THE GARDENS AT NORTH CAREFREE
FINAL DRAINAGE REPORT
EL PASO COUNTY, COLORADO

PROJECT NO. 187608744

Prepared for:
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2727 GLEN ARBOR DRIVE
COLORADO SPRINGS, CO 80124

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PCD File No:

PCD File No. SF195

Engineering Documents
Reviewed By:
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EPC Planning & Community
Development Department

CERTIFICATIONS

Design Engineer's Statement:

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

____ Seal

Charlene. M. Durham, P.E. #36727

Owner/Developer's Statement:

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

By (signature): ____________________________________ Date: __________________

Title: ____________________________________

Address: 2727 Glen Arbor Drive

Colorado Springs, CO 80124

El Paso County:

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

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Jennifer Irvine, P.E., Date

County Engineer / ECM Administrator

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PURPOSE

The purpose of this Final Drainage Report (FDR) is to identify and analyze on and offsite drainage patterns, locate and identify tributary and downstream drainage features and facilities that impact the proposed site. Runoff quantities and proposed facilities have been calculated using the City of Colorado Springs/El Paso County Drainage Criteria Manual (DCM) revised November 1991; and in accordance with El Paso County ordinance 15-042.

The Gardens at North Carefree is approximately 11.6 acres and is located within El Paso County.

GENERAL LOCATION & DESCRIPTION

The Gardens at North Carefree is approximately 11.6 acres of single-family development. The site will include the construction of 3 public roads, 71 single family lots and 5 tracts. The project is bounded by North Carefree Circle to the north, Akers Drive to the west, Sika Deer Place to the south and open land to the east. The project is located in the eastern portion of Section 29, Township 13 South, Range 65 West.

The Gardens at North Carefree development site is located within the northern end of the Sand Creek Basin.

Description of Property

The project site is 11.6 acres of vegetation, consisting of short grasses and weeds. The average slope of the site is between 3 and 9%, generally sloping to the west.

The site is composed of a single soil type. From the NRCS report in Appendix A, the site falls into the following soil type:

97 – Truckton sandy loam (3-9%) – Type A Soil

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. Group A soil is defined by:

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.

Climate

The climate of the site is typical of a sub-humid to semiarid climate with mild summers and winters. The average temperature is 31 degrees F in the winter and 68.4 degrees in the summer. Total annual precipitation is 15.21 inches.

Floodplain Statement

The Flood Insurance Rate Map (FIRM No. 08041C0539-G dated 12/7/18) indicates that there is no floodplain in the vicinity of the proposed site.

Utilities & Other Encumbrances

The site is currently undeveloped and there are no known utilities on site.

DRAINAGE DESIGN CRITERIA

Development Criteria Reference

Resolution No. 15-042, Adoption for portions of the El Paso County Drainage Criteria Manual (DCM), El Paso County Engineering Criteria Manual (ECM) and Urban Storm Drainage Criteria Manual (USDCM) by Urban Drainage & Flood Control District was used in preparation of this report. Additional preliminary and final drainage plans, master development drainage plans, and drainage basin planning studies used in the preparation of the report are listed in the References Section.

Hydrologic Criteria

Rational Method

The rational method was used to determine onsite flows, as required by the current El Paso County Drainage Criteria Manual (DCM). Both the 5-year and 100-year storm events were considered in this analysis. Runoff coefficients appropriate to the existing and proposed land uses were selected for an SCS type "B" soil from Table 6-6 of the DCM even though the existing soil type is designated as a type "A" soil. The time of concentration was calculated per DCM requirements. Rational Method results are shown in the Appendix B & C. USDCM spreadsheets were used to design the detention and water quality pond features.

Storm Sewer Design

Storm Sewer systems have been designed to the 100-year storm and checked with the 5-year storm. Inlets are located at sump areas and intersections where street flow is larger than street capacity. UDFCD Inlet spreadsheet will be used to determine the size of all at-grade and sump inlets. Onsite flow captured within the storm system will be released into one of the two water quality facilities. Final design of these facilities is included in the appendix.

Detention Storage Criteria

The proposed Water quality facilities will not be designed as detention structures, as it was determined from previous studies that onsite detention was not necessary. This will be explained and addressed later in the report. Water quality requirements were determined from the UDFCD Volume 3 spreadsheet for an Extended Detention Basin.

Final storage volumes and outflows have been calculated and are included in the appendix.

Waivers/Deviations

No variances are being requested for this development.

A deviation has been requested and approved for El Paso County ECM_Appendix I Section I.7.1.B: 1st Bullet; Providing Water Quality for Entire Development.

The deviation was for Basins D-7, D-11, D-15 and D-17 thru D-20, which drain into Akers Drive and are intercepted by existing inlets and will not reach an on-site water quality facility. These basins account for approximately 8% (0.94 acres of 11.56) of the overall site area. The remaining 92% of the development area is treated through 1 of the 2 proposed ponds.

The topography of the site will not allow all areas within the site to drain to the proposed ponds. Of the area inside the development boundary that will not reach a facility only 0.19 acres is proposed roadway, and 0.75 acres will be sloped areas at the back of lots along the exterior boundary.

DRAINAGE BASINS

Offsite Basins

There is one off site basin contributing flows to the proposed development. It is located on the east side of the property along the southern half. The basin is 2.25 acres and is currently undeveloped. Flows from the basin are 0.59 cfs and 4.3 cfs for the minor and major storms. If this parcel develops, it will need to provide its own onsite water quality.

Existing Drainage Analysis

Historic drainage analysis was determined by analyzing runoff quantities and patterns for the site. There are 9 existing basins for the proposed site.

- Basin E-1 (5.41 acres) is the top north half of the site between North Carefree Circle and Akers Drive. Flows are diverted through existing drainage swales to where they will release into Akers Drive. Flows for this basin are 1.41 cfs for the 5-year storm and 10.33 cfs for the 100-year storm.

- Basin E-2 (0.61 acres) is located south of Basin E-1. Existing drainage swales will divert this flow to an existing low point/detention area. Flows for this basin are 0.23 cfs for the 5-year storm and 1.72 cfs for the 100-year storm.

- Basin E-3 (1.59 acres) is south of Basin E-2. Flows are diverted to the west through existing drainage swales to an existing low point. Flows for this basin are 0.56 cfs for the 5-year storm and 4.11 cfs for the 100-year storm.

- Basin E-4 (1.28 acres) is south of Basin E-3. Existing drainage swales direct flows to the west to an existing low area. Flows for this basin are 0.46 cfs for the 5-year storm and 3.35 cfs for the 100-year storm.

- Basin E-5 (0.36 acres) is south of Basin E-1 and west of Basin E-2. Flows for this basin are 0.15 cfs for the 5-year storm and 1.08 cfs for the 100-year storm.

- Basin E-6 (1.55 acres) is south of Basin E-4. Existing drainage swales direct flows towards the west, where they will release into Akers Drive. Flows for this basin are 0.55 cfs for the 5-year storm and 4.03 cfs for the 100-year storm.

- Basin E-7 (0.10 acres) is south of Basin E-5 and west of Basin E-3. Flows for this basin are 0.04 cfs for the 5-year storm and 0.29 cfs for the 100-year storm.

- Basin E-9 (0.05 acres) is located between Basin E-7 and Akers Drive. This area is the low area/detention where an existing 30” rcp collects runoff. Flows for this basin are 0.02 cfs for the 5-year storm and 0.14 cfs for the 100-year storm.

- Basin E-10 (0.51 acres) is along the south boundary of the project, along the private driveway. Flows for this basin are 0.21 cfs for the 5-year storm and 1.52 cfs for the 100-year storm.

Design Points

- Design Point Z (Q_5=0.6, Q_{100}=4.4) consists of flow from Basin OS-1. Flow from this basin release on site and combine with other onsite basins.

- Design Point A (Q_5=1.4, Q_{100}=10.6) consists of flow from Basin E-1. Flow from this basin is released directly into Akers Drive where it is intercepted by an existing Type R inlet.

- Design Point B (Q_5=0.2, Q_{100}=1.8) consists of flow from Basin E-2. It is a natural low point on the site. Flows will release from this location via an existing culvert and continue to DP E.

- Design Point D (Q_5=0.5, Q_{100}=3.5) consists of flow from Basin E-4. Flows will continue over existing ground to combine at DP C.

- Design Point C (Q_5=1.2, Q_{100}=9.4) consists of flow from Basins, OS-1and E-3 and DP D. Flows will continue to the north where they will combine with other flows at DP H.

- Design Point E (Q_5=0.4, Q_{100}=2.9) consists of flow from Basin E-5 and DP B. This is a naturally occurring low spot on site. Flows will continue via an existing pipe to DP G.

- Design Point F (Q_5=0.6, Q_{100}=4.2) consists of flow from Basin E-6. These flows are released directly into Akers Drive where they are intercepted by an existing Type R inlet.

- Design Point G (Q_5=0.4, Q_{100}=3.22) consists of flow from Basin E-7 and DP E. This is a sump area which has an existing culvert for flows to continue to DP H.

- Design Point H (Q_5=1.5, Q_{100}=11.4) consists of flow from Basin E-9 and DP C and DP G. This is the final low point where flows are collected and via a 30” RCP, exit the site and combine with flows from Akers Drive and the Mule Deer development to the west.

- Design Point I (Q_5=0.2, Q_{100}=1.6) consists of flow from Basin E10. Flow will be collected in the curb and gutter of the existing driveway and flow west to Akers Drive.

Proposed Drainage Analysis

The proposed development consists of 20 developed basins and the offsite basin has been divided into 4 separate basins, based on where flows enter onto developed site basins. The majority of the runoff from the site will be collected via inlets and pipes and diverted to one of two water quality ponds for the development. The ponds will then release into the existing inlets in Akers Drive and continue through the existing storm system to the existing drainage channel to the west.

- Basin OS-1 (0.26 acres) is the southern most offsite basin. This flow is released into Basin D-20 Flows for this basin are 0.08 cfs for the 5-year storm and 0.56 cfs for the 100-year storm.

- Basin OS-2 (0.27 acres) is north of OS-1. Runoff is directed towards Basin D-13. Flows for this basin are 0.08 cfs for the 5-year storm and 0.57 cfs for the 100-year storm.

- Basin OS-3 (0.1.63 acres) is located between OS-2 and OS-4 along the south portion of the eastern boundary of the site. Runoff is directed towards Basin D-2. Flows for this basin are 0.43 cfs for the 5-year storm and 3.17 cfs for the 100-year storm.

- Basin OS-4 (0.07 acres) is the north of OS-3. Runoff is directed towards Basin D-1. Flows for this basin are 0.02 cfs for the 5-year storm and 0.17 cfs for the 100-year storm.

- Basin D-1 (1.24 acres) is the north half of the site along the east boundary to the east leg of Vineyard Circle. This flow is directed towards a sump inlet on the east side of Vineyard Circle. Flows for this basin are 2.34 cfs for the 5-year storm and 5.15 cfs for the 100-year storm.

- Basin D-2 (0.99 acres) is the south half of the site along the east boundary to the east leg of Vineyard Circle. Runoff is directed towards a sump inlet on the west side of Vineyard Circle. Flows for this basin are 1.81 cfs for the 5-year storm and 3.99 cfs for the 100-year storm.

- Basin D-3 (0.17 acres) is the southeast half of Vineyard Circle. Runoff is directed towards a sump inlet on the west side of the east leg of Vineyard Circle. Flows for this basin are 0.37 cfs for the 5-year storm and 0.82 cfs for the 100-year storm.

- Basin D-4 (0.21 acres) is the northeast half of Vineyard Circle. Runoff is directed towards a sump inlet on the west side of the east leg of Vineyard Circle. Flows for this basin are 0.48 cfs for the 5-year storm and 1.06 cfs for the 100-year storm.

- Basin D-5 (2.03 acres) is along the north boundary of the site, along North Carefree and along Akers Drive, north of Fallow Lane. Runoff continues to an at-grade inlet on the west side of the west leg of Vineyard Circle. Flows for this basin are 3.85 cfs for the 5-year storm and 8.47 cfs for the 100-year storm.

- Basin D-6 (0.08 acres) is the east half of Fallow Lane. Flows for this basin are 0.37 cfs for the 5-year storm and 0.66 cfs for the 100-year storm.

- Basin D-7 (0.04 acres) is the southwest half of Fallow Lane. Flows for this basin are 0.18 cfs for the 5-year storm and 0.33 cfs for the 100-year storm.

- Basin D-8 (1.90 acres) is the northwest half of the area inside of Vineyard Circle. Runoff is released into the east side of the west leg of Vineyard Circle to an at-grade inlet. Flows for this basin are 3.46 cfs for the 5-year storm and 7.62 cfs for the 100-year storm.

- Basin D-9 (0.52 acres) is the area between the west leg of Vineyard Circle, Fallow Lane and Akers Drive. Runoff releases to an at-grade inlet on the west side of Vineyard Circle. Flows for this basin are 0.99 cfs for the 5-year storm and 2.17 cfs for the 100-year storm.

- Basin D-10 (0.33 acres) is the North Pond area. Flows for this basin are 0.43 cfs for the 5-year storm and 1.14 cfs for the 100-year storm.

- Basin D-11 (0.07 acres) is the north half of Running Deer Way. Flows for this basin are 0.32 cfs for the 5-year storm and 0.57 cfs for the 100-year storm.

- Basin D-12 (0.93 acres) is the south half of the area in between the two legs of Vineyard Circle. Runoff will release to a sump inlet in the east side of Vineyard Circle. Flows for this basin are 1.99 cfs for the 5-year storm and 4.38 cfs for the 100-year storm.

- Basin D-13 (1.72 acres) is the south portion of the site. Runoff is directed towards a sump inlet on the west half of Vineyard Circle. Flows for this basin are 3.39 cfs and 7.46 cfs for the minor and major storms, respectively.

- Basin D-14 (0.64 acres) is the middle area on the west half of the area between the two legs of Vineyard Circle, across from Running Deer Way. Flows are 1.31 cfs for the 5-year storm and 2.88 cfs for the 100-year storm.

- Basin D-15 (0.04 acres) is northwest half of Fallow Lane. Flows are 0.09 cfs for the 5-year storm and 0.20 cfs for the 100-year storm.

- Basin D-16 (0.13 acres) is the South Pond area. Flows for this basin are 0.21 cfs for the minor storm and 0.57 cfs for the major storm.

- Basin D-17 (0.08 acres) is the south half of Running Deer Way. Flows are 0.37 cfs and 0.66 cfs or the minor and major storms respectively.

- Basin D-18 (0.19 acres) is the area north of Fallow Land and south of North Carefree which flows towards Akers Drive. Runoff for this basin is 0.42 cfs for the 5-year storm and 0.92 cfs for the 100-year storm.

- Basin D-19 (0.11 acres) is the area between Fallow Land and Running Deer Way which flows towards Akers Drive. Flows are 0.25 cfs and 0.55 cfs for the minor and major storms, respectively.

- Basin D-20 (0.41 acres) is the area south of Running Deer Way, along the western boundary, which flows towards Akers Drive. Flows are 0.80 cfs for the minor storm and 1.99 cfs for them major storm.

Design Points

- Design Point Z (Q_5=0.1, Q_{100}=0.6) consists of flow from Basin OS-1. Flow from this basin release on site and will combine with Basin D-20.

- Design Point Y (Q_5=0.1, Q_{100}=0.6) consists of flow from Basin OS-2. Flow from this basin release on site and will combine with Basin D-13.

- Design Point X (Q_5=0.4, Q_{100}=3.3) consists of flow from Basin OS-3. Flow from this basin release on site and will combine with Basin D-2.

Include discussion regarding the bypass flow at design points C and D.

- Design Point W (Q_5=0.0, Q_{100}=0.2) consists of flow from Basin OS-4. Flow from this basin release on site and will combine with Basin D-1.

- Design Point A (Q_5=3.4, Q_{100}=9.9) consists of flow from Basins D-1 and D-2 and Design Points DP W and DP X. A sump inlet will be installed on the east side of the east leg of Vineyard Circle to intercept this flow. This will connect with the storm system which will release into the North Pond.

- Design Point B (Q_5=0.9, Q_{100}=2.0) consists of flow from Basins D-3 and D-4. A, at-grade inlet will be installed on west side of the east leg of Vineyard Circle to intercept the street flow. The inlet will connect with a storm system which releases into the North Pond.

- Design Point C (Q_5=3.5, Q_{100}=7.9) consists of flow from Basin D-8. A sump inlet will be installed on the east side of the west leg of Vineyard Circle to intercept gutter flow. The inlet will be part of a storm system which releases into the North Pond.

- Design Point V (Q_5=4.2, Q_{100}=9.4) combines flow from Basins D-5 and D-6 at the Fallow Lane and Vineyard Circle intersection. Flows will continue as gutter flow to the south along Vineyard Circle.

- Design Point D (Q_5=4.9, Q_{100}=11.0) consists of flow from Basin D-9 and design point DP V. This at-grade inlet will intercept the flows from the west half of the west leg of Vineyard Circle. The inlet will connect to the system which will release into the North Pond.

- Design Point E (Q_5=3.2, Q_{100}=7.4) consists of flow from Basins D-12 and D-14. This is street flow at the east half of Vineyard Circle beginning at the southeast knuckle. Flows will direct towards a sump inlet on the east half of the west leg of Vineyard Circle, which releases into the South Pond.

- Design Point F (Q_5=2.5, Q_{100}=6.1) consists of flow from Basin D-13 and design point DP Y. This is street flow at the west half of Vineyard Circle beginning at the southeast knuckle. Flows will direct towards a sump inlet on the west half of the west leg of Vineyard Circle, which releases into the South Pond.

- Design Point G (Q_5=0.4, Q_{100}=1.0) consists of flow from Basin D-18. This is the street flow which has been released into Akers Drive north of Fallow Lane. Flow is intercepted by an existing type R inlet, north of the Fallow Lane Intersection.

- Design Point H (Q_5=0.3, Q_{100}=0.6) consists of flow from Basins D-7, D-15 and D-19. This is flow from Fallow Lane and street flow from Akers Drive, between Fallow Lane and Running Deer Way. Runoff is intercepted by an existing type R inlet in Akers Drive, north of the Running Deer Way intersection.

- Design Point I (Q_5=0.9, Q_{100}=2.0) consists of flow Basins D-11, D-17 and D-20. This is the flow from Running Deer Way and the flow released onto Akers Drive from the site south of Running Deer Way. An existing type R inlet, south of the Running Deer Way intersection will intercept these flows.

- Design Point NP (Q_5=10.3, Q_{100}=25.8) combines basin D-10 with flows from DP A, DP B, DP C and DP D. This is the flow being released into the North Pond.

- Design Point SP (Q_5=4.8, Q_{100}=11.5) combines basin D-16 with flows from DP E and DP F. This is the flow being released into the South Pond.

Deviations

A deviation has been requested and approved for El Paso County ECM_Appendix I Section I.7.1.B: 1st Bullet; Providing Water Quality for Entire Development.

Basins D-7, D-11, D-15 and D-17 thru D-20 all release into Akers Drive and are intercepted by existing inlets and will not reach an on-site water quality facility. These basins account for approximately 8% (0.94 acres of 11.56) of the overall site area. The remaining 92% of the development area is treated through 1 of the 2 proposed ponds.

The topography of the site will not allow all areas within the site to drain to the proposed ponds. Of the area inside the development boundary that will not reach a facility only 0.19 acres is proposed roadway, and 0.75 acres will be sloped areas at the back of lots along the exterior boundary.

DRAINAGE FACILITY DESIGN

General Concept

The Gardens at North Carefree is located in the Sand Creek Drainage Basin.

Storm Sewer System

All development is anticipated to be urban and will include storm sewer and street inlets. Two storm sewers collect storm water runoff and convey the runoff to the proposed ponds prior to discharging into the existing storm system offsite. The WQ outlet structures will connect to the existing inlets via proposed concrete culverts.

Storm System 1 will connect the set of sump inlets on the east leg of Vineyard Circle with the set of sump inlets on the west leg of Vineyard Circle. This system will release into the South WQ Pond.

Storm System 2 will connect a set of at-grade inlets on the west leg of Vineyard Circle, just north of Running Deer Way. The system will release into the North WQ Pond

On-Site Water Quality

There are two proposed water quality facilities on site that will provide water quality for the proposed improvements. Flows will pass through the outlet structures of one of the two proposed ponds. The existing storm system was designed to account for a 100-year flow of 55 cfs from this development. The two water quality ponds, based on the UDFCD pond spreadsheets, have a release rate of 28.8 cfs (South Pond is 8.30 cfs and North Pond is 20.5 cfs). The basins releasing offsite have a combined flow of 8.9 cfs. Flows in Akers Drive and the two ponds have a total combined flow of 37.7 cfs being captured in the existing storm system. Pond sizing calculations are provided in Appendix D.

Include excerpt from previous approved report where this flow was provided.

The two ponds have been designed to act only as water quality, and not detention. From previous reports, it was determined that on-site detention would not be necessary.

From the *Sand Creek Drainage Basin Planning Study*, the only facility in this area was for a check structure along the southwest property boundary of Mule Deer Crossing. (See Appendix for excerpt)

The detention pond for the southwest corner of the Mule Deer development was mentioned in the *Master Development Drainage Plan (MDDP) for Hilltop Subdivision by URS Greiner.* It stated that this pond was not necessary if proposed improvements to the downstream channel were sufficient to handle the unattenuated flows. (See excerpt in Appendix)

From the *Final Drainage Report for Mule Deer Filing 1, Lots 1 & 2 and Preliminary Drainage Report for Mule Deer Filing 1, Lots 3-36* by URS, states that after discussions with the El Paso County Department of Transportation, the proposed detention at the southwest corner of the Mule Deer development was not required, as it was determined that the existing channel was able to handle the upstream flows. (See Appendix for excerpt).

The *Preliminary/Final Drainage Report for Mule Deer Crossing* has the design and construction of the check structure identified in the Sand Creek DBPS, as well as the improvements to the channel along the western boundary of the Mule Deer development. (see excerpt in Appendix).

From the Mule Deer FDR report, there are two design points, which will tie into the storm system designed in Akers Drive. Design Point 6 (DP-6) designates the existing inlet north of the Running Deer intersection and Design Point 7 (DP-7) designates the existing inlet south of Running Deer. DP-6 had a design flow of 11 cfs and 20 cfs for the 5- and 100-year flows. DP-7 had flows of 36 and 69 cfs, which included flows from the commercial site south of Sika Deer Place. If these flows are removed (Q5=24 cfs, Q100=47 cfs), DP-7 would have corresponding flows of 12 cfs and 22 cfs for the minor and major storm events. Flows entering the WQ facilities are 10.3 cfs and 25.8 cfs for the North Pond and 5.0 cfs and 16.6 cfs for the South Pond. Even though the two ponds are meant to serve water quality purposes, there is some small detention acquired, which will result in release rates of 8.8 cfs and 20.5 cfs for the North Pond and 3.7 cfs and 8.3 cfs for the South Pond. Released flows are less than the design flows accounted for in the previous report, which indicates that the existing channel, accepting less flows than the approved FDR had accounted for, will still function adequately, as stated in the approved URS report.

The lower run off values as compared to the original design values is primarily due to the change in use from commercial to residential with additional reduction due to the detention attributed to the water quality ponds.

The existing channel has been shown to be able to handle previous design flows. The Gardens at North Carefree, proposed flows are less than those previously designed for (flows exiting ponds are less than previous design flows, as shown above), the need for on-site full spectrum detention is not required.

The WQCV is treated through two proposed extended detention basins, North Pond and South Pond. There are no proposed major drainageways for the site that would need to be stabilized. 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.

After discussion with engineering manager, staff has determined that Full Spectrum Detention is required. The existing downstream channel in the El Paso County parcel is a wetlands that has degradation and is not able to handle the upstream flows. Additionally at the time of the previously approved FDR's the EPC criteria had not adopted full spectrum detention as is currently required. Please revise design accordingly.

The narrative indicates that detention is not provided. Revise.

Temporary Sedimentation Basins

The water quality facilities (North Pond and South Pond) will work as temporary sedimentation ponds, until final construction is complete.

Four Step Process

In accordance with the El Paso County Engineering Criteria Manual, Appendix I, 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.

Reduce Runoff

In order to reduce runoff volume, the new impervious area for the site was minimized. Existing features will be preserved as all of the offsite basins which are undeveloped open space will continue to be so, and all developable areas will be required to release existing flows and handle their own detention and water quality needs. Existing drainage paths have been maintained as much as possible to also help reduce overall impacts from the site.

Treat & Release WQCV

The WQCV is treated through 2 separate water quality ponds. The outlet structures for both ponds have been designed according to the FSD spreadsheet by UDFCD to ensure the release times of the facilities meet the requirements.

Stabilize Stream Channels

There are no proposed major drainageways for the site that would need to be stabilized. Downstream of the project, all flows enter into existing storm systems, which are adequate to handle existing released flows, which will be the case as both ponds are designed to release less than existing flows. Therefore, those downstream channel/facilities would also, not see any increase or adverse effects to their functionality.

Implement Source Controls

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, sediment ponds, designated concrete truck washout basin, designated vehicle fueling areas, covered storage areas, spill containment and control, etc.

DRAINAGE FEES, COST ESTIMATE & MAINTENANCE

Per submitted documents there will be no HOA. A district is intended to be set up. Please revise.

Maintenance

The water quality ponds will be maintained by the Home Owners Association. Facilities located within the project boundary will be private facilities and will also be maintained by Home Owners Association. All facilities located outside of the project boundary and within public right-of-way, will be maintained by the county. A BMP maintenance agreement and easement will be provided for the ponds, as well as an Operations and Maintenance manual. The remaining utilities (gas, phone, electric, cable, etc.) will be owned and maintained by their respective companies. Easements will be issued to ensure each entity is able to access and maintain their facilities.

Drainage Fees

The proposed development falls within the Sand Creek Basin. The entire development occupies approximately 11.6 acres. The project consists of 2.66 acres of right-of-way, 6.96 acres of residential lots, and tracts of open space of 1.98 acres. The following calculations for the imperviousness of this development have been computed as follows:

Average Residential lot size: 6.96 acres / 71 lots = 4270 sf

Average lot imperviousness = 2200 sf

Average Residential Imperviousness 2200/4270 = 51.50%

Current drainage and bridge fees are $18,940 and $5,559. Revise accordingly.

R.O.W. area 2.66 acres; imperviousness 100 %
Open Space area 1.98 acres; imperviousness 0%

Average imperviousness for developed area:

(0.5150 x 6.96) + (1.0 x 2.66)+ (0 x 1.95)/(11.6) = 0.5383 = 53.83%. The impervious area that the fees will be based on is 6.24 acres (11.6 x 53.83%)

Drainage fees in the Sand Creek Basin are $17,197 and bridge fees are $5,210. The calculated fees due will be as follows:

Drainage Fees: $107,309 (6.24 x $17,197)

Bridge Fees: $32,510 (6.24 x $5,210)

Proposed Facilities Estimate

ITEM	UNITS	UNIT COST	QUANTITY	ITEM COST
GRADING AND EROSION CONTROL				
CURB BACKFILL	LF	$ 4.00	4650	$ 18,600
MISC SEEDING AND MULCH	AC	$ 5,000.00	1	$ 5,000
HAY BALE CHECKS	EA	$ 15.00	100	$ 1,500
INLET PROTECTION	EA	$ 500.00	6	$ 3,000
VEHICLE TRACKING CONTROL	EA	$ 2,000.00	2	$ 4,000
SILT FENCING	LF	$ 2.50	1,000	$ 2,500
SUBTOTAL GRADING & EROSION CONTROL				**$ 34,6000**
DRAINAGE				
18” RCP	LF	$ 125.00	180	$ 22,500
36” RCP	LF	$ 220.00	128	$ 28,160
10’ Type R Inlet	EA	$ 6,800.00	3	$ 20,400
20’ Type R Inlet	EA	$ 10,000.00	3	$ 30,000
Outlet Structure	EA	$ 10,000.00	2	$ 20,000
SUBTOTAL DRAINAGE				**$ 121,060**
SUBTOTAL DRAINAGE & GRADING/EROSION CONTROL				**$ 155,660**
ENGINEERING (10%)				$ 15,566
CONTINGENCY (25%)				$ 38,915
TOTAL				***$ 210,141***

EROSION CONTROL

General Concept

During construction, best management practices for erosion control will be employed based on El Paso County criteria and the erosion control plan. The erosion control plan is included at the end of this report.

Ditches will be designed to meet El Paso County criteria for slope and velocity, keeping velocities below scouring levels.

During construction, best management practices (BMP) for erosion control will be employed based on El Paso County Criteria. BMP's will be utilized as deemed necessary by contractor and/or engineer and are not limited to measure shown on construction drawing set. The contractor shall minimize amount of area disturbed during all construction activities.

In general, the following shall be applied in developing the sequence of major activities:

- Install downslope and sideslope perimeter BMP's before the land disturbing activity occurs.
- Do not disturb an area until it is necessary for the construction activity to proceed.
- Cover or stabilize as soon as possible.
- Time the construction activities to reduce the impacts from seasonal climatic changes or weather events.
- The construction of filtration BMP's should wait until the end of the construction project when upstream drainage areas have been stabilized.
- Do not remove temporary perimeter controls until after all upstream areas are stabilized.

Silt Fence

Silt fence will be placed along downstream limits of disturbed areas. This will prevent suspended sediment from leaving the site during infrastructure construction. Silt fencing is to remain in place until vegetation is reestablished.

Erosion Bales

Erosion bales will be placed ten (10) feet from the inlet of all culverts and inlets during construction to prevent culverts from filling with sediment. Erosion bales will remain in place until vegetation is reestablished in graded roadside ditches. Erosion bale ditch checks will be used on slopes greater than 1% to reduce flow velocities until vegetation is reestablished.

Vehicle Tracking Control

This BMP is used to stabilize construction entrances, roads, parking areas and staging areas to prevent the tracking of sediment from the construction site. A vehicle tracking control (VTC) is to be used at all locations where vehicles exit the construction site onto public roads, loading and unloading areas, storage and staging areas, where construction trailers are to be located, any construction area that receives high vehicular traffic, construction roads and parking areas. VTC's should not be installed in areas where soils erode easily or are wet.

Sedimentation Pond

This BMP is used to detain runoff which has become laden with sediment long enough to allow the sediment to settle out. As the construction area is larger than 1 acre, a temporary sediment basin is required per Volume 2 of the Drainage Criteria Manual.

SUMMARY

Development within the site is to be single family residential. The existing storm sewer will connect to the new water quality facilities, allowing flows to continue as they currently are.

REFERENCE MATERIALS

1. "City of Colorado Springs Drainage Criteria Manual Volume 1" May 2014.

2. Soils Survey of El Paso County Area, Natural Resources Conservation Services of Colorado.

3. Flood Insurance Rate Study for El Paso County, Colorado and Incorporated Areas. Federal Emergency Management Agency, Revised March 17, 1997.

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

5. "Engineering Criteria Manual El Paso County" January 9, 2006, Revised December, 2016.

6. "Urban Storm Drainage Criteria Manual, Volume 1: Management, Hydrology & Hydraulics" Original September 1969, Updated January 2016.

7. "Urban Storm Drainage Criteria Manual, Volume 2: Structures, Storage & Recreation" Original September 1969, Updated January 2016.

8. "Urban Storm Drainage Criteria Manual, Volume 3: Stormwater Quality" Original September 1992, Updated November 2010.

9. "Sand Creek Drainage Basin Planning Study Preliminary Design Report", Kiowa Engineering Corporation.

10. "Master Development Drainage Plan for Hilltop Subdivision" Revised February 1998. Prepared by URS Greiner, Inc

11. Final Drainage Report and Erosion Control for Chateau at

12. "Final Drainage Report for Mule Deer Filing 1, Lots 1 & 2 and Preliminary Drainage Report for Mule Deer Filing 1, Lots 3-46" January 2004. Prepared by URS.

