DRAINAGE LETTER REPORT

for

STRUTHERS RANCH POLARIS
847 STRUTHERS RANCH ROAD
LOTS 1-2, STRUTHERS RANCH SUBDIVISION FILING NO. 4

Prepared for:

Hammers Construction, Inc.
1411 Woolsey Heights
Colorado Springs, CO 80915

August 10, 2022
Revised October 21, 2022
Revised February 21, 2023
Revised April 7, 2023

Prepared by:

JPS ENGINEERING

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JPS Project No. 032203
PCD Filing No. PPR2248

STRUTHERS RANCH POLARIS
DRAINAGE LETTER REPORT
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APPENDICES

DRAINAGE STATEMENT

Engineer's Statement:

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

COLORADO REGISTERED PROFESSIONAL ENGINEER JOHN P. SCHWAB 29891 4/7/23

John P. Schwab, P.E. #29891

Developer's Statement:

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

By: ______________________________ 4-12-23
Date

Hammers Construction, Inc.
1411 Woolsey Heights, Colorado Springs, CO 80915

El Paso County's Statement

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

Joshua Palmer, P.E. Date
County Engineer / ECM Administrator

Conditions:

I. INTRODUCTION

A. Property Location and Description

Hammers Construction is planning to construct a new Polaris dealership on the vacant 2.94-acre property at the southeast corner of Struthers Road and Struthers Ranch Road in northern El Paso County, Colorado. The property is described as Lots 1 and 2, Struthers Ranch Subdivision Filing No. 4 (El Paso County Assessor's Parcel Numbers 71363-03-010 and 71363-03-011).

The project consists of a new 12,000 square-foot, single-story Polaris dealership building with associated parking and site improvements. The property is bounded by Struthers Road on the southwest side and Struthers Ranch Road on the northwest side. Struthers Road is a fully improved, asphalt-paved arterial public street, and Struthers Ranch Road is a fully improved local public street. Existing platted residential lots are located along the northeast boundary of the parcel (Struthers Ranch Filing No. 2). The south boundary of the site adjoins vacant commercial properties (Lots 3 and 4, Struthers Ranch Subdivision Filing No. 4).

The property is zoned Planned Unit Development (PUD), and the proposed site development is fully consistent with the existing zoning of the site. Access to the site will be provided by the existing private driveway connection to Struthers Ranch Road along the north boundary of Lot 1.

The site is located in the Black Forest Creek Drainage Basin, and surface drainage from this site sheet flows southwesterly to an existing public storm sewer system along the west boundary of the property, flowing to the existing Struthers Ranch stormwater detention pond on the west side of Struthers Road.

This report is intended to meet the requirements of a site-specific "Letter Type" drainage report in accordance with El Paso County subdivision drainage criteria.

B. Drainage Analysis Methods and Criteria

ITEM	DESCRIPTION	REFERENCE
Design Storm (initial/major)	5-year/100-year	CS/EPC DCM
Storm Runoff	Rational Method (Area<100acres)	CS/EPC DCM
Major Drainage Basin	Black Forest Creek	
Floodplain Impacts	Parcel is located outside any delineated FEMA floodplains	FIRM
Existing Downstream Facilities	Existing storm sewer system on east side of Struthers Road; Existing detention pond on west side of Struthers Road	

CS/EPC DCM = City of Colorado Springs & El Paso County Drainage Criteria Manual

C. References

JPS Engineering, Inc., "Final Drainage Report for Struthers Ranch Filing No. 2," October 14, 2004 (approved by El Paso County 10/20/04).

JPS Engineering, Inc., "Drainage Letter Report for Struthers Ranch Subdivision Filing No. 4," February 22, 2006.

II. EXISTING / PROPOSED DRAINAGE CONDITIONS

Subdivision Drainage Report

Drainage planning for this site was previously master planned during original development of the Struthers Ranch Subdivision, as detailed in the "Final Drainage Report (FDR) for Struthers Ranch Filing No. 2" by JPS Engineering, dated October 14, 2004 (see excerpts in Appendix A). The project area at the southeast corner of Struthers Road and Struthers Ranch Road was identified as a future commercial development area in the original planning of the subdivision.

According to the original FDR, Basins D6A (3.0 acres) and D9A (3.18 acres) comprise the future commercial development areas on the south side of Struthers Ranch Road. The previously approved subdivision drainage planning assumed full commercial development within all of Basins D6A and D9A, with runoff coefficients of $C_5 = 0.90$ and $C_{100} = 0.90$, and impervious areas of 95 percent for the entirely of these basins. According to the Rational Method calculations in the original subdivision drainage report, developed peak flows from Basin D6A were calculated as $Q_5 = 14.0$ cfs and $Q_{100} = 24.3$ cfs, and peak flows from Basin D9A were calculated as $Q_5 = 14.9$ cfs and $Q_{100} = 25.8$ cfs (see Appendix A).

As shown on the enclosed Struthers Ranch Subdivision Drainage Plan (Figure D1, Appendix F), the proposed Polaris development site lies entirely within Basin D6A as delineated in the approved "Final Drainage Report for Struthers Ranch Filing No. 2." The site slopes downward to the southwest, with average grades of 1-4 percent. On-site soils are classified by SCS as type 71, "Pring" series coarse sandy loam soils. These soils have moderately rapid permeability and slow to medium surface runoff characteristics. The soils are classified as hydrologic soils group B.

Developed drainage from this commercial site will sheet flow southwesterly to the existing storm sewer system along the east side of Struthers Road. Flows combine at the existing grated inlet on the east side of Struthers Road, where double 48-inch culverts convey developed flows across Struthers Road and into the existing detention pond. The previously approved drainage report for Struthers Ranch Filing No. 2 assumed full commercial development for this basin, which is consistent with the proposed site development. The existing detention pond was sized to account for fully developed flows from this commercial area.

The impervious area for the proposed Struthers Ranch Polaris development (delineated as Basin A within this report, which correlates with Basin D6A in the FDR) amounts to approximately 69 percent of the site (as tabulated on Sh. D1.1 and Appendix B), which is well below the impervious area of 95 percent assumed for full commercial development in the previously approved subdivision drainage report (see Appendix A).

Based on the previous construction of drainage improvements for the Struthers Ranch Subdivision, no significant impact on downstream drainage facilities is anticipated from this site development and replat. Proper erosion control measures will be required for development of the site, including silt fence along property boundaries to minimize off-site transport of construction sediment.

Existing Drainage Conditions

As shown on the enclosed Drainage Plan (Figure D1.1, Appendix F), the site has been delineated as two on-site drainage basins. The project area (Lots 1-2, Struthers Ranch Filing No. 4) has been delineated as Basin A, and the future development area to the southeast (Lots 3-4, Struthers Ranch Filing No. 4) has been delineated as Basin B. The site is impacted by an off-site basin consisting of the rear sides of the adjoining single-family residential lots (platted as part of Struthers Ranch Filing No 2) along the southeast boundary of the site, which has been delineated as Basin OB1.

Existing drainage from Basin A sheet flows southwesterly across the property, with peak flows calculated as $Q_5 = 0.8$ cfs and $Q_{100} = 5.8$ cfs. Basin A flows to the existing ditch along the east side of Struthers Road, and the ditch flows are captured in the existing grated storm inlet identified as Design Point #1.

Existing drainage from off-site Basin OB1 (back sides of adjoining developed single-family residential lots along northeast boundary of project site) sheet flows southwesterly into Basin B, and Basin B flows southwesterly to the existing ditch along the east side of Struthers Road, ultimately flowing into the existing grated storm inlet at Design Point #1. Existing flows from Basins OB1 and B combine at Design Point #B1, with peak flows calculated as $Q_5 = 1.9$ cfs and $Q_{100} = 7.0$ cfs.

Existing flows from Basins A, OB1, and B combine at Design Point #1, with peak flows calculated as $Q_5 = 2.5$ cfs and $Q_{100} = 12.0$ cfs. A double 48-inch RCP storm sewer conveys the flow from the grated storm inlet southwesterly across Struthers Road into the existing regional Struthers Ranch Detention Pond.

Developed Drainage Plan

Developed flows have been calculated based on the impervious areas associated with the proposed building and parking improvements. Surface drainage swales and a private storm sewer system will convey developed flows to the proposed Water Quality Pond A along the west boundary of the site. Site grades will slope to storm inlets and curb openings at selected locations, collecting surface drainage and conveying stormwater to

Water Quality Pond A. The proposed building pad will be graded with protective slopes to provide positive drainage away from the building, and the curb, gutter, drainage swales, and private storm sewer system will convey developed flows southwesterly into Water Quality Pond A.

The proposed Polaris site development on Lots 1-2 has been delineated as Basin A, which drains by sheet flow and curb and gutter to the proposed Stormwater Quality Detention Basin along the west boundary of the site. Private Storm Inlet A1 (Type 16) will intercept surface drainage from the north side of the Polaris site, and Private Storm Sewer A1 (18") will convey this flow into the on-site Water Quality Pond A. The balance of the Polaris site will flow by drainage swales and curb and gutter into the south side of Water Quality Pond A.

Developed peak flows at Design Point A are calculated as $Q_5 = 8.9$ cfs and $Q_{100} = 17.7$ cfs. Basin A generally correlates with "Basin D6A" in the Final Drainage Report for Struthers Ranch Filing No. 2 ($Q_5 = 14.0$ cfs and $Q_{100} = 24.3$ cfs).

The future commercial site development areas to the south in Lots 3-4 have been delineated as Basin B, which will generally drain northwesterly by sheet flow and curb and gutter to a future private storm sewer via a proposed 18" HDPE pipe conveying developed flows into Water Quality Pond A. Developed peak flows at Design Point B are calculated as $Q_5 = 4.7$ cfs and $Q_{100} = 9.0$ cfs. Basin B generally correlates with "Basin D9A" in the Final Drainage Report for Struthers Ranch Filing No. 2 ($Q_5 = 14.9$ cfs and $Q_{100} = 25.8$ cfs). Developed flows from off-site Basin OB1 will continue to combine with Basin B at Design Point #B1, with peak flows calculated as $Q_5 = 5.9$ cfs and $Q_{100} = 12.2$ cfs.

The 18" HDPE discharge pipe from Water Quality Pond A (along with overflows from the pond spillway) will drain into the existing grated storm inlet along the east side of Struthers Road, and the existing double 48-inch RCP storm sewer will continue to convey the flow from the grated storm inlet southwesterly across Struthers Road into the existing regional Struthers Ranch Detention Pond ("Detention Pond 11" per Black Forest Creek DBPS).

Developed flows from Basins A, OB1, and B combine at Design Point #1, with peak flows calculated as $Q_5 = 11.9$ cfs and $Q_{100} = 24.2$ cfs. As detailed in Appendix B, for comparison with the original Subdivision FDR, the total flows from Basins D6A and D9A (equivalent to Design Point #1) have been calculated as $Q_5 = 23.2$ cfs and $Q_{100} = 38.9$ cfs (significantly higher than the current developed flow calculations). As such, the developed flows are well below the previously master planned developed flows entering the regional detention pond.

Hydrologic and hydraulic calculations for the site are detailed in the appendices (Appendix B and C), and peak flows are identified on Figure D1.1 (Appendix F).

III. DRAINAGE PLANNING FOUR STEP PROCESS

El Paso County Drainage Criteria require drainage planning to include a Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls.

As stated in ECM Appendix I.7., the Four Step Process is applicable to all new and re-development projects with construction activities that disturb 1 acre or greater or that disturb less than 1 acre but are part of a larger common plan of development. The Four Step Process has been implemented as follows in the planning of this project:

Step 1: Employ Runoff Reduction Practices

- Extended Detention Basin: The majority of developed flows will be routed through the on-site detention basin, which will be grass-lined to encourage stormwater infiltration.

Step 2: Stabilize Drainageways

- There are no drainageways directly adjacent to this project site. Implementation of the on-site drainage improvements and detention basin will minimize downstream drainage impacts from this site.
- Drainage basin fees were previously paid during recording of the subdivision plat, and these fees provided the applicable cost contribution towards regional drainage improvements.

Step 3: Provide Water Quality Capture Volume (WQCV)

- EDB: The majority of the developed site will drain through an on-site Private Extended Detention Basin (EDB) along the west boundary of the property. The extended detention basin which will capture and slowly release the WQCV over an extended release period.

Step 4: Consider Need for Industrial and Commercial BMPs

- No industrial uses are proposed for this site.
- The commercial property owner will implement a Stormwater Management Plan including proper housekeeping practices and spill containment procedures.
- On-site drainage will be routed through the Extended Detention Basin (EDB) to minimize introduction of contaminants to the County's public drainage system.

