Final Drainage Report
Rocky Top Resources
Tract 7 Valley Garden Subdivision
1755 East Las Vegas
El Paso County, Colorado

Prepared for:
Rocky Top Resources
1755 East Las Vegas
Colorado Springs, Colorado 80903
719-579-9103

Prepared by:

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

Kiowa Project No. 17066
March 26, 2019

Table of Contents

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

Kiowa Engineering Corporation, 1604 South 21st Street, Colorado Springs, Colorado 80904

_____ _____

Richard N. Wray Date
Registered Engineer #19310
For and on Behalf of Kiowa Engineering Corporation

Developer's Statement:

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

BY: _____ _____

Date

_____

Printed

ADDRESS: Peterson Group, LLC
90 South Cascade Suite 1500
Colorado Springs, Colorado 80903

Should this be the owner of the property?

El Paso County:

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

_____ _____

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

I. General Location and Description of Project

The Rocky Top Resources project is a site development involving a portion of Tract 7 of the Garden Subdivision located in El Paso County, Colorado. The property subject to site development cover approximately 22 acres of the total 44.81 acres. Site development activities as proposed will not require that a re-plat be prepared however a rezone of the property is required.

ESQCP shows 29 acres.

The proposed site improvements will include grading, stormwater detention basin, office building, parking lot(s), onsite individual wastewater system (septic and leach field), landscaping and access driveways. The site presently operates as a waste wood, lawn waste and concrete recycling center. Recycled materials are used to make mulch, fine soil mulch and concrete base course. Approximately 22 acres of the parcel are not used for the active recycling and sales operations.

The site is a 44.8 -acre commercial recycling center site located at 1755 East Las Vegas in El Paso County, Colorado. The site is located within a portion of Sections 28 and 29, Township 14 South, Range 66 West of the 6th Principal Meridian, in Colorado Springs, Colorado. The El Paso County Assessor parcel number is 64291-01-029, 030 and 031. The parcel is legally described as Tract 7 in the Valley Gardens Subdivision. The location of the site is shown on the Vicinity Map (Figure 1). The site is bordered by East Las Vegas Street on the northeast, US Highway 24 Bypass right-of-way on the northwest, Spring Creek on the southeast and Fountain Creek on the southwest.

There are no public streets that will be constructed as part of the development of the site. Access off Las Vegas Avenue has already been designed as part of the City's Spring Creek/Royer Road/Las Vegas Street Roadway Design. The access is shown on the site development plan. A private full spectrum detention basin will be constructed and will be operated and maintained by the property owner and subject to a private detention basin maintenance agreement.

submit a maintenance agreement and O&M

II. Previous Reports and References

The following reports and plans were reviewed [illegible] this drainage report:

1) *Spring Creek Road/Las Vegas Street Roadway Design Plan,* prepared by Felsburg Holt and Ullevig, March 2018.
2) *City of Colorado Springs and El Paso County Flood Insurance Study* prepared by the Federal Emergency Management Agency, dated December 2018.
3) *City of Colorado Springs and El Paso County Drainage Criteria Manual*, most current versions, Volumes 1 and 2.
4) *Soil Survey of El Paso County Area, Colorado*, prepared by United States Department of Agriculture Soil Conservation Service, dated June 1981.

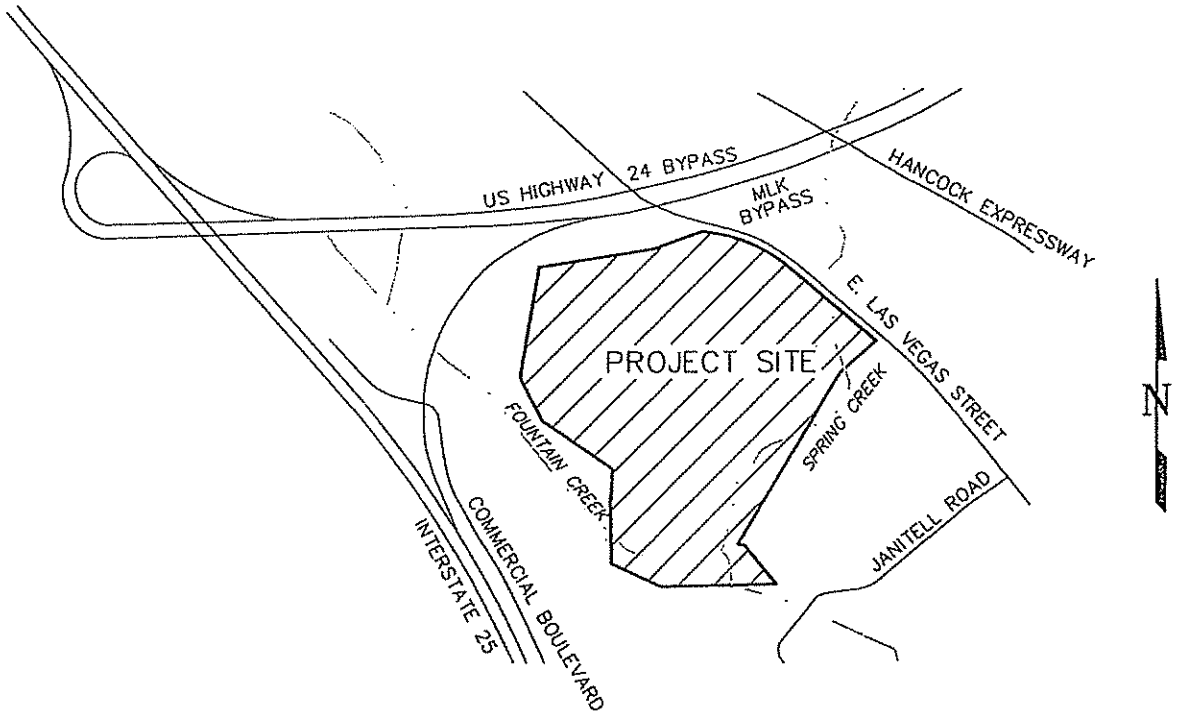


FIGURE 1
VICINITY MAP
NO SCALE

Reference 1 was reviewed to assess whether any facilities shown on the design plans would impact the site development. The access off Las Vegas will be constructed as part of the City's roadway improvement project.