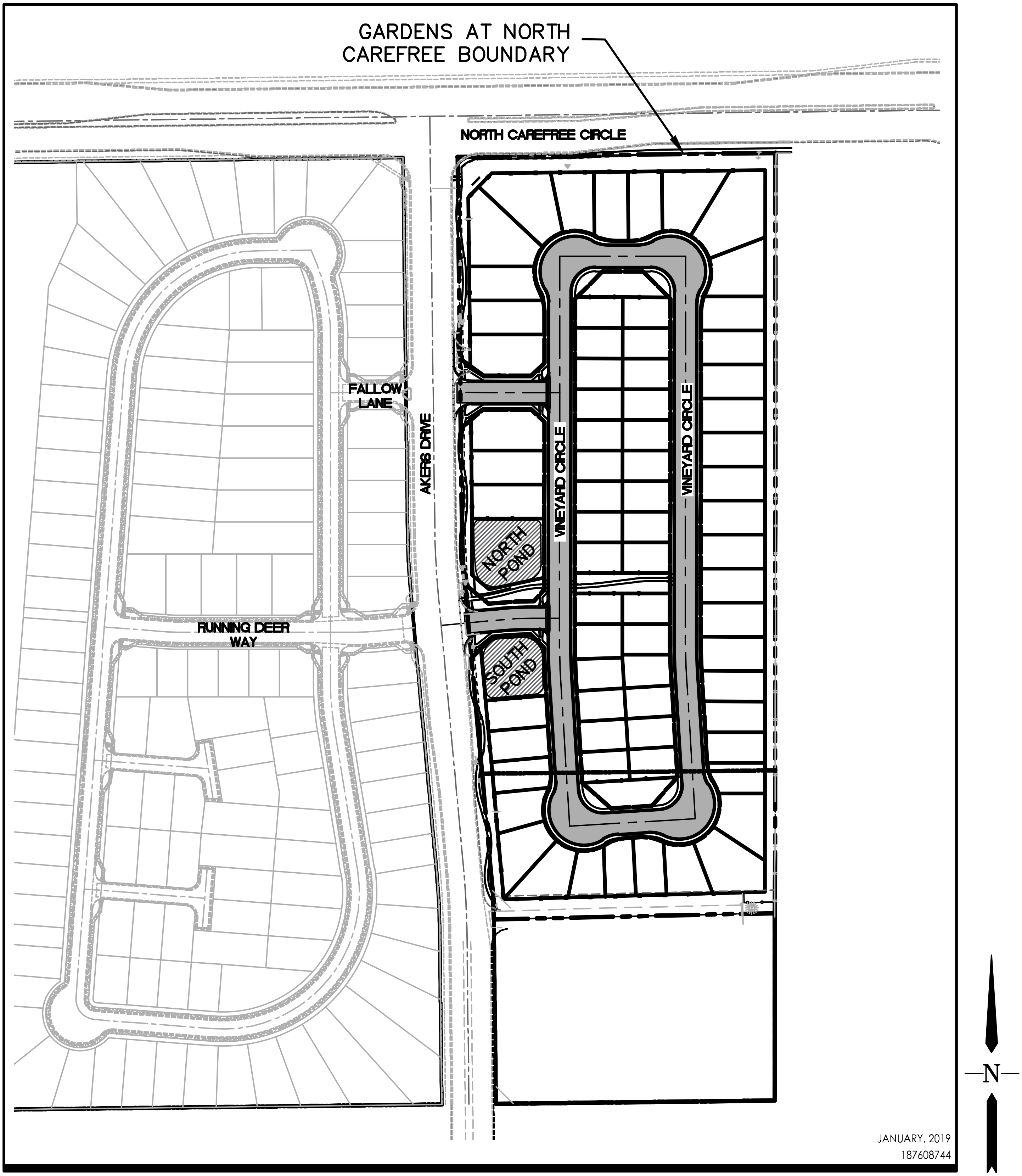
13. "Preliminary Drainage Report for Mule Deer Business Park" January 2005. Prepared by URS.

14. "Final Drainage Report for Mule Deer Business Park" April 2005. Prepared by URS.

15. "Preliminary/Final Drainage Report for Mule Deer Crossing" May 2005. Prepared by URS.

16. "Final Drainage Report for Mule Deer Crossing" December 2005. Prepared by URS.

Figure 1: Vicinity Map



V:\52876\ACTIVE\187608744-MULE DEER\REPORTS\DRAINAGE\EXHIBITS\FDR\FIG01-VMAP.DWG
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Stantec

5725 MARK DABLING BLVD, SUITE 190
COLORADO SPRINGS, CO 80919
www.stantec.com

Client/Project
MULE DEER INVESTMENTS, LLC
GARDENS AT NORTH CAREFREE

Figure No.
1.0

Title
VICINITY MAP

Appendix A: NRCS Soil Report

United States Department of Agriculture

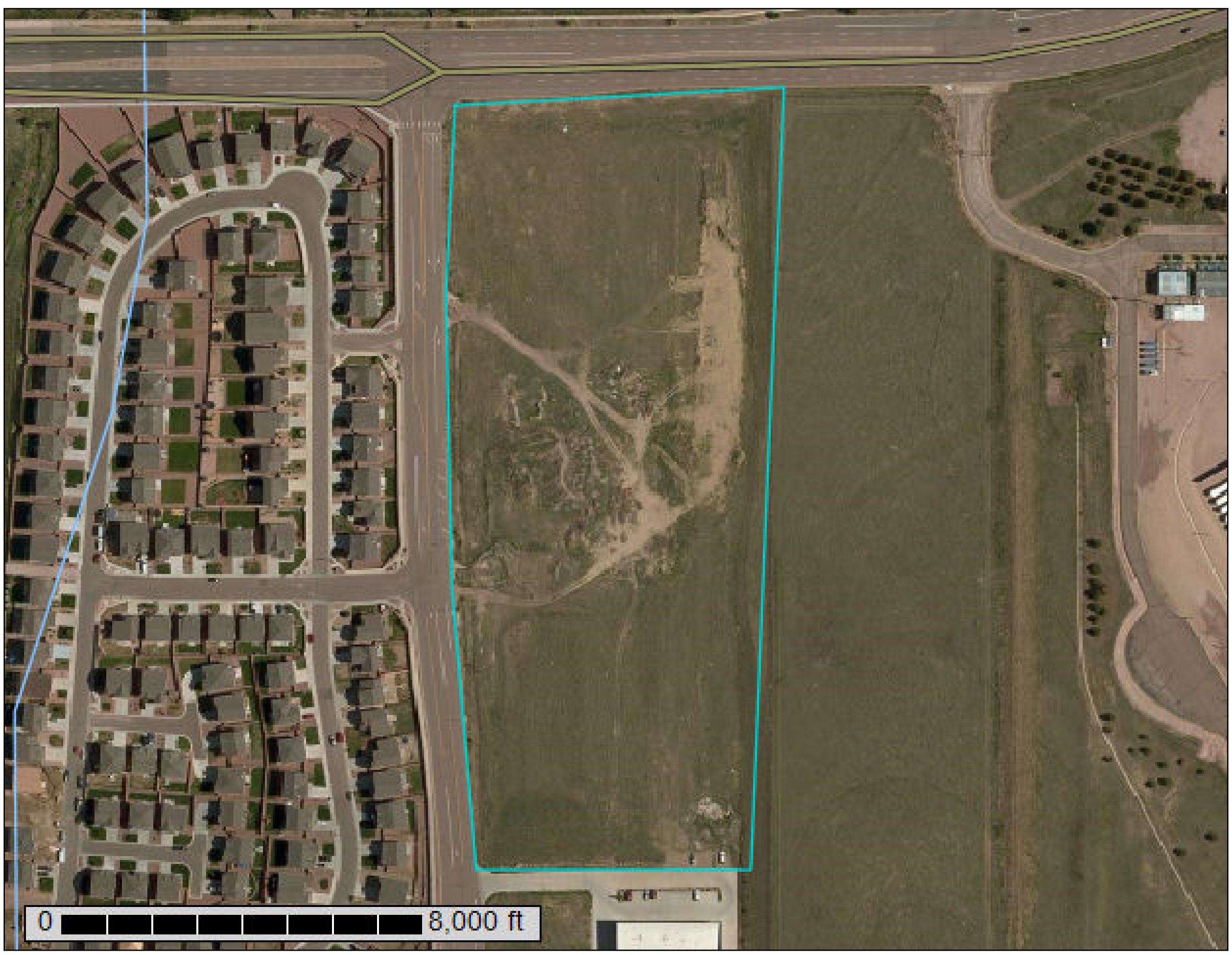
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

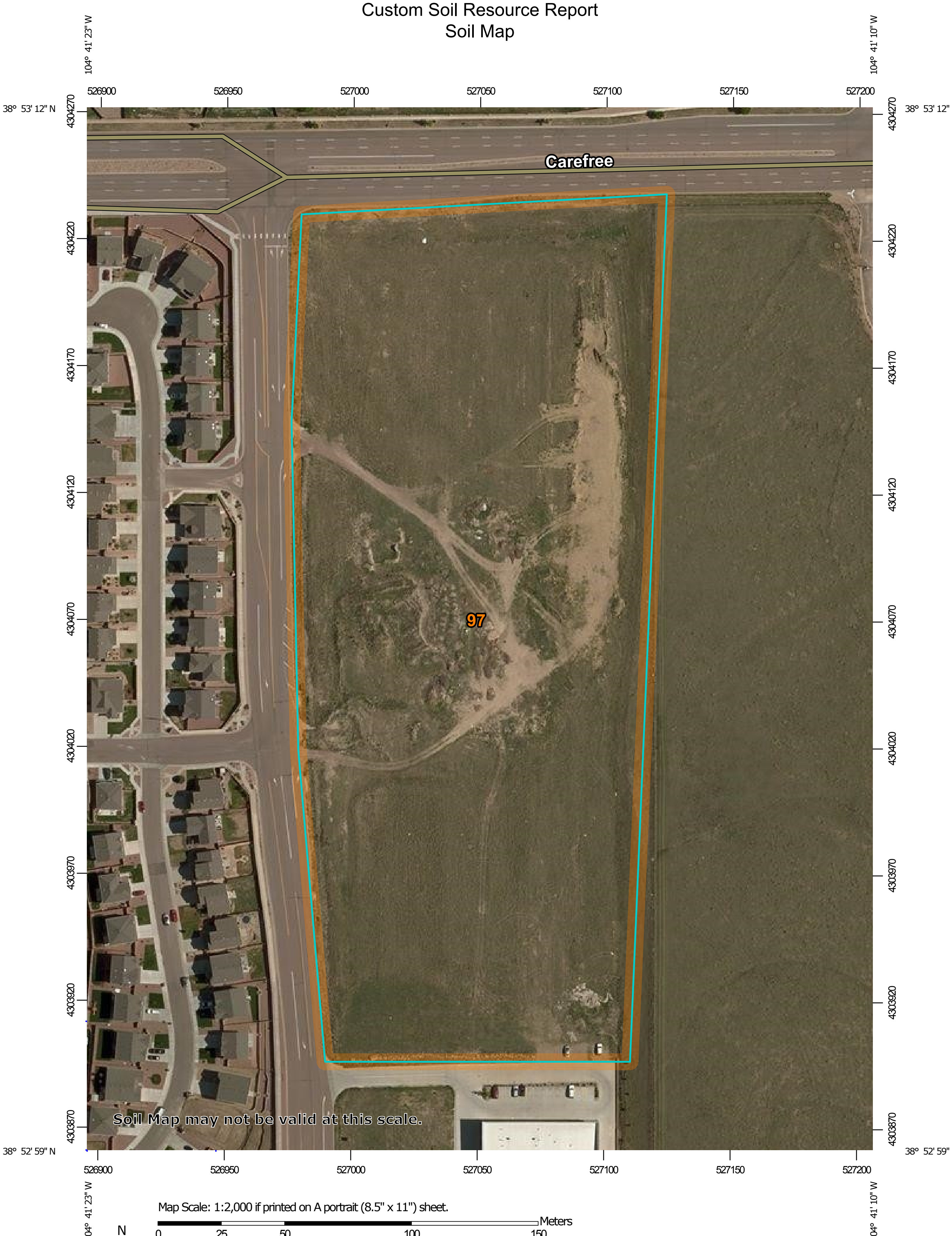
Custom Soil Resource Report for

El Paso County Area, Colorado



June 8, 2017

Soil Map



Map Scale: 1:2,000 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 25 50 100 150

Feet: 0 50 100 200 300

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

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 14, Sep 23, 2016

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

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

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

Map Unit Legend

El Paso County Area, Colorado (CO625)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
97	Truckton sandy loam, 3 to 9 percent slopes	11.5	100.0%
Totals for Area of Interest		**11.5**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

El Paso County Area, Colorado

97—Truckton sandy loam, 3 to 9 percent slopes

Map Unit Setting

National map unit symbol: 36bg
Elevation: 6,000 to 7,000 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Truckton and similar soils: 80 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Truckton

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock and/or arkosic residuum weathered from sedimentary rock

Typical profile

A - 0 to 8 inches: sandy loam
Bt - 8 to 24 inches: sandy loam
C - 24 to 60 inches: coarse sandy loam

Properties and qualities

Slope: 3 to 9 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.7 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: Sandy Foothill (R049BY210CO)
Hydric soil rating: No

Minor Components

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Haplaquolls

Percent of map unit:
Landform: Marshes
Hydric soil rating: Yes

Other soils

Percent of map unit:
Hydric soil rating: No

Appendix B: Existing Hydrology Calculations

Standard Form SF-1 . Time of Concentration

Project: Gardens at North Carefree
Section: Existing Conditions

Created by: CMD   Date: 1/13/2017
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)	$Tc_{max} > t_c$	
OS-1	Offsite Basin @ East Side	0.08	2.25	100	0.035	12.18	555	0.0455	4	Nearly bare ground	10.00	2.13	4.34	16.52	NO	655.00	13.64	Check	16.5
E-1	North portion of site	0.08	5.41	45	0.333333	3.88	995	0.0171	4	Nearly bare ground	10.00	1.31	12.68	16.57	NO	1040.00	15.78	Check	16.6
E-2	South of E-1	0.08	0.61	30	0.33333	3.17	305	0.0295	4	Nearly bare ground	10.00	1.72	2.96	6.13	NO	335.00	11.86	Check	6.1
E-3	South of E-2	0.08	1.59	40	0.333333	3.66	470	0.0319	4	Nearly bare ground	10.00	1.79	4.39	8.05	NO	510.00	12.83	Check	8.0
E-4	South of E-3	0.08	1.28	50	0.333333	4.09	370	0.0270	4	Nearly bare ground	10.00	1.64	3.75	7.85	NO	420.00	12.33	Check	7.8
E-5	South of E-1 and West of E-2	0.08	0.36	5	0.5	1.13	135	0.0296	4	Nearly bare ground	10.00	1.72	1.31	2.44	NO	140.00	10.78	Check	5.0
E-6	South of E-4 and along Akers Dr	0.08	1.55	55	0.333333	4.29	410	0.0366	4	Nearly bare ground	10.00	1.91	3.57	7.87	NO	465.00	12.58	Check	7.9
E-7	South of E-5 and West of E-3	0.08	0.10	5	0.5	1.13	55	0.0545	4	Nearly bare ground	10.00	2.34	0.39	1.52	NO	60.00	10.33	Check	5.0
E-9	West of E-7	0.08	0.05	5	0.3333	1.29	30	0.3333	4	Nearly bare ground	10.00	5.77	0.09	1.38	NO	35.00	10.19	Check	5.0
E-10	South portion of Site along Private Driveway	0.08	0.51	15	0.5	1.96	105	0.0381	4	Nearly bare ground	10.00	1.95	0.90	2.86	NO	120.00	10.67	Check	5.0

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

UDFCD Table RO-2	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)	7.0

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

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

Project: Gardens at North Carefree
Section: Existing Conditions
Design Storm: 5-yr P = 1.50 in

Created by: CMD Date: 1/13/2017
Checked by: CKC Date:

LOCATION	DIRECT RUNOFF							TOTAL RUNOFF				STREET		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)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
Offsite Basin @ East Side	OS-1	2.25	0.08	16.52	0.18	3.25	0.59													
North portion of site	E-1	5.41	0.08	16.57	0.43	3.25	1.41													
South of E-1	E-2	0.61	0.08	6.13	0.05	4.81	0.23													
South of E-2	E-3	1.59	0.08	8.05	0.13	4.40	0.56													
South of E-3	E-4	1.28	0.08	7.85	0.10	4.44	0.46													
South of E-1 and West of E-2	E-5	0.36	0.08	5.00	0.03	5.09	0.15													
South of E-4 and along Akers Dr	E-6	1.55	0.08	7.87	0.12	4.43	0.55													
South of E-5 and West of E-3	E-7	0.10	0.08	5.00	0.01	5.09	0.04													
West of E-7	E-9	0.05	0.08	5.00	0.00	5.09	0.02													
South portion of Site along Private Driveway	E-10	0.51	0.08	5.00	0.04	5.09	0.21													

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

Project: Gardens at North Carefree — Created by: CMD — Date: 1/13/2017
Section: Existing Conditions — Checked by: CKC — Date:
Design Storm: 100-yr — P = 2.52 in

LOCATION	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)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
Offsite Basin @ East Side	OS-1	2.25	0.35	16.52	0.79	5.46	4.30													
North portion of site	E-1	5.41	0.35	16.57	1.89	5.45	10.33													
South of E-1	E-2	0.61	0.35	6.13	0.21	8.07	1.72													
South of E-2	E-3	1.59	0.35	8.05	0.56	7.39	4.11													
South of E-3	E-4	1.28	0.35	7.85	0.45	7.46	3.35													
South of E-1 and West of E-2	E-5	0.36	0.35	5.00	0.13	8.55	1.08													
South of E-4 and along Akers Dr	E-6	1.55	0.35	7.87	0.54	7.45	4.03													
South of E-5 and West of E-3	E-7	0.10	0.35	5.00	0.03	8.55	0.29													
West of E-7	E-9	0.05	0.35	5.00	0.02	8.55	0.14													
South portion of Site along Private Driveway	E-10	0.51	0.35	5.00	0.18	8.55	1.52													

All Equations follow UDFCD 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) =28.5*P/(10+Column 6)^0.786
(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) =28.5*P/(10+Column 10)^0.786
(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

GARDENS AT NORTH CAREFREE
SURFACE ROUTING

DESIGN POINT	ONTRIBUTIN BASINS	C A (e q u i v a l e n t) CA(5)	CA(100)	Tc (min.)	I N T E N S I T Y I(5) (in/hr)	I(100) (in/hr)	T O T A L F L O W S Q(5) (cfs)	Q(100) (cfs)
Z	OS-1	0.18	0.79	16.5	3.2	5.6	0.6	4.4
				T R A V E L T I M E				
		0.18	0.79	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				Channel	510	3.5	2.4	18.9
A	E-1	0.43	1.89	16.6	3.2	5.6	1.4	10.6
				T R A V E L T I M E				
		0.43	1.89	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
						3.5	0.0	16.6
B	E-2	0.05	0.21	6.1	4.9	8.5	0.2	1.8
				T R A V E L T I M E				
		0.05	0.21	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				PIPE	25	4.4	0.1	6.2
D	E-4	0.10	0.45	7.8	4.5	7.8	0.5	3.5
				T R A V E L T I M E				
		0.10	0.45	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				CHANNEL	65	2.8	0.4	8.2
C	E-3	0.13	0.56	18.9	3.0	5.2	1.2	9.4
	DP D	0.10	0.45	T R A V E L T I M E				
	DP Z	0.18	0.79					
		0.41	1.79	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					0	4.4	0.0	18.9
E	E-5	0.03	0.13	6.2	4.8	8.5	0.4	2.9
	DP B	0.05	0.21	T R A V E L T I M E				
		0.08	0.34	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				PIPE	15	5.0	0.1	6.3
F	E-6	0.12	0.54	7.9	4.5	7.8	0.6	4.2
				T R A V E L T I M E				
		0.12	0.54	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					270	4.4	1.0	8.9
G	E-7	0.01	0.03	6.3	4.8	8.4	0.4	3.2
	DP E	0.08	0.34	T R A V E L T I M E				
		0.09	0.37	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				PIPE	15	5.0	0.1	6.3
H	D-9	0.00	0.02	18.9	3.0	5.2	1.5	11.4
	DP C	0.41	1.79					
	DP G	0.09	0.37	T R A V E L T I M E				
		0.50	2.18	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				PIPE	15	5.0	0.1	19.0
I	E-10	0.04	0.18	5.0	5.2	9.1	0.2	1.6
				T R A V E L T I M E				
		0.04	0.18	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				PIPE	15	5.0	0.1	5.1

Appendix C: Proposed Hydrology Calculations

Standard Form SF-1 . Time of Concentration

Project: Gardens at North Carefree - FDR
Section: Proposed Conditions

Created by: CMD   Date: 1/16/2019
Checked by: CKC   Date:

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

	Offsite Basin @ East Side releases to D-20			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)	$Tc_{max} > t_c$	
OS-1	Offsite Basin @ East Side releases to D-20	0.08	0.26	100	0.035	12.18	150	0.0455	4	Nearly bare ground	10.00	2.13	1.17	13.35	YES	250.00	11.39	Check	13.4
OS-2	Offsite Basin @ East Side releases to D-13	0.08	0.27	100	0.035	12.18	225	0.0455	4	Nearly bare ground	10.00	2.13	1.76	13.94	YES	325.00	11.81	Check	13.9
OS-3	Offsite Basin @ East Side releases to D-2	0.08	1.63	100	0.035	12.18	480	0.0444	4	Nearly bare ground	10.00	2.11	3.80	15.98	YES	580.00	13.22	Check	16.0
OS-4	Offsite Basin @ East Side releases to D-1	0.08	0.07	86	0.040	10.81			4	Nearly bare ground	10.00	0.00	0.00	10.81	YES	86.00	10.48	Check	10.8
D-1	East portion of Site btwn North half of Vineyard and East Boundary	0.45	1.24	100	0.062	6.43	383	0.0132	6	Paved areas and shallow paved swales	20.00	2.30	2.78	9.21	YES	483.00	12.68	Check	9.2
D-2	East portion of Site btwn South half of Vineyard and East Boundary	0.45	0.99	100	0.060	6.50	310	0.0055	6	Paved areas and shallow paved swales	20.00	1.48	3.48	9.98	YES	410.00	12.28	Check	10.0
D-3	South/Middle portion of Site inside of Vineyard Circle which drains to east	0.45	0.17	6	0.020	2.29	310	0.0055	6	Paved areas and shallow paved swales	20.00	1.48	3.48	5.77	YES	316.00	11.76	Check	5.8
D-4	North/Middle portion of Site inside of Vineyard Circle which drains to east	0.45	0.21	5	0.020	2.09	405	0.0132	6	Paved areas and shallow paved swales	20.00	2.30	2.94	5.03	YES	410.00	12.28	Check	5.0
D-5	North portion of site, along Carefree Circle	0.45	2.03	100	0.064	6.36	450	0.0190	6	Paved areas and shallow paved swales	20.00	2.76	2.72	9.08	YES	550.00	13.06	Check	9.1
D-6	East Half of Fallow Lane which drains to Vineyard Circle	0.90	0.08	25	0.020	1.44	40	0.0200	6	Paved areas and shallow paved swales	20.00	2.83	0.24	1.67	YES	65.00	10.36	Check	5.0
D-7	Southwest Half of Fallow Lane which drains to Akers	0.90	0.04	5	0.020	0.64	80	0.0450	6	Paved areas and shallow paved swales	20.00	4.24	0.31	0.96	YES	85.00	10.47	Check	5.0
D-8	North/Middle portion of Site inside of Vineyard Circle which drains to west	0.45	1.90	58	0.020	7.11	490	0.0190	6	Paved areas and shallow paved swales	20.00	2.76	2.96	10.07	YES	548.00	13.04	Check	10.1
D-9	Portion of site south of Fallow and btwn Akers and Vineyard	0.45	0.52	100	0.027	8.46	100	0.0190	6	Paved areas and shallow paved swales	20.00	2.76	0.60	9.06	YES	200.00	11.11	Check	9.1
D-10	North Pond	0.32	0.33	100	0.027	10.15			6	Paved areas and shallow paved swales	20.00	0.00	0.00	10.15	YES	100.00	10.56	Check	10.1
D-11	North half of Running Deer Way	0.90	0.07	20	0.020	1.28	105	0.0600	6	Paved areas and shallow paved swales	20.00	4.90	0.36	1.64	YES	125.00	10.69	Check	5.0
D-12	South/Middle portion of Site inside of Vineyard Circle which drains to west	0.45	0.93	30	0.020	5.11	295	0.0380	6	Paved areas and shallow paved swales	20.00	3.90	1.26	6.37	YES	325.00	11.81	Check	6.4
D-13	Southern portion of site along Sika Deer Place and Akers	0.45	1.38	90	0.060	6.16	470	0.0380	6	Paved areas and shallow paved swales	20.00	3.90	2.01	8.17	YES	560.00	13.11	Check	8.2
D-14	Along eastern Edge of Vineyard (West Side) opposite North Pond	0.45	0.64	100	0.056	6.65	110	0.0190	6	Paved areas and shallow paved swales	20.00	2.76	0.67	7.31	YES	210.00	11.17	Check	7.3
D-15	Northwest Half of Fallow Lane which drains to Akers	0.45	0.04	25	0.020	4.67	80	0.0450	6	Paved areas and shallow paved swales	20.00	4.24	0.31	4.98	YES	105.00	10.58	Check	5.0

	Offsite Basin @ East Side releases to D-20			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)	$Tc_{max} > t_c$	
D-16	South Pond	0.32	0.15	25	0.250	2.43			6	Paved areas and shallow paved swales	20.00	0.00	0.00	2.43	YES	25.00	10.14	Check	5.0
D-17	South half of of Running Deer Way	0.90	0.08	10	0.020	0.91	75	0.0600	6	Paved areas and shallow paved swales	20.00	4.90	0.26	1.16	YES	85.00	10.47	Check	5.0
D-18	ROW north of Fallow which drains towards Akers	0.45	0.19	55	0.091	4.20	285	0.0200	6	Paved areas and shallow paved swales	20.00	2.83	1.68	5.88	YES	340.00	11.89	Check	5.9
D-19	ROW btwn Fallow & Running Deer which drains towards Akers	0.45	0.11	5	0.333	0.83			6	Paved areas and shallow paved swales	20.00	0.00	0.00	0.83	YES	5.00	10.03	Check	5.0
D-20	ROW south of Running Deer which drains towards Akers	0.45	0.41	45	0.333	2.47	720	0.0236	6	Paved areas and shallow paved swales	20.00	3.07	3.90	6.38	YES	765.00	14.25	Check	6.4

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

UDFCD Table RO-2	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)	7.0

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

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

Project: Gardens at North Carefree - FDR
Section: Proposed Conditions
Design Storm: 5-yr   P = 1.50 in

Created by: CMD Date: 1/16/2019
Checked by: CKC Date:

LOCATION	DIRECT RUNOFF							TOTAL RUNOFF				STREET		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)	
	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
Offsite Basin @ East Side releases to D-20	OS-1	0.26	0.08	13.35	0.02	3.59	0.08													
Offsite Basin @ East Side releases to D-13	OS-2	0.27	0.08	13.94	0.02	3.52	0.08													
Offsite Basin @ East Side releases to D-2	OS-3	1.63	0.08	15.98	0.13	3.30	0.43													
Offsite Basin @ East Side releases to D-1	OS-4	0.07	0.08	10.81	0.01	3.93	0.02													
East portion of Site btwn North half of Vineyard and East Boundary	D-1	1.24	0.45	9.21	0.56	4.19	2.34													
East portion of Site btwn South half of Vineyard and East Boundary	D-2	0.99	0.45	9.98	0.45	4.06	1.81													
South/Middle portion of Site inside of Vineyard Circle which drains to east	D-3	0.17	0.45	5.77	0.08	4.89	0.37													
North/Middle portion of Site inside of Vineyard Circle which drains to east	D-4	0.21	0.45	5.03	0.09	5.08	0.48													
North portion of site, along Carefree Circle	D-5	2.03	0.45	9.08	0.91	4.21	3.85													
East Half of Fallow Lane which drains to Vineyard Circle	D-6	0.08	0.90	5.00	0.07	5.09	0.37													
Southwest Half of Fallow Lane which drains to Akers	D-7	0.04	0.90	5.00	0.04	5.09	0.18													
North/Middle portion of Site inside of Vineyard Circle which drains to west	D-8	1.90	0.45	10.07	0.86	4.05	3.46													
Portion of site south of Fallow and btwn Akers and Vineyard	D-9	0.52	0.45	9.06	0.23	4.21	0.99													
North Pond	D-10	0.33	0.32	10.15	0.11	4.03	0.43													
North half of Running Deer Way	D-11	0.07	0.90	5.00	0.06	5.09	0.32													
South/Middle portion of Site inside of Vineyard Circle which drains to west	D-12	0.93	0.45	6.37	0.42	4.75	1.99													
Southern portion of site along Sika Deer Place and Akers	D-13	1.72	0.45	8.17	0.77	4.38	3.39													
Along eastern Edge of Vineyard (West Side) opposite North Pond	D-14	0.64	0.45	7.31	0.29	4.55	1.31													
Northwest Half of Fallow Lane which drains to Akers	D-15	0.04	0.45	5.00	0.02	5.09	0.09													

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

Project: Gardens at North Carefree - FDR   Created by: CMD   Date: 1/16/2019
Section: Proposed Conditions   Checked by: CKC   Date:

	South Pond	D-16	0.13	0.32	5.00	0.04	5.09	0.21													
	South half of of Running Deer Way	D-17	0.08	0.90	5.00	0.07	5.09	0.37													
	ROW north of Fallow which drains towards Akers	D-18	0.19	0.45	5.88	0.09	4.86	0.42													
	ROW btwn Fallow & Running Deer which drains towards Akers	D-19	0.11	0.45	5.00	0.05	5.09	0.25													
	ROW south of Running Deer which drains towards Akers	D-20	0.41	0.45	6.38	0.18	4.75	0.88													

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

Project: Gardens at North Carefree - FDR
Section: Proposed Conditions
Design Storm: 100-yr   P = 2.52 in

Created by: CMD   Date: 1/16/2019
Checked by: CKC   Date:

LOCATION	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)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
Offsite Basin @ East Side releases to D-20	OS-1	0.26	0.35	13.35	0.09	6.04	0.56													
Offsite Basin @ East Side releases to D-13	OS-2	0.27	0.35	13.94	0.10	5.92	0.57													
Offsite Basin @ East Side releases to D-2	OS-3	1.63	0.35	15.98	0.57	5.55	3.17													
Offsite Basin @ East Side releases to D-1	OS-4	0.07	0.35	10.81	0.03	6.61	0.17													
East portion of Site btwn North half of Vineyard and East Boundary	D-1	1.24	0.59	9.21	0.73	7.04	5.15													
East portion of Site btwn South half of Vineyard and East Boundary	D-2	0.99	0.59	9.98	0.58	6.82	3.99													
South/Middle portion of Site inside of Vineyard Circle which drains to east	D-3	0.17	0.59	5.77	0.10	8.22	0.82													
North/Middle portion of Site inside of Vineyard Circle which drains to east	D-4	0.21	0.59	5.03	0.12	8.54	1.06													
North portion of site, along Carefree Circle	D-5	2.03	0.59	9.08	1.20	7.07	8.47													
East Half of Fallow Lane which drains to Vineyard Circle	D-6	0.08	0.96	5.00	0.08	8.55	0.66													
Southwest Half of Fallow Lane which drains to Akers	D-7	0.04	0.96	5.00	0.04	8.55	0.33													
North/Middle portion of Site inside of Vineyard Circle which drains to west	D-8	1.90	0.59	10.07	1.12	6.80	7.62													
Portion of site south of Fallow and btwn Akers and Vineyard	D-9	0.52	0.59	9.06	0.31	7.08	2.17													
North Pond	D-10	0.33	0.51	10.15	0.17	6.78	1.14													
North half of Running Deer Way	D-11	0.07	0.96	5.00	0.07	8.55	0.57													
South/Middle portion of Site inside of Vineyard Circle which drains to west	D-12	0.93	0.59	6.37	0.55	7.98	4.38													
Southern portion of site along Sika Deer Place and Akers	D-13	1.72	0.59	8.17	1.01	7.35	7.46													
Along eastern Edge of Vineyard (West Side) opposite North Pond	D-14	0.64	0.59	7.31	0.38	7.64	2.88													
Northwest Half of Fallow Lane which drains to Akers	D-15	0.04	0.59	5.00	0.02	8.55	0.20													