IV. FLOODPLAIN IMPACTS

According to the FEMA floodplain map for this area, El Paso County FIRM Panel No. 08041C0287G, dated December 7, 2018, the site is located beyond the limits of any delineated floodplains.

V. STORMWATER DETENTION AND WATER QUALITY

Stormwater detention for this site is provided in the existing regional stormwater detention pond constructed during initial development of the Struthers Ranch Subdivision. The Struthers Ranch Homeowners Association is the owner of the existing Struthers Ranch Detention Pond located within Tract C, Struthers Ranch Filing No. 2. There currently appears to be a need for removal of excess vegetation within the pond to ensure proper operation of the detention facilities. The developer will need to coordinate with the HOA to ensure that the required maintenance is performed on the existing regional detention pond.

An on-site private Water Quality Pond will be constructed to meet stormwater quality improvements for this project site in accordance with current El Paso County drainage criteria.

As detailed in the detention pond calculations in Appendix D, the required Water Quality Capture Volume (WQCV) has been calculated as 0.13 acre-feet. The water quality capture volume has been calculated based on the actual impervious area of the proposed site development within Basin A (calculated as 69%), along with the typical single-family residential impervious area of 40% within the adjoining developed Basin OB1, and a conservative estimated impervious area of 95 percent for the anticipated future commercial development within Basin B (consistent with the original FDR).

The proposed Water Quality Basin has been designed utilizing the Denver Mile High Flood District's "MH-Detention_v4.05" software package. Calculations and details for the proposed Water Quality Basin are enclosed in Appendix D, and design parameters for the Water Quality Basin are summarized as follows:

Water Quality Basin	Tributary Drainage Basin	Tributary Area (ac)	Impervious Percentage	Min. WQCV (af)	Design Volume (af)
A	A,OB1,B	5.62	68.1	0.13	0.25

The proposed on-site Water Quality Pond A provides a storage volume of 0.25 acre-feet, which meets the required WQCV volume.

The proposed water quality pond will include concrete forebays, trickle channels, and an outlet structure with a water quality orifice plate to maintain discharges below the allowable release rates. The pond outlet structure has been designed for a 40-hour release of the WQCV, and outlet structure sizing to maintain maximum allowable release rates from the pond. The water quality pond will have a grass-lined bottom to encourage infiltration of stormwater prior to discharging into the downstream public drainage system.

The new on-site Water Quality Basin will be privately owned and maintained by the property owner, and maintenance access will be provided from the southwest parking lot.

VI. PUBLIC IMPROVEMENTS / DRAINAGE BASIN FEES

No public drainage improvements are required or proposed for this project. As detailed in Appendix E, the proposed private Water Quality Pond A has an estimated cost of approximately $65,846.

The site lies completely within the Black Forest Creek Drainage Basin. Applicable drainage basin fees were paid at the time of original platting of Struthers Ranch Filing No. 2, so no drainage basin fees or bridge fees are applicable at this time.

VII. SUMMARY

The developed drainage patterns for the proposed site development on Lots 1-2, Struthers Ranch Filing No. 4 will remain consistent with the established drainage plan for this subdivision. The grading and drainage plan for the proposed Polaris site development fully conforms to the approved drainage plan for Struthers Ranch Filings No. 2 and 4.

Developed flows from the site will drain through a Private Water Quality Pond at the southwest corner of the property prior to discharging to the existing downstream public drainage system. Stormwater detention is provided by the existing Struthers Ranch Detention Pond which was designed to accept fully developed flows from the commercial area encompassing this site (Lots 1-4, Struthers Ranch Filing No. 4). The proposed on-site Water Quality Pond will be constructed to meet current stormwater quality requirements. Construction and proper maintenance of the on-site drainage facilities and Extended Detention Basin, in conjunction with proper erosion control practices, will ensure that this developed site has no significant adverse drainage impact on downstream or surrounding areas.

APPENDIX A

EXCERPTS FROM SUBDIVISION DRAINAGE REPORT

FINAL DRAINAGE REPORT

for

STRUTHERS RANCH FILING NO. 2

Prepared for:

WL Homes LLC
8610 Explorer Drive, Suite 300
Colorado Springs, CO 80920

November 6, 2003
Revised April 12, 2004
Revised May 7, 2004
Revised May 25, 2004
Revised September 3, 2004
Revised October 14, 2004

Prepared by:

JPS
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JPS Project No. 080006

2. Developed Drainage Conditions

The developed drainage basins and projected flows are shown in Figure D1, and preliminary hydrologic calculations are enclosed in Appendix B. The developed site has been divided into five major basins (A-E) and five design points (DP1-DP5), as shown on the enclosed Drainage Plan (Sheets D1 and D1.02). Hydrologic flow schematics and calculations are enclosed in Appendix B.

Struthers Ranch Filing No. 2 is located within parts of Basins C-F at the northwest corner of the site. The majority of developed areas ultimately flow to the proposed detention pond at Design Point No. 4. The internal road gutters of sub-basins D1-D10 will be graded to drain southwesterly through the interior road system. Storm inlets will be constructed in the interior roads as required to intercept developed flows exceeding the allowable street capacity. Storm sewer outfalls will be extended to the proposed detention pond.

To minimize the impacts of developed drainage from Struthers Ranch, flows from Basins C, D, and F will be routed through the proposed detention pond. Off-site Basins OC1 and OD1 will combine with flows from on-site Sub-basins D1-D10, C, E2, E3, and F at the proposed detention pond (Design Point #4), with developed flows of Q_5 = 66 cfs and Q_{100} = 191 cfs (SCS Method). The detention pond will discharge historic flows to the existing swale at the southerly site boundary, flowing into the existing 48-inch culvert crossing I-25. The proposed 48-inch RCP discharge pipe from the detention pond will be released to a riprap apron, flowing to an existing stable grass-lined swale across a parcel owned by the U.S Air Force Academy, ultimately crossing I-25 through the existing 48-inch CMP culvert.

The proposed site layout will significantly reduce the amount of developed flow reaching the existing 3.5'x2' culvert (Structure #11) at the westerly site boundary (Design Point #3). Flows from Sub-basin E4 (Q_5 = 1.9 cfs and Q_{100} = 3.7 cfs) represent the westerly side of the proposed Struthers Road draining to the existing culvert crossing I-25.

Basin E1 represents the small developed area at the northwest corner of the site, draining to the existing 4'x4' box culvert at Design Point #5. The proposed grading scheme for the commercial area north of Struthers Ranch Road will direct the majority of developed flows into Basin C, ultimately flowing to the proposed detention pond. As a result, developed flow impacts to the Jackson Creek Basin at the northwest corner of the site will be minimized. Estimated developed peak flows of Q_5 = 4.6 cfs and Q_{100} = 8.9 cfs at Design Point #5 remain within the capacity of the existing culvert.

C. Comparison of Developed to Historic Discharges

Based on the hydrologic calculations in Appendix B, the total undetained developed flow from the site will exceed historic flow from the parcel. Projected increases in developed flows will be mitigated by routing flows through a proposed on-site stormwater detention pond. The comparison of developed to historic discharges at key design points is summarized as follows:

Design Point	Historic Flow			Developed Flow			Comparison of Developed to Historic Flow (Q_5%/Q_{100}%)
	Area (ac)	Q_5 (cfs)	Q_{100} (cfs)	Area (ac)	Q_5 (cfs)	Q_{100} (cfs)	
1 (SCS)	1,266	473	1,281	1,274	464	1,263	98% / 99% (decrease)
2	15.1	9.3	22.4	1.4	1.7	3.6	18% / 16% (decrease)
3	16.0	9.9	24.0	0.6	1.9	3.7	19% / 15% (decrease)
4 (SCS)	133.6	50	148	155.4	66	191	132% / 129% (increase)
5	6.8	8	9.2	4.0	4.6	8.9	121% / 99% (increase)

D. Detention Ponds

The total developed storm runoff downstream of Struthers Ranch will be maintained at historic levels by routing flows through the proposed on-site detention pond located at the westerly boundary of the Struthers Ranch property (equivalent to "Detention Pond #11" as identified in the DBPS). The proposed detention facility will be sized to attenuate peak flows through the pond, based on the difference between outflow and inflow hydrographs. Flows from Basins C and D will be routed through the proposed detention pond at Design Point #4. The pond will be designed to "over-detain" to account for release of developed flows from Basins A and B, ensuring that the net discharge from the overall site will be maintained below historic levels.

As depicted on Sheet C1.02 (Appendix A), the proposed interim access connection from the I-25 Frontage Road to Struthers Road will bisect the pond, providing for a forebay at the upstream end of the pond. Once the interim access to the frontage road is abandoned, the maintenance access road will remain, and the forebay will continue to serve as a water quality enhancement feature. A detailed pond routing analysis utilizing the "Intelisolve Hydraflow" software package is enclosed in Appendix C1, resulting in the following pond design parameters:

Pond	**Pond Inflow (Q_5 / Q_{100}, cfs)**	**Pond Outflow (Q_5 / Q_{100}, cfs)**	**Pond Volume (ac-ft)**
DP4 ("Pond #11")	35 / 191	19.3 / 138.4	4.7

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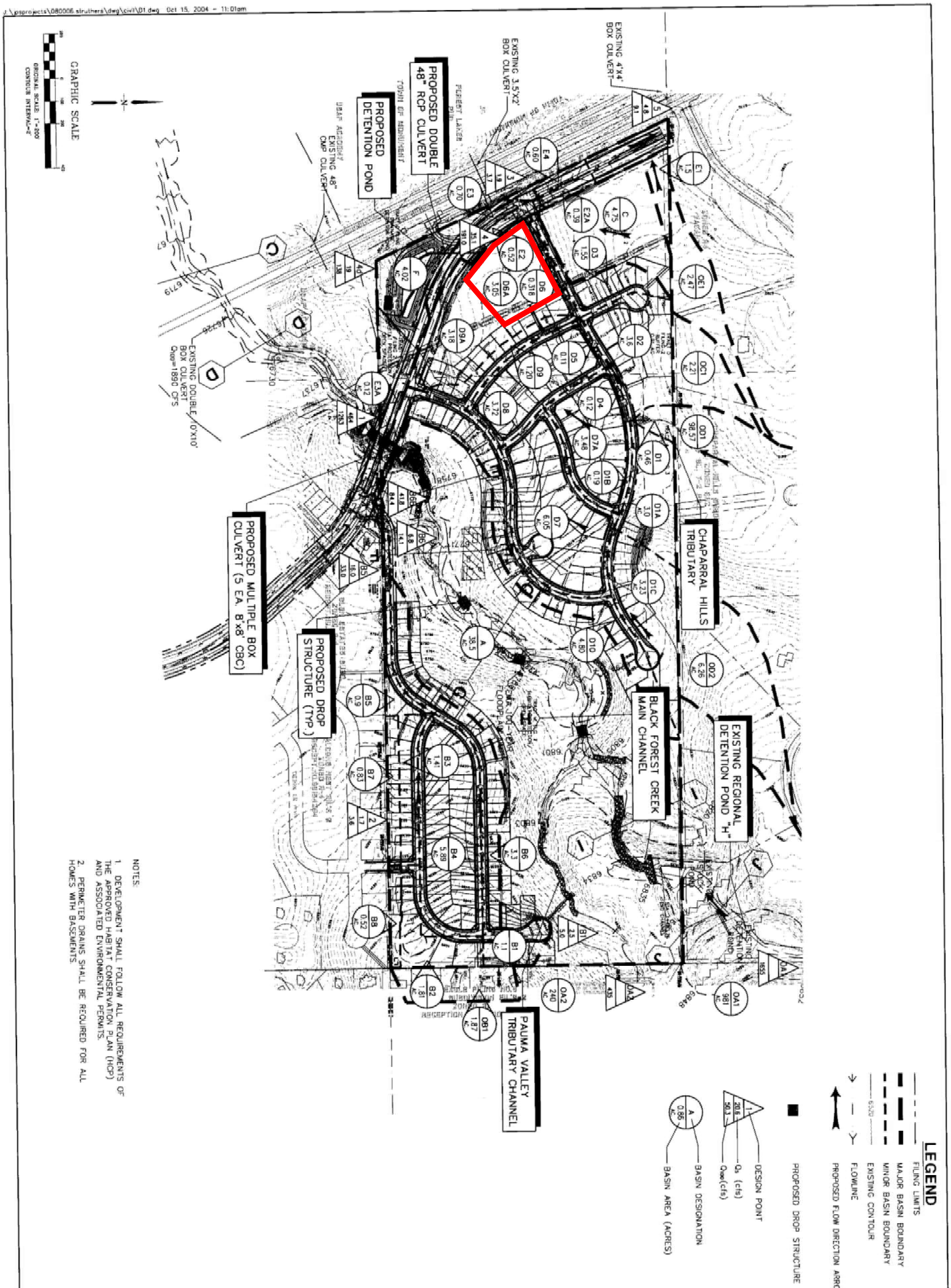

