Final Drainage Report
Drennan Subdivision Filing No. 1
&
Master Development Drainage Plan
Drennan Subdivision Filing No. 1

Prepared for:

Ermand Ruybal
5720 Observation Court
Colorado Springs, CO 80916

Prepared by:

Kiowa Engineering Corporation
Celebrating 30 years

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Kiowa Project No. 18015

September 2019

Signature Page
Drennan Subdivision Filing No. 1

Engineer's Statement

This report and plan for the drainage design of Drennan Subdivision Filing No. 1 was prepared by me (or under my direct supervision) and is correct to the best of my knowledge and belief. Said report and plan has been prepared in accordance with the City of Colorado Springs Drainage Criteria Manual and is in conformity with the master plan of the drainage basin. I understand that the City of Colorado Springs does not and will not assume liability for drainage facilities designed by others. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

Signature (Affix Seal): [signature] 9/26/19

Richard N. Wray Colorado P.E. No. 19310 Date

COLORADO REGISTERED RICHARD NORMAN WRAY 19310 PROFESSIONAL ENGINEER

Developer's Statement

Ermand Ruybal hereby certifies that the drainage facilities for Drennan Subdivision Filing No. 1 shall be constructed according to the design presented in this report. I understand that the City of Colorado Springs does not and will not assume liability for the drainage facilities designed and/or certified by my engineer and that are submitted to the City of Colorado Springs pursuant to section 7.7.906 of the City Code; and cannot, on behalf of Drennan Subdivision Filing No. 1, guarantee that final drainage design review will absolve Ermand Ruybal and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the final plat does not imply approval of my engineer's drainage design.

Name of Developer: Advance Concrete Inc

[signature] 9-25-19

Authorized Signature Date

Printed Name: Ermand Ruybal

Title: President

Address: 5720 Observation Court, Colorado Springs, CO 80916-4740

City of Colorado Springs Statement:

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

Jonathan B. Scherer 10/04/2019

For City Engineer Date

Conditions:

I. General Location and Description

The purpose of this Final Drainage Report and Master Development Drainage Plan is to identify on-site and off-site drainage patterns, storm sewers, culvert and inlet locations, areas tributary to the site, and to safely route developed storm water to adequate outfalls.

Drennan Subdivision Filing No. 1 lies within the Northwest Quarter of Section 3 and the Northeast Quarter of Section 4, Township 15 South, Range 65 West of the 6th Principal Meridian, in El Paso County, Colorado. The property contains approximately 20.31 acres and is bounded on the west by Foreign Trade Zone Boulevard (a public Street), on the north by Drennan Road (a public Street) on the south by undeveloped/unplatted land, and on the east by Aerospace Boulevard (a public Street). The site is to be platted as Drennan Subdivision Filing No. 1, which contains three lots. A vicinity map showing the general location of the site is presented on Figure 1.

Development of the property will involve the construction of a 16,800 square foot commercial building, associated drives and parking, landscaped areas, and a private full spectrum extended detention basin on proposed Lot 1. A 100,000 square foot commercial building, associated drives and parking, landscaped areas, and a private full spectrum extended detention basin are also proposed on Lot 3. There are currently no plans to develop Lot 2. Access is proposed off Aerospace Boulevard to the east. The site lies in the Jimmy Camp Creek Drainage Basin.

The two proposed private full spectrum extended detention basins are designed to release the water quality capture volume in 40 hours and the 100-year runoff volume will be released at 90 percent of historic peak flows. Runoff from the private full spectrum extended detention basin on Lot 1 will discharge onto Aerospace Boulevard to the east. Runoff from the private full spectrum extended detention basin on Lot 3 will discharge to the south, as it does in the existing condition, where it enters an existing grass-lined swale that drains to the east and then south, ultimately into Jimmy Camp Creek east of Marksheffel Road south of Bradley Road.

The site has relatively gentle slopes of approximately 2 to 5 percent with the site draining generally from the northwest to the southeast. Existing vegetation on the site consists primarily of native and non-native grasses. According to the *Soil Survey for El Paso County, Colorado*, the majority of the site's soil, as shown on Figure 2, consists of Truckton sandy loam (#96), which is classified within Hydrologic Soil Group A. The remainder of the site's soil consists of Truckton sandy loam (#97), which is also classified within Hydrologic Soil Group A.

II. References

1) *Jimmy Camp Creek Drainage Basin Planning Study, March 9, 2015*, Kiowa Engineering Corp.

2) *Jimmy Camp Creek Master Drainage Planning Study, January 1987*, Wilson & Company.

3) *City of Colorado Springs Drainage Criteria Manual Volume 1,* May 2014.

4) *City of Colorado Springs Drainage Criteria Manual Volume 2*, May 2014.

5) *Soil Survey of El Paso County Area, Colorado*, prepared by United States Department of Agriculture Soil Conservation Service, dated June 1981.

6) *Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map Number 08041CO768F,* March 17, 1997.

Reference 1 was prepared by the City of Colorado Springs in order to analyze the existing and future drainage conditions of the watershed. The project site lies within the Jimmy Camp Creek Drainage Basin. There were no major drainageway facilities shown in Reference 1 for the Drennan Subdivision Filing No. 1 site.

Review of Reference 2 revealed that there were no specific improvements immediately proposed for the Marksheffel Tributary reach of the Jimmy Camp Creek Drainage Basin through the Drennan Subdivision Filing 1 site.

There were not any other prior studies found which affect the Drennan Subdivision Filing 1 site.

III. Drainage Design Criteria

The hydrology for this site was estimated using the methods outlined in the *City of Colorado Springs Drainage Criteria Manuals*. The topography for the site was compiled using a one-foot contour interval and is presented at a horizontal scale of 1-inch to 50-feet on Figures 2 & 3, which also include drainage patterns, sub-basins and the corresponding flow rates. The flow rates for the sub-basins were estimated using the Rational Method. The 5-year and 100-year recurrence intervals were determined.

Runoff coefficients for the development were determined using Table 6-6 of the *City of Colorado Springs Drainage Criteria Manual*. Copies of Tables 6-2, 6-6, and 6-7 are included in Appendix A of this report. Hydrologic calculations were performed assuming Hydrologic Soil Group A and are also included in Appendix A of this report.

The private full spectrum extended detention basins for the development were sized using UD-Detention software. Other hydraulic calculations were made using UD-Inlet and UD-Culvert software and can be found in Appendix B of this report.

The 5-year and 10-year HGL calculations will be determined using UD-Sewer software. These HGL calculations will be shown on the storm sewer plan and profiles of the construction drawings as well as in the form of an addendum to this Final Drainage Report.

IV. Existing Drainage

In the existing condition, the site generally drains from northwest to the southeast. The northern portion of the site, which includes 0.22 ac. of off-site runoff from the Drennan Road R.O.W., sheet flows onto the Aerospace Boulevard R.O.W. From here runoff gutter flows south into an existing public 10' D-10-R curb inlet that discharges into the Marksheffel Tributary of Jimmy Camp Creek approximately 2200 feet south of the property.

This existing public 10’ D-10-R curb inlet intercepts 100 percent of the 100-year flows (see calculations in Appendix B).

The southern portion of the site sheet flows south offsite onto the unplatted property to the south. There is an existing stabilized grass-lined swale approximately 700 feet south of the property which intercepts flows and conveys them east and then south, ultimately into Jimmy Camp Creek east of Marksheffel Road south of Bradley Road. Existing drainage conditions are depicted on Figure 2.

A description of the existing drainage basins follows:

Drainage Basin E-1 is approximately 8.23 acres in area, which includes 0.22 acres of off-site Drennan Road R.O.W., and is comprised of native and non-native grasses as well as asphalt paving in the Drennan Road R.O.W. Runoff from this basin, Q_5=3.2 cfs and Q_{100}=17.8 cfs, sheet flows southeast across the basin onto the Aerospace Boulevard R.O.W., then gutter flows approximately 2200 feet south into the above-mentioned existing public 10’ D-10-R curb inlet.

Drainage Basin E-2 is approximately 10.05 acres in area and is comprised of native and non-native grasses. Runoff from this basin, Q_5=3.0 cfs and Q_{100}=20.0 cfs, sheet flows southeast across the basin to an existing low point west of the southeast corner of Lot 3. From here runoff sheet flows approximately 700 feet south into the above-mentioned existing grass-lined swale that conveys them east and then south, ultimately into Jimmy Camp Creek east of Marksheffel Road south of Bradley Road.

Drainage Basin E-3 is approximately 3.16 acres in area and is comprised of native and non-native grasses. Runoff from this basin, Q_5=1.1 cfs and Q_{100}=7.2 cfs, sheet flows south across the basin offsite approximately 700 feet south into the above-mentioned existing grass-lined swale that conveys flow east and then south, ultimately into Jimmy Camp Creek east of Marksheffel Road south of Bradley Road.

V. Developed Drainage

Drennan Subdivision Filing No. 1 generally drains to the south and east, into proposed private full spectrum extended detention basins located in the southern portion of Lot 1, and the southeastern portion of Lot 3.

Collection of the runoff will be accomplished through a combination of sheet flow, gutter flow, and private storm sewer flow. All proposed private inlet structures were sized to intercept 100 percent of 100-year flows reaching them. Proposed private storm sewers will convey runoff to the private full spectrum extended detention basins. All private storm sewer pipes have been sized based upon gravity flow. No pressure flow was used. As such, hydraulic grade lines (HGL) are located below the crown of each pipe. The 5-year and 10-year HGL calculations will be determined using UD-Sewer software. These HGL calculations will be shown on the storm sewer plan and profiles of the construction drawings as well as in the form of an addendum to this Final Drainage Report. Developed drainage conditions are depicted on Figure 3.

A description of the proposed drainage basins follows:

Drainage Basin D-1 is approximately 3.17 acres in area and is comprised of native and non-native grasses areas and the proposed full spectrum extended detention basin on Lot 3. Runoff from this basin, Q_5=0.9 cfs and Q_{100}=6.6 cfs, sheet flows south and east across the basin into the proposed private full spectrum extended detention basin on Lot 3.

Drainage Basin D-2 is approximately 0.12 acres in area and includes drive aisles and landscaped areas. Runoff from this basin, Q_5=0.5 cfs and Q_{100}=1.0 cfs, sheet flows east into a proposed private trench drain (D-2) and private 10-inch PVC pipe (2), and then into a proposed private 18-inch HDPE pipe (3) that conveys runoff to the private full spectrum extended detention basin on Lot 3. If the proposed private trench drain (D-2) should become clogged, flows will overtop the high point located east of the basin and sheet flow onto the Aerospace Boulevard R.O.W.

Drainage Basin D-3 is approximately 0.83 acres in area and includes drive aisles, sidewalks, parking, and landscaped areas. Runoff from this basin, Q_5=2.3 cfs and Q_{100}=4.6 cfs, sheet flows to the south and east into a grass-lined swale, and then into a proposed private 12-inch PVC pipe (3A) and proposed private 18-inch HDPE pipe (3) that convey runoff to the private full spectrum extended detention basin on Lot 3. If the proposed private 12-inch PVC pipe (3A) should become clogged, flows will overtop the high point located east of the pipe inlet and sheet flow onto the Aerospace Boulevard R.O.W.

Drainage Basin D-4 is approximately 0.07 acres in area and includes drive aisles and landscaped areas. Runoff from this basin, Q_5=0.3 cfs and Q_{100}=0.5 cfs, sheet flows east into a proposed private trench drain (D-4) and private 10-inch PVC pipe (4), and then into a proposed private 12-inch PVC pipe (5) that conveys runoff to the private 5' dia. Type II manhole (D-1) where a private 30-inch HDPE pipe (1) conveys runoff to the private full spectrum extended detention basin on Lot 3. If the proposed private trench drain (D-4) should become clogged, flows will overtop the high point located east of the basin and sheet flow onto the Aerospace Boulevard R.O.W.

Drainage Basin D-5 is approximately 0.43 acres in area and includes areas of turf grass. Runoff from this basin, Q_5=0.1 cfs and Q_{100}=0.9 cfs, sheet flows to proposed private 12-inch PVC pipe (5) that conveys runoff to the private 5' dia. Type II manhole (D-1) where a private 30-inch HDPE pipe (1) conveys runoff to the private full spectrum extended detention basin on Lot 3. If the proposed private 12-inch PVC pipe (5) should become clogged, flows will overtop the high point located east of the basin and sheet flow onto the Aerospace Boulevard R.O.W.

Drainage Basin D-6 is approximately 0.84 acres in area and includes a portion of the proposed building, drive aisles, sidewalks, and parking. Runoff from this basin, Q_5=3.4 cfs and Q_{100}=6.2 cfs, sheet flows and gutter flows into a proposed private 8' D-10-R inlet (D-6) in sump condition and private 24-inch HDPE pipe (6), that conveys runoff to the private full spectrum extended detention basin on Lot 3. If the proposed private 8' D-10-R inlet (D-6) in sump condition should become clogged, flows will overtop the curb south of the inlet and sheet flow into the proposed private extended detention basin on lot 3.

Drainage Basin D-7 is approximately 0.86 acres in area and includes a portion of the proposed building, drive aisles, sidewalks, and parking. Runoff from this basin, Q_5=3.4 cfs and Q_{100}=6.3 cfs, sheet flows and gutter flows into a proposed private 8' D-10-R inlet (D-7) and private 18-inch HDPE pipe (7) and private 24-inch HDPE pipe (6), that conveys runoff to the private full spectrum extended detention basin on Lot 3. If the proposed private 8' D-10-R inlet (D-7) in sump condition should become clogged, flows will overtop the curb south of the inlet and sheet flow into the proposed private extended detention basin on lot 3.

Drainage Basin D-8 is approximately 0.85 acres in area and includes native and non-native grass areas and drive aisle. Runoff from this basin, Q_5=1.5 cfs and Q_{100}=3.5 cfs, sheet flows and gutter flows into a proposed private 4' D-10-R inlet (D-8), private 15-inch HDPE pipe (8), private 18-inch HDPE pipe (7) and private 24-inch HDPE pipe (6), that conveys runoff to the private full spectrum extended detention basin on Lot 3. If the proposed private 4' D-10-R inlet (D-8) in sump condition should become clogged, flows will overtop the curb southwest of the inlet and sheet flow into the proposed private extended detention basin on lot 3.

Drainage Basin D-9 is approximately 0.96 acres in area and includes a portion of the proposed building, drive aisles, sidewalks, and parking. Runoff from this basin, Q_5=3.5 cfs and Q_{100}=6.6 cfs, sheet flows and gutter flows into a proposed private 4' D-10-R inlet (D-9), private 24-inch HDPE pipe (9), that conveys runoff to the private 5' dia. Type II manhole (D-1) where a private 30-inch HDPE pipe (1) conveys runoff to the private full spectrum extended detention basin on Lot 3. If the proposed private 4' D-10-R inlet (D-9) in sump condition should become clogged, flows will overtop the high point east of the inlet and sheet flow into basin D-3

Drainage Basin D-10 is approximately 1.71 acres in area and includes native and non-native grass areas, a portion of the proposed building, drive aisles, sidewalks, and parking. Runoff from this basin, Q_5=4.8 cfs and Q_{100}=9.6 cfs, sheet flows and gutter flows into a proposed private 4' D-10-R inlet (D-10), private 18-inch HDPE pipe (10), private 24-inch HDPE pipe (9), that convey runoff to the private 5' dia. Type II manhole (D-1) where a private 30-inch HDPE pipe (1) conveys runoff to the private full spectrum extended detention basin on Lot 3. If the proposed private 4' D-10-R inlet (D-10) in sump condition should become clogged, flows will overtop the high point east of the inlet and sheet flow into basin D-9

Drainage Basin D-11 is approximately 0.68 acres in area and is comprised of the proposed full spectrum extended detention basin on Lot 1. Runoff from this basin, Q_5=0.2 cfs and Q_{100}=1.6 cfs, sheet flows east across the basin in the proposed private full spectrum extended detention basin on Lot 1.

Drainage Basin D-12 is approximately 1.65 acres in area and includes a portion of the proposed building, drive aisles, sidewalks, parking, and landscaped areas. Runoff from this basin, Q_5=4.3 cfs and Q_{100}=8.4 cfs, sheet flows and gutter flows to a proposed 4.25' curb opening (see Appendix B calculations), where a concrete channel conveys runoff into the private full spectrum extended detention basin on Lot 1.

Drainage Basin D-13 is approximately 2.74 acres in area and includes a portion of the proposed building, drive aisles, sidewalks, parking, gravel storage, and landscaped areas. Runoff from this basin, Q_5=5.9 cfs and Q_{100}=12.2 cfs, sheet flows and gutter flows to a proposed 5.67' curb opening (see Appendix B calculations), and into the private full spectrum extended detention basin on Lot 1.

Drainage Basin D-14 is approximately 5.44 acres in area and is comprised of native and non-native grass areas. Runoff from this basin, Q_5=8.1 cfs and Q_{100}=19.4 cfs, sheet flows south and east across the basin into the proposed private full spectrum extended detention basin on Lot 1. There is no development currently proposed for this basin (Lot 2) however, developed conditions were incorporated into the design of the private full spectrum extended detention basin on Lot 1. Developed conditions are assumed to be a 17,000± square foot commercial building, 84,500± square feet of paved parking/drive aisles, and 135,470± square feet of landscaped area.

VI. Detention Storage / Water Quality

The proposed private full spectrum extended detention basin for Lots 1 & 2 will collect runoff from 10.51 acres comprised of basins D-11, D-12, D-13, and D-14. These basins have a collective watershed imperviousness of 41.7% (see IRF spreadsheet in Appendix B). Inflow to the private full spectrum extended detention basin will be controlled by three forebays. Forebay volumes and release rates will be controlled by notches in the crest of the forebay wall (see Appendix B forebay calculations). The private full spectrum extended detention basin includes a 10' wide × 12-inch thick layer of aggregate base course or crushed gravel, over compacted subgrade, maintenance access drive as shown on Figure 3. A proposed private outlet structure will be designed to release runoff at 90 percent of historic peak flow. The outlet structure consists of two chambers that release the WQCV and EURV at flowrates and times outlined in the City's *Drainage Criteria Manual*. A 5'×3' sloped grated opening will convey the 100-year storm event. The need to control the five-year release is not needed since the 5-year volume is contained within the EURV storage pool (stage 2). The water quality storage will be controlled by a perforated plate affixed on the inlet side of the proposed outlet structure. The horizontal trash rack that covers the structure is sized to account for 50 percent blockage. The design 100-year outflow discharge of 4.1 cfs will be conveyed by a proposed private 18-inch HDPE outfall pipe that conveys runoff to the Aerospace Boulevard curb and gutter which conveys flow south approximately 2200 feet to the existing public 10' D-10-R curb inlet which discharges into Jimmy Camp Creek. A 15' emergency spillway is provided on the east side of the private full spectrum extended detention basin and will route emergency overflows to the Aerospace Boulevard curb and gutter. The spillway has the capacity to convey the 100-year design inflow of 16.6 cfs. The crest of the spillway will be protected by a 24-inch thick layer of soil/riprap (type H). Required and provided private full spectrum extended detention basin volumes for lots 1 & 2 are as follows:

Stage	Required Volume	Provided Volume
WQCV	0.161 acre-feet	0.178 acre-feet
EURV	0.319 acre-feet	0.486 acre-feet
100-year	0.323 acre-feet	0.810 acre-feet
Total	0.804 acre-feet	0.810 acre-feet

Hydraulic calculations related to the private full spectrum extended detention basin for lots 1 & 2, private outlet structure, and emergency spillway, can be found in Appendix B. Construction details of the forebays, trickle channels, outlet structure, and emergency spillway, will be provided on the Permanent BMP plans of the final design construction drawings. Erosion control measures will be provided on the Grading and Erosion Control plans of the final design construction drawings.

The proposed private full spectrum extended detention basin for Lot 3 will collect runoff from 9.48 acres comprised of basins D-1 through D-10. These basins have a collective watershed imperviousness of 46.2% (see IRF spreadsheet in Appendix B). Inflow to the private full spectrum extended detention basin will be controlled by four forebays. Forebay volumes and release rates will be controlled by notches in the crest of forebay wall (see Appendix B forebay calculations). The private full spectrum extended detention basin includes a 10' wide × 12-inch thick layer of aggregate base course or crushed gravel, over compacted subgrade, maintenance access drive as shown on Figure 3. A proposed private outlet structure will be designed to release runoff at 90 percent of historic peak flow. The outlet structure consists of two chambers that release the WQCV and EURV at flowrates and times outlined in the City's *Drainage Criteria Manual*. A 3'×4' sloped grated opening will convey the 100-year storm event. The need to control the five-year release is not needed since the 5-year volume is contained within the EURV storage pool (stage 2). The water quality storage will be controlled by a perforated plate affixed on the inlet side of the proposed outlet structure. The horizontal trash rack that covers the structure is sized to account for 50 percent blockage. The design 100-year outflow discharge of 2.8 cfs will be conveyed by a proposed private 18-inch HDPE outfall pipe that conveys runoff south onto existing vegetated land where runoff will sheet flow south approximately 700 feet to an existing stabilized grass-lined swale which discharges ultimately into Jimmy Camp Creek just east of Marksheffel Road south of Bradley Road. A 10' emergency spillway is provided on the south side of the private full spectrum extended detention basin and will route emergency overflows onto existing vegetated land where runoff will sheet flow south approximately 700 feet to an existing stabilized grass-lined swale which discharges ultimately into Jimmy Camp Creek just east of Marksheffel Road south of Bradley Road. The spillway has the capacity to convey the 100-year design inflow of 13.6 cfs. The crest of the spillway will be protected by a 24-inch thick layer of soil/riprap (type H). Required and provided private full spectrum extended detention basin volumes for lot 3 are as follows:

Stage	Required Volume	Provided Volume
WQCV	0.161 acre-feet	0.161 acre-feet
EURV	0.352 acre-feet	0.538 acre-feet
100-year	0.834 acre-feet	0.884 acre-feet
Total	0.834 acre-feet	0.884 acre-feet

Hydraulic calculations related to the private full spectrum extended detention basin for lot 3, private outlet structure, and emergency spillway, can be found in Appendix B. Construction details of the forebays, trickle channels, outlet structure, and emergency spillway, will be provided on the Permanent BMP plans of the final design construction drawings. Erosion control measures will be provided on the Grading and Erosion Control plans of the final design construction drawings.

VII. Flood Plain Statement

According to the Federal Emergency Management Agency (FEMA), the proposed development does not lie within a designated floodplain. The *Floodplain Insurance Rate Map (FIRM) for El Paso County panel 08041C0768 G* dated December 7, 2018 was reviewed to determine any potential floodplain delineation. A copy of the relevant portion of the FIRM panel is shown on Figure 2.