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

Project: Gardens at North Carefree - FDR — Created by: CMD — Date: 1/16/2019

Section: Proposed Conditions — Checked by: CKC — Date:

	South Pond	D-16	0.13	0.51	5.00	0.07	8.55	0.57													
	South half of of Running Deer Way	D-17	0.08	0.96	5.00	0.08	8.55	0.66													
	ROW north of Fallow which drains towards Akers	D-18	0.19	0.59	5.88	0.11	8.17	0.92													
	ROW btwn Fallow & Running Deer which drains towards Akers	D-19	0.11	0.59	5.00	0.06	8.55	0.55													
	ROW south of Running Deer which drains towards Akers	D-20	0.41	0.59	6.38	0.24	7.98	1.93													

All Equations follow UDFCD 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) =28.5*P/(10+Column 6)^0.786
(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) =28.5*P/(10+Column 10)^0.786
(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

GARDENS AT NORTH CAREFREE - FDR
SURFACE ROUTING

DESIGN POINT	CONTRIBUTING BASINS	CA(equivalent) CA(5)	CA(100)	Tc (min.)	INTENSITY I(5) (in/hr)	I(100) (in/hr)	TOTAL FLOWS Q(5) (cfs)	Q(100) (cfs)
Z	OS-1	0.02	0.09	13.4	3.6	6.2	0.1	0.6
				TRAVEL TIME				
		0.02	0.09	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					750	2.1	6.0	19.3
Y	OS-2	0.02	0.10	13.9	3.5	6.1	0.1	0.6
				TRAVEL TIME				
		0.02	0.10	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					450	2.1	3.6	17.5
X	OS-3	0.13	0.57	16.0	3.3	5.7	0.4	3.3
				TRAVEL TIME				
		0.13	0.57	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					115	2.1	0.9	16.9
W	OS-4	0.01	0.03	10.8	3.9	6.8	0.0	0.2
				TRAVEL TIME				
		0.01	0.03	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					115	2.1	0.9	11.7
A	D-1	0.56	0.73	19.3	3.0	5.2	3.4	9.9
	D-2	0.45	0.58					
	DP W	0.01	0.03					
	DP X	0.13	0.57	TRAVEL TIME				
		1.14	1.91	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				PIPE	34	2.5	0.2	19.5
B	D-3	0.08	0.10	5.0	5.2	9.0	0.9	2.0
	D-4	0.09	0.12	TRAVEL TIME				
		0.17	0.22	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				PIPE	205	2.5	1.4	6.4
C	D-8	0.86	1.12	10.1	4.0	7.1	3.5	7.9
				TRAVEL TIME				
		0.86	1.12	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				CHANNEL	34	2.5	0.2	10.3
V	D-5	0.91	1.20	9.1	4.2	7.4	4.2	9.4
	D-6	0.07	0.08					
		0.99	1.27	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				STREET	205	2.8	1.2	10.3
D	D-9	0.23	0.31	10.3	4.0	7.0	4.9	11.0
	DP V	0.99	1.27					
		1.22	1.58	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				PIPE	10	2.5	0.1	10.4
E	D-12	0.42	0.55	7.3	4.6	8.0	3.3	9.3
	D-14	0.29	0.38	TRAVEL TIME				
	FB Inlet C	0.02	0.24					
		0.73	1.16	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				PIPE	34	2.5	0.2	7.5
F	D-13	0.77	1.01	17.5	3.1	5.5	2.6	10.0
	DP Y	0.02	0.10	TRAVEL TIME				
	FB Inlet D	0.03	0.71					
		0.83	1.83	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)

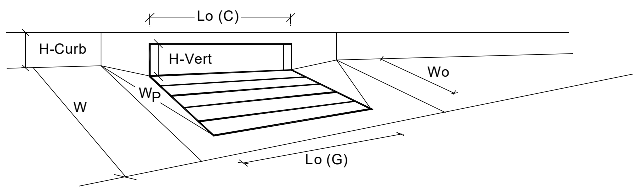
DESIGN POINT	CONTRIBUTING BASINS	C A (e q u i v a l e n t)		Tc	I N T E N S I T Y		T O T A L F L O W S	
		CA(5)	CA(100)	(min.)	I(5) (in/hr)	I(100) (in/hr)	Q(5) (cfs)	Q(100) (cfs)
				PIPE	10	2.5	0.1	17.6

DESIGN POINT	CONTRIBUTING BASINS	CA (equivalent)		Tc	INTENSITY		TOTAL FLOWS	
		CA(5)	CA(100)	(min.)	I(5) (in/hr)	I(100) (in/hr)	Q(5) (cfs)	Q(100) (cfs)
G	D-18	0.09	0.11	5.9	4.9	8.6	0.4	1.0
				TRAVEL TIME				
		0.09	0.11	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					25	5.0	0.1	6.0
H	D-15	0.02	0.02	5.0	5.2	9.1	0.3	0.6
	D-7	0.04	0.04	TRAVEL TIME				
	D-19	0.05	0.06					
		0.05	0.06	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					25	5.0	0.1	5.1
I	D-11	0.06	0.07	19.3	3.0	5.2	0.9	2.0
	D-17	0.07	0.08					
	D-20	0.18	0.24					
	DP Z	0.02	0.09	TRAVEL TIME				
		0.32	0.39	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
						5.0	0.0	19.3
NP	D-10	0.11	0.17	19.5	3.0	5.2	10.3	25.8
	DP A	1.14	1.91					
	DP B	0.17	0.22					
	DP C	0.86	1.12					
	DP D	1.22	1.58	TRAVEL TIME				
		3.49	5.01	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					80	4.0	0.3	19.9
SP	D-16	0.04	0.07	17.6	3.1	5.4	5.0	16.6
	DP E	0.73	1.16					
	DP F	0.83	1.83	TRAVEL TIME				
		1.60	3.06	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
						5.0	0.0	17.6

Appendix D: Inlet Calculations

INLET IN A SUMP OR SAG LOCATION

Project = Gardens at North Carefree
Inlet ID = Proposed Type R Inlet - DP A



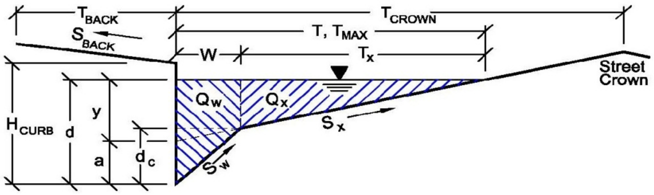
		MINOR	MAJOR	
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Inlet Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	3.4	5.6	inches
				Override Depths
Grate Information		MINOR	MAJOR	
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) =	20.00	20.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	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 UDFCD - CSU 2010 Study)		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 UDFCD - CSU 2010 Study)		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 =	1.33	1.33	
Clogging Factor for Multiple Units	Clog =	0.03	0.03	
Curb Opening as a Weir (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	3.68	10.63	cfs
Interception with Clogging	Q_{wa} =	3.56	10.28	cfs
Curb Opening as an Orifice (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	32.25	37.75	cfs
Interception with Clogging	Q_{oa} =	31.18	36.50	cfs
Curb Opening Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	10.14	18.63	cfs
Interception with Clogging	Q_{ma} =	9.80	18.01	cfs
Resulting Curb Opening Capacity (assumes clogged condition)	Q_{Curb} =	**3.56**	**10.28**	**cfs**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	20.00	20.00	feet
Resultant Street Flow Spread (based on sheet *Q-Allow* geometry)	T =	10.3	17.0	ft
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.0	inches
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**3.6**	**10.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)	Q PEAK REQUIRED =	3.4	9.9	cfs

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

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

Project: Gardens at North Carefree

Inlet ID: Proposed Type R Inlet - DP A



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.015		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.020		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	8.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

		Minor Storm	Major Storm	
Maximum Capacity for 1/2 Street based On Allowable Spread				
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.92	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.52	1.52	inches
Water Depth at Gutter Flowline	d =	3.44	5.60	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	6.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.688	0.350	
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	

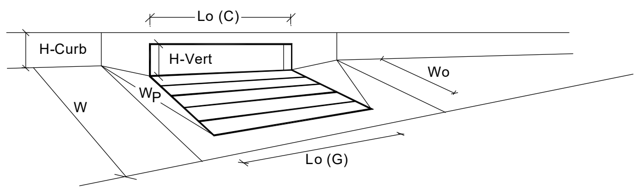
		Minor Storm	Major Storm	
Maximum Capacity for 1/2 Street based on Allowable Depth				
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
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 ($d \geq 6"$) 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**

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'
Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET IN A SUMP OR SAG LOCATION

Project = Gardens at North Carefree
Inlet ID = Proposed Type R Inlet - DP B



		MINOR	MAJOR	
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Inlet Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	3.4	5.6	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) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	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 UDFCD - CSU 2010 Study)		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 UDFCD - CSU 2010 Study)		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 =	0.10	0.10	
Curb Opening as a Weir (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	1.26	5.09	cfs
Interception with Clogging	Q_{wa} =	1.14	4.58	cfs
Curb Opening as an Orifice (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	7.52	9.44	cfs
Interception with Clogging	Q_{oa} =	6.77	8.49	cfs
Curb Opening Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	2.87	6.44	cfs
Interception with Clogging	Q_{ma} =	2.58	5.80	cfs
Resulting Curb Opening Capacity (assumes clogged condition)	Q_{Curb} =	**1.14**	**4.58**	**cfs**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	5.00	5.00	feet
Resultant Street Flow Spread (based on sheet *Q-Allow* geometry)	T =	8.0	17.0	ft
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.0	inches
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**1.1**	**4.6**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	0.9	2.0	cfs

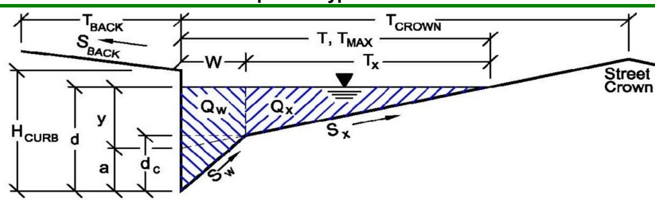
The construction drawings indicate a 10' inlet. Revise so that they match.

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

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

Project: Gardens at North Carefree

Inlet ID: Proposed Type R Inlet - DP B



Gutter Geometry (Enter data in the blue cells)			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.015	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	8.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	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 =	1.92	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.52	1.52	inches
Water Depth at Gutter Flowline	d =	3.44	5.60	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	6.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.688	0.350	
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} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\ TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
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 ($d \geq 6"$) 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

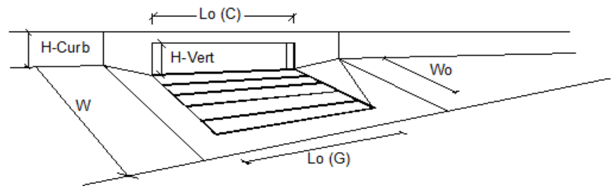
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: Gardens at North Carefree
Inlet ID: Proposed Type R Inlet - DP C



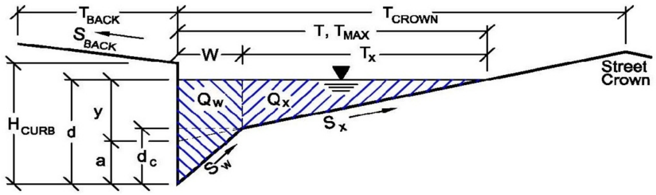
		MINOR	MAJOR	
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	10.00	10.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	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 *Q-Peak*)	**Q_o =**	3.9	7.9	cfs
Water Spread Width	T =	8.3	11.5	ft
Water Depth at Flowline (outside of local depression)	d =	3.5	4.3	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 =	0.671	0.511	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	1.3	3.9	cfs
Discharge within the Gutter Section W	Q_w =	2.6	4.0	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.82	1.45	sq ft
Velocity within the Gutter Section W	V_W =	4.8	5.4	fps
Water Depth for Design Condition	d_{LOCAL} =	6.5	7.3	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 =	0.146	0.116	ft/ft
Required Length L_T to Have 100% Interception	L_T =	10.90	17.36	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	10.00	10.00	ft
Interception Capacity	Q_i =	3.9	6.2	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.25	1.25	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	8.75	8.75	ft
Actual Interception Capacity	**Q_a =**	3.8	6.0	cfs
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	0.1	1.9	cfs
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**3.80**	**6.00**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.1**	**1.9**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**98**	**76**	**%**

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

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

Project: Gardens at North Carefree

Inlet ID: Proposed Type R Inlet - DP C



Gutter Geometry (Enter data in the blue cells)			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.015	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.023	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	8.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	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 =	1.92	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.52	1.52	inches
Water Depth at Gutter Flowline	d =	3.44	5.60	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	6.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.688	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	1.1	13.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	2.5	7.0	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 =**	**3.6**	**20.1**	**cfs**
Flow Velocity within the Gutter Section	V =	6.1	9.2	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	1.8	4.3	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	17.3	198.7	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	17.2	138.3	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	8.1	29.9	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	32.8	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	25.3	200.9	cfs
Average Flow Velocity Within the Gutter Section	V =	9.7	16.3	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	4.8	16.3	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	0.94	0.76	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**23.7**	**152.5**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.89	10.82	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.29	5.22	inches

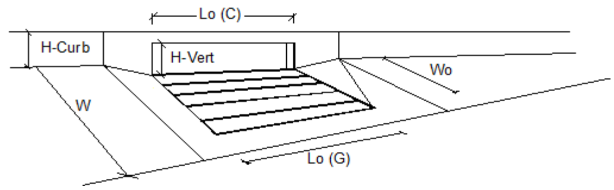
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**3.6**	**20.1**	**cfs**

WARNING: MINOR STORM max. allowable capacity is less than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: Gardens at North Carefree
Inlet ID: Proposed Type R Inlet - DP D



		MINOR	MAJOR	
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	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 =	10.00	10.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	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 *Q-Peak*)	Q_o =	3.9	11.0	cfs
Water Spread Width	T =	8.3	13.3	ft
Water Depth at Flowline (outside of local depression)	d =	3.5	4.7	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	0.448	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	1.3	6.1	cfs
Discharge within the Gutter Section W	Q_w =	2.6	4.9	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.82	1.89	sq ft
Velocity within the Gutter Section W	V_W =	4.8	5.8	fps
Water Depth for Design Condition	d_{LOCAL} =	6.5	7.7	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	$E_{o-GRATE}$ =	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 =	0.146	0.104	ft/ft
Required Length L_T to Have 100% Interception	L_T =	10.90	21.60	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	10.00	10.00	ft
Interception Capacity	Q_i =	3.9	7.4	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.25	1.25	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	8.75	8.75	ft
Actual Interception Capacity	Q_a =	3.8	7.1	cfs
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	Q_b =	0.1	3.9	cfs
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	**3.80**	**7.12**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	**0.1**	**3.9**	**cfs**
Capture Percentage = Q_a/Q_o =	C% =	**98**	**65**	**%**

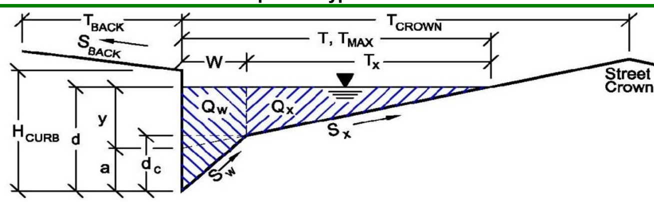
Per surface routing calculations, drainage plan and narrative the minor flow at design point D is 4.9 cfs. Revise accordingly.

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

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

Project: Gardens at North Carefree

Inlet ID: Proposed Type R Inlet - DP D



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.015		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.020		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.023		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	8.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	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 =	1.92	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.52	1.52	inches
Water Depth at Gutter Flowline	d =	3.44	5.60	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	6.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.688	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	1.1	13.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	2.5	7.0	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 =	**3.6**	**20.1**	**cfs**
Flow Velocity within the Gutter Section	V =	6.1	9.2	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	1.8	4.3	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	17.3	198.7	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	17.2	138.3	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	8.1	29.9	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	32.8	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	25.3	200.9	cfs
Average Flow Velocity Within the Gutter Section	V =	9.7	16.3	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	4.8	16.3	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	0.94	0.76	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**23.7**	**152.5**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.89	10.82	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.29	5.22	inches

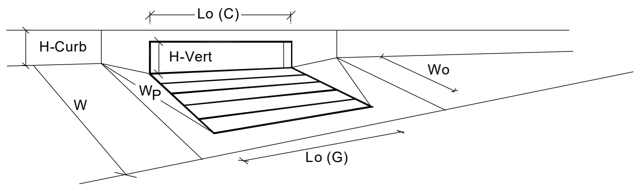
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	Q_{allow} =	**3.6**	**20.1**	**cfs**

WARNING: MINOR STORM max. allowable capacity is less than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET IN A SUMP OR SAG LOCATION

Project = Gardens at North Carefree
Inlet ID = Proposed Type R Inlet - DP E



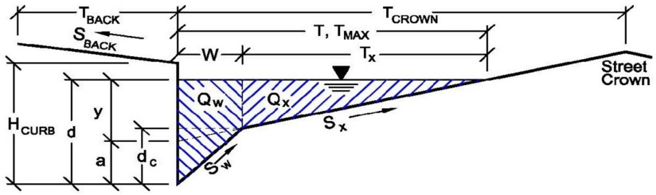
		MINOR	MAJOR	
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Inlet Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	3.4	5.6	inches
				☐ Override Depths
Grate Information		MINOR	MAJOR	
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) =	20.00	20.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	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 UDFCD - CSU 2010 Study)		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 UDFCD - CSU 2010 Study)		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 =	1.33	1.33	
Clogging Factor for Multiple Units	Clog =	0.03	0.03	
Curb Opening as a Weir (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	3.36	10.63	cfs
Interception with Clogging	Q_{wa} =	3.25	10.28	cfs
Curb Opening as an Orifice (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	31.88	37.75	cfs
Interception with Clogging	Q_{oa} =	30.82	36.50	cfs
Curb Opening Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	9.63	18.63	cfs
Interception with Clogging	Q_{ma} =	9.31	18.01	cfs
Resulting Curb Opening Capacity (assumes clogged condition)	Q_{Curb} =	**3.25**	**10.28**	**cfs**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	20.00	20.00	feet
Resultant Street Flow Spread (based on sheet *Q-Allow* geometry)	T =	9.9	17.0	ft
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.0	inches
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**3.3**	**10.3**	**cfs**
WARNING: Inlet Capacity less than Q Peak for Minor Storm	$Q_{PEAK\ REQUIRED}$ =	3.3	9.3	cfs

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

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

Project: Gardens at North Carefree

Inlet ID: Proposed Type R Inlet - DP E



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft	
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft	
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.015		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches	
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft	
Gutter Width	W =	2.00	ft	
Street Transverse Slope	S_X =	0.020	ft/ft	
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft	
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft	
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013		

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	8.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	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 =	1.92	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.52	1.52	inches
Water Depth at Gutter Flowline	d =	3.44	5.60	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	6.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.688	0.350	
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} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
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 $\geq$ 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

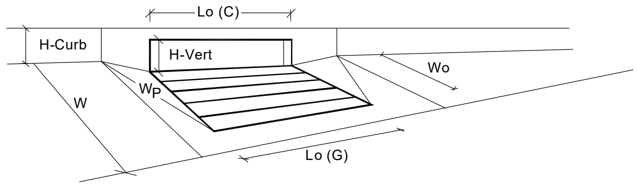
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET IN A SUMP OR SAG LOCATION

Project = **Gardens at North Carefree**
Inlet ID = **Proposed Type R Inlet - DP F**



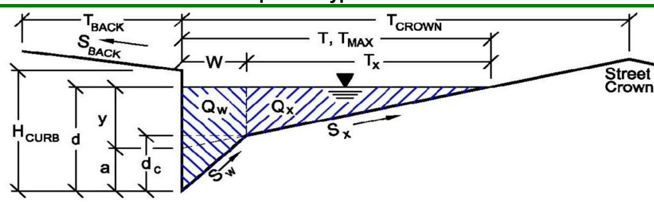
		MINOR	MAJOR	
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Inlet Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	3.4	5.6	inches
	☐ Override Depths			
Grate Information		MINOR	MAJOR	
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) =	20.00	20.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	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 UDFCD - CSU 2010 Study)		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 UDFCD - CSU 2010 Study)		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 =	1.33	1.33	
Clogging Factor for Multiple Units	Clog =	0.03	0.03	
Curb Opening as a Weir (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	2.76	10.63	cfs
Interception with Clogging	Q_{wa} =	2.67	10.28	cfs
Curb Opening as an Orifice (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	31.11	37.75	cfs
Interception with Clogging	Q_{oa} =	30.08	36.50	cfs
Curb Opening Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	8.62	18.63	cfs
Interception with Clogging	Q_{ma} =	8.33	18.01	cfs
Resulting Curb Opening Capacity (assumes clogged condition)	Q_{Curb} =	**2.67**	**10.28**	**cfs**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	20.00	20.00	feet
Resultant Street Flow Spread (based on sheet *Q-Allow* geometry)	T =	9.1	17.0	ft
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.0	inches
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**2.7**	**10.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	2.6	10.0	cfs

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

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

Project: Gardens at North Carefree

Inlet ID: Proposed Type R Inlet - DP F



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.015	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	8.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	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 =	1.92	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.52	1.52	inches
Water Depth at Gutter Flowline	d =	3.44	5.60	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	6.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.688	0.350	
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} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\ TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
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 ($d \geq 6"$) 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**

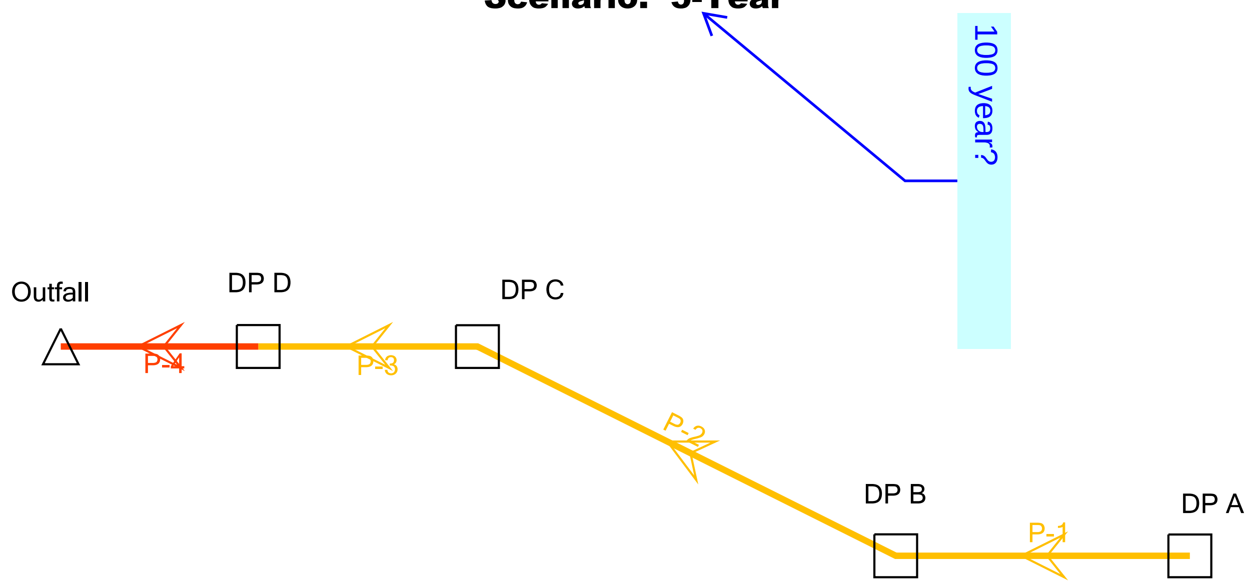
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Appendix E: StormCAD

Storm System 1

Scenario: 5-Year

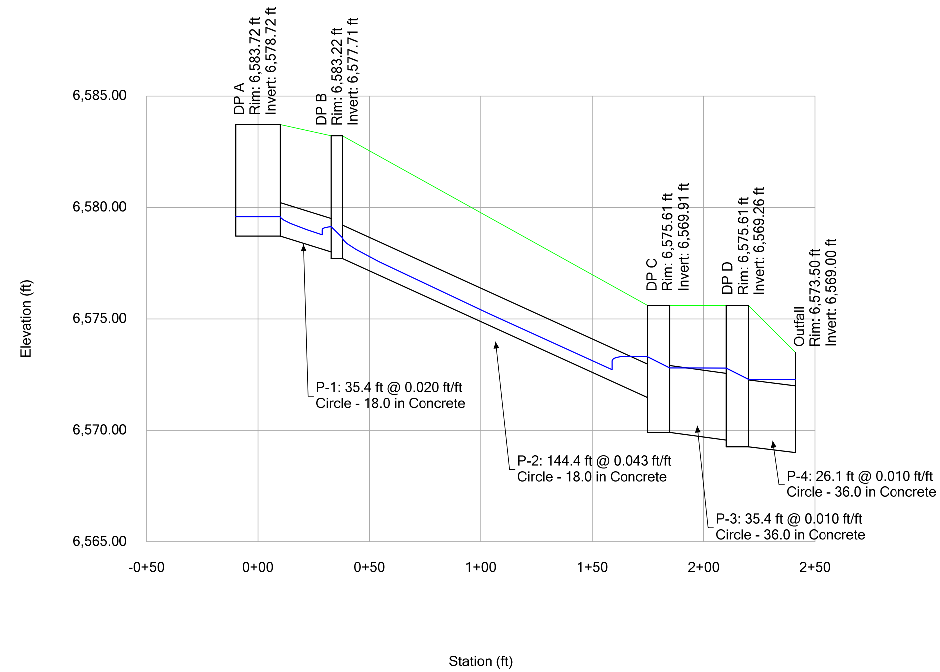


Storm System 1 - 100 Year

Label	Start Node	Stop Node	Length (Unified) (ft)	Diameter (in)	Capacity (Full Flow) (cfs)	System Rational Flow (cfs)	Velocity (ft/s)	Elevation Ground (Start) (ft)	Hydraulic Grade Line (In) (ft)	Invert (Start) (ft)	Cover (Start) (ft)	Elevation Ground (Stop) (ft)	Hydraulic Grade Line (Out) (ft)	Invert (Stop) (ft)	Cover (Stop) (ft)	Slope (Calculated) (ft/ft)
P-1	DP A	DP B	35.4	18	14.89	5.09	7.63	6,583.72	6,579.59	6,578.72	3.5	6,583.22	6,579.14	6,578.01	3.71	2.00%
P-2	DP B	DP C	144.4	18	21.83	5.84	10.47	6,583.22	6,578.64	6,577.71	4.01	6,575.61	6,573.30	6,571.47	2.64	4.30%
P-3	DP C	DP D	35.4	36	66.36	9.63	6.69	6,575.61	6,572.80	6,569.91	2.7	6,575.61	6,572.79	6,569.56	3.05	1.00%
P-4	DP D	Outfall	26.1	36	66.54	15.01	2.12	6,575.61	6,572.29	6,569.26	3.35	6,573.50	6,572.28	6,569.00	1.5	1.00%

Provide input values for stormcad modeling. There appears to be an error as the system flow values are the same for the 100yr and 5yr flows.

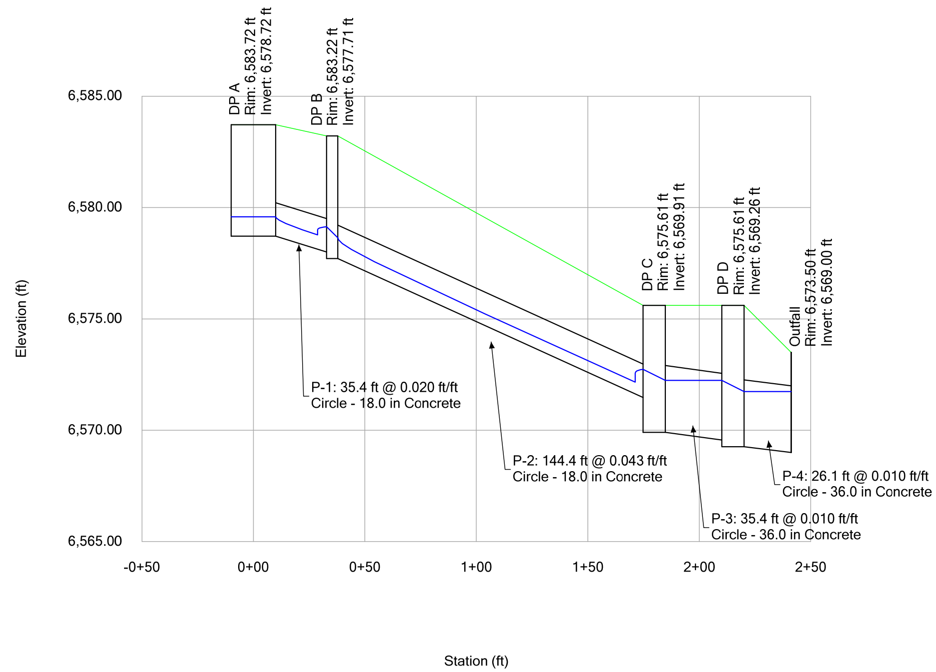
Profile Report
Engineering Profile - DP A to Outfall (St Sys 1.stsw)



Storm System 1 - 5 Year

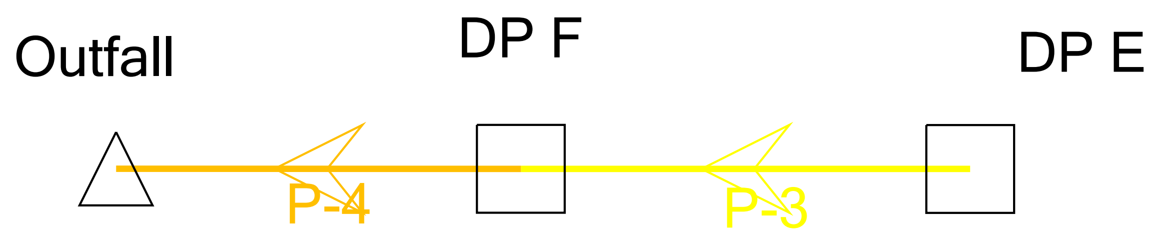
Label	Start Node	Stop Node	Length (Unified) (ft)	Diameter (in)	Capacity (Full Flow) (cfs)	System Rational Flow (cfs)	Velocity (ft/s)	Elevation Ground (Start) (ft)	Hydraulic Grade Line (In) (ft)	Invert (Start) (ft)	Cover (Start) (ft)	Elevation Ground (Stop) (ft)	Hydraulic Grade Line (Out) (ft)	Invert (Stop) (ft)	Cover (Stop) (ft)	Slope (Calculated) (ft/ft)
P-1	DP A	DP B	35.4	18	14.89	5.09	7.63	6,583.72	6,579.59	6,578.72	3.5	6,583.22	6,579.14	6,578.01	3.71	2.00%
P-2	DP B	DP C	144.4	18	21.83	5.84	10.47	6,583.22	6,578.64	6,577.71	4.01	6,575.61	6,572.74	6,571.47	2.64	4.30%
P-3	DP C	DP D	35.4	36	66.36	9.63	6.69	6,575.61	6,572.24	6,569.91	2.7	6,575.61	6,572.24	6,569.56	3.05	1.00%
P-4	DP D	Outfall	26.1	36	66.54	15.01	7.6	6,575.61	6,571.74	6,569.26	3.35	6,573.50	6,571.74	6,569.00	1.5	1.00%

Profile Report
Engineering Profile - DP A to Outfall (St Sys 1.stsw)



Storm System 2

Scenario: 100-Year

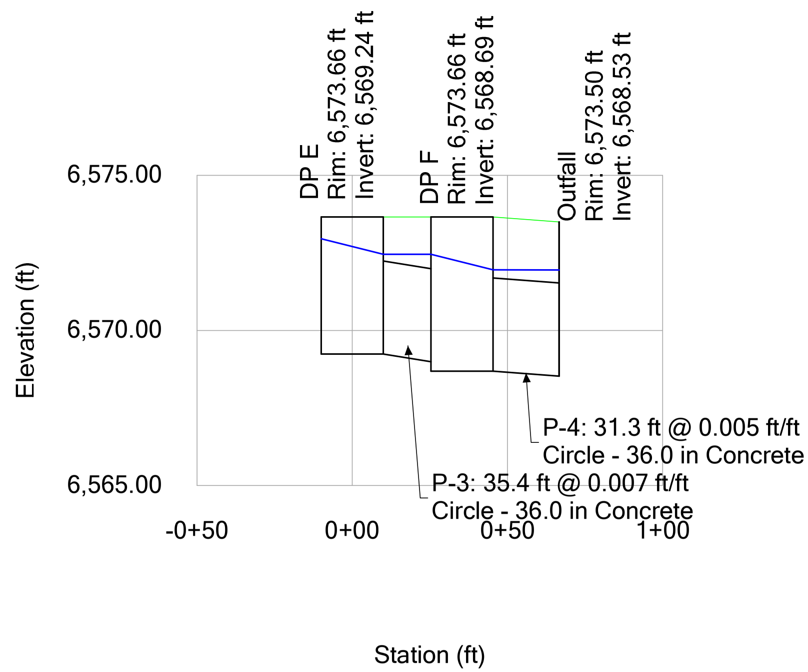


Storm System 2 - 100 Year

Label	Start Node	Stop Node	Length (Unified) (ft)	Diameter (in)	Capacity (Full Flow) (cfs)	System Rational Flow (cfs)	Velocity (ft/s)	Elevation Ground (Start) (ft)	Hydraulic Grade Line (In) (ft)	Invert (Start) (ft)	Cover (Start) (ft)	Elevation Ground (Stop) (ft)	Hydraulic Grade Line (Out) (ft)	Invert (Stop) (ft)	Cover (Stop) (ft)	Slope (Calculated) (ft/ft)
P-3	DP E	DP F	35.4	36	56.09	4.21	0.6	6,573.66	6,572.46	6,569.24	1.42	6,573.66	6,572.45	6,568.99	1.67	0.70%
P-4	DP F	Outfall	31.3	36	47.7	7.24	1.02	6,573.66	6,571.95	6,568.69	1.97	6,573.50	6,571.95	6,568.53	1.97	0.50%

Does not meet ECM criteria for min. velocity (4 ft/s).

