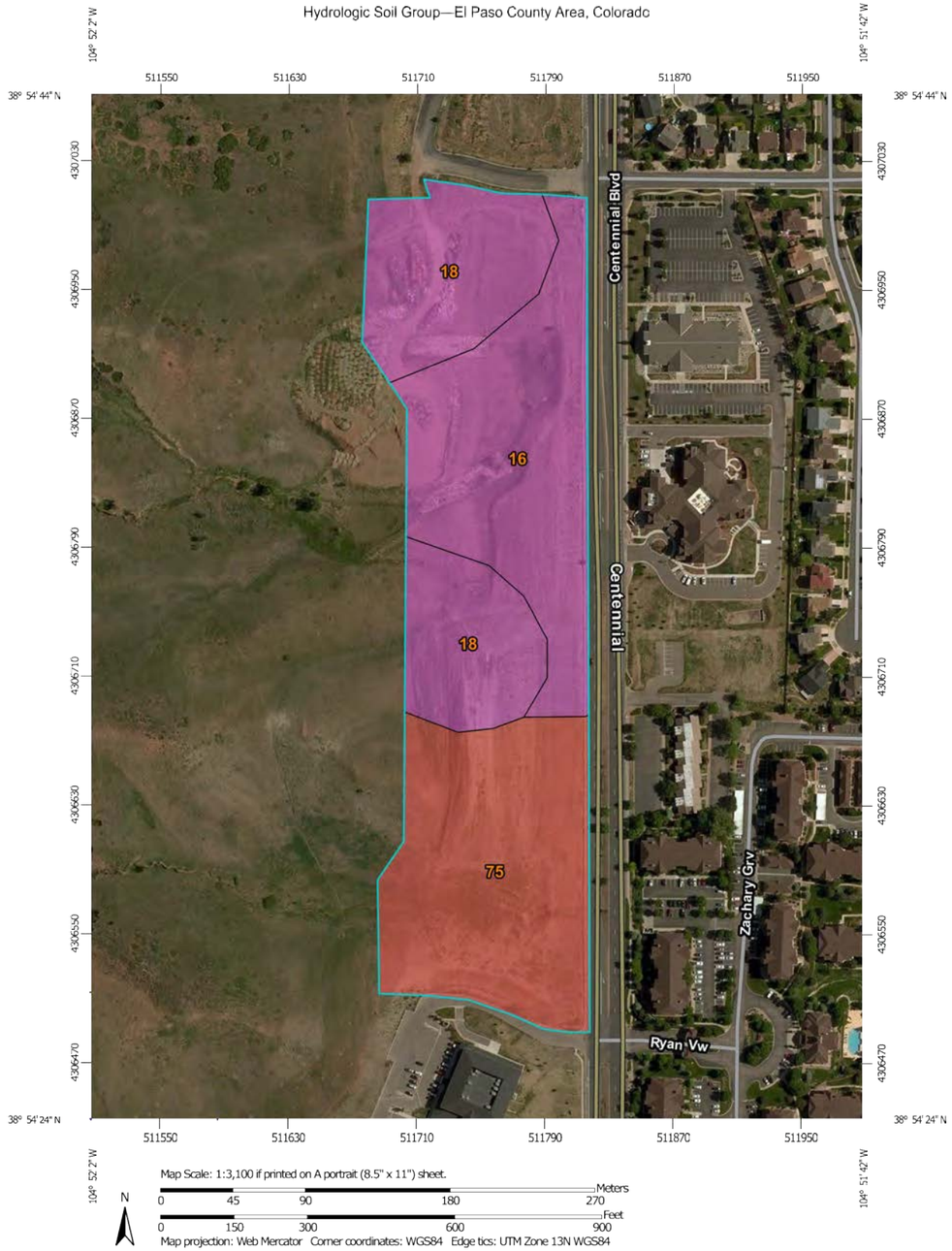
Preliminary Drainage Report for Tuscan Foothill Village, JR Engineering, October 2006.

APPENDICES

APPENDIX A FIGURES & EXHIBIT



VICINITY MAP
SCALE : 1"=1,000'



Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — El Paso County Area, Colorado (CO625)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
16	Chaseville gravelly sandy loam, 1 to 8 percent slopes	A	5.2	33.6%
18	Chaseville-Midway complex	A	4.8	30.9%
75	Razor-Midway complex	D	5.5	35.6%
Totals for Area of Interest			**15.5**	**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.

FIGURE 2 - SOILS MAP

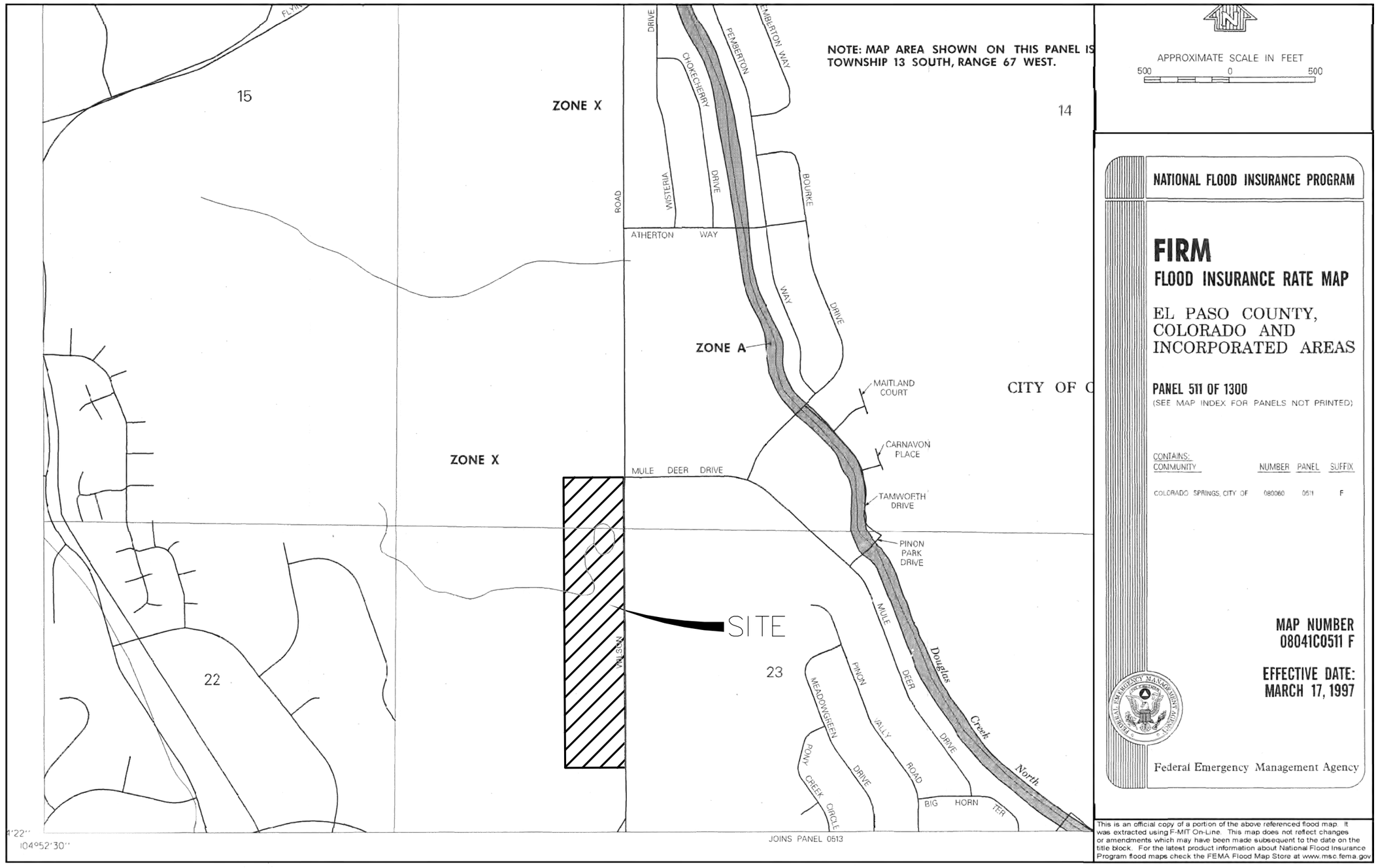


FIGURE 3 - FIRM MAP

APPENDIX B

EXISTING RATIONAL ANALYSIS

Runoff Coefficients (C-Values)

Project: Tuscan Foothills | Created by: CMD | Date: 5/11/2017
Section: Existing Conditions | Checked by: CKC | Date:

Sub-Basin Data			Composite C		Paved Area			Residential (1/3 ac lots)			Lawns/Grass			Undeveloped Offsite Flow		
Basin ID	Description/Soil Type	Total Area (ac)	C_5	C_{100}	C_5	C_{100}	Area (ac)	C_5	C_{100}	Area (ac)	C_5	C_{100}	Area (ac)	C_5	C_{100}	Area (ac)
E-1	Basin @ South Boundary	17.58	0.37	0.59	0.90	0.96	0.00	0.25	0.30	0.00	0.08	0.15	0.00	0.37	0.59	17.58
E-2	North of E-1	27.83	0.32	0.51	0.90	0.96	0.00	0.25	0.30	0.00	0.08	0.15	0.00	0.32	0.51	27.83
E-3	North of E-2 @ North Boundary	15.37	0.32	0.51	0.90	0.96	0.00	0.25	0.30	0.00	0.08	0.15	0.00	0.32	0.51	15.37
E-4	Btwn E-2 and E-3 W. of Centennial	5.44	0.32	0.51	0.90	0.96	0.00	0.25	0.30	0.00	0.08	0.15	0.00	0.32	0.51	5.44
E-5	Btwn E-4 and E-6	2.80	0.32	0.51	0.90	0.96	0.00	0.25	0.30	0.00	0.08	0.15	0.00	0.32	0.51	2.80
E-6	South half of Mule Deer Drive	0.32	0.88	1.11	0.90	0.96	0.20	0.25	0.30	0.00	0.08	0.15	0.00	0.32	0.51	0.32

Notes:

1. Runoff Coefficients (C-Values) determined by Runoff Coefficient Table 6-6 in Drainage Criteria Manual Vol 1

Standard Form SF-1 . Time of Concentration

Project: Tuscan Foothills
Section: Existing Conditions

Created by: CMD Date: 5/12/2017
Checked by: CKC Date:

Urban TOC $_{min}$ = 5 min
Rural TOC $_{min}$ = 10 min

SUB-BASIN DATA				INITIAL/OVERLAND FLOW (t_i)			TRAVEL TIME (t_t)								Tc CHECK (Urbanized basins)				FINAL Tc (min)
									Type of Land Surface					TOTAL					
Basin ID	Description	C_5	Area (ac)	Length, L (ft)	Slope, s (ft/ft)	t_i (min) (1)	Length (ft)	S_w (ft/ft)	Code	Description	Convey Coef (C_v) (2)	Velocity (V) (ft/s) (3)	t_t Travel Time (min) (4)	$t_c = t_i + t_t$ (min)	Urban (Yes /No)	Length (ft)	$T_{c\,max}$ (min) (5)	$Tc_{max} > t_c$	
E-1	Basin @ South Boundary	0.37	17.58	205	0.11	8.50	2125	0.0900	4	Nearly bare ground	10.00	3.00	11.81	20.30	NO	2330.00	22.94	Check	20.3
E-2	North of E-1	0.32	27.83	220	0.29	6.87	2605	0.1423	4	Nearly bare ground	10.00	3.77	11.51	18.38	NO	2825.00	25.69	Check	18.4
E-3	North of E-2 @ North Boundary	0.32	15.37	300	0.14	10.21	1420	0.1080	4	Nearly bare ground	10.00	3.29	7.20	17.41	NO	1720.00	19.56	Check	17.4
E-4	Btwn E-2 and E-3 W. of Centennial	0.32	5.44	155	0.16	7.08	475	0.1220	4	Nearly bare ground	10.00	3.49	2.27	9.35	NO	630.00	13.50	Check	9.4
E-5	Btwn E-4 and E-6	0.32	2.80	100	0.10	6.59	345	0.1040	4	Nearly bare ground	10.00	3.22	1.78	8.37	NO	445.00	12.47	Check	8.4
E-6	South half of Mule Deer Drive	0.88	0.32	20	0.02	1.39	285	0.0110	4	Nearly bare ground	10.00	1.05	4.53	5.92	NO	305.00	11.69	Check	5.9

Notes:
All Equations are from COS Drainage Criteria Manual/Runoff
(1) t_i= (0.395*(1.1-C_5)*(L^0.5))/(S^0.33), from COS DCM Equation 6-8
(2) Cv from COS DCM Table 6-7
(3) Velocity from V = C_v*S_w^0.5, from COS DCM Equation 6-9
(4) t_t=L/60V
(5) t_i max = 10+L/180, from COS DCM Equation 6-10

COS DCM Table 6-7	Land Surface Coefficients	
Code	Description	Cv
1	Heavy meadow	2.5
2	Tillage/field	5
3	Short pasture and lawns	7
4	Nearly bare ground	10
5	Grassed waterway	15
6	Paved areas and shallow paved swales	20
*7	Riprap (not buried)	6.5

* determined for the project based on UDFCD equations (Equation RO-4)

Standard Form SF-2 . Storm Drainage System Design (Rational Method Procedure)

Project: Tuscan Foothills
Section: Proposed Conditions

Created by: CMD Date: 5/11/2017
Checked by: CKC Date:

Design Storm: 5-yr P = 1.50 in

LOCATION	DESIGN POINT	DIRECT RUNOFF: AREA DESIGN	AREA (A) (AC)	RUNOFF COEFF (C)	t_c (MIN)	C.A. (AC)	I (IN / HR)	Q (CFS)	TOTAL RUNOFF: t_c (MIN)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	STREET/SWALE: SLOPE (%)	STREET FLOW (CFS)	PIPE: DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE (INCHES)	TRAVEL TIME: LENGTH (FT)	VELOCITY (FPS)	t_t (MIN)	REMARKS
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
	A	E-1	17.58	0.37	20.30	6.50	3.07	19.95													
	B	E-2	27.83	0.32	18.38	8.91	3.22	28.64													
	C	E-3	15.37	0.32	17.41	4.92	3.30	16.22													
	D	E-4	5.44	0.32	9.35	1.74	4.23	7.36													
	E	E-5	2.80	0.32	8.37	0.90	4.40	3.94													
		E-6	0.32	0.88	5.92	0.28	4.92	1.39													
Flow in one-half of Mule Deer Dr & DP C	Q	E-6, DP-C	15.69	0.33					23.33	5.20	2.86	14.87									

Design Storm: 100-yr P = 2.52 in

LOCATION	DESIGN POINT	DIRECT RUNOFF: BASIN ID	AREA (A) (AC)	RUNOFF COEFF (C)	t_c (MIN)	C.A. (AC)	I (IN / HR)	Q (CFS)	TOTAL RUNOFF: t_c (MIN)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	STREET: SLOPE (%)	STREET FLOW (CFS)	PIPE: DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE (INCHES)	TRAVEL TIME: LENGTH (FT)	VELOCITY (FPS)	t_t (MIN)	REMARKS
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
	A	E-1	17.58	0.59	20.30	10.37	5.15	53.39													
	B	E-2	27.83	0.51	18.38	14.19	5.40	76.63													
	C	E-3	15.37	0.51	17.41	7.84	5.54	43.39													
	D	E-4	5.44	0.51	9.35	2.77	7.10	19.70													
	E	E-5	2.80	0.51	8.37	1.43	7.38	10.54													
		E-6	0.32	1.11	5.92	0.36	8.25	2.93													
Flow in one-half of Mule Deer Dr & DP C	Q	E-6, DP-C	15.69	0.52					23.33	8.19	2.86	23.42									

All Equations follow COS DCM Rational Method

(1) Basin Description linked to C-Value Sheet
(2) Basin Design Point
(3) Enter the Basin Name from C-Value Sheet
(4) Basin Area linked to C-Value Sheet
(5) Composite C linked to C-Value Sheet
(6) Time of Concentration linked to SF-1 Sheet
(7) =Column 4 x Column 5
(8) IDF Equations from Fig 6-15 COS DCM
(9) =Column 7 x Column 8
(10) =Column 6 + Column 21
(11) Add the C.A. Values Column 7 to get the cummulative C.A. Values
(12) IDF Equations from Fig 6-15 COS DCM
(13) Sum of Qs
(14) Additional Street Longitudinal Slope
(15) Additional Street Overland Flow
(16) Additional Pipe Design Flow
(17) Additional Pipe Slope
(18) Additional Pipe Size
(19) Additional Flow Length
(20) Street or Pipe Velocity
(21) =Column 15 OR Column 16 OR Column 20 / 60

APPENDIX C

PROPOSED RATIONAL ANALYSIS

Runoff Coefficients (C-Values)

Project: Tuscan Foothills | Created by: CMD | Date: 5/11/2017
Section: Proposed Conditions | Checked by: CKC | Date:

Sub-Basin Data			Composite C		Paved Area			Residential (1/3 ac lots)			Lawns/Grass			Undeveloped Offsite Flow		
Basin ID	Description/Soil Type	Total Area (ac)	C_5	C_{100}	C_5	C_{100}	Area (ac)	C_5	C_{100}	Area (ac)	C_5	C_{100}	Area (ac)	C_5	C_{100}	Area (ac)
OFFSITE BASINS																
OS-1	Basin @ South Boundary	16.98	0.37	0.59	0.90	0.96	0.00	0.25	0.30	0.00	0.08	0.15	0.00	0.37	0.59	16.98
OS-2	North of OS-1 and W. of Prop	2.46	0.32	0.51	0.90	0.96	0.00	0.25	0.30	0.00	0.08	0.15	0.00	0.32	0.51	2.46
OS-3	W. of Prop btwn OS-2 & OS-4	19.77	0.32	0.51	0.90	0.96	0.00	0.25	0.30	0.00	0.08	0.15	0.00	0.32	0.51	19.77
OS-4	Btwn OS-3 and OS-5 W. of Prop	2.48	0.32	0.51	0.90	0.96	0.00	0.25	0.30	0.00	0.08	0.15	0.00	0.32	0.51	2.48
OS-5	Btwn OS-4 and OS-6 W. of Prop	2.11	2.31	3.68	0.90	0.96	0.00	0.25	0.30	0.00	0.08	0.15	0.00	0.32	0.51	15.25
OS-7	Btwn OS-6 and OS-8 W. of Prop	6.60	0.32	0.37	0.90	0.96	0.00	0.25	0.30	0.00	0.08	0.15	0.00	0.32	0.37	6.60
OS-8	North of Prop	1.51	0.32	0.37	0.90	0.96	0.00	0.25	0.30	0.00	0.08	0.15	0.00	0.32	0.37	1.51
OS-9	Btwn OS-3 & OS-7 West of Prop	10.93	0.32	0.37	0.90	0.96	0.00	0.25	0.30	0.00	0.08	0.15	0.00	0.32	0.37	10.93
ONSITE BASINS		**24.72**														
D-1	South Portion on west half of Silverstone Terr.	0.18	0.90	0.96	0.90	0.96	0.18	0.25	0.30	0.00	0.08	0.15	0.00	0.32	0.37	0.00
D-2	South Portion on east half of Silverstone Terr.	0.69	0.80	0.86	0.90	0.96	0.58	0.25	0.30	0.11	0.08	0.15	0.00	0.32	0.37	0.00
D-3	South end btwn D-2 and Centennial Blvd	0.96	0.47	0.55	0.90	0.96	0.34	0.25	0.30	0.37	0.08	0.15	0.62	0.32	0.37	0.00
D-4	West portion of Silverstone Terr-North of D-1	1.61	0.40	0.45	0.90	0.96	0.36	0.25	0.30	1.25	0.08	0.15	0.00	0.32	0.37	0.00
D-5	East Portion of Silverstone Terr-North of D-2	0.73	0.44	0.49	0.90	0.96	0.21	0.25	0.30	0.52	0.08	0.15	0.00	0.32	0.37	0.00
D-6a	West portion of Silverstone Terr-North of D-4	0.72	0.37	0.43	0.90	0.96	0.14	0.25	0.30	0.58	0.08	0.15	0.00	0.32	0.37	0.00
D-6b	West portion of Silverstone Terr-North of D-4	0.41	0.28	0.34	0.90	0.96	0.02	0.25	0.30	0.39	0.08	0.15	0.00	0.32	0.37	0.00
D-7a	East Portion of Silverstone Terr-North of D-5	0.30	0.55	0.61	0.90	0.96	0.14	0.25	0.30	0.16	0.08	0.15	0.00	0.32	0.37	0.00
D-7b	East Portion of Silverstone Terr-North of D-5	0.27	0.30	0.35	0.90	0.96	0.02	0.25	0.30	0.25	0.08	0.15	0.00	0.32	0.37	0.00
D-8	South half of Hammerhead	0.13	0.44	0.50	0.90	0.96	0.04	0.25	0.30	0.09	0.08	0.15	0.00	0.32	0.37	0.00
D-9	South and West portion of Villa Lorenzo Dr	1.01	0.36	0.41	0.90	0.96	0.17	0.25	0.30	0.84	0.08	0.15	0.00	0.32	0.37	0.00
D-10	South and East portion of Villa Lorenzo Dr	0.39	0.45	0.50	0.90	0.96	0.12	0.25	0.30	0.27	0.08	0.15	0.00	0.32	0.37	0.00
D-11	Water Quality Pond	0.90	0.16	0.22	0.90	0.96	0.00	0.25	0.30	0.42	0.08	0.15	0.48	0.32	0.37	0.00
D-12	North and West portion of Villa Lorenzo Dr	1.34	0.44	0.49	0.90	0.96	0.38	0.25	0.30	0.96	0.08	0.15	0.00	0.32	0.37	0.00
D-13	North and East Portion of Villa Lorenzo Dr	0.41	0.47	0.52	0.90	0.96	0.14	0.25	0.30	0.27	0.08	0.15	0.00	0.32	0.37	0.00
D-14	North end btwn D-13 and Silverstone Terr	0.82	0.43	0.49	0.90	0.96	0.30	0.25	0.30	0.25	0.08	0.15	0.27	0.32	0.37	0.00
D-15	East portion of Silverstone Terr-South of Mule Deer Dr	0.20	0.47	0.53	0.90	0.96	0.07	0.25	0.30	0.13	0.08	0.15	0.00	0.32	0.37	0.00
D-16	South half of Mule Deer Dr	0.32	0.66	0.72	0.90	0.96	0.20	0.25	0.30	0.12	0.08	0.15	0.00	0.32	0.37	0.00
D-17	Detention Pond	5.10	0.32	0.38	0.90	0.96	1.16	0.25	0.30	1.49	0.08	0.15	2.45	0.32	0.37	0.00
D-18	Btwn D-17 and D-3	1.80	0.38	0.44	0.90	0.96	0.56	0.25	0.30	0.48	0.08	0.15	0.76	0.32	0.37	0.00