VIII. Drainage and Bridge Fees

The Drennan Subdivision Filing No. 1 site lies entirely within the Jimmy Camp Creek basin therefore drainage and pond facility fees (2019) are due prior to plat recordation as follows:

Type of Fee	Acres	Fee / Acre (2019)	Fee:
Drainage Fee	20.307	$7,975	$161,948.33
Pond Facility Fee	20.307	$2,599	$ 52,777.89
Total Fees	**20.307**	**$10,574**	**$214,726.22**

IX. Construction Cost Estimate

Estimated construction costs for Drennan Subdivision Filing No. 1 are as follows:

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL
4' Dia. Type II Manhole	1	Ea.	$ 8,000.00	$ 8,000.00
5' Dia. Type II Manhole	1	Ea.	$ 9,000.00	$ 9,000.00
4' D-10-R Inlet	3	Ea.	$ 8,000.00	$ 24,000.00
8' D-10-R Inlet	2	Ea.	$ 9,000.00	$ 18,000.00
Trench Drain	2	Ea.	$ 8,000.00	$ 16,000.00
10-inch PVC Pipe	23	L.F.	$ 40.00	$ 920.00
12-inch PVC Pipe	202	L.F.	$ 50.00	$ 10,100.00
15-inch HDPE Pipe	148	L.F.	$ 60.00	$ 8,880.00
18-inch HDPE Pipe	278	L.F.	$ 80.00	$ 22,240.00

24-inch HDPE Pipe	386	L.F.	$ 90.00	$ 34,740.00
30-inch HDPE Pipe	301	L.F.	$ 100.00	$ 30,100.00
EDB Lots 1 & 2	1	L.S.	$ 49,162.00	$ 49,162.00
EDB Lot 3	1	L.S.	$ 61,133.00	$ 61,133.00
			Estimated Cost	$292,275.00
			Engineering 10%	$ 29,275.00
			Contingency 5%	$ 14,614.00
Total Estimated Private Non-Reimbursable Storm Drainage Facilities Cost				**$336,164.00**

X. Four Step Process

Step 1: Runoff reduction Practices

New construction will utilize existing and proposed grassed areas as buffers, allowing sediment to drop out of the storm runoff, and helping to reduce runoff.

Step 2: Implement BMP's that Slowly Release the Water Quality Capture Volume

Treatment and slow release of 40 hours of the water quality capture volume (WQCV) will be accomplished by the implementation of a proposed private full spectrum extended detention basin.

Step 3: Stabilize Drainageways

The proposed private full spectrum extended detention basin for lots 1 and 2 will release runoff to the west curb and gutter of Aerospace Boulevard, which is the historic and stabilized out-fall location for lots 1 and 2. The existing public 10' D-10-R curb inlet, located approximately 2200 feet south, will except 100 percent of developed flows from Drennan Subdivision Filing No. 1. The existing public 10' D-10-R curb inlet discharges to an existing stabilized grass-lined channel. These out-fall channels are stable; therefore, no improvements are necessary. Drainage fees, which will be paid prior to plat recordation, will fund channel improvements according to the Jimmy Camp Creek Drainage Basin Planning Study.

The private full spectrum extended detention basin for lot 3 will release runoff onto the adjacent property to the south, which is the historic and stabilized out-fall location for lot 3. This out-fall is a very broad stabilized grassed low area that conveys flows to an existing stabilized grass-lined channel approximately 700 feet south of Drennan Subdivision Filing No. 1. These out-fall channels are stable; therefore, no improvements are necessary. Drainage fees, which will be paid prior to plat recordation, will fund channel improvements according to the Jimmy Camp Creek Drainage Basin Planning Study.

Step 4: Implement Site Specific & Source Control BMP's

Construction BMPs in the form of vehicle tracking control, concrete washout area, inlet protection, rock socks, and silt fences will be utilized to protect receiving waters. The owner will be responsible maintenance activities throughout the property. These activities would include:

1. Routine sweeping of parking and driveway areas;
2. Snow plowing and removal of snow stockpiles;
3. Removal of trash and debris from the property;
4. Cleaning of the two private full spectrum extended basins and outlet structures;
5. Maintenance of trash handling and spill prevention and containment measures.

Each of the above activities will be implemented upon development of the Drennan Subdivision Filing No. 1 project. The result will be that stormwater generated from the site will be managed both structurally and non-structurally, and thereby help to mitigate the effects urbanization upon stormwater runoff.

XI. Summary and Conclusions

Drennan Subdivision Filing No. 1 contains approximately 20.307 acres and is located south of Drennan Road between Foreign Trade Zone Boulevard and Aerospace Boulevard. The proposed site lies within the Jimmy Camp Creek Drainage Basin. Runoff from the site will generally follow existing drainage patterns which route flows to existing downstream facilities which are adequately sized to accept runoff coming from the site. Other existing downstream conveyance systems have adequate capacity for the proposed flows leaving the site.

This report and its findings are in general conformance with all previously approved studies and reports which included this site. Site runoff and storm drain & appurtenances associated with proposed improvements to Drennan Subdivision Filing No. 1 will not adversely affect the downstream and surrounding developments.

Appendix A
Hydrologic Calculations
Runoff Coefficient Calculations
Time of Concentration
Runoff Calculations

Table 6-2. Rainfall Depths for Colorado Springs

Return Period	1-Hour Depth	6-Hour Depth	24-Hour Depth
2	1.19	1.70	2.10
5	1.50	2.10	2.70
10	1.75	2.40	3.20
25	2.00	2.90	3.60
50	2.25	3.20	4.20
100	2.52	3.50	4.60

Where Z= 6,840 ft/100

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

* For buried riprap, select C_v value based on type of vegetative cover.

Table 6-6. Runoff Coefficients for Rational Method

(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis-- Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

Drennen Subdivision Filing No. 1
Runoff Coeficient and Percent Impervious Calculation
Existing Condition

Basin	Basin/DP Area (DP contributing basins)		Soil Type	HI	Area 1 Land Use			PV	Area 2 Land Use			RO	Area 3 Land Use			GR	Area 4 Land Use			LA	Area 5 Land Use			Basin % Imperv	Runoff Coef. (C_c)	
				% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp		C_5	C_{100}
E-1	358,432 sf	8.23ac	A	2%	8.01ac	97%	2%	100%	0.22ac	3%	3%	90%		0%	0%	80%		0%	0%	0%		0%	0%	4.6%	0.11	0.38
E-2	437,757 sf	10.05ac	A	2%	10.05ac	100%	2%	100%		0%	0%	90%		0%	0%	80%		0%	0%	0%		0%	0%	2.0%	0.09	0.36
E-3	137,844 sf	3.16ac	A	2%	3.16ac	100%	2%	100%		0%	0%	90%		0%	0%	80%		0%	0%	0%		0%	0%	2.0%	0.09	0.36

Basin Runoff Coefficient is a weighted average

Runoff Coefficients and Percents Impervious (DCM Table 6-6)

Hydrologic Soil Type: A **Runoff Coef Calc Method:** Weighted

Land Use	Abb	%	C_2	C_5	C_{10}	C_{25}	C_{50}	C_{100}	Weighted
Business: Downtown	BD	95%	0.79	0.81	0.83	0.85	0.87	0.88	%Imp
Business: Suburban	BS	70%	0.45	0.49	0.53	0.58	0.60	0.62	
Drives and Walks	DR	100%	0.89	0.90	0.92	0.94	0.95	0.96	A
Streets - Gravel (Packed)	GR	80%	0.57	0.59	0.63	0.66	0.68	0.70	B
Historic Flow Analysis	HI	2%	0.03	0.09	0.17	0.26	0.31	0.36	C
Lawns	LA	0%	0.02	0.08	0.15	0.25	0.30	0.35	D
Off-site flow-Undeveloped	OF	45%	0.26	0.32	0.38	0.44	0.48	0.51	
Park	PA	7%	0.05	0.12	0.20	0.30	0.34	0.39	
Streets - Paved	PV	100%	0.89	0.90	0.92	0.94	0.95	0.96	
Roofs	RO	90%	0.71	0.73	0.75	0.78	0.80	0.81	

Equation:

$C_c=(C_1A_1+C_2A_2+C_3A_3+...C_i+A_i) / A_t$

(City of Colorado Springs DCM Equation 6-6) Where:

C_c = composite runoff coefficient for total area

C_i = runoff coefficient for subarea (surface type or land use)

A_i = area of surface type corresponding to C_i

A_t = total area of all sub areas

$_i$ = number of surface types in the drainage area

Drennen Subdivision Filing No. 1
Time of Concentration Calculation
Existing Condition

Sub-Basin Data				Time of Concentration Estimate										t_c (1st DP in Urban Catchments)		Final t_c
				Initial/Overland Time (t_i)			Travel Time (t_t)						Comp.			
Basin	Area	C_5	i	Length	Slope	t_i	Length	Slope	Land Type	K	Velocity	t_t	t_c	Total Length	t_c (1st DP)	
E-1	8.23ac	0.11	4.6%	100lf	1.8%	15.0 min.	960lf	1.8%	SP	7	0.9 ft/sec	17.2 min.	32.1 min.	1060lf	15.9 min.	**15.9 min.**
E-2	10.05ac	0.09	2.0%	100lf	1.7%	15.6 min.	1226lf	1.7%	SP	7	0.9 ft/sec	22.5 min.	38.1 min.	1326lf	17.4 min.	**17.4 min.**
E-3	3.16ac	0.09	2.0%	100lf	2.5%	13.7 min.	415lf	2.5%	SP	7	1.1 ft/sec	6.3 min.	20.0 min.	515lf	12.9 min.	**12.9 min.**

Equations:

t_i (Overland) = $0.395(1.1-C_5)L^{0.5} S^{-0.333}$
(DCM Equation 6-8) Where:
- C_5 = Runoff coefficient for 5-year
- L = Length of overland flow (ft)
- S = Average basin slope (ft/ft)

$t_t = L_t / 60KS^{0.5}$ Where:
- t_t = Channelized flow time (travel time)(min.)
- L_t = Waterway length (ft)
- K = Conveyance Factor (see DCM Table 6-7)
- S = Watercourse slope (ft/ft)

t_c (1st DP) = $(18-15i) + L_t / (60 (24i+12)S^{0.5})$ Where:
- t_c (1st DP) = First DP Time of Concentration in urban catchments
- L_t = Length of Flow Path
- i = imperviousness (expressed as a decimal)

City of Colorado Springs DCM Table 6-7

Type of Land Surface	Land Type	K
Grassed Waterway	GW	15
Heavy Meadow	HM	2.5
Nearly Bare Ground	NBG	10
Paved Area/Swales	PV	20
Riprap (Not Buried)	RR	6.5
Short Pasture/Lawns	SP	7
Tillage/Fields	TF	5

Drennen Subdivision Filing No. 1
Runoff Calculation
Existing Condition

Basin	Contributing Basins	Drainage Area	Coef. (C_c)		Time of Concentration	Rainfall Intensity				Runoff		Basin
			C_5	C_{100}		i_2	i_5	i_{10}	i_{100}	**Q_5**	**Q_{100}**	
E-1	E-1	8.23 ac	0.11	0.38	15.9 min.	2.7 in/hr	3.4 in/hr	4.0 in/hr	5.8 in/hr	**3.2 cfs**	**17.8 cfs**	E-1
E-2	E-2	10.05 ac	0.09	0.36	17.4 min.	2.6 in/hr	3.3 in/hr	3.9 in/hr	5.5 in/hr	**3.0 cfs**	**20.0 cfs**	E-2
E-3	E-3	3.16 ac	0.09	0.36	12.9 min.	3.0 in/hr	3.8 in/hr	4.4 in/hr	6.3 in/hr	**1.1 cfs**	**7.2 cfs**	E-3

Equations:

City of Colorado Springs DCM, Figure 6-5:

i_2=-1.19 ln(T_c) + 6.035

i_5=-1.50 ln(T_c) + 7.583

i_{10}=-1.75 ln(T_c) + 8.847

i_{100}=-2.52 ln(T_c) + 12.735

Q = CiA Where:

Q = Peak Runoff Rate (cubic feet/second)

C = Runoff coef representing a ration of peak runoff rate to ave rainfall intensity for a duration equal to the runoff time of concentration.

i = average rainfall intensity in inches per hour

A = Drainage area in acres

Drennan Subdivision Filing No. 1

Runoff Coeficient and Percent Impervious Calculation - Developed Conditions

Basin	Basin/DP Area (DP contributing basins)		Soil Type	DR	Area 1 Land Use			LA	Area 2 Land Use			RO	Area 3 Land Use			GR	Area 4 Land Use			HI	Area 5 Land Use			Basin % Imperv	Runoff Coef. (C_c)	
				% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp		C_5	C_{100}
D-1	137,970 sf	3.17ac	A	100%	0.00ac	0%	0%	0%	3.17ac	100%	0%	90%		0%	0%	80%		0%	0%	2%		0%	0%	0.0%	0.08	0.35
D-2	5,355 sf	0.12ac	A	100%	0.11ac	92%	92%	0%	0.01ac	8%	0%	90%		0%	0%	80%		0%	0%	2%		0%	0%	91.9%	0.83	0.91
D-3	36,201 sf	0.83ac	A	100%	0.55ac	66%	66%	0%	0.28ac	34%	0%	90%		0%	0%	80%		0%	0%	2%		0%	0%	66.3%	0.62	0.75
D-4	3,242 sf	0.07ac	A	100%	0.05ac	73%	73%	0%	0.02ac	27%	0%	90%		0%	0%	80%		0%	0%	2%		0%	0%	73.1%	0.68	0.80
D-5	18,802 sf	0.43ac	A	100%	0.00ac	0%	0%	0%	0.43ac	100%	0%	90%		0%	0%	80%		0%	0%	2%		0%	0%	0.0%	0.08	0.35
D-6	36,383 sf	0.84ac	A	100%	0.27ac	32%	32%	0%		0%	0%	90%	0.57ac	68%	61%	80%		0%	0%	2%		0%	0%	93.2%	0.78	0.86
D-7	37,250 sf	0.86ac	A	100%	0.28ac	32%	32%	0%	0.01ac	1%	0%	90%	0.57ac	67%	60%	80%		0%	0%	2%		0%	0%	92.2%	0.78	0.85
D-8	36,907 sf	0.85ac	A	100%	0.38ac	45%	45%	0%	0.47ac	55%	0%	90%		0%	0%	80%		0%	0%	2%		0%	0%	44.5%	0.45	0.62
D-9	41,922 sf	0.96ac	A	100%	0.27ac	28%	28%	0%	0.12ac	12%	0%	90%	0.57ac	59%	53%	80%		0%	0%	2%		0%	0%	81.6%	0.70	0.80
D-10	74,592 sf	1.71ac	A	100%	0.67ac	39%	39%	0%	0.47ac	27%	0%	90%	0.57ac	33%	30%	80%		0%	0%	2%		0%	0%	69.2%	0.62	0.74
D-14	236,798 sf	5.44ac	A	100%	1.94ac	36%	36%	0%	3.11ac	57%	0%	90%	0.39ac	7%	6%	80%		0%	0%	2%		0%	0%	42.1%	0.42	0.60
D-11	29,702 sf	0.68ac	A	100%	0.00ac	0%	0%	0%	0.68ac	100%	0%	90%		0%	0%	80%		0%	0%	2%		0%	0%	0.3%	0.08	0.35
D-12	71,922 sf	1.65ac	A	100%	1.12ac	68%	68%	0%	0.34ac	21%	0%	90%	0.19ac	12%	10%	80%		0%	0%	2%		0%	0%	78.3%	0.71	0.82
D-13	119,516 sf	2.74ac	A	100%	0.68ac	25%	25%	0%	0.61ac	22%	0%	90%	0.19ac	7%	6%	80%	1.26ac	46%	37%	2%		0%	0%	67.9%	0.56	0.69

Basin Runoff Coefficient is a weighted average

Runoff Coefficients and Percents Impervious (DCM Table 6-6)

Hydrologic Soil Type: **A** **Runoff Coef Calc Method:** Weighted

Land Use	Abb	%	C_2	C_5	C_{10}	C_{25}	C_{50}	C_{100}	Weighted
Business: Downtown	BD	95%	0.79	0.81	0.83	0.85	0.87	0.88	%Imp
Business: Suburban	BS	70%	0.45	0.49	0.53	0.58	0.60	0.62	
Drives and Walks	DR	100%	0.89	0.90	0.92	0.94	0.95	0.96	A
Streets - Gravel (Packed)	GR	80%	0.57	0.59	0.63	0.66	0.68	0.70	B
Historic Flow Analysis	HI	2%	0.03	0.09	0.17	0.26	0.31	0.36	C
Lawns	LA	0%	0.02	0.08	0.15	0.25	0.30	0.35	D
Off-site flow-Undeveloped	OF	45%	0.26	0.32	0.38	0.44	0.48	0.51	
Park	PA	7%	0.05	0.12	0.20	0.30	0.34	0.39	
Streets - Paved	PV	100%	0.89	0.90	0.92	0.94	0.95	0.96	
Roofs	RO	90%	0.71	0.73	0.75	0.78	0.80	0.81	

Equation:

$C_c=(C_1A_1+C_2A_2+C_3A_3+...C_i+A_i) / A_t$

(City of Colorado Springs DCM Equation 6-6) Where:

- C_c = composite runoff coefficient for total area
- C_i = runoff coefficient for subarea (surface type or land use)
- A_i = area of surface type corresponding to C_i
- A_t = total area of all sub areas
- $_i$ = number of surface types in the drainage area

Drennan Subdivision Filing No. 1

Time of Concentration Calculation - Developed Conditions

Sub-Basin Data				Time of Concentration Estimate										t_c (1st DP in Urban Catchments)		Final t_c
				Initial/Overland Time (t_i)			Travel Time (t_t)						Comp.			
Basin	Area	C_5	i	Length	Slope	t_i	Length	Slope	Land Type	K	Velocity	t_t	t_c	Total Length	t_c (1st DP)	
D-1	3.17ac	0.08	0.0%	95lf	2.6%	13.2 min.	801lf	1.1%	GW	15	1.5 ft/sec	8.7 min.	21.9 min.	896lf	15.0 min.	**15.0 min.**
D-2	0.12ac	0.83	91.9%	90lf	3.6%	3.0 min.	36lf	8.3%	PV	20	5.8 ft/sec	0.1 min.	5.0 min.	126lf	10.7 min.	**5.0 min.**
D-3	0.83ac	0.62	66.3%	100lf	1.4%	7.8 min.	122lf	4.2%	GW	15	3.1 ft/sec	0.7 min.	8.5 min.	222lf	11.2 min.	**8.5 min.**
D-4	0.07ac	0.68	73.1%	57lf	7.9%	2.9 min.	0lf	0.0%	PV	20	0.0 ft/sec	0.0 min.	5.0 min.	57lf	10.3 min.	**5.0 min.**
D-5	0.43ac	0.08	0.0%	100lf	3.9%	11.9 min.	474lf	1.3%	GW	15	1.7 ft/sec	4.7 min.	16.6 min.	574lf	13.2 min.	**13.2 min.**
D-6	0.84ac	0.78	93.2%	100lf	8.0%	2.9 min.	176lf	2.3%	PV	20	3.0 ft/sec	1.0 min.	5.0 min.	276lf	11.5 min.	**5.0 min.**
D-7	0.86ac	0.78	92.2%	100lf	8.0%	3.0 min.	176lf	2.3%	PV	20	3.0 ft/sec	1.0 min.	5.0 min.	276lf	11.5 min.	**5.0 min.**
D-8	0.85ac	0.45	44.5%	100lf	3.0%	8.3 min.	324lf	1.2%	GW	15	1.7 ft/sec	3.2 min.	11.5 min.	424lf	12.4 min.	**11.5 min.**
D-9	0.96ac	0.70	81.6%	100lf	8.0%	3.7 min.	138lf	3.3%	PV	20	3.6 ft/sec	0.6 min.	5.0 min.	238lf	11.3 min.	**5.0 min.**
D-10	1.71ac	0.62	69.2%	100lf	3.3%	5.9 min.	270lf	2.8%	GW	15	2.5 ft/sec	1.8 min.	7.7 min.	370lf	12.1 min.	**7.7 min.**
D-14	5.44ac	0.42	42.1%	100lf	3.0%	8.7 min.	750lf	1.5%	NBG	10	1.2 ft/sec	10.3 min.	19.0 min.	850lf	14.7 min.	**14.7 min.**
D-11	0.68ac	0.08	0.3%	30lf	7.0%	5.3 min.	335lf	0.5%	NBG	10	0.7 ft/sec	7.6 min.	12.9 min.	365lf	12.0 min.	**12.0 min.**
D-12	1.65ac	0.71	78.3%	62lf	9.1%	2.7 min.	535lf	0.7%	NBG	10	0.8 ft/sec	10.7 min.	13.3 min.	597lf	13.3 min.	**13.3 min.**
D-13	2.74ac	0.56	67.9%	63lf	7.9%	3.9 min.	535lf	1.1%	NBG	10	1.0 ft/sec	8.5 min.	12.5 min.	598lf	13.3 min.	**12.5 min.**

Equations:

t_i (Overland) = $0.395(1.1-C_5)L^{0.5}S^{-0.333}$ (DCM Equation 6-8) Where:

- C_5 = Runoff coefficient for 5-year
- L = Length of overland flow (ft)
- S = Average basin slope (ft/ft)

$t_t = L_t / 60KS^{0.5}$ Where:

- t_t = Channelized flow time (travel time)(min.)
- L_t = Waterway length (ft)
- K = Conveyance Factor (see DCM Table 6-7)
- S = Watercourse slope (ft/ft)

t_c (1st DP) = $(18-15i) + L_t / (60(24i+12)S^{0.5})$ Where:

- t_c (1st DP) = First DP Time of Concentration in urban catchments
- L_t = Length of Flow Path
- i = imperviousness (expressed as a decimal)

City of Colorado Springs DCM Table 6-7

Type of Land Surface	Land Type	K
Grassed Waterway	GW	15
Heavy Meadow	HM	2.5
Nearly Bare Ground	NBG	10
Paved Area/Swales	PV	20
Riprap (Not Buried)	RR	6.5
Short Pasture/Lawns	SP	7
Tillage/Fields	TF	5

Drennan Subdivision Filing No. 1

Runoff Calculation - Developed Conditions

Basin	Contributing Basins	Drainage Area	C_2	C_5	C_{10}	C_{100}	Time of Concentration	Rainfall Intensity i_2	i_5	i_{10}	i_{100}	**Runoff** Q_5	Q_{100}	**Basin**
D-1	D-1	3.17 ac	0.02	0.08	0.15	0.35	15.0 min.	2.8 in/hr	3.5 in/hr	4.1 in/hr	5.9 in/hr	**0.9 cfs**	**6.6 cfs**	D-1
D-2	D-2	0.12 ac	0.82	0.83	0.86	0.91	5.0 min.	4.1 in/hr	5.2 in/hr	6.0 in/hr	8.7 in/hr	**0.5 cfs**	**1.0 cfs**	D-2
D-3	D-3	0.83 ac	0.60	0.62	0.66	0.75	8.5 min.	3.5 in/hr	4.4 in/hr	5.1 in/hr	7.4 in/hr	**2.3 cfs**	**4.6 cfs**	D-3
D-4	D-4	0.07 ac	0.66	0.68	0.71	0.80	5.0 min.	4.1 in/hr	5.2 in/hr	6.0 in/hr	8.7 in/hr	**0.3 cfs**	**0.5 cfs**	D-4
D-5	D-5	0.43 ac	0.02	0.08	0.15	0.35	13.2 min.	3.0 in/hr	3.7 in/hr	4.3 in/hr	6.2 in/hr	**0.1 cfs**	**0.9 cfs**	D-5
D-6	D-6	0.84 ac	0.77	0.78	0.80	0.86	5.0 min.	4.1 in/hr	5.2 in/hr	6.0 in/hr	8.7 in/hr	**3.4 cfs**	**6.2 cfs**	D-6
D-7	D-7	0.86 ac	0.76	0.78	0.80	0.85	5.0 min.	4.1 in/hr	5.2 in/hr	6.0 in/hr	8.7 in/hr	**3.4 cfs**	**6.3 cfs**	D-7
D-8	D-8	0.85 ac	0.41	0.45	0.49	0.62	11.5 min.	3.1 in/hr	3.9 in/hr	4.6 in/hr	6.6 in/hr	**1.5 cfs**	**3.5 cfs**	D-8
D-9	D-9	0.96 ac	0.67	0.70	0.72	0.80	5.0 min.	4.1 in/hr	5.2 in/hr	6.0 in/hr	8.7 in/hr	**3.5 cfs**	**6.6 cfs**	D-9
D-10	D-10	1.71 ac	0.59	0.62	0.65	0.74	7.7 min.	3.6 in/hr	4.5 in/hr	5.3 in/hr	7.6 in/hr	**4.8 cfs**	**9.6 cfs**	D-10
D-14	D-14	5.44 ac	0.38	0.42	0.47	0.60	14.7 min.	2.8 in/hr	3.5 in/hr	4.1 in/hr	6.0 in/hr	**8.1 cfs**	**19.4 cfs**	D-14
D-11	D-11	0.68 ac	0.02	0.08	0.15	0.35	12.0 min.	3.1 in/hr	3.9 in/hr	4.5 in/hr	6.5 in/hr	**0.2 cfs**	**1.6 cfs**	D-11
D-12	D-12	1.65 ac	0.69	0.71	0.74	0.82	13.3 min.	3.0 in/hr	3.7 in/hr	4.3 in/hr	6.2 in/hr	**4.3 cfs**	**8.4 cfs**	D-12
D-13	D-13	2.74 ac	0.54	0.56	0.60	0.69	12.5 min.	3.0 in/hr	3.8 in/hr	4.4 in/hr	6.4 in/hr	**5.9 cfs**	**12.2 cfs**	D-13