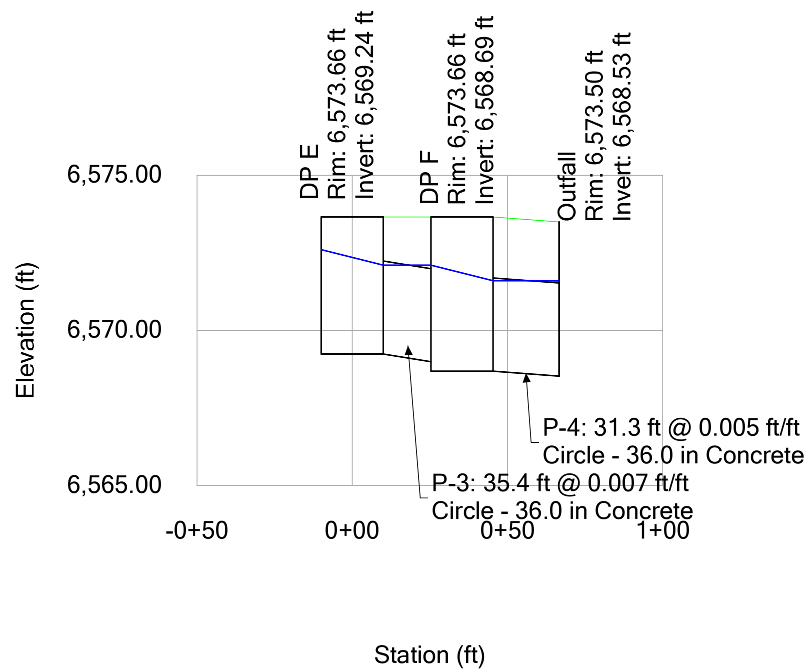
Profile Report
Engineering Profile - DP E to Outfall (St Sys 2.stsw)



Storm System 2 - 5 Year

Label	Start Node	Stop Node	Length (Unified) (ft)	Diameter (in)	Capacity (Full Flow) (cfs)	System Rational Flow (cfs)	Velocity (ft/s)	Elevation Ground (Start) (ft)	Hydraulic Grade Line (In) (ft)	Invert (Start) (ft)	Cover (Start) (ft)	Elevation Ground (Stop) (ft)	Hydraulic Grade Line (Out) (ft)	Invert (Stop) (ft)	Cover (Stop) (ft)	Slope (Calculated) (ft/ft)
P-3	DP E	DP F	35.4	36	56.09	4.21	4.66	6,573.66	6,572.10	6,569.24	1.42	6,573.66	6,572.10	6,568.99	1.67	0.70%
P-4	DP F	Outfall	31.3	36	47.7	7.24	4.87	6,573.66	6,571.60	6,568.69	1.97	6,573.50	6,571.60	6,568.53	1.97	0.50%

Profile Report
Engineering Profile - DP E to Outfall (St Sys 2.stsw)



Appendix F: Water Quality Pond Calculations

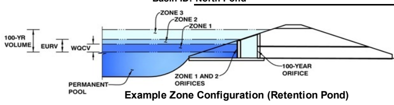
North Pond

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Gardens at North Carefree

Basin ID: North Pond



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB			
Watershed Area =	6.84	acres		
Watershed Length =	570	ft		
Watershed Slope =	0.022	ft/ft		
Watershed Imperviousness =	80.00%	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 =	User Input			
Water Quality Capture Volume (WQCV) =	0.187	acre-feet	Optional User Override 1-hr Precipitation	
Excess Urban Runoff Volume (EURV) =	0.720	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.498	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.647	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.780	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.924	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.065	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.234	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.29 in.) =	1.692	acre-feet	3.29	inches
Approximate 2-yr Detention Volume =	0.472	acre-feet		
Approximate 5-yr Detention Volume =	0.614	acre-feet		
Approximate 10-yr Detention Volume =	0.733	acre-feet		
Approximate 25-yr Detention Volume =	0.871	acre-feet		
Approximate 50-yr Detention Volume =	0.952	acre-feet		
Approximate 100-yr Detention Volume =	1.026	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.187	acre-feet	
Select Zone 2 Storage Volume (Optional) =		acre-feet	**Total detention volume is less than 100-year volume.**
Select Zone 3 Storage Volume (Optional) =		acre-feet	
Total Detention Basin Volume =	0.187	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)
Top of Micropool	--	0.00	--	--	--	2,828	0.065		
	--	0.50	--	--	--	3,159	0.073	1,465	0.034
	--	1.00	--	--	--	3,507	0.081	3,128	0.072
	--	1.50	--	--	--	3,874	0.089	4,970	0.114
	--	2.00	--	--	--	4,259	0.098	6,999	0.161
	--	2.50	--	--	--	4,661	0.107	9,272	0.213
	--	3.00	--	--	--	5,082	0.117	11,708	0.269
	--	3.50	--	--	--	5,521	0.127	14,358	0.330
	--	4.00	--	--	--	5,977	0.137	17,233	0.396
	--	4.50	--	--	--	6,452	0.148	20,340	0.467
	--	5.00	--	--	--	6,944	0.159	23,689	0.544
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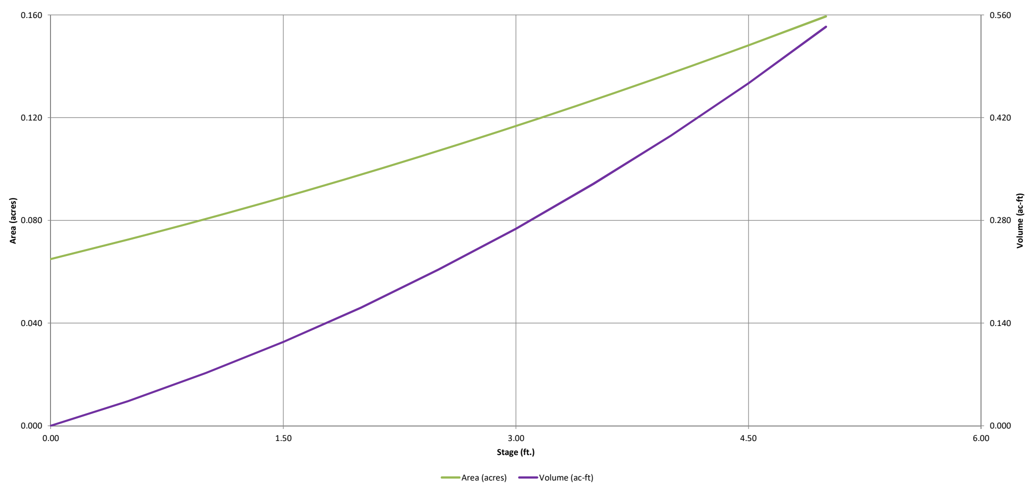
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

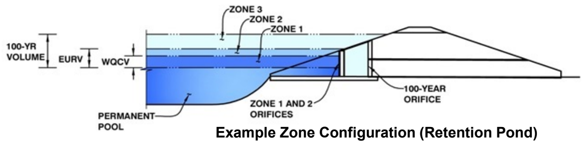
UD-Detention, Version 3.07 (February 2017)



Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Gardens at North Carefree
Basin ID: North Pond



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.26	0.187	Orifice Plate
Zone 2			Weir&Pipe (Rect.)
Zone 3			
		0.187	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 =	2.26	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	12.00	inches
Orifice Plate: Orifice Area per Row =	1.40	sq. inches (diameter = 1-5/16 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =	9.722E-03	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.00	2.00					
Orifice Area (sq. inches)	1.40	1.40	1.40					

	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 =			ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =			inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

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

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.26		ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00		feet
Overflow Weir Slope =	3.00		H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	4.00		feet
Overflow Grate Open Area % =	70%		%, grate open area/total area
Debris Clogging % =	50%		%

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.59		feet
Over Flow Weir Slope Length =	4.22		feet
Grate Open Area / 100-yr Orifice Area =	5.25		should be $\geq$ 4
Overflow Grate Open Area w/o Debris =	11.81		ft^2
Overflow Grate Open Area w/ Debris =	5.90		ft^2

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

	Zone 2 Rectangular	Not Selected	
Depth to Invert of Outlet Pipe =	2.50		ft (distance below basin bottom at Stage = 0 ft)
Rectangular Orifice Width =	18.00		inches
Rectangular Orifice Height =	18.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Rectangular	Not Selected	
Outlet Orifice Area =	2.25		ft^2
Outlet Orifice Centroid =	0.75		feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.70	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	50.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

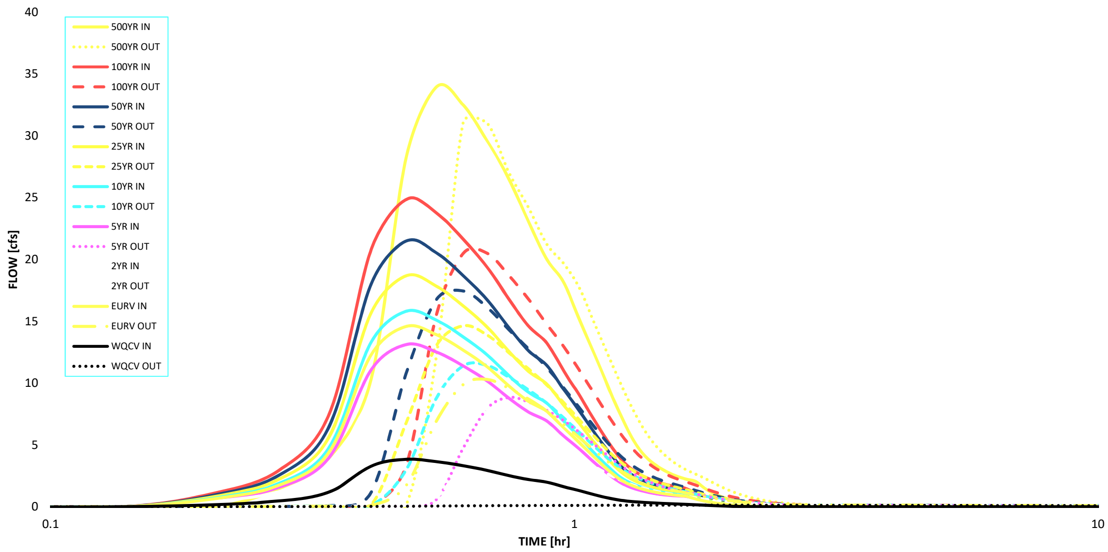
Spillway Design Flow Depth=	0.29	feet
Stage at Top of Freeboard =	4.99	feet
Basin Area at Top of Freeboard =	0.16	acres

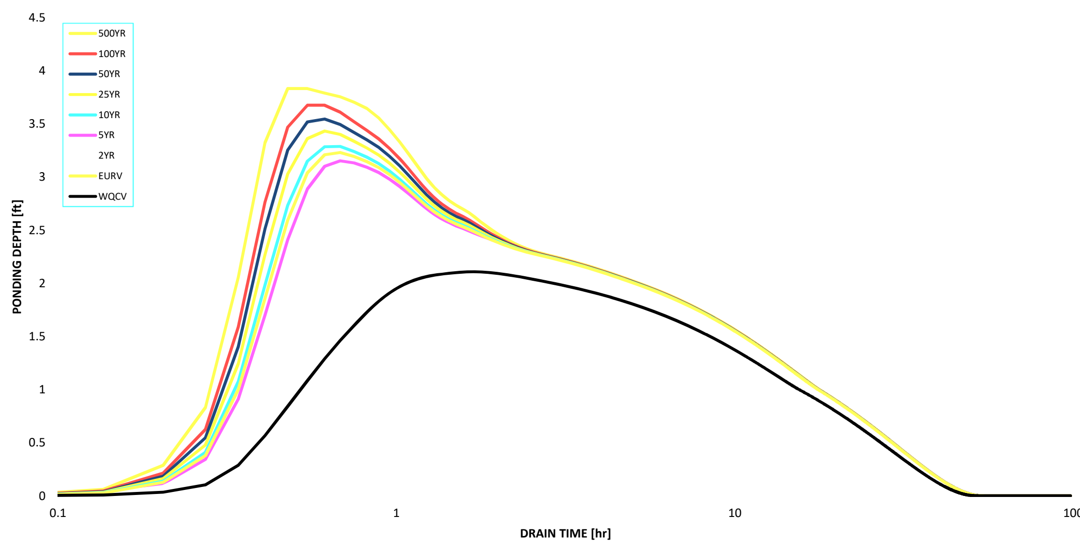
Routed Hydrograph Results

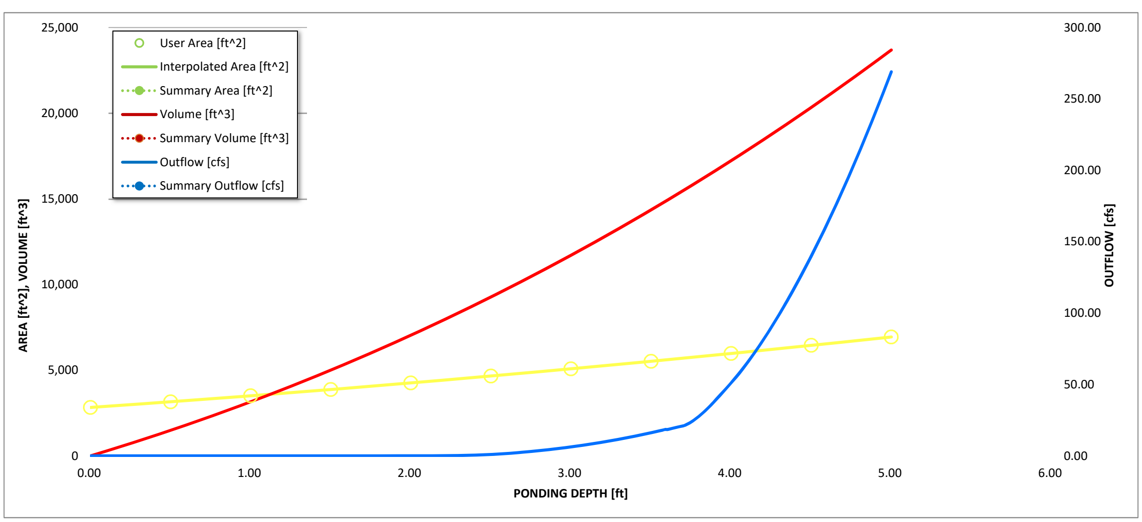
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.29
Calculated Runoff Volume (acre-ft) =	0.187	0.720	0.498	0.647	0.780	0.924	1.065	1.234	1.692
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.186	0.719	0.498	0.646	0.780	0.923	1.064	1.233	1.691
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.00	0.01	0.02	0.04	0.26	0.63	1.46
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.0	0.1	0.2	1.8	4.3	10.0
Peak Inflow Q (cfs) =	3.8	14.6	10.1	13.1	15.8	18.7	21.5	24.8	33.9
Peak Outflow Q (cfs) =	0.1	10.3	5.8	8.8	11.4	14.6	17.4	20.5	31.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	189.3	105.1	60.1	9.7	4.7	3.1
Structure Controlling Flow =	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.85	0.47	0.7	1.0	1.2	1.5	1.7	2.0
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) =	42	34	38	35	34	32	30	28	24
Time to Drain 99% of Inflow Volume (hours) =	**46**	43	44	43	42	41	40	39	37
Maximum Ponding Depth (ft) =	2.11	3.23	2.96	3.15	3.29	3.43	3.55	3.68	3.83
Area at Maximum Ponding Depth (acres) =	0.10	0.12	0.12	0.12	0.12	0.13	0.13	0.13	0.13
Maximum Volume Stored (acre-ft) =	0.172	0.296	0.264	0.286	0.302	0.321	0.335	0.351	0.373

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







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

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

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

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

Time Interval: 4.09 min

Hydrograph Constant: 1.222

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]
0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:04:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:08:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:12:16	0.17	0.64	0.45	0.58	0.70	0.82	0.94	1.08	1.47
0:16:22	0.46	1.74	1.21	1.56	1.88	2.22	2.55	2.94	4.00
0:20:27	1.19	4.46	3.12	4.02	4.83	5.70	6.54	7.55	10.27
0:24:32	3.28	12.26	8.57	11.05	13.28	15.65	17.97	20.74	28.18
0:28:38	3.84	14.57	10.14	13.11	15.80	18.67	21.48	24.85	33.95
0:32:43	3.65	13.91	9.67	12.51	15.09	17.84	20.53	23.76	32.49
0:36:49	3.32	12.67	8.80	11.39	13.74	16.24	18.69	21.63	29.57
0:40:54	2.94	11.32	7.85	10.18	12.28	14.53	16.74	19.38	26.53
0:44:59	2.52	9.78	6.76	8.78	10.62	12.57	14.49	16.80	23.04
0:49:05	2.20	8.52	5.90	7.65	9.24	10.94	12.61	14.61	20.01
0:53:10	1.99	7.72	5.34	6.94	8.38	9.92	11.43	13.24	18.15
0:57:16	1.62	6.38	4.40	5.72	6.93	8.21	9.48	11.00	15.12
1:01:21	1.31	5.21	3.58	4.67	5.67	6.73	7.78	9.03	12.45
1:05:26	0.99	4.02	2.75	3.60	4.38	5.21	6.04	7.03	9.74
1:09:32	0.72	3.00	2.04	2.68	3.27	3.90	4.54	5.30	7.40
1:13:37	0.53	2.17	1.48	1.94	2.36	2.82	3.29	3.86	5.42
1:17:43	0.41	1.68	1.15	1.50	1.83	2.18	2.53	2.96	4.13
1:21:48	0.34	1.38	0.95	1.24	1.50	1.79	2.08	2.42	3.37
1:25:53	0.29	1.17	0.80	1.05	1.27	1.52	1.76	2.05	2.84
1:29:59	0.26	1.03	0.71	0.92	1.12	1.33	1.54	1.79	2.49
1:34:04	0.23	0.93	0.64	0.83	1.01	1.20	1.39	1.61	2.23
1:38:10	0.22	0.85	0.59	0.77	0.93	1.10	1.28	1.48	2.05
1:42:15	0.16	0.63	0.43	0.56	0.68	0.81	0.94	1.09	1.51
1:46:20	0.12	0.46	0.32	0.41	0.50	0.59	0.69	0.80	1.10
1:50:26	0.08	0.34	0.23	0.30	0.37	0.44	0.50	0.59	0.81
1:54:31	0.06	0.25	0.17	0.22	0.27	0.32	0.37	0.43	0.60
1:58:37	0.04	0.18	0.12	0.16	0.19	0.23	0.27	0.31	0.43
2:02:42	0.03	0.13	0.09	0.11	0.14	0.16	0.19	0.22	0.31
2:06:47	0.02	0.09	0.06	0.08	0.10	0.12	0.14	0.16	0.22
2:10:53	0.01	0.06	0.04	0.05	0.06	0.08	0.09	0.11	0.15
2:14:58	0.01	0.04	0.02	0.03	0.04	0.05	0.06	0.07	0.09
2:19:04	0.00	0.02	0.01	0.02	0.02	0.02	0.03	0.03	0.05
2:23:09	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.02
2:27:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:31:20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:35:25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:39:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:43:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:47:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:51:47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:55:52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:59:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:04:03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:08:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:12:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:16:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:20:25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:24:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:28:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:32:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:36:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:40:52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:44:57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:49:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:53:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:57:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:01:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:05:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:09:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:13:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:17:40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:21:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:25:51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:29:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:34:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:38:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:42:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:46:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:50:23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:54:29	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: January 21, 2019
Project: Gardens at North Carefree
Location: North Pond

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a	I_a = 80.0 %
B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	i = 0.800
C) Contributing Watershed Area	Area = 6.840 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}= 0.187 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 **WQCV selected. Soil group not required.**
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 = ______ 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 = 1.5 : 1 **INCREASE FLOW PATH FOR 2:1 RATIO**
3. Basin Side Slopes A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z = 4.00 ft / ft
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: January 21, 2019
Project: Gardens at North Carefree
Location: North Pond

5. Forebay

A) Minimum Forebay Volume — V_{FMIN} = 0.006 ac-ft
(V_{FMIN} = 3% of the WQCV)

B) Actual Forebay Volume — V_F = 0.006 ac-ft

C) Forebay Depth — D_F = 12.0 in
(D_F = 18 inch maximum)

D) Forebay Discharge

i) Undetained 100-year Peak Discharge — Q_{100} = 27.80 cfs

ii) Forebay Discharge Design Flow — Q_F = 0.56 cfs
($Q_F = 0.02 * Q_{100}$)

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 = 4.4 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) — $D_{orifice}$ = 1.25 inches

E) Total Outlet Area — A_{ot} = 3.60 square inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Charlene Durham
Company: Stantec
Date: January 21, 2019
Project: Gardens at North Carefree
Location: North Pond

8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 4 in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = 24.5 cu ft
C) Initial Surcharge Provided Above Micropool	V_s= 3.3 cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = 123 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} = 173 sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= 2.26 feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= 55.12 inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = 12.0 inches

Design Procedure Form: Extended Detention Basin (EDB)

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Date:	**January 21, 2019**
Project:	**Gardens at North Carefree**
Location:	**North Pond**

10. Overflow Embankment

A) Describe embankment protection for 100-year and greater overtopping:

B) Slope of Overflow Embankment
(Horizontal distance per unit vertical, 4:1 or flatter preferred)

11. Vegetation

Choose One
- ○ Irrigated
- ○ Not Irrigated

12. Access

A) Describe Sediment Removal Procedures

Notes:

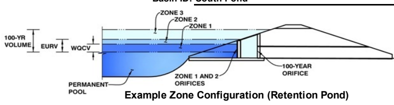
South Pond

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Gardens at North Carefree

Basin ID: South Pond



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	**EDB**			
Watershed Area =	3.14	acres		
Watershed Length =	605	ft		
Watershed Slope =	0.030	ft/ft		
Watershed Imperviousness =	80.00%	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 = User Input				
Water Quality Capture Volume (WQCV) =	0.086	acre-feet	Optional User Override 1-hr Precipitation	
Excess Urban Runoff Volume (EURV) =	0.330	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.229	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.297	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.358	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.424	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.489	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.567	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.29 in.) =	0.777	acre-feet	3.29	inches
Approximate 2-yr Detention Volume =	0.217	acre-feet		
Approximate 5-yr Detention Volume =	0.282	acre-feet		
Approximate 10-yr Detention Volume =	0.337	acre-feet		
Approximate 25-yr Detention Volume =	0.400	acre-feet		
Approximate 50-yr Detention Volume =	0.437	acre-feet		
Approximate 100-yr Detention Volume =	0.471	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.086	acre-feet	
Select Zone 2 Storage Volume (Optional) =		acre-feet	**Total detention volume is less than 100-year volume.**
Select Zone 3 Storage Volume (Optional) =		acre-feet	
Total Detention Basin Volume =	0.086	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)
Top of Micropool	--	0.00	--	--	--	878	0.020		
	--	0.50	--	--	--	1,062	0.024	474	0.011
	--	1.00	--	--	--	1,262	0.029	1,053	0.024
	--	1.50	--	--	--	1,480	0.034	1,737	0.040
	--	2.00	--	--	--	1,715	0.039	2,533	0.058
	--	2.50	--	--	--	1,968	0.045	3,471	0.080
	--	3.00	--	--	--	2,237	0.051	4,523	0.104
	--	3.50	--	--	--	2,524	0.058	5,713	0.131
	--	4.00	--	--	--	2,828	0.065	7,051	0.162
	--	4.50	--	--	--	3,149	0.072	8,545	0.196
	--	5.00	--	--	--	3,488	0.080	10,204	0.234
	--	5.50	--	--	--	3,843	0.088	12,037	0.276
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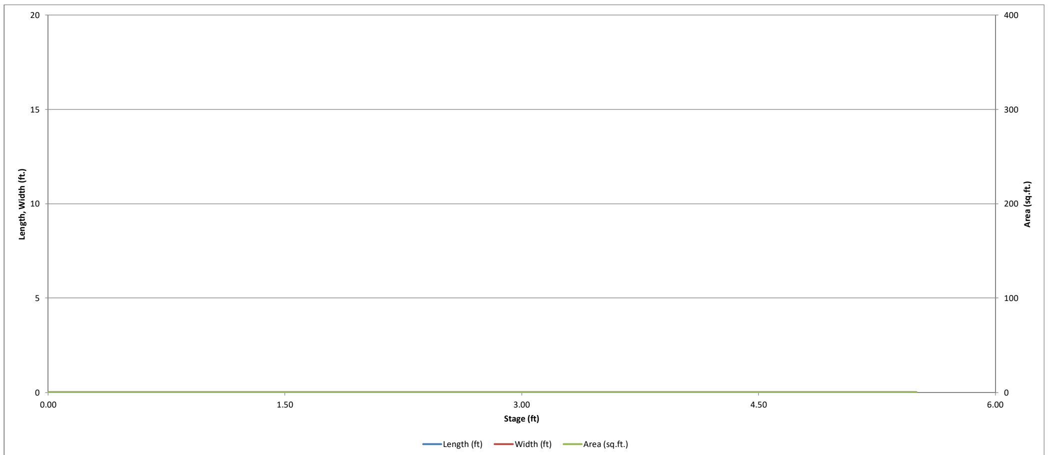
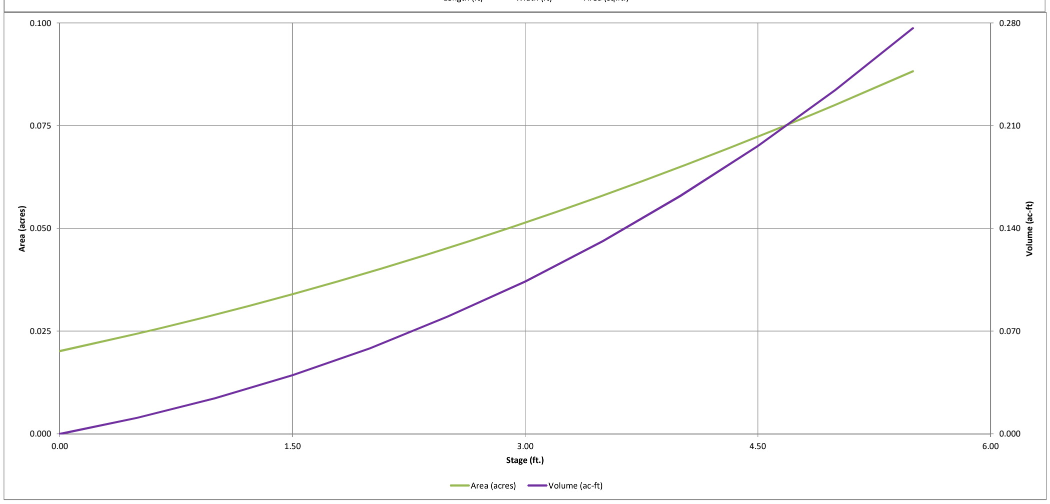
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

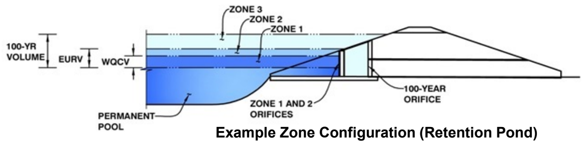




Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Gardens at North Carefree
Basin ID: South Pond



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.64	0.086	Orifice Plate
Zone 2			Weir&Pipe (Rect.)
Zone 3			
		0.086	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 =	2.64	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	14.00	inches
Orifice Plate: Orifice Area per Row =	0.60	sq. inches (diameter = 7/8 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row =	4.174E-03	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.20	2.40					
Orifice Area (sq. inches)	0.60	0.60	0.60					

	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 =			ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =			inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

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

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.70		ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	2.92		feet
Overflow Weir Slope =	3.00		H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	2.92		feet
Overflow Grate Open Area % =	70%		%, grate open area/total area
Debris Clogging % =	50%		%

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.67		feet
Over Flow Weir Slope Length =	3.07		feet
Grate Open Area / 100-yr Orifice Area =	#DIV/0!		should be $\geq$ 4
Overflow Grate Open Area w/o Debris =	6.28		ft^2
Overflow Grate Open Area w/ Debris =	3.14		ft^2

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

	Zone 2 Rectangular	Not Selected	
Depth to Invert of Outlet Pipe =	2.50		ft (distance below basin bottom at Stage = 0 ft)
Rectangular Orifice Width =	18.00		inches
Rectangular Orifice Height =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Rectangular	Not Selected	
Outlet Orifice Area =	0.00		ft^2
Outlet Orifice Centroid =	0.00		feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	10.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