Notes: 10.51 0.3719877 0.4337558

1. Runoff Coefficients (C-Values) determined by Runoff Coefficient Table 6-6 in Drainage Criteria Manual Vol 1

Standard Form SF-1 . Time of Concentration

Project: Tuscan Foothills
Section: Proposed Conditions

Created by: CMD Date: 5/12/2017
Checked by: CKC Date:

Urban TOC $_{min}$ = 5 min
Rural TOC $_{min}$ = 10 min

	SUB-BASIN DATA			INITIAL/OVERLAND FLOW (t_i)			TRAVEL TIME (t_t)							TOTAL	Tc CHECK (Urbanized basins)				FINAL Tc (min)
									Type of Land Surface										
Basin ID	Description	C_5	Area (ac)	Length, L (ft)	Slope, s (ft/ft)	t_i (min) (1)	Length (ft)	S_w (ft/ft)	Code	Description	Convey Coef (C_v) (2)	Velocity (V) (ft/s) (3)	t_t Travel Time (min) (4)	$t_c = t_i + t_t$ (min)	Urban (Yes /No)	Length (ft)	$T_{c\,max}$ (min) (5)	$Tc_{max} > t_c$	
OFFSITE BASINS																			
OS-1	Basin @ South Boundary	0.37	16.98	205	0.11	8.50	2055	0.0900	4	Nearly bare ground	10.00	3.00	11.42	19.91	NO	2260.00	22.56	Check	19.9
OS-2	North of OS-1 and W. of Prop	0.32	2.46	220	0.29	6.87	260	0.1423	4	Nearly bare ground	10.00	3.77	1.15	8.02	NO	480.00	12.67	Check	8.0
OS-3	W. of Prop btwn OS-2 & OS-4	0.32	19.77	300	0.14	10.21	1915	0.1080	4	Nearly bare ground	10.00	3.29	9.71	19.92	NO	2215.00	22.31	Check	19.9
OS-4	Btwn OS-3 and OS-5 W. of Prop	0.32	2.48	200	0.37	6.05	295	0.0877	4	Nearly bare ground	10.00	2.96	1.66	7.71	NO	495.00	12.75	Check	7.7
OS-5	Btwn OS-4 and OS-6 W. of Prop	0.32	2.11	210	0.26	6.95	200	0.1667	4	Nearly bare ground	10.00	4.08	0.82	7.76	NO	410.00	12.28	Check	7.8
OS-7	Btwn OS-6 and OS-8 W. of Prop	0.32	6.60	300	0.22	8.80	1060	0.1461	4	Nearly bare ground	10.00	3.82	4.62	13.42	NO	1360.00	17.56	Check	13.4
OS-8	North of Prop	0.32	1.51	250	0.29	7.35	350	0.0743	4	Nearly bare ground	10.00	2.73	2.14	9.49	NO	600.00	13.33	Check	9.5
OS-9	Btwn OS-3 & OS-7 West of Prop	0.32	10.93	300	0.36	7.48	1050	0.1419	4	Nearly bare ground	10.00	3.77	4.65	12.12	NO	1350.00	17.50	Check	12.1
ONSITE BASINS																			
D-1	South Portion on west half of Silverstone Terr.	0.90	0.18	10	0.02	0.92	250	0.0100	6	Paved areas and shallow paved swales	20.00	2.00	2.08	3.01	YES	260.00	11.44	Check	5.0
D-2	South Portion on east half of Silverstone Terr.	0.80	0.69	45	0.02	2.89	275	0.0100	6	Paved areas and shallow paved swales	20.00	2.00	2.29	5.18	YES	320.00	11.78	Check	5.2
D-3	South end btwn D-2 and Centennial Blvd	0.47	0.96	50	0.14	3.39	150	0.2000	3	Short pasture and lawns	7.00	3.13	0.80	4.19	YES	200.00	11.11	Check	5.0
D-4	West portion of Silverstone Terr-North of D-1	0.40	1.61	100	0.02	10.11	450	0.0200	6	Paved areas and shallow paved swales	20.00	2.83	2.65	12.76	YES	550.00	13.06	Check	12.8
D-5	East Portion of Silverstone Terr-North of D-2	0.44	0.73	35	0.02	5.62	465	0.0200	6	Paved areas and shallow paved swales	20.00	2.83	2.74	8.36	YES	500.00	12.78	Check	8.4
D-6a	West portion of Silverstone Terr-North of D-4	0.37	0.72	100	0.02	10.44	205	0.0100	6	Paved areas and shallow paved swales	20.00	2.00	1.71	12.14	YES	305.00	11.69	Check	12.1
D-6b	West portion of Silverstone Terr-North of D-4	0.28	0.41	100	0.02	11.72	190	0.0100	6	Paved areas and shallow paved swales	20.00	2.00	1.58	13.30	YES	290.00	11.61	Check	13.3
D-7a	East Portion of Silverstone Terr-North of D-5	0.55	0.30	25	0.02	3.92	230	0.0100	6	Paved areas and shallow paved swales	20.00	2.00	1.92	5.83	YES	255.00	11.42	Check	5.8
D-7b	East Portion of Silverstone Terr-North of D-5	0.30	0.27	25	0.02	5.74	160	0.0100	6	Paved areas and shallow paved swales	20.00	2.00	1.33	7.07	YES	185.00	11.03	Check	7.1
D-8	South half of Hammerhead	0.44	0.13	70	0.37	3.01	165	0.0200	6	Paved areas and shallow paved swales	20.00	2.83	0.97	3.98	YES	235.00	11.31	Check	5.0
D-9	South and West portion of Villa Lorenzo Dr	0.36	1.01	100	0.10	6.35	265	0.0400	6	Paved areas and shallow paved swales	20.00	4.00	1.10	7.46	YES	365.00	12.03	Check	7.5
D-10	South and East portion of Villa Lorenzo Dr	0.45	0.39	45	0.02	6.28	260	0.0400	6	Paved areas and shallow paved swales	20.00	4.00	1.08	7.37	YES	305.00	11.69	Check	7.4
D-11	Water Quality Pond	0.16	0.90	70	0.13	6.10		0.0100	5	Grassed waterway	15.00	1.50	0.00	6.10	YES	70.00	10.39	Check	6.1

	SUB-BASIN DATA			INITIAL/OVERLAND FLOW (t_i)			TRAVEL TIME (t_t)								Tc CHECK (Urbanized basins)				FINAL Tc (min)
									Type of Land Surface					TOTAL					
Basin ID	Description	C_5	Area (ac)	Length, L (ft)	Slope, s (ft/ft)	t_i (min) (1)	Length (ft)	S_w (ft/ft)	Code	Description	Convey Coef (C_v) (2)	Velocity (V) (ft/s) (3)	t_t Travel Time (min) (4)	$t_c = t_i + t_t$ (min)	Urban (Yes /No)	Length (ft)	$T_{c\,max}$ (min) (5)	$Tc_{max} > t_c$	
D-12	North and West portion of Villa Lorenzo Dr	0.44	1.34	100	0.10	5.71	390	0.0100	6	Paved areas and shallow paved swales	20.00	2.00	3.25	8.96	YES	490.00	12.72	Check	9.0
D-13	North and East Portion of Villa Lorenzo Dr	0.47	0.41	45	0.02	6.09	335	0.0100	6	Paved areas and shallow paved swales	20.00	2.00	2.79	8.88	YES	380.00	12.11	Check	8.9
D-14	North end btwn D-13 and Silverstone Terr	0.43	0.82	5	0.02	2.14	300	0.0400	3	Short pasture and lawns	7.00	1.40	3.57	5.71	YES	305.00	11.69	Check	5.7
D-15	East portion of Silverstone Terr-South of Mule Deer Dr	0.47	0.20	10	0.02	2.84	145	0.0400	6	Paved areas and shallow paved swales	20.00	4.00	0.60	3.44	YES	155.00	10.86	Check	5.0
D-16	South half of Mule Deer Dr	0.66	0.32	20	0.02	2.83	285	11.0000	6	Paved areas and shallow paved swales	20.00	66.33	0.07	2.90	YES	305.00	11.69	Check	5.0
D-17	Detention Pond	0.32	5.10	35	0.20	3.11	200	0.0900	3	Short pasture and lawns	7.00	2.10	1.59	4.70	YES	235.00	11.31	Check	5.0
D-18	Btwn D-17 and D-3	0.38	1.80	45	0.20	3.24	155	0.1650	3	Short pasture and lawns	7.00	2.84	0.91	4.15	YES	200.00	11.11	Check	5.0

Notes:

All Equations are from COS Drainage Criteria Manual/Runoff

(1) $t_i = (0.395*(1.1-C_5)*(L^{0.5}))/(S^{0.33})$, from COS DCM Equation 6-8

(2) Cv from COS DCM Table 6-7

(3) Velocity from $V = C_v*S_w^{0.5}$, from COS DCM Equation 6-9

(4) $t_t = L/60V$

(5) t_i max = 10+L/180, from COS DCM Equation 6-10

COS DCM Table 6-7	Land Surface Coefficients	
Code	Description	Cv
1	Heavy meadow	2.5
2	Tillage/field	5
3	Short pasture and lawns	7
4	Nearly bare ground	10
5	Grassed waterway	15
6	Paved areas and shallow paved swales	20
*7	Riprap (not buried)	6.5

* determined for the project based on UDFCD equations (Equation RO-4)

Standard Form SF-2 . Storm Drainage System Design (Rational Method Procedure)

Project: Tuscan Foothills
Section: Proposed Conditions

Created by: CMD Date: 5/11/2017
Checked by: CKC Date:

Design Storm: 5-yr P = 1.50 in

LOCATION	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET/SWALE		PIPE			TRAVEL TIME			REMARKS
		AREA DESIGN	AREA (A) (AC)	RUNOFF COEFF (C)	t_c (MIN)	C.A. (AC)	I (IN / HR)	Q (CFS)	t_c (MIN)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE (INCHES)	LENGTH (FT)	VELOCITY (FPS)	t_t (MIN)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
		D-1	0.18	0.90	5.00	0.16	5.17	0.84													
		D-2	0.69	0.80	5.18	0.55	5.12	2.83													
Low Point in Stonepoint Terr	A		0.87	0.82					5.18	0.71	5.12	3.65									
		OS-1	16.98	0.37	19.91	6.28	3.10	19.45													
Ex Culvert West of Centennial Blvd	B	OS-1 & DP A	17.85	0.39					19.91	7.00	3.10	21.66									
		OS-2	2.46	0.32	8.02	0.79	4.46	3.51													
		OS-3	19.77	0.32	19.92	6.33	3.10	19.58													
		OS-4	2.48	0.32	7.71	0.79	4.52	3.59													
Combine Offsite Basin prior to entering Site	C	OS-2, 3 and 4	24.72	0.32					19.92	7.91	3.10	24.48									
Street flow to Proposed Culvert		D-4	1.61	0.40	12.76	0.64	3.76	2.40													
Proposed Culvert under Stonepoint Terr	D	D-4 & DP C	26.32	0.32					19.92	8.54	3.10	26.45									
Sump Inlet	Y	D-5	0.73	0.44	8.36	0.32	4.40	1.40													
Proposed Culvert under Stonepoint Terr	F	D-5 & DP D	27.05	0.33					12.76	8.86	3.76	33.36									
South end of Proj sheetflow to Centennial Blvd	G	D-3	0.96	0.47	5.00	0.45	5.17	2.32													
Mid Portion of Site sheetflow to Centennial Blvd	H	D-18	1.80	0.38	5.00	0.68	5.17	3.54													
		OS-5	2.11	2.31	7.76	4.88	4.51	22.00													
		OS-7	6.60	0.32	13.42	2.11	3.69	7.79													

LOCATION	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET/SWALE		PIPE			TRAVEL TIME			REMARKS
		AREA DESIGN	AREA (A) (AC)	RUNOFF COEFF (C)	t_c (MIN)	C.A. (AC)	I (IN / HR)	Q (CFS)	t_c (MIN)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE (INCHES)	LENGTH (FT)	VELOCITY (FPS)	t_t (MIN)	
		OS-9	10.93	0.32	12.12	3.50	3.84	13.43													
		D-8	0.13	0.44	5.00	0.06	5.17	0.30													
Inflow to Phase II Pond	I	OS-5 ,OS-7, OS-9 & D8	19.78	0.53					12.12	10.55	3.84	54.24									
		D-9	1.01	0.36	7.46	0.36	4.57	1.66													
		D-10	0.39	0.45	7.37	0.18	4.59	0.81													
Inflow to Phase II Pond	J	D-9 & D-10	1.40	0.38					7.46	0.54	4.57	4.92									
	N	OS-8	1.51	0.32	9.49	0.48	4.21	2.03													
		D-12	1.34	0.44	8.96	0.58	4.29	2.50													
		D-13	0.41	0.47	8.88	0.19	4.31	0.83													
	O	D-12, D-13 & DP N	3.26	0.39					8.96	1.26	4.29	8.74									
		D-14	0.82	0.43	5.71	0.35	4.97	1.76													
Inflow to Phase II Pond	P	D-14 & DP O	4.08	0.40					8.96	0.35	4.29	3.28									
		D-11	0.90	0.16	6.10	0.14	4.87	0.70													
Total Flow to Phase II Pond	R	D-11, DP-I, DP-J & DP-P	26.16	0.49					12.12	11.58	3.84	45.19									
At-grade Inlet	LL	D-6a	0.72	0.37	12.14	0.27	3.84	1.04													
		D-6b	0.41	0.28	13.30	0.12	3.70	0.43													
By-Pass flow from DP-LL (from Inlet Spreadsheet)								0.00													
At-grade Inlet	L	D-6b & DP-LL Bypass	0.41	0.28					13.30	0.12	3.70	0.86									
At-grade Inlet	MM	D-7a	0.30	0.55	5.83	0.17	4.94	0.82													

LOCATION	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET/SWALE		PIPE			TRAVEL TIME			REMARKS
		AREA DESIGN	AREA (A) (AC)	RUNOFF COEFF (C)	t_c (MIN)	C.A. (AC)	I (IN / HR)	Q (CFS)	t_c (MIN)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE (INCHES)	LENGTH (FT)	VELOCITY (FPS)	t_t (MIN)	
		D-7b	0.27	0.30	7.07	0.08	4.65	0.37													
		D-15	0.20	0.47	5.00	0.10	5.17	0.49													
	By-Pass flow from DP-MM (from Inlet Spreadsheet)							0.00													
	At-grade Inlet	M	D-7 & D-15, DP-MM Bypass	0.47	0.78				7.07	0.18	4.65	1.69									
	By-Pass flow from DP-L(from Inlet spreadsheet)							0.00													
	By-Pass flow from DP-M(from Inlet spreadsheet)							0.00													
	Flow in one-half of Mule Deer Dr	Q	D-16	0.32	0.66	5.00	0.21	5.17	1.09												
	Release Rate from WQ Pond (From pond spreadsheet)							1.70													
			D-17	5.10	0.32	5.00	1.61	5.17	8.33												
	Flow into Det Pond	S	D-17, DP-F	32.15	0.33				12.76	10.48	3.76	39.43									

LOCATION	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET/SWALE		PIPE			TRAVEL TIME			REMARKS
		AREA DESIGN	AREA (A) (AC)	RUNOFF COEFF (C)	t_c (MIN)	C.A. (AC)	I (IN / HR)	Q (CFS)	t_c (MIN)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE (INCHES)	LENGTH (FT)	VELOCITY (FPS)	t_t (MIN)	

Design Storm: 100-yr P = 2.52 in

LOCATION	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
		BASIN ID	AREA (A) (AC)	RUNOFF COEFF (C)	t_c (MIN)	C.A. (AC)	I (IN / HR)	Q (CFS)	t_c (MIN)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE (INCHES)	LENGTH (FT)	VELOCITY (FPS)	t_t (MIN)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
		D-1	0.18	0.96	5.00	0.17	8.68	1.50													
		D-2	0.69	0.86	5.18	0.59	8.59	5.09													
Low Point in Stonepoint Terr	A		0.87	0.88					5.18	0.77	8.59	6.58									
		OS-1	16.98	0.59	19.91	10.02	5.20	52.06													
Ex Culvert West of Centennial Blvd	B	OS-1	17.85	0.60					19.91	10.78	5.20	56.04									
		OS-2	2.46	0.51	8.02	1.25	7.49	9.40													
		OS-3	19.77	0.51	19.92	10.08	5.20	52.39													
		OS-4	2.48	0.51	7.71	1.26	7.59	9.60													
Combine Offsite Basin prior to entering Site	C	OS-2, 3 and 4	24.72	0.51					19.92	12.60	5.20	65.48									
Street flow to Proposed Culvert		D-4	1.61	0.45	12.76	0.72	6.32	4.55													
Proposed Culvert under Stonepoint Terr	D	D-4 & DP C	26.32	0.51					19.92	13.32	5.20	69.22									
Sump Inlet	Y	D-5	0.73	0.49	8.36	0.36	7.39	2.64													
Proposed Culvert under Stonepoint Terr	F	D-5 & DP D	27.05	0.51					12.76	13.68	6.32	86.44									
South end of Proj sheetflow to Centennial Blvd	G	D-3	0.96	0.55	5.00	0.53	8.68	4.60													
Mid Portion of Site sheetflow to Centennial Blvd	H	D-18	1.80	0.44	5.00	0.80	8.68	6.91													
		OS-5	2.11	3.68	7.76	7.78	4.51	35.07													

LOCATION	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET/SWALE		PIPE			TRAVEL TIME			REMARKS
		AREA DESIGN	AREA (A) (AC)	RUNOFF COEFF (C)	t_c (MIN)	C.A. (AC)	I (IN / HR)	Q (CFS)	t_c (MIN)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE (INCHES)	LENGTH (FT)	VELOCITY (FPS)	t_t (MIN)	
		OS-7	6.60	0.37	13.42	2.44	3.69	9.01													
		OS-9	10.93	0.37	12.12	4.04	3.84	15.53													
		D-8	0.13	0.50	5.00	0.07	5.17	0.34													
Inflow to Phase II Pond	I	OS-5 ,OS-7, OS-9 & D8	19.78	0.72					12.12	14.33	3.84	70.90									
		D-9	1.01	0.41	7.46	0.42	4.57	1.90													
		D-10	0.39	0.50	7.37	0.20	4.59	0.90													
Inflow to Phase II Pond	J	D-9 & D-10	1.40	0.44					7.46	0.61	4.57	5.59									
	N	OS-8	1.51	0.37	9.49	0.56	4.21	2.35													
		D-12	1.34	0.49	8.96	0.65	4.29	2.80													
		D-13	0.41	0.52	8.88	0.22	4.31	0.93													
	O	D-12, D-13 & DP N	3.26	0.44					8.96	1.43	4.29	9.86									
		D-14	0.82	0.49	5.71	0.40	4.97	2.00													
Inflow to Phase II Pond	P	D-14 & DP O	4.08	0.45					8.96	0.40	4.29	3.74									
		D-11	0.90	0.22	6.10	0.20	4.87	0.96													
Total Flow to Phase II Pond	R	D-11, DP-I, DP-J & DP-P	26.16	0.65					12.12	15.54	3.84	60.65									
At-grade Inlet	LL	D-6a	0.72	0.43	12.14	0.31	6.44	1.98													
		D-6b	0.41	0.34	13.30	0.14	6.21	0.85													
By-Pass flow from DP-LL (from Inlet Spreadsheet)								0.10													
At-grade Inlet	L	D-6b & DP-LL Bypass							13.30	0.14	3.70	1.45									