Equations: City of Colorado Springs DCM, Figure 6-5:

i_2=-1.19 ln(T_c) + 6.035

i_5=-1.50 ln(T_c) + 7.583

i_{10}=-1.75 ln(T_c) + 8.847

i_{100}=-2.52 ln(T_c) + 12.735

Q = CiA Where:

Q = Peak Runoff Rate (cubic feet/second)

C = Runoff coef representing a ration of peak runoff rate to ave rainfall intensity for a duration equal to the runoff time of concentration.

i = average rainfall intensity in inches per hour

A = Drainage area in acres

Appendix B
Hydraulic Calculations

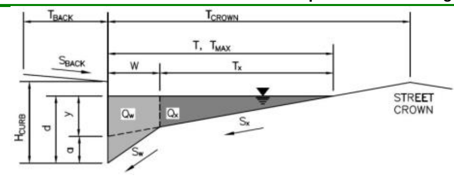
Version 4.05 Released March 2017

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

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

Project: **Drennan Subdivision Filing No. 1**

Inlet ID: **Aerospace Blvd. Existing 10' D-10-R**



Gutter Geometry (Enter data in the blue cells)

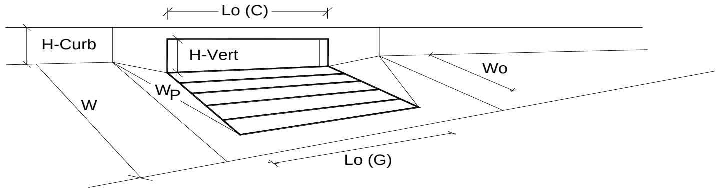
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =		
Height of Curb at Gutter Flow Line	H_{CURB} =	8.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	24.0	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 =	0.000	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} =	24.0	24.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	8.0	8.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

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

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



			MINOR	MAJOR	
Design Information (Input)	Colorado Springs D-10-R				
Type of Inlet		Type =	Colorado Springs D-10-R		
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local} =	4.00	4.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	3	3	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	5.3	5.3	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) =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	8.00	8.00	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	8.00	8.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	81.00	81.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W_p =	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	

		MINOR	MAJOR	
Low Head Performance Reduction (Calculated)				
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.44	0.44	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.50	0.50	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.74	0.74	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	

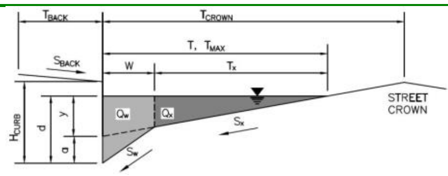
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**25.7**	**25.7**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	Q PEAK REQUIRED =	4.3	9.3	cfs

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

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

Project: Drennan Subdivision Filing No. 1

Inlet ID: D-6



Gutter Geometry (Enter data in the blue cells)

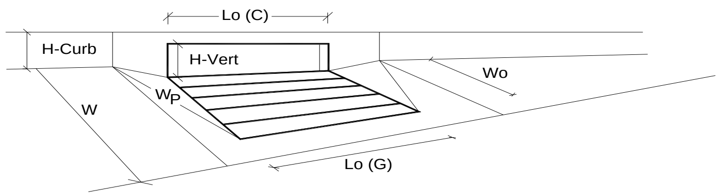
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	25.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	25.0	25.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

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

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



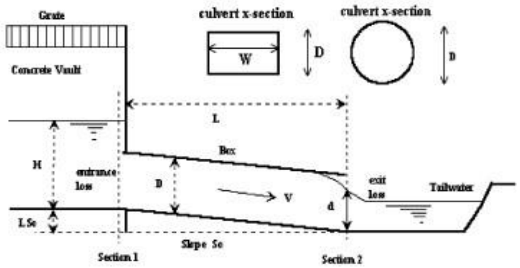
Design Information (Input)	Colorado Springs D-10-R		MINOR	MAJOR	
Type of Inlet		Type =	Colorado Springs D-10-R		
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local} =	4.00	4.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	2	2	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	6.0	6.0	inches
Grate Information			MINOR	MAJOR	Override Depths
Length of a Unit Grate		L_o (G) =	N/A	N/A	feet
Width of a Unit Grate		W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C_o (G) =	N/A	N/A	
Curb Opening Information			MINOR	MAJOR	
Length of a Unit Curb Opening		L_o (C) =	4.00	4.00	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	8.00	8.00	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	8.00	8.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	81.00	81.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W_p =	1.00	1.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.42	0.42	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.61	0.61	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**10.5**	**10.5**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	3.4	6.2	cfs

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Drennan Subdivision Filing No. 1
Basin ID: D-6
Status:



Design Information (Input):

Circular Culvert: Barrel Diameter in Inches — D = 24 inches
Inlet Edge Type (choose from pull-down list) — Square End Projection

OR:

Box Culvert: Barrel Height (Rise) in Feet — Height (Rise) = ft.
Barrel Width (Span) in Feet — Width (Span) = ft.
Inlet Edge Type (choose from pull-down list) — Square Edge w/ 30-78 deg. Flared Wingwall

Number of Barrels	No =	1	
Inlet Elevation at Culvert Invert	Inlet Elev =	5856.45	ft. elev.
Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Slope =	0.0068	ft vert. / ft horiz.
Culvert Length in Feet	L =	25.1	ft.
Manning's Roughness	n =	0.012	
Bend Loss Coefficient	K_b =	0	
Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.50
Friction Loss Coefficient	K_f =	0.26
Sum of All Loss Coefficients	K_s =	1.76
Orifice Inlet Condition Coefficient	C_d =	0.85
Minimum Energy Condition Coefficient	KE_{low} =	0.0598

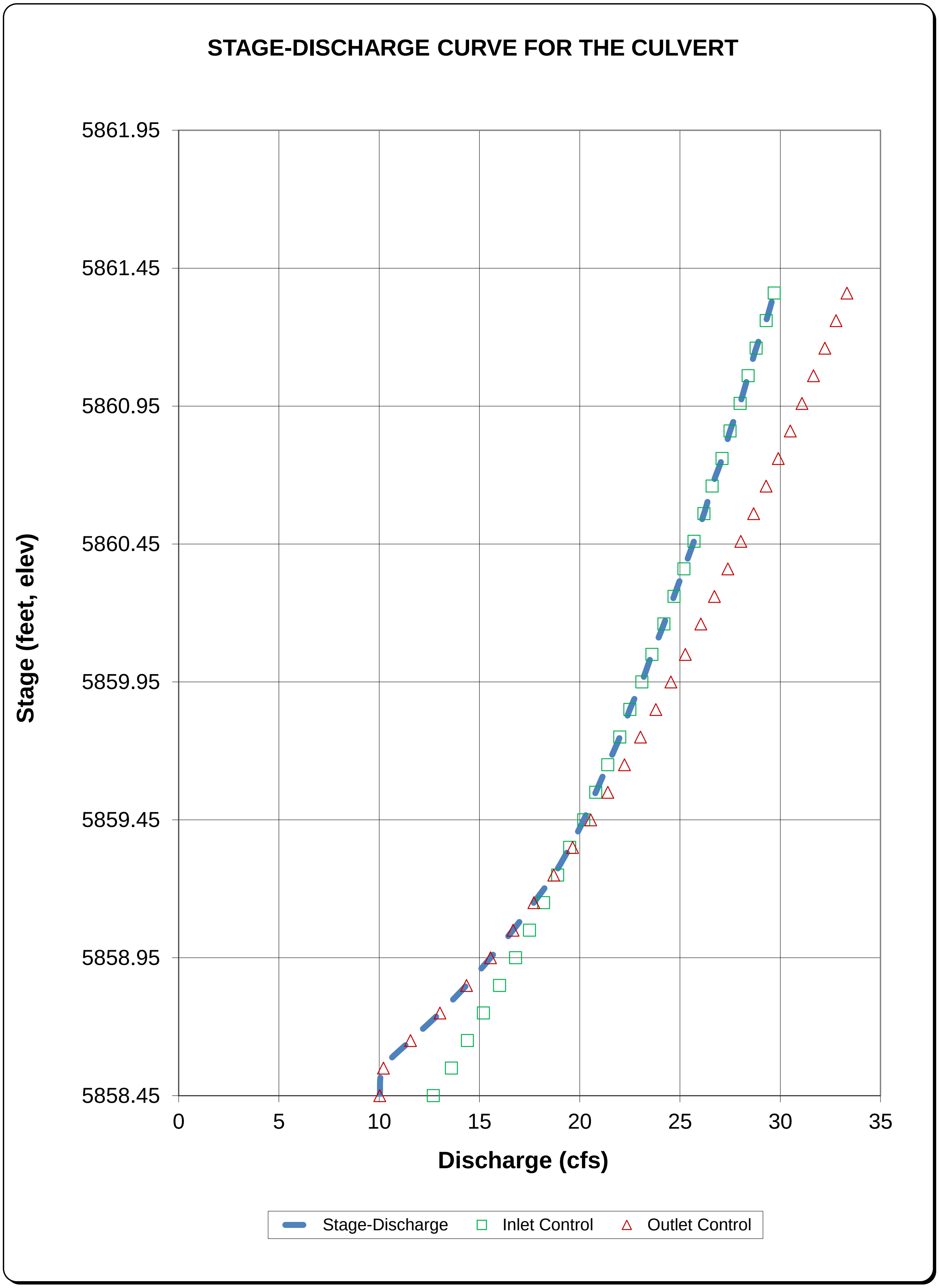
Calculations of Culvert Capacity (output):

Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
5858.45	5857.89	12.70	10.02	**10.02**	Regression Eqn.	OUTLET
5858.55	5857.89	13.60	10.21	**10.21**	Regression Eqn.	OUTLET
5858.65	5857.89	14.40	11.56	**11.56**	Regression Eqn.	OUTLET
5858.75	5857.89	15.20	13.03	**13.03**	Regression Eqn.	OUTLET
5858.85	5857.89	16.00	14.35	**14.35**	Regression Eqn.	OUTLET
5858.95	5857.89	16.80	15.55	**15.55**	Regression Eqn.	OUTLET
5859.05	5857.89	17.50	16.67	**16.67**	Regression Eqn.	OUTLET
5859.15	5857.89	18.20	17.71	**17.71**	Regression Eqn.	OUTLET
5859.25	5857.89	18.90	18.70	**18.70**	Regression Eqn.	OUTLET
5859.35	5857.89	19.50	19.64	**19.50**	Regression Eqn.	INLET
5859.45	5857.89	20.20	20.54	**20.20**	Regression Eqn.	INLET
5859.55	5857.89	20.80	21.40	**20.80**	Regression Eqn.	INLET
5859.65	5857.89	21.40	22.23	**21.40**	Regression Eqn.	INLET
5859.75	5857.89	22.00	23.03	**22.00**	Regression Eqn.	INLET
5859.85	5857.89	22.50	23.80	**22.50**	Regression Eqn.	INLET
5859.95	5857.89	23.10	24.54	**23.10**	Regression Eqn.	INLET
5860.05	5857.89	23.60	25.26	**23.60**	Regression Eqn.	INLET
5860.16	5857.89	24.20	26.04	**24.20**	Regression Eqn.	INLET
5860.26	5857.89	24.70	26.72	**24.70**	Regression Eqn.	INLET
5860.36	5857.89	25.20	27.38	**25.20**	Regression Eqn.	INLET
5860.46	5857.89	25.70	28.03	**25.70**	Regression Eqn.	INLET
5860.56	5857.89	26.20	28.67	**26.20**	Regression Eqn.	INLET
5860.66	5857.89	26.60	29.29	**26.60**	Regression Eqn.	INLET
5860.76	5857.89	27.10	29.90	**27.10**	Regression Eqn.	INLET
5860.86	5857.89	27.50	30.50	**27.50**	Regression Eqn.	INLET
5860.96	5857.89	28.00	31.08	**28.00**	Regression Eqn.	INLET
5861.06	5857.89	28.40	31.66	**28.40**	Regression Eqn.	INLET
5861.16	5857.89	28.80	32.22	**28.80**	Regression Eqn.	INLET
5861.26	5857.89	29.30	32.78	**29.30**	Regression Eqn.	INLET
5861.36	5857.89	29.70	33.33	**29.70**	Regression Eqn.	INLET

Processing Time: 01.80 Seconds

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Drennan Subdivision Filing No. 1
Basin ID: D-6



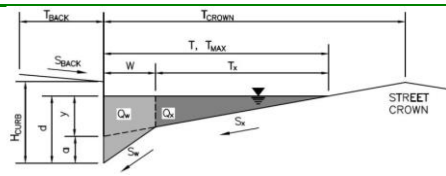
Version 4.05 Released March 2017

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

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

Project: Drennan Subdivision Filing No. 1

Inlet ID: D-7



Gutter Geometry (Enter data in the blue cells)

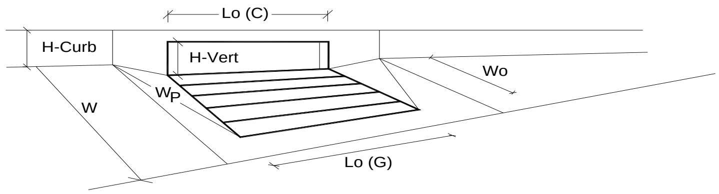
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	25.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	25.0	25.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

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

INLET IN A SUMP OR SAG LOCATION

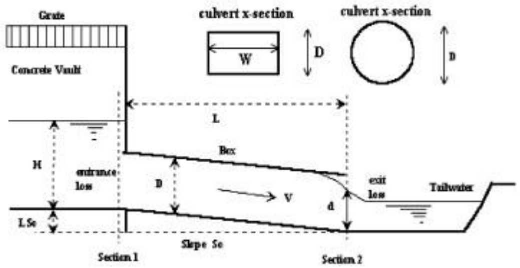
Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (Colorado Springs D-10-R)	Type =	Colorado Springs D-10-R		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	4.00	4.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	2	2	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	6.0	inches
Grate Information		MINOR	MAJOR	Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	4.00	4.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	8.00	8.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	8.00	8.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	81.00	81.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	1.00	1.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.42	0.42	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.61	0.61	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**10.5**	**10.5**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	3.4	6.3	cfs

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Drennan Subdivision Filing No. 1
Basin ID: D-7
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	24	inches
	Inlet Edge Type (choose from pull-down list)		Square End Projection	
OR:				
Box Culvert:	Barrel Height (Rise) in Feet	Height (Rise) =		ft.
	Barrel Width (Span) in Feet	Width (Span) =		ft.
	Inlet Edge Type (choose from pull-down list)		Square Edge w/ 30-78 deg. Flared Wingwall	
	Number of Barrels	No =	1	
	Inlet Elevation at Culvert Invert	Inlet Elev =	5857.52	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Slope =	0.005	ft vert. / ft horiz.
	Culvert Length in Feet	L =	193.92	ft.
	Manning's Roughness	n =	0.012	
	Bend Loss Coefficient	K_b =	0	
	Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.50
Friction Loss Coefficient	K_f =	2.04
Sum of All Loss Coefficients	K_s =	3.54
Orifice Inlet Condition Coefficient	C_d =	0.85
Minimum Energy Condition Coefficient	KE_{low} =	0.1121

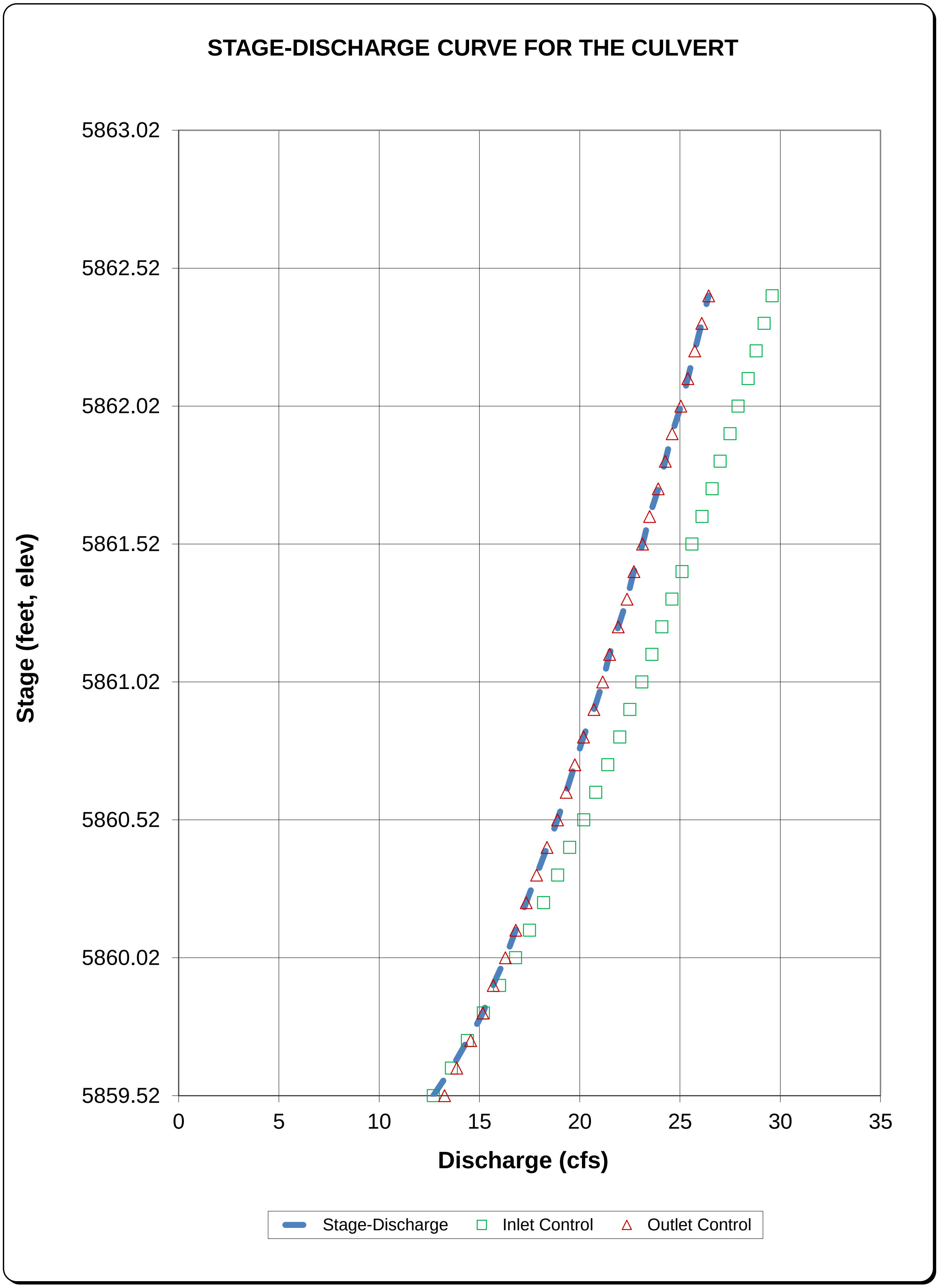
Calculations of Culvert Capacity (output):

Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
5859.52	5858.18	12.70	13.26	**12.70**	Regression Eqn.	INLET
5859.62	5858.18	13.60	13.86	**13.60**	Regression Eqn.	INLET
5859.72	5858.18	14.40	14.56	**14.40**	Regression Eqn.	INLET
5859.82	5858.18	15.20	15.16	**15.16**	Regression Eqn.	OUTLET
5859.92	5858.18	16.00	15.68	**15.68**	Regression Eqn.	OUTLET
5860.02	5858.18	16.80	16.29	**16.29**	Regression Eqn.	OUTLET
5860.12	5858.18	17.50	16.81	**16.81**	Regression Eqn.	OUTLET
5860.22	5858.18	18.20	17.33	**17.33**	Regression Eqn.	OUTLET
5860.32	5858.18	18.90	17.85	**17.85**	Regression Eqn.	OUTLET
5860.42	5858.18	19.50	18.37	**18.37**	Regression Eqn.	OUTLET
5860.52	5858.18	20.20	18.89	**18.89**	Regression Eqn.	OUTLET
5860.62	5858.18	20.80	19.32	**19.32**	Regression Eqn.	OUTLET
5860.72	5858.18	21.40	19.76	**19.76**	Regression Eqn.	OUTLET
5860.82	5858.18	22.00	20.19	**20.19**	Regression Eqn.	OUTLET
5860.92	5858.18	22.50	20.71	**20.71**	Regression Eqn.	OUTLET
5861.02	5858.18	23.10	21.14	**21.14**	Regression Eqn.	OUTLET
5861.12	5858.18	23.60	21.49	**21.49**	Regression Eqn.	OUTLET
5861.22	5858.18	24.10	21.92	**21.92**	Regression Eqn.	OUTLET
5861.32	5858.18	24.60	22.36	**22.36**	Regression Eqn.	OUTLET
5861.42	5858.18	25.10	22.70	**22.70**	Regression Eqn.	OUTLET
5861.52	5858.18	25.60	23.13	**23.13**	Regression Eqn.	OUTLET
5861.62	5858.18	26.10	23.48	**23.48**	Regression Eqn.	OUTLET
5861.72	5858.18	26.60	23.91	**23.91**	Regression Eqn.	OUTLET
5861.82	5858.18	27.00	24.26	**24.26**	Regression Eqn.	OUTLET
5861.92	5858.18	27.50	24.61	**24.61**	Regression Eqn.	OUTLET
5862.02	5858.18	27.90	25.04	**25.04**	Regression Eqn.	OUTLET
5862.12	5858.18	28.40	25.39	**25.39**	Regression Eqn.	OUTLET
5862.22	5858.18	28.80	25.73	**25.73**	Regression Eqn.	OUTLET
5862.32	5858.18	29.20	26.08	**26.08**	Regression Eqn.	OUTLET
5862.42	5858.18	29.60	26.43	**26.43**	Regression Eqn.	OUTLET