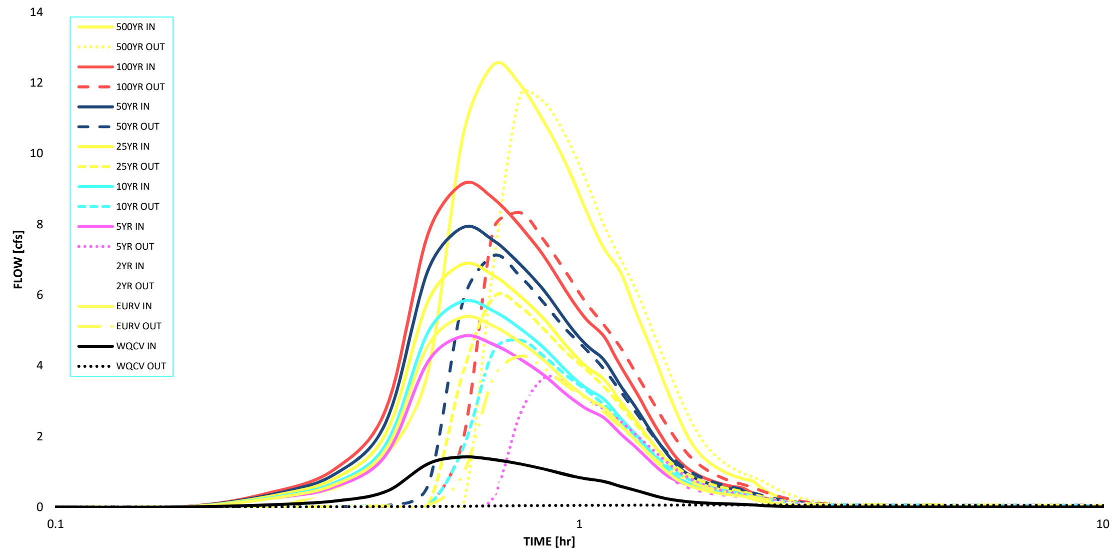
Spillway Design Flow Depth=	0.41	feet
Stage at Top of Freeboard =	5.41	feet
Basin Area at Top of Freeboard =	0.09	acres

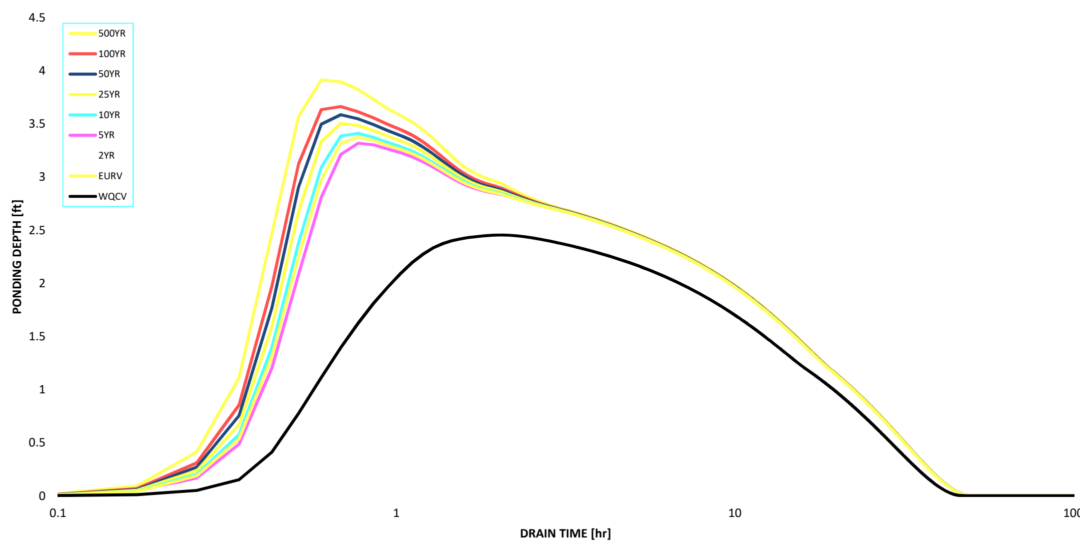
Routed Hydrograph Results

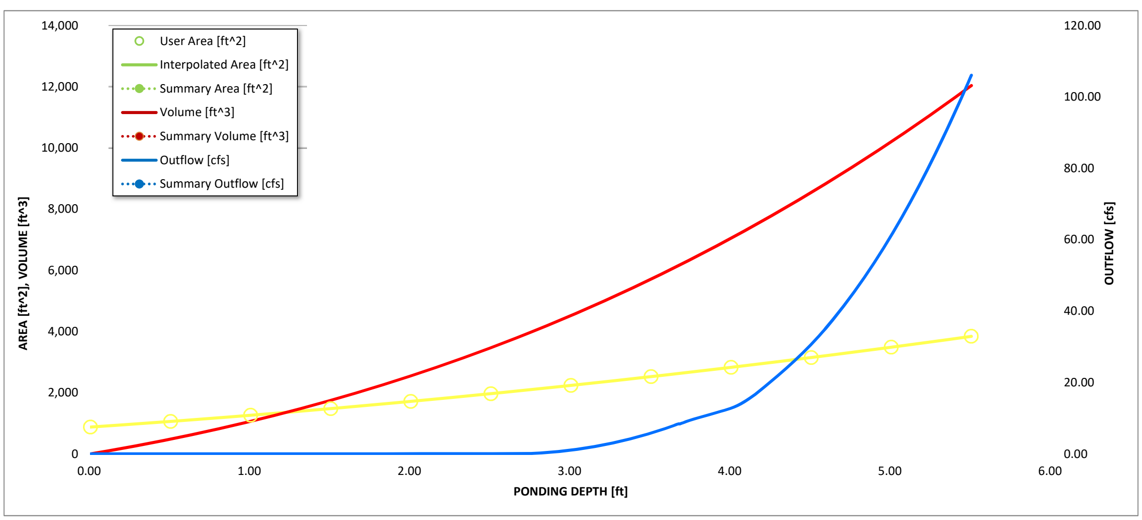
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.29
Calculated Runoff Volume (acre-ft) =	0.086	0.330	0.229	0.297	0.358	0.424	0.489	0.567	0.777
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.085	0.330	0.228	0.296	0.358	0.423	0.488	0.565	0.776
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.00	0.00	0.01	0.03	0.19	0.46	1.09
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.0	0.0	0.1	0.6	1.4	3.4
Peak Inflow Q (cfs) =	1.4	5.4	3.7	4.8	5.8	6.9	7.9	9.1	12.5
Peak Outflow Q (cfs) =	0.1	4.3	2.4	3.7	4.7	5.9	7.1	8.3	11.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	237.9	132.2	73.0	12.0	5.8	3.4
Structure Controlling Flow =	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1
Max Velocity through Grate 1 (fps) =	N/A	-0.01	-0.01	0.0	0.0	0.0	0.0	0.0	0.0
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) =	39	33	36	34	32	31	29	27	23
Time to Drain 99% of Inflow Volume (hours) =	**42**	40	42	41	40	39	38	37	35
Maximum Ponding Depth (ft) =	2.46	3.37	3.19	3.32	3.41	3.51	3.59	3.66	3.91
Area at Maximum Ponding Depth (acres) =	0.04	0.06	0.05	0.06	0.06	0.06	0.06	0.06	0.06
Maximum Volume Stored (acre-ft) =	0.077	0.124	0.113	0.120	0.126	0.131	0.136	0.141	0.156

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







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

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

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

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

	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.14 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrograph	0:10:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant	0:15:25	0.07	0.24	0.17	0.22	0.26	0.31	0.35	0.41	0.55
0.972	0:20:34	0.17	0.65	0.45	0.58	0.70	0.82	0.95	1.09	1.49
	0:25:42	0.44	1.66	1.16	1.50	1.80	2.12	2.43	2.81	3.83
	0:30:50	1.22	4.57	3.19	4.11	4.94	5.82	6.69	7.72	10.51
	0:35:59	1.42	5.37	3.73	4.83	5.82	6.87	7.91	9.15	12.51
	0:41:07	1.34	5.12	3.55	4.60	5.55	6.55	7.54	8.73	11.95
	0:46:16	1.22	4.66	3.23	4.19	5.05	5.96	6.86	7.94	10.88
	0:51:24	1.08	4.14	2.87	3.72	4.49	5.31	6.12	7.09	9.72
	0:56:32	0.92	3.56	2.46	3.20	3.86	4.57	5.28	6.12	8.40
	1:01:41	0.80	3.11	2.15	2.79	3.37	3.99	4.60	5.33	7.32
	1:06:49	0.72	2.81	1.94	2.53	3.05	3.61	4.17	4.83	6.63
	1:11:58	0.58	2.31	1.59	2.07	2.50	2.97	3.43	3.98	5.48
	1:17:06	0.47	1.87	1.28	1.68	2.03	2.42	2.79	3.25	4.49
	1:22:14	0.35	1.43	0.97	1.27	1.55	1.85	2.14	2.50	3.46
	1:27:23	0.25	1.05	0.71	0.94	1.14	1.37	1.59	1.85	2.59
	1:32:31	0.18	0.77	0.52	0.68	0.83	0.99	1.15	1.34	1.87
	1:37:40	0.15	0.60	0.41	0.53	0.65	0.77	0.90	1.04	1.45
	1:42:48	0.12	0.49	0.34	0.44	0.54	0.64	0.74	0.86	1.19
	1:47:56	0.10	0.42	0.29	0.38	0.46	0.54	0.63	0.73	1.01
	1:53:05	0.09	0.37	0.25	0.33	0.40	0.48	0.55	0.64	0.89
	1:58:13	0.08	0.33	0.23	0.30	0.36	0.43	0.50	0.58	0.80
	2:03:22	0.08	0.31	0.21	0.28	0.33	0.40	0.46	0.53	0.73
	2:08:30	0.06	0.23	0.16	0.20	0.25	0.29	0.34	0.39	0.54
	2:13:38	0.04	0.17	0.11	0.15	0.18	0.21	0.25	0.29	0.40
	2:18:47	0.03	0.12	0.08	0.11	0.13	0.16	0.18	0.21	0.29
	2:23:55	0.02	0.09	0.06	0.08	0.10	0.11	0.13	0.15	0.21
	2:29:04	0.02	0.06	0.04	0.06	0.07	0.08	0.09	0.11	0.15
	2:34:12	0.01	0.04	0.03	0.04	0.05	0.06	0.07	0.08	0.11
	2:39:20	0.01	0.03	0.02	0.03	0.03	0.04	0.05	0.06	0.08
	2:44:29	0.00	0.02	0.01	0.02	0.02	0.03	0.03	0.04	0.05
	2:49:37	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03
	2:54:46	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.02
	2:59:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:53	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
	3:46:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:51:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:56:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:01:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:06:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:11:52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:17:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:22:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:27:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:32:25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:37:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:42:42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:47:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:52:59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:58:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:03:16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:08:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:13:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:18:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:23:49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	5:59:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:04:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:10:05	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: January 21, 2019
Project: Gardens at North Carefree
Location: South Pond

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a	I_a = 80.0 %
B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	i = 0.800
C) Contributing Watershed Area	Area = 3.140 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}= 0.086 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 **WQCV selected. Soil group not required.**
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 = ______ 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 = 1.0 : 1 **INCREASE FLOW PATH FOR 2:1 RATIO**
3. Basin Side Slopes	
A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z = 4.00 ft / ft
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:	**January 21, 2019**
Project:	**Gardens at North Carefree**
Location:	**South Pond**

5. Forebay

A) Minimum Forebay Volume (V_{FMIN} = 2% of the WQCV) — V_{FMIN} = 0.002 ac-ft

B) Actual Forebay Volume — V_F = 0.002 ac-ft

C) Forebay Depth (D_F = 18 inch maximum) — D_F = 6.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge — Q_{100} = 6.40 cfs

ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$) — Q_F = 0.13 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 = 2.5 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) — $D_{orifice}$ = 0.50 inches

E) Total Outlet Area — A_{ot} = 1.50 square inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Charlene Durham
Company: Stantec
Date: January 21, 2019
Project: Gardens at North Carefree
Location: South Pond

8. Initial Surcharge Volume

A) Depth of Initial Surcharge Volume
(Minimum recommended depth is 4 inches) — D_{IS} = 4 in

B) Minimum Initial Surcharge Volume
(Minimum volume of 0.3% of the WQCV) — V_{IS} = ____ cu ft

C) Initial Surcharge Provided Above Micropool — V_s= 3.3 cu ft

9. Trash Rack

A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$ — A_t = 55 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.) — *S.S. Well Screen with 60% Open Area*

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} = 92 sq. in.

E) Depth of Design Volume (EURV or WQCV)
(Based on design concept chosen under 1E) — H= 2.64 feet

F) Height of Water Quality Screen (H_{TR}) — H_{TR}= 59.68 inches

G) Width of Water Quality Screen Opening ($W_{opening}$)
(Minimum of 12 inches is recommended) — $W_{opening}$ = 12.0 inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer:	Charlene Durham
Company:	Stantec
Date:	January 21, 2019
Project:	Gardens at North Carefree
Location:	South Pond

10. Overflow Embankment

A) Describe embankment protection for 100-year and greater overtopping:

B) Slope of Overflow Embankment
(Horizontal distance per unit vertical, 4:1 or flatter preferred)

11. Vegetation

Choose One
- ○ Irrigated
- ○ Not Irrigated

12. Access

A) Describe Sediment Removal Procedures

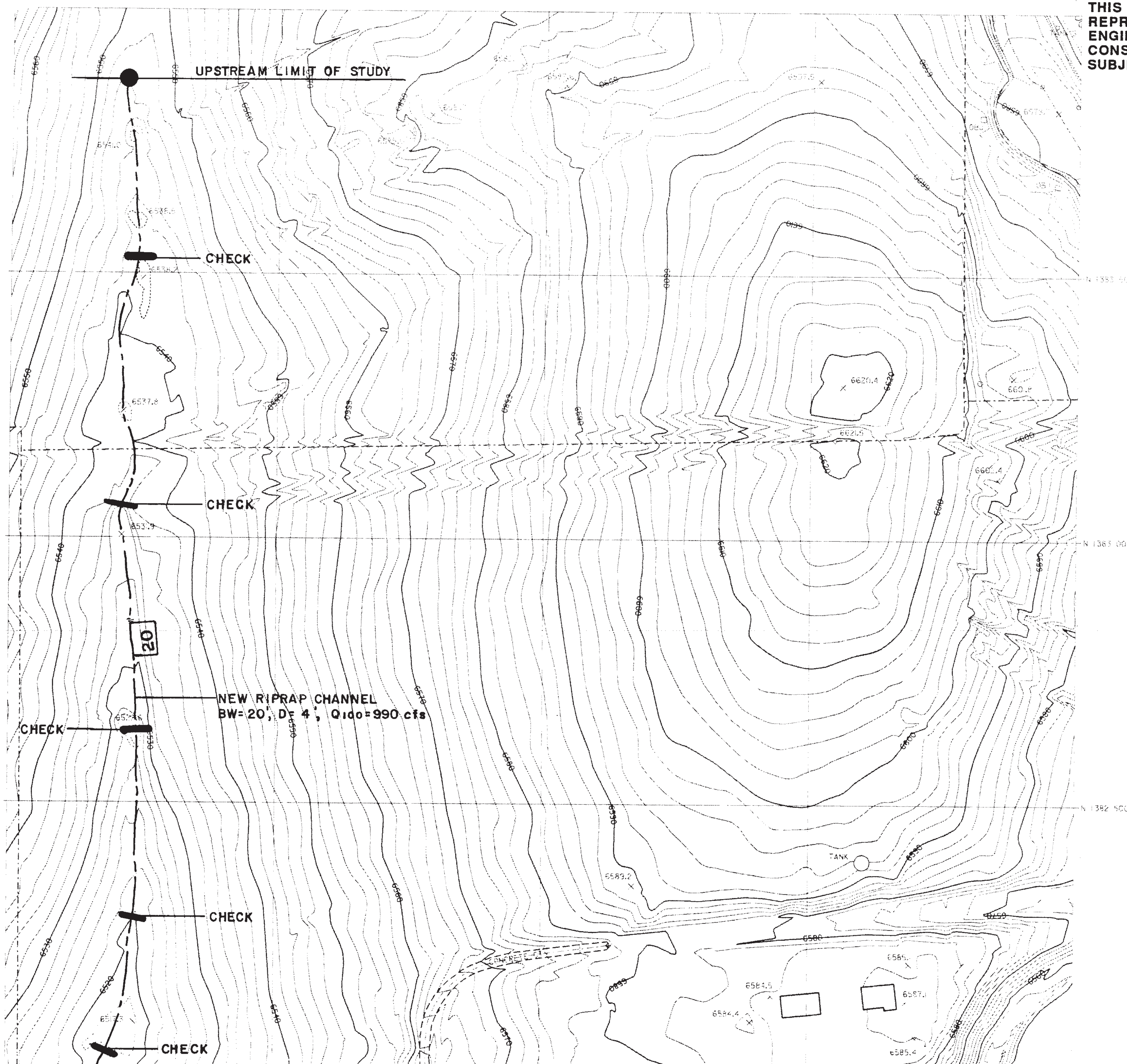
Notes:

Appendix G: Deviation Request

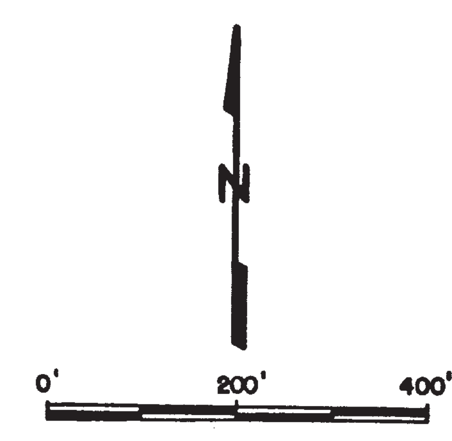
Appendix H: Excerpts from Previous Drainage Reports

Excerpt from Sand Creek Drainage Basin Planning Study

THIS DRAWING IS A MASTER PLANNING SHEET REPRESENTING PRELIMINARY AND CONCEPTUAL ENGINEERING. IT SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES. THESE PLANS ARE SUBJECT TO CHANGE.



MATCH SHEET EF– 25



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

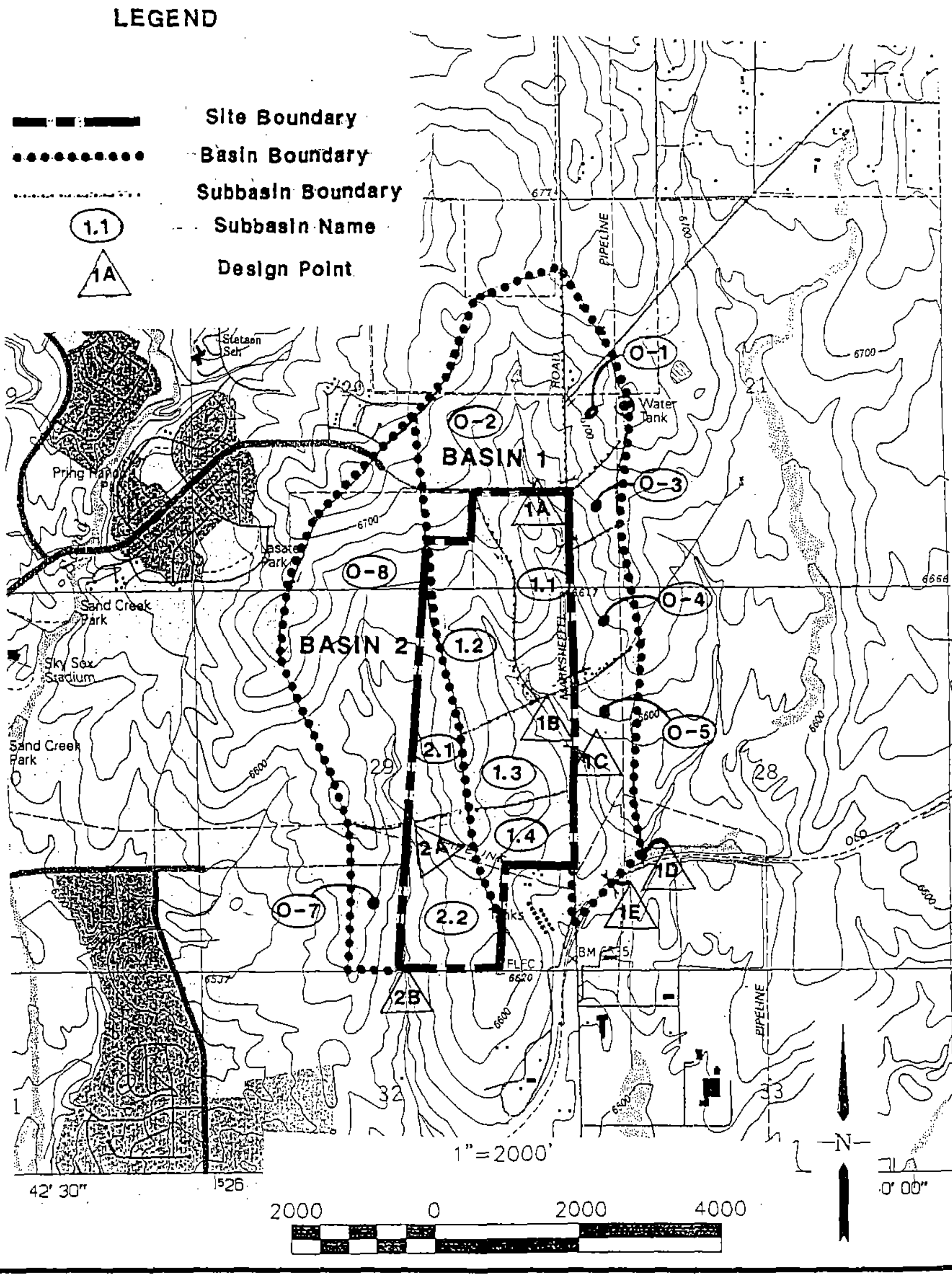
SAND CREEK DRAINAGE BASIN PLANNING STUDY

PRELIMINARY DESIGN PLANS

Project No
Date:
Design:
Drawn:
Check.
Revisions:

EF-26

Excerpt from Hilltop Master Development Drainage Plan



EXISTING CONDITIONS HEC-1 SUBBASINS

HILLTOP SUBDIVISION MDDP

URS Greiner

PROJ NO. 6742212

FIGURE 3

FIG3.dwg dtt 10/28/96

TABLE 2
HEC-1 BASIN PEAK FLOWS

BASIN 1			
Basin No.	Historic Flows Q5 (cfs) Q100 (cfs)	Developed Flows Q5 (cfs) Q100 (cfs)	Difference (cfs)
	26	42	16
O-1	91	119	28
	69	109	40
O-2	231	302	71
	19	27	8
O-3	56	71	15
	40	57	17
O-4	118	153	35
	59	59	0
O-5	177	177	0
	45	42	-3 *
1.1	136	107	-29 *
	56	94	38
1.2	168	229	61
	50	103	53
1.3	141	206	65
	28	55	27
1.4	86	105	19
	proposed only	8	
1.5	(was part of 1.1)	16	
BASIN 2			
Basin No.	Historic Flows Q5 (cfs) Q100 (cfs)	Developed Flows Q5 (cfs) Q100 (cfs)	Difference (cfs)
	111	142	31
O-7	364	417	53
	34	41	7
O-8	94	104	10
	31	48	17
2.1	97	135	38
	49	36	88 **
2.2	152	84	148 **
		101	
2.3	proposed only	216	

NOTES: * Offsite flow and commercial Basin 1.5 diverted from Basin 1.1 under proposed conditions

NOTES: ** Basin 2.3 part of Basin 2.2 under existing conditions

TABLE 3
HEC-1 DESIGN POINT PEAK FLOWS

BASIN 1				
Design Point	Historic Flows Q5 (cfs) Q100 (cfs)	Design Flows*** Q5 (cfs) Q100 (cfs)	Difference (cfs)	Difference (per cent)
	95	95	0	
1A	318	318	0	
		144	144	
1X		481	481	
	239	136	-103 *	-43%
1B	767	336	-431 *	-56%
	250	352	102	41%
1C	852	995	143	17%
	283	398	115	41%
1D	1003	1155	152	15%
	286	427	141	49%
1E	1063	1214	151	14%
BASIN 2				
Design Point	Historic Flows Q5 (cfs) Q100 (cfs)	Design Flows*** Q5 (cfs) Q100 (cfs)	Difference (cfs)	Difference (per cent)
	141	159	18	13%
2A	461	498	37	8%
	187	275	88	47%
2B	622	786	164	26%

NOTES: *** Design Flows use Historic flows from offsite basins and Developed flows from onsite basins. (see Proposed HEC-1 Runs, subset X)

\67742212\MDDP\HEC-SUM.xls

B. Existing Drainage Characteristics

Off-site drainage basins entering the site have been identified as O-1 through O-5 (Basin 1) and O-7 and O-8 (Basin 2). The runoff from these sources has been incorporated into the analysis of the site drainage. The existing drainage ways are draws or intermittent streams.

Basin 1

Runoff from basins O-1 and O-2 combines at Design Point 1A near the northeast corner of the site. The 18" steel culverts under Barnes Road are in poor condition. Erosion on the downstream side of the embankment indicates that seepage is probably occurring either through the silted-in culverts, or around them. Design Point 1A discharges to a draw through Basin 1.1.

Basin 1.1 has a 100-year peak runoff of 136 cfs. Basin 1.2 has a 100-year peak runoff of 168 cfs. Runoff from Basins 1.1 and 1.2 combines with runoff from Design Point 1A, and basins O-3 and O-4 at the existing stock pond at Design Point 1B.

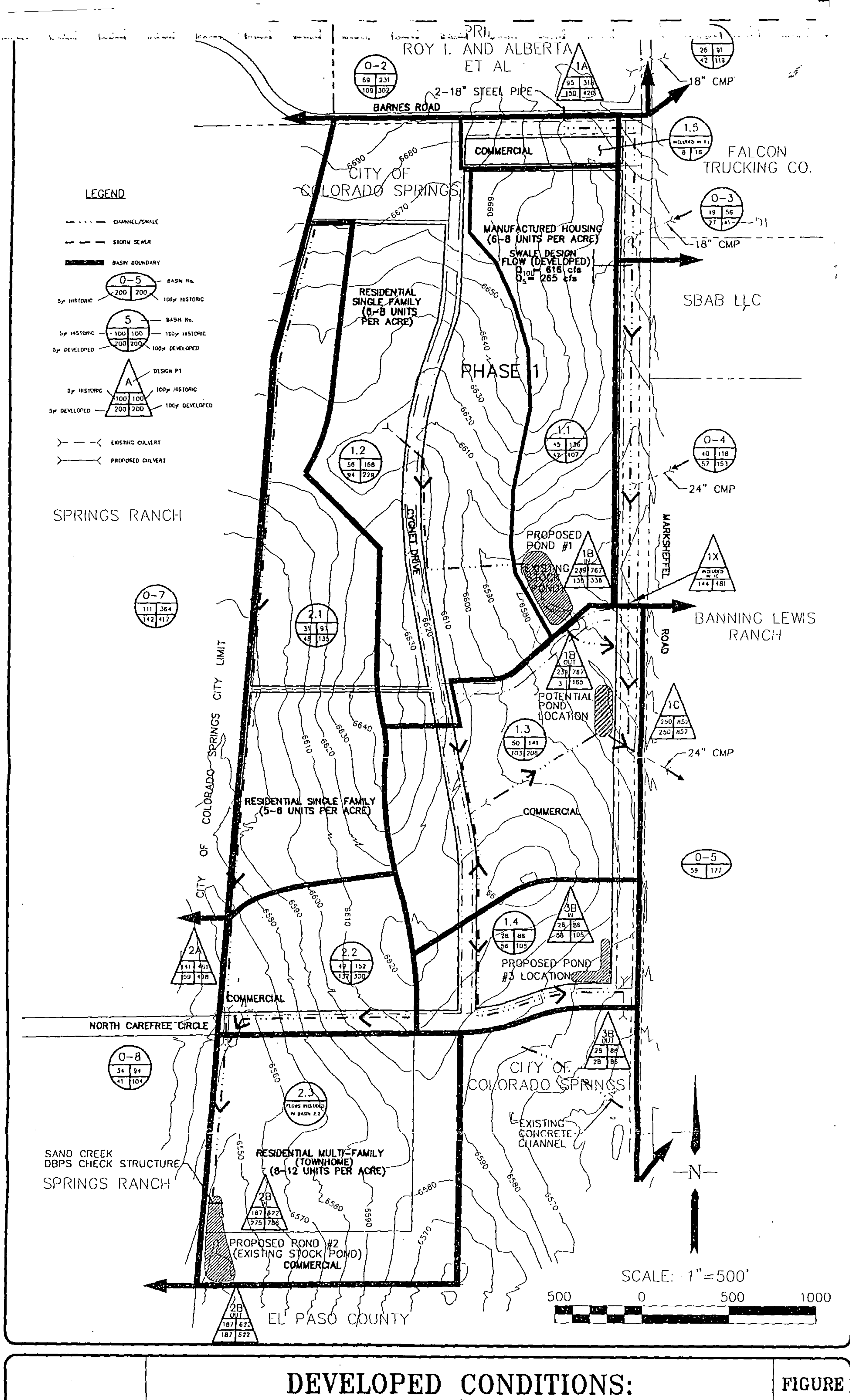
Basin 1.3 has a 100-year peak runoff of 141 cfs. Runoff combines with discharge from the stock pond at Design Point 1C before crossing Marksheffel Road via a 24" CMP culvert. Design Point 1C is routed and combines with basin O-5 at Design Point 1D on the tributary to East Sand Creek.

Basin 1.4 has a 100-year peak runoff of 86 cfs. Runoff is intercepted north of the City Gas facility by a concrete interceptor swale, which conveys flow to Marksheffel Road. Water collects at the low point just north of the Gas facility driveways before sheet flowing across Marksheffel Road. This runoff is conveyed via a swale to the tributary of East Sand Creek where it combines with runoff from Design Point 1D at Design Point 1E.

Basin 2

Basin 2.1 has a 100-year peak runoff of 97 cfs. Runoff combines with runoff from off-site Basin O-7 at Design Point 2A.

Basin 2.2 has a 100-year peak runoff of 152 cfs. Design point 2A is routed and combined with runoff from basins 2.2 and O-8 at the stock pond at Design Point 2B.



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REVISED DFS 12/24/97

URS Greiner
COLORADO SPRINGS, COLORADO
PROJ NO. 6742212

DEVELOPED CONDITIONS: DRAINAGE PLANNING MAP

HILLTOP SUBDIVISION MDDP

FIGURE 4

VI. DEVELOPED DRAINAGE CONDITIONS

A. General Concept

Storm runoff will continue to follow historic patterns where development does not occur. Subbasin boundaries will be altered by the proposed development. Curb and gutter along the residential and collector roads will intercept overland flow. Storm inlets and sewers will then convey the 5-year storm runoff to proposed detention ponds. Runoff in excess of the 5-year storm will follow streets, swales and ditches to the detention ponds. Release rates from the detention ponds will be maintained at or below historic levels for the 100-year storm. Design Points 1C, 2B and Basin 1.4 have been established to confirm acceptable flow levels leaving the site.

Improvements to the existing stock ponds at Design Point 1B and 2B will incorporate outlet structures and overflow weirs designed to mitigate developed flows and insure design flows leaving the property will be at or below historic levels. The pond at Design Point 1B will be designed to over-detain runoff from Basins 1.1 and 1.2 to ensure discharge from Design Point 1C is at or below historic levels. Increased peak flows from Basin 1.4 may be detained in parking lot storage, in a detention pond, in ditch storage or by a combination of methods. The present owner of the Hilltop Development anticipates that different parcels of land may be sold to different parties. The proposed design does not differentiate between ownership lines and is designed to operate within basins based on efficient hydraulic and hydrologic design. All detention facilities will be privately held and maintained. Therefore, all property owners within this development will be required to allow for drainage through their property as planned in this MDDP. Drainage facilities will be designed as part of the preliminary and final drainage reports in accordance with preliminary and final plat submittal.

Developed basin delineations are shown in Figure 4. Peak discharges for historic and developed conditions at specific design points are shown on Figure 4 and are tabulated in Tables 2 and 3.