LOCATION	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET/SWALE		PIPE			TRAVEL TIME			REMARKS
		AREA DESIGN	AREA (A) (AC)	RUNOFF COEFF (C)	t_c (MIN)	C.A. (AC)	I (IN / HR)	Q (CFS)	t_c (MIN)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE (INCHES)	LENGTH (FT)	VELOCITY (FPS)	t_t (MIN)	
At-grade Inlet	MM	D-7a	0.30	0.61	5.83	0.18	4.94	0.90													
		D-7b	0.27	0.35	7.07	0.09	4.65	0.44													
		D-15	0.20	0.53	5.00	0.11	5.17	0.55													
By-Pass flow from DP-MM (from Inlet Spreadsheet)								0.00													
At-grade Inlet	M	D-7 & D-15	0.47	0.88					7.07	0.20	4.65	1.92									
By-Pass flow from DP-L(from Inlet spreadsheet)								0.00													
By-Pass flow from DP-M(from Inlet spreadsheet)								0.10													
Flow in one-half of Mule Deer Dr	Q	D-16	0.32	0.72	5.00	0.23	8.68	1.98													
Release Rate from WQ Pond (From pond spreadsheet)								33.50													
		D-17	5.10	0.38	5.00	13.68	8.68	118.73													
Flow into Det Pond	S	D-17, DP-F	32.15	0.49					12.76	27.36	6.32	172.89									

All Equations follow COS DCM Rational Method

(1) Basin Description linked to C-Value Sheet
(2) Basin Design Point
(3) Enter the Basin Name from C-Value Sheet
(4) Basin Area linked to C-Value Sheet
(5) Composite C linked to C-Value Sheet
(6) Time of Concentration linked to SF-1 Sheet
(7) =Column 4 x Column 5
(8) IDF Equations from Fig 6-15 COS DCM
(9) =Column 7 x Column 8
(10) =Column 6 + Column 21
(11) Add the C.A. Values Column 7 to get the cummulative C.A. Values
(12) IDF Equations from Fig 6-15 COS DCM
(13) Sum of Qs
(14) Additional Street Longitudinal Slope
(15) Additional Street Overland Flow
(16) Additional Pipe Design Flow
(17) Additional Pipe Slope
(18) Additional Pipe Size
(19) Additional Flow Length
(20) Street or Pipe Velocity
(21) =Column 15 OR Column 16 OR Column 20 / 60

% Impervious

Project: Tuscan Foothills
Section: Areas draining to Proposed Pond

Created by: CMD
Checked by: CKC

Sub-Basin Data				Paved Area		Residential (1/3 ac lots)		Lawns/Grass		Undeveloped Offsite Flow	
Basin ID	Description/Soil Type	Total Area (ac)	% Imp	% Imp	Area (ac)	% Imp	Area (ac)	% Imp	Area (ac)	% Imp	Area (ac)
OFFSITE BASINS											
OS-2	North of OS-1 and W. of Prop	2.46	7.00%	100%	0.00	30%	0.00	0%	0.00	7%	2.46
OS-3	W. of Prop btwn OS-2 & OS-4	19.77	7.00%	100%	0.00	30%	0.00	0%	0.00	7%	19.77
OS-4	Btwn OS-3 and OS-5 W. of Prop	2.48	6.99%	100%	0.00	30%	0.00	0%	0.00	7%	2.48
ONSITE BASINS											
D-3	South end btwn D-2 and Centennial Blvd	0.96	11.53%	100%	0.00	30%	0.37	0%	0.62	45%	0.00
D-4	West portion of Silverstone Terr-North of D-1	1.61	45.78%	100%	0.36	30%	1.25	0%	0.00	45%	0.00
D-5	East Portion of Silverstone Terr-North of D-2	0.73	50.39%	100%	0.21	30%	0.52	0%	0.00	45%	0.00
D-16	South half of Mule Deer Dr	0.32	74.17%	100%	0.20	30%	0.12	0%	0.00	45%	0.00
D-17	Detention Pond	5.10	31.52%	100%	1.16	30%	1.49	0%	2.45	45%	0.00
D-18	Btwn D-17 and D-3	1.80	39.06%	100%	0.56	30%	0.48	0%	0.76	45%	0.00

Overall % Impervious for Area to Pond ***15.58%***

APPENDIX D

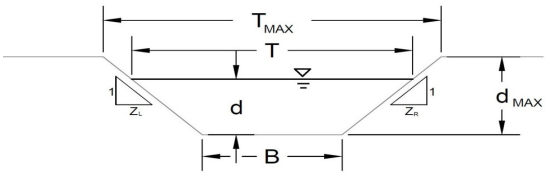
HYDRAULIC CALCULATIONS

Inlets, StormCAD & Channels

AREA INLET IN A SWALE

Tuscan Foothills - DP D

DP D



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

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

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

Check one of the following soil types:

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

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

		Minor Storm	Major Storm	
Max. Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	**25.00**	**40.00**	**feet**
Max. Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	**2.00**	**4.00**	**feet**

Maximum Channel Capacity Based On Allowable Top Width

		Minor Storm	Major Storm	
Max. Allowable Top Width	T_{MAX} =	**25.00**	**40.00**	**ft**
Water Depth	d =	1.88	3.75	ft
Flow Area	A =	32.81	93.75	sq ft
Wetted Perimeter	P =	25.46	40.92	ft
Hydraulic Radius	R =	1.29	2.29	ft
Manning's n based on NRCS Vegetal Retardance	n =	0.223	0.066	
Flow Velocity	V =	1.12	5.58	fps
Velocity-Depth Product	VR =	1.44	12.77	ft^2/s
Hydraulic Depth	D =	1.31	2.34	ft
Froude Number	Fr =	0.17	0.64	
Max. Flow Based On Allowable Top Width	Q_T =	**36.7**	**522.8**	**cfs**

Maximum Channel Capacity Based On Allowable Water Depth

		Minor Storm	Major Storm	
Max. Allowable Water Depth	d_{MAX} =	**2.00**	**4.00**	**feet**
Top Width	T =	26.00	42.00	feet
Flow Area	A =	36.00	104.00	square feet
Wetted Perimeter	P =	26.49	42.98	feet
Hydraulic Radius	R =	1.36	2.42	feet
Manning's n based on NRCS Vegetal Retardance	n =	0.166	0.064	
Flow Velocity	V =	1.56	5.96	fps
Velocity-Depth Product	VR =	2.12	14.43	ft^2/s
Hydraulic Depth	D =	1.38	2.48	feet
Froude Number	Fr =	0.23	0.67	
Max. Flow Based On Allowable Water Depth	Q_d =	**56.1**	**620.1**	**cfs**

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Top Width Criterion	Q_{allow} =	**36.7**	**522.8**	**cfs**
MAJOR STORM Allowable Capacity is based on Top Width Criterion	d_{allow} =	**1.88**	**3.75**	**ft**

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	**26.5**	**69.2**	**cfs**
Water Depth	d =	**1.76**	**2.05**	**feet**
Top Width	T =	24.11	26.39	feet
Flow Area	A =	30.07	37.28	square feet
Wetted Perimeter	P =	24.54	26.89	feet
Hydraulic Radius	R =	1.23	1.39	feet
Manning's n based on NRCS Vegetal Retardance	n =	0.274	0.141	
Flow Velocity	V =	0.88	1.86	fps
Velocity-Depth Product	VR =	1.08	2.57	ft^2/s
Hydraulic Depth	D =	1.25	1.41	feet
Froude Number	Fr =	0.14	0.28	

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

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

Version 4.05 Released March 2017

AREA INLET IN A SWALE

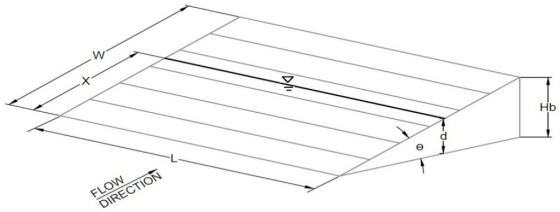
Tuscan Foothills - DP D

DP D

Inlet Design Information (Input)

Type of Inlet: CDOT Type D (In Series & Depressed)

Inlet Type = CDOT Type D (In Series & Depressed)



Angle of Inclined Grate (must be <= 30 degrees)	θ =	30.00		degrees
Width of Grate	W =	3.00		feet
Length of Grate	L =	6.00		feet
Open Area Ratio	A_{RATIO} =	0.70		
Height of Inclined Grate	H_B =	3.00		feet
Clogging Factor	C_f =	0.38		
Grate Discharge Coefficient	C_d =	0.78		
Orifice Coefficient	C_o =	0.52		
Weir Coefficient	C_w =	1.67		

		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	2.76	3.05	
Grate Capacity as a Weir				
Submerged Side Weir Length	X =	5.53	6.00	feet
Inclined Side Weir Flow	Q_{ws} =	25.7	32.8	cfs
Base Weir Flow	Q_{wb} =	57.5	66.6	cfs
Interception without Clogging	Q_{wi} =	108.9	132.3	cfs
Interception with Clogging	Q_{wa} =	68.0	82.7	cfs
Grate Capacity as an Orifice				
Interception without Clogging	Q_{oi} =	69.7	113.6	cfs
Interception with Clogging	Q_{oa} =	43.6	71.0	cfs
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**43.6**	**71.0**	**cfs**
	Bypassed Flow, Q_b =	**0.0**	**0.0**	**cfs**
	Capture Percentage = Q_a/Q_o = C%	**100**	**100**	**%**

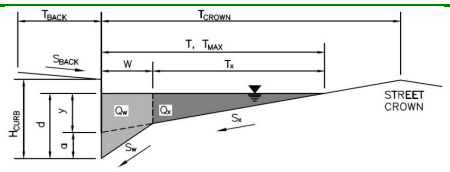
Version 4.05 Released March 2017

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

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

Project: Tuscan Foothills - DP Y

Inlet ID: DP Y



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} =	0.015	
Height of Curb at Gutter Flow Line	H_{CURB} =	8.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	16.2	ft
Gutter Width	W =	1.00	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} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	16.0	16.2	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	8.0	12.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	3.84	3.89	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	1.0	1.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	0.76	0.76	inches
Water Depth at Gutter Flowline	d =	4.60	4.64	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	15.0	15.2	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.181	0.179	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**SUMP**	**SUMP**	**cfs**
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	30.2	46.9	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	29.2	45.9	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.093	0.059	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	0.0	0.0	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**SUMP**	**SUMP**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

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

INLET IN A SUMP OR SAG LOCATION

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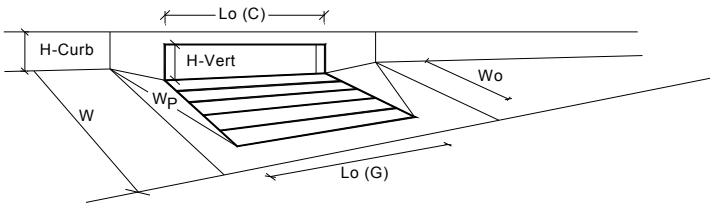


Design Information (Input)	Colorado Springs D-10-R	MINOR	MAJOR	
Type of Inlet	Type =	Colorado Springs D-10-R		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	4.00	4.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4.6	4.6	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	4.00	4.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	8.00	8.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	8.00	8.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	81.00	81.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	1.00	1.00	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) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Grate Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate Capacity as a Weir (based on Modified HEC22 Method)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	N/A	N/A	cfs
Interception with Clogging	Q_{wa} =	N/A	N/A	cfs
Grate Capacity as a Orifice (based on Modified HEC22 Method)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	N/A	N/A	cfs
Interception with Clogging	Q_{oa} =	N/A	N/A	cfs
Grate Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	N/A	N/A	cfs
Interception with Clogging	Q_{ma} =	N/A	N/A	cfs
Resulting Grate Capacity (assumes clogged condition)	**Q_{Grate} =**	**N/A**	**N/A**	**cfs**
Curb Opening Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.00	1.00	
Clogging Factor for Multiple Units	Clog =	0.13	0.13	
Curb Opening as a Weir (based on Modified HEC22 Method)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	3.4	3.5	cfs
Interception with Clogging	Q_{wa} =	3.0	3.1	cfs
Curb Opening as an Orifice (based on Modified HEC22 Method)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	8.9	9.0	cfs
Interception with Clogging	Q_{oa} =	7.8	7.8	cfs
Curb Opening Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	5.1	5.2	cfs
Interception with Clogging	Q_{ma} =	4.5	4.6	cfs
Resulting Curb Opening Capacity (assumes clogged condition)	**Q_{Curb} =**	**3.0**	**3.1**	**cfs**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	4.00	4.00	feet
Resultant Street Flow Spread (based on street geometry from above)	T =	16.0	16.2	ft
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.0	inches
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.30	0.30	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.65	0.65	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**3.0**	**3.1**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	1.4	2.6	cfs

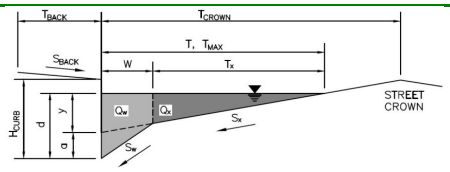
Version 4.05 Released March 2017

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

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

Project: Tuscan Foothills - DP LL (Basin D-6a)

Inlet ID: DP LL



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} =	0.015	
Height of Curb at Gutter Flow Line	H_{CURB} =	8.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	16.2	ft
Gutter Width	W =	1.00	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 =	0.040	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	5.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	8.0	12.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.20	3.12	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	1.0	1.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	0.76	0.76	inches
Water Depth at Gutter Flowline	d =	1.96	3.88	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	4.0	12.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.577	0.225	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.5	9.6	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.7	2.8	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**1.2**	**12.4**	**cfs**
Flow Velocity within the Gutter Section	V =	1.4	2.5	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.2	0.8	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	30.2	46.9	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	29.2	45.9	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.093	0.059	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	102.5	341.9	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	88.1	225.1	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	10.5	21.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	12.2	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	98.6	258.7	cfs
Average Flow Velocity Within the Gutter Section	V =	4.2	5.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.8	5.6	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	0.59	0.48	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**58.3**	**124.0**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.51	8.80	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	1.86	4.16	inches

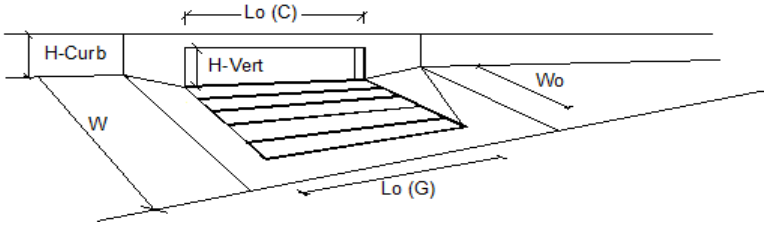
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**1.2**	**12.4**	**cfs**

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)	Colorado Springs D-10-R		MINOR	MAJOR	
Type of Inlet		Type =	Colorado Springs D-10-R		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	4.0	4.0	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 =	6.00	6.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f-G =	N/A	N/A	
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	
Design Discharge for Half of Street (from Sheet *Inlet Management*)		**Q_o =**	**1.0**	**2.0**	cfs
Water Spread Width		T =	4.7	6.2	ft
Water Depth at Flowline (outside of local depression)		d =	1.9	2.3	inches
Water Depth at Street Crown (or at T_{MAX})		d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow		E_o =	0.613	0.476	
Discharge outside the Gutter Section W, carried in Section T_x		Q_x =	0.4	1.0	cfs
Discharge within the Gutter Section W		Q_w =	0.6	0.9	cfs
Discharge Behind the Curb Face		Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W		A_W =	0.11	0.15	sq ft
Velocity within the Gutter Section W		V_W =	5.6	6.5	fps
Water Depth for Design Condition		d_{LOCAL} =	5.9	6.3	inches
Grate Analysis (Calculated)			MINOR	MAJOR	
Total Length of Inlet Grate Opening		L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow		$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition			MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins		V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow		R_f =	N/A	N/A	
Interception Rate of Side Flow		R_x =	N/A	N/A	
Interception Capacity		Q_i =	N/A	N/A	cfs
Under Clogging Condition			MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet		GrateCoef =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet		GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet		L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins		V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow		R_f =	N/A	N/A	
Interception Rate of Side Flow		R_x =	N/A	N/A	
Actual Interception Capacity		**Q_a =**	**N/A**	**N/A**	cfs
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)		**Q_b =**	**N/A**	**N/A**	cfs
Curb or Slotted Inlet Opening Analysis (Calculated)			MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)		S_e =	0.263	0.208	ft/ft
Required Length L_T to Have 100% Interception		L_T =	4.39	6.78	ft
Under No-Clogging Condition			MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)		L =	4.39	6.00	ft
Interception Capacity		Q_i =	1.0	1.9	cfs
Under Clogging Condition			MINOR	MAJOR	
Clogging Coefficient		CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet		CurbClog =	0.08	0.08	
Effective (Unclogged) Length		L_s =	5.40	5.40	ft
Actual Interception Capacity		**Q_a =**	**1.0**	**1.9**	cfs
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a		**Q_b =**	**0.0**	**0.1**	cfs
Summary			MINOR	MAJOR	
Total Inlet Interception Capacity		**Q =**	**1.0**	**1.9**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)		**Q_b =**	**0.0**	**0.1**	**cfs**
Capture Percentage = Q_a/Q_o =		**C% =**	**100**	**95**	**%**

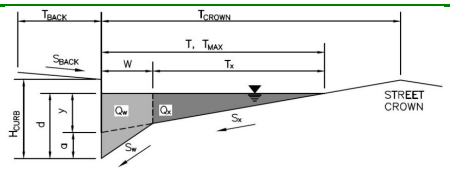
Version 4.05 Released March 2017

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

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

Project: Tuscan Foothills - DP MM (Basin D-7a)

Inlet ID: DP MM



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} =	0.015	
Height of Curb at Gutter Flow Line	H_{CURB} =	8.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	16.2	ft
Gutter Width	W =	1.00	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 =	0.040	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	5.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	8.0	12.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.20	3.12	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	1.0	1.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	0.76	0.76	inches
Water Depth at Gutter Flowline	d =	1.96	3.88	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	4.0	12.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.577	0.225	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.5	9.6	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.7	2.8	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**1.2**	**12.4**	**cfs**
Flow Velocity within the Gutter Section	V =	1.4	2.5	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.2	0.8	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	30.2	46.9	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	29.2	45.9	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.093	0.059	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	102.5	341.9	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	88.1	225.1	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	10.5	21.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	12.2	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	98.6	258.7	cfs
Average Flow Velocity Within the Gutter Section	V =	4.2	5.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.8	5.6	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	0.59	0.48	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**58.3**	**124.0**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.51	8.80	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	1.86	4.16	inches

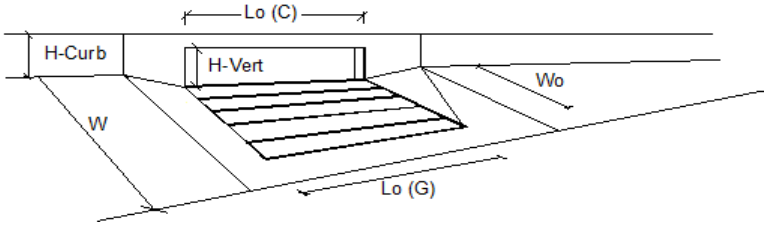
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**1.2**	**12.4**	**cfs**