Processing Time: 01.28 Seconds

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Drennan Subdivision Filing No. 1
Basin ID: D-7



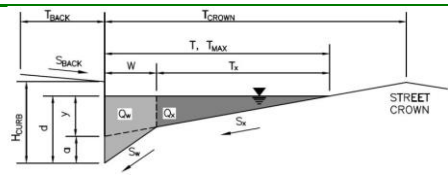
Version 4.05 Released March 2017

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

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

Project: Drennan Subdivision Filing No. 1

Inlet ID: D-8



Gutter Geometry (Enter data in the blue cells)

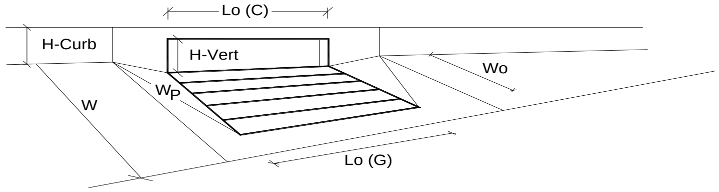
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	16.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.031	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	16.0	16.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

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

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



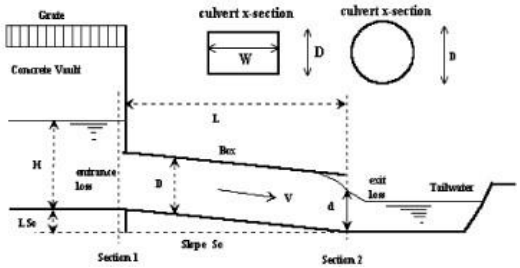
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Colorado Springs D-10-R		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	4.00	4.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	6.0	inches
Grate Information		MINOR	MAJOR	Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	4.00	4.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	8.00	8.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	8.00	8.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	81.00	81.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	1.00	1.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.42	0.42	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.85	0.85	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**4.9**	**4.9**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	1.5	3.5	cfs

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: **Drennan Subdivision Filing No. 1**
Basin ID: **D-8**
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	15	inches
	Inlet Edge Type (choose from pull-down list)		Square End Projection	
OR:				
Box Culvert:	Barrel Height (Rise) in Feet	Height (Rise) =		ft.
	Barrel Width (Span) in Feet	Width (Span) =		ft.
	Inlet Edge Type (choose from pull-down list)		Square Edge w/ 30-78 deg. Flared Wingwall	
	Number of Barrels	No =	1	
	Inlet Elevation at Culvert Invert	Inlet Elev =	5859	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Slope =	0.005	ft vert. / ft horiz.
	Culvert Length in Feet	L =	146.21	ft.
	Manning's Roughness	n =	0.012	
	Bend Loss Coefficient	K_b =	0	
	Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.50
Friction Loss Coefficient	K_f =	2.88
Sum of All Loss Coefficients	K_s =	4.38
Orifice Inlet Condition Coefficient	C_d =	0.85
Minimum Energy Condition Coefficient	KE_{low} =	0.0560

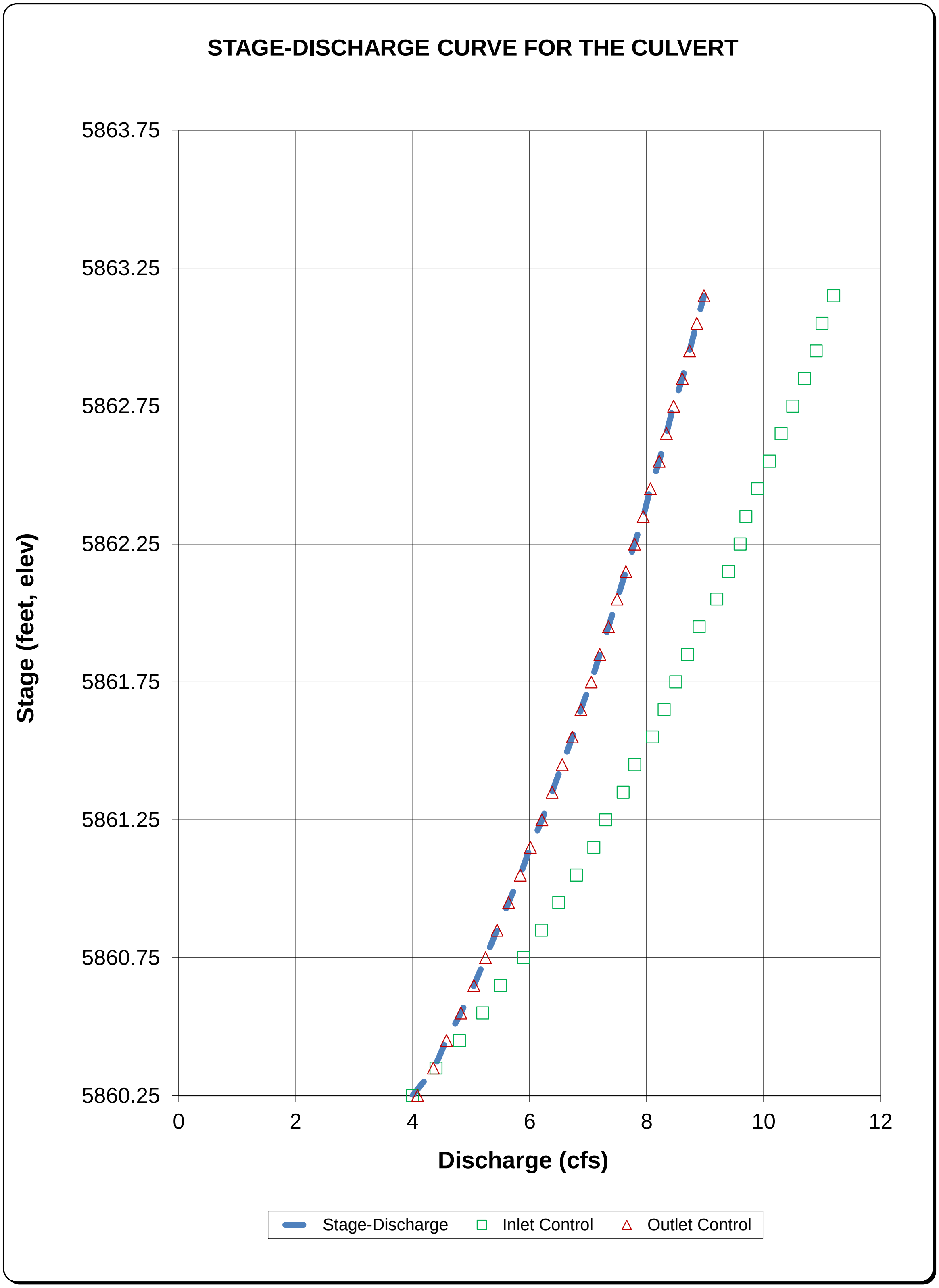
Calculations of Culvert Capacity (output):

Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
5860.25	5859.09	4.00	4.08	**4.00**	Regression Eqn.	INLET
5860.35	5859.09	4.40	4.35	**4.35**	Regression Eqn.	OUTLET
5860.45	5859.09	4.80	4.58	**4.58**	Regression Eqn.	OUTLET
5860.55	5859.09	5.20	4.82	**4.82**	Regression Eqn.	OUTLET
5860.65	5859.09	5.50	5.05	**5.05**	Regression Eqn.	OUTLET
5860.75	5859.09	5.90	5.25	**5.25**	Regression Eqn.	OUTLET
5860.85	5859.09	6.20	5.44	**5.44**	Regression Eqn.	OUTLET
5860.95	5859.09	6.50	5.64	**5.64**	Regression Eqn.	OUTLET
5861.05	5859.09	6.80	5.84	**5.84**	Regression Eqn.	OUTLET
5861.15	5859.09	7.10	6.01	**6.01**	Regression Eqn.	OUTLET
5861.25	5859.09	7.30	6.21	**6.21**	Regression Eqn.	OUTLET
5861.35	5859.09	7.60	6.38	**6.38**	Regression Eqn.	OUTLET
5861.45	5859.09	7.80	6.56	**6.56**	Regression Eqn.	OUTLET
5861.55	5859.09	8.10	6.73	**6.73**	Regression Eqn.	OUTLET
5861.65	5859.09	8.30	6.88	**6.88**	Regression Eqn.	OUTLET
5861.75	5859.09	8.50	7.05	**7.05**	Regression Eqn.	OUTLET
5861.85	5859.09	8.70	7.20	**7.20**	Regression Eqn.	OUTLET
5861.95	5859.09	8.90	7.35	**7.35**	Regression Eqn.	OUTLET
5862.05	5859.09	9.20	7.50	**7.50**	Regression Eqn.	OUTLET
5862.15	5859.09	9.40	7.65	**7.65**	Regression Eqn.	OUTLET
5862.25	5859.09	9.60	7.79	**7.79**	Regression Eqn.	OUTLET
5862.35	5859.09	9.70	7.94	**7.94**	Regression Eqn.	OUTLET
5862.45	5859.09	9.90	8.07	**8.07**	Regression Eqn.	OUTLET
5862.55	5859.09	10.10	8.21	**8.21**	Regression Eqn.	OUTLET
5862.65	5859.09	10.30	8.34	**8.34**	Regression Eqn.	OUTLET
5862.75	5859.09	10.50	8.46	**8.46**	Regression Eqn.	OUTLET
5862.85	5859.09	10.70	8.61	**8.61**	Orifice Eqn.	OUTLET
5862.95	5859.09	10.90	8.73	**8.73**	Orifice Eqn.	OUTLET
5863.05	5859.09	11.00	8.86	**8.86**	Orifice Eqn.	OUTLET
5863.15	5859.09	11.20	8.98	**8.98**	Orifice Eqn.	OUTLET

Processing Time: 03.19 Seconds

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: **Drennan Subdivision Filing No. 1**
Basin ID: **D-8**



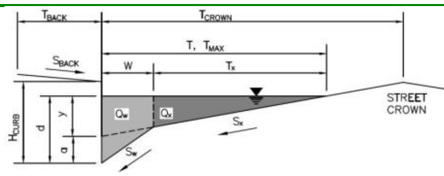
Version 4.05 Released March 2017

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

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

Project: Drennan Subdivision Filing No. 1

Inlet ID: D-9



Gutter Geometry (Enter data in the blue cells)

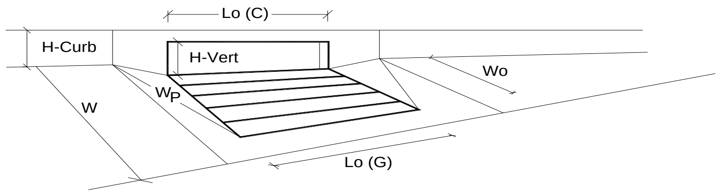
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	20.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.050	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013	
Height of Curb at Gutter Flow Line	H_{CURB} =	8.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	48.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	48.0	48.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	8.0	8.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

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

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



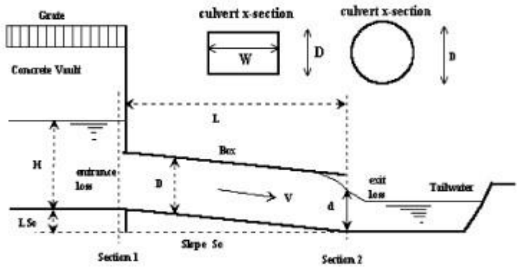
Design Information (Input)	Colorado Springs D-10-R		MINOR	MAJOR	
Type of Inlet		Type =	Colorado Springs D-10-R		
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local} =	4.00	4.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	12.0	12.0	inches
Grate Information			MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate		L_o (G) =	N/A	N/A	feet
Width of a Unit Grate		W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C_o (G) =	N/A	N/A	
Curb Opening Information			MINOR	MAJOR	
Length of a Unit Curb Opening		L_o (C) =	4.00	4.00	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	8.00	8.00	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	8.00	8.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	81.00	81.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W_p =	1.00	1.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.92	0.92	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	1.00	1.00	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**12.6**	**12.6**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	3.5	6.6	cfs

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: **Drennan Subdivision Filing No. 1**
Basin ID: **D-9**
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	24	inches
	Inlet Edge Type (choose from pull-down list)		Grooved End with Headwall	
OR:				
Box Culvert:	Barrel Height (Rise) in Feet	Height (Rise) =		ft.
	Barrel Width (Span) in Feet	Width (Span) =		ft.
	Inlet Edge Type (choose from pull-down list)		Square Edge w/ 30-78 deg. Flared Wingwall	
	Number of Barrels	No =	1	
	Inlet Elevation at Culvert Invert	Inlet Elev =	5857.83	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Outlet Elev =	5857	ft. elev.
	Culvert Length in Feet	L =	166.99	ft.
	Manning's Roughness	n =	0.012	
	Bend Loss Coefficient	K_b =	0	
	Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.20
Friction Loss Coefficient	K_f =	1.76
Sum of All Loss Coefficients	K_s =	2.96
Orifice Inlet Condition Coefficient	C_d =	0.99
Minimum Energy Condition Coefficient	KE_{low} =	-0.0342

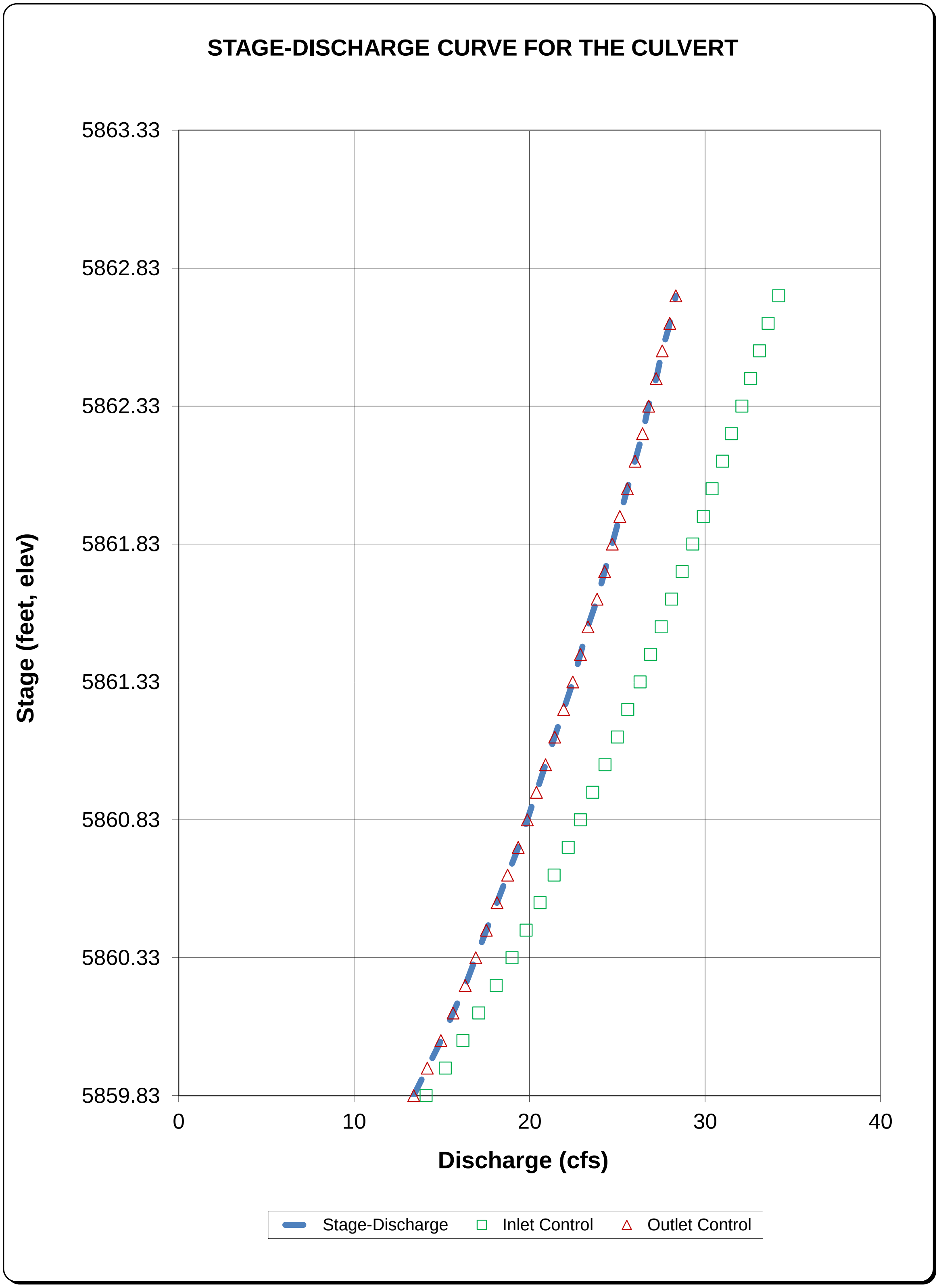
Calculations of Culvert Capacity (output):

Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
5859.83	5859.00	14.10	13.39	**13.39**	Regression Eqn.	OUTLET
5859.93	5859.00	15.20	14.17	**14.17**	Regression Eqn.	OUTLET
5860.03	5859.00	16.20	14.95	**14.95**	Regression Eqn.	OUTLET
5860.13	5859.00	17.10	15.64	**15.64**	Regression Eqn.	OUTLET
5860.23	5859.00	18.10	16.33	**16.33**	Regression Eqn.	OUTLET
5860.33	5859.00	19.00	16.93	**16.93**	Regression Eqn.	OUTLET
5860.43	5859.00	19.80	17.54	**17.54**	Regression Eqn.	OUTLET
5860.53	5859.00	20.60	18.14	**18.14**	Regression Eqn.	OUTLET
5860.63	5859.00	21.40	18.75	**18.75**	Regression Eqn.	OUTLET
5860.73	5859.00	22.20	19.35	**19.35**	Regression Eqn.	OUTLET
5860.83	5859.00	22.90	19.87	**19.87**	Regression Eqn.	OUTLET
5860.93	5859.00	23.60	20.39	**20.39**	Regression Eqn.	OUTLET
5861.03	5859.00	24.30	20.91	**20.91**	Regression Eqn.	OUTLET
5861.13	5859.00	25.00	21.42	**21.42**	Regression Eqn.	OUTLET
5861.23	5859.00	25.60	21.94	**21.94**	Regression Eqn.	OUTLET
5861.33	5859.00	26.30	22.46	**22.46**	Regression Eqn.	OUTLET
5861.43	5859.00	26.90	22.89	**22.89**	Regression Eqn.	OUTLET
5861.53	5859.00	27.50	23.33	**23.33**	Regression Eqn.	OUTLET
5861.63	5859.00	28.10	23.84	**23.84**	Regression Eqn.	OUTLET
5861.73	5859.00	28.70	24.28	**24.28**	Regression Eqn.	OUTLET
5861.83	5859.00	29.30	24.71	**24.71**	Regression Eqn.	OUTLET
5861.93	5859.00	29.90	25.14	**25.14**	Regression Eqn.	OUTLET
5862.03	5859.00	30.40	25.57	**25.57**	Regression Eqn.	OUTLET
5862.13	5859.00	31.00	26.00	**26.00**	Regression Eqn.	OUTLET
5862.23	5859.00	31.50	26.44	**26.44**	Regression Eqn.	OUTLET
5862.33	5859.00	32.10	26.78	**26.78**	Regression Eqn.	OUTLET
5862.43	5859.00	32.60	27.21	**27.21**	Regression Eqn.	OUTLET
5862.53	5859.00	33.10	27.56	**27.56**	Regression Eqn.	OUTLET
5862.63	5859.00	33.60	27.99	**27.99**	Regression Eqn.	OUTLET
5862.73	5859.00	34.20	28.34	**28.34**	Regression Eqn.	OUTLET

Processing Time: 01.22 Seconds

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Drennan Subdivision Filing No. 1
Basin ID: D-9



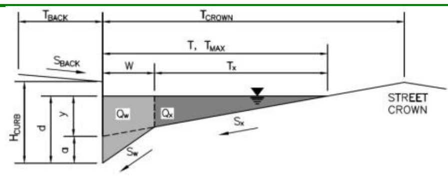
Version 4.05 Released March 2017

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

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

Project: Drennan Subdivision Filing No. 1

Inlet ID: D-10



Gutter Geometry (Enter data in the blue cells)

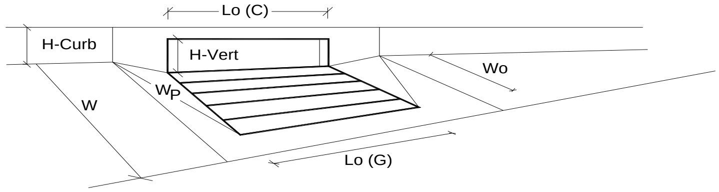
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	20.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.050	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013	
Height of Curb at Gutter Flow Line	H_{CURB} =	12.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	48.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	48.0	48.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	8.0	8.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

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

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



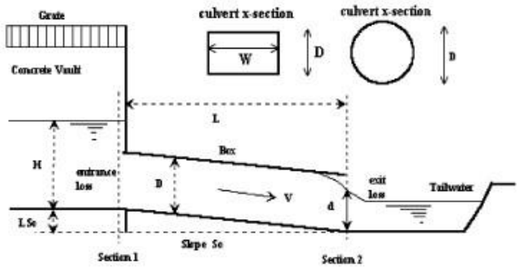
Design Information (Input) Colorado Springs D-10-R		MINOR	MAJOR	
Type of Inlet	Type =	Colorado Springs D-10-R		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	4.00	4.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	12.0	12.0	inches
Grate Information		MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	4.00	4.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	8.00	8.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	8.00	8.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	81.00	81.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	1.00	1.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.92	0.92	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	1.00	1.00	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**12.6**	**12.6**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	4.8	9.6	cfs

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: **Drennan Subdivision Filing No. 1**
Basin ID: **D-10**
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	18	inches
	Inlet Edge Type (choose from pull-down list)		Square End Projection	
OR:				
Box Culvert:	Barrel Height (Rise) in Feet	Height (Rise) =		ft.
	Barrel Width (Span) in Feet	Width (Span) =		ft.
	Inlet Edge Type (choose from pull-down list)		Square Edge w/ 30-78 deg. Flared Wingwall	
	Number of Barrels	No =	1	
	Inlet Elevation at Culvert Invert	Inlet Elev =	5858.92	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Outlet Elev =	5857.92	ft. elev.
	Culvert Length in Feet	L =	200	ft.
	Manning's Roughness	n =	0.012	
	Bend Loss Coefficient	K_b =	0	
	Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.50
Friction Loss Coefficient	K_f =	3.09
Sum of All Loss Coefficients	K_s =	4.59
Orifice Inlet Condition Coefficient	C_d =	0.85
Minimum Energy Condition Coefficient	KE_{low} =	0.1091