At the request of El Paso County DOT, the swale along the east property boundary, within the Marksheffel Road future R.O.W. dedicated by this development, will be designed to carry developed flows from all basins it drains. The northeast portion of this swale associated with Phase I development will be designed to convey developed flows from off-site basins O-1, O-2, O-3 and O-4 and on site basin 1.5.

Negotiations are currently underway to request the upstream landowner (Basin O-2) to reduce peak flows leaving that property in order to reduce the size of the culvert required at Barnes Road. Developed conditions upstream would require a 6' x 10' box culvert, or four 60" RCPs. Maintaining flows at existing levels would reduce the necessary culvert size to a single 60" RCP or twin 48" RCPs. This would also impact the size of the drainageway required within the westerly right-of-way of Marksheffel Rd.

B. Developed Drainage Characteristics

Basin 1

Offsite runoff from Basins O-1 and O-2 will be intercepted by a ditch at the northern boundary of the development, Design Point 1A (DP 1A). This runoff will discharge along with runoff from the commercial area, Basin 1.5, into the west Marksheffel Road ditch. Basin 1.5 has a 100-year runoff of 16 cfs. Offsite Basins O-3 and O-4 also discharge to this ditch via existing culverts under Marksheffel Road and combine with routed flows from DP 1A at Design Point 1X.

Basin 1.1 has a 100-year peak runoff of 107 cfs. Basin 1.2 has a 100-year peak runoff of 229 cfs. These Basins combine at Design Point 1B in Detention Pond #1. Detention Pond #1 will be designed to over-detain runoff from Basins 1.1 and 1.2 to ensure that discharge from Design Point 1C downstream is at or below historic levels. Discharge from Pond #1 will be restricted to 165 cfs for the 100-year storm.

Routed flows from Detention Pond #1 (DP 1B), from the west Marksheffel Road ditch (DP 1X), and runoff from Basin 1.3 combines at Design Point 1C before being discharged across Marksheffel Road. The developed 100-year runoff from Basin 1.3 is 206 cfs. 100-year peak flows at DP 1X are 481 cfs. Discharge from DP 1C will be restricted to the historic 100-year runoff of 852 cfs. Preliminary and Final drainage reports will be required to ensure that over-detention in Pond #1 is adequate to provide for a developed design flow at DP 1C at or below historic rates. If historic rates cannot be met, then additional detention (see Potential Pond location in Basin 1.3, Figure 4) or other mitigation will be required.

Basin 1.4 has a 100-year peak runoff of 105 cfs. Runoff will be intercepted by the extension of North Carefree Circle and conveyed south along the west side of Marksheffel Road to an existing low point where it is detained in Detention Pond #3 (Design Point 3B). Discharge from Pond #3 will be restricted to the historic level of 86 cfs for the 100-year storm.

Basin 2

Basin 2.1 has a 100-year peak discharge of 135 cfs. Runoff combines with Basin O-7 at Design Point 2A for a combined peak flow of 448 cfs.

The existing configuration of Basin 2.2 will be divided by the extension of North Carefree Circle into proposed Basin 2.2 and Basin 2.3. Basin 2.2 has a 100-year peak discharge of 84 cfs. Basin 2.3 (south of North Carefree Circle) has a 100-year peak runoff of 216 cfs. Runoff from Design Point 2A and Basin 2.2 is routed, then combined with runoff from Basins 2.3 and O-8 for a combined peak flow of 786 cfs at Design Point 2B.

It is anticipated that runoff from Basin 2 will be detained in detention Pond No. 2 to ensure that flow leaving the site at design point 2B does not exceed historic rates. However, this pond may not be necessary if proposed improvements to the downstream channel (by others) are sufficient to handle the unattenuated developed flows. A possible configuration for Pond No. 2 is described in section C: "Proposed Facilities."

C. Proposed Facilities

1.1 Sand Creek DBPS Facilities

Only one facility is shown in the Sand Creek DBPS for this property. This facility is a check structure in the Basin 2 drainage along the southwest property boundary. This facility is shown on Figure 4, Developed Conditions Drainage Planning Map.

1.2 Detention Ponds

The detention ponds will be designed to maintain flows leaving the property at or below historic levels. Flows are summarized in Tables 2 and 3. Preliminary values for the storage requirements of each pond are tabulated below. Because there will be no detention for Basin 1.3, the storage volume at Design Point 1B has taken into account over-detention at Detention Pond #1 in order to maintain historic peak flows downstream at Design Point 1C.

The existing stock ponds upstream of Design Points 1B and 2B will require additional grading and the construction of outlet and emergency overflow structures. If the existing berm for Pond #1 is going to be used as an embankment for a road, further investigation will be required to determine its stability and strength.

TABLE 4
DETENTION POND STORAGE VOLUMES

Pond #	Design Point	Storage Volume (Ac-ft)	Surface Area (Ac)*
1	1B	6.51	1.30
2	2B	4.67	0.94
3	Basin 1.4	1.04	0.10

*Assumes 5' depth.

Several alternatives exist for detaining the runoff from Basin 1.4. These include parking lot storage, a detention pond, ditch storage and a combination of the above. Ponds will be

HILLTOP SUBDIVISION MDDP
HEC-1 RESULTS: SUMMARY
URS Greiner Job No. 6742212

	EXISTING		DEVELOPED ONSITE, EXISTING OFFSITE		DEVELOPED ONSITE AND OFFSITE	
BASIN	5-Yr (cfs)	100-Yr (cfs)	5-Yr (cfs)	100-Yr (cfs)	5-Yr (cfs)	100-Yr (cfs)
O-1	26	91	26	91	42	119
O-2	69	231	69	231	109	302
O-3	19	56	22	63	27	71
O-4	40	118	46	137	57	153
O-5	59	177	59	177	59	177
1.1	45	136	42	107	42	107
1.2	56	168	94	229	94	229
1.3	50	141	103	206	103	206
1.4	28	86	55	105	55	105
1.5	INCLUDED IN BASIN 1.1		8	16	8	16
O-7	111	364	111	364	142	417
O-8	34	94	34	94	41	104
2.1	31	97	48	135	48	135
2.2	49	152	36	84	36	84
2.3	INCLUDED IN BASIN 2.2		101	216	101	216
DESIGN POINT						
1A	95	318	95	318	150	420
1X	INCLUDED IN DP 1C		144	481	215	611
1B	239	767	136	336	136	336
1C	250	852	352	995	424	1125
1D	283	1003	398	1155	471	1287
1E	286	1063	427	1214	505	1348
2A	141	461	159	498	190	552
2B	187	622	275	786	309	850

Excerpt from Preliminary/Final Drainage Report for Mule Deer Crossing

The 10-foot sump inlet at design point 10 intercepts runoff from Basin D-11 and D-12 as well as the by-passed flows from design point 9. The routed flows intercepted the 10-foot inlet at design point 10 are 8.9 cfs and 18.4 cfs for the 5-year and 100-year storms.

Basin D-13 covers 3.47 acres that includes the drainage channel and a portion of the adjacent Springs Ranch property to the west. Basin D-13 slopes to the south to design point 12. Basin D-13 generates 2.6 and 6.3 cfs for the 5-year and 100-year storms.

Basin D-14 covers 2.44 acres that includes the drainage channel and a portion of the adjacent Springs Ranch property to the west. Basin D-14 slopes to the south to design point 13. Basin D-14 generates 2.0 and 4.8 cfs for the 5-year and 100-year storms.

Basin D-15 covers 1.30 acres that includes the drainage channel and a portion of the adjacent Springs Ranch property to the west. Basin D-15 slopes to the south from design point 13 to design point 14 at the southwest corner or the development. The drainage channel discharges onto the adjacent El Paso County property at design point 14. Basin D-15 generates 1.1 cfs and 2.8 cfs for the 5-year and 100-year storms.

Routing Analysis

Routing was used to determine both historic and developed flows for the site. Both historic and developed flows were routed to the design point at the southwest corner of the development, DP-7 for historic and DP-14 for developed. The largest contributor of runoff flow is from the 72-inch culvert from the Pronghorn Meadows development to the north. These flows are from the Pronghorn Meadows subdivision, the Springs Ranch detention pond, and the North Carefree Circle inlets. The time of concentration at the 72-inch culvert was conservatively estimated to be 20.6 minutes. The time of concentration for the development was determined by routing the flows entering the site from the north to the design point at the southwest corner of the site. This time of concentration is conservative and will produce conservative results.

Historic runoff from the site is estimated to be 166 cfs and 327.8 cfs for the 5-year and 100-year storms. Developed flows at design point 14 are 192.6 cfs and 384.3 cfs for the 5-year and 100-year storms.

Developed flows at design point 14 continue south along the existing drainage channel. The historic channel section south of the Mule Deer development is a V-shaped section with 5 percent to 6 percent side slopes and a 2 percent longitudinal slope. The existing channel will carry the 100-year storm of 384.3 cfs at a depth of 1.6 feet, velocity of 7.6 fps, and a top width of 58 feet. No downstream improvements are anticipated for this channel to handle the upstream developed flows. The existing channel vegetation is well established and the cutoff wall and riprap at the south end of the Mule Deer Crossing development will slow velocities at that point.

Sand Creek DBPS

The Sand Creek DBPS was reviewed for this final drainage report. The channel along the western boundary of Mule Deer Crossing is at the upper reaches of the Sand Creek DBPS. The estimated 100-year storm at this point is 990 cfs. This is much larger than the calculated value of

384.3 cfs as shown in this report. This is possibly due to the fact that the property was initially analyzed as industrial rather than residential.

Storm Drain System

The storm drain system for Mule Deer Crossing is designed to collect runoff from the development and discharge intercepted runoff in the drainage channel along the western property line. There are two storm trunk lines planned for the development. The northern storm system will connect the existing storm system from the Mule Deer Business Park to the east. Two 10-foot inlets will be installed to collect runoff. The main trunk line will consist of 42-inch rcp with a 24-inch lateral. The storm system will discharge into the drainage channel along the western boundary at design point 12.

The southern storm system will consist of 24-inch and 30-inch rcp with four (4) inlets for storm water collection. The system discharges into the drainage channel at design point 13.

Channel Improvements

The drainage channel along the western boundary of the development will carry developed flows from the northwest corner of the development to the existing channel at the southwest corner of the development. At the north end the channel will be 10 feet wide with 4 to 1 side slopes. After the discharge point at design point 12, the channel widens to a 20-foot bottom width with 4 to 1 side slopes along the eastern side of the channel and 2 to 1 side slopes with riprap protection along the west side of the channel. The channel will carry the 100-year storm with the required freeboard.

The Sand Creek DBPS identifies this reach of the Sand Creek Basin on page EF-26 of the Sand Creek DBPS. The DBPS channel volume through this reach is stated to be 990 cfs, which is much greater than the 384.3 cfs calculated in this report. This is because the Mule Deer development is at the upstream limit of the DBPS. The runoff calculated for the entire basin, that includes this tributary, was assigned to the entire channel. The 990 cfs in this tributary is also shown on page EF-23, approximately 4,000 south of the Mule Deer development, where it combines with a tributary from an adjacent basin. The actual 990 cfs does not occur at the upstream end of the basin, only at the downstream end.

The DBPS also proposes an improved channel and crossing downstream of the development that includes the crossing at the Chicago Rock Island & Pacific RR, which is approximately 2,100 feet south of the development. The improved crossing is proposed to be an 8-foot by 12-foot concrete box culvert. The existing structure at this location was not identified. The proposed DBPS channel improvements include a riprap lined, 20-foot wide channel with check structures. The channel in this area will be evaluated with future development.

The area adjacent to the channel downstream of the development is currently undeveloped. The Sand Creek DBPS proposes check structures from the southern boundary of the Mule Deer development to the RR intersection. One of these check structures will be constructed at the southern boundary of the development. Because the existing channel is established and has gradual longitudinal and side slopes, minimal erosion is anticipated along this channel. There are no adverse impacts expected to occur to adjacent properties.

Final Drainage Report for
Mule Deer Filing 1, Lots 1 & 2
And
Preliminary Drainage Report for
Mule Deer Filing 1, Lots 3-46

El Paso County, Colorado
January 2004

Prepared for:
Mule Deer Investments, LLC
520 E. Colorado Ave
Colorado Springs, CO 80903

Prepared by:

URS
9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
URS Job No. 21711206

Mule Deer

DRAINAGE PLAN STATEMENTS

ENGINEER'S STATEMENT:

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

____________________________________ ____________

William D. Chaffin, P.E. 35136 Date
For and on behalf of URS

DEVELOPER'S STATEMENT:

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

By (signature): ______________________________ Date:________

Address: 520 E. Colorado Ave.
Colorado Springs, CO 80903

EL PASO COUNTY STATEMENT:

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

____________________________________ ____________

John A. McCarty, County Engineer/Manager Date

Conditions:

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General Location and Description

Location

The Mule Deer development is located west of Marksheffel Road, east of Barnes Road, and south of North Carefree Circle. The site lies within a portion of the east ½ of Section 29 of Township 13 South, Range 65 West of the 6th Principal Meridian. The site is approximately 5 miles southwest of Falcon, Colorado in El Paso County (see Figure 1: Vicinity Map). The site is bounded by Colorado Springs Utilities property to the east, North Carefree Circle to the north, Northcrest Heights Subdivision to the west and El Paso County property to the south. The entire site is currently zoned Residential (R-1).

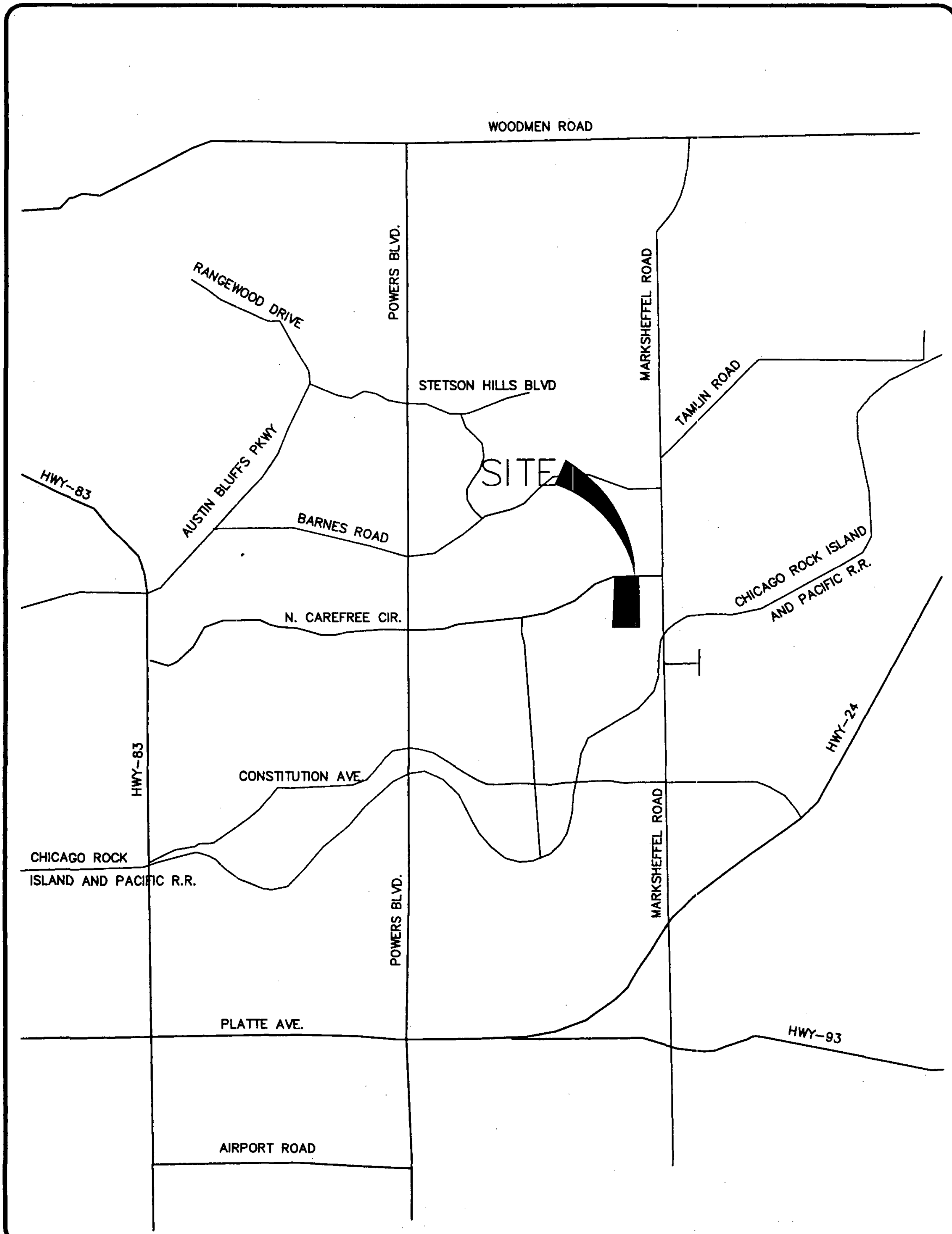
The Mule Deer development contains 39.46 acres and will be constructed in three Filings. Filing 1 consists of Akers Drive and Lots 1 and 2 in the southeast corner of the development, Filing 2 contains 3 commercial lots in the northeast corner and Filing 3 consist of residential development in the area west of Akers Drive. A separate final drainage report for Filings 2 and 3 will be submitted at a later date.

The terrain of the site descends to the west and southwest from a ridge that runs along the eastern property line. Slopes range from 6percent to 10 percent. The vegetation is typical eastern Colorado prairie grass with Yucca plants but little or no shrubs. There is an existing drainage swale along the west side of the property. This drainage channel will be improved with the construction of Filing 3. Runoff from the site creates intermittent streams that drain into the Sand Creek Basin which ultimately outfalls into Fountain Creek.

There are no irrigation facilities or utilities that affect the drainage analysis of this site

Soil Types

Soil types for the area were derived from the Soil Conservation Services, Soil Study of El Paso County Area, Colorado. The native soils on the proposed site are the Blendon and the Truckton sandy loam. The Blendon Series consists of deep well-drained soils that formed in sandy arkosic alluvium. These soils are on terraces, on flood plains, and in drainageways. They have slopes of 0 to 3 percent. The Truckton sandy loam soils are deep, well drained soils that formed in alluvium residuum derived from arkosic sedimentary rock on uplands. They have slopes of 0 to 3 percent. The Blendon Series and the Truckton sandy loam are both from the "B" Hydrologic Soil Group. The site and surrounding area have soil characterized as #97, Truckton Sandy Loam (hydrologic soil Group B) as classified by the Soil Conservation Service (see Figure 2: Soils Map).



URS PROJ NO. 21711239	VICINITY MAP MULE DEER SUBDIVISION	FIGURE 1

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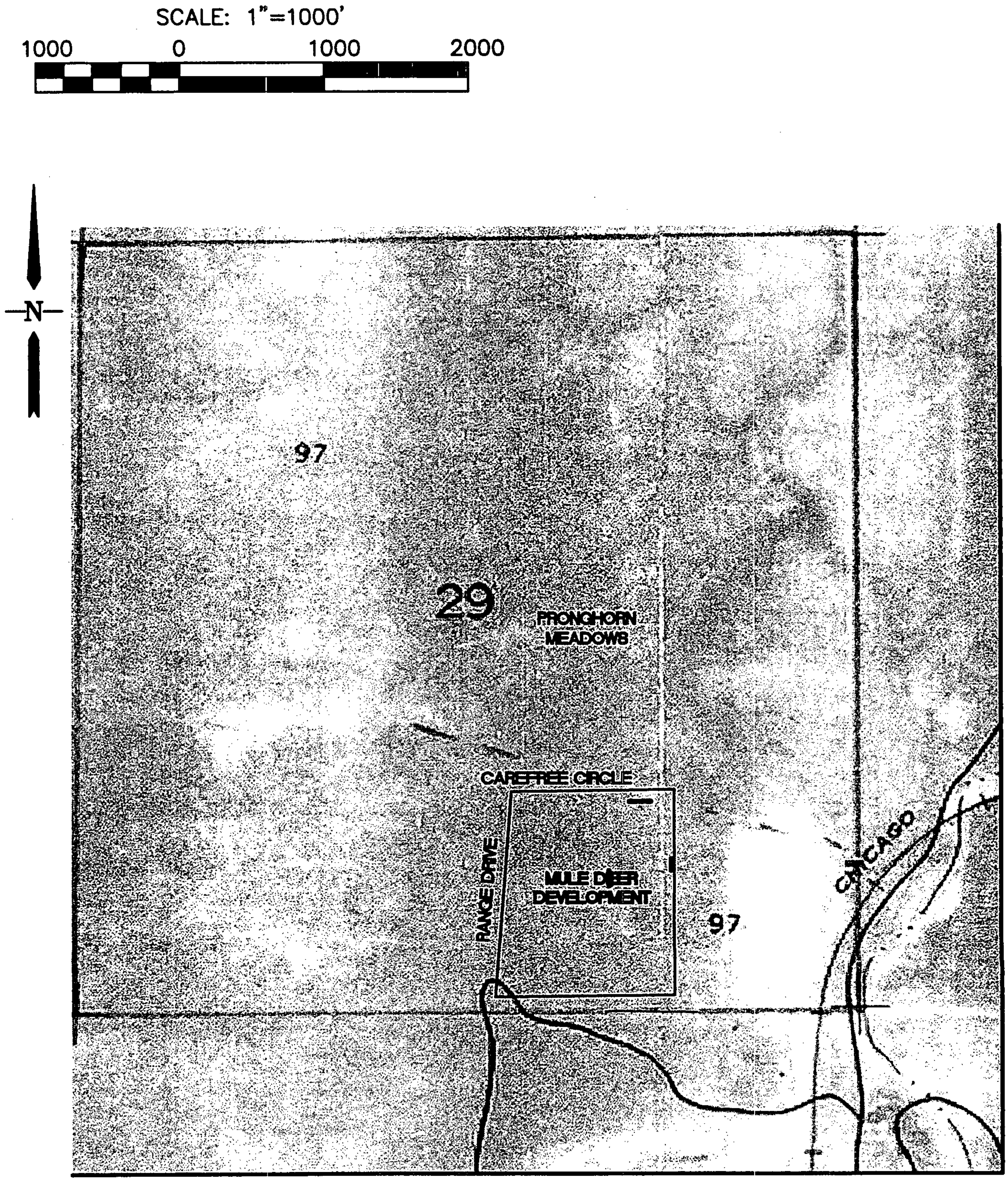


Mule Deer Subdivision

Soils Map

URS
9960 FEDERAL DRIVE, SUITE 300
COLORADO SPRINGS, COLORADO 80921
TEL: (719) 531-0001 FAX: (719) 531-0007

Figure 2

PROJECT NO. 21711239

Floodplain Statement

According to the Federal Emergency Management Agency (FEMA), as depicted on Flood Insurance Rate Maps (FIRM) 08041 CO539 F (March 1997) and 08041 CO543 F (March 1997), no portion of the site lies within a designated FEMA floodplain.

Drainage Design Criteria

The current City of Colorado Springs and El Paso County Drainage Criteria Manual was used in the preparation of this report. The Rational Method was used to determine the runoff quantities as required for basins containing less that 100 acres. Peak runoff was determined for both the 5-year and 100 year frequency storms.

Drainage Basins and Sub-basins

Recent development in the area includes the Pronghorn Meadows development directly north of the Mule Deer development, the North Range at Springs Ranch, which is west of the Pronghorn Meadows development and Chateau at Antelope Ridge Filings 1 and 2, which are northeast of the Pronghorn Meadows development. Chateau at Antelope Ridge Filing 3 is directly north of Pronghorn Meadows.

The MDDP for the Hilltop Subdivision (Hilltop MDDP), the Final Drainage Report for Pronghorn Meadows and the Final Drainage Report for North Carefree Circle were consulted in preparation of this report. The Hilltop MDDP was submitted in November 1996. The latest revision to the Hilltop MDDP was submitted in September 2001, but these changes did not pertain to the Mule Deer development area.

The Final Drainage Report for Pronghorn Meadows states that approximately 220 cfs for the 100-year storm flows south from the Pronghorn Meadows development, through the existing 72-inch RCP and into the existing drainage channel that runs north to south along the western edge of the Mule Deer property. Flows for the proposed Mule Deer development were also estimated in the FDR for Pronghorn Meadows to determine if the existing channel is adequate. The estimated flows from the FDR for Pronghorn Meadows were approximately 228 cfs for the 100-yar storm. The existing channel was determined to be adequate to handle the flows from both Pronghorn Meadows and the proposed Mule development.

Hilltop MDDP

The MDDP for the Hilltop Subdivision (Hilltop MDDP) was consulted in preparation of this report. The Hilltop MDDP was submitted in November 1996. The latest revision to the Hilltop MDDP was submitted in September 2001, but these changes did not pertain to the Mule Deer development site.

The Mule Deer Development is contained in Basin 2.3 of the Hilltop MDDP. The report states that approximately 216 cfs will be generated by this basin and discharge at the southwest corner of the site during the 100-year storm. This number is very close the 220 cfs calculated for the site in this report.

Historic Drainage Analysis

Historic drainage analysis was determined by analyzing runoff quantities and patterns for the site. Historic storm runoff generally flows from the east to west. (see Figure 3, Mule Deer Existing Basins - pocket). The site is undeveloped with native grasses and plants and slopes to the west.

Basin EX-1 encompasses 0.68 acres of North Carefree Circle in the northern portion of the site. The Final Drainage report for North Carefree Circle indicates that the runoff from this area will be contained in the road and bypass the Akers Drive entrance. However, it appears that a small amount of runoff may discharge into the site at the intersection of Akers Drive and North Carefree Circle. Runoff rates for Basin EX-1 are 3 cfs and 6 cfs for the 5-year and 100-year storms respectively.

Basin EX-2 encompasses the majority of the site, 33.27 acres of undeveloped land with native vegetation. This basin includes a portion of the adjacent Colorado Spring Utilities property to the east. Runoff from this basin flows west and into the drainage channel along the western boundary. Flows from Basin EX-2 are 12 cfs and 40 cfs for the 5 and 100-year storms respectively.

Basin EX-3 encompasses 9.59 acres along the southern portion of the Mule Deer development. The basin includes a portion of the adjacent El Paso County and Colorado Springs Utilities properties. Runoff from the basin flows west and into the drainage channel along the western boundary. Flows from this basin are 5 cfs and 17 cfs for the 5-year and 100-year storms respectively.

Developed Drainage Analysis

The Mule Deer development consists of eight developed sub-basins. The runoff from the east half of the site will collect in the three proposed storm inlets in the proposed Akers Road extension and flow via pipe to the drainage channel along the western boundary. The runoff from the west half of the site will sheet flow to the drainage channel. Developed drainage patterns are shown on the Developed Drainage Plan (see Figure 4, pocket). The following is a description of each basin and the proposed runoff patterns and improvements.

Basin D-1 is located at the southeast corner of the Mule Deer development and contains 4.63 acres. This portion of the Mule Deer property is proposed for two commercial buildings and parking and will be developed in Filing I. Runoff from basin D-1 will flow to the northwest to design point 1 (DP-1) and will be collected in the proposed storm drain in Akers Drive. Flows from this basin are 14 cfs and 28 cfs for the 5-yr and 100-yr storm respectively.

Basin D-2 is north of D-1 and contains 2.68 acres. This area will be commercial buildings and associated parking and will be developed in Filing I. Runoff from this basin will flow southwest to DP-2. Approximately 10 cfs (5-yr) and 20 cfs (100-yr) will be discharged into the Akers Drive storm drain from Basin D-2.

Basin D-3 is the northeastern portion of the property and contains 10.07 acres. This portion of the site will be developed as a commercial property as part of Filing II. Runoff from this basin will flow to DP-5. Runoff for this basin is calculated to be 40 cfs and 77 cfs respectively for the 5-year and 100-year storm. Flows from this basin will be captured by internal inlets and discharged into the proposed inlets along Akers Drive.

Basin D-4 is northwest of D-3 and covers 1.47 acres. Runoff from this basin will sheet flow west to the proposed access to Akers Drive at DP-4. The runoff will flow south along the curb and gutter and be intercepted by the proposed inlets along Akers Drive. Approximately 7 cfs and 13 cfs will be generated from Basin D-4 for the 5-yr and 100-yr storm.

Basin D-5 encompasses 0.68 acres of North Carefree Circle in the northern portion of the site. The Final Drainage report for North Carefree Circle indicates that the runoff from this area will be contained in the road and bypass the Akers Drive entrance. However, it appears that a small amount of runoff may discharge into the site at the Akers Drive entrance. In order to be conservative, this basin was included in the developed drainage analysis. Runoff rates for Basin D-5 are 3 cfs and 6 cfs for the 5-year and 100-year storms respectively.

Basin D-6 covers 21.83 acres and contains the western half of the site. This area will be residential lots 1/8 acre or less, but the final layout has not been finalized. Runoff will sheet flow to the west and discharge into the drainage channel along the western property line. Approximately 56 cfs and 113 cfs will be generated from this basin for the 5-yr and 100-yr storms respectively. Runoff totals calculated for this basin are conservative because no routing was used to determine the flow totals.

Basin D-7 contains 1.11 acres and consists of the western half of Akers Drive. Runoff rates of 5 cfs and 10 cfs for the 5-yr and 100-yr storm will collect in the street and flow into Basin D-6 at DP-8.

Basin D-8 contains 0.47 acres and consists of a portion of the eastern half of Akers Drive. Runoff rates of 2 cfs and 4 cfs for the 5-yr and 100-yr storm will collect in the street and discharge at the on-grade inlet at DP-6. By-passed flows will be intercepted by the inlet at DP-7.

Basin D-9 contains 0.13 acres and consists of a portion of the eastern half of Akers Drive between the 10-foot on-grade inlets. Runoff rates of 1 cfs and 1 cfs for the 5-yr and 100-yr storm will collect in the street and discharge into the sump inlet at DP-7.

Basin D-10 contains 0.50 acres and consists of the south portion of the eastern half of Akers Drive. Runoff rates of 2 cfs and 4 cfs for the 5-yr and 100-yr storm will collect in the street and discharge into the on-grade inlet a DP-3. By-passed flows will continue north and be intercepted by the sump inlet at DP-7.

Storm Drain System

The storm drain system for Mule Deer is designed to collect runoff from the site and carry it to the existing drainage channel along the western property line. Although, the site will be built in three Filings, the proposed inlets and pipes in Akers Drive have been sized for the fully developed condition. Three inlets will be placed along Akers Drive to intercept flow along the eastern curb and gutter. There are two 10-foot inlets and one 20-foot inlet to intercept flow. The inlets connect with 24-inch RCP. A 42-inch pipe extends to the west from the middle 20-foot inlet and discharges into the existing channel along the western boundary of the property.

Channel Improvements

The existing channel along the west side of the site will be improved with riprap. The channel will have a 6-foot bottom with 4:1 side slopes. The slope of the channel will be decreased to reduce the velocity of the flow. Riprap will line the bottom of the channel where necessary to prevent channel erosion. Drop structures will be added to the channel with riprap on the upstream and downstream side for protection. A final design for the channel will be provided with the Final Drainage Report for the area west of Akers Drive.

The previously approved Hilltop MDDP shows a detention pond at the southwest corner of the Mule Deer property. From previous conversations with the El Paso County Department of Transportation, the detention pond is no longer required because is was determined that the existing channel can handle the flows from all of the upstream developments without encroaching on the adjacent property

Erosion Control

General Concept

Due to the steep slopes of the property, erosion may be substantial once the native vegetation is removed. During construction, best management practices for erosion control will be employed based on El Paso County criteria and the erosion control plan.

The site will be developed in three Filings. Filing 1 is 4.72 acres and will be developed beginning in the summer of 2004. The remaining property will be rough graded as needed during Filing 1 construction. The remaining Filings will drain to the west, into Akers Drive or into the existing channel. Erosion bails and silt fence will be used, where necessary, to prevent excess sediment from leaving the site or entering Akers Drive. Seeding will occur on areas in Filing II and Filing III to prevent erosion.