STRUTHERS RANCH SUBDIVISION

DEVELOPED DRAINAGE PLAN

No.	REVISION	BY	DATE
E	EPC COMMENTS	JPS	4/8/04
F	EPC COMMENTS	JPS	5/7/04
G	EPC COMMENTS	JPS	5/25/04
H	EPC COMMENTS	JPS	9/2/04
I	RE-SUBMITTAL TO EPC	JPS	9/30/04

HORZ. SCALE: 1"=200'	DRAWN:		
VERT. SCALE: N/A	DESIGNED: JPS		
SURVEYED: PINNACLE	CHECKED:		
CREATED: 9/11/00	LAST MODIFIED: 10/15/04		
PROJECT NO. 080006	MODIFIED BY: MJP		

SHEET: D1

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TABLE 5-1

RECOMMENDED AVERAGE RUNOFF COEFFICIENTS AND PERCENT IMPERVIOUS

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	"C" FREQUENCY 10 A&B*	10 C&D*	100 A&B*	100 C&D*
Business					
Commercial Areas	95	0.90	0.90	0.90	0.90
Neighborhood Areas	70	0.75	0.75	0.80	0.80
Residential					
1/8 Acre or less	65	0.60	0.70	0.70	0.80
1/4 Acre	40	0.50	0.60	0.60	0.70
1/3 Acre	30	0.40	0.50	0.55	0.60
1/2 Acre	25	0.35	0.45	0.45	0.55
1 Acre	20	0.30	0.40	0.40	0.50
Industrial					
Light Areas	80	0.70	0.70	0.80	0.80
Heavy Areas	90	0.80	0.80	0.90	0.90
Parks and Cemeteries	7	0.30	0.35	0.55	0.60
Playgrounds	13	0.30	0.35	0.60	0.65
Railroad Yard Areas	40	0.50	0.55	0.60	0.65
Undeveloped Areas					
Historic Flow Analysis- Greenbelts, Agricultural	2	0.15	0.25	0.20	0.30
Pasture/Meadow	0	0.25	0.30	0.35	0.45
Forest	0	0.10	0.15	0.15	0.20
Exposed Rock	100	0.90	0.90	0.95	0.95
Offsite Flow Analysis (when land use not defined)	45	0.55	0.60	0.65	0.70
Streets					
Paved	100	0.90	0.90	0.95	0.95
Gravel	80	0.80	0.80	0.85	0.85
Drive and Walks	100	0.90	0.90	0.95	0.95
Roofs	90	0.90	0.90	0.95	0.95
Lawns	0	0.25	0.30	0.35	0.45

* Hydrologic Soil Group

9/30/90

(EPC-DCM)

STRUTHERS RANCH
COMPOSITE RUNOFF COEFFICIENTS

DEVELOPED CONDITIONS

5-YEAR C VALUES

BASIN	TOTAL AREA (AC)	SOIL TYPE	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA1	981	B	981	0.25-AC LOTS	0.5							0.500
OA2	240	B	240	0.25-AC LOTS	0.5							0.500
OA1,OA2	1221											0.500
B1	1.1	B	1.1	0.25-AC LOTS	0.5							0.500
A	38.5	B	38.5	OPEN SPACE	0.25							0.250
OA1,OA2,B1,A	1260.6											0.492
OB1	1.87	B	1.87	0.25-AC LOTS	0.5							0.500
B2	1.81	B	1.81	0.25-AC LOTS	0.5							0.500
B3	1.4	B	1.41	0.25-AC LOTS	0.5							0.500
B4	5.8	B	5.8	0.25-AC LOTS	0.5							0.500
OB1,B2-B4	10.9											0.500
B5	0.9	B	0.9	0.25-AC LOTS	0.5							0.500
OB1,B2-B5	11.8											0.500
B6	3.3	B	3.3	0.25-AC LOTS	0.5							0.500
OB1,B2-B6	15.1											0.500
OA1,OA2,A,B1-B6	1275.7											0.492
B7	0.83	B	0.83	0.25-AC LOTS	0.5							0.500
B8	0.52	B	0.52	0.25-AC LOTS	0.5							0.500
B7,B8	1.4											0.500
E4	0.6	B	0.34	PAVED	0.9	0.3	LANDSCAPE	0.25				0.618
OD1	98.57	B	98.57	5-AC LOTS	0.3							0.300
D1	0.46	B	0.46	MEADOW	0.25							0.250
OD1,D1	99.03											0.300

OD2	6.26	B	6.26	5-AC LOTS	0.3							0.300
D1C	3.23	B	1.5	0.25-AC LOTS	0.5	1.7	OPEN SPACE	0.25				0.366
OD2,D1C	9.49											0.322
D1A	3.00	B	0.8	0.25-AC LOTS	0.5	2.2	PARK / OS	0.25				0.317
OD2,D1C,D1A	12.49											0.321
D1B	0.19	B	0.19	ROADWAY	0.9							0.900
OD1,D1,D1A,D1B	111.71											0.303
D4	0.12	B	0.12	ROADWAY	0.9							0.900
OD1,D1,D1A,D1B,D4	111.83											0.304
D5	0.11	B	0.11	ROADWAY	0.9							0.900
OD1,D1,D1A,D1B,D4,D5	111.94											0.304
D6	0.32	B	0.318	ROADWAY	0.9							0.900
OD1,D1,D1A,D1B,D4-D6	112.26											0.306
OC1	2.21	B	2.21	5-AC LOTS	0.3							0.300
D2	3.60	B	3.6	0.25-AC LOTS	0.5							0.500
OC1,D2	5.81											0.424
E2A	0.39	B	0.3	PAVED	0.9	0.1	LANDSCAPE	0.25				0.750
D3	1.55	B	1.55	0.25-AC LOTS	0.5							0.500
C	4.75	B	4.75	COMMERCIAL	0.9							0.900
D3,C	6.30											0.802
OD1,OC1,C,E2A,D1-D6	124.76											0.338
E2	0.52	B	0.4	PAVED	0.9	0.1	LANDSCAPE	0.25				0.750
D6A	3.00	B	3	COMMERCIAL	0.9							0.900
OD1,OC1,C,D1-D6A	128.28											0.350
D7A	3.48	B	3.48	0.25-AC LOTS	0.5							0.500
D7	6.05	B	6.05	0.25-AC LOTS	0.5							0.500
D7A,D7	9.53											0.500
D8	3.72	B	3.72	0.25-AC LOTS	0.5							0.500
D7A,D7,D8	13.25											0.500
D9	1.20	B	1.2	0.25-AC LOTS	0.5							0.500
D7A-D9	14.45											0.500
E3A	0.12	B	0.12	MEDIAN	0.25							0.250
D10	4.80	B	4.8	0.25-AC LOTS	0.5							0.500
D7A-D10,E3A	19.37											0.498
D9A	3.18	B	3.18	COMMERCIAL	0.9							0.900
D7A-D10,E3A	22.55											0.555
E3	0.70	B	0.5	PAVED	0.9	0.2	LANDSCAPE	0.25				0.714
F	4.02	B	4.02	OPEN SPACE	0.25							0.250
OD1,C,D1-D10,E2-E3,F	155.55	B										0.379
OE1	2.47	B	2.47	5-AC LOTS	0.3							0.300
E1	1.5	B	1.5	COMMERCIAL	0.9							0.900
OE1,E1	4.0											0.527

STRUTHERS RANCH
COMPOSITE RUNOFF COEFFICIENTS

DEVELOPED CONDITIONS

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	SOIL TYPE	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA1	981	B	981	0.25-AC LOTS	0.6							0.600
OA2	240	B	240	0.25-AC LOTS	0.6							0.600
OA1,OA2	1221											0.600
B1	1.1	B	1.1	0.25-AC LOTS	0.6							0.600
A	38.5	B	38.5	OPEN SPACE	0.35							0.350
OA1,OA2,B1,A	1260.6											0.592
OB1	1.87	B	1.87	0.25-AC LOTS	0.6							0.600
B2	1.81	B	1.81	0.25-AC LOTS	0.6							0.600
B3	1.4	B	1.41	0.25-AC LOTS	0.6							0.600
B4	5.8	B	5.8	0.25-AC LOTS	0.6							0.600
OB1,B2-B4	10.9											0.600
B5	0.9	B	0.9	0.25-AC LOTS	0.6							0.600
OB1,B2-B5	11.8											0.600
B6	3.3	B	3.3	0.25-AC LOTS	0.6							0.600
OB1,B2-B6	15.1											0.600
OA1,OA2,A,B1-B6	1275.7											0.592
B7	0.83	B	0.83	0.25-AC LOTS	0.6							0.600
B8	0.52	B	0.52	0.25-AC LOTS	0.6							0.600
B7,B8	1.4											0.600
E4	0.6	B	0.34	PAVED	0.95	0.3	LANDSCAPE	0.35				0.690
OD1	98.57	B	98.57	5-AC LOTS	0.4							0.400
D1	0.46	B	0.46	MEADOW	0.35							0.350
OD1,D1	99.03											0.400

OD2	6.26	B	6.26	5-AC LOTS	0.4							0.400
D1C	3.23	B	1.5	0.25-AC LOTS	0.6	1.7	OPEN SPACE	0.35				0.466
OD2,D1C	9.49											0.422
D1A	3.00	B	0.8	0.25-AC LOTS	0.6	2.2	PARK / OS	0.35				0.417
OD2,D1C,D1A	12.49											0.421
D1B	0.19	B	0.19	ROADWAY	0.95							0.950
OD1,D1,D1A,D1B	111.71											0.403
D4	0.12	B	0.12	ROADWAY	0.95							0.950
OD1,D1,D1A,D1B,D4	111.83											0.404
D5	0.11	B	0.11	ROADWAY	0.95							0.950
OD1,D1,D1A,D1B,D4,D5	111.94											0.404
D6	0.32	B	0.318	ROADWAY	0.95							0.950
OD1,D1,D1A,D1B,D4-D6	112.26											0.406
OC1	2.21	B	2.21	5-AC LOTS	0.4							0.400
D2	3.60	B	3.6	0.25-AC LOTS	0.6							0.600
OC1,D2	5.81											0.524
E2A	0.39	B	0.3	PAVED	0.95	0.1	LANDSCAPE	0.35				0.812
D3	1.55	B	1.55	0.25-AC LOTS	0.6							0.600
C	4.75	B	4.75	COMMERCIAL	0.9							0.900
D3,C	6.30											0.826
OD1,OC1,C,E2A,D1-D6	124.76											0.434
E2	0.52	B	0.4	PAVED	0.95	0.1	LANDSCAPE	0.35				0.812
D6A	3.00	B	3	COMMERCIAL	0.9							0.900
OD1,OC1,C,D1-D6A	128.28											0.443
D7A	3.48	B	3.48	0.25-AC LOTS	0.6							0.600
D7	6.05	B	6.05	0.25-AC LOTS	0.6							0.600
D7A,D7	9.53											0.600
D8	3.72	B	3.72	0.25-AC LOTS	0.6							0.600
D7A,D7,D8	13.25											0.600
D9	1.20	B	1.2	0.25-AC LOTS	0.6							0.600
D7A-D9	14.45											0.600
E3A	0.12	B	0.12	MEDIAN	0.35							0.350
D10	4.80	B	4.8	0.25-AC LOTS	0.6							0.600
D7A-D10,E3A	19.37											0.598
D9A	3.18	B	3.18	COMMERCIAL	0.9							0.900
D7A-D10,E3A	22.55											0.641
E3	0.70	B	0.5	PAVED	0.95	0.2	LANDSCAPE	0.35				0.779
F	4.02	B	4.02	OPEN SPACE	0.35							0.350
OD1,C,D1-D10,E2-E3,F	155.55	B										0.471
OE1	2.47	B	2.47	5-AC LOTS	0.4							0.400
E1	1.5	B	1.5	COMMERCIAL	0.9							0.900
OE1,E1	4.0											0.589