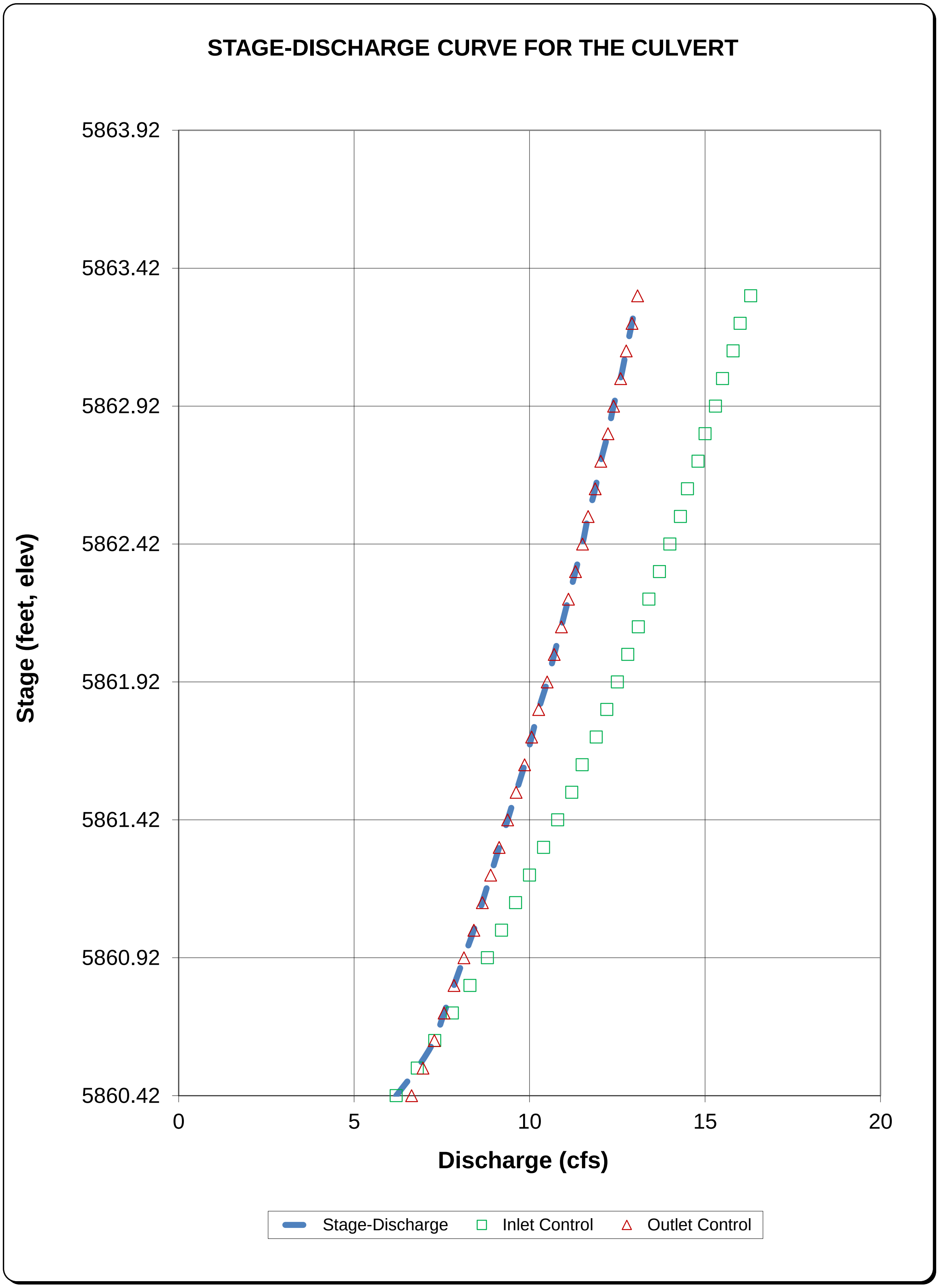
Calculations of Culvert Capacity (output):

Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
5860.42	5859.42	6.20	6.64	**6.20**	Regression Eqn.	INLET
5860.52	5859.42	6.80	6.96	**6.80**	Regression Eqn.	INLET
5860.62	5859.42	7.30	7.28	**7.28**	Regression Eqn.	OUTLET
5860.72	5859.42	7.80	7.56	**7.56**	Regression Eqn.	OUTLET
5860.82	5859.42	8.30	7.85	**7.85**	Regression Eqn.	OUTLET
5860.92	5859.42	8.80	8.13	**8.13**	Regression Eqn.	OUTLET
5861.02	5859.42	9.20	8.41	**8.41**	Regression Eqn.	OUTLET
5861.12	5859.42	9.60	8.65	**8.65**	Regression Eqn.	OUTLET
5861.22	5859.42	10.00	8.89	**8.89**	Regression Eqn.	OUTLET
5861.32	5859.42	10.40	9.13	**9.13**	Regression Eqn.	OUTLET
5861.42	5859.42	10.80	9.37	**9.37**	Regression Eqn.	OUTLET
5861.52	5859.42	11.20	9.62	**9.62**	Regression Eqn.	OUTLET
5861.62	5859.42	11.50	9.86	**9.86**	Regression Eqn.	OUTLET
5861.72	5859.42	11.90	10.06	**10.06**	Regression Eqn.	OUTLET
5861.82	5859.42	12.20	10.26	**10.26**	Regression Eqn.	OUTLET
5861.92	5859.42	12.50	10.50	**10.50**	Regression Eqn.	OUTLET
5862.02	5859.42	12.80	10.70	**10.70**	Regression Eqn.	OUTLET
5862.12	5859.42	13.10	10.90	**10.90**	Regression Eqn.	OUTLET
5862.22	5859.42	13.40	11.10	**11.10**	Regression Eqn.	OUTLET
5862.32	5859.42	13.70	11.31	**11.31**	Regression Eqn.	OUTLET
5862.42	5859.42	14.00	11.51	**11.51**	Regression Eqn.	OUTLET
5862.52	5859.42	14.30	11.67	**11.67**	Regression Eqn.	OUTLET
5862.62	5859.42	14.50	11.87	**11.87**	Regression Eqn.	OUTLET
5862.72	5859.42	14.80	12.03	**12.03**	Regression Eqn.	OUTLET
5862.82	5859.42	15.00	12.23	**12.23**	Regression Eqn.	OUTLET
5862.92	5859.42	15.30	12.39	**12.39**	Regression Eqn.	OUTLET
5863.02	5859.42	15.50	12.59	**12.59**	Regression Eqn.	OUTLET
5863.12	5859.42	15.80	12.75	**12.75**	Regression Eqn.	OUTLET
5863.22	5859.42	16.00	12.91	**12.91**	Regression Eqn.	OUTLET
5863.32	5859.42	16.30	13.08	**13.08**	Regression Eqn.	OUTLET

Processing Time: 01.27 Seconds

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Drennan Subdivision Filing No. 1
Basin ID: D-10



Drennan Subdivision Filing No. 1
Curb Opening Calculations

Curb Opening	Water Surf Elevation (assumed)	Crest Elevation (assumed)	Crest Length	Flow Depth	**Calc'd Flow**	Required Flow
Basin D-12	100.50	100.0	4.25 ft	0.50 ft	**4.5 cfs**	4.3 cfs
Basin D-13	100.50	100.0	5.67 ft	0.50 ft	**6.0 cfs**	5.90 cfs

Weir Equation:

$Q = CLH^{1.5}$

C = 3.0

C = Weir coefficient (dimensionless), C = 3.0 (most cases)

L = Length of weir at Crest, in ft. Not including sideslopes.

Drennan Subdivisioniling No. 1
D-21A Curb Opening Capacity Calculations

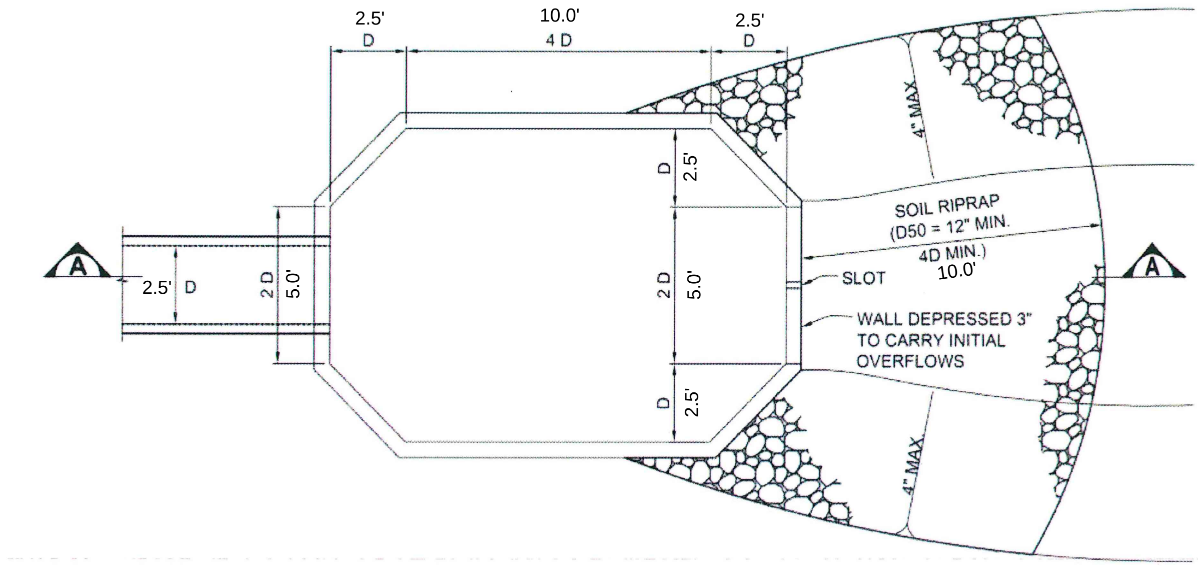
100-year EDB Outfall Channel Description	**Design Flow**	Bottom Width	Channel Side Slope		Flow Depth	Channel Slope	Manning "n"	Top Width	Channel Area	Wetted Perimeter	Hydraulic Radius	Flow Velocity	**Channel Flow Capacity**
			Left	Right									
Lots 1&2	**4.1 cfs**	4.0 ft	0:1	0:1	0.50 ft	2.0%	0.015	4.0 ft	2.00 sf	5.0 ft	0.40 ft	7.6 ft/sec	**15.3 cfs**

Equations:

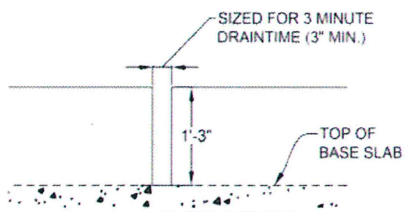
Area (A) = $b(d)+zd^2$
b = width
d = depth

Perimeter (P) = $b+2d*(1+z^2)^{0.5}$
z = side slope
Hydraulic Radius = A/P

Velocity = $(1.49/n)R_n^{2/3} S^{1/2}$
S = Slope of the channel
n = Manning's number
R_n = Hydraulic Radius (Reynold's Number)
Flow = $(1.49/n)AR_n^{2/3} S^{1/2}$



PLAN



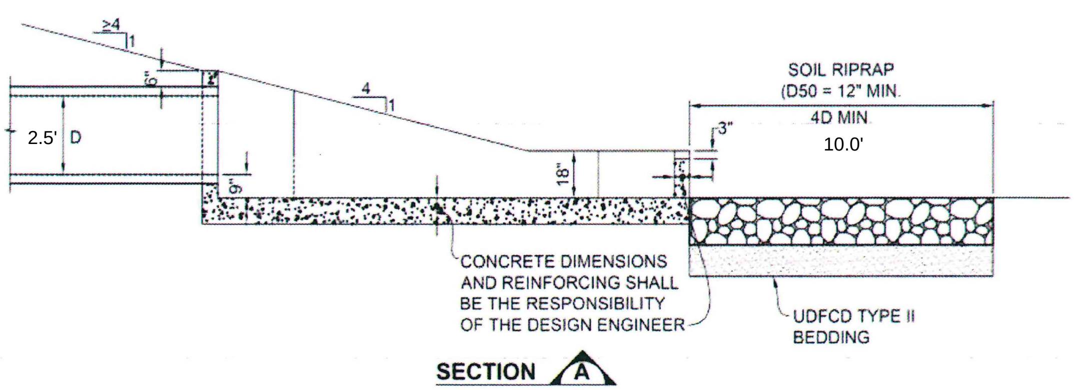
SLOT DETAIL

Volume to drain in 3 minutes = 206.25 cu.ft.

Q = 206.25 cu.ft. / 180 sec. = 1.146 cfs

Length of notch (3" min.) = 1.146 cfs / $(3 \times 1.25^{1.5})$ = 0.820 in. = 53/64 in.

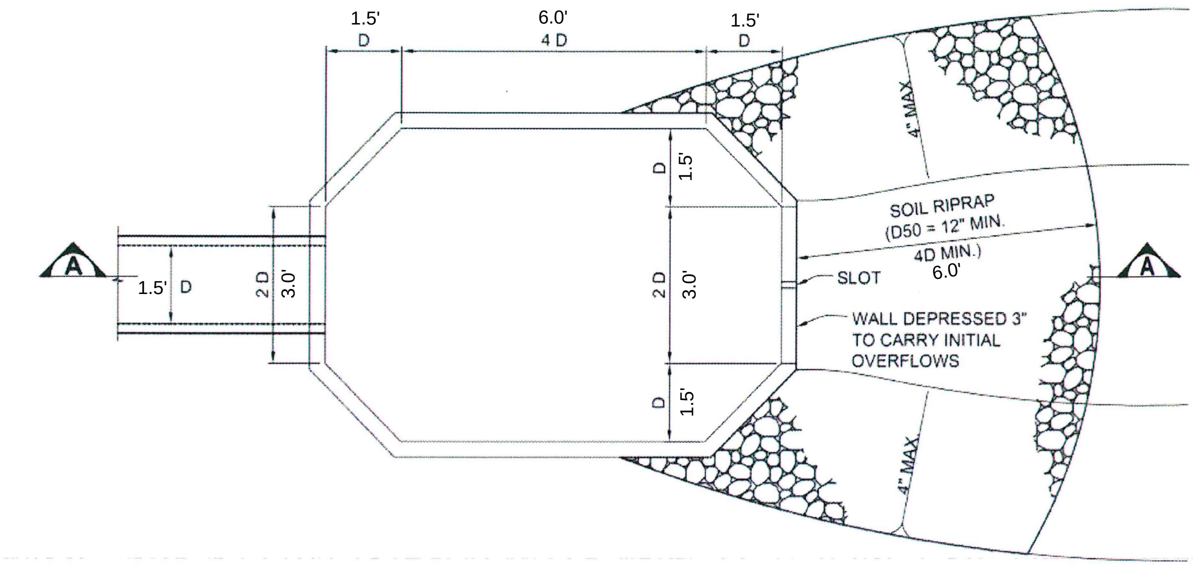
Use 3" for Length of Notch



SECTION A

FOREBAY #1

NTS



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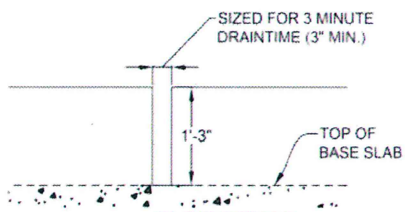


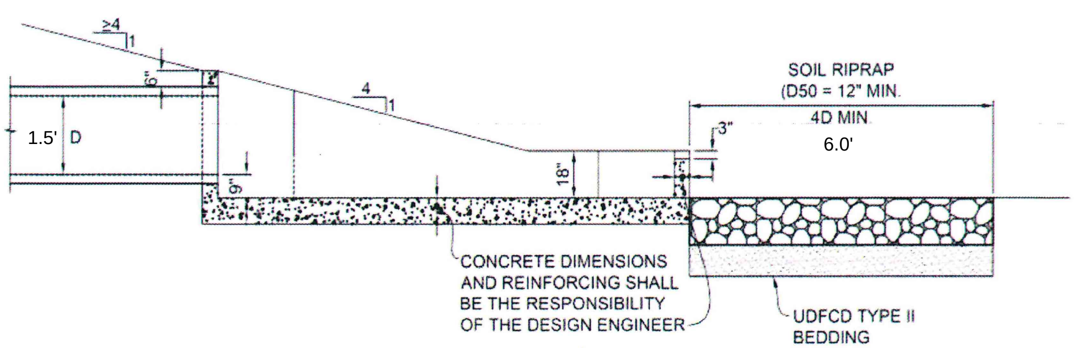
SLOT DETAIL

Volume to drain in 3 minutes = 74.25 cu.ft.

Q = 74.25 cu.ft. / 180 sec. = 0.4125 cfs

Length of notch (3" min.) = 0.4125 cfs / (3x$1.25^{1.5}$) = 0.295 in. = 19/64 in.

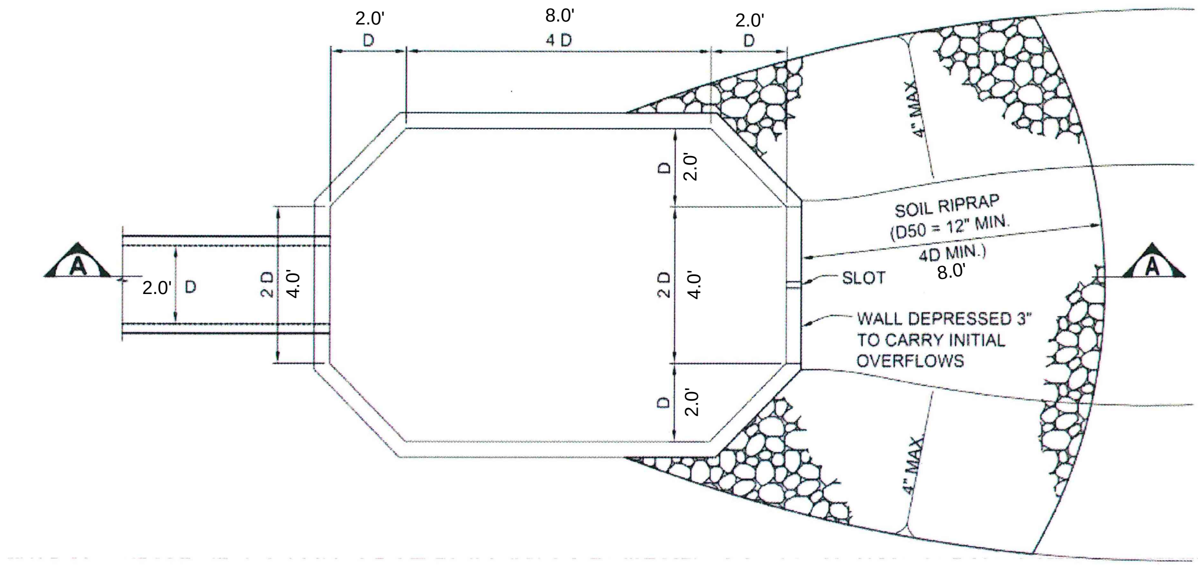
Use 3" for Length of Notch



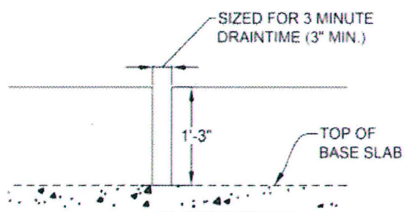
SECTION A

FOREBAY #2

NTS



PLAN



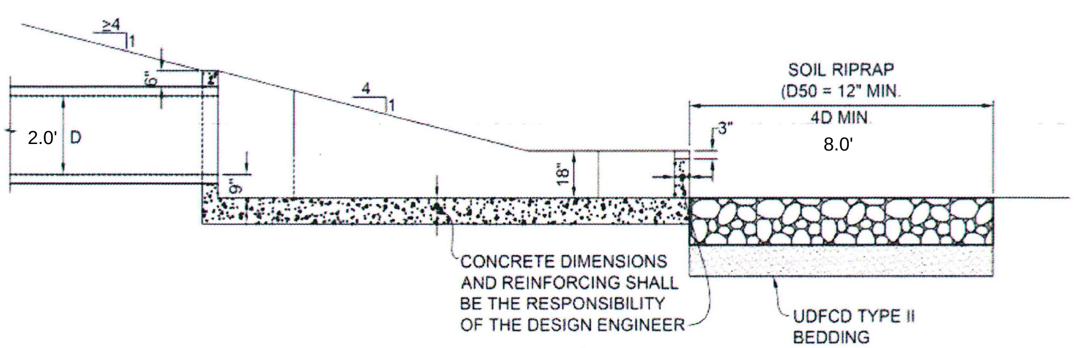
SLOT DETAIL

Volume to drain in 3 minutes = 132.00 cu.ft.

Q = 132.00 cu.ft. / 180 sec. = 0.733 cfs

Length of notch (3" min.) = 0.733 cfs / ($3 \times 1.25^{1.5}$) = 0.525 in. = 17/32 in.

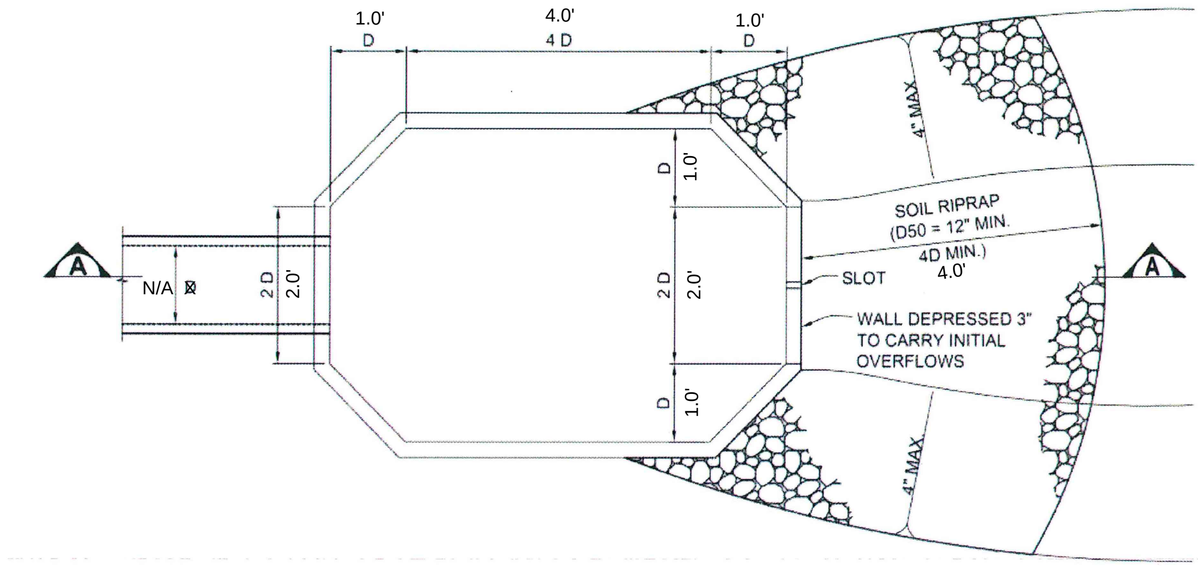
Use 3" for Length of Notch



SECTION A

FOREBAY #3

NTS



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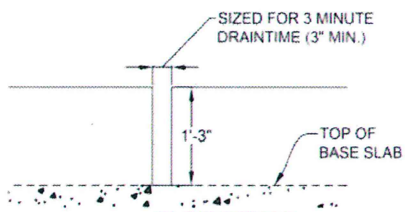


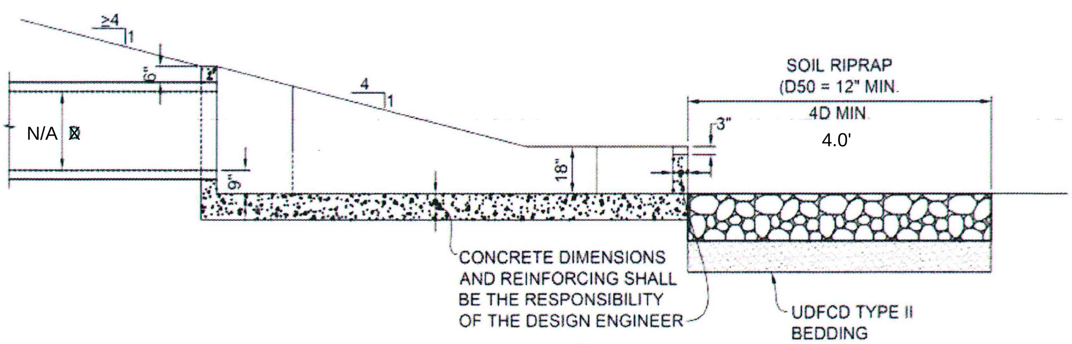
SLOT DETAIL

Volume to drain in 3 minutes = 33.00 cu.ft.