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)	Colorado Springs D-10-R		MINOR	MAJOR	
Type of Inlet		Type =	Colorado Springs D-10-R		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	4.0	4.0	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 =	6.00	6.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f-G =	N/A	N/A	
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	
Design Discharge for Half of Street (from Sheet *Inlet Management*)		**Q_o =**	**0.8**	**0.9**	cfs
Water Spread Width		T =	4.2	4.4	ft
Water Depth at Flowline (outside of local depression)		d =	1.8	1.8	inches
Water Depth at Street Crown (or at T_{MAX})		d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow		E_o =	0.671	0.647	
Discharge outside the Gutter Section W, carried in Section T_x		Q_x =	0.3	0.3	cfs
Discharge within the Gutter Section W		Q_w =	0.5	0.6	cfs
Discharge Behind the Curb Face		Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W		A_W =	0.10	0.11	sq ft
Velocity within the Gutter Section W		V_W =	5.3	5.4	fps
Water Depth for Design Condition		d_{LOCAL} =	5.8	5.8	inches
Grate Analysis (Calculated)			MINOR	MAJOR	
Total Length of Inlet Grate Opening		L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow		$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition			MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins		V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow		R_f =	N/A	N/A	
Interception Rate of Side Flow		R_x =	N/A	N/A	
Interception Capacity		Q_i =	N/A	N/A	cfs
Under Clogging Condition			MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet		GrateCoef =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet		GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet		L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins		V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow		R_f =	N/A	N/A	
Interception Rate of Side Flow		R_x =	N/A	N/A	
Actual Interception Capacity		**Q_a =**	**N/A**	**N/A**	cfs
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)		**Q_b =**	**N/A**	**N/A**	cfs
Curb or Slotted Inlet Opening Analysis (Calculated)			MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)		S_e =	0.285	0.276	ft/ft
Required Length L_T to Have 100% Interception		L_T =	3.74	3.98	ft
Under No-Clogging Condition			MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)		L =	3.74	3.98	ft
Interception Capacity		Q_i =	0.8	0.9	cfs
Under Clogging Condition			MINOR	MAJOR	
Clogging Coefficient		CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet		CurbClog =	0.08	0.08	
Effective (Unclogged) Length		L_s =	5.40	5.40	ft
Actual Interception Capacity		**Q_a =**	**0.8**	**0.9**	cfs
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a		**Q_b =**	**0.0**	**0.0**	cfs
Summary			MINOR	MAJOR	
Total Inlet Interception Capacity		**Q =**	**0.8**	**0.9**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)		**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o =		**C% =**	**100**	**100**	**%**

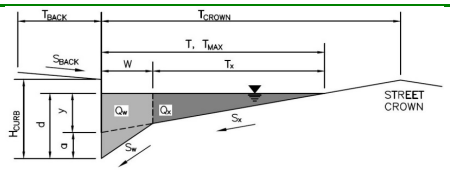
Version 4.05 Released March 2017

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

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

Project: Tuscan Foothills - DP L

Inlet ID: DP L



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} =	0.015	
Height of Curb at Gutter Flow Line	H_{CURB} =	8.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	16.2	ft
Gutter Width	W =	1.00	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 =	0.040	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	5.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	8.0	12.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.20	3.12	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	1.0	1.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	0.76	0.76	inches
Water Depth at Gutter Flowline	d =	1.96	3.88	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	4.0	12.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.577	0.225	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.5	9.6	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.7	2.8	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**1.2**	**12.4**	**cfs**
Flow Velocity within the Gutter Section	V =	1.4	2.5	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.2	0.8	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	30.2	46.9	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	29.2	45.9	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.093	0.059	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	102.5	341.9	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	88.1	225.1	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	10.5	21.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	12.2	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	98.6	258.7	cfs
Average Flow Velocity Within the Gutter Section	V =	4.2	5.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.8	5.6	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	0.59	0.48	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**58.3**	**124.0**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.51	8.80	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	1.86	4.16	inches

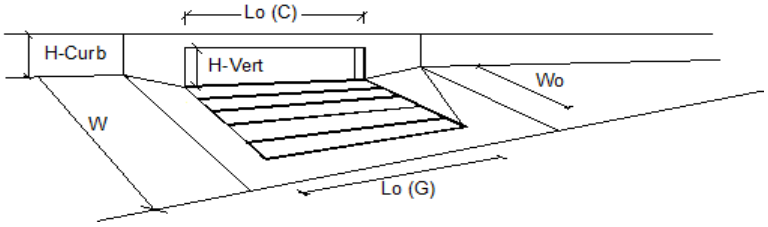
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**1.2**	**12.4**	**cfs**

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 (Colorado Springs D-10-R)	Type =	Colorado Springs D-10-R		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	4.0	4.0	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 =	6.00	6.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
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	
Design Discharge for Half of Street (from Sheet *Inlet Management*)	**Q_o =**	**0.9**	**1.5**	cfs
Water Spread Width	T =	4.3	5.4	ft
Water Depth at Flowline (outside of local depression)	d =	1.8	2.1	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.659	0.539	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.3	0.7	cfs
Discharge within the Gutter Section W	Q_w =	0.6	0.8	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.11	0.13	sq ft
Velocity within the Gutter Section W	V_W =	5.3	6.0	fps
Water Depth for Design Condition	d_{LOCAL} =	5.8	6.1	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	cfs
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	cfs
Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.280	0.233	ft/ft
Required Length L_T to Have 100% Interception	L_T =	3.86	5.49	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	3.86	5.49	ft
Interception Capacity	Q_i =	0.9	1.4	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.08	0.08	
Effective (Unclogged) Length	L_s =	5.40	5.40	ft
Actual Interception Capacity	**Q_a =**	**0.9**	**1.4**	cfs
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.0**	cfs
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.9**	**1.4**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100**	**100**	**%**

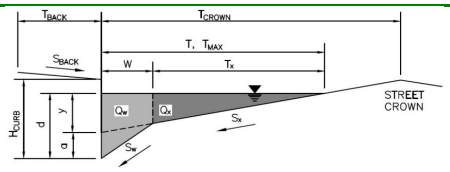
Version 4.05 Released March 2017

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

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

Project: Tuscan Foothills - DP M

Inlet ID: DP M



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} =	0.015	
Height of Curb at Gutter Flow Line	H_{CURB} =	8.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	16.2	ft
Gutter Width	W =	1.00	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 =	0.040	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	5.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	8.0	12.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.20	3.12	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	1.0	1.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	0.76	0.76	inches
Water Depth at Gutter Flowline	d =	1.96	3.88	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	4.0	12.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.577	0.225	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.5	9.6	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.7	2.8	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**1.2**	**12.4**	**cfs**
Flow Velocity within the Gutter Section	V =	1.4	2.5	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.2	0.8	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	30.2	46.9	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	29.2	45.9	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.093	0.059	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	102.5	341.9	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	88.1	225.1	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	10.5	21.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	12.2	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	98.6	258.7	cfs
Average Flow Velocity Within the Gutter Section	V =	4.2	5.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.8	5.6	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	0.59	0.48	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**58.3**	**124.0**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.51	8.80	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	1.86	4.16	inches

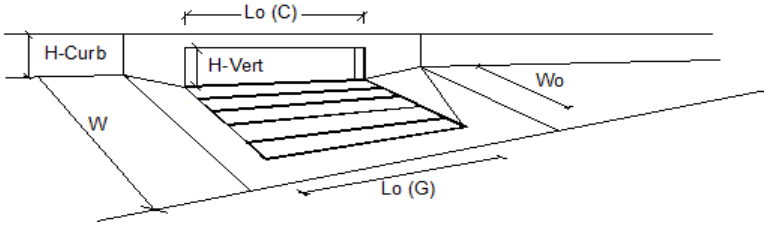
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**1.2**	**12.4**	**cfs**

WARNING: MINOR STORM max. allowable capacity is less 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 (Colorado Springs D-10-R)	Type =	Colorado Springs D-10-R		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	4.0	4.0	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 =	6.00	6.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: WARNING: Q > ALLOWABLE Q FOR MINOR STORM'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Inlet Management*)	**Q_o =**	**1.7**	**1.9**	cfs
Water Spread Width	T =	5.8	6.2	ft
Water Depth at Flowline (outside of local depression)	d =	2.2	2.2	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.508	0.482	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.8	1.0	cfs
Discharge within the Gutter Section W	Q_w =	0.9	0.9	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.14	0.14	sq ft
Velocity within the Gutter Section W	V_W =	6.2	6.4	fps
Water Depth for Design Condition	d_{LOCAL} =	6.2	6.2	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	cfs
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	cfs
Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.221	0.211	ft/ft
Required Length L_T to Have 100% Interception	L_T =	6.09	6.64	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	6.00	6.00	ft
Interception Capacity	Q_i =	1.7	1.9	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.08	0.08	
Effective (Unclogged) Length	L_s =	5.40	5.40	ft
Actual Interception Capacity	**Q_a =**	**1.7**	**1.8**	cfs
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.1**	cfs
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.7**	**1.8**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.1**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**99**	**96**	**%**

Worksheet for Curb Chase @ DP-A

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01000	ft/ft
Bottom Width	2.00	ft
Discharge	6.58	ft^3/s

Results

Normal Depth	0.57	ft
Flow Area	1.13	ft^2
Wetted Perimeter	3.13	ft
Hydraulic Radius	0.36	ft
Top Width	2.00	ft
Critical Depth	0.70	ft
Critical Slope	0.00562	ft/ft
Velocity	5.81	ft/s
Velocity Head	0.52	ft
Specific Energy	1.09	ft
Froude Number	1.36	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.57	ft
Critical Depth	0.70	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00562	ft/ft

Worksheet for Rundown @ DP-A

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.069	
Channel Slope	0.25000	ft/ft
Bottom Width	2.00	ft
Discharge	6.58	ft^3/s

Results

Normal Depth	0.59	ft
Flow Area	1.18	ft^2
Wetted Perimeter	3.18	ft
Hydraulic Radius	0.37	ft
Top Width	2.00	ft
Critical Depth	0.70	ft
Critical Slope	0.15831	ft/ft
Velocity	5.57	ft/s
Velocity Head	0.48	ft
Specific Energy	1.07	ft
Froude Number	1.28	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.59	ft
Critical Depth	0.70	ft
Channel Slope	0.25000	ft/ft
Critical Slope	0.15831	ft/ft

Worksheet for Swale OS-2

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.02000	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	9.40	ft³/s

Results

Normal Depth	0.32	ft
Flow Area	3.54	ft²
Wetted Perimeter	12.04	ft
Hydraulic Radius	0.29	ft
Top Width	11.94	ft
Critical Depth	0.29	ft
Critical Slope	0.02788	ft/ft
Velocity	2.65	ft/s
Velocity Head	0.11	ft
Specific Energy	0.43	ft
Froude Number	0.86	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.32	ft
Critical Depth	0.29	ft
Channel Slope	0.02000	ft/ft

Worksheet for Swale OS-2

GVF Output Data

Critical Slope	0.02788	ft/ft

Worksheet for Swale OS-4

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.05000	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	5.00	ft
Discharge	9.60	ft³/s

Results

Normal Depth	0.37	ft
Flow Area	2.23	ft²
Wetted Perimeter	7.31	ft
Hydraulic Radius	0.31	ft
Top Width	7.20	ft
Critical Depth	0.44	ft
Critical Slope	0.02559	ft/ft
Velocity	4.30	ft/s
Velocity Head	0.29	ft
Specific Energy	0.65	ft
Froude Number	1.36	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.37	ft
Critical Depth	0.44	ft
Channel Slope	0.05000	ft/ft

Worksheet for Swale OS-4

GVF Output Data

Critical Slope	0.02559	ft/ft

Worksheet for Swale DP-C

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.00600	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	65.48	ft³/s

Results

Normal Depth	1.37	ft
Flow Area	19.42	ft²
Wetted Perimeter	18.69	ft
Hydraulic Radius	1.04	ft
Top Width	18.25	ft
Critical Depth	0.99	ft
Critical Slope	0.01970	ft/ft
Velocity	3.37	ft/s
Velocity Head	0.18	ft
Specific Energy	1.55	ft
Froude Number	0.58	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.37	ft
Critical Depth	0.99	ft
Channel Slope	0.00600	ft/ft

Worksheet for Swale DP-C

GVF Output Data

Critical Slope	0.01970	ft/ft

Worksheet for Rundown @ DP-F

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.069	
Channel Slope	0.33333	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	86.44	ft³/s

Results

Normal Depth	0.77	ft
Flow Area	9.42	ft²
Wetted Perimeter	14.84	ft
Hydraulic Radius	0.63	ft
Top Width	14.60	ft
Critical Depth	1.17	ft
Critical Slope	0.07322	ft/ft
Velocity	9.18	ft/s
Velocity Head	1.31	ft
Specific Energy	2.07	ft
Froude Number	2.01	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.77	ft
Critical Depth	1.17	ft
Channel Slope	0.33333	ft/ft

Worksheet for Rundown @ DP-F

GVF Output Data

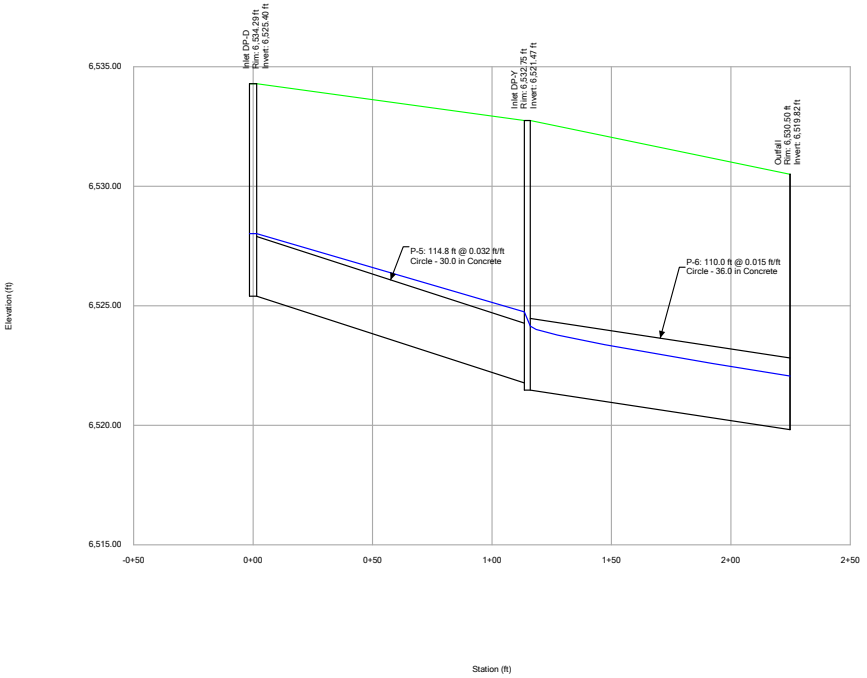
Critical Slope	0.07322	ft/ft

Scenario: 5-Year

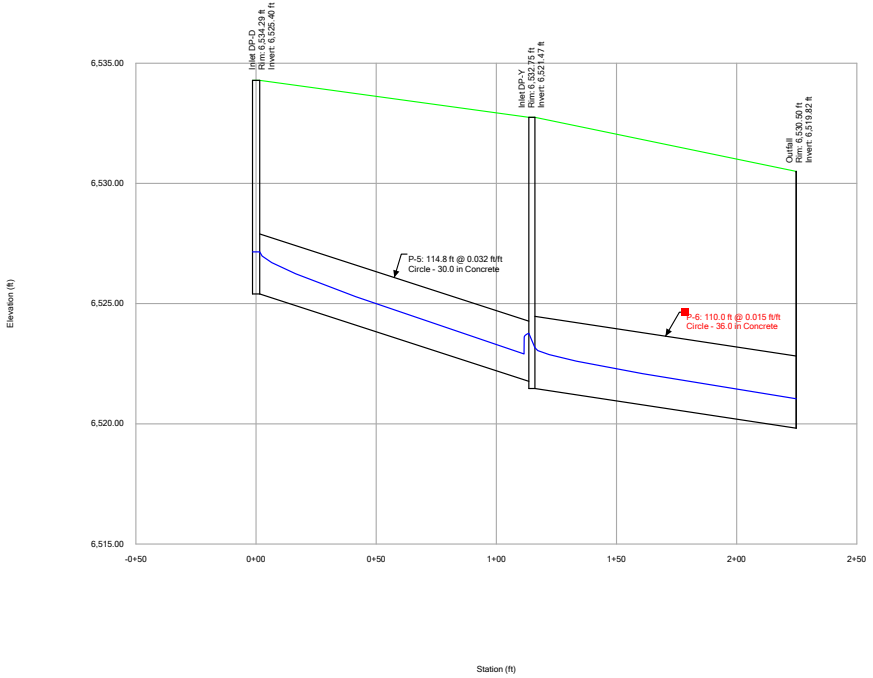
STORMCAD TABLE - STA 11+00

Label	Start Node	Stop Node	Length (ft)	Conduit Description	Flow (cfs)	Capacity (Full Flow) (cfs)	Velocity (ft/s)	Elevation Ground (Start) (ft)	Upstream Structure Hydraulic Grade Line (In) (ft)	Invert (Start) (ft)	Cover (Start) (ft)	Elevation Ground (Stop) (ft)	Invert (Stop) (ft)	Cover (Stop) (ft)	Slope (ft/ft)
5-YEAR															
P-6	Inlet DP-Y	Outfall	110	Circle - 36.0 in	27.5	81.7	10.42	6,532.75	6,523.17	6,521.47	8.28	6,530.50	6,519.82	7.68	0.015
P-5	Inlet DP-D	Inlet DP-Y	114.8	Circle - 30.0 in	26.45	72.93	13.67	6,534.29	6,527.15	6,525.40	6.39	6,532.75	6,521.77	8.48	0.032
100-YEAR															
P-6	Inlet DP-Y	Outfall	110	Circle - 36.0 in	71.47	81.7	13.03	6,532.75	6,524.15	6,521.47	8.28	6,530.50	6,519.82	7.68	0.015
P-5	Inlet DP-D	Inlet DP-Y	114.8	Circle - 30.0 in	69.22	72.93	14.1	6,534.29	6,528.02	6,525.40	6.39	6,532.75	6,521.77	8.48	0.032

Profile Report
Engineering Profile - Tuscan Foothills-100 YR (Sta 11+00.stsw)



Profile Report
Engineering Profile - Tuscan Foothills-5 YR (Sta 11+00.stsw)

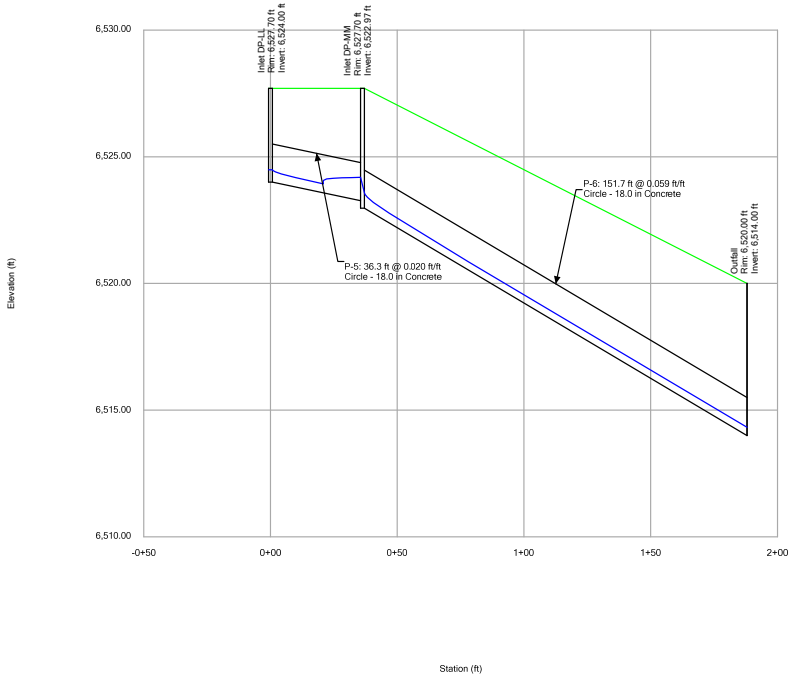


Scenario: 100-Year

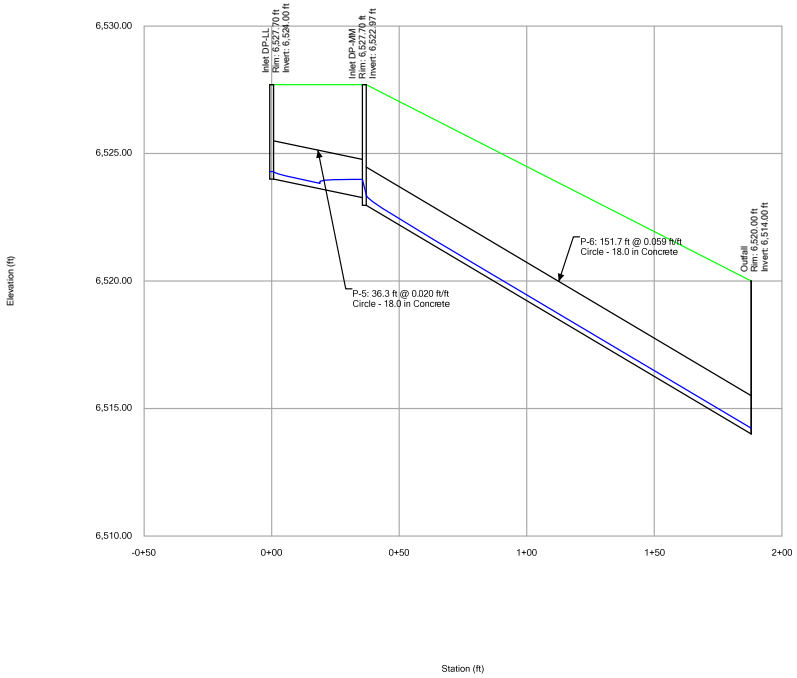
STORMCAD TABLE - STA 14+50

Label	Start Node	Stop Node	Length (ft)	Conduit Description	Flow (cfs)	Capacity (Full Flow) (cfs)	Velocity (ft/s)	Elevation Ground (Start) (ft)	Upstream Structure Hydraulic Grade Line (In) (ft)	Invert (Start) (ft)	Cover (Start) (ft)	Elevation Ground (Stop) (ft)	Invert (Stop) (ft)	Cover (Stop) (ft)	Slope (ft/ft)
5-YEAR															
P-6	Inlet DP-MM	Outfall	151.7	Circle - 18.0 in	1.25	25.54	7.48	6,527.70	6,523.99	6,522.97	3.23	6,520.00	6,514.00	4.5	0.059
P-5	Inlet DP-LL	Inlet DP-MM	36.3	Circle - 18.0 in	0.62	14.9	4.16	6,527.70	6,524.29	6,524.00	2.20	6,527.70	6,523.27	2.93	0.02
100-YEAR															
P-6	Inlet DP-MM	Outfall	151.7	Circle - 18.0 in	2.64	25.54	9.33	6,527.70	6,524.19	6,522.97	3.23	6,520.00	6,514.00	4.5	0.059
P-5	Inlet DP-LL	Inlet DP-MM	36.3	Circle - 18.0 in	1.67	14.9	5.58	6,527.70	6,524.49	6,524.00	2.2	6,527.70	6,523.27	2.93	0.02