STRUTHERS RANCH
RATIONAL METHOD - DRAINAGE CALCULATIONS

DEVELOPED FLOWS

BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR [7]	C 100-YEAR [7]	OVERLAND LENGTH (FT)	SLOPE (%)	Tco [1] (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT K	SLOPE (%)	SCS [2] VELOCITY (FT/S)	Tt [3] (MIN)	TOTAL Tc [4] (MIN)	INTENSITY [5] 5-YR (IN/HR)	INTENSITY [5] 100-YR (IN/HR)	PEAK FLOW Q5 [6] (CFS)	PEAK FLOW Q100 [6] (CFS)
OA1		981.00	0.500	0.600	300	5.4	10.7	11900	1.50	5.4	3.49	56.9	67.6	1.50	2.65	735.75	1559.79
OA2		240.00	0.500	0.600	300	5.5	10.6	620	1.50	5.5	3.52	2.9	13.5	3.60	6.10	432.00	878.40
OA1,OA2	OA1	1221.00	0.500	0.600									67.6	1.50	2.65	915.75	1941.39
B1	B1	1.10	0.500	0.600	250	12.8	7.3	0				0.0	7.3	4.50	7.60	2.48	5.02
A		38.50	0.250	0.350	0		0.0	2730	1.50	3.2	2.68	17.0	17.0	3.20	5.50	30.80	74.11
OA1,OA2,B1,A		1260.60	0.492	0.592									84.5	1.50	2.65	930.32	1977.63
B2		1.81	0.500	0.600	150	5.3	7.6	450	2.00	4.9	4.43	1.7	9.3	4.10	7.10	3.71	7.71
B3		1.41	0.500	0.600	0		0.0	700	2.00	3	3.46	3.4	3.4	5.20	9.00	3.67	7.61
B4		5.89	0.500	0.600	0		0.0	1180	2.00	3.7	3.85	5.1	5.1	5.20	9.00	15.31	31.81
OB1,B2,B3,B4	B3	9.11	0.500	0.600									12.7	3.70	6.20	16.85	33.89
B5		0.90	0.500	0.600	0		0.0	1000	2.00	3.3	3.63	4.6	4.6	5.20	9.00	2.34	4.86
OB1,B2-B5	B5	10.01	0.500	0.600									17.2	3.20	5.50	16.02	33.03
B6	B6	3.30	0.500	0.600	0		0.0	2100	2.00	3.7	3.85	9.1	9.1	4.10	7.10	6.77	14.06
OB1,B2-B6	B6A	13.31	0.500	0.600									17.2	3.20	5.50	21.30	43.92
B6A	B6B															41.80	84.40
OA1,OA2,A,B1-B6	1	1273.9	0.492	0.592									84.5	1.50	2.65	940.15	1998.51
B7		0.83	0.500	0.600	150	4.0	8.3	0				0.0	8.3	4.25	7.50	1.76	3.74
B8		0.52	0.500	0.600	850	5.5	17.8	0				0.0	17.8	3.10	5.20	0.81	1.62
B7,B8	2	1.35	0.500	0.600									26.2	2.50	4.40	1.69	3.56
E4	3	0.60	0.618	0.690	0		0.0	450	1.50	5.5	3.52	2.1	2.1	5.20	9.00	1.93	3.73
OD1		98.57	0.300	0.400	1000	10.0	21.2	3300	1.50	3.9	2.96	18.6	39.7	1.90	3.40	56.18	134.06
D1		0.46	0.250	0.350	0		0.0	180	1.50	2.5	2.37	1.3	1.3				
OD1,D1	D1	99.03	0.300	0.400									41.0	1.90	3.40	56.45	134.68
OD2		6.26	0.300	0.400	1000	3.5	30.0	0				0.0	30.0	2.35	4.10	4.41	10.27
D1C		3.23	0.366	0.466	0		0.0	700	2.00	3.4	3.69	3.2	3.2				
OD2,D1C	D1C	9.49	0.322	0.422									33.2	2.20	3.85	6.72	15.42
D1A		3.00	0.317	0.417	0		0.0	370	2.00	2.7	3.29	1.9	1.9				
OD2,D1C,D1A	D1A	12.49	0.321	0.421									35.0	2.10	3.75	8.42	19.72
D1B	D1B	0.19	0.900	0.950	0		0.0	420	2.00	1.6	2.53	2.8	2.8	5.20	9.00	0.89	1.62
OD1,D1,D1A,D1B	D1A1	111.71	0.303	0.403									41.0	1.90	3.40	64.31	153.07
D4	D4	0.12	0.900	0.950	0		0.0	700	2.00	1.56	2.50	4.7	4.7	5.20	9.00	0.56	1.03
OD1,D1,D1A,D1B,D4	D4A	111.83	0.304	0.404									45.7	1.75	3.20	64.87	154.09
D5	D5	0.11	0.900	0.950	0		0.0	250	2.00	3.27	3.62	1.2	1.2	5.20	9.00	0.51	0.94
OD1,D1,D1A,D1B,D4,D5	D5A	111.94	0.304	0.404									46.8	1.70	3.15	65.39	155.03
D6	D6	0.32	0.900	0.950	0		0.0	480	2.00	4.44	4.21	1.9	1.9	5.20	9.00	1.49	2.72
OD1,D1,D1A,D1B,D4-D6	D6A1	112.26	0.306	0.406									48.7	1.70	3.00	66.88	157.75

BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR[7]	C 100-YEAR[7]	OVERLAND LENGTH (FT)	SLOPE (%)	Tco[1] (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT K	SLOPE (%)	SCS[2] VELOCITY (FT/S)	Tt[3] (MIN)	TOTAL Tc[4] (MIN)	INTENSITY[5] 5-YR (IN/HR)	INTENSITY[5] 100-YR (IN/HR)	PEAK FLOW Q5[6] (CFS)	PEAK FLOW Q100[6] (CFS)
OC1		2.21	0.300	0.400	550	3.3	22.7					0.0	22.7	2.70	4.70	1.79	4.15
D2		3.60	0.500	0.600	0		0.0	600	2.00	3.6	3.79	2.6	2.6				
OC1,D2	D2	5.81	0.424	0.524									25.3	2.60	4.50	6.40	13.70
E2A	E2A	0.39	0.750	0.812	0		0.0	300	1.50	4	3.00	1.7	1.7	5.20	9.00	1.52	2.85
D3		1.55	0.500	0.600	0		0.0	580	2.00	4.3	4.15	2.3	2.3	5.20	9.00	4.03	8.37
C		4.75	0.900	0.900	0		0.0	750	2.00	3.3	3.63	3.4	3.4	5.20	9.00	22.23	38.48
D3,C	C	6.30	0.802	0.826									5.8	5.00	8.50	25.26	44.23
OD1,OC1,E2A,C,D1-D6	C1	124.76	0.338	0.434									48.7	1.70	3.00	71.69	162.43
E2		0.52	0.750	0.812	0		0.0	300	1.50	4	3.00	1.7	1.7	5.20	9.00	2.03	3.80
D6A	D6A	3.00	0.900	0.900	0		0.0	470	2.00	3.4	3.69	2.1	2.1	5.20	9.00	14.04	24.30
OD1,OC1,C,D1-D6A	D6A2	128.28	0.350	0.443									50.8	1.60	2.90	71.84	164.80
D7A	D7A	3.48	0.500	0.600	0		0.0	950	2.00	1.68	2.59	6.1	6.1	5.00	8.50	8.70	17.75
D7		6.05	0.500	0.600	0		0.0	1244	2.00	2.17	2.95	7.0	7.0	4.60	8.00	13.92	29.04
D7A,D7	D7	9.53	0.500	0.600									7.0	4.60	8.00	21.92	45.74
D8	D8	3.72	0.500	0.600	0		0.0	225	2.00	3.4	3.69	1.0	1.0	5.20	9.00	9.67	20.09
D7A-D8	D8A	13.25	0.500	0.600									8.1	4.40	7.50	29.15	59.63
D9	D9	1.20	0.500	0.600	0		0.0	210	2.00	3.4	3.69	0.9	0.9	5.20	9.00	3.12	6.48
D7A-D9	D9A	14.45	0.500	0.600									9.0	4.20	7.20	30.35	62.42
E3A	E3A	0.12	0.250	0.350	0		0.0	220	1.50	4.3	3.11	1.2	1.2	5.20	9.00	0.16	0.38
D10	D10	4.80	0.500	0.600	300	4.0	11.8	1820	2.00	3	3.46	8.8	20.5	2.95	5.05	7.08	14.54
D10A	D10A	0.23	0.500	0.600	0		0.0	200	1.50	0.5	1.06	3.1	3.1	5.20	9.00	0.60	1.24
D7A-D10,E3A	D10B	19.37	0.498	0.598									20.5	2.95	5.05	28.46	58.50
D9A		3.18	0.900	0.900	0		0.0	620	1.50	0.5	1.06	9.7	9.7	5.20	9.00	14.88	25.76
D7A-D10,E3A	D9B	22.55	0.555	0.641									30.3	2.30	4.05	28.79	58.54
E3	E3	0.70	0.714	0.779	0		0.0	620	1.50	0.8	1.34	7.7	7.7	4.40	7.50	2.20	4.09
F		4.02	0.250	0.350	0		0.0	570	1.50	1.0	1.50	6.3	6.3	5.00	8.50	5.03	11.96
OD1,OC1,C,D1-D10,E2-E3,F	4	155.55	0.379	0.471									50.8	1.60	2.90	94.32	212.46
OE1		2.47	0.300	0.400	850	2.8	29.8	0				0.0	29.8	2.35	4.10	1.74	4.05
E1		1.50	0.900	0.900	0		0.0	700	2.00	2.3	3.03	3.8	3.8	5.20	9.00	7.02	12.15
OE1,E1	5	3.97	0.527	0.589									33.6	2.20	3.80	4.60	8.89

1) OVERLAND FLOW Tco = (1.87*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))
2) SCS VELOCITY = K * ((SLOPE(%))^0.5)
K = 0.70 FOR MEADOW / FOREST
K = 1.0 FOR BARE SOIL
K = 1.5 FOR GRASS CHANNEL
K = 2.0 FOR PAVEMENT
3) GUTTER/SWALE FLOW, TRAVEL TIME, Tt = (CHANNEL LENGTH/ SCS VELOCITY) / 60 SEC
4) Tc = Tco + Tt
*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED
5) INTENSITY BASED ON I-D-F CURVE IN EL PASO COUNTY DRAINAGE CRITERIA MANUAL
6) Q = CiA
7) WEIGHTED AVERAGE C VALUES FOR COMBINED BASINS

APPENDIX B

HYDROLOGIC CALCULATIONS

Table 6-6. Runoff Coefficients for Rational Method

(Source: UDFCD 2001)

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

3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

$$t_c = t_i + t_t \qquad \text{(Eq. 6-7)}$$

Where:

t_c = time of concentration (min)

t_i = overland (initial) flow time (min)

t_t = travel time in the ditch, channel, gutter, storm sewer, etc. (min)

3.2.1 Overland (Initial) Flow Time

The overland flow time, t_i, may be calculated using Equation 6-8.

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \qquad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \qquad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

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.

The travel time is calculated by dividing the flow distance (in feet) by the velocity calculated using Equation 6-9 and converting units to minutes.

The time of concentration (t_c) is then the sum of the overland flow time (t_i) and the travel time (t_t) per Equation 6-7.

3.2.3 First Design Point Time of Concentration in Urban Catchments

Using this procedure, the time of concentration at the first design point (typically the first inlet in the system) in an urbanized catchment should not exceed the time of concentration calculated using Equation 6-10. The first design point is defined as the point where runoff first enters the storm sewer system.

$$t_c = \frac{L}{180} + 10 \qquad \text{(Eq. 6-10)}$$

Where:

t_c = maximum time of concentration at the first design point in an urban watershed (min)

L = waterway length (ft)

Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional "calibration" of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, the time of concentration is calculated by accumulating the travel times in downstream drainageway reaches.