Q = 33.00 cu.ft. / 180 sec. = 0.183 cfs

Length of notch (3" min.) = 0.183 cfs / $(3 \times 1.25^{1.5})$ = 0.131 in. = 1/8 in.

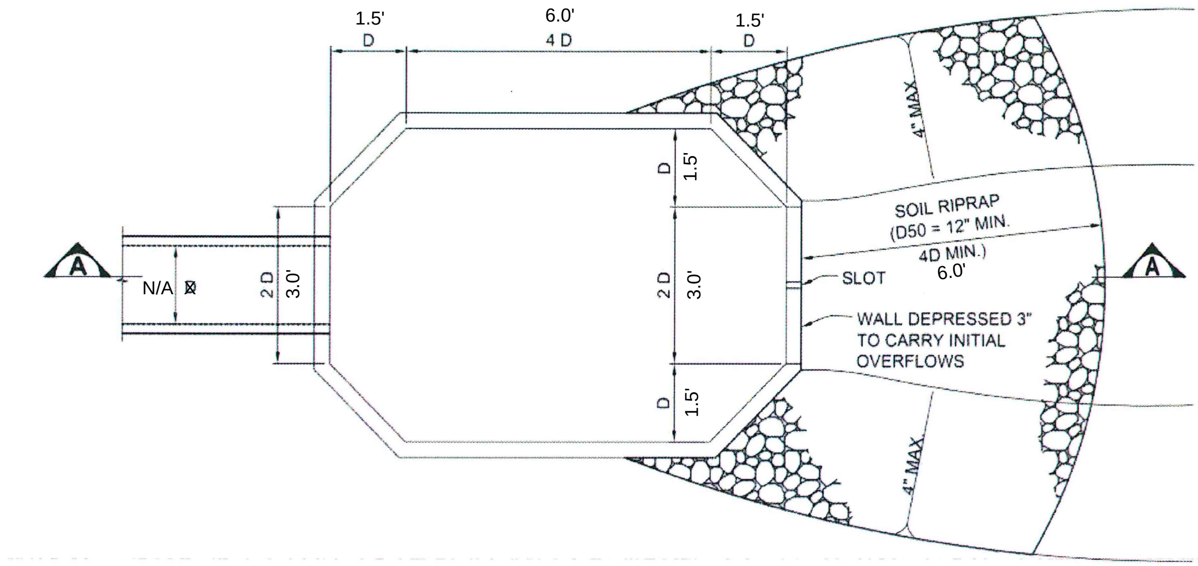
Use 3" for Length of Notch



SECTION A

FOREBAY #4

NTS



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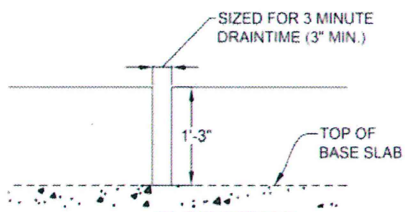


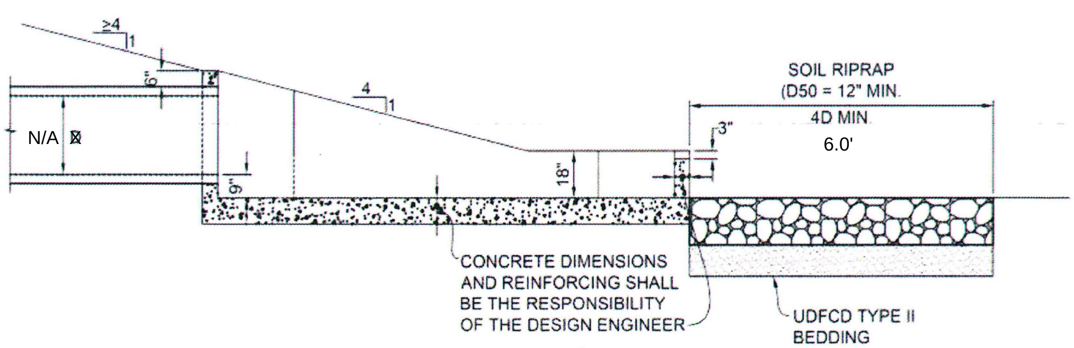
SLOT DETAIL

Volume to drain in 3 minutes = 74.25 cu.ft.

Q = 74.25 cu.ft. / 180 sec. = 0.4125 cfs

Length of notch (3" min.) = 0.4125 cfs / ($3 \times 1.25^{1.5}$) = 0.2950 in. = 19/64 in.

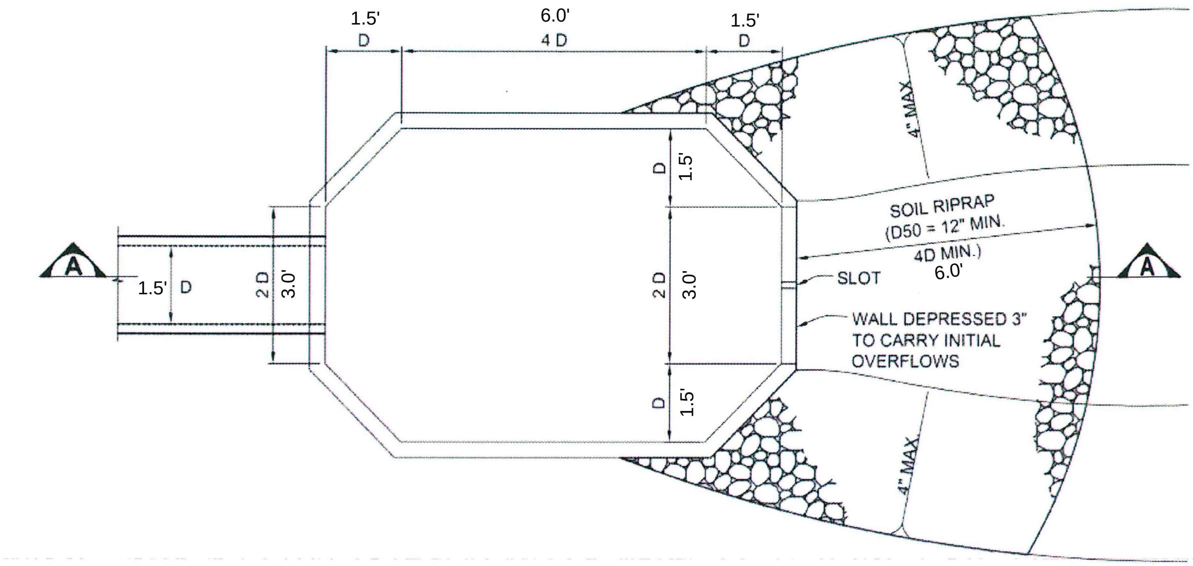
Use 3" for Length of Notch



SECTION A

FOREBAY #5

NTS



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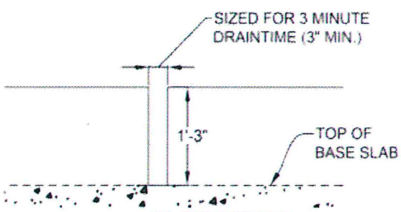


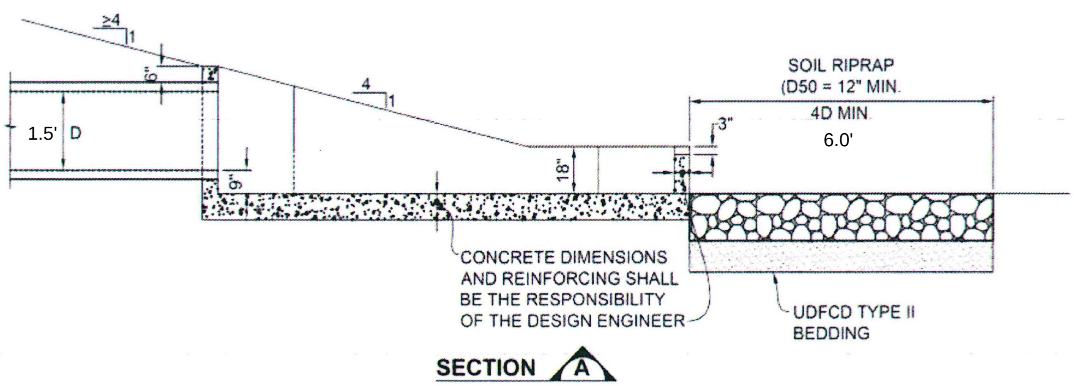
SLOT DETAIL

Volume to drain in 3 minutes = 74.25 cu.ft.

Q = 74.25 cu.ft. / 180 sec. = 0.4125 cfs

Length of notch (3" min.) = 0.4125 cfs / ($3 \times 1.25^{1.5}$) = 0.295 in. = 19/64 in.

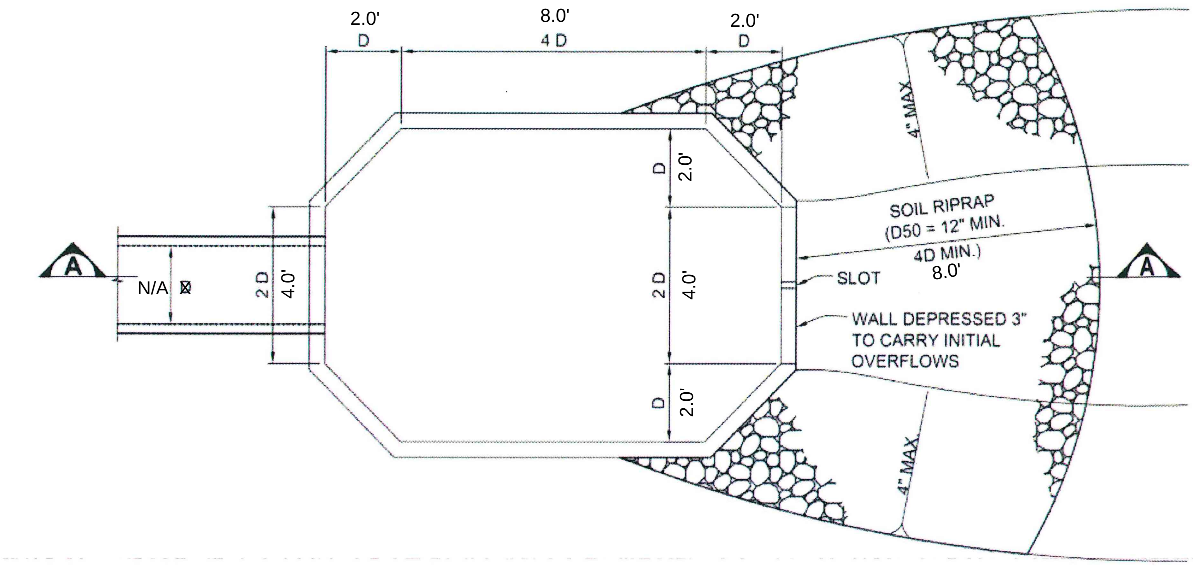
Use 3" for Length of Notch



SECTION A

FOREBAY #6

NTS



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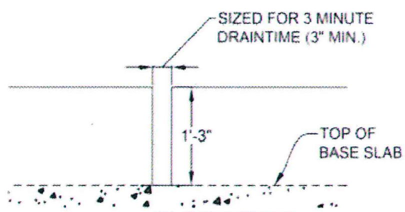


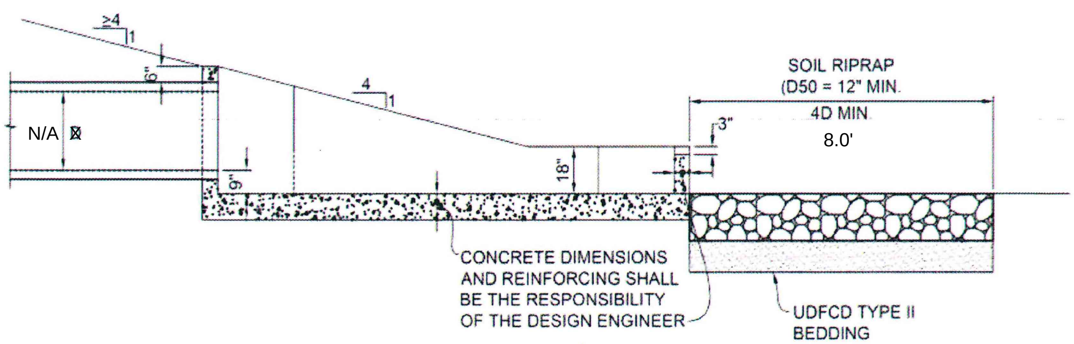
SLOT DETAIL

Volume to drain in 3 minutes = 132.00 cu.ft.

Q = 1.32.00 cu.ft. / 180 sec. = 0.733 cfs

Length of notch (3" min.) = 0.733 cfs / $(3 \times 1.25^{1.5})$ = 0.525 in. = 17/32 in.

Use 3" for Length of Notch



SECTION A

FOREBAY #7

NTS

Site-Level Low Impact Development (LID) Design Effective Impervious Calculator
LID Credit by Impervious Reduction Factor (IRF) Method

UD-BMP (Version 3.06, November 2016)

User Input

Calculated cells

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.53	inches
***Minor Storm: 1-Hour Rain Depth	10-Year Event	1.75	inches
***Major Storm: 1-Hour Rain Depth	100-Year Event	2.52	inches
Optional User Defined Storm	CUHP		
(CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm	100-Year Event		
Max Intensity for Optional User Defined Storm	0		

Designer: NRK
Company: Kiowa Engineering
Date: June 26, 2019
Project: Drennan Subdivision Filing No. 1
Location: Lot 1 & Lot 2

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	**Total**													
Receiving Pervious Area Soil Type	Sandy Loam													
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	10.510													
Directly Connected Impervious Area (DCIA, acres)	2.200													
Unconnected Impervious Area (UIA, acres)	2.330													
Receiving Pervious Area (RPA, acres)	2.290													
Separate Pervious Area (SPA, acres)	3.690													
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	V													

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	10.510													
Directly Connected Impervious Area (DCIA, %)	20.9%													
Unconnected Impervious Area (UIA, %)	22.2%													
Receiving Pervious Area (RPA, %)	21.8%													
Separate Pervious Area (SPA, %)	35.1%													
A_R (RPA / UIA)	0.983													
I_a Check	0.500													
f / I for WQCV Event:	2.0													
f / I for 10-Year Event:	0.5													
f / I for 100-Year Event:	0.3													
f / I for Optional User Defined Storm CUHP:														
IRF for WQCV Event:	0.00													
IRF for 10-Year Event:	0.89													
IRF for 100-Year Event:	0.94													
IRF for Optional User Defined Storm CUHP:														
Total Site Imperviousness: I_{total}	43.1%													
Effective Imperviousness for WQCV Event:	20.9%													
Effective Imperviousness for 10-Year Event:	40.6%													
Effective Imperviousness for 100-Year Event:	41.7%													
Effective Imperviousness for Optional User Defined Storm CUHP:														

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

WQCV Event CREDIT: Reduce Detention By:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10-Year Event CREDIT**: Reduce Detention By:	6.2%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	3.2%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:														

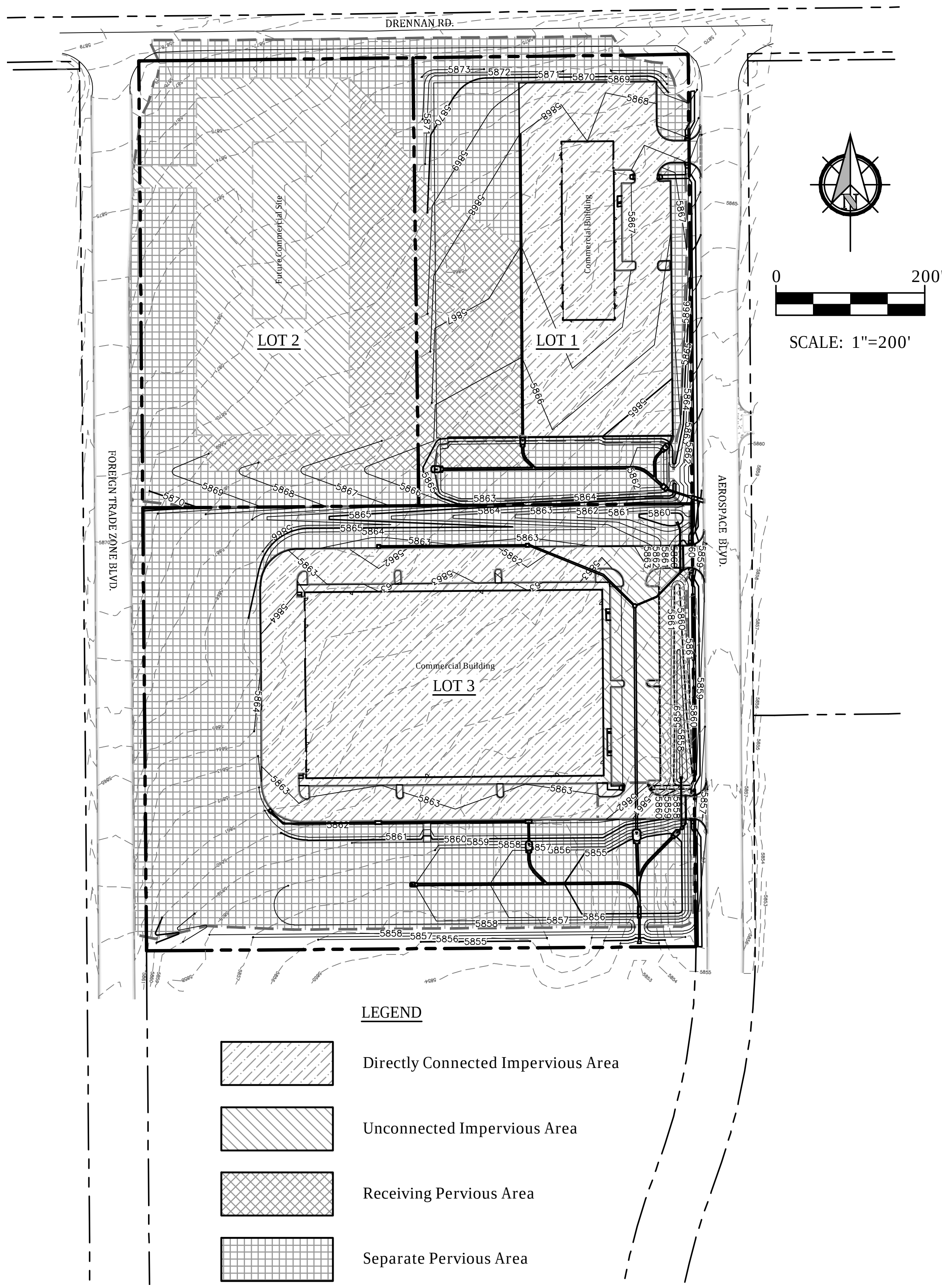
Total Site Imperviousness:	**43.1%**
Total Site Effective Imperviousness for WQCV Event:	**20.9%**
Total Site Effective Imperviousness for 10-Year Event:	**40.6%**
Total Site Effective Imperviousness for 100-Year Event:	**41.7%**
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	

Notes:

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

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

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



IMPERVIOUS REDUCTION FACTOR (IRF) COMPONENTS

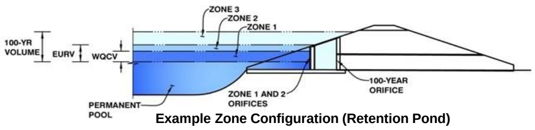
IRF–Map.dwg/Jun 27, 2019/7:34am

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Drennan Subdivision Filing No. 1

Basin ID: Lot 1 & Lot 2



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	**EDB**			
Watershed Area =	10.51	acres		
Watershed Length =	1,083	ft		
Watershed Slope =	0.017	ft/ft		
Watershed Imperviousness =	41.70%	percent		
Percentage Hydrologic Soil Group A =	100.0%	percent		
Percentage Hydrologic Soil Group B =	0.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Desired WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			
Water Quality Capture Volume (WQCV) =	0.161	acre-feet	Optional User Override 1-hr Precipitation	
Excess Urban Runoff Volume (EURV) =	0.480	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.326	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.430	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.534	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.679	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.876	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.115	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.2 in.) =	1.705	acre-feet	3.20	inches
Approximate 2-yr Detention Volume =	0.306	acre-feet		
Approximate 5-yr Detention Volume =	0.405	acre-feet		
Approximate 10-yr Detention Volume =	0.499	acre-feet		
Approximate 25-yr Detention Volume =	0.617	acre-feet		
Approximate 50-yr Detention Volume =	0.696	acre-feet		
Approximate 100-yr Detention Volume =	0.804	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.161	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.319	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.323	acre-feet
Total Detention Basin Volume =	0.804	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 = 1 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	15	0.000		
5861	--	0.05	--	--	--	15	0.000	1	0.000
5862	--	1.05	--	--	--	2,366	0.054	1,168	0.027
5863	--	2.05	--	--	--	20,887	0.479	12,610	0.289
5863.79	--	2.84	--	--	--	23,351	0.536	30,292	0.695
5864	--	3.05	--	--	--	23,991	0.551	35,262	0.810
5865	--	4.05	--	--	--	27,263	0.626	60,889	1.398
5865.5	--	4.55	--	--	--	30,368	0.697	75,297	1.729
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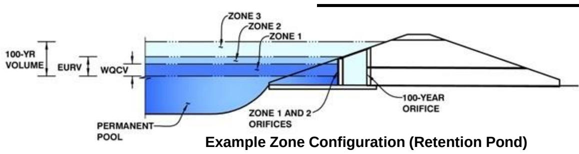
Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Drennan Subdivision Filing No. 1

Basin ID: Lot 1 & Lot 2



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.73	0.161	Orifice Plate
Zone 2 (EURV)	2.43	0.319	Orifice Plate
Zone 3 (100-year)	3.04	0.323	Weir&Pipe (Restrict)
		0.804	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 =	2.07	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	8.30	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

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

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.69	1.38					
Orifice Area (sq. inches)	0.79	0.61	0.69					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.07	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	5.00	N/A	feet
Overflow Weir Slope =	4.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	3.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	2.82	N/A	feet
Over Flow Weir Slope Length =	3.09	N/A	feet
Grate Open Area / 100-yr Orifice Area =	21.48	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	10.82	N/A	ft^2
Overflow Grate Open Area w/ Debris =	5.41	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	5.90		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.50	N/A	ft^2
Outlet Orifice Centroid =	0.29	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.22	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.04	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	15.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