Erosion Bales

Erosion bales will be placed 10-feet from the inlet of all culverts and discharge pipes during construction to prevent pipes from filling with sedimentation. Erosion bales will remain in place until vegetation is reestablished on pond side slopes and in drainage swales. Erosion bales will also be placed around all inlets to minimize sediment transport.

Miscellaneous

Best erosion control practices will be utilized as deemed necessary by the Contractor or Engineer and are not limited to the measures described above.

Cost Estimate

Drainage Fees

The proposed platted area for Filing 1 contains 9.53 acres in the Sand Creek Basin. Drainage fees for Filing 1 will be paid at the time of platting. The drainage fees for the Sand Creek Basin are calculated based on the imperviousness of the site. Because the site is commercial, the estimated imperviousness of the site is 95 percent.

Sand Creek Fees

Drainage Fee = $15,000/impervious acre

Fees for this development were calculated as follows:

Filing 1 Drainage Fees

Drainage Fees:	9.53 ac. X 0.95 X $15,000/ac	=	$ 135,803.50
Bridge Fees	9.53 ac. X 0.95 X $ 1,336/ac	=	$ 12,095.48
TOTAL		=	**$ 147,897.98**

Proposed Facilities

Filing 2 Proposed Facilities

ITEM	UNIT	COST
10' Type R Inlet	3 @ $ 4,500/Ea	$ 9,000
20' Type R Inlet	1 @ $ 12,000/Ea	$ 12,000
24" RCP	140 L.F. @ $34.00	$ 4,760
42" RCP	635 L.F. @ $55.00	$ 34,925
42" FES	1 @ $500.00	$ 500
42" Bend	1 @ $500	$ 500
Riprap	10 tons @$26.00	$ 260
Total		**$ 61,945**

Item	Quantity	Unit	Unit Cost	Extension
Erosion Control Measures				
Vehicle Tracking Control	40	CY	$28	$ 1,120
Erosion Control Hay Bales	86	EA	$15	$ 1,290
Silt Fencing	4,475	LF	$3	$ 13,425
Subtotal, Erosion Control Measures				**$ 15,834**
Stormwater System				
Inlets, Pipes	1	L.S.	$54,445	$ 61,945
Subtotal, Stormwater System				**$ 61,945**
Subtotal, All Drainage & Erosion Control				**$ 77,779**
Contingency (10%)				$ 7,778
TOTAL, DRAINAGE & EROSION CONTROL				**$ 85,557**

Appendix A: Hydrologic and Hydraulic Calculations and other Information

Mule Deer Existing Conditions
(RATIONAL METHOD Q=CIA)

BASIN	TOTAL FLOWS				AREA	WEIGHTED		OVERLAND				CHANNEL				Tc	INTENSITY		COMMENTS
	Q(5)	Q(100)	CA(equiv.)		TOTAL	C(5)	C(100)	C(5)	Length	Slope	Tc	Length	Slope	Velocity	Tc	TOTAL	I(5)	I(100)	
	(c.f.s.)	(c.f.s.)	5 YR	100 YR	(Ac)				(ft)	(ft)	(min)	(ft)	(%)	(fps)	(min)	(min)	(in/hr)	(in/hr)	
EX-1	3	6	0.61	0.65	0.68	0.90	0.95	0.90	5	2.4%	0.6	460	2.4%	4.5	1.7	5.0	5.2	9.1	
EX-2	12	40	4.99	9.98	33.27	0.15	0.30	0.15	300	3.5%	20.4	2,585	3.5%	4.5	9.6	29.9	2.3	4.1	
EX-3	5	16	1.44	2.88	9.59	0.15	0.30	0.15	115	4.0%	12.1	1,215	4.0%	4.5	4.5	16.6	3.2	5.6	

Mule Deer Existing Conditions
SURFACE ROUTING

DESIGN POINT	CONTRIBUTING BASINS	CA(equivalent)		Tc	INTENSITY		TOTAL FLOWS	
		CA(5)	CA(100)	(min.)	I(5) (in/hr)	I(100) (in/hr)	Q(5) (cfs)	Q(100) (cfs)
1	EX-1	0.61	0.65	5.0	5.2	9.1	3	6
				TRAVEL TIME				
		0.61	0.65	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					1700	4.5	6.3	11.3
2	EX-1, EX-2, EX-3	7.04	13.50	29.9	2.3	4.1	16	55
				TRAVEL TIME				
		7.04	13.50	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
						4.5	0.0	29.9

Mule Deer Developed Conditions
(RATIONAL METHOD Q=CIA)

BASIN	TOTAL FLOWS Q(5) (c.f.s.)	Q(100) (c.f.s.)	CA(equiv.) 5 YR	100 YR	AREA TOTAL (Ac)	WEIGHTED C(5)	C(100)	OVERLAND C(5)	Length (ft)	Slope (ft)	Tc (min)	CHANNEL Length (ft)	Slope (%)	Velocity (fps)	Tc (min)	Tc TOTAL (min)	INTENSITY I(5) (in/hr)	I(100) (in/hr)	COMMENTS
D-1	14	28	2.69	3.10	4.63	0.58	0.67	0.58	10	33.0%	1.0	635	2.0%	4.5	2.4	5.0	5.2	9.1	
D-2	10	20	1.96	2.17	2.68	0.73	0.81	0.73	10	18.0%	0.8	560	3.0%	4.5	2.1	5.0	5.2	9.1	
D-3	40	77	7.75	8.46	10.07	0.77	0.84	0.77	10	14.0%	0.8	1,010	2.0%	4.5	3.7	5.0	5.2	9.1	
D-4	7	13	1.32	1.40	1.47	0.90	0.95	0.90	20	2.0%	1.3	370	2.0%	4.5	1.4	5.0	5.2	9.1	
D-5	3	6	0.61	0.65	0.68	0.90	0.95	0.90	5	2.4%	0.6	460	2.4%	4.5	1.7	5.0	5.2	9.1	
D-6	56	113	13.10	15.28	21.83	0.60	0.70	0.60	10	2.0%	2.4	1,775	2.0%	4.5	6.6	8.9	4.2	7.4	
D-7	5	10	1.00	1.05	1.11	0.90	0.95	0.90	5	2.0%	0.7	700	3.0%	4.5	2.6	5.0	5.2	9.1	
D-8	2	4	0.42	0.45	0.47	0.90	0.95	0.90	5	2.0%	0.7	485	3.0%	4.5	1.8	5.0	5.2	9.1	
D-9	1	1	0.12	0.12	0.13	0.90	0.95	0.90	5	0.5%	1.1	140	2.0%	4.5	0.5	5.0	5.2	9.1	
D-10	2	4	0.45	0.48	0.50	0.90	0.95	0.90	5	2.0%	0.7	770	3.0%	4.5	2.9	5.0	5.2	9.1	

Mule Deer Developed Conditions
SURFACE ROUTING

DESIGN POINT	CONTRIBUTING BASINS	CA(equivalent) CA(5)	CA(equivalent) CA(100)	Tc (min.)	INTENSITY I(5) (in/hr)	INTENSITY I(100) (in/hr)	TOTAL FLOWS Q(5) (cfs)	TOTAL FLOWS Q(100) (cfs)
1	D-1	2.69	3.10	5.0	5.2	9.1	14	28
				TRAVEL TIME				
		2.69	3.10	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					34	5.0	0.1	5.1
2	D-1	2.69	3.10	5.1	5.2	9.0	24	47
	D-2	1.96	2.17	TRAVEL TIME				
		4.64	5.27	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					365	5.9	1.0	6.1
3	DP-2	4.64	5.27	6.1	4.9	8.5	25	49
	D-10	0.45	0.48	TRAVEL TIME				
		5.09	5.75	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					75	5.9	0.2	6.3
4	D-5	0.61	0.65	5.0	5.2	9.1	3	6
				TRAVEL TIME				
		0.61	0.65	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					205	6.2	0.6	5.6
5	D-5	0.61	0.65	5.6	5.0	8.8	10	18
	D-4	1.32	1.40	TRAVEL TIME				
		1.94	2.04	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					290	5.9	0.8	6.4
6	DP-5	1.94	2.04	6.4	4.8	8.4	11	21
	D-8	0.42	0.45	TRAVEL TIME				
		2.36	2.49	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					150	5.9	0.4	6.8
7	DP-6, DP-3,	7.45	8.24	6.8	4.7	8.2	36	69
	D-9	0.12	0.12	TRAVEL TIME				
		7.57	8.36	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					1300	4.5	4.8	11.6
8				6.9	4.7	8.2	5	9
	D-7	1.00	1.05	TRAVEL TIME				
		1.00	1.05	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					1245	4.5	4.6	11.5
9	DP-7, DP-8	8.57	9.41	11.6	3.8	6.6	112	220
	D-6, D-3	20.85	23.74	TRAVEL TIME				
		29.42	33.15	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
						4.5	0.0	11.6

Mule Deer Developed Conditions
ON-GRADE INLET CALCULATIONS

Based on Table 7-2 Drainage Criteria Manual

						Q_5							Q_{100}					Bypass	
DP	Inlet size L(i)	CROSS SLOPE	STREET SLOPE	Q(5)	Q(100)	Qi (5)	T	F_W	L1	L2	L3	Qi (100)	T	F_W	L1	L2	L3	Q_5	Q_{100}
3	10	2.0%	0.5%	24.8	48.8	11.4	27	1.0355	22	13	47	25.1	35	1.0836	19	9	62	13.4	23.7
6	10	2.0%	0.5%	11.3	20.8	7.0	20	0.9815	15	9	33	15.6	26	1.0236	13	6	43	4.3	5.2

Mule Deer Developed Conditions
SUMP INLET CALCULATIONS

Based on formula: Qi = 1.7(Li + 1.8w)(dmax + w/12)1.85

					Q_5				Q_{100}					
DP	Inlet size L(i) initial	CROSS SLOPE	Q(5)	Q(100)	Qi (5)	d_{max}	W	a	Qi (100)	d_{max}	W	a	Clogging Factor	Length Final
7	16	2.0%	17.6	28.3	17.6	0.5	2	0.17	28.3	1.0	2	0.2	1.25	20.00

Job Mule Deer Subdivision Project No. 21711239 Page ____ of ____

Sheet ____ of ____

Description ____ Computed by ____ Date ____

Checked by ____ Date ____

Reference

Calculations for Nomograph in Table 7.2 of El Paso County Drainage Criteria

Assumptions

$n = 0.013$ for concrete

$Z = \frac{1}{0.02} = 50$

$\frac{Z}{n} = 3846$

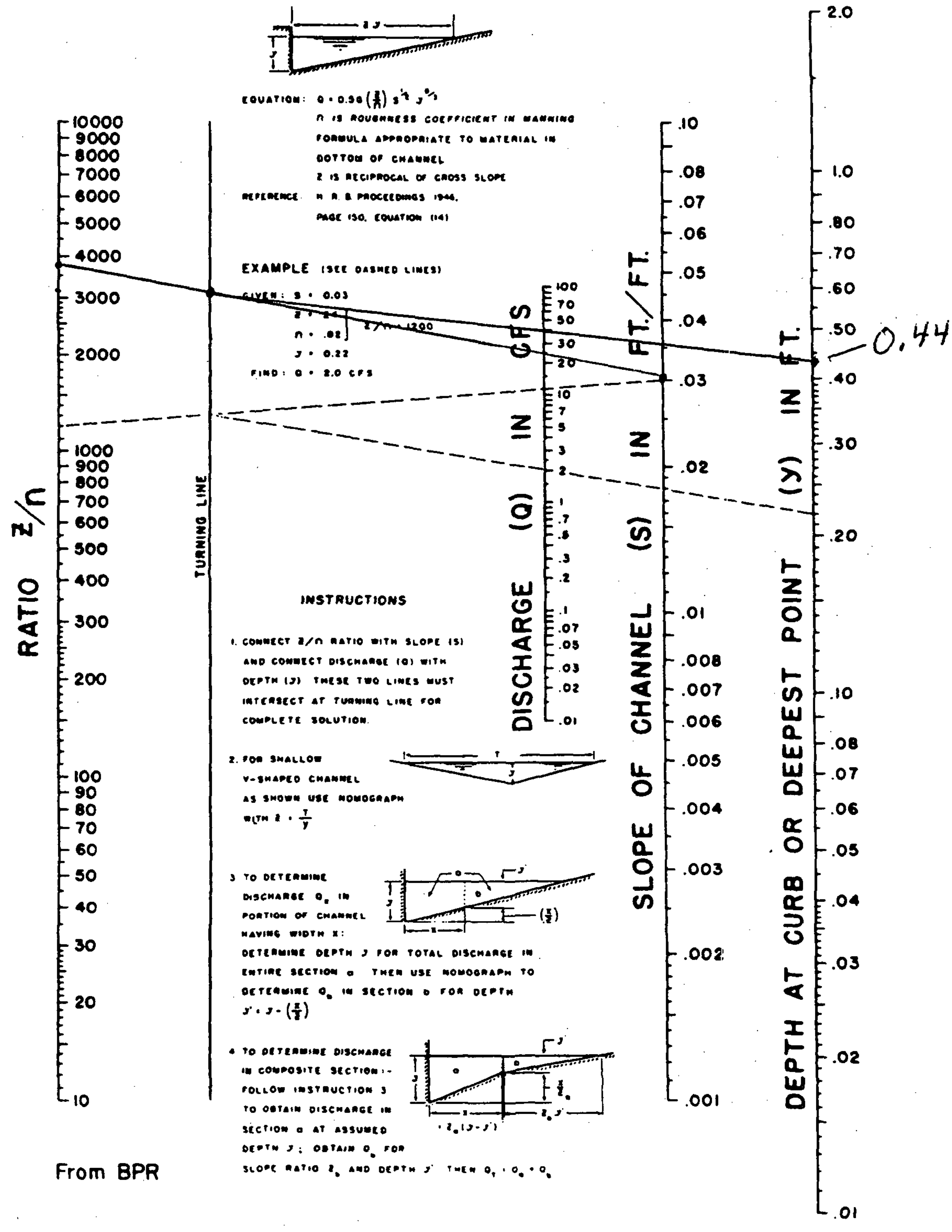
$S = 0.03$

Q_{100} at DP-2 = 40 cfs

Using nomograph on Table 7.2

Depth = 0.44"

This is less than 0.5" max in County Criteria



NONOGRAPH FOR FLOW IN TRIANGULAR GUTTERS
(From U.S. Dept. of Commerce, Bureau of Public Roads, 1965)

HDR Infrastructure, Inc.
A Centerra Company

The City of Colorado Springs / El Paso County
Drainage Criteria Manual

NOMOGRAPH FOR FLOW IN TRIANGULAR GUTTERS.

Date: OCT. 1987

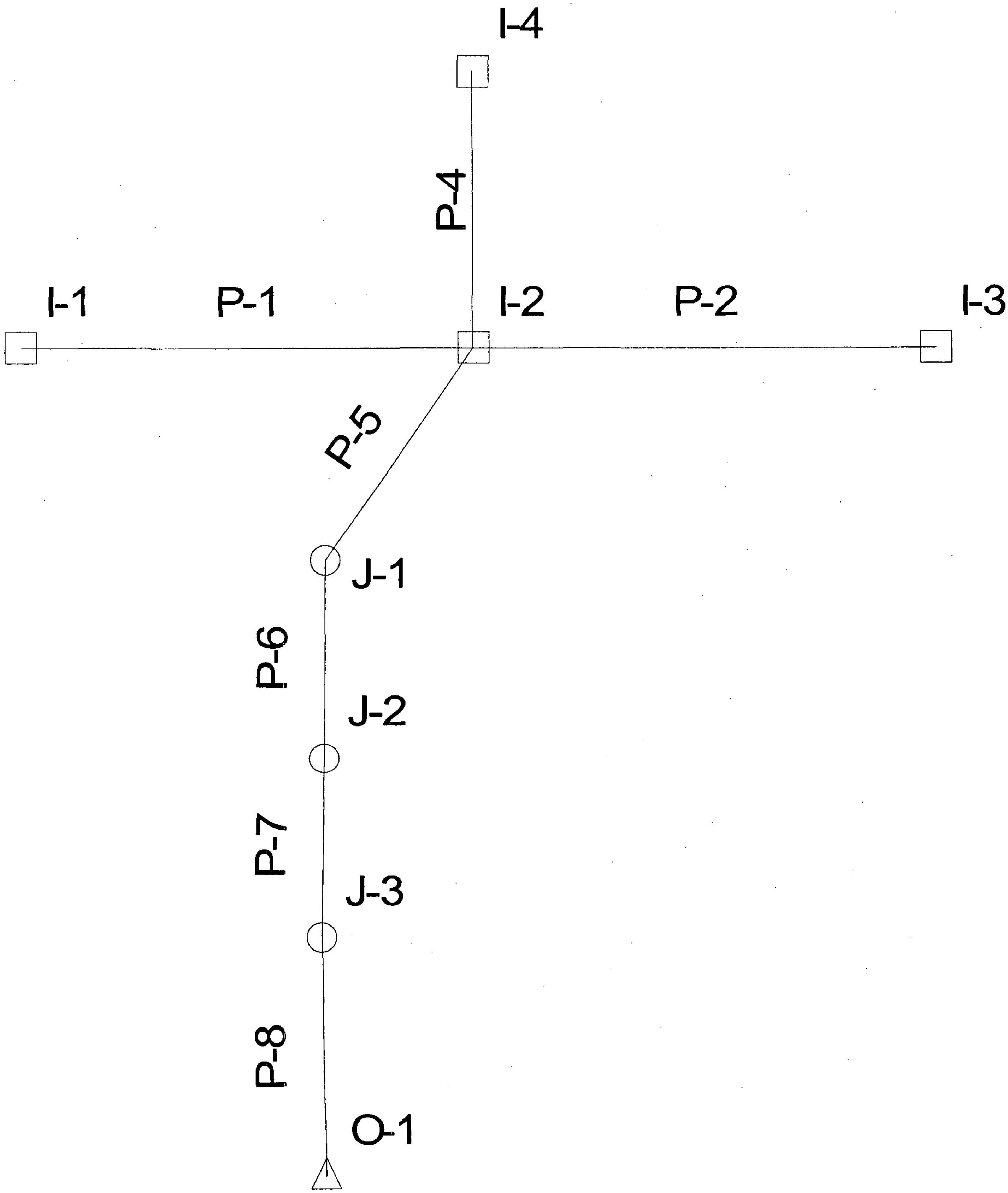
Figure: 7 - 2

STREET CAPACITY

FOR 1/2 STREET SECTION

	Formula	Longitudinal Slope	Cross Slope	n	Curb Type	Depth of flow	Q_{max}	Q	Comments
Residential	$Q=170.2\ S^{1/2}$	0.5%	0.02	0.016	V/R	0.5	34	12.0	County ramp curb is 6"
		1.0%					34	17.0	
		1.5%					34	20.8	
		2.0%					34	24.1	
		2.5%					34	26.9	
		3.0%					34	29.5	
		3.5%					34	31.8	
		4.0%					34	34.0	
Collector/Arterial	$Q=171.7\ S^{1/2}$	0.5%	0.02	0.016	V	0.5	34	12.0	
		1.0%					34	17.0	
		1.5%					34	20.8	
		2.0%					34	24.1	
		2.5%					34	26.9	
		3.0%					34	29.5	
		3.5%					34	31.8	
		4.0%					34	34.0	

Scenario: 5-year



Scenario: 5-year

Pipe Report

Label	Upstream Node	Downstream Node	Section Size	Number of Sections	Full Capacity (cfs)	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-2	I-3	I-2	24 inch	1	24.12	7.46	70.35	0.011372	6,566.18	6,565.71
P-4	I-4	I-2	24 inch	1	45.24	39.86	100.00	0.040000	6,570.36	6,565.93
P-1	I-1	I-2	24 inch	1	22.56	4.87	70.35	0.009950	6,565.89	6,565.71
P-5	I-2	J-1	42 inch	1	92.49	73.33	57.98	0.008451	6,565.63	6,565.68
P-6	J-1	J-2	42 inch	1	158.94	72.98	500.00	0.024960	6,565.10	6,551.60
P-7	J-2	J-3	42 inch	1	241.79	70.96	76.87	0.057760	6,552.28	6,546.69
P-8	J-3	O-1	42 inch	1	142.28	70.67	10.00	0.020000	6,547.53	6,546.98

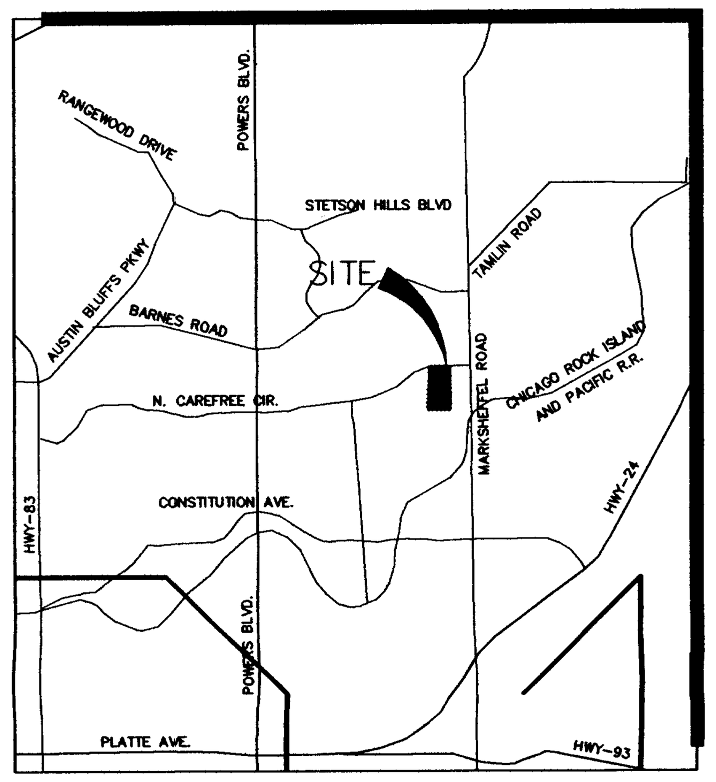
Scenario: 100-year

Pipe Report

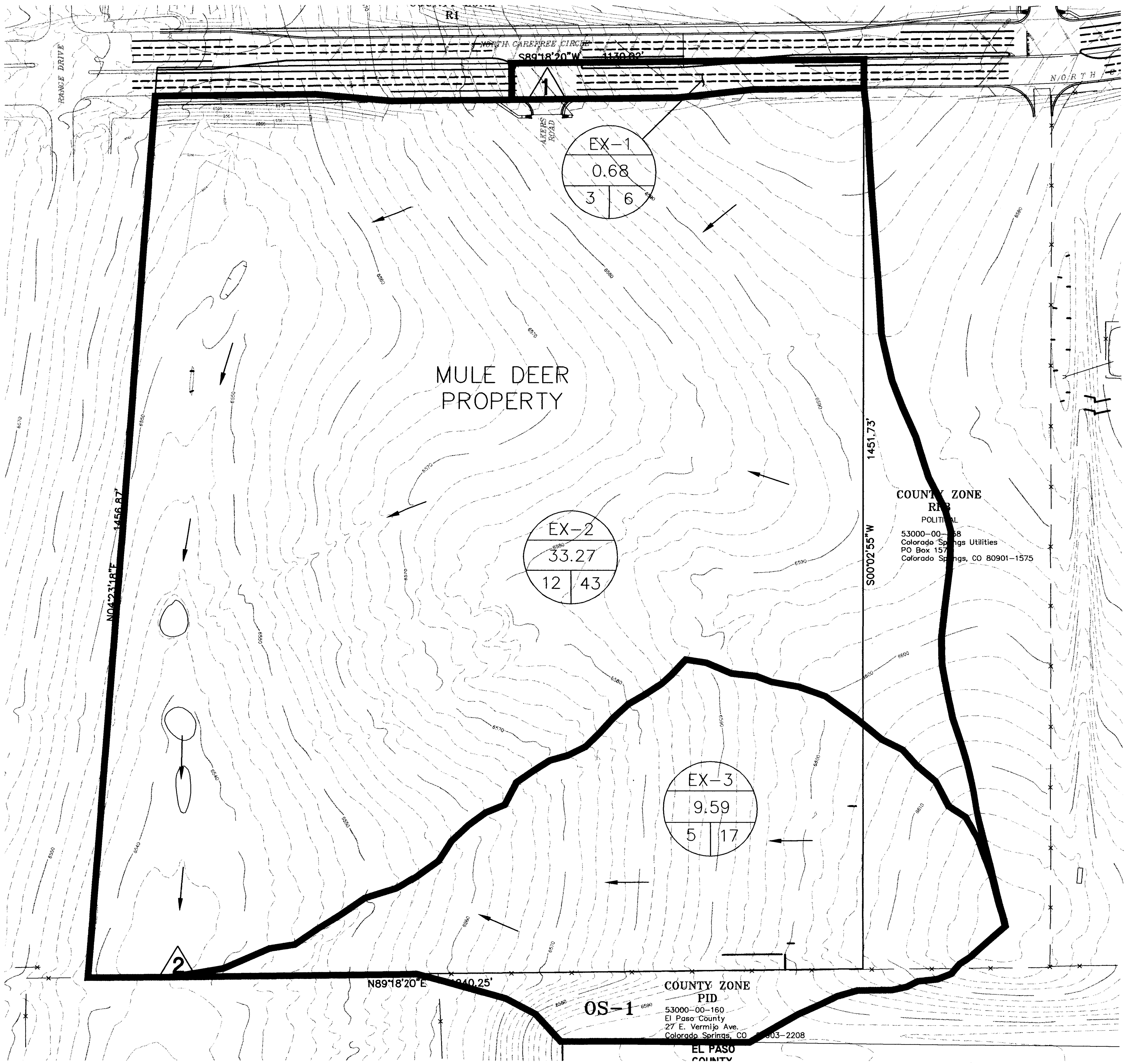
Label	Upstream Node	Downstream Node	Section Size	Number of Sections	Full Capacity (cfs)	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-2	I-3	I-2	24 inch	1	24.12	10.88	70.35	0.011372	6,569.08	6,568.92
P-4	I-4	I-2	24 inch	1	45.24	77.34	100.00	0.040000	6,580.61	6,568.92
P-1	I-1	I-2	24 inch	1	22.56	6.77	70.35	0.009950	6,568.98	6,568.92
P-5	I-2	J-1	42 inch	1	92.49	141.50	57.98	0.008451	6,568.67	6,567.52
P-6	J-1	J-2	42 inch	1	158.94	141.10	500.00	0.024960	6,565.78	6,552.51
P-7	J-2	J-3	42 inch	1	241.79	138.11	76.87	0.057760	6,552.99	6,547.46
P-8	J-3	O-1	42 inch	1	142.28	137.68	10.00	0.020000	6,548.24	6,547.89

MULE DEER
EXISTING BASINS

1"=100'
100 0 100 200



VICINITY MAP
NTS



SURFACE FLOW			
DESIGN POINT	CONTRIBUTING BASINS	Q – 5 yr. (cfs)	Q – 100 yr. (cfs)
1	EX-1	3	6
2	EX-1, EX-2, EX-3	16	55

LEGEND

EXISTING COUNTOURS — 6680 — —

HISTORIC BASINS — — — —

DIRECTION OF FLOW ←——

DRAINAGE BASIN: D-1 — BASIN DESIGNATION; AREA — 2.63; 12 — Q 5 YR; 21 — Q 100 YR

REVISIONS:		
NO.	DESCRIPTION	DATE

ENGINEER:
DESIGNED BY: WDC DATE: 01-23-04
DRAWN BY: DJM DATE: 01-23-04
CHECKED BY: WDC DATE:

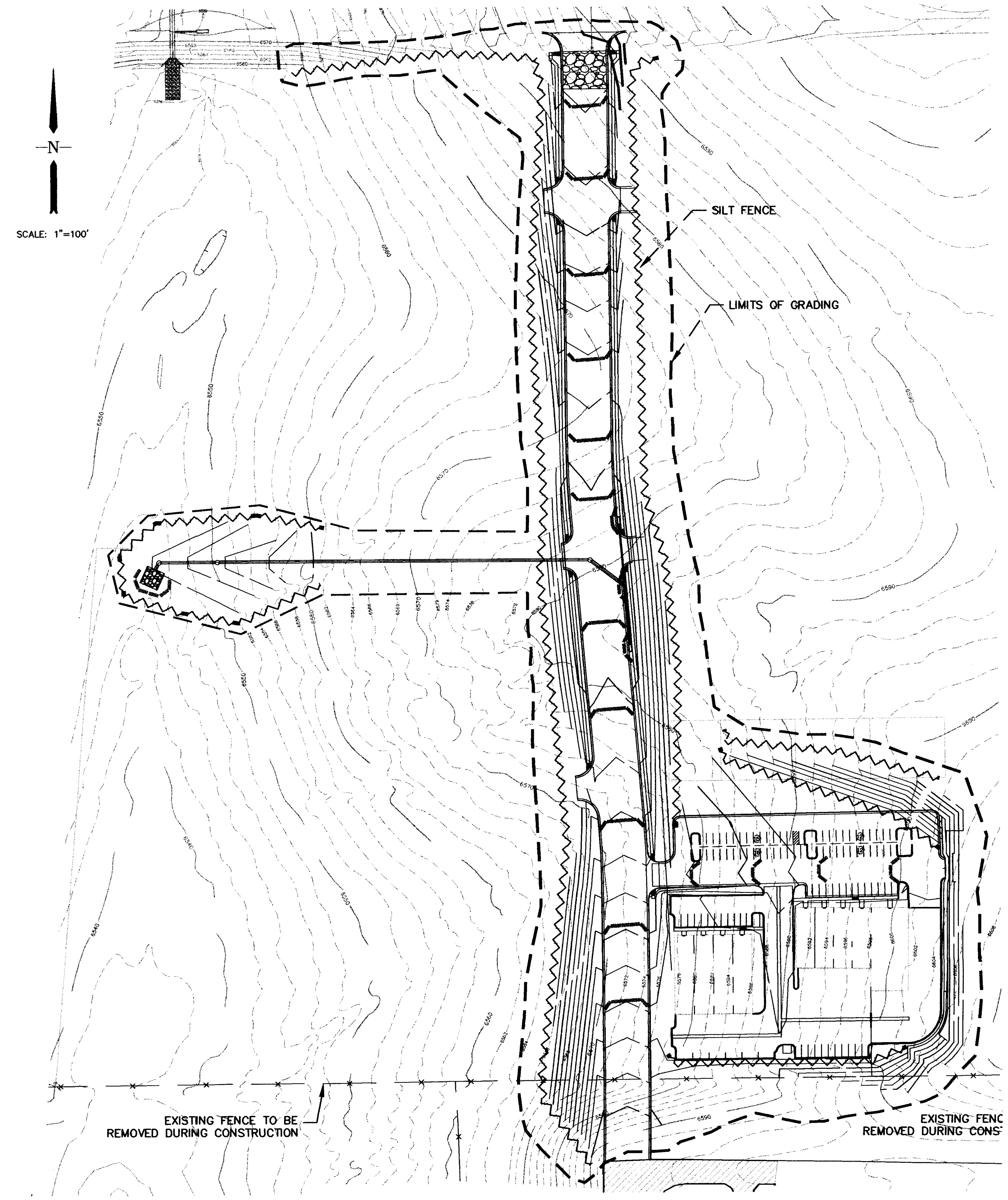
48 HOURS BEFORE YOU DIG, CALL UTILITY LOCATORS
1-800-922-1987
CITY OF COLORADO SPRINGS DEPT. OF UTILITIES GAS, ELECTRIC, WATER AND WASTEWATER