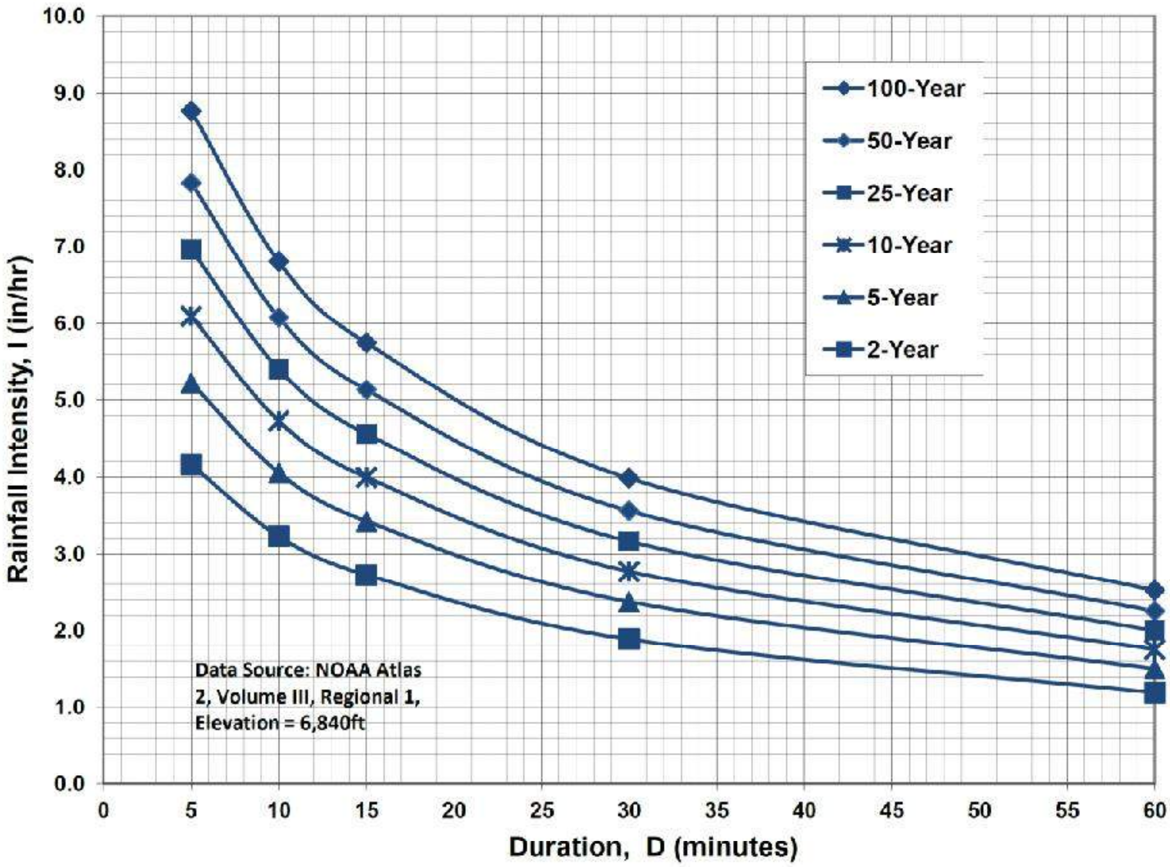
3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

3.2.5 Post-Development Time of Concentration

As Equation 6-8 indicates, the time of concentration is a function of the 5-year runoff coefficient for a drainage basin. Typically, higher levels of imperviousness (higher 5-year runoff coefficients) correspond to shorter times of concentration, and lower levels of imperviousness correspond to longer times of

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

$$I_{100} = -2.52 \ln(D) + 12.735$$

$$I_{50} = -2.25 \ln(D) + 11.375$$

$$I_{25} = -2.00 \ln(D) + 10.111$$

$$I_{10} = -1.75 \ln(D) + 8.847$$

$$I_{5} = -1.50 \ln(D) + 7.583$$

$$I_{2} = -1.19 \ln(D) + 6.035$$

Note: Values calculated by equations may not precisely duplicate values read from figure.

STRUTHERS RANCH POLARIS
COMPOSITE RUNOFF COEFFICIENTS

EXISTING CONDITIONS

5-YEAR C VALUES

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
A	2.74	2.74	VACANT	0.08							0.080
OB1	1.47	1.47	SF RESIDENTIAL	0.3							0.300
B	1.41	1.41	VACANT	0.08							0.080
OB1,B	2.88										0.192
A,OB1,B	5.62										0.138

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
A	2.74	2.74	VACANT	0.35							0.350
OB1	1.47	1.47	SF RESIDENTIAL	0.5							0.500
B	1.41	1.41	VACANT	0.35							0.350
OB1,B	2.88										0.427
A,OB1,B	5.62										0.389

STRUTHERS RANCH POLARIS
COMPOSITE RUNOFF COEFFICIENTS

DEVELOPED CONDITIONS

5-YEAR C VALUES

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
A	2.74	1.90	PAVED/IMPERVIOUS	0.9	0.84	LANDSCAPED	0.08				0.649
OB1	1.47	1.47	SF RESIDENTIAL	0.3							0.300
B	1.41	1.34	PAVED/IMPERVIOUS	0.9	0.07	LANDSCAPED	0.08				0.859
OB1,B	2.88										0.574
A,OB1,B	5.62										0.610

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
A	2.74	1.90	PAVED/IMPERVIOUS	0.96	0.84	LANDSCAPED	0.35				0.773
OB1	1.47	1.47	SF RESIDENTIAL	0.5							0.500
B	1.41	1.34	PAVED/IMPERVIOUS	0.96	0.07	LANDSCAPED	0.35				0.930
OB1,B	2.88										0.710
A,OB1,B	5.62										0.741

STRUTHERS RANCH POLARIS
RATIONAL METHOD

EXISTING CONDITIONS

			C		Overland Flow			Channel flow							INTENSITY [5]		PEAK FLOW	
BASIN	**DESIGN POINT**	**AREA (AC)**	**5-YEAR**	**100-YEAR**	**LENGTH (FT)**	**SLOPE (FT/FT)**	**Tco [1] (MIN)**	**CHANNEL LENGTH (FT)**	**CONVEYANCE COEFFICIENT C**	**SLOPE (FT/FT)**	**SCS [2] VELOCITY (FT/S)**	**Tt [3] (MIN)**	**TOTAL Tc [4] (MIN)**	**TOTAL Tc [4] (MIN)**	**5-YR (IN/HR)**	**100-YR (IN/HR)**	**Q5 [6] (CFS)**	**Q100 [6] (CFS)**
A	A	2.74	0.080	0.350	100	0.030	13.0	275	15	0.047	3.25	1.4	14.4	14.4	3.59	6.02	0.79	5.77
OB1	OB1	1.47	0.300	0.500	100	0.020	11.6					0.0	11.6	11.6	3.90	6.55	1.72	4.82
B	B	1.41	0.080	0.350	100	0.030	13.0	585	15	0.018	2.01	4.8	17.8	17.8	3.26	5.48	0.37	2.70
OB1,B	B1	2.88	0.192	0.427									16.5	16.5	3.38	5.67	1.87	6.98
Tt DP-B1 to DP1								225	15	0.036	2.85	1.3						
A,OB1,B	**1**	**5.62**	**0.138**	**0.389**									**17.8**	**17.8**	**3.27**	**5.48**	**2.53**	**11.98**

DEVELOPED CONDITIONS

			C		Overland Flow			Channel flow							INTENSITY [5]		PEAK FLOW	
BASIN	**DESIGN POINT**	**AREA (AC)**	**5-YEAR**	**100-YEAR**	**LENGTH (FT)**	**SLOPE (FT/FT)**	**Tco [1] (MIN)**	**CHANNEL LENGTH (FT)**	**CONVEYANCE COEFFICIENT C**	**SLOPE (FT/FT)**	**SCS [2] VELOCITY (FT/S)**	**Tt [3] (MIN)**	**TOTAL Tc [4] (MIN)**	**TOTAL Tc [4] (MIN)**	**5-YR (IN/HR)**	**100-YR (IN/HR)**	**Q5 [6] (CFS)**	**Q100 [6] (CFS)**
A	A	2.74	0.649	0.773	60	0.083	3.2	490	20	0.027	3.29	2.5	5.6	5.6	4.99	8.37	8.87	17.73
OB1	OB1	1.47	0.300	0.500	100	0.020	11.6					0.0	11.6	11.6	3.90	6.55	1.72	4.82
B	B	1.41	0.859	0.930	100	0.030	3.1	500	20	0.02	2.83	2.9	6.0	6.0	4.89	8.22	5.93	10.78
OB1,B	B1	2.88	0.574	0.710									14.6	14.6	3.56	5.98	5.89	12.24
Tt DP-B1 to DP1								225	20	0.036	3.79	1.0						
A,OB1,B	**1**	**5.62**	**0.610**	**0.741**									**15.6**	**15.6**	**3.47**	**5.82**	**11.88**	**24.23**

DEVELOPED CONDITIONS - COMPARISON WITH SUBDIVISION DRAINAGE REPORT ("FINAL DRAINAGE REPORT FOR STRUTHERS RANCH FILING NO. 2" BY JPS DATED 10/14/04)

			C		Overland Flow			Channel flow							INTENSITY [5]		PEAK FLOW	
BASIN	**DESIGN POINT**	**AREA (AC)**	**5-YEAR**	**100-YEAR**	**LENGTH (FT)**	**SLOPE (FT/FT)**	**Tco [1] (MIN)**	**CHANNEL LENGTH (FT)**	**CONVEYANCE COEFFICIENT C**	**SLOPE (FT/FT)**	**SCS [2] VELOCITY (FT/S)**	**Tt [3] (MIN)**	**TOTAL Tc [4] (MIN)**	**TOTAL Tc [4] (MIN)**	**5-YR (IN/HR)**	**100-YR (IN/HR)**	**Q5 [6] (CFS)**	**Q100 [6] (CFS)**
D6A	D6A	3.00	0.900	0.900			0.0	300	15	0.04	3.00	1.7	1.7	5.0	5.17	8.68	13.96	23.43
D9A	D9A	3.18	0.900	0.900			0.0	620	15	0.005	1.06	9.7	9.7	9.7	4.17	7.00	11.93	20.03
D6A,D9A	**1**	**6.18**	**0.900**	**0.900**									**9.7**	**9.7**	**4.17**	**7.00**	**23.18**	**38.92**

1) OVERLAND FLOW Tco = (0.395*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))
2) SCS VELOCITY = C * ((SLOPE(FT/FT)^0.5)
C = 2.5 FOR HEAVY MEADOW
C = 5 FOR TILLAGE/FIELD
C = 7 FOR SHORT PASTURE AND LAWNS
C = 10 FOR NEARLY BARE GROUND
C = 15 FOR GRASSED WATERWAY
C = 20 FOR PAVED AREAS AND SHALLOW PAVED SWALES

3) MANNING'S CHANNEL TRAVEL TIME = L/V (WHEN CHANNEL VELOCITY IS KNOWN)
4) Tc = Tco + Tt
*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED
5) INTENSITY BASED ON I-D-F EQUATIONS IN CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL
$I_5 = -1.5 * \ln(Tc) + 7.583$
$I_{100} = -2.52 * \ln(Tc) + 12.735$
6) Q = CiA

APPENDIX C

HYDRAULIC CALCULATIONS

STRUTHERS RANCH POLARIS
STORM INLET SIZING SUMMARY

	BASIN FLOW			INLET FLOW						
INLET	DP	Q5 FLOW (CFS)	Q100 FLOW (CFS)	INLET FLOW % OF BASIN	Q5 FLOW (CFS)	Q100 FLOW (CFS)		INLET CONDITION / TYPE	INLET SIZE (FT)	INLET CAPACITY (CFS)
A1	A	8.9	17.7	40	3.6	7.1		SUMP TYPE 16	SGL	8.7

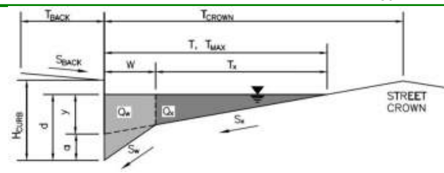
Version 4.05 Released March 2017

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

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

Project: Struthers Ranch Polaris - Inlet A1

Inlet ID: Inlet A1



Gutter Geometry (Enter data in the blue cells)

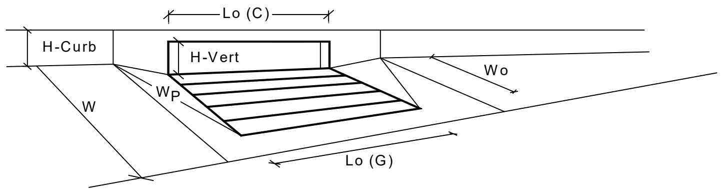
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	2.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	50.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	50.0	50.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	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)	Denver No. 16 Combination		MINOR	MAJOR	
Type of Inlet		Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	6.0	12.0	inches
Grate Information			MINOR	MAJOR	Override Depths
Length of a Unit Grate		L_o (G) =	3.00	3.00	feet
Width of a Unit Grate		W_o =	1.73	1.73	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A_{ratio} =	0.31	0.31	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C_w (G) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C_o (G) =	0.60	0.60	
Curb Opening Information			MINOR	MAJOR	
Length of a Unit Curb Opening		L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	5.25	5.25	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C_o (C) =	0.66	0.66	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.523	1.023	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.83	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.94	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} =	0.94	1.00	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**3.9**	**8.7**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	3.6	7.1	cfs

STRUTHERS RANCH POLARIS
STORM SEWER SIZING SUMMARY

	PIPE FLOW				PIPE CAPACITY		
PIPE	DESIGN POINT	Q5 FLOW (CFS)	Q100 FLOW (CFS)		PIPE SIZE	MIN. PIPE SLOPE	PIPE CAPACITY (CFS)
A1	A1	3.6	7.1		18	1.0%	10.5

ASSUMPTIONS:
1. STORM DRAIN PIPE ASSUMED TO BE RCP OR HDPE

Hydraulic Analysis Report

Project Data

Project Title: Project - Polaris

Designer: JPS

Project Date: Monday, June 13, 2022

Project Units: U.S. Customary Units

Notes:

Channel Analysis: SD-A1

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 1.5000 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0130

Depth: 1.5000 ft

Result Parameters

Flow: 10.5043 cfs

Area of Flow: 1.7671 ft^2

Wetted Perimeter: 4.7124 ft

Hydraulic Radius: 0.3750 ft

Average Velocity: 5.9442 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.2451 ft

Critical Velocity: 6.6989 ft/s

Critical Slope: 0.0098 ft/ft

Critical Top Width: 1.13 ft

Calculated Max Shear Stress: 0.9360 lb/ft^2

Calculated Avg Shear Stress: 0.2340 lb/ft^2

APPENDIX D

WATER QUALITY POND CALCULATIONS

STRUTHERS RANCH POLARIS
COMPOSITE IMPERVIOUS AREAS

IMPERVIOUS AREAS

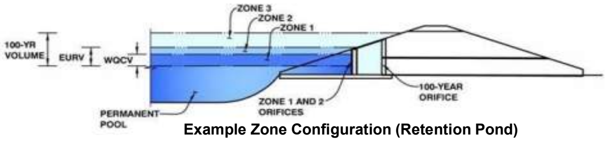
BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	WEIGHTED % IMP
A	2.74	1.90	PAVED/IMPERVIOUS	100	0.84	LANDSCAPED	0.00				69.343
OB1	1.47	1.47	SF RESIDENTIAL	40							40.000
B	1.41	1.34	PAVED/IMPERVIOUS	100	0.07	LANDSCAPED	0.00				95.000
OB1,B	2.88										66.927
A,OB1,B	5.62										68.105

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

Project: **Struthers Ranch Polaris**

Basin ID: **Water Quality Pond A**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	5.62	acres
Watershed Length =	825	ft
Watershed Length to Centroid =	400	ft
Watershed Slope =	0.024	ft/ft
Watershed Imperviousness =	68.10%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.125	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.419	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.370	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.500	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.611	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.743	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.859	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.998	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	1.293	acre-feet	3.14	inches
Approximate 2-yr Detention Volume =	0.327	acre-feet		
Approximate 5-yr Detention Volume =	0.436	acre-feet		
Approximate 10-yr Detention Volume =	0.553	acre-feet		
Approximate 25-yr Detention Volume =	0.595	acre-feet		
Approximate 50-yr Detention Volume =	0.619	acre-feet		
Approximate 100-yr Detention Volume =	0.665	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.125	acre-feet
Zone 2 Volume (User Defined - Zone 1) =	0.000	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.125	acre-feet

Total detention volume is less than 100-year volume.

Depth Increment = 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	--	--	--	10	0.000		
Bot EL=6752.0	--	1.00	--	--	--	1,433	0.033	721	0.017
	--	3.00	--	--	--	2,456	0.056	4,610	0.106
EL=6756.0	--	5.00	--	--	--	3,626	0.083	10,692	0.245
Top EL=6758.0	--	7.00	--	--	--	4,500	0.103	18,818	0.432
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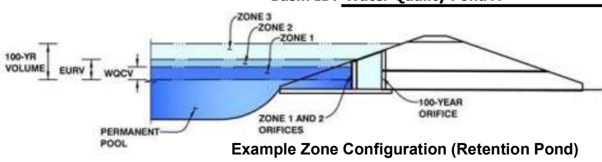
SEE COMPOSITE IMPERVIOUS AREA CALCULATIONS ON PRECEDING PAGE (...WATER QUALITY POND A IS DESIGNED FOR THE COMBINED FLOW FROM DEVELOPED BASINS A, OB1, AND B)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Project: **Struthers Ranch Polaris**
Basin ID: **Water Quality Pond A**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.33	0.125	Orifice Plate
Zone 2 (User)	3.33	0.000	Weir&Pipe (Restrict)
Zone 3			Not Utilized
Total (all zones)		0.125	

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

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

Calculated Parameters for Underdrain

Underdrain Orifice Area =		ft^2
Underdrain Orifice Centroid =		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)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	3.33	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	14.40	inches
Orifice Plate: Orifice Area per Row =	0.58	sq. inches (diameter = 7/8 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row =	4.028E-03	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.20	2.40					
Orifice Area (sq. inches)	0.58	0.58	0.58					

	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 with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.50	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	2.50	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.50	N/A	feet
Overflow Weir Slope Length =	2.50	N/A	feet
Grate Open Area / 100-yr Orifice Area =	3.94	N/A	
Overflow Grate Open Area w/o Debris =	6.96	N/A	ft^2
Overflow Grate Open Area w/ Debris =	3.48	N/A	ft^2

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

	Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	18.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

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

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.50	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	14.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.50	feet
Stage at Top of Freeboard =	7.00	feet
Basin Area at Top of Freeboard =	0.10	acres
Basin Volume at Top of Freeboard =	0.43	acre-ft

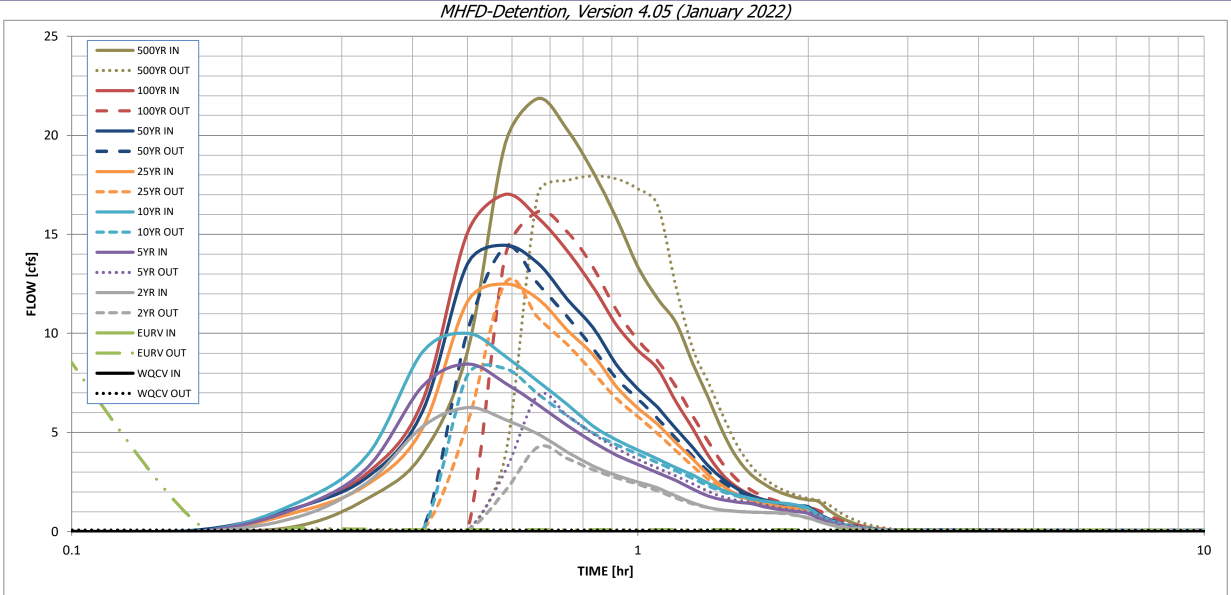
Routed Hydrograph Results

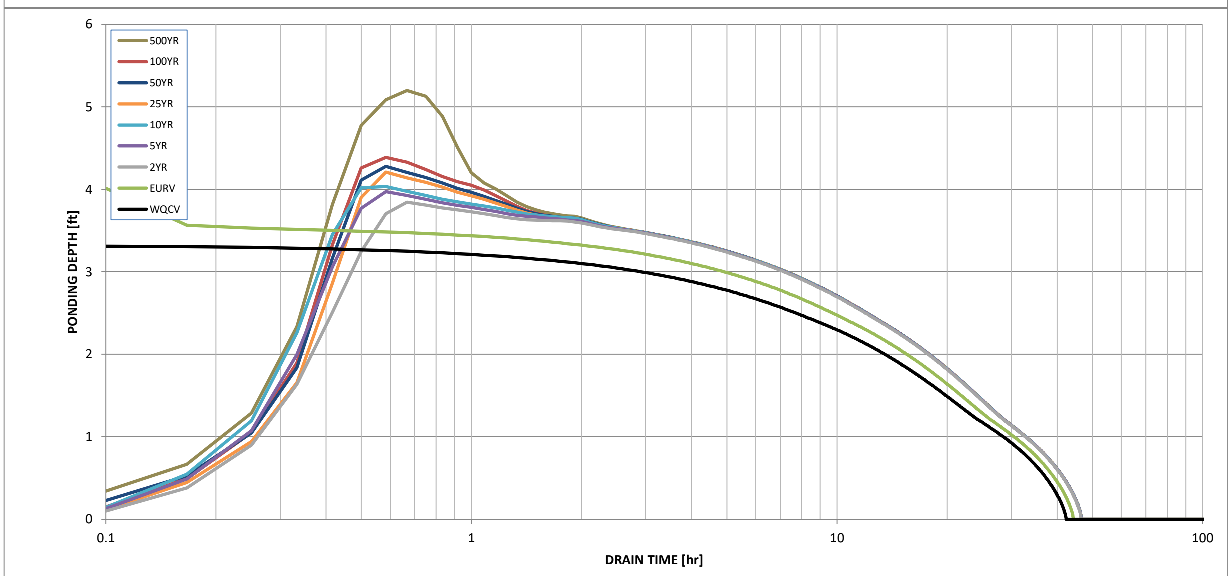
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

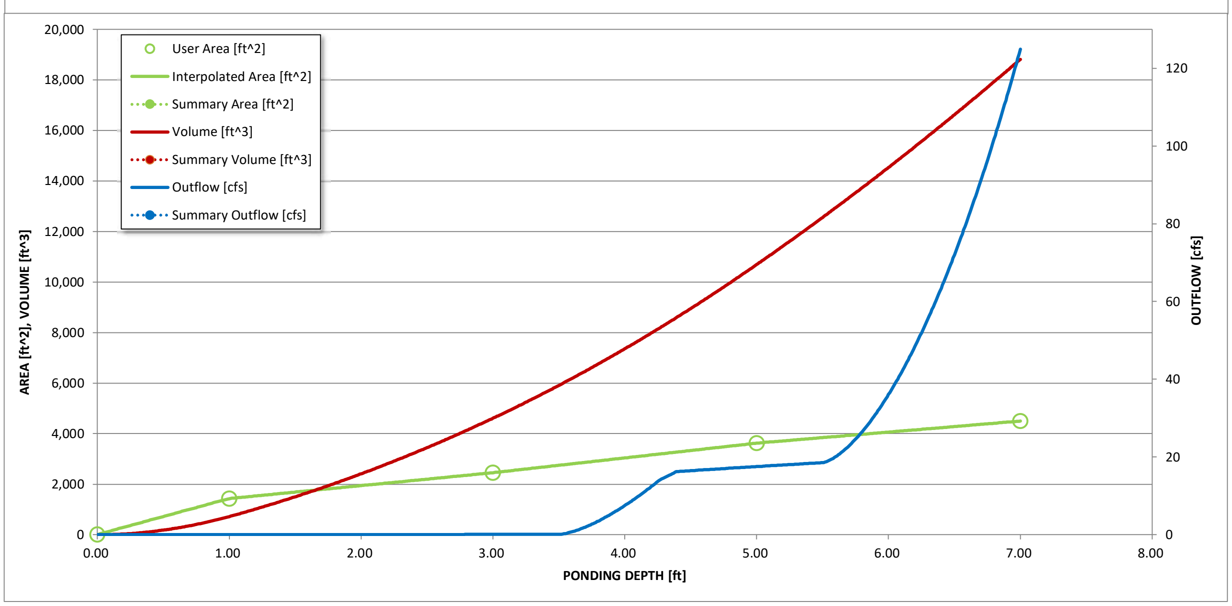
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.125	0.419	0.370	0.500	0.611	0.743	0.859	0.998	1.293
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.370	0.500	0.611	0.743	0.859	0.998	1.293
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.6	1.6	2.4	4.3	5.4	6.9	9.7
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.10	0.29	0.43	0.77	0.96	1.23	1.72
Peak Inflow Q (cfs) =	N/A	N/A	6.3	8.5	10.0	12.5	14.4	17.0	21.9
Peak Outflow Q (cfs) =	0.1	28.7	4.3	6.9	8.2	12.5	14.3	16.2	17.9
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	4.3	3.4	2.9	2.7	2.3	1.9
Structure Controlling Flow =	Plate	Spillway	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	3.01	0.60	1.0	1.2	1.8	2.0	2.3	2.6
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	35	36	34	32	29	28	26	23
Time to Drain 99% of Inflow Volume (hours) =	**40**	40	42	41	40	39	38	37	35
Maximum Ponding Depth (ft) =	3.33	6.88	3.84	3.97	4.03	4.21	4.28	4.39	5.20
Area at Maximum Ponding Depth (acres) =	0.06	0.10	0.07	0.07	0.07	0.07	0.07	0.07	0.09
Maximum Volume Stored (acre-ft) =	0.125	0.420	0.158	0.167	0.171	0.183	0.188	0.196	0.261