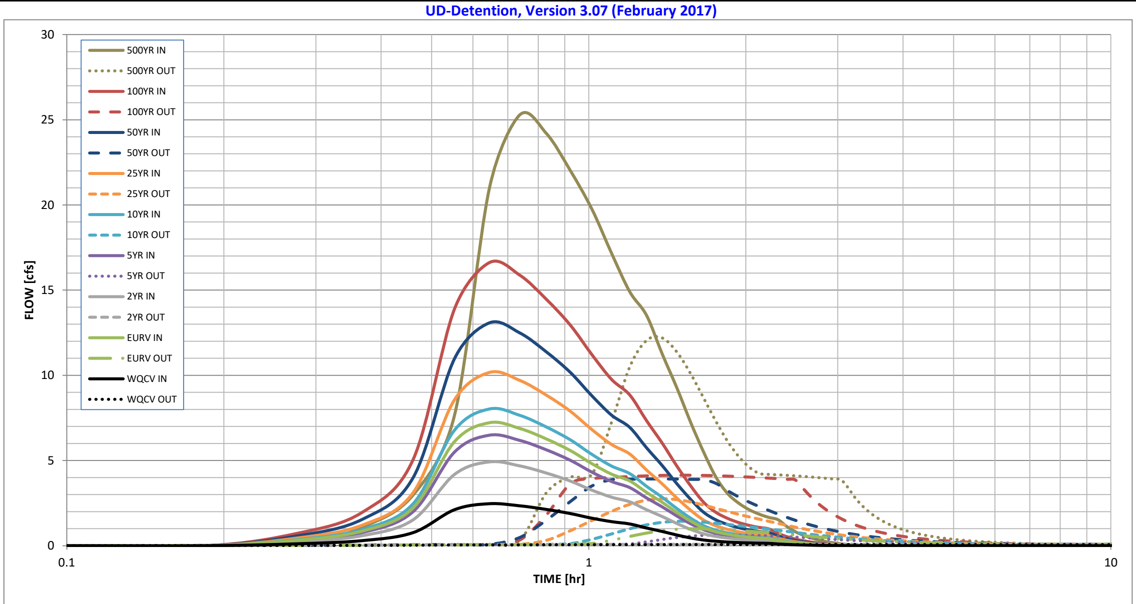
Spillway Design Flow Depth=	0.48	feet
Stage at Top of Freeboard =	4.52	feet
Basin Area at Top of Freeboard =	0.69	acres

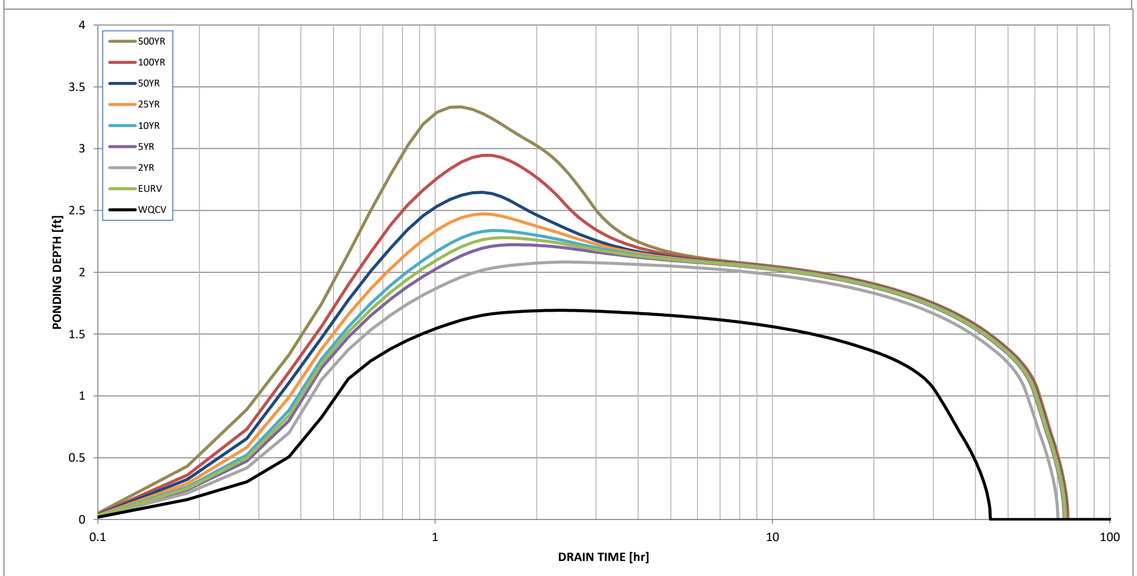
Routed Hydrograph Results

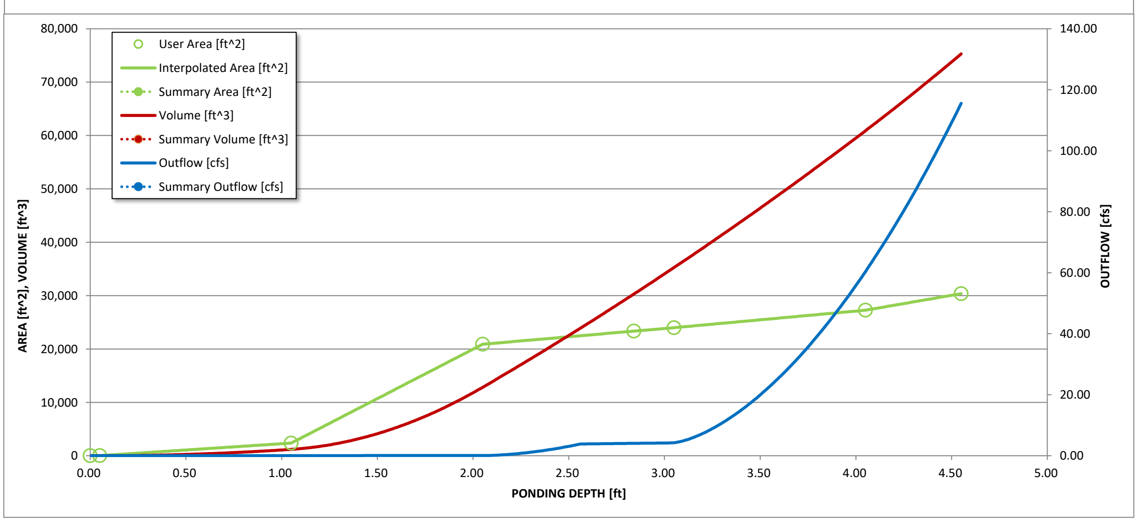
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.20
Calculated Runoff Volume (acre-ft) =	0.161	0.480	0.326	0.430	0.534	0.679	0.876	1.115	1.705
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.161	0.479	0.325	0.430	0.533	0.678	0.874	1.114	1.703
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.00	0.00	0.01	0.02	0.17	0.42	0.97
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.0	0.1	0.2	1.8	4.4	10.2
Peak Inflow Q (cfs) =	2.5	7.2	4.9	6.5	8.0	10.2	13.1	16.6	25.3
Peak Outflow Q (cfs) =	0.1	1.0	0.1	0.6	1.4	2.8	3.9	4.1	12.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	13.5	13.2	11.4	2.2	0.9	1.2
Structure Controlling Flow =	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.08	0.00	0.0	0.1	0.2	0.4	0.4	0.4
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	40	64	63	64	64	62	61	59	55
Time to Drain 99% of Inflow Volume (hours) =	**43**	70	67	70	69	69	68	67	65
Maximum Ponding Depth (ft) =	1.69	2.28	2.08	2.22	2.34	2.47	2.65	2.95	3.34
Area at Maximum Ponding Depth (acres) =	0.33	0.50	0.48	0.49	0.50	0.51	0.52	0.54	0.57
Maximum Volume Stored (acre-ft) =	0.149	0.401	0.309	0.377	0.431	0.502	0.590	0.749	0.967

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)



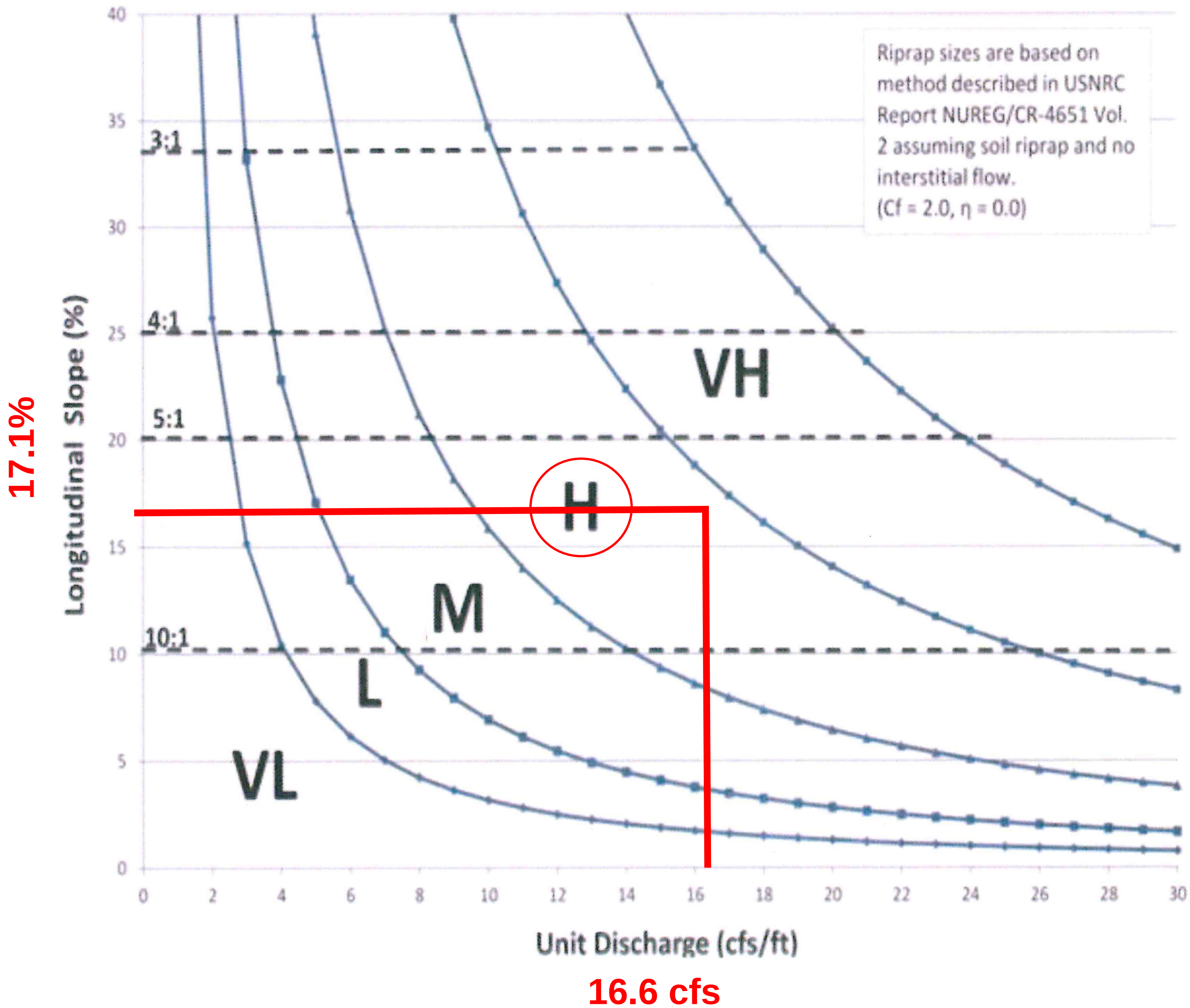




S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

Colorado Springs Drainage Criteria Manual, Volume 1

Figure 13-12d. Riprap Types for Emergency Spillway Protection



Riprap Calculation - Emergency Spillway, Lots 1 & 2

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

LID Credit by Impervious Reduction Factor (IRF) Method

UD-BMP (Version 3.06, November 2016)

User Input

Calculated cells

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.53	inches
***Minor Storm: 1-Hour Rain Depth	10-Year Event	1.75	inches
***Major Storm: 1-Hour Rain Depth	100-Year Event	2.52	inches
Optional User Defined Storm	CUHP		
(CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm	100-Year Event		
Max Intensity for Optional User Defined Storm	0		

Designer: NRK
Company: Kiowa Engineering
Date: June 26, 2019
Project: Drennan Subdivision Filing No. 1
Location: Lot 3

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	**Total**													
Receiving Pervious Area Soil Type	Sandy Loam													
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	9.840													
Directly Connected Impervious Area (DCIA, acres)	4.020													
Unconnected Impervious Area (UIA, acres)	0.540													
Receiving Pervious Area (RPA, acres)	0.280													
Separate Pervious Area (SPA, acres)	5.000													
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	V													

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	9.840													
Directly Connected Impervious Area (DCIA, %)	40.9%													
Unconnected Impervious Area (UIA, %)	5.5%													
Receiving Pervious Area (RPA, %)	2.8%													
Separate Pervious Area (SPA, %)	50.8%													
A_R (RPA / UIA)	0.519													
I_a Check	0.660													
f / I for WQCV Event:	2.0													
f / I for 10-Year Event:	0.5													
f / I for 100-Year Event:	0.3													
f / I for Optional User Defined Storm CUHP:														
IRF for WQCV Event:	0.00													
IRF for 10-Year Event:	0.92													
IRF for 100-Year Event:	0.97													
IRF for Optional User Defined Storm CUHP:														
Total Site Imperviousness: I_{total}	46.3%													
Effective Imperviousness for WQCV Event:	40.9%													
Effective Imperviousness for 10-Year Event:	45.9%													
Effective Imperviousness for 100-Year Event:	46.2%													
Effective Imperviousness for Optional User Defined Storm CUHP:														

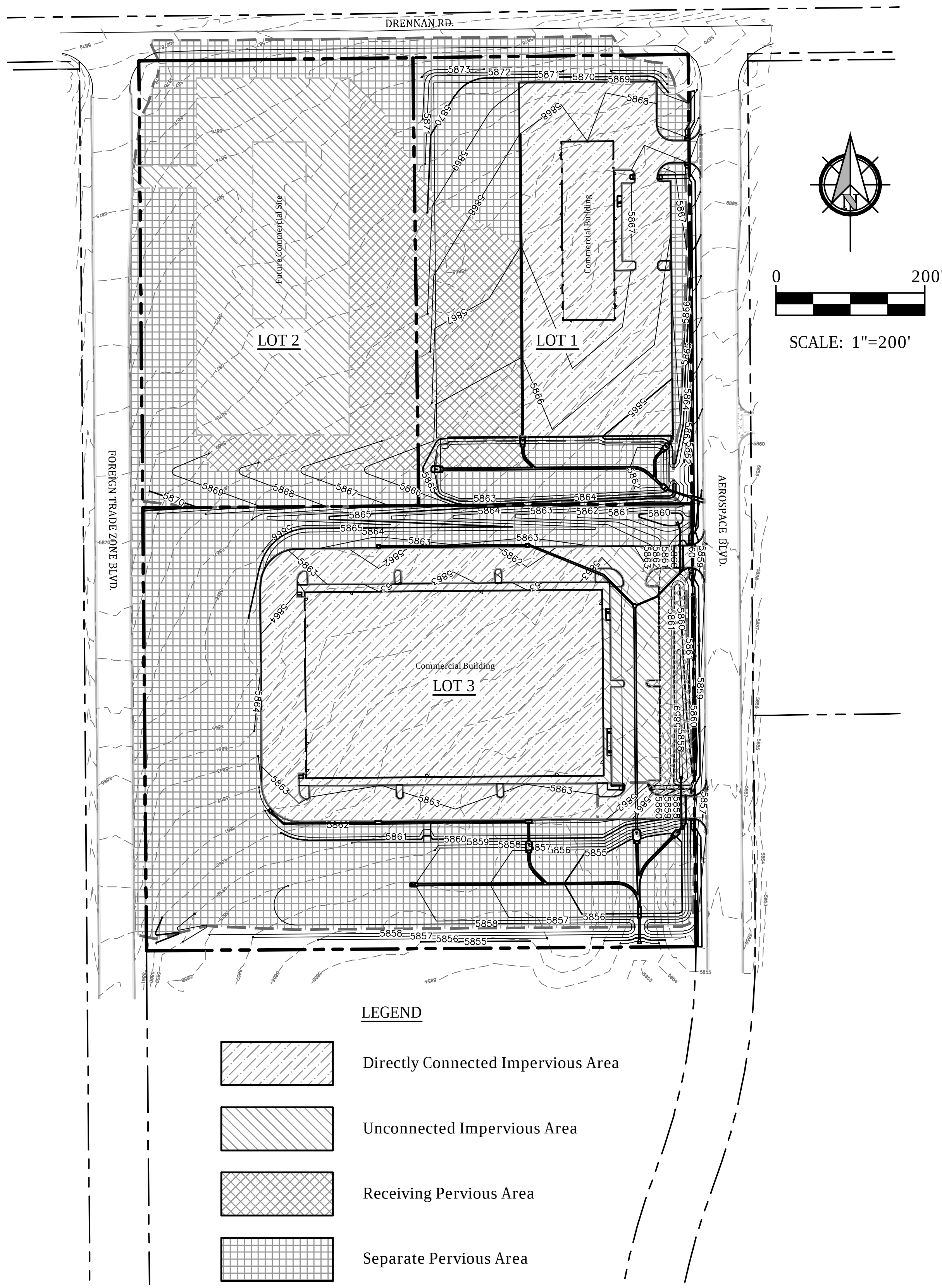
LID / EFFECTIVE IMPERVIOUSNESS CREDITS

WQCV Event CREDIT: Reduce Detention By:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10-Year Event CREDIT**: Reduce Detention By:	1.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	0.3%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:														

Total Site Imperviousness:	**46.3%**
Total Site Effective Imperviousness for WQCV Event:	**40.9%**
Total Site Effective Imperviousness for 10-Year Event:	**45.9%**
Total Site Effective Imperviousness for 100-Year Event:	**46.2%**
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	

Notes:

* Use Green-Ampt average infiltration rate values from Table 3-3.
** Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.
*** Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed



IMPERVIOUS REDUCTION FACTOR (IRF) COMPONENTS

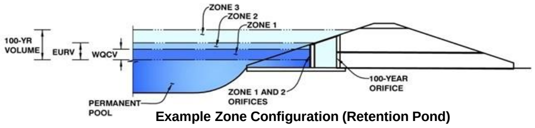
IRF–Map.dwg/Jun 27, 2019/7:34am

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: **Drennan Subdivision Filing No. 1**

Basin ID: **Lot 3**



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	**EDB**			
Watershed Area =	9.85	acres		
Watershed Length =	1,400	ft		
Watershed Slope =	0.014	ft/ft		
Watershed Imperviousness =	46.20%	percent		
Percentage Hydrologic Soil Group A =	100.0%	percent		
Percentage Hydrologic Soil Group B =	0.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Desired WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			
Water Quality Capture Volume (WQCV) =	0.161	acre-feet	Optional User Override 1-hr Precipitation	
Excess Urban Runoff Volume (EURV) =	0.513	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.349	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.460	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.569	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.715	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.904	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.131	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.2 in.) =	1.688	acre-feet	3.20	inches
Approximate 2-yr Detention Volume =	0.329	acre-feet		
Approximate 5-yr Detention Volume =	0.434	acre-feet		
Approximate 10-yr Detention Volume =	0.531	acre-feet		
Approximate 25-yr Detention Volume =	0.653	acre-feet		
Approximate 50-yr Detention Volume =	0.732	acre-feet		
Approximate 100-yr Detention Volume =	0.834	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.161	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.352	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.320	acre-feet
Total Detention Basin Volume =	0.834	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 = 1 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	28	0.001		
5854	--	0.31	--	--	--	28	0.001	8	0.000
5455	--	1.31	--	--	--	14,250	0.327	7,006	0.161
5856	--	2.31	--	--	--	24,662	0.566	26,603	0.611
5857	--	3.31	--	--	--	36,683	0.842	57,276	1.315
5858	--	4.31	--	--	--	42,001	0.964	96,618	2.218
5858.12	--	4.43	--	--	--	43,136	0.990	101,726	2.335
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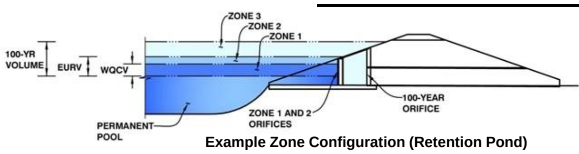
Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Drennan Subdivision Filing No. 1

Basin ID: Lot 3



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.31	0.161	Orifice Plate
Zone 2 (EURV)	2.14	0.352	Orifice Plate
Zone 3 (100-year)	2.68	0.320	Weir&Pipe (Restrict)
		0.834	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 =	2.12	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	8.50	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

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

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.71	1.41					
Orifice Area (sq. inches)	1.05	1.11	2.40					

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

Calculated Parameters for Vertical Orifice

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

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.12	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	3.00	N/A	feet
Overflow Weir Slope =	4.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.12	N/A	feet
Over Flow Weir Slope Length =	4.12	N/A	feet
Grate Open Area / 100-yr Orifice Area =	24.30	N/A	should be $\geq$ 4
Overflow Grate Open Area w/o Debris =	8.66	N/A	ft^2
Overflow Grate Open Area w/ Debris =	4.33	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	4.60		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.36	N/A	ft^2
Outlet Orifice Centroid =	0.23	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.06	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	2.75	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

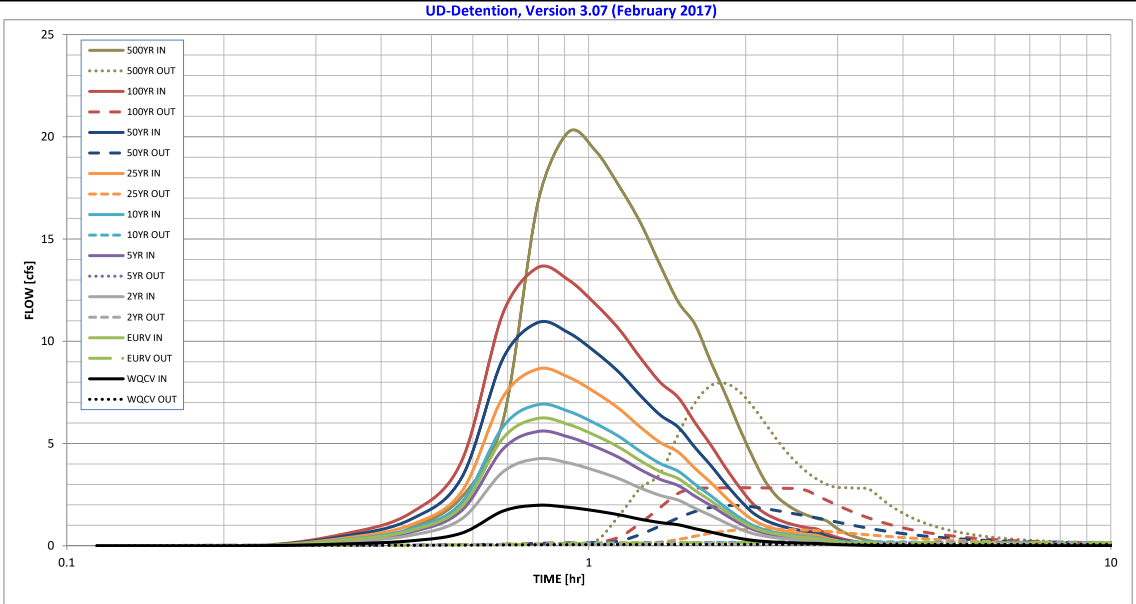
Spillway Design Flow Depth=	0.53	feet
Stage at Top of Freeboard =	4.28	feet
Basin Area at Top of Freeboard =	0.96	acres