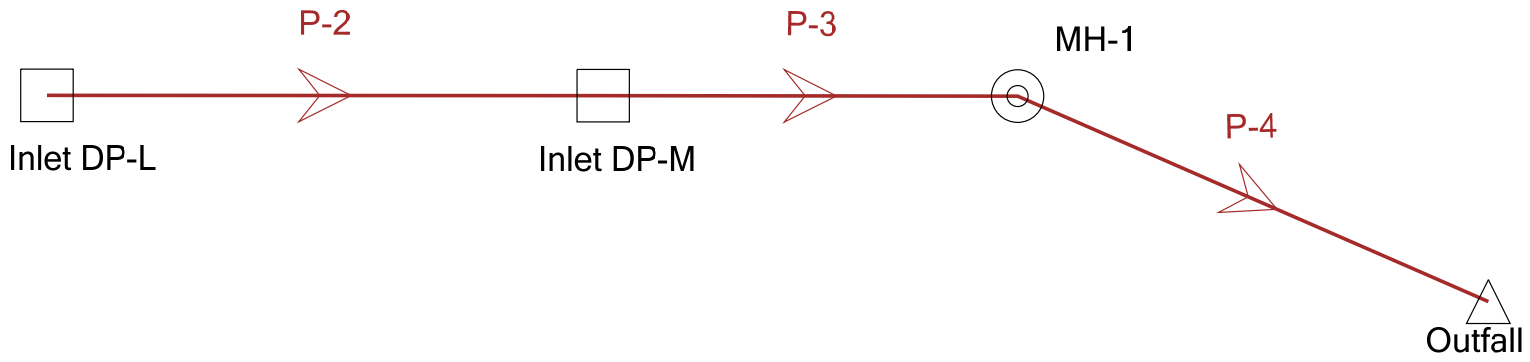
Profile Report
Engineering Profile - Tuscan Foothills-100 YR (Sta 14+50.stsw)



Profile Report
Engineering Profile - Tuscan Foothills-5 YR (Sta 14+50.stsw)



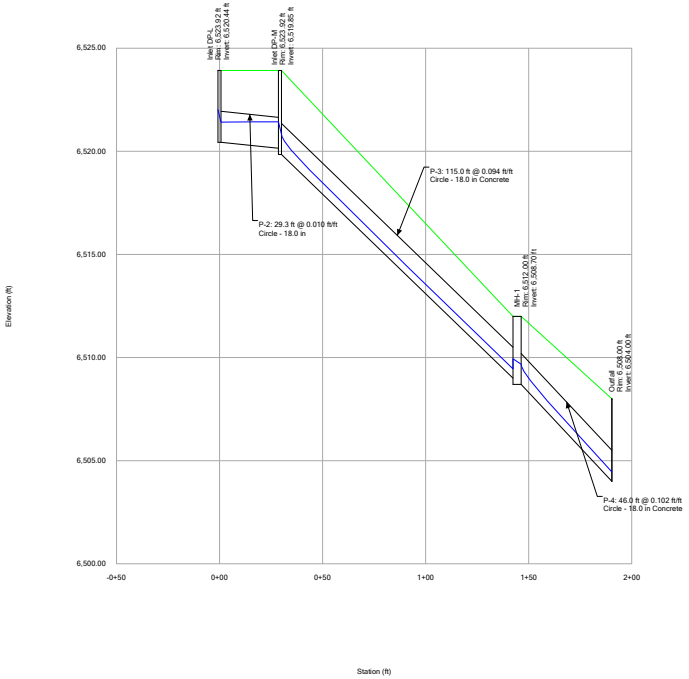
Scenario: 5-Year



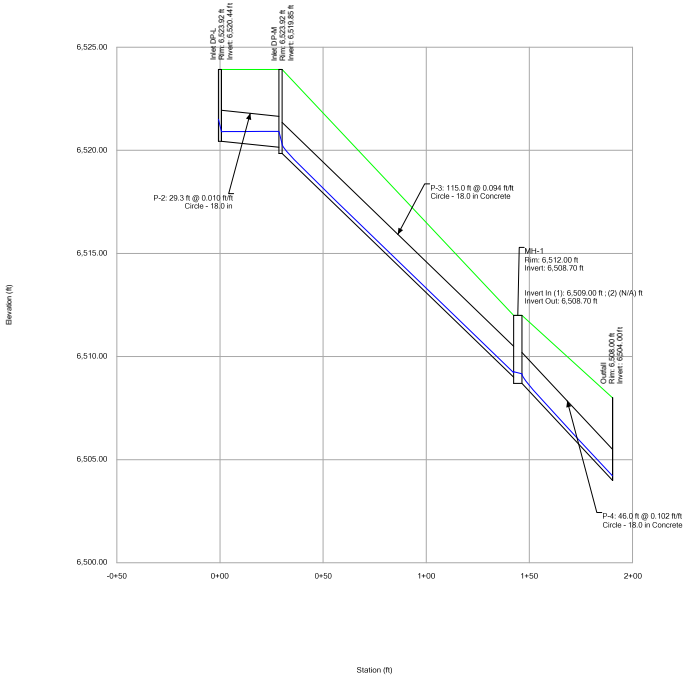
STORMCAD TABLE - STA 16+50

Label	Start Node	Stop Node	Length (ft)	Conduit Description	Flow (cfs)	Capacity (Full Flow) (cfs)	Velocity (ft/s)	Elevation Ground (Start) (ft)	Upstream Structure Hydraulic Grade Line (In) (ft)	Invert (Start) (ft)	Cover (Start) (ft)	Elevation Ground (Stop) (ft)	Invert (Stop) (ft)	Cover (Stop) (ft)	Slope (ft/ft)
5-YEAR															
P-2	Inlet DP-L	Inlet DP-M	29.3	Circle - 18.0 in	0.62	10.44	3.25	6,523.92	6,521.51	6,520.44	1.98	6,523.92	6,520.15	2.27	0.01
P-3	Inlet DP-M	MH-1	115	Circle - 18.0 in	1.55	32.26	9.4	6,523.92	6,520.92	6,519.85	2.57	6,512.00	6,509.00	1.5	0.094
P-4	MH-1	Outfall	46	Circle - 18.0 in	1.54	33.59	9.65	6,512.00	6,509.27	6,508.70	1.8	6,508.00	6,504.00	2.5	0.102
100-YEAR															
P-2	Inlet DP-L	Inlet DP-M	29.3	Circle - 18.0 in	3.5	10.44	5.32	6,523.92	6,522.02	6,520.44	1.98	6,523.92	6,520.15	2.27	0.01
P-3	Inlet DP-M	MH-1	115	Circle - 18.0 in	6.46	32.26	14.26	6,523.92	6,521.43	6,519.85	2.57	6,512.00	6,509.00	1.5	0.094
P-4	MH-1	Outfall	46	Circle - 18.0 in	6.43	33.59	14.66	6,512.00	6,509.94	6,508.70	1.8	6,508.00	6,504.00	2.5	0.102

Profile Report
Engineering Profile - Tuscan Foothills-100 YR (Sta 16+50.stsw)



Profile Report
Engineering Profile - Tuscan Foothills-5 YR (Sta 16+50.stsw)



Riprap Sizing & Culvert Outlet Protection

Tuscan Foothills - City of Colorado Springs

Culvert	Diameter - Height	Allowable Velocity	Velocity	Slope	Tailwater	Q(100)	Y(t)/D	Q/D^1.5	D50*	Riprap Size	Q/D^2.5	A(t)	Expansion Factor**	Riprap Length (Calculated)	Min Length	Max Length	Riprap Length (Used)	Riprap Width (DS end)
	(in)	ft/s	ft/s		Y(t)	cfs			in			(Q/V)	1/(2 tan θ)	L(p)	ft	ft	ft	ft
Storm @ Sta 11+00	36	5.50	13.03	1.50%	2.68	69.2	0.893	13.321	**14.13**	**M**	4.4	12.585	6.25	10.60	9	30	10.6	13.24
Storm @ Sta 14+50	18	5.50	9.33	5.90%	1.22	1.2	0.813	0.664	**11.54**	**L**	0.4	0.222	6.25	-8.24	4.5	15	4.5	6.30
Storm @ Sta 16+50	18	5.50	14.66	9.40%	1.24	6.4	0.827	3.500	**33.38**	**VH**	2.3	1.169	6.25	-3.48	4.5	15	4.5	6.30
Pond 2 Outlet	18	5.50	15.02	11.91%	0.34	3.3	0.227	1.796	**37.97**	**VH**	1.2	0.600	4.9	1.30	4.5	15	4.5	9.00
Rundown @ DP A	18	5.50	5.57	25.00%	0.37	3.3	0.247	1.802	**6.72**	**VL**								
Rundown @ DP F	24	5.50	9.18	25.00%	0.77	86.4	0.385	30.561	**18.25**	**H**								
Spillway - Pond 1	1.4	5.50	4.43	33.33%	0.26	172.9	2.229	4338.601	**4.69**	**VL**								
Spillway - Pond 2	1.1	5.50	5.89	33.33%	0.42	54.2	4.582	1952.549	**8.29**	**VL**								

* Determined from Eqn 8-11 in UDFCD Drainage Criteria Manual

** Determined from Fig 9-35 in UDFCD Drainage Criteria Manual

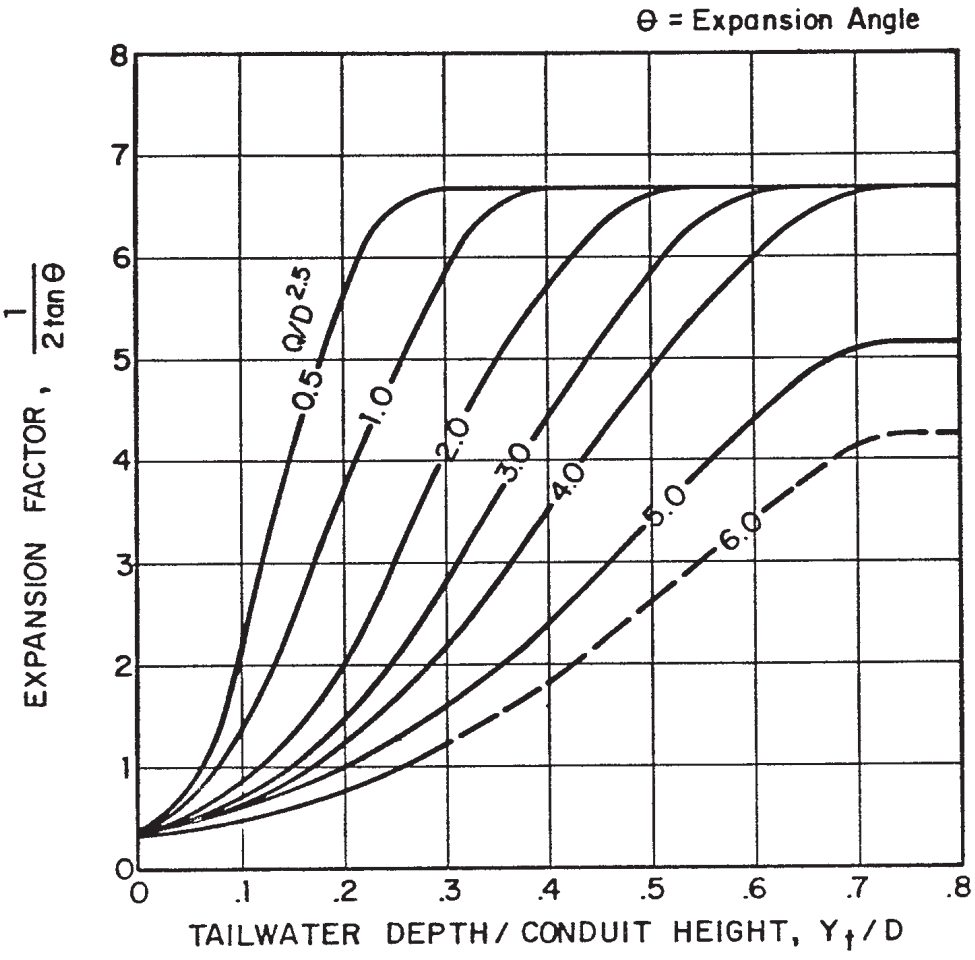


Figure 9-35. Expansion factor for circular conduits

APPENDIX E

DETENTION POND CALCULATIONS

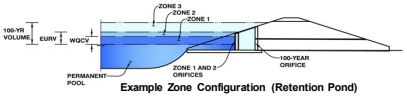
Filing No I (Final)

Filing No II (Preliminary)

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

Project: Tuscan Foothills - Phase 1 Pond 1

Basin ID: Douglass Creek Basin



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	37.88	acres
Watershed Length =	2,450	ft
Watershed Slope =	0.080	ft/ft
Watershed Imperviousness =	16.50%	percent
Percentage Hydrologic Soil Group A =	62.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	38.0%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	UDFCD Default	
Water Quality Capture Volume (WQCV) =	0.317	acre-feet
Excess Urban Runoff Volume (EURV) =	0.533	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.376	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.812	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	1.246	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	2.145	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	2.783	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	3.642	acre-feet
500-yr Runoff Volume (P1 = 3.29 in.) =	5.737	acre-feet
Approximate 2-yr Detention Volume =	0.351	acre-feet
Approximate 5-yr Detention Volume =	0.586	acre-feet
Approximate 10-yr Detention Volume =	0.745	acre-feet
Approximate 25-yr Detention Volume =	0.951	acre-feet
Approximate 50-yr Detention Volume =	1.206	acre-feet
Approximate 100-yr Detention Volume =	1.646	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

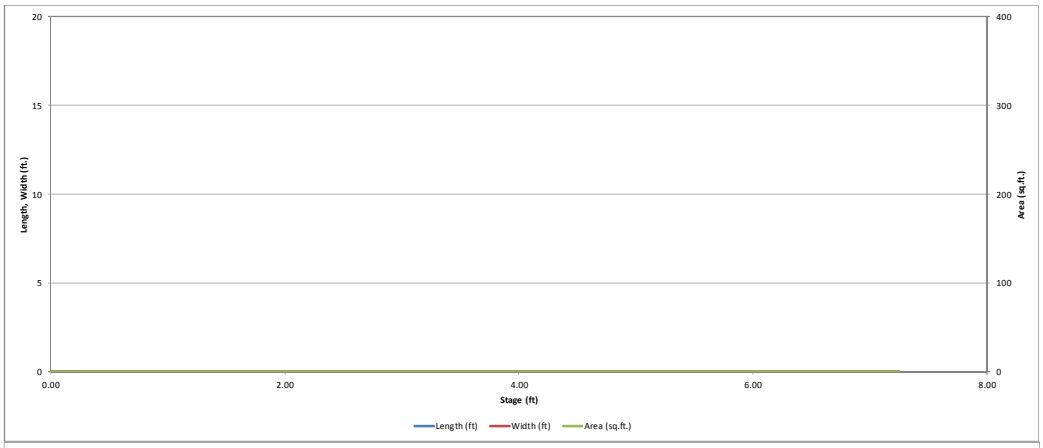
Stage-Storage Calculation

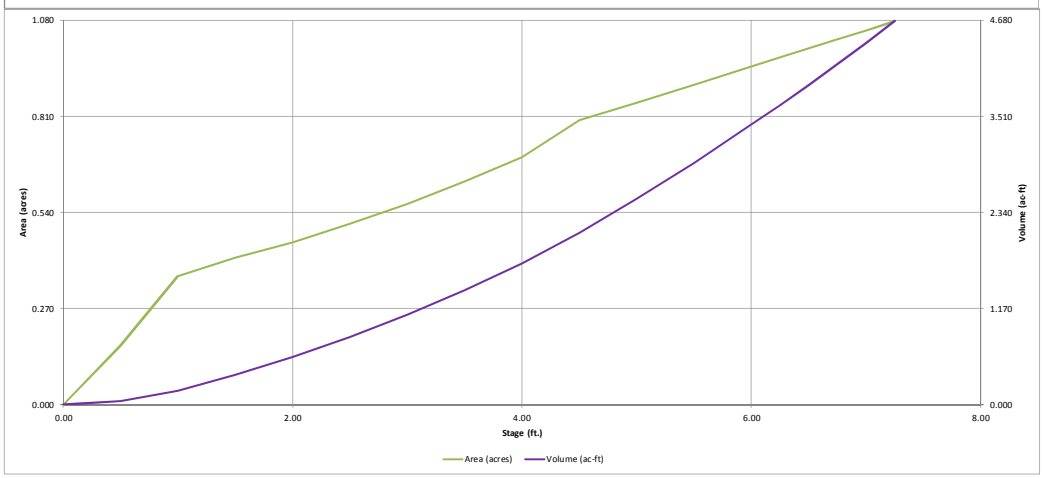
Zone 1 Volume (WQCV) =	0.317	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.216	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.113	acre-feet
Total Detention Basin Volume =	1.646	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (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 = 0.5 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)
Micropool	--	0.00	--	--	--	0	0.000		
	--	0.50	--	--	--	7,282	0.167	1,748	0.040
	--	1.00	--	--	--	15,704	0.361	7,410	0.170
	--	1.50	--	--	--	17,971	0.413	15,806	0.363
	--	2.00	--	--	--	19,833	0.455	25,238	0.579
	--	2.50	--	--	--	22,102	0.507	35,920	0.825
	--	3.00	--	--	--	24,567	0.564	47,588	1.092
	--	3.50	--	--	--	27,282	0.626	60,550	1.390
	--	4.00	--	--	--	30,255	0.695	74,934	1.720
	--	4.50	--	--	--	34,780	0.798	91,193	2.093
	--	5.00	--	--	--	36,953	0.848	109,126	2.505
	--	5.50	--	--	--	39,140	0.899	128,149	2.942
	--	6.00	--	--	--	41,342	0.949	148,270	3.404
	--	6.25	--	--	--	42,448	0.974	158,743	3.644
	--	6.50	--	--	--	43,556	1.000	169,494	3.891
	--	7.00	--	--	--	45,786	1.051	191,829	4.404
	--	7.25	--	--	--	46,906	1.077	203,416	4.670

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

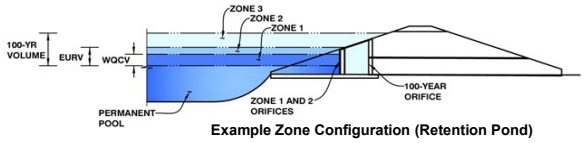




Detention Basin Outlet Structure Design

Project: Tuscan Foothills - Det Pond Phase 1 Pond 1

Basin ID: Douglass Creek Basin



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.38	0.317	Orifice Plate
Zone 2 (EURV)	1.89	0.216	Orifice Plate
Zone 3 (100-year)	3.90	1.113	Weir&Pipe (Circular)
		1.646	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 =	1.89	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	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	0.50	1.00	1.50	1.80			
Orifice Area (sq. inches)	1.53	1.53	1.53	1.53	2.00			

	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)