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

Time Interval	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.01	0.26
	0:15:00	0.00	0.00	0.72	1.18	1.45	0.98	1.21	1.19	1.67
	0:20:00	0.00	0.00	2.48	3.23	3.87	2.38	2.76	2.96	3.90
	0:25:00	0.00	0.00	5.30	7.33	9.05	5.20	6.06	6.57	9.09
	0:30:00	0.00	0.00	6.26	8.45	10.02	11.61	13.52	15.09	19.59
	0:35:00	0.00	0.00	5.65	7.50	8.85	12.49	14.45	17.02	21.87
	0:40:00	0.00	0.00	4.92	6.40	7.56	11.73	13.53	15.83	20.30
	0:45:00	0.00	0.00	4.02	5.36	6.43	10.17	11.73	14.18	18.17
	0:50:00	0.00	0.00	3.31	4.52	5.33	8.93	10.29	12.36	15.82
	0:55:00	0.00	0.00	2.83	3.86	4.62	7.31	8.43	10.42	13.37
	1:00:00	0.00	0.00	2.50	3.38	4.12	6.23	7.20	9.16	11.76
	1:05:00	0.00	0.00	2.20	2.97	3.66	5.42	6.27	8.22	10.56
	1:10:00	0.00	0.00	1.80	2.57	3.23	4.48	5.19	6.57	8.48
	1:15:00	0.00	0.00	1.45	2.14	2.85	3.66	4.25	5.19	6.73
	1:20:00	0.00	0.00	1.21	1.78	2.43	2.85	3.30	3.82	4.95
	1:25:00	0.00	0.00	1.08	1.59	2.07	2.27	2.63	2.82	3.67
	1:30:00	0.00	0.00	1.01	1.49	1.83	1.85	2.13	2.22	2.89
	1:35:00	0.00	0.00	0.98	1.41	1.67	1.58	1.82	1.85	2.41
	1:40:00	0.00	0.00	0.96	1.26	1.55	1.40	1.61	1.60	2.08
	1:45:00	0.00	0.00	0.94	1.14	1.47	1.29	1.46	1.42	1.85
	1:50:00	0.00	0.00	0.93	1.06	1.41	1.21	1.37	1.30	1.70
	1:55:00	0.00	0.00	0.80	0.99	1.33	1.15	1.30	1.22	1.59
	2:00:00	0.00	0.00	0.70	0.92	1.19	1.12	1.26	1.18	1.53
	2:05:00	0.00	0.00	0.51	0.67	0.86	0.81	0.91	0.86	1.11
	2:10:00	0.00	0.00	0.37	0.48	0.61	0.58	0.65	0.62	0.80
	2:15:00	0.00	0.00	0.26	0.34	0.43	0.41	0.46	0.44	0.57
	2:20:00	0.00	0.00	0.18	0.23	0.30	0.29	0.32	0.31	0.40
	2:25:00	0.00	0.00	0.12	0.15	0.20	0.20	0.22	0.21	0.27
	2:30:00	0.00	0.00	0.08	0.10	0.14	0.13	0.15	0.14	0.19
	2:35:00	0.00	0.00	0.05	0.07	0.09	0.09	0.10	0.09	0.12
	2:40:00	0.00	0.00	0.02	0.04	0.05	0.05	0.06	0.05	0.07
	2:45:00	0.00	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.03
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer: JPS
Company: JPS
Date: October 21, 2022
Project: Struthers Ranch Polaris
Location: Water Quality Pond A - Forebay A1

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a	I_a = 69.3 %
B) Tributary Area's Imperviousness Ratio (i = I_a / 100)	i = 0.693
C) Contributing Watershed Area	Area = 2.740 ac
D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = in
E) Design Concept (Select EURV when also designing for flood control)	Choose One: (●) Water Quality Capture Volume (WQCV) ( ) Excess Urban Runoff Volume (EURV)
F) Design Volume (WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$)	V_{DESIGN}= 0.062 ac-ft
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6*(V_{DESIGN}/0.43))$	$V_{DESIGN\ OTHER}$= ac-ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{DESIGN\ USER}$= ac-ft
I) NRCS Hydrologic Soil Groups of Tributary Watershed	
i) Percentage of Watershed consisting of Type A Soils	HSG_A = 0 %
ii) Percentage of Watershed consisting of Type B Soils	HSG_B = 100 %
iii) Percentage of Watershed consisting of Type C/D Soils	$HSG_{C/D}$ = 0 %
J) Excess Urban Runoff Volume (EURV) Design Volume For HSG A: $EURV_A = 1.68 * i^{1.28}$ For HSG B: $EURV_B = 1.36 * i^{1.08}$ For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$	$EURV_{DESIGN}$ = 0.209 ac-f t
K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired)	$EURV_{DESIGN\ USER}$= ac-f t
2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)	L : W = 3.0 : 1
3. Basin Side Slopes	
A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z = 3.00 ft / ft **DIFFICULT TO MAINTAIN, INCREASE WHERE POSSIBLE**
4. Inlet	
A) Describe means of providing energy dissipation at concentrated inflow locations:	Concrete Forebay
5. Forebay	
A) Minimum Forebay Volume (V_{FMIN} = 1% of the WQCV)	V_{FMIN} = 0.001 ac-ft
B) Actual Forebay Volume	V_F = 0.001 ac-ft
C) Forebay Depth (D_F = 12 inch maximum)	D_F = 12.0 in
D) Forebay Discharge	
i) Undetained 100-year Peak Discharge	Q_{100} = 17.70 cfs
ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)	Q_F = 0.35 cfs
E) Forebay Discharge Design	Choose One: ( ) Berm With Pipe (●) Wall with Rect. Notch ( ) Wall with V-Notch Weir **Flow too small for berm w/ pipe**
F) Discharge Pipe Size (minimum 8-inches)	Calculated D_P = in
G) Rectangular Notch Width	Calculated W_N = 3.7 in

Design Procedure Form: Extended Detention Basin (EDB)

Designer:	**JPS**
Company:	**JPS**
Date:	**October 21, 2022**
Project:	**Struthers Ranch Polaris**
Location:	**Water Quality Pond A - Forebay A1**

6. Trickle Channel	
A) Type of Trickle Channel	Choose One (●) Concrete ( ) Soft Bottom
F) Slope of Trickle Channel	S = 0.0050 ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5 ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = sq ft
C) Outlet Type	Choose One (●) Orifice Plate ( ) Other (Describe):
D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)	$D_{orifice}$ = 0.58 inches
E) Total Outlet Area	A_{ot} = 1.74 square inches
8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 6 in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = cu ft
C) Initial Surcharge Provided Above Micropool	V_s= cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = 63 square inches
B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.) Other (Y/N): N	*S.S. Well Screen with 60% Open Area*
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio =
D) Total Water Quality Screen Area (based on screen type)	A_{total} = 106 sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= 3.47 feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= 69.64 inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = 12.0 inches **VALUE LESS THAN RECOMMENDED MIN. WIDTH. WIDTH HAS BEEN SET TO 12 INCHES.**

Design Procedure Form: Extended Detention Basin (EDB)

Designer: JPS
Company: JPS
Date: October 21, 2022
Project: Struthers Ranch Polaris
Location: Water Quality Pond A - Forebay A1

10. Overflow Embankment	
A) Describe embankment protection for 100-year and greater overtopping:	Buried Riprap Spillway
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Ze = 4.00 ft / ft
11. Vegetation	Choose One: ○ Irrigated ◉ Not Irrigated
12. Access	
A) Describe Sediment Removal Procedures	Periodic inspection and removal as needed; Access ramp provided to pond bottom

Notes:

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer: JPS
Company: JPS
Date: October 21, 2022
Project: Struthers Ranch Polaris
Location: Water Quality Pond A - Forebay B1

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a	I_a = 66.9 %
B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	i = 0.669
C) Contributing Watershed Area	Area = 2.880 ac
D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = in
E) Design Concept (Select EURV when also designing for flood control)	Choose One: (●) Water Quality Capture Volume (WQCV); ( ) Excess Urban Runoff Volume (EURV)
F) Design Volume (WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area)$)	V_{DESIGN}= 0.063 ac-ft
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6*(V_{DESIGN}/0.43))$)	$V_{DESIGN\ OTHER}$= ac-ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{DESIGN\ USER}$= ac-ft
I) NRCS Hydrologic Soil Groups of Tributary Watershed	
i) Percentage of Watershed consisting of Type A Soils	HSG_A = %
ii) Percentage of Watershed consisting of Type B Soils	HSG_B = %
iii) Percentage of Watershed consisting of Type C/D Soils	$HSG_{C/D}$ = %
J) Excess Urban Runoff Volume (EURV) Design Volume For HSG A: $EURV_A = 1.68 * i^{1.28}$ For HSG B: $EURV_B = 1.36 * i^{1.08}$ For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$	$EURV_{DESIGN}$ = ac-f t
K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired)	$EURV_{DESIGN\ USER}$= ac-f t
2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)	L : W = 3.0 : 1
3. Basin Side Slopes	
A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z = 3.00 ft / ft DIFFICULT TO MAINTAIN, INCREASE WHERE POSSIBLE
4. Inlet	
A) Describe means of providing energy dissipation at concentrated inflow locations:	Concrete Forebay
5. Forebay	
A) Minimum Forebay Volume (V_{FMIN} = 1% of the WQCV)	V_{FMIN} = 0.001 ac-ft
B) Actual Forebay Volume	V_F = 0.001 ac-ft
C) Forebay Depth (D_F = 12 inch maximum)	D_F = 12.0 in
D) Forebay Discharge	
i) Undetained 100-year Peak Discharge	Q_{100} = 12.20 cfs
ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)	Q_F = 0.24 cfs
E) Forebay Discharge Design	Choose One: ( ) Berm With Pipe; (●) Wall with Rect. Notch; ( ) Wall with V-Notch Weir Flow too small for berm w/ pipe
F) Discharge Pipe Size (minimum 8-inches)	Calculated D_P = in
G) Rectangular Notch Width	Calculated W_N = 3.3 in

Design Procedure Form: Extended Detention Basin (EDB)

Designer: JPS
Company: JPS
Date: October 21, 2022
Project: Struthers Ranch Polaris
Location: Water Quality Pond A - Forebay B1

6. Trickle Channel	
A) Type of Trickle Channel	Choose One: (●) Concrete ( ) Soft Bottom
F) Slope of Trickle Channel	S = 0.0050 ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5 ft
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C) Outlet Type	Choose One: (●) Orifice Plate ( ) Other (Describe):
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Design Procedure Form: Extended Detention Basin (EDB)

Designer:	**JPS**
Company:	**JPS**
Date:	**October 21, 2022**
Project:	**Struthers Ranch Polaris**
Location:	**Water Quality Pond A - Forebay B1**

10. Overflow Embankment A) Describe embankment protection for 100-year and greater overtopping:	Buried Riprap Spillway
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Ze = 4.00 ft / ft
11. Vegetation	Choose One ○ Irrigated ◉ Not Irrigated
12. Access A) Describe Sediment Removal Procedures	Periodic inspection and removal as needed; Access ramp provided to pond bottom

Notes:

APPENDIX E

WATER QUALITY POND COST ESTIMATE

STRUTHERS RANCH POLARIS
LOTS 1-2, STRUTHERS RANCH SUBDIVISION FILING NO. 4
ENGINEER'S COST ESTIMATE
DRAINAGE IMPROVEMENTS - WATER QUALITY POND

Item No.	Description	Quantity	Unit	Unit Cost ($$$)	Total Cost ($$$)
	PRIVATE DRAINAGE FACILITIES (NON-REIMBURSABLE)				
203	Detention Basin Earthwork	630	CY	$22	$13,860
301	Retaining Walls	1320	SF	$25	$33,000
301	Concrete Forebays (10'x8')	6.0	CY	$300	$1,800
301	Concrete Trickle Channels	1	LS	$1,200	$1,200
604	Detention Basin Outlet Structure / Buried Riprap Spillway	1	LS	$10,000	$10,000
	SUBTOTAL				**$59,860**
	Engineering @ 10%				$5,986
	TOTAL (NON-REIMBURSABLE)				**$65,846**
	Note: This estimate does not include costs for street improvements and general civil costs (curb & gutter, crosspans, etc.)				