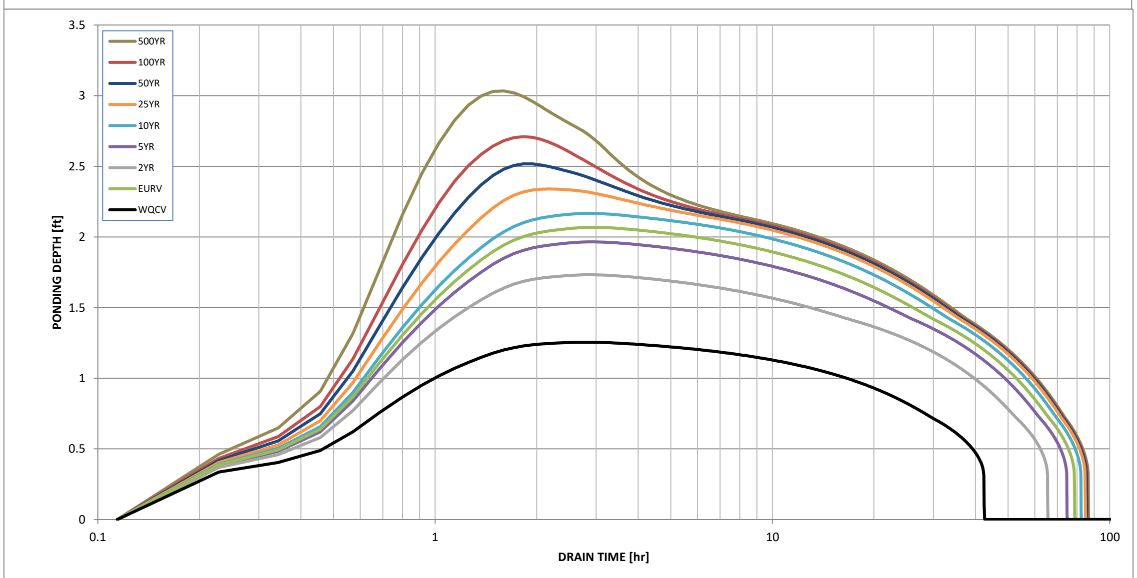
Routed Hydrograph Results

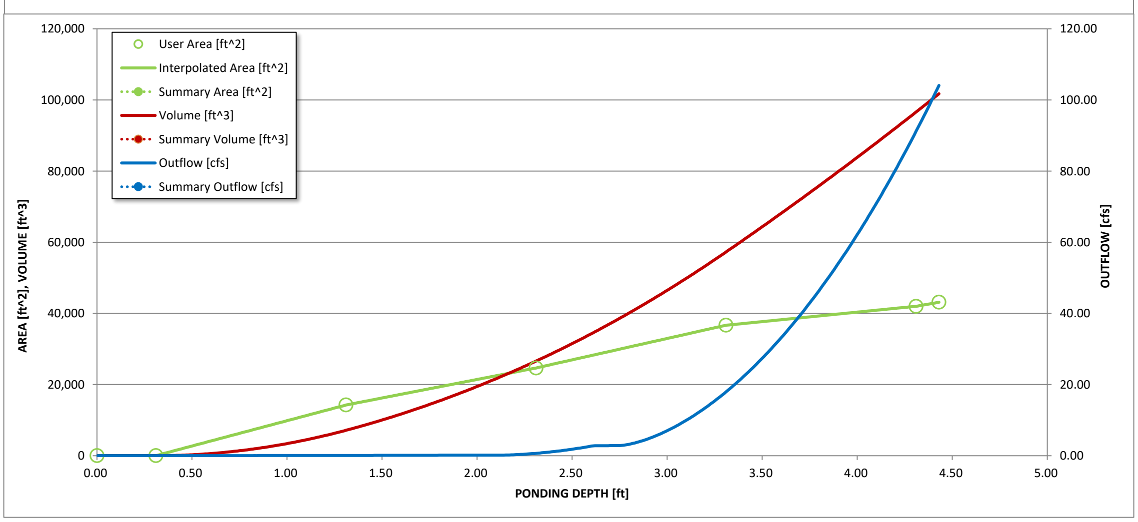
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.20
Calculated Runoff Volume (acre-ft) =	0.161	0.513	0.349	0.460	0.569	0.715	0.904	1.131	1.688
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.160	0.512	0.348	0.459	0.569	0.714	0.904	1.130	1.687
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.00	0.00	0.01	0.02	0.13	0.31	0.74
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.0	0.1	0.2	1.3	3.1	7.3
Peak Inflow Q (cfs) =	2.0	6.2	4.3	5.6	6.9	8.6	10.9	13.6	20.2
Peak Outflow Q (cfs) =	0.1	0.2	0.1	0.2	0.2	0.8	2.0	2.8	7.9
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	4.6	2.9	4.9	1.6	0.9	1.1
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.1	0.2	0.3	0.3
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	40	71	60	68	74	75	73	71	67
Time to Drain 99% of Inflow Volume (hours) =	42	76	64	72	79	81	81	80	78
Maximum Ponding Depth (ft) =	1.26	2.07	1.73	1.97	2.17	2.34	2.52	2.71	3.03
Area at Maximum Ponding Depth (acres) =	0.31	0.51	0.43	0.48	0.53	0.57	0.62	0.68	0.76
Maximum Volume Stored (acre-ft) =	0.145	0.477	0.323	0.427	0.528	0.622	0.729	0.859	1.090

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

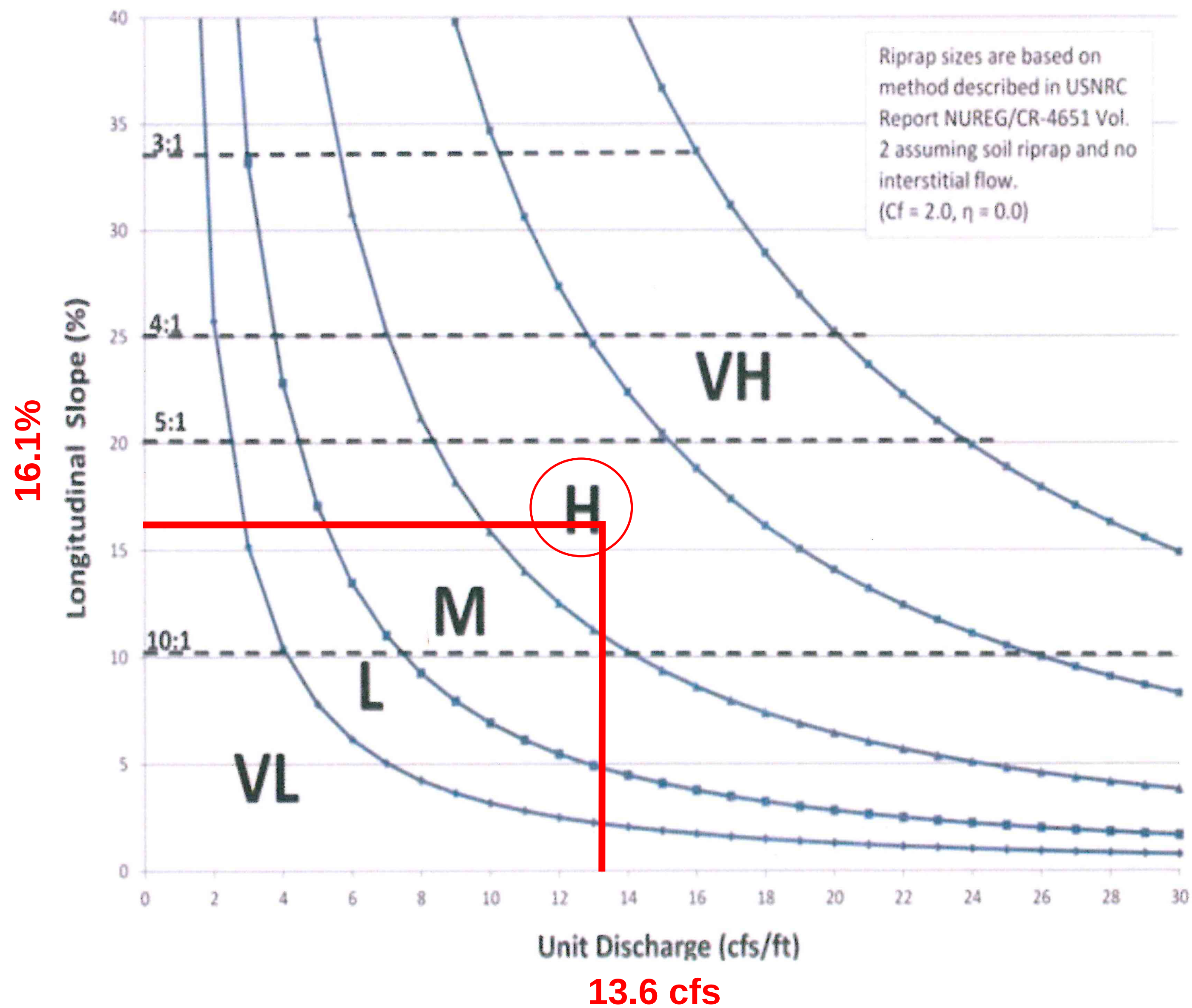






S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

Figure 13-12d. Riprap Types for Emergency Spillway Protection



Riprap Calculation - Emergency Spillway, Lot 3

National Flood Hazard Layer FIRMette

FEMA

38°46'57.35"N

104°40'6.73"W

104°39'29.27"W

38°46'29.30"N

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

1:6,000

Legend

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

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

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

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

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

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 1/8/2019 at 4:47:21 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

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

Drennen Subdivision No. 1

August 30, 2019

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

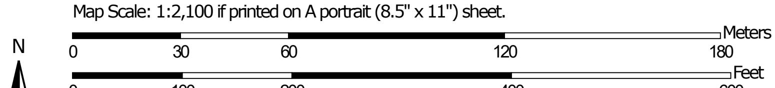
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map

Map Scale: 1:2,100 if printed on A portrait (8.5" x 11") sheet.



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 16, Sep 10, 2018

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

Date(s) aerial images were photographed: Sep 8, 2018—May 26, 2019

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

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
96	Truckton sandy loam, 0 to 3 percent slopes	15.7	77.1%
97	Truckton sandy loam, 3 to 9 percent slopes	4.7	22.9%
Totals for Area of Interest		**20.4**	**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

96—Truckton sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 36bf
Elevation: 6,000 to 7,000 feet
Mean annual precipitation: 14 to 15 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60

Map Unit Composition

Truckton and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Truckton

Setting

Landform: Flats
Landform position (three-dimensional): Talf
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: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very 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): 2e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: A
Ecological site: Sandy Foothill (R049BY210CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

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

97—Truckton sandy loam, 3 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2x0j2
Elevation: 5,300 to 6,850 feet
Mean annual precipitation: 14 to 19 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 85 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition

Truckton and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Truckton

Setting

Landform: Interfluves, hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Re-worked alluvium derived from arkose

Typical profile

A - 0 to 4 inches: sandy loam
Bt1 - 4 to 12 inches: sandy loam
Bt2 - 12 to 19 inches: sandy loam
C - 19 to 80 inches: 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 (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 1 percent
Salinity, maximum in profile: Nonsaline (0.1 to 1.9 mmhos/cm)
Available water storage in profile: Moderate (about 6.6 inches)

Interpretive groups

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

Minor Components

Blakeland

Percent of map unit: 8 percent
Landform: Interfluves, hillslopes
Landform position (two-dimensional): Shoulder, backslope, summit
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Ecological site: Sandy Foothill (R049BY210CO)
Hydric soil rating: No

Bresser

Percent of map unit: 7 percent
Landform: Interfluves, low hills
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Ecological site: Sandy Foothill (R049BY210CO)
Hydric soil rating: No

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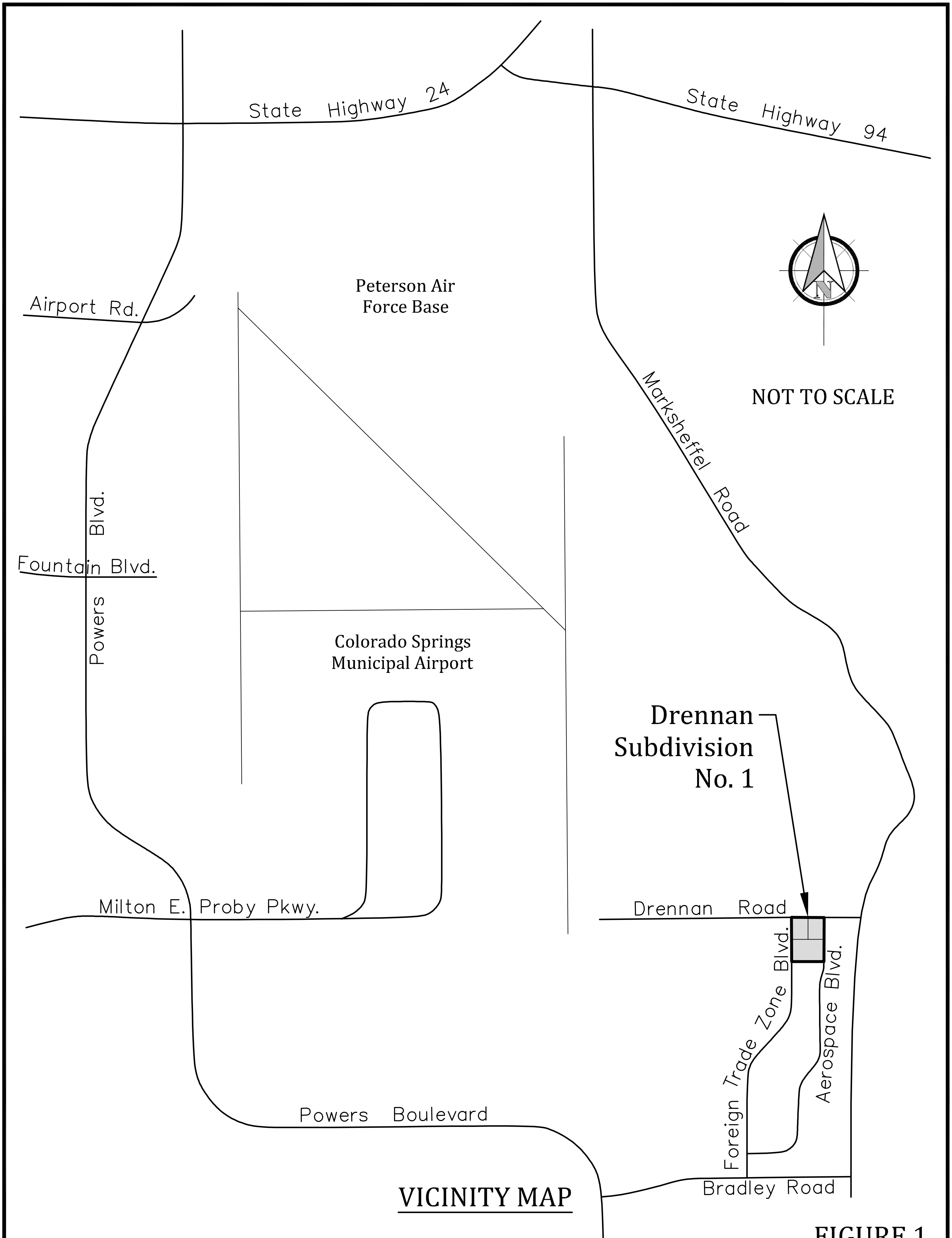
Figures



VICINITY MAP

FIGURE 1

Figure 1.dwg/Aug 30, 2019

BASIN RUNOFF CALCULATIONS			
BASIN	AREA	Q_5	Q_{100}
E-1	8.23 Acres	3.2 cfs	17.8 cfs
E-2	10.05 Acres	3.0 cfs	20.0 cfs
E-3	3.16 Acres	1.1 cfs	7.2 cfs

LEGEND

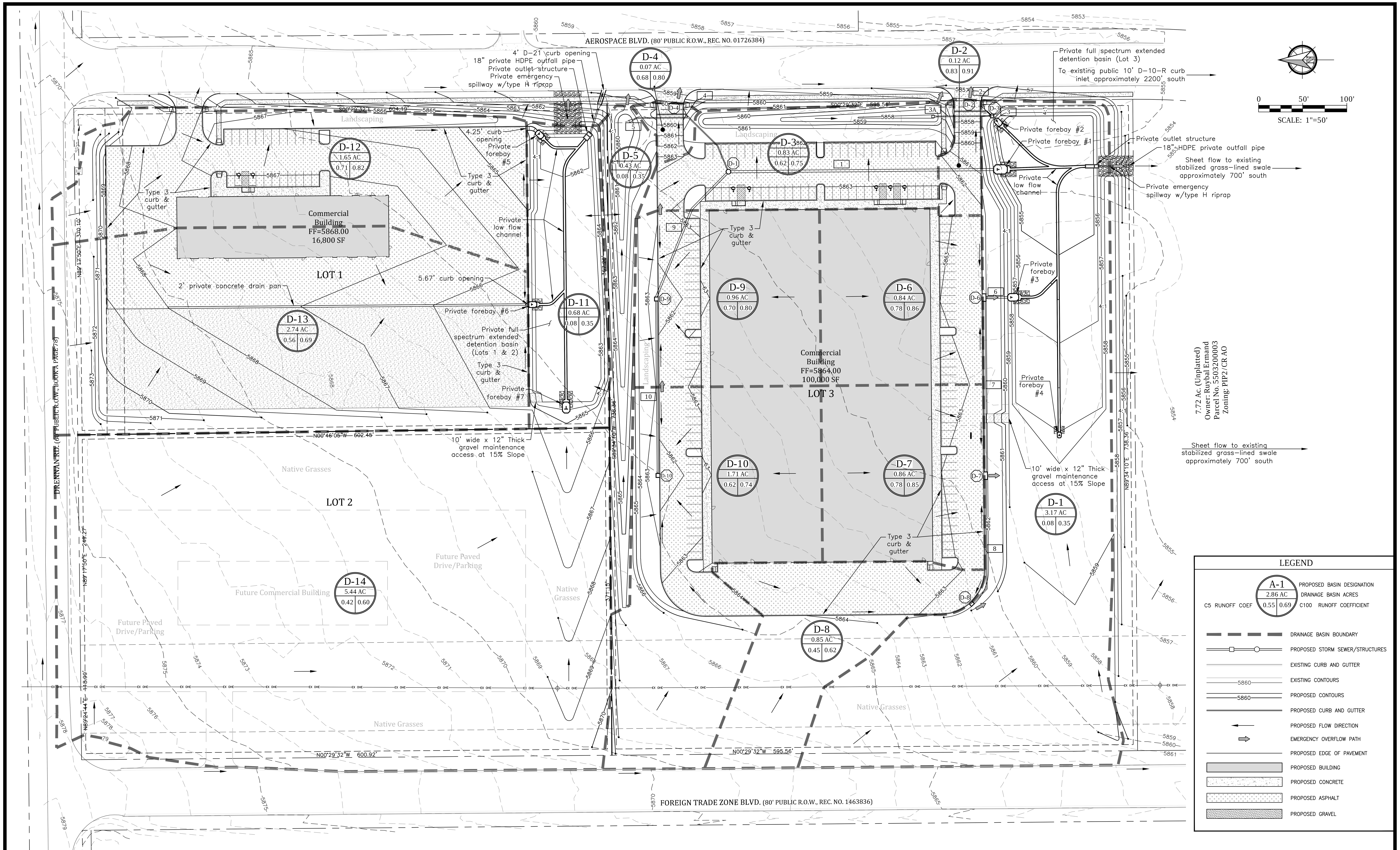
- E-1 — PROPOSED BASIN DESIGNATION
- 8.23AC — DRAINAGE BASIN ACRES
- 0.11 — C5 RUNOFF COEF
- 0.38 — C100 RUNOFF COEFFICIENT
- DRAINAGE BASIN BOUNDARY
- EXISTING CURB AND GUTTER
- 5860 — EXISTING CONTOURS
- EXISTING FLOW DIRECTION

Celebrating 30 years
Kiowa
Engineering Corporation
1604 South 21st Street
Colorado Springs, Colorado 80904
(719) 630-7342

Drennan Subdivision Filing No. 1
Existing Condition Drainage Plan
Colorado Springs, Colorado

Project No.:	18015
Date:	September, 2019
Design:	NRK
Drawn:	CAD
Check:	RNW
Revisions:	

Figure 2



HYDRAULIC STRUCTURES			
STRUCTURE ID	DESCRIPTION	STRUCTURE ID	DESCRIPTION
D-1	5' Dia. Private Type II Manhole	D-6	8' Private D-10-R Inlet
D-2	12" Private Trench Drain	D-7	8' Private D-10-R Inlet
D-3	4' Dia. Type II Manhole	D-8	4' Private D-10-R Inlet
D-4	12" Private Trench Drain	D-9	4' Private D-10-R Inlet
		D-10	4' Private D-10-R Inlet

STORM SEWERS			
STORM SEWER ID	DESCRIPTION	STORM SEWER ID	DESCRIPTION
1	30" Private HDPE @ 0.50%	6	24" Private HDPE @ 0.68%
2	10" Private PVC @ 1.00%	7	24" Private HDPE @ 0.50%
3	18" Private HDPE @ 0.50%	8	15" Private HDPE @ 0.50%
3A	12" Private PVC @ 2.15%	9	24" Private HDPE @ 0.50%
4	10" Private PVC @ 1.00%	10	18" Private HDPE @ 0.50%
5	12" Private PVC @ 0.69%		

BASIN RUNOFF CALCULATIONS							
BASIN	AREA	Q_5	Q_{100}	BASIN	AREA	Q_5	Q_{100}
D-1	3.17 Acres	0.9 cfs	6.6 cfs	D-8	0.85 Acres	1.5 cfs	3.5 cfs
D-2	0.12 Acres	0.5 cfs	1.0 cfs	D-9	0.96 Acres	3.5 cfs	6.6 cfs
D-3	0.83 Acres	2.3 cfs	4.6 cfs	D-10	1.71 Acres	4.8 cfs	9.6 cfs
D-4	0.07 Acres	0.3 cfs	0.5 cfs	D-11	0.68 Acres	0.2 cfs	1.6 cfs
D-5	0.43 Acres	0.1 cfs	0.9 cfs	D-12	1.65 Acres	4.3 cfs	8.4 cfs
D-6	0.84 Acres	3.4 cfs	6.2 cfs	D-13	2.74 Acres	5.9 cfs	12.2 cfs
D-7	0.86 Acres	3.4 cfs	6.3 cfs	D-14	5.44 Acres	8.1 cfs	19.4 cfs

PRIVATE FULL SPECTRUM EXTENDED DETENTION BASIN VOLUMES			
EDB ID	DESCRIPTION	REQUIRED VOLUME	PROVIDED VOLUME
Lots 1 & 2	WQCV	0.161 Acre-Feet	0.178 Acre-Feet
Lots 1 & 2	EURV	0.319 Acre-Feet	0.486 Acre-Feet
Lots 1 & 2	100-Year	0.323 Acre-Feet	0.810 Acre-Feet
Lot 3	WQCV	0.161 Acre-Feet	0.161 Acre-Feet
Lot 3	EURV	0.352 Acre-Feet	0.538 Acre-Feet
Lot 3	100-Year	0.834 Acre-Feet	0.884 Acre-Feet

Kiowa Engineering Corporation
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Drennan Subdivision Filing No.1
Developed Drainage Plan
Colorado Springs, Colorado

Project No.: 18015
Date: September 2019
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Drawn: CAD
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Revisions:

Figure 3