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

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.20	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	6.00	N/A	feet
Overflow Weir Slope =	3.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	6.00	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 =	5.20	N/A	feet
Over Flow Weir Slope Length =	6.32	N/A	feet
Grate Open Area / 100-yr Orifice Area =	8.46	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	26.56	N/A	ft^2
Overflow Grate Open Area w/ Debris =	13.28	N/A	ft^2

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

	Zone 3 Circular	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =	24.00	N/A	inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Circular	Not Selected	
Outlet Orifice Area =	3.14	N/A	ft^2
Outlet Orifice Centroid =	1.00	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.10	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

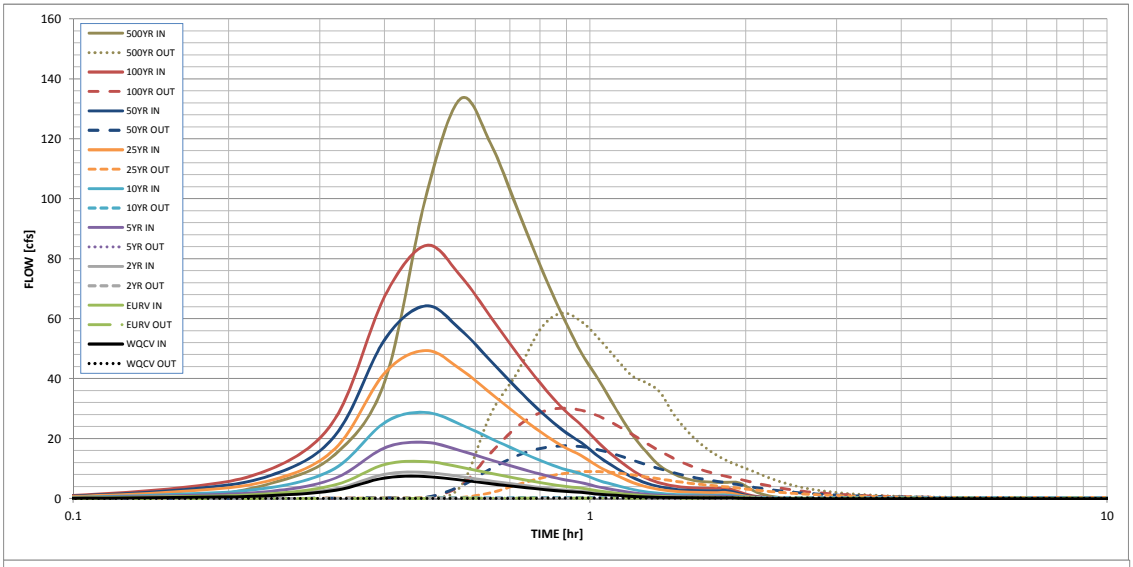
Calculated Parameters for Spillway

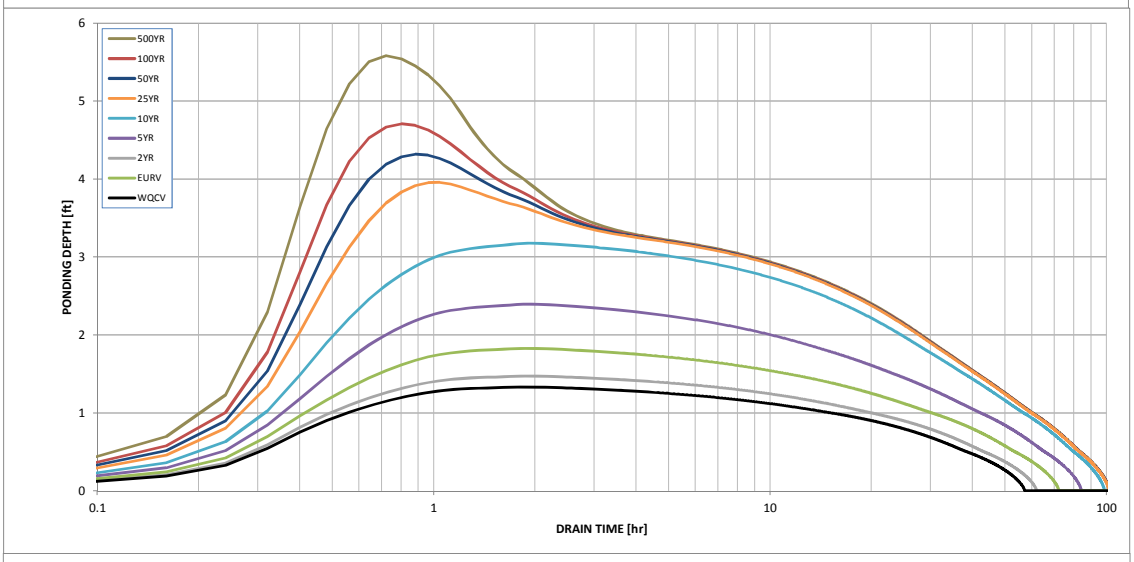
Spillway Design Flow Depth=	1.12	feet
Stage at Top of Freeboard =	7.22	feet
Basin Area at Top of Freeboard =	1.07	acres

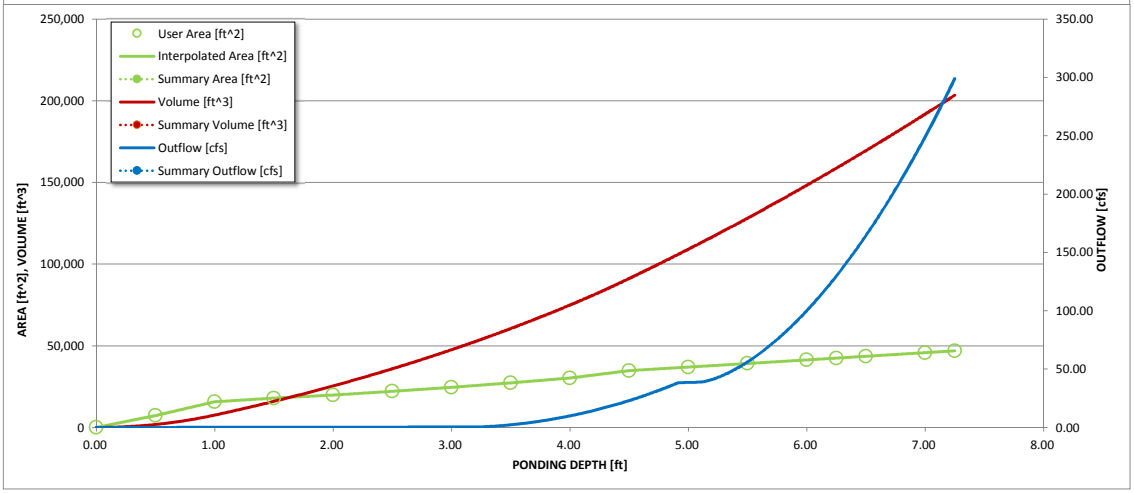
Routed Hydrograph Results

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	3.29
Calculated Runoff Volume (acre-ft) =	0.317	0.533	0.376	0.812	1.246	2.145	2.783	3.642	5.737
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.317	0.534	0.375	0.811	1.246	2.147	2.785	3.644	5.738
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.12	0.19	0.47	0.69	0.95	1.50
Predevelopment Peak Q (cfs) =	0.0	0.0	0.2	4.4	7.4	17.7	26.0	36.1	56.9
Peak Inflow Q (cfs) =	7.4	12.4	8.7	18.8	28.7	49.4	64.3	84.5	133.4
Peak Outflow Q (cfs) =	0.1	0.2	0.1	0.3	0.4	9.0	17.6	30.2	61.9
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.1	0.5	0.7	0.8	1.1
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.3	0.6	1.1	1.5
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) =	51	63	55	72	82	78	74	70	61
Time to Drain 99% of Inflow Volume (hours) =	**55**	68	59	79	91	91	88	85	80
Maximum Ponding Depth (ft) =	1.33	1.83	1.47	2.40	3.18	3.96	4.32	4.71	5.58
Area at Maximum Ponding Depth (acres) =	0.39	0.44	0.41	0.50	0.59	0.69	0.76	0.82	0.91
Maximum Volume Stored (acre-ft) =	0.298	0.503	0.355	0.769	1.190	1.686	1.946	2.255	3.014

Detention Basin Outlet Structure Design







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

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

Time Interval	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
	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]
4.81 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:04:49	0.01	0.02	0.02	0.03	0.05	0.08	0.09	0.12	0.16
Hydrograph Constant	0:09:37	0.42	0.68	0.49	0.99	1.46	2.33	2.89	3.57	5.03
	0:14:26	1.00	1.64	1.17	2.45	3.66	6.07	7.70	9.83	14.73
1.040	0:19:14	2.76	4.54	3.25	6.74	10.07	16.57	20.93	26.53	39.29
	0:24:03	6.94	11.43	8.17	17.00	25.43	42.01	53.19	67.65	100.78
	0:28:52	7.35	12.36	8.69	18.75	28.75	49.40	64.32	84.46	133.39
	0:33:40	6.19	10.47	7.33	16.01	24.77	43.14	56.36	74.35	118.56
	0:38:29	4.97	8.43	5.89	12.94	20.10	35.20	46.00	60.73	97.05
	0:43:17	3.99	6.76	4.73	10.37	16.10	28.16	36.77	48.50	77.42
	0:48:06	3.12	5.31	3.71	8.16	12.69	22.25	29.09	38.42	61.49
	0:52:55	2.47	4.21	2.94	6.47	10.05	17.62	23.01	30.35	48.58
	0:57:43	2.06	3.48	2.44	5.32	8.23	14.31	18.63	24.48	39.21
	1:02:32	1.46	2.49	1.73	3.83	5.97	10.52	13.83	18.35	29.82
	1:07:20	1.10	1.87	1.31	2.87	4.47	7.83	10.23	13.50	21.69
	1:12:09	0.76	1.29	0.90	2.00	3.12	5.53	7.26	9.65	15.66
	1:16:58	0.55	0.94	0.66	1.45	2.26	3.96	5.18	6.84	11.01
	1:21:46	0.43	0.73	0.51	1.12	1.75	3.07	4.00	5.28	8.48
	1:26:35	0.36	0.60	0.42	0.92	1.43	2.49	3.25	4.27	6.83
	1:31:23	0.32	0.54	0.38	0.82	1.26	2.19	2.84	3.72	5.93
	1:36:12	0.31	0.52	0.36	0.78	1.21	2.08	2.71	3.55	5.60
	1:41:01	0.30	0.51	0.36	0.77	1.18	2.04	2.64	3.46	5.45
	1:45:49	0.30	0.51	0.36	0.77	1.18	2.04	2.64	3.46	5.44
	1:50:38	0.30	0.51	0.36	0.77	1.18	2.04	2.64	3.46	5.44
	1:55:26	0.19	0.32	0.22	0.50	0.78	1.40	1.85	2.48	4.08
	2:00:15	0.11	0.19	0.13	0.29	0.46	0.82	1.08	1.44	2.36
	2:05:04	0.06	0.11	0.07	0.16	0.26	0.47	0.62	0.83	1.37
	2:09:52	0.03	0.06	0.04	0.09	0.14	0.26	0.34	0.45	0.74
	2:14:41	0.02	0.03	0.02	0.04	0.07	0.13	0.17	0.22	0.38
	2:19:29	0.00	0.01	0.01	0.01	0.02	0.04	0.05	0.07	0.14
	2:24:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	2:29:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:33:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:38:44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:43:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:48:21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:53:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:57:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:02:47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:07:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:12:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:17:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:22:01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:26:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:31:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:36:27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:41:16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:46:04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:14:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:19:44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:24:33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:29:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:34:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:38:59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:43:47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:48:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:53:25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:58:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:03:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:07:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:12:39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:17:28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:22:16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:27:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:31:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:36:42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:41:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:46:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.06, November 2016)

Designer: Charlene Durham
Company: Stantec
Date: December 1, 2017
Project: Tuscan Foothills Phase 1
Location: Phase 1 Pond 1

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 16.5 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.165

C) Contributing Watershed Area — Area = 37.860 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = ____ in

E) Design Concept (Select EURV when also designing for flood control)

Choose One
- ○ Water Quality Capture Volume (WQCV)
- ◉ Excess Urban Runoff Volume (EURV)

F) Design Volume (WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$)
— V_{DESIGN} = 0.317 ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN}/0.43))$)
— $V_{DESIGN\ OTHER}$ = ____ ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)
— $V_{DESIGN\ USER}$ = ____ ac-ft

I) Predominant Watershed NRCS Soil Group

Choose One
- ◉ A
- ○ B
- ○ C / D

J) Excess Urban Runoff Volume (EURV) Design Volume
For HSG A: $EURV_A = 1.68 * i^{1.28}$
For HSG B: $EURV_B = 1.36 * i^{1.08}$
For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$
— EURV = 0.528 ac-f t

2. Basin Shape: Length to Width Ratio
(A basin length to width ratio of at least 2:1 will improve TSS reduction.)
— L : W = 3.0 : 1

3. Basin Side Slopes

A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)
— Z = 3.00 ft / ft
DIFFICULT TO MAINTAIN, INCREASE WHERE POSSIBLE

4. Inlet

A) Describe means of providing energy dissipation at concentrated inflow locations:

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Charlene Durham
Company: Stantec
Date: December 1, 2017
Project: Tuscan Foothills Phase 1
Location: Phase 1 Pond 1

5. Forebay	
A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV)	V_{FMIN} = 0.010 ac-ft
B) Actual Forebay Volume	V_F = 0.010 ac-ft
C) Forebay Depth (D_F = 18 inch maximum)	D_F = 12.0 in
D) Forebay Discharge	
i) Undetained 100-year Peak Discharge	Q_{100} = 206.58 cfs
ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)	Q_F = 4.13 cfs
E) Forebay Discharge Design	Choose One: ○ Berm With Pipe ◉ Wall with Rect. Notch ○ Wall with V-Notch Weir (flow too small for berm w/ pipe)
F) Discharge Pipe Size (minimum 8-inches)	Calculated D_P = in
G) Rectangular Notch Width	Calculated W_N = 17.3 in
6. Trickle Channel	
A) Type of Trickle Channel	Choose One: ◉ Concrete ○ Soft Bottom
F) Slope of Trickle Channel	S = 0.0050 ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5 ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = 10 sq ft
C) Outlet Type	Choose One: ◉ Orifice Plate ○ Other (Describe):
D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)	$D_{orifice}$ = 1.81 inches
E) Total Outlet Area	A_{ot} = 8.13 square inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Charlene Durham
Company: Stantec
Date: December 1, 2017
Project: Tuscan Foothills Phase 1
Location: Phase 1 Pond 1

8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 6 in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = 41.4 cu ft
C) Initial Surcharge Provided Above Micropool	V_s = 5.0 cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = 263 square inches
B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.)	*Aluminum Amico-Klemp SR Series with Cross Rods 2" O.C.*
Other (Y/N): N	
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio =
D) Total Water Quality Screen Area (based on screen type)	A_{total} = 371 sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= 1.89 feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= 50.68 inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = 12.0 inches

Culvert Designer/Analyzer Report
Det Pond 1 Outlet - Phase 1

Analysis Component			
Storm Event	Design	Discharge	35.30 cfs

Peak Discharge Method: User-Specified			
Design Discharge	35.30 cfs	Check Discharge	0.40 cfs

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.			
Discharge	35.30 cfs	Bottom Elevation	5,808.00 ft
Depth	0.22 ft	Velocity	1.56 ft/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-24 inch Circular	35.30 cfs	6,498.29 ft	17.58 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
Det Pond 1 Outlet - Phase 1

Component:Culvert-1

Culvert Summary					
Computed Headwater Elev	6,498.29	ft	Discharge	35.30	cfs
Inlet Control HW Elev.	6,498.29	ft	Tailwater Elevation	5,808.22	ft
Outlet Control HW Elev.	6,496.94	ft	Control Type	Inlet Control	
Headwater Depth/Height	3.15				

Grades					
Upstream Invert	6,492.00	ft	Downstream Invert	6,487.50	ft
Length	63.50	ft	Constructed Slope	0.070866	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.22	ft
Slope Type	Steep		Normal Depth	1.10	ft
Flow Regime	Supercritical		Critical Depth	1.92	ft
Velocity Downstream	17.58	ft/s	Critical Slope	0.021240	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

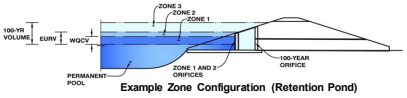
Outlet Control Properties					
Outlet Control HW Elev.	6,496.94	ft	Upstream Velocity Head	2.01	ft
Ke	0.50		Entrance Loss	1.01	ft

Inlet Control Properties					
Inlet Control HW Elev.	6,498.29	ft	Flow Control	N/A	
Inlet Type	Square edge w/headwall		Area Full	3.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

Project: Tuscan Foothills - WQ Pond Phase 1 Pond 2

Basin ID: Douglass Creek Basin



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	SF	
Watershed Area =	0.87	acres
Watershed Length =	200	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	90.00%	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 =	UDFCD Default	
Water Quality Capture Volume (WQCV) =	0.023	acre-feet
Excess Urban Runoff Volume (EURV) =	0.107	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.075	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.095	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	0.114	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	0.136	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	0.155	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	0.177	acre-feet
500-yr Runoff Volume (P1 = 3.29 in.) =	0.237	acre-feet
Approximate 2-yr Detention Volume =	0.072	acre-feet
Approximate 5-yr Detention Volume =	0.092	acre-feet
Approximate 10-yr Detention Volume =	0.110	acre-feet
Approximate 25-yr Detention Volume =	0.121	acre-feet
Approximate 50-yr Detention Volume =	0.130	acre-feet
Approximate 100-yr Detention Volume =	0.143	acre-feet

Drain Time Too Long

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

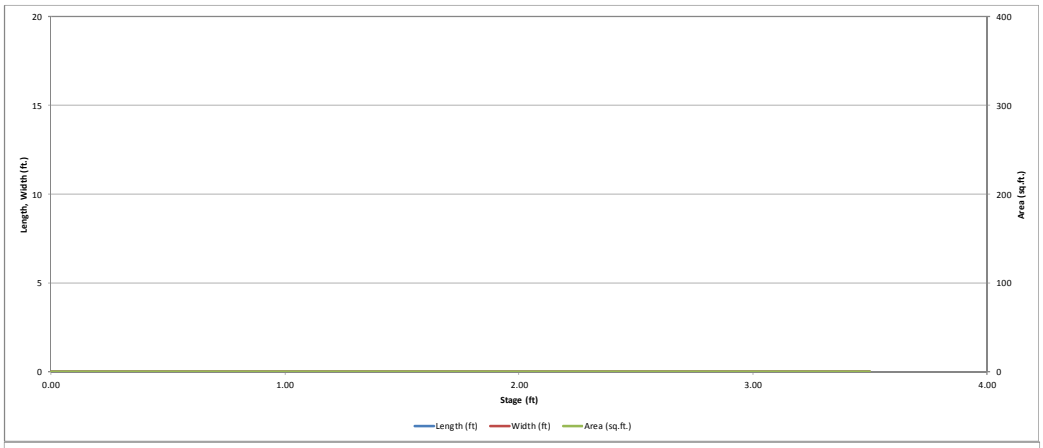
Stage-Storage Calculation

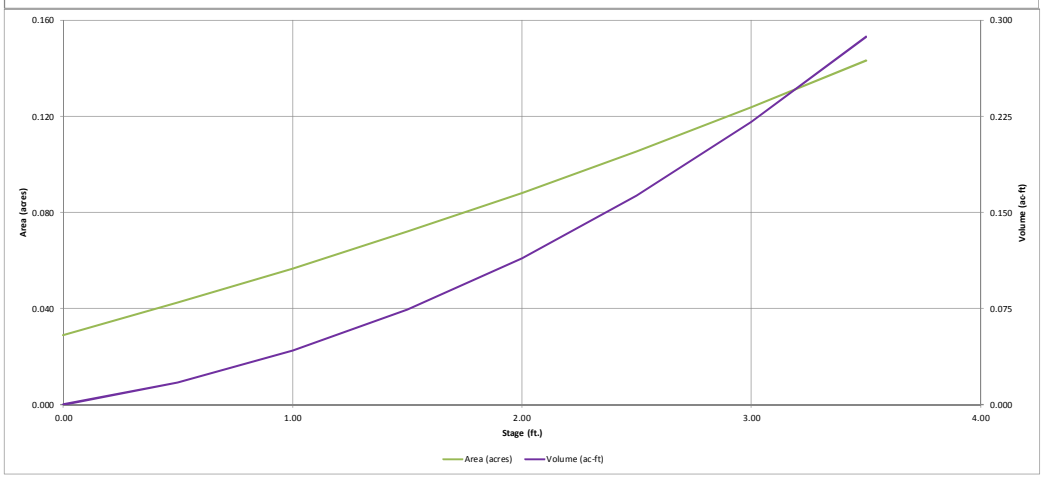
Zone 1 Volume (WQCV) =	0.023	acre-feet
Zone 2 Volume (5-year - Zone 1) =	0.068	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.051	acre-feet
Total Detention Basin Volume =	0.143	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{TOTAL}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	N/A	ft
Slope of Trickle Channel (S_{TC}) =	N/A	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 = 0.5 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)
Media Surface	--	0.00	--	--	--	1,258	0.029		
	--	0.50	--	--	--	1,845	0.042	757	0.017
	--	1.00	--	--	--	2,469	0.057	1,830	0.042
	--	1.50	--	--	--	3,133	0.072	3,223	0.074
	--	2.00	--	--	--	3,839	0.088	4,959	0.114
	--	2.50	--	--	--	4,588	0.105	7,105	0.163
	--	3.00	--	--	--	5,385	0.124	9,598	0.220
	--	3.50	--	--	--	6,235	0.143	12,503	0.287