The cost estimate submitted herein is based on time-honored practices within the construction industry. As such the engineer does not control the cost of labor, materials, equipment or a contractor's method of determining prices and competitive bidding practices or market conditions. The estimate represents our best judgement as design professionals using current information available at the time of the preparation. The engineer cannot guarantee that proposals, bids and/or construction costs will not vary from this cost estimate.

APPENDIX F

FIGURES

1DWLRQDO)ORRG+D]DUG/DHU)50(WWH

FEMA

)HHW

/HJHQG

6HH),6 5HSRUW IRU GHWDLOHG OHJHQG DQG LQGH[PDS IRU ILUP SDQHO OD\RXW

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 — Cross Sections with 1% Annual Chance Water Surface Elevation; Coastal Transect; 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

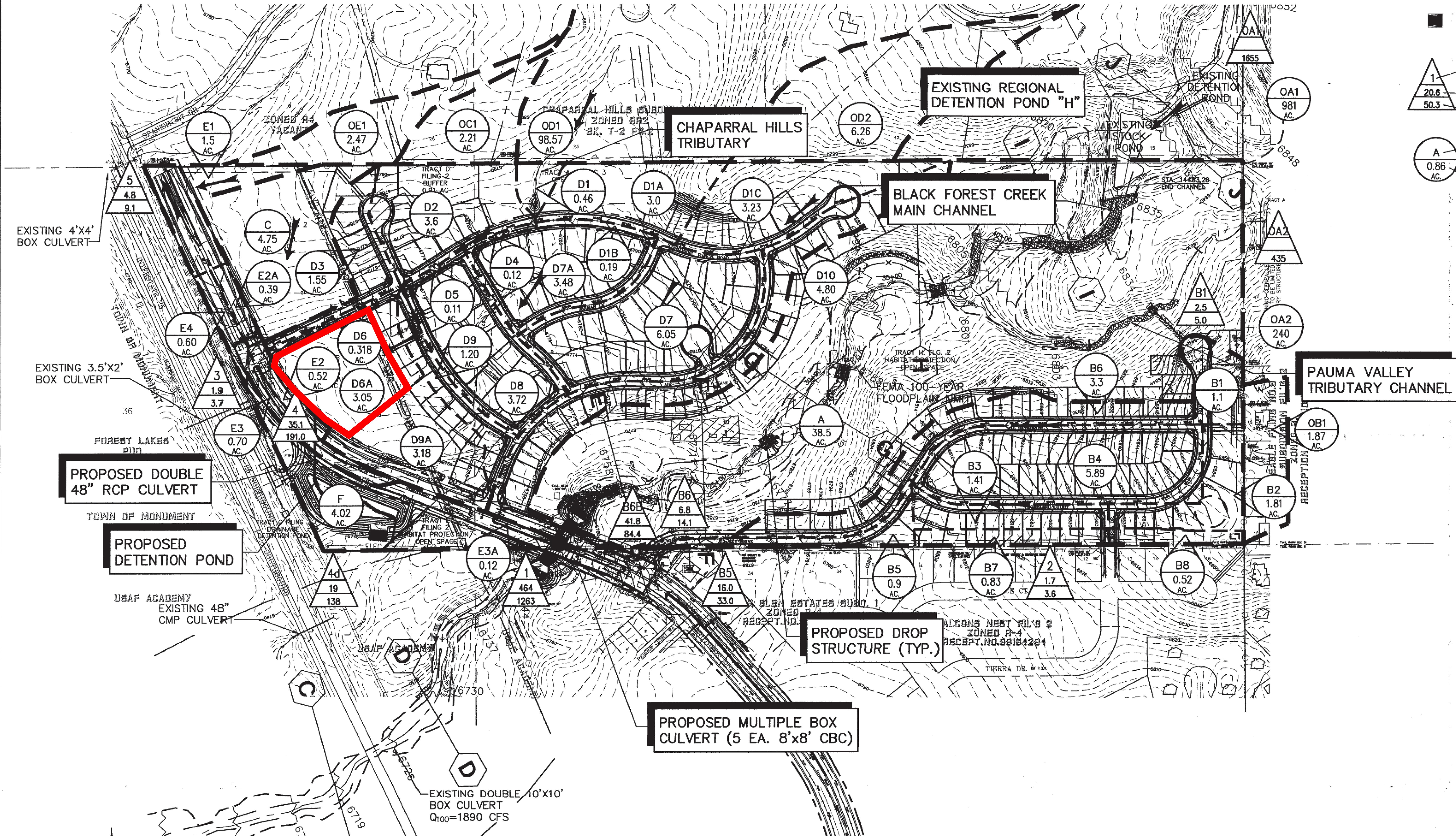
The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

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 [date] 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.

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020



LEGEND

- FILING LIMITS
- MAJOR BASIN BOUNDARY
- MINOR BASIN BOUNDARY
- 6520 EXISTING CONTOUR
- FLOWLINE
- PROPOSED FLOW DIRECTION ARROW
- PROPOSED DROP STRUCTURE
- DESIGN POINT (1 / 20.6 / 50.3): Q_5 (cfs), Q_{100} (cfs)
- BASIN DESIGNATION (A / 0.86 AC.): BASIN AREA (ACRES)

-N-

GRAPHIC SCALE

200 0 100 200 400

ORIGINAL SCALE: 1"=200'
CONTOUR INTERVAL=2'

NOTES:

1. DEVELOPMENT SHALL FOLLOW ALL REQUIREMENTS OF THE APPROVED HABITAT CONSERVATION PLAN (HCP) AND ASSOCIATED ENVIRONMENTAL PERMITS.

2. PERIMETER DRAINS SHALL BE REQUIRED FOR ALL HOMES WITH BASEMENTS.

J:\jpsprojects\080006.struthers\dwg\civil\D1.dwg Oct 15, 2004 - 12:12pm

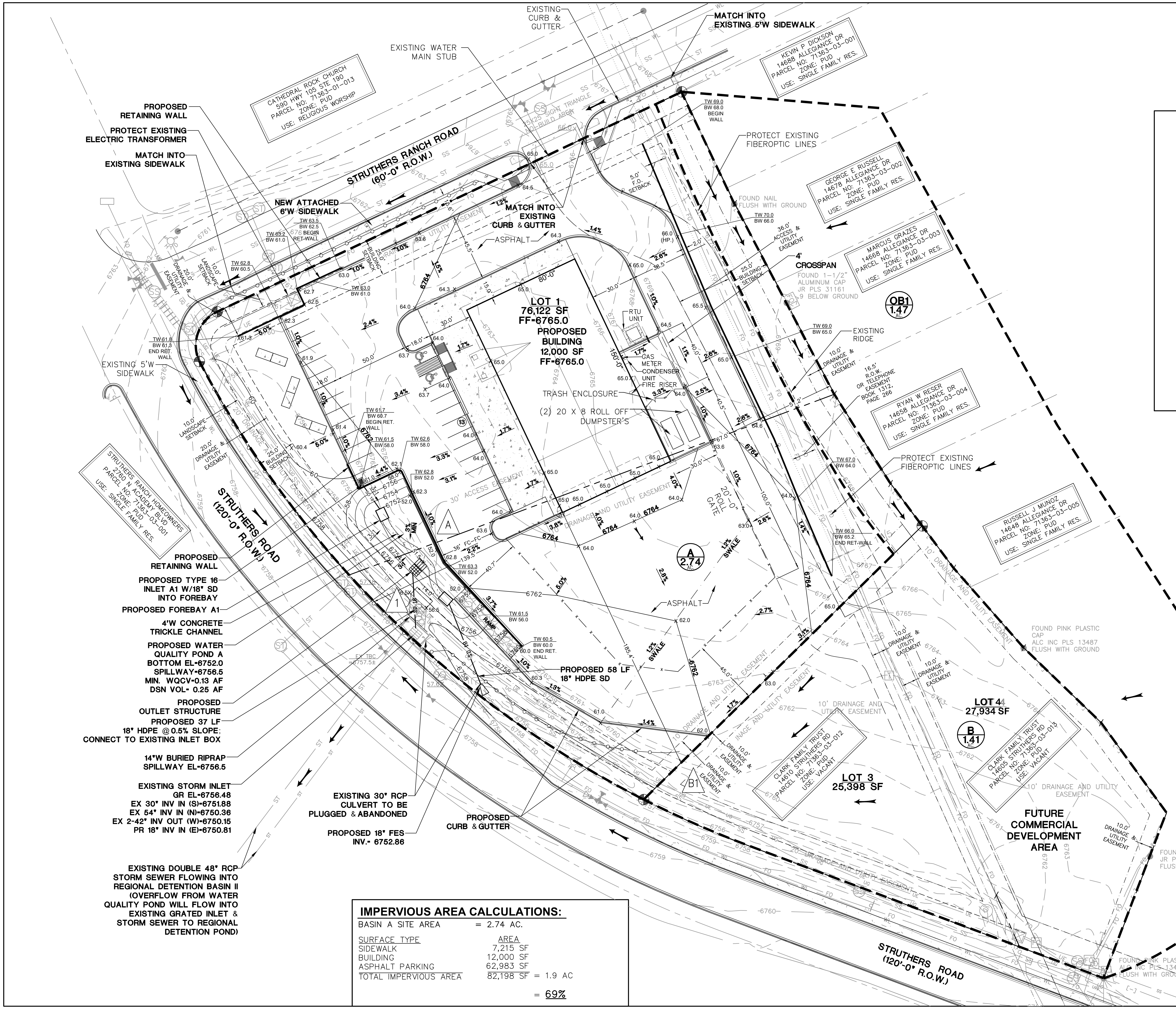
STRUTHERS RANCH SUBDIVISION

DEVELOPED DRAINAGE PLAN

JPS ENGINEERING
19 E. Willamette Ave.
Colorado Springs, CO 80903
PH: 719-477-9429
FAX: 719-471-0766

No.	REVISION	BY	DATE
E	EPC COMMENTS	JPS	4/8/04
F	EPC COMMENTS	JPS	5/7/04
G	EPC COMMENTS	JPS	5/25/04
H	EPC COMMENTS	JPS	9/2/04
I	RE-SUBMITTAL TO EPC	JPS	9/30/04

HORZ. SCALE: 1"=200'	DRAWN: MJP
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: PINNACLE	CHECKED: JPS
CREATED: 9/11/00	LAST MODIFIED: 10/15/04
PROJECT NO: 080006	MODIFIED BY: MJP
SHEET: D1	



IMPERVIOUS AREA CALCULATIONS:

BASIN A SITE AREA = 2.74 AC.

SURFACE TYPE	AREA
SIDEWALK	7,215 SF
BUILDING	12,000 SF
ASPHALT PARKING	62,983 SF
TOTAL IMPERVIOUS AREA	82,198 SF = 1.9 AC

= 69%

LEGEND

FEMA 100-YEAR FLOODWAY	
FEMA 100-YR FLOODPLAIN	
PROPERTY LINE	
DRAINAGE BASIN BOUNDARY	
EASEMENT LINE	
6762	PROPOSED CONTOUR
6762	EXISTING CONTOUR
× 49.0	PROPOSED SPOT ELEVATION (FLOWLINE)
× 74.5	EXIST. SPOT ELEVATION
1.0%	PROPOSED SLOPE
TW	TOP OF RETAINING WALL
BW	BOTTOM OF RETAINING WALL
	FLOWLINE
	FLOW DIRECTION ARROW
1	DESIGN POINT
A / XX AC	BASIN DESIGNATION / BASIN AREA (ACRES)

EXISTING CONDITIONS SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
A	0.8	5.8
B1	1.9	7.0
1	2.5	12.0

DEVELOPED CONDITIONS SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
A	8.9	17.7
B1	5.9	12.2
1	11.9	24.2

DETENTION POND CONTOUR AREAS

CONTOUR	AREA (SF)
6752	1,433 SF
6754	2,456 SF
6756	3,626 SF

STRUTHERS RANCH POLARIS
LOTS 1-2, STRUTHERS RANCH SUBDIVISION FILING NO. 4

DEVELOPED DRAINAGE PLAN

JPS ENGINEERING
19 E. Willamette Ave.
Colorado Springs, CO 80903
PH: 719-477-9429
FAX: 719-471-0766
www.jpsengr.com

CALL UTILITY NOTIFICATION CENTER OF COLORADO
1-800-922-1987
CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

NO.	REVISION	BY	DATE

HORZ. SCALE:	1"=30'	DRAWN:	PV
VERT. SCALE:	N/A	DESIGNED:	JPS
SURVEYED:	COMPASS	CHECKED:	JPS
CREATED:	05/27/20	LAST MODIFIED:	04/07/23
PROJECT NO:	032203	MODIFIED BY:	PV

SHEET: D1.1