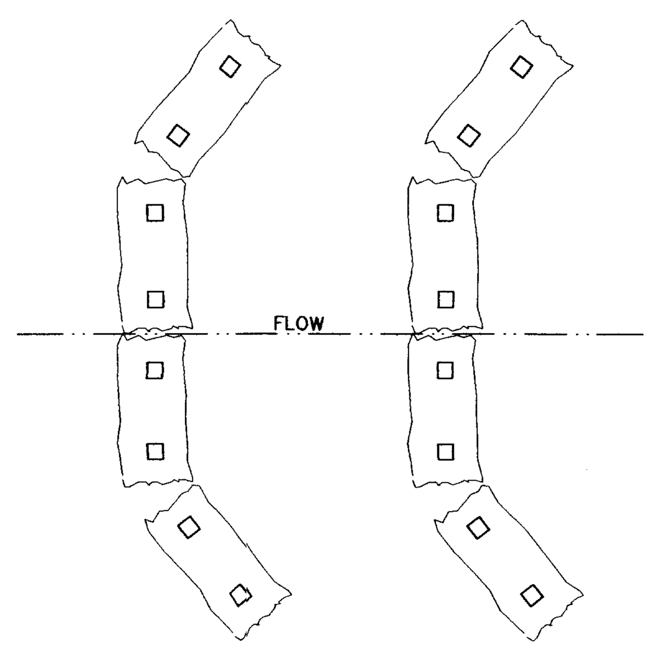
URS
9960 Federal Drive, Suite 300
Colorado Springs, Colorado 80918
PHONE: (719) 531-0001
FAX: (719) 531-0007

PROJECT MULE DEER
SHEET TITLE EXISTING DRAINAGE BASINS
FROM . TO .
JOB NO. 21711239 SHEET 3 OF

FILENAME: \\S031ntfile1\21711239\Cad\Exhibits\E01EXBAS03.dwg DATE: 01/26/2004 12:04:42 PM MST

GRADING AND EROSION CONTROL PLAN

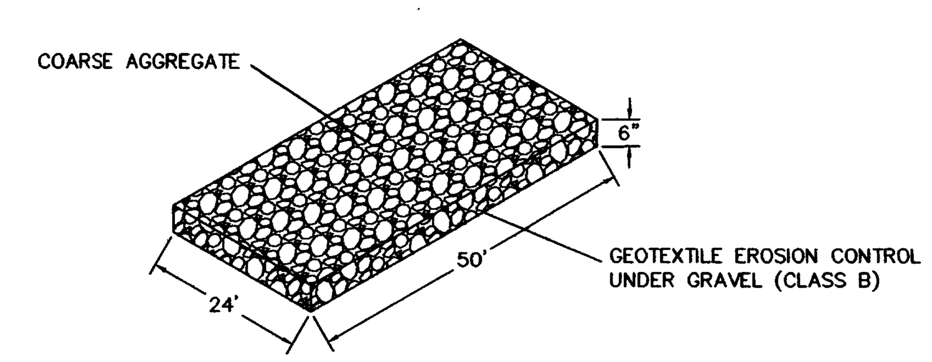




SLOPE	INTERVALS IN FEET
0.5%	200'
1.0%	100'
2.0%	50'
3.0%	33'

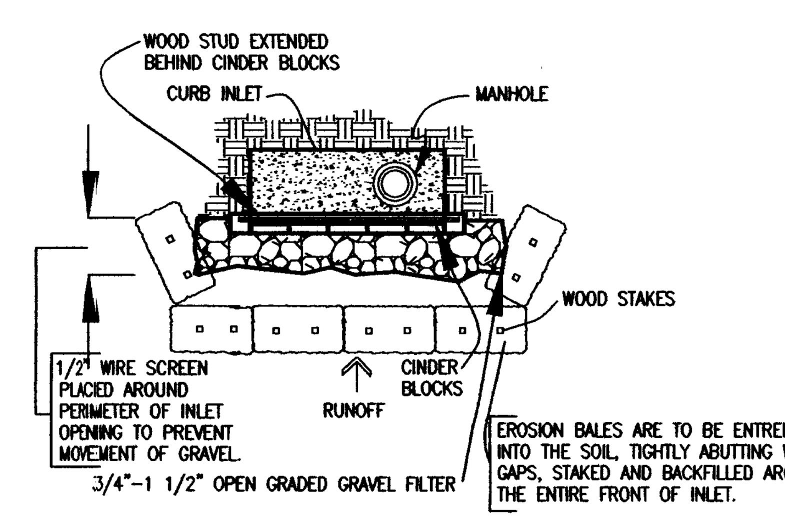
STRAW BALE CHECK DAM IN ROW

N.T.S



VEHICLE TRACKING CONTROL

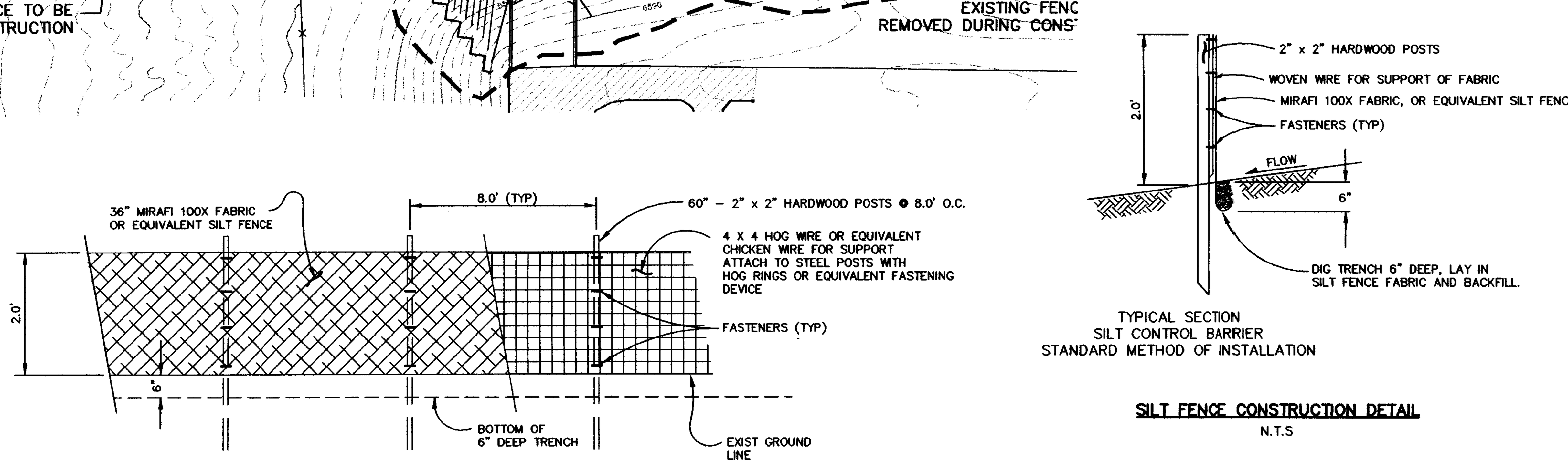
N.T.S.



PLAN VIEW

INLET PROTECTION

N.T.S.



SILT FENCE CONSTRUCTION DETAIL

N.T.S

GENERAL NOTES

1. ALL DRAINAGE CONSTRUCTION SHALL MEET THE SPECIFICATIONS OF THE CITY OF COLORADO SPRINGS/EL PASO COUNTY DRAINAGE CRITERIA MANUAL, VOLUME 2.

2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE NOTIFICATION AND FIELD LOCATION OF ALL EXISTING UTILITIES, WHETHER SHOWN ON THE PLANS OR NOT, BEFORE BEGINNING CONSTRUCTION. LOCATION OF EXISTING UTILITIES SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO CONSTRUCTION.

3. THE SOILS REPORT FOR THIS SITE SHALL BE CONSIDERED A PART OF THESE PLANS AND SHALL BE ADHERED TO.

4. THE CONTRACTOR SHALL HAVE AT LEAST ONE (1) SIGNED COPY OF THESE APPROVED PLANS AND SOILS REPORT AND AT LEAST ONE (1) COPY OF THE APPROPRIATE DESIGN AND CONSTRUCTION STANDARDS AND SPECIFICATIONS AT THE JOB SITE AT ALL TIMES. MANUALS SHALL INCLUDE, BUT NOT LIMITED TO THE FOLLOWING:
   A. STATE OF COLORADO SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION.
   B. EL PASO COUNTY SUBDIVISION CRITERIA MANUAL.
   C. CITY OF COLORADO SPRINGS/ EL PASO COUNTY DRAINAGE CRITERIA MANUAL.
   D. CDOT, M & S STANDARDS.

5. ALL DISTURBED AREAS OUTSIDE OF PROPOSED PAVEMENT SHALL BE REVEGETATED WITH THE SEED MIX DETAILED ON THIS SHEET OF THESE PLANS, OR AN APPROVED EQUAL WITHIN TWO WEEKS AFTER FINAL GRADE IS ESTABLISHED. EROSION CONTROL FABRIC SHALL BE USED ON SANDY SLOPES WHICH ARE EQUAL TO OR GREATER THAN 3H: 1V SLOPE.

6. EROSION CONTROL WILL CONSIST OF BUT NOT LIMITED TO STRAW BALES PLACED AT THE LOCATIONS SHOWN ON THIS PLAN, AND TOPSOIL MIXED WITH GRASS SEED, WHICH WILL BE WATERED UNTIL VEGETATION HAS BEEN REESTABLISHED.

7. THE EROSION CONTROL MEASURES OUTLINED ON THIS PLAN ARE THE RESPONSIBILITY OF THE DEVELOPER TO MONITOR AND REPLACE, REGRADE AND REBUILD AS NECESSARY UNTIL VEGETATION IS REESTABLISHED.

8. EROSION CONTROL MEASURES SHALL BE IMPLEMENTED IN A MANNER THAT WILL PROTECT ADJACENT PROPERTIES AND PUBLIC FACILITIES FROM THE ADVERSE EFFECTS OF EROSION AND SEDIMENTATION AS A RESULT OF CONSTRUCTION AND EARTHWORK ACTIVITIES WITHIN THE PROJECT SITE.

9. ADDITIONAL MEASURES MAY BE REQUIRED.

10. OWNER IS RESPONSIBLE FOR IMPLEMENTATION OF STORM WATER MANAGEMENT PLAN.

EROSION CONTROL

STEPS FOR CONSTRUCTION

THE ANTICIPATED START FOR THIS PROJECT IS MAY 2004 WITH AN ANTICIPATED COMPLETION DATE OF MAY 2005. BELOW IS A BRIEF OUTLINE OF THE CONSTRUCTION SEQUENCE FOR THIS PROJECT.

* SANITARY SEWER
* WATER
* STORM SEWER AND CULVERTS
* GAS
* ELECTRIC
* PHONE
* CATV
* FINISH ROAD GRADING AND PAVING

EROSION AND SEDIMENT CONTROLS
EROSION CONTROL WILL CONSIST OF HAY BALES PLACED AT THE POSITION SHOWN ON THE EROSION CONTROL PLAN, AND TOP SOIL MIXED WITH GRASS SEED WHICH WILL BE WATERED UNTIL VEGETATION HAS BEEN REESTABLISHED, AT A MINIMUM. OTHER MEASURES MAY BE SPECIFIED.

EROSION CONTROL MEASURES SHALL BE IMPLEMENTED IN A MANNER THAT WILL PROTECT ADJACENT PROPERTIES AND PUBLIC FACILITIES FROM THE ADVERSE EFFECTS OF EROSION AND SEDIMENTATION AS A RESULT OF CONSTRUCTION AND EARTHWORK ACTIVITIES WITHIN THE PROJECT SITE. OWNER IS RESPONSIBLE FOR IMPLEMENTATION OF STORM WATER MANAGEMENT PLAN. THE EROSION CONTROL MEASURES OUTLINED ON THE EROSION CONTROL ARE THE RESPONSIBILITY OF THE DEVELOPER TO MONITOR AND REPLACE, REGRADE AND REBUILD AS NECESSARY UNTIL VEGETATION IS ESTABLISHED.

MATERIAL HANDLING AND SPILL PREVENTION
THE MOST PROBABLE SOURCE OF NON-STORMWATER POLLUTION IS REFUELING AND DAILY MAINTENANCE OPERATIONS. IF MOBILE FUEL TRUCKS ARE USED TO SERVICE EQUIPMENT, ABSORBENT MATERIALS AND CONTAINERS FOR THE STORAGE OF USED ABSORBENT MATERIAL WILL BE CLOSE BY. IF A FUEL TANK IS LEFT ON SITE, BERMS WILL BE BUILT AROUND THE TANK TO CAPTURE ANY SPILLED FUEL. AGAIN, ABSORBENT MATERIALS AND THEIR CONTAINERS WILL BE ON HAND.

FINAL STABILIZATION AND LONG TERM STORMWATER MANAGEMENT
ONCE THE MAJOR ROADS ARE PAVED AND THE SURROUNDING DISTURBED AREAS ARE 70% ESTABLISHED WITH VEGETATION AND UPON ACCEPTANCE BY THE MERIDIAN RANCH SERVICE DISTRICT, THE STRAW BALE CHECK DAMS AND SILT FENCES AROUND THE STREETS CAN BE REMOVED. AFTER COMPLETION OF THE STORM SEWER SYSTEM, THE STRAW BALES AROUND THE TEMPORARY DETENTION POND CAN BE REMOVED. AFTER ALL GROUND-DISTURBING CONSTRUCTION HAS BEEN COMPLETED AND ALL SLOPES ARE 70% ESTABLISHED WITH VEGETATION AND UPON ACCEPTANCE BY THE MERIDIAN RANCH SERVICE DISTRICT, REMAINING STRAW BALE CHECK DAMS AND SILT FENCES CAN BE REMOVED. THE RIP RAP ON ANY OF THE OUTLETS WILL REMAIN AFTER CONSTRUCTION TO REDUCE EROSION OF THE CHANNELS. ALL PERMANENT SWALES WILL BE LINED WITH LANDSCAPING TO SLOW RUNOFF AND FILTER SEDIMENTS.

OTHER CONTROLS
THERE ARE SEVERAL BEST MANAGEMENT PRACTICES THAT CAN BE EMPLOYED TO PREVENT OR MITIGATE THE SOURCE OF POLLUTANTS AND CONTAMINATION OF STORMWATER RUNOFF. SOME OF THESE ARE:
* ALL REFUSE DUMPSTERS AND RECEPTACLES SHALL BE EQUIPPED WITH FUNCTIONAL LIDS TO PREVENT RAIN AND SNOW FROM ENTERING.
* STORAGE CONTAINERS, DRUMS AND BAGS SHALL BE STORED AWAY FROM DIRECT TRAFFIC ROUTES TO PREVENT ACCIDENTAL SPILLS.
* EMPTY DRUMS SHALL BE COVERED TO PREVENT COLLECTION OF PRECIPITATION.
* CONTAINERS SHALL BE STORED ON PALLETS OR OTHER DUNNAGE TO PREVENT CORROSION OF CONTAINERS, WHICH CAN RESULT WHEN CONTAINERS COME IN CONTACT WITH MOISTURE ON THE GROUND.
* REGULARLY SCHEDULED REMOVAL OF CONSTRUCTION TRASH AND DEBRIS.

THE CONTRACTOR IS CERTAINLY NOT LIMITED TO THESE GOOD HOUSEKEEPING MEASURES, AND MAY IMPLEMENT FURTHER CONTROLS AS PRUDENCE AND GOOD JUDGMENT DEEM NECESSARY.

INSPECTION AND MAINTENANCE
A THOROUGH INSPECTION OF THE STORMWATER MANAGEMENT SYSTEM SHALL BE PERFORMED EVERY 14 DAYS AS WELL AS AFTER ANY RAIN OR SNOWMELT EVENT THAT CAUSES SURFACE EROSION:
* WHEN STRAW BALE CHECK DAMS HAVE SILTED UP TO HALF THEIR HEIGHT, THE SILT SHALL BE REMOVED, CHANNEL GRADE REESTABLISHED, AND SIDE SLOPES RE-SEEDED IF NECESSARY. ANY STRAW BALES THAT HAVE SHIFTED OR DECAYED SHALL BE REPAIRED OR REPLACED.
* ANY ACCUMULATED TRASH OR DEBRIS SHALL BE REMOVED FROM OUTLETS.

AN INSPECTION AND MAINTENANCE LOG FOLLOWS THIS STORMWATER MANAGEMENT PLAN.

REVEGETATION AND SEEDINGRM
ALL DISTURBED AREA SHALL REQUIRE SEEDING WITHIN TWO (2) WEEKS FOLLOWING THE ESTABLISHMIENT OF FINAL GRADE. AREAS TO RECEIVE PAVEMENT DURING THE CONSTRUCTION OF THE ROAD SYSTEM SHALL NOT RECEIVE ANY SEEDING. SEEDING SHOUD BE ACCOMPLISHED USING AN APPROPRIATE GRASS DRILL, BY BROADCASTING OR BY HYDROMULCHING. IF SEEDING BY THE BROADCAST METHOD IS SELECTED , THE APPLICATION RATE SHOULD BE DOUBLED. IF HYDROMULCHING IS SELECTED TWO OPERATIONS SHOULD BE CONSIDERED, APPLYING THE SEED FIRST AND THE MULCH IN A SECOND OPERATION. UPON COMPLETION OF THE SEEDING OPERATION THE SITE SHOULD BE COVERED WITH WEED FREE MULCH AT A RATE OF 4,000 LBS. PER ACRE. BELOW IS THE ACCEPTED GRASS MIX FOR SANDY SOILS:

GRASS	VARIETY	AMOUNT IN PLS LBS. PER ACRE
SIDEOATS GRAMA	EL RENO	3.0
WESTERN WHEATGRASS	BARTON	2.5
SLENDER WHEATGRASS	NATIVE	2.0
LITTLE BLUESTERN	PASTURA	2.0
SAND DROPSEED	NATIVE	0.5
SWITCH GRASS	NEBRASKA	3.0
WEEPING LOVE GRASS	MORPHA	1.0

PRELIMINARY - NOT FOR CONSTRUCTION
Jan 28 2004

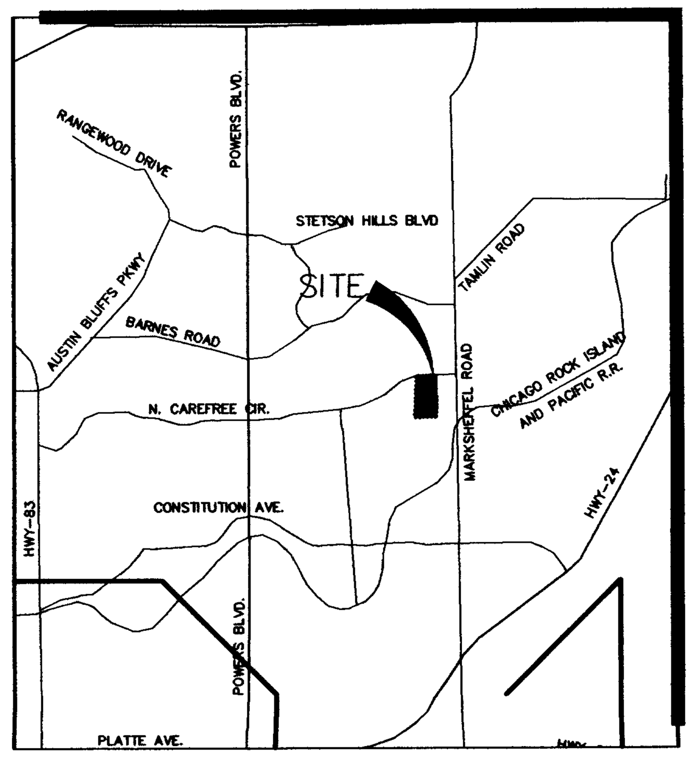
REVISIONS:		
	DESCRIPTION	DATE

ENGINEER:
DESIGNED BY: DDS DATE: 01/23/04
DRAWN BY: DDS DATE: 01/23/04
CHECKED BY: WDC DATE: 01/26/04

48 HOURS BEFORE YOU DIG,
CALL UTILITY LOCATORS
1-800-922-1987
(SEE COVER FOR LIST OF UTILITY CONTACTS)

URS
9960 FEDERAL DRIVE #300
COLORADO SPRINGS, COLORADO 80921
PHONE: (719) 531-0001
FAX: (719) 531-0007

PROJECT MULE DEER SUBDIVISION - FILING 1
SHEET TITLE GRADING AND EROSION CONTROL PLAN
FROM ______ TO ______
JOB NO. 21711239 SHEET 8 OF 8



VICINITY MAP
NTS

MULE DEER DEVELOPED BASINS

1"=100'

100 0 100 200

LEGEND

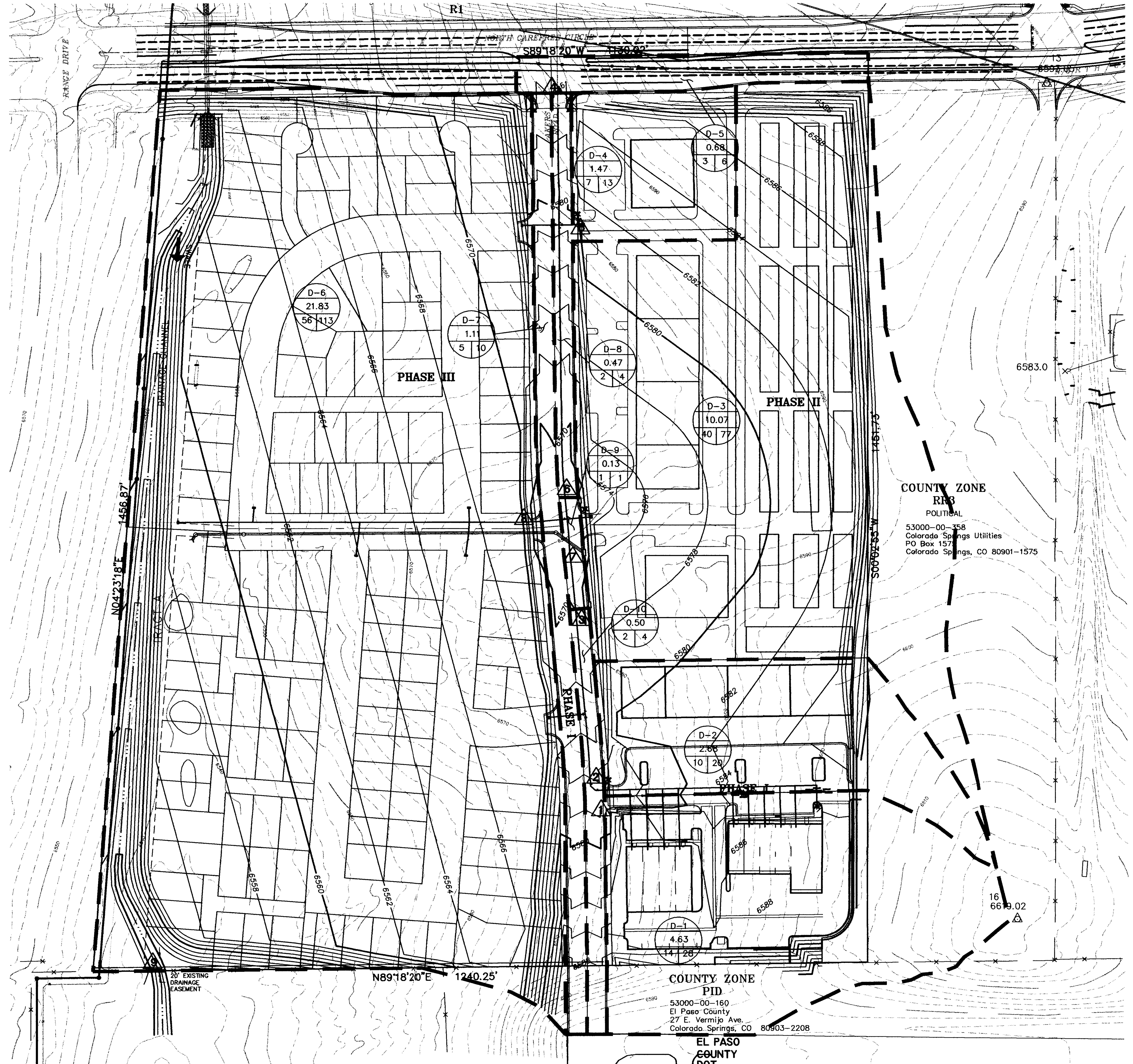
PROPOSED COUNTOURS

DEVELOPED BASINS

TOC LINE

DIRECTION OF FLOW

DRAINAGE BASIN — D-1 BASIN DESIGNATION; AREA 2.63; Q 5 YR 12; Q 100 YR 21



	SURFACE FLOW		
DESIGN POINT	CONTRIBUTING BASINS	Q - 5 yr. (cfs)	Q - 100 yr. (cfs)
1	D-1	14	28
2	D-1, D-2	24	47
3	DP-2, D-10	25	49
4	D-5	3	6
5	D-4, D-5	10	18
6	DP-5, D-8	11	20
7	DP-3, DP-6, D-3, D-9	72	138
8	DP-7, D-7	76	146
9	DP-8, D-6	112	221

REVISIONS:		
NO.	DESCRIPTION	DATE

ENGINEER:
DESIGNED BY: WDC DATE: 01-23-04
DRAWN BY: DJM DATE: 01-23-04
CHECKED BY: WDC DATE:

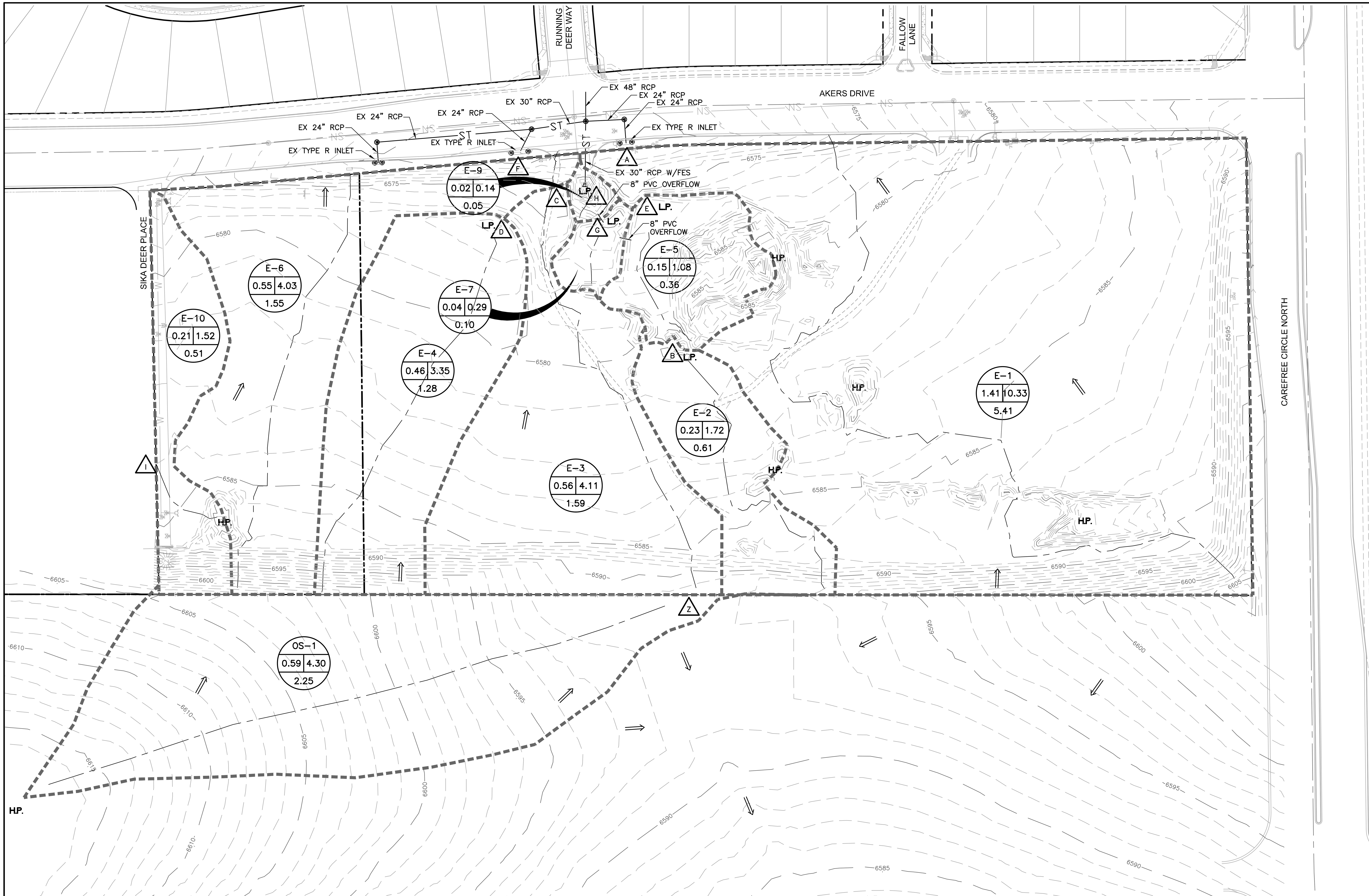
48 HOURS BEFORE YOU DIG, CALL UTILITY LOCATORS
1-800-922-1987
CITY OF COLORADO SPRINGS DEPT. OF UTILITIES
GAS, ELECTRIC, WATER AND WASTEWATER

URS
9960 Federal Drive, Suite 300
Colorado Springs, Colorado 80918
PHONE: (719) 531-0001
FAX: (719) 531-0007

PROJECT MULE DEER
SHEET TITLE DEVELOPED DRAINAGE BASINS
FROM . TO .
JOB NO. 2171129 SHEET 4 OF

FILENAME: DATE:

Figure 2: Existing Drainage Map



LEGEND

EXISTING 1' CONTOUR
EXISTING 5' CONTOUR
PROPERTY BOUNDARY
DRAINAGE BASIN BOUNDARY
FLOW PATH
DESIGN POINT
BASIN LABEL (BASIN / Q5 | Q100 / AREA)

1"=50'
50 0 50 100

DESIGN POINT SUMMARY

DESIGN POINT	Q5	Q100
Z	0.6	4.3
A	1.4	10.6
B	0.2	1.8
C	1.2	9.4
D	0.5	3.5
E	0.4	2.9
F	0.6	4.2
G	0.4	3.2
H	1.5	11.4
I	0.2	1.6

Computer File Information
Creation Date: 6-5-17 Initials: CMD
Last Modification Date: 6-12-17 Initials: BG
Full Path & Drawing File Name: V:\52876\active\187608744-Mule Deer\Reports\Drainage\Exhibits\ Ex Basin Exhibit.dwg
Acad Ver. 2017 Scale: see plan Units: Feet

Index of Revisions

Stantec
Stantec Consulting Inc.
1110 Elkton Drive
Suite B
Colorado Springs, CO 80907
Tel. (719) 432-6889
Fax.
www.stantec.com

GARDENS AT NORTH CAREFREE
EXISTING DRAINAGE PLAN

Designer: CMS
Detailer: BG
Sheet Subset:
Structure Numbers

Project No./Code
187608744

Sheet Number 1 of 1

Figure 3: Proposed Drainage Map

DESIGN POINT SUMMARY

DESIGN POINT	Q_5	Q_{100}
A	3.4	9.9
B	0.9	2.0
C	3.5	7.9
D	4.9	11.0
E	3.2	7.9
F	2.5	6.1
G	0.4	1.0
H	0.3	0.6
I	0.9	2.0
Z	0.1	0.6
NP	10.3	25.8
SP	4.8	11.5
Y	0.1	0.6
X	0.4	3.3
W	0.0	0.2
V	4.2	9.4

Computer File Information

Creation Date: 6-5-17 Initials: CMD

Last Modification Date: 6-13-17 Initials: BG

Full Path & Drawing File Name: V:\52876\active\187608744-Mule Deer\Reports\Drainage\Exhibits\Pr Basin Exhibit.dwg

Acad Ver. 2017 Scale: see plan Units: Feet

Index of Revisions

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THE GARDENS AT NORTH CAREFREE
PROPOSED DRAINAGE PLAN

Project No./Code: 187608744

Designer: CMD

Detailer: BG

Sheet Subset:

Structure Numbers

Sheet Number 1 of 1