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

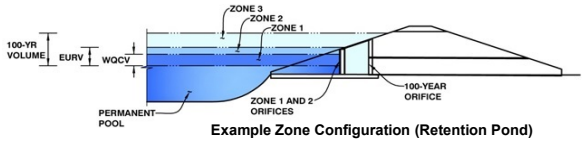




Detention Basin Outlet Structure Design

Project: Tuscan Foothills

Basin ID: WQ Pond Phase 1 Pond 2



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.63	0.023	Filtration Media
Zone 2 (5-year)	1.73	0.068	Rectangular Orifice
Zone 3 (100-year)	2.31	0.051	Weir&Pipe (Restrict)
		0.143	Total

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

Underdrain Orifice Invert Depth =	1.00	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	0.48	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	0.0	ft^2
Underdrain Orifice Centroid =	0.02	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 =	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	N/A	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	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 (optional)	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)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orifice Area (sq. inches)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

	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)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orifice Area (sq. inches)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	0.63	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	1.73	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Height =	1.00	N/A	inches
Vertical Orifice Width =	1.00		inches

Calculated Parameters for Vertical Orifice

	Zone 2 Rectangular	Not Selected	
Vertical Orifice Area =	0.01	N/A	ft^2
Vertical Orifice Centroid =	0.04	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.15	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	1.00	N/A	feet
Overflow Weir Slope =	4.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	1.00	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 =	2.40	N/A	feet
Over Flow Weir Slope Length =	1.03	N/A	feet
Grate Open Area / 100-yr Orifice Area =	0.41	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	0.72	N/A	ft^2
Overflow Grate Open Area w/ Debris =	0.36	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 =	2.50	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 =	18.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	1.77	N/A	ft^2
Outlet Orifice Centroid =	0.75	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	2.70	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	45.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

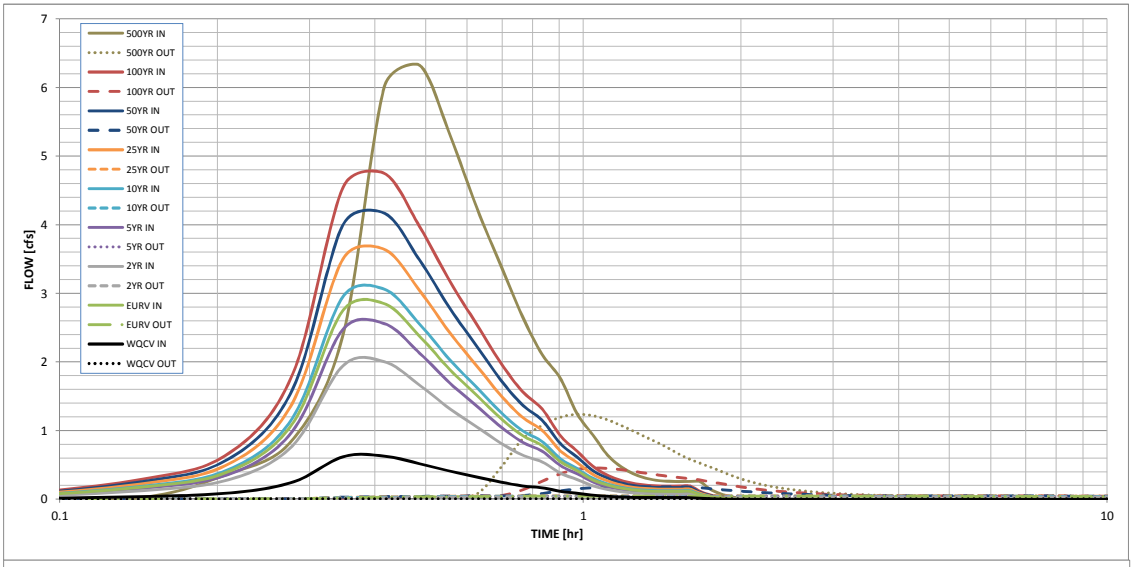
Calculated Parameters for Spillway

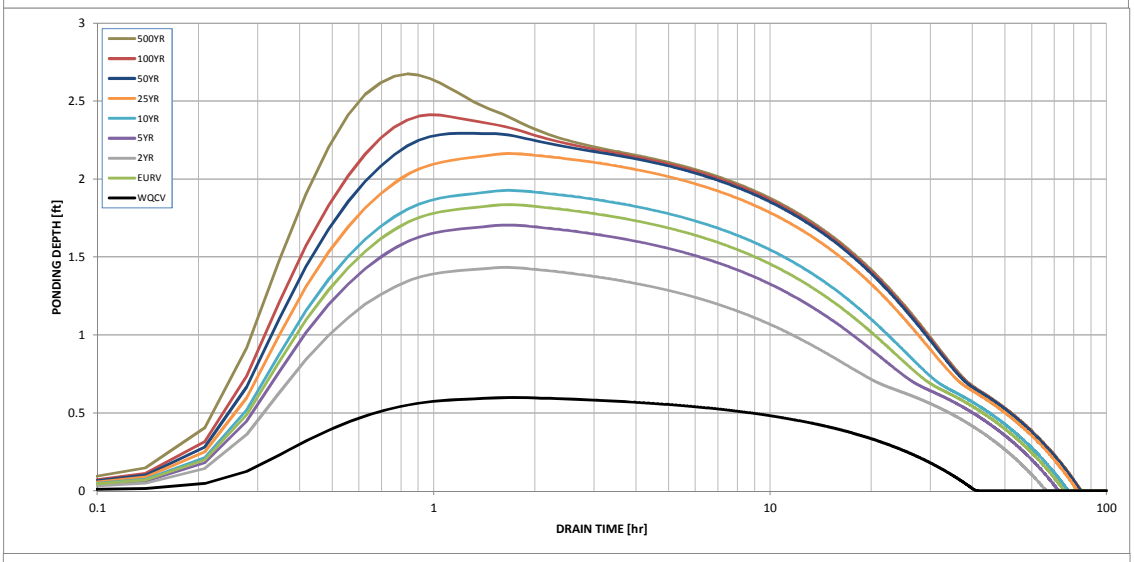
Spillway Design Flow Depth=	0.10	feet
Stage at Top of Freeboard =	3.80	feet
Basin Area at Top of Freeboard =	0.14	acres

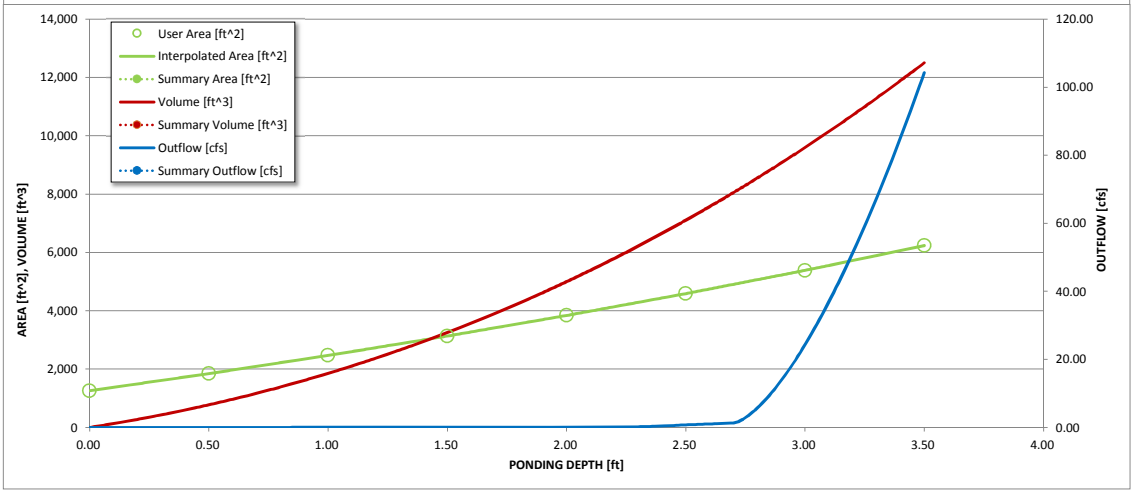
Routed Hydrograph Results

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	3.29
Calculated Runoff Volume (acre-ft) =	0.023	0.107	0.075	0.095	0.114	0.136	0.155	0.177	0.237
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.023	0.106	0.074	0.095	0.114	0.136	0.155	0.177	0.236
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.00	0.01	0.02	0.21	0.44	0.72	1.30
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.0	0.0	0.2	0.4	0.6	1.1
Peak Inflow Q (cfs) =	0.6	2.8	2.0	2.6	3.1	3.6	4.2	4.7	6.3
Peak Outflow Q (cfs) =	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.5	1.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	4.6	3.0	0.3	0.5	0.7	1.1
Structure Controlling Flow =	Filtration Media	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.0	0.2	0.6	1.6
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) =	40	69	62	67	70	74	75	74	71
Time to Drain 99% of Inflow Volume (hours) =	**40**	73	65	70	75	80	81	80	80
Maximum Ponding Depth (ft) =	0.60	1.84	1.43	1.70	1.93	2.16	2.29	2.41	2.67
Area at Maximum Ponding Depth (acres) =	0.04	0.08	0.07	0.08	0.09	0.09	0.10	0.10	0.11
Maximum Volume Stored (acre-ft) =	0.022	0.100	0.070	0.090	0.108	0.129	0.142	0.154	0.182

Detention Basin Outlet Structure Design







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

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

Time Interval	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
	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]
4.17 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:04:10	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01
Hydrograph Constant	0:08:20	0.04	0.17	0.12	0.15	0.18	0.21	0.24	0.28	0.36
	0:12:31	0.09	0.40	0.28	0.36	0.42	0.50	0.57	0.65	0.86
1.200	0:16:41	0.25	1.10	0.78	0.99	1.18	1.40	1.60	1.81	2.40
	0:20:51	0.62	2.75	1.95	2.48	2.96	3.50	4.00	4.55	6.02
	0:25:01	0.63	2.85	2.00	2.56	3.06	3.64	4.17	4.75	6.33
	0:29:11	0.52	2.38	1.66	2.13	2.55	3.04	3.49	3.98	5.31
	0:33:22	0.41	1.89	1.32	1.69	2.03	2.42	2.78	3.18	4.25
	0:37:32	0.33	1.52	1.06	1.36	1.63	1.95	2.23	2.55	3.41
	0:41:42	0.25	1.18	0.82	1.06	1.27	1.52	1.74	1.99	2.67
	0:45:52	0.20	0.93	0.65	0.83	1.00	1.20	1.38	1.57	2.11
	0:50:02	0.17	0.78	0.55	0.70	0.84	1.00	1.15	1.32	1.76
	0:54:13	0.12	0.55	0.38	0.49	0.59	0.71	0.81	0.93	1.24
	0:58:23	0.09	0.42	0.29	0.37	0.45	0.53	0.61	0.70	0.94
	1:02:33	0.06	0.28	0.20	0.25	0.30	0.36	0.42	0.48	0.64
	1:06:43	0.04	0.21	0.14	0.19	0.22	0.27	0.31	0.35	0.47
	1:10:53	0.03	0.16	0.11	0.15	0.17	0.21	0.24	0.27	0.37
	1:15:04	0.03	0.14	0.09	0.12	0.15	0.17	0.20	0.23	0.30
	1:19:14	0.03	0.12	0.09	0.11	0.13	0.16	0.18	0.20	0.27
	1:23:24	0.03	0.12	0.08	0.11	0.13	0.15	0.17	0.20	0.26
	1:27:34	0.03	0.12	0.08	0.10	0.12	0.15	0.17	0.19	0.26
	1:31:44	0.03	0.12	0.08	0.10	0.12	0.15	0.17	0.19	0.26
	1:35:55	0.03	0.12	0.08	0.10	0.12	0.15	0.17	0.19	0.26
	1:40:05	0.01	0.07	0.05	0.06	0.07	0.09	0.10	0.12	0.16
	1:44:15	0.01	0.04	0.03	0.04	0.04	0.05	0.06	0.07	0.09
	1:48:25	0.00	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.05
	1:52:35	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03
	1:56:46	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01
	2:00:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:05:06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:09:16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:13:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:17:37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:21:47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:25:57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:30:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:34:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:38:28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:42:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:46:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:59:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:03:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:07:39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:11:49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:24:20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:28:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:32:40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:36:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:41:01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:49:21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:53:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:57:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:01:52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:06:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:14:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:18:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:22:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:26:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:31:03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:39:23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:43:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:47:44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:51:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:56:04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Culvert Designer/Analyzer Report
Det Pond 2 Outlet - Phase 1

Analysis Component			
Storm Event	Design	Discharge	6.58 cfs

Peak Discharge Method: User-Specified			
Design Discharge	6.58 cfs	Check Discharge	3.65 cfs

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.			
Discharge	6.58 cfs	Bottom Elevation	6,517.40 ft
Depth	0.14 ft	Velocity	1.14 ft/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-18 inch Circular	6.58 cfs	6,524.65 ft	15.02 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
Det Pond 2 Outlet - Phase 1

Component:Culvert-1

Culvert Summary					
Computed Headwater Elev	6,524.65	ft	Discharge	6.58	cfs
Inlet Control HW Elev.	6,524.48	ft	Tailwater Elevation	6,517.54	ft
Outlet Control HW Elev.	6,524.65	ft	Control Type	Entrance Control	
Headwater Depth/Height	1.10				

Grades					
Upstream Invert	6,523.00	ft	Downstream Invert	6,517.40	ft
Length	47.00	ft	Constructed Slope	0.119149	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.44	ft
Slope Type	Steep		Normal Depth	0.43	ft
Flow Regime	Supercritical		Critical Depth	0.99	ft
Velocity Downstream	15.02	ft/s	Critical Slope	0.006527	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.50	ft
Section Size	18 inch		Rise	1.50	ft
Number Sections	1				

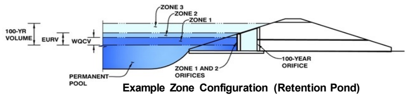
Outlet Control Properties					
Outlet Control HW Elev.	6,524.65	ft	Upstream Velocity Head	0.44	ft
Ke	0.50		Entrance Loss	0.22	ft

Inlet Control Properties					
Inlet Control HW Elev.	6,524.48	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	1.8	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

Project: WQ Pond - Phase 2 Pond (Preliminary Design)

Basin ID: Douglass Creek Basin



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	**EDB**			
Watershed Area =	5.00	acres		
Watershed Length =	625	ft		
Watershed Slope =	0.080	ft/ft		
Watershed Imperviousness =	30.00%	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 =	UDFCD Default			
Water Quality Capture Volume (WQCV) =	0.063	acre-feet	Optional User Override 1-hr Precipitation	
Excess Urban Runoff Volume (EURV) =	0.150	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.088	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.124	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.171	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.286	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.365	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.465	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.29 in.) =	0.727	acre-feet		inches
Approximate 2-yr Detention Volume =	0.083	acre-feet		
Approximate 5-yr Detention Volume =	0.117	acre-feet		
Approximate 10-yr Detention Volume =	0.162	acre-feet		
Approximate 25-yr Detention Volume =	0.197	acre-feet		
Approximate 50-yr Detention Volume =	0.223	acre-feet		
Approximate 100-yr Detention Volume =	0.280	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.063	acre-feet
Zone 2 Volume (5-year - Zone 1) =	0.054	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.163	acre-feet
Total Detention Basin Volume =	0.280	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 = 0.5 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)
Micropool	--	0.00	--	--	--	4,022	0.092		
	--	0.50	--	--	--	5,115	0.117	2,233	0.051
	--	1.00	--	--	--	6,470	0.149	5,116	0.117
	--	1.50	--	--	--	7,877	0.181	8,689	0.199
	--	2.00	--	--	--	9,310	0.214	12,971	0.298
	--	2.50	--	--	--	10,768	0.247	18,083	0.415
	--	3.00	--	--	--	12,251	0.281	23,838	0.547
	--	3.50	--	--	--	13,759	0.316	30,341	0.697
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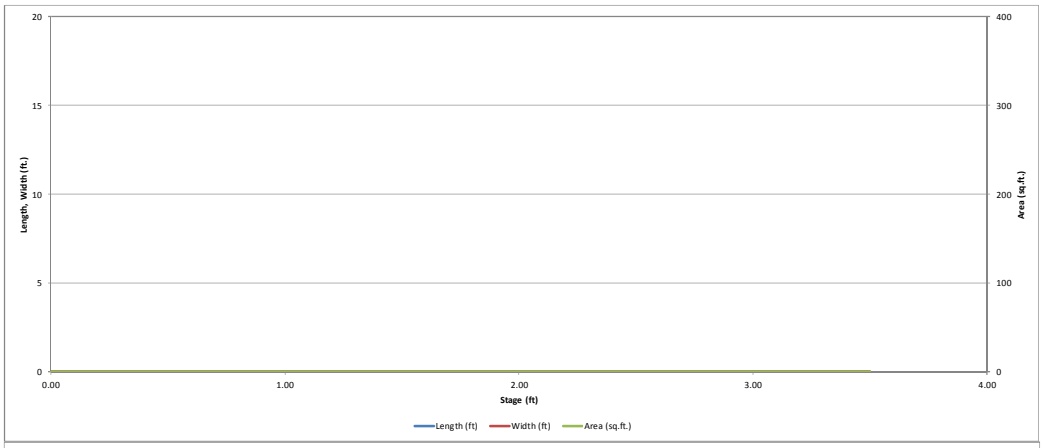
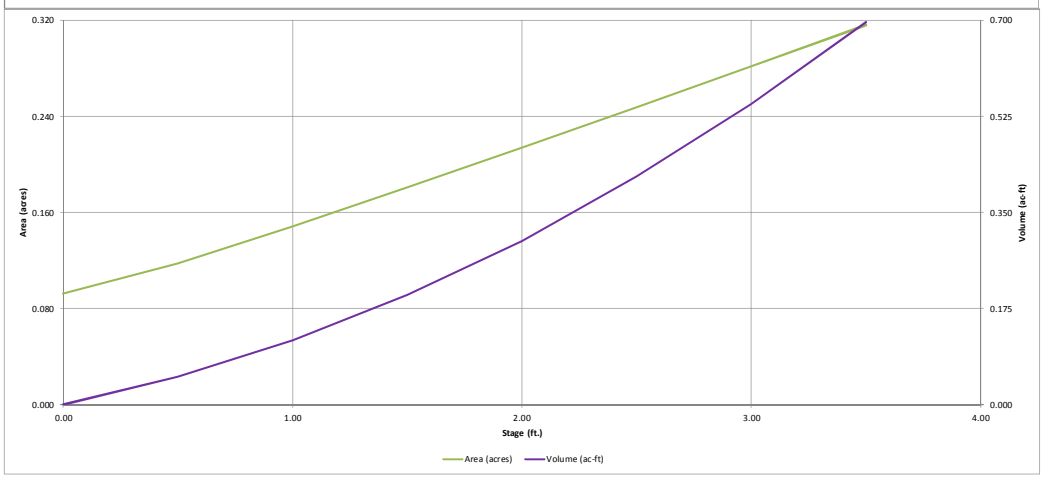
DETENTION BASIN STAGE-STORAGE TABLE BUILDER





Worksheet Protected

Site-Level Low Impact Development (LID) Design Effective Impervious Calculator

LID Credit by Impervious Reduction Factor (IRF) Method

UD-BMP (Version 3.06, November 2016)

User Input

Calculated cells

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.60	inches	**Designer:**	**Charlene Durham**
***Minor Storm: 1-Hour Rain Depth	10-Year Event	1.75	inches	**Company:**	**Stantec**
***Major Storm: 1-Hour Rain Depth	100-Year Event	2.52	inches	**Date:**	**February 23, 2018**
Optional User Defined Storm	CUHP			**Project:**	**Tuscan Foothills**
(CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm	100-Year Event			**Location:**	**Phase 1 and Phase 2**

Max Intensity for Optional User Defined Storm: 0

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	**Ph 1 Pond 1**	**Ph 1 Pond 2**	**Ph 2 Pond 1**											
Receiving Pervious Area Soil Type	Sandy Loam	Sandy Loam	Sandy Loam											
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	37.880	0.870	5.000											
Directly Connected Impervious Area (DCIA, acres)	4.170	0.780	1.720											
Unconnected Impervious Area (UIA, acres)	0.000	0.000	3.150											
Receiving Pervious Area (RPA, acres)	0.000	0.000	0.130											
Separate Pervious Area (SPA, acres)	33.710	0.090	0.000											
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	V	V	V											

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	37.880	0.870	5.000											
Directly Connected Impervious Area (DCIA, %)	11.0%	89.7%	34.4%											
Unconnected Impervious Area (UIA, %)	0.0%	0.0%	63.0%											
Receiving Pervious Area (RPA, %)	0.0%	0.0%	2.6%											
Separate Pervious Area (SPA, %)	89.0%	10.3%	0.0%											
A_R (RPA / UIA)	0.000	0.000	0.041											
I_a Check	1.000	1.000	0.960											
f / I for WQCV Event:	1.7	1.7	1.7											
f / I for 10-Year Event:	0.5	0.5	0.5											
f / I for 100-Year Event:	0.3	0.3	0.3											
f / I for Optional User Defined Storm CUHP:														
IRF for WQCV Event:	0.00	0.00	0.00											
IRF for 10-Year Event:	1.00	1.00	0.99											
IRF for 100-Year Event:	1.00	1.00	1.00											
IRF for Optional User Defined Storm CUHP:														
Total Site Imperviousness: I_{total}	11.0%	89.7%	97.4%											
Effective Imperviousness for WQCV Event:	11.0%	89.7%	34.4%											
Effective Imperviousness for 10-Year Event:	11.0%	89.7%	96.8%											
Effective Imperviousness for 100-Year Event:	11.0%	89.7%	97.4%											
Effective Imperviousness for Optional User Defined Storm CUHP:														

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

WQCV Event CREDIT: Reduce Detention By:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10-Year Event CREDIT**: Reduce Detention By:	0.0%	0.0%	0.7%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	0.0%	0.0%	0.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:														

Total Site Imperviousness:	**22.4%**
Total Site Effective Imperviousness for WQCV Event:	**15.2%**
Total Site Effective Imperviousness for 10-Year Event:	**22.4%**
Total Site Effective Imperviousness for 100-Year Event:	**22.4%**
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	

Notes:

* Use Green-Ampt average infiltration rate values from Table 3-3.

** Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.

*** Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

APPENDIX F

MAPS

1"=100'

100 0 100 200

N

EX SECTION LINE

EX PROPERTY LINE (TYP)

BOUNDARY LINE (TYP)

E-1
19.95 53.39
17.58

E-2
28.64 76.63
27.83

E-3
16.22 43.39
15.37

CITY OF COLORADO SPRINGS MOUNTAIN SHADOWS OPEN SPACE

CITY OF COLORADO SPRINGS MOUNTAIN SHADOWS OPEN SPACE

CITY OF COLORADO SPRINGS MOUNTAIN SHADOWS OPEN SPACE

CITY OF COLORADO SPRINGS MOUNTAIN SHADOWS OPEN SPACE

MATCH LINE SEE SHEET 2

LEGEND

- EXISTING 2' CONTOUR
- EXISTING 10' CONTOUR
- PROPERTY BOUNDARY
- FLOW PATH
- DRAINAGE BASIN BOUNDARY
- FLOW DIRECTION
- DESIGN POINT (N)
- BASIN LABEL (LABEL / Q5 / Q100 / AREA)

DESIGN POINT	Q5	Q100
A	19.95	53.39
B	28.64	76.63
C	116.22	43.39
D	7.36	19.70
E	3.94	10.54
Q	14.87	23.42

Stantec
1110 ELKTON DRIVE, SUITE B
COLORADO SPRINGS, CO 80907
(719) 432-6889

REVISIONS:

NO.	DESCRIPTION	DATE

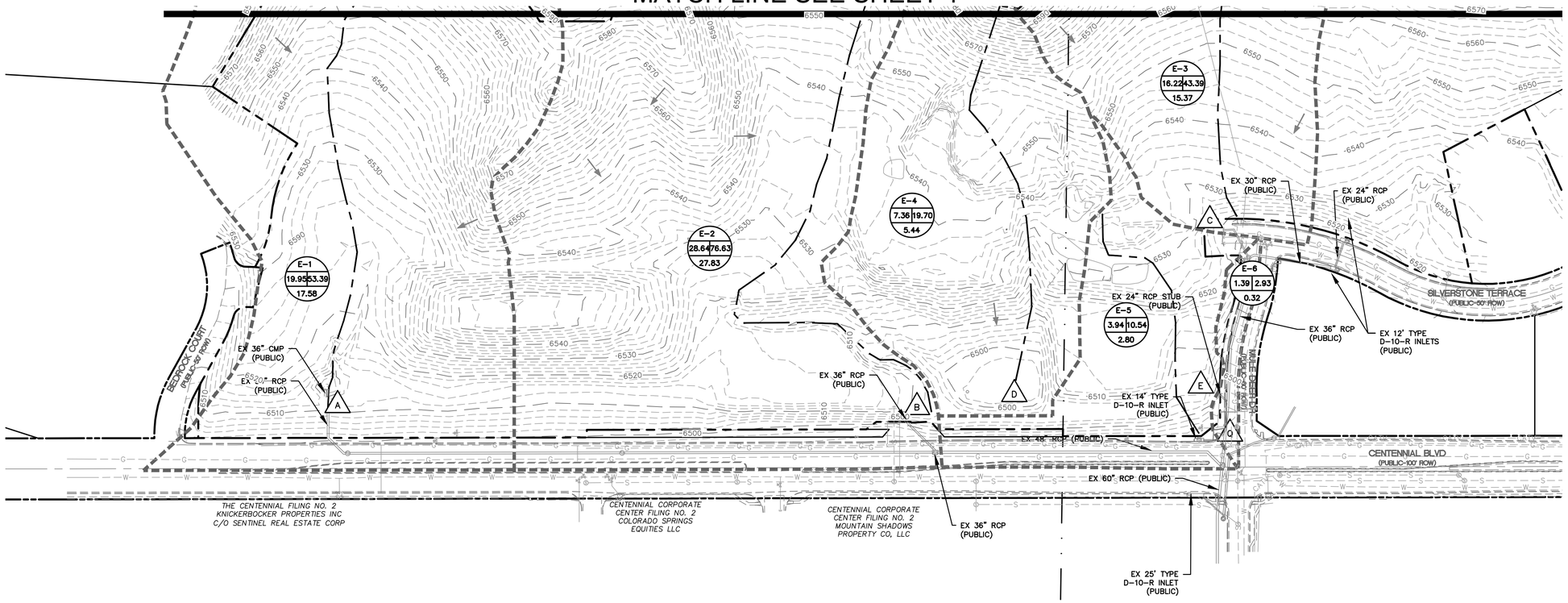
ENGINEER:
DESIGNED BY: CMD DATE: 5-15-17
DRAWN BY: BG DATE: 5-15-17
CHECKED BY: CMD DATE: 5-17-17

48 HOURS BEFORE YOU DIG,
CALL UTILITY LOCATORS
1-800-922-1987
CITY OF COLORADO SPRINGS DEPT. OF UTILITIES
GAS, ELECTRIC, WATER AND WASTEWATER

DSE Dakota Springs Engineering
31 N. TEJON, SUITE 500
COLORADO SPRINGS, CO 80903
P: (719) 227-7388
F: (719) 227-7392

PROJECT TUSCAN FOOTHILLS VILLAGE
SHEET TITLE Existing Basins
FROM NA TO NA
JOB NO. 181710238 SHEET 1 OF 2

MATCH LINE SEE SHEET 1



1"=100'

100 0 100 200

N

DESIGN POINT	Q5	Q100
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C	116.22	43.39
D	7.36	19.70
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Q	14.87	23.42

LEGEND

- EXISTING 2' CONTOUR
- EXISTING 10' CONTOUR
- PROPERTY BOUNDARY
- FLOW PATH
- DRAINAGE BASIN BOUNDARY
- FLOW DIRECTION
- DESIGN POINT (N)
- BASIN LABEL (LABEL / Q5 / Q100 / AREA)

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PROJECT TUSCAN FOOTHILLS VILLAGE
SHEET TITLE Existing Basins
FROM NA TO NA
JOB NO. 181710238 SHEET 2 OF 2

1"=100'

100 0 100 200

N

NOTE:

SEE SHEET 2+3 FOR ONSITE INFORMATION

LEGEND

- PROPOSED 2' CONTOURS
- PROPOSED 10' CONTOURS
- EXISTING 2' CONTOUR
- EXISTING 10' CONTOUR
- PROPERTY BOUNDARY
- FLOW PATH
- DRAINAGE BASIN BOUNDARY
- NO BUILD LINES
- LOT LINES
- PHASE LINE
- FLOW DIRECTION
- DESIGN POINT
- BASIN LABEL (LABEL / Q5 / Q100 / AREA)

OS-1 | 19.45 | 52.06 | 16.98

OS-2 | 3.51 | 9.40 | 2.46

OS-3 | 19.58 | 52.39 | 19.77

OS-4 | 3.59 | 9.60 | 2.48

OS-5 | 22.00 | 35.07 | 2.11

OS-7 | 7.79 | 9.01 | 6.60

OS-8 | 2.03 | 2.35 | 1.51

OS-9 | 13.43 | 15.53 | 10.93

CITY OF COLORADO SPRINGS MOUNTAIN SHADOWS OPEN SPACE

BOUNDARY LINE

NO BUILD LINE (TYP)

PROPOSED DRAINAGE SWALE

SEE SHEET 2+3 FOR ONSIDE INFORMATION

SILVERSTONE TERRACE (PUBLIC 60' ROW)

PHASE II

MOUNTAIN SHADOWS FILING NO. 2 - FRONT RANGE ALLIANCE CHURCH OF CHRISTIAN AND MISSIONARY ALLIANCE

DESIGN POINT	Q5	Q100
A	3.65	6.58
B	21.66	56.04
C	24.48	65.48
D	26.45	69.22
Y	1.40	2.64
F	33.36	86.44
G	2.32	4.60
H	3.54	6.91
J	4.92	5.59
L	0.86	1.45
M	1.69	1.92
P	3.28	3.74
Q	1.09	1.98
R	45.19	60.65
S	39.43	172.89
I	54.24	70.90
N	2.03	2.35
O	8.74	9.86
LL	1.04	1.98
MM	0.82	0.90

Stantec
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REVISIONS:

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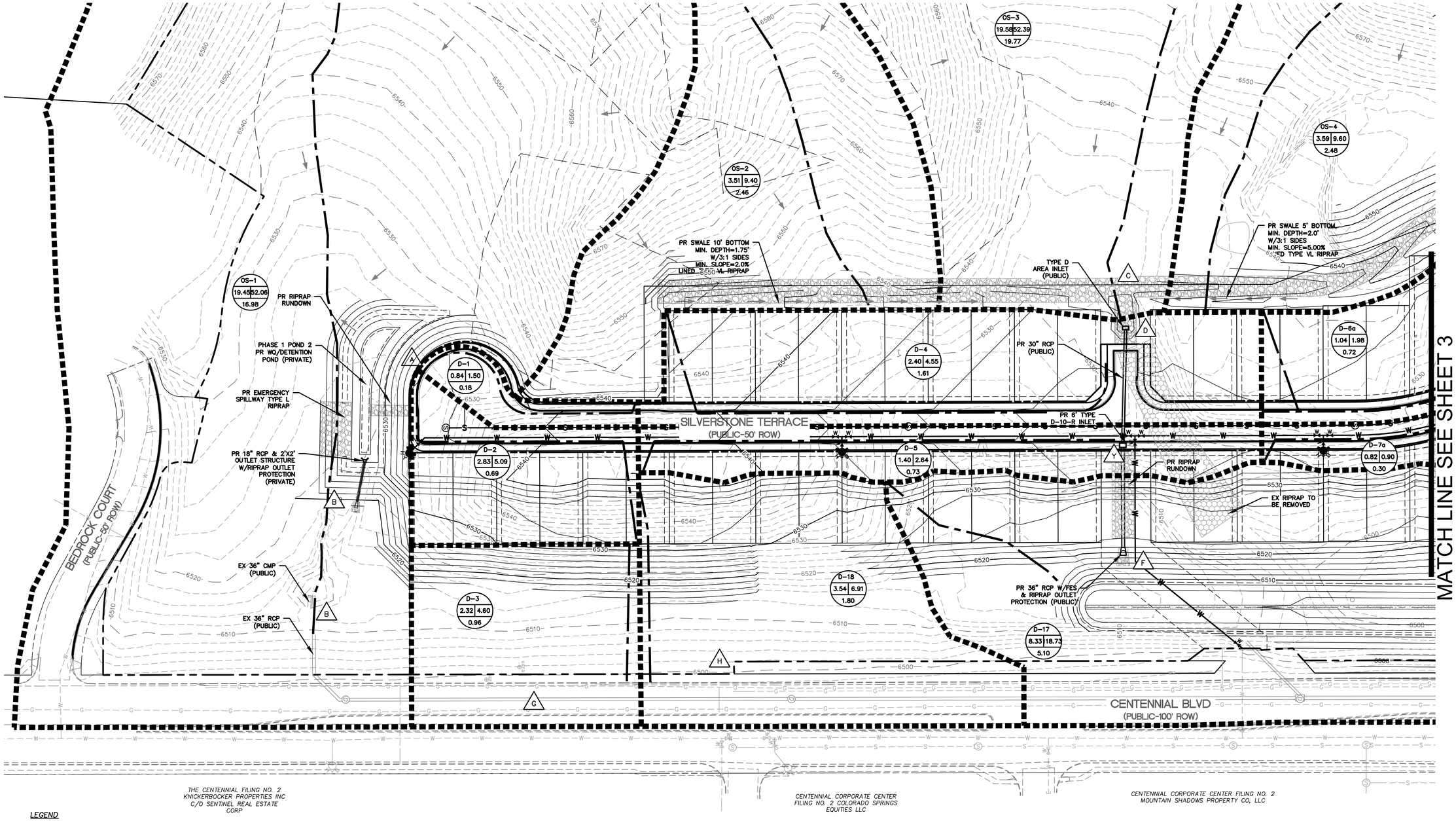
CITY OF COLORADO SPRINGS DEPT. OF UTILITIES GAS, ELECTRIC, WATER AND WASTEWATER

DSE Dakota Springs Engineering
31 N. TEJON, SUITE 500
COLORADO SPRINGS, CO 80903
P: (719) 227-7388
F: (719) 227-7392

PROJECT TUSCAN FOOTHILLS VILLAGE
SHEET TITLE Offsite Basins
FROM NA TO NA
JOB NO. 1817102.38 SHEET 1 OF 3



THE CENTENNIAL FILING NO. 2
KNICKERBOCKER PROPERTIES INC
C/O SENTINEL REAL ESTATE
CORP

CENTENNIAL CORPORATE CENTER
FILING NO. 2 COLORADO SPRINGS
EQUITIES LLC

CENTENNIAL CORPORATE CENTER FILING NO. 2
MOUNTAIN SHADOWS PROPERTY CO, LLC

LEGEND

- PROPOSED 2' CONTOURS
- PROPOSED 10' CONTOURS
- EXISTING 2' CONTOUR
- EXISTING 10' CONTOUR
- PROPERTY BOUNDARY
- FLOW PATH
- DRAINAGE BASIN BOUNDARY
- NO BUILD LINES
- LOT LINES
- PHASE LINE
- FLOW DIRECTION
- DESIGN POINT
- BASIN LABEL (LABEL / Q5 Q100 / AREA)

DESIGN POINT	Q5	Q100
A	3.65	6.58
B	21.66	56.04
C	24.48	65.48
D	26.45	69.22
Y	1.40	2.64
F	33.36	86.44
G	2.32	4.60
H	3.54	6.91
J	4.92	5.59
L	0.86	1.45
M	1.69	1.92
P	3.28	3.74
Q	1.09	1.98
R	45.19	60.65
S	39.43	172.89
I	54.24	70.90
N	2.03	2.35
O	8.74	9.86
LL	1.04	1.98
MM	0.82	0.90

NOTE:
SEE SHEET 1 FOR OFFSITE INFORMATION

1"=50'
50 0 50 100

N

Stantec
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COLORADO SPRINGS, CO 80907
(719) 432-6889

REVISIONS:

NO.	DESCRIPTION	DATE

ENGINEER:
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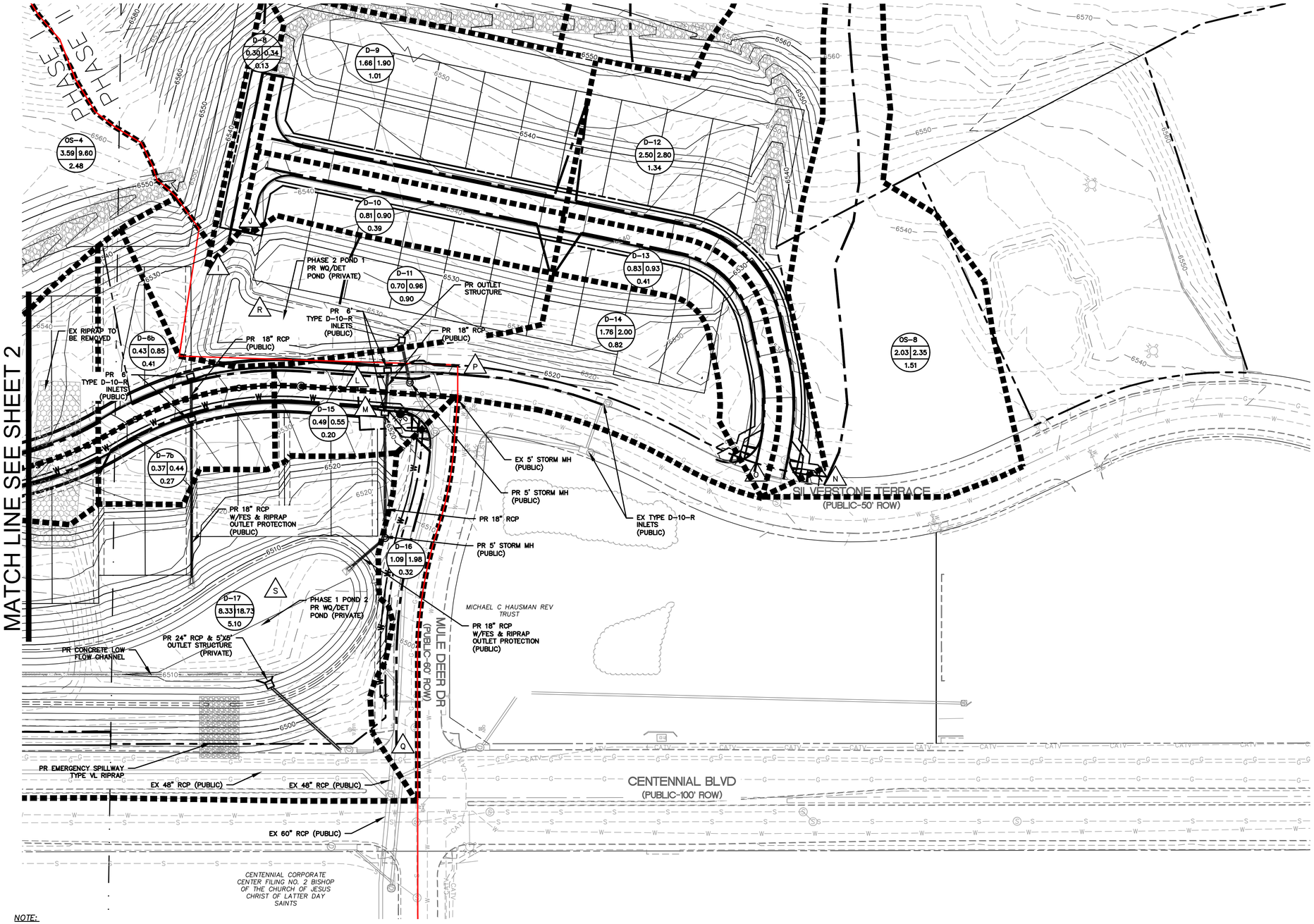
PROJECT TUSCAN FOOTHILLS VILLAGE
SHEET TITLE Proposed Basins
FROM NA TO NA
JOB NO. 181710238 SHEET 2 OF 3



1"=50'

50 0 50 100

N

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LEGEND

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- PROPOSED 10' CONTOURS
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- NO BUILD LINES
- LOT LINES
- PHASE LINE
- FLOW DIRECTION
- DESIGN POINT
- BASIN LABEL (LABEL / Q5 | Q100 / AREA)

NOTE:

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NO.	DESCRIPTION	DATE

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PROJECT TUSCAN FOOTHILLS VILLAGE
SHEET TITLE Proposed Basins
FROM NA TO NA
JOB NO. 181710238 SHEET 3 OF 3