Reference 2 was reviewed in order to assess whether the regulatory floodplains for Spring Creek and Fountain Creek impact any of the proposed buildings or the recycling operation itself. As a result of this review, there will be no habitable structures that will be constructed within the 100-year floodplain, and all grading associated with the FSD and site improvements will occur within the 500-year or the 100-year flood fringe. There will be no encroachment of fill into the floodway of either Spring or Fountain Creek.

III. Hydrology

Existing Basin Description: Existing sub-basins have been delineated on Exhibit 1. Four existing condition sub-basins occur within the Rocky Top property. Approximately one-third of the property now drains to the Spring Creek floodplain and the remaining portion of the property drains to the Fountain Creek floodplain. The is only one area of offsite drainage that enters the property at the north boundary which is the slope to the US 24 Bypass on ramp.

Soils within portion of the property subject to the recycling operations are classified to be within Hydrologic Soils Groups (HSG) A and B as shown in the El Paso County Soils Survey. The predominant soil covering 85 percent of the recycling operation are identified as Ustic Torrifluvents (HSG B), that is a loamy soil that is well drained. Soil covering the remainder of the recycling operation is identified as Ellicott (HSG A), loamy coarse sand that is somewhat excessively drained. These soils have a moderate to high infiltration rate when thoroughly wet. These soils have a low to moderate hazard of erosion. The existing vegetation is mostly native grasses within the portion of the property that is not used for the recycling operation. Along the Springs Creek and Fountain Creek drainageways cottonwoods, native shrubs and invasive species such as Russian olive and Dutch elm. There will be no disturbance to these areas as part of the site improvements. Within the active areas of the recycling operations the vegetative cover is sparse and there are numerous haul roads and gravel access drives. Vegetative cover outside of the active area of the recycling operation is 85 percent. Within the operations areas vegetative cover is less than 10 percent. Ground slopes are less than 2 percent in the active operations areas.

Existing Basin Descriptions: Total drainage area estimated to discharge to Fountain Creek and Spring Creek 44.8 acres. Developed runoff from the active area of the recycling operations is now being controlled by a temporary storage bas located near the southwest corner of the property. There is no discharge of runoff from the active portion of the site. The descriptions below are for present development condition and the discharges are for the pre-development condition.

Sub-basin A: This sub-basin is located at east corner of the property and discharges to the existing temporary storage basin located in sub-basin D. The colorant and colored mulch storage area operations is within this sub-basin. This sub-basin lies within portion of the 100- and 500-year floodplain of Spring Creek however the active portion associated with the colorant storage and processing lies outside of the 500-year floodplain. The colorant storage material is

stored on an existing concrete slab. The sub-basin covers 5.32 acres and has slopes of 1 to 2 percent. The estimated 5- and 100-year discharges are 2.5 and 16.9 cubic feet per second, respectively.

Sub-basin B: This sub-basin is located at south corner of the property and is a direct flow basin to Spring Creek. This sub-basin lies within portion of the 100- and 500-year floodplain of Spring Creek. There are no active operations associated with the recycling within this sub-basin. This sub-basin covers 7.51 acres and has slopes of 2 to 4 percent. The estimated 5- and 100-year discharges are 3.5 and 23.8 cubic feet per second, respectively for the pre-development condition.

Sub-basin C: This sub-basin is located at south corner of the property and is a direct flow basin to Fountain Creek. This sub-basin lies within portion of the 100- and 500-year floodplain of Spring Creek. There are no active operations associated with the recycling within this sub-basin. This sub-basin covers 3.59 acres and has slopes of 1 to 2 percent. The estimated 5- and 100-year discharges are 1.7 and 11.4 cubic feet per second, respectively for the pre-development condition.

Sub-basin D: This sub-basin covers the active areas of the recycling operations and discharges to the existing temporary storage basin located in sub-basin B. The retail office, waste concrete storage, waste concrete processing waste wood storage and yard waste storage and processing now existing in this sub-basin. This sub-basin lies within portion of the 500-year floodplain of Fountain Creek. The sub-basin covers 29.42 acres and has slopes of 1 to 2 percent. The estimated 5- and 100-year discharges are 6.9 and 57.2 cubic feet per second, respectively for the pre-development condition.

Proposed Basin Descriptions: Developed runoff from the active area of the recycling operations will be controlled by a proposed full spectrum detention basin. There will be no direct discharge to Spring or Fountain Creek other than from this sub-basin that lies outside of the active area of operations. The descriptions below are for the proposed development condition. The proposed condition sub-basins are shown on Exhibit 2.

Sub-basin 1: This sub-basin covers the active areas of the recycling operations and discharges to the existing temporary storage basin located in sub-basin B. The news retail office, parking area and access driveways, waste concrete storage, waste concrete processing waste wood storage and yard waste storage and processing now existing in this sub-basin. This sub-basin lies within portion of the 500-year floodplain of Fountain Creek. The sub-basin covers 30.45 acres and will have slopes of 1 to 2 percent. The estimated 5- and 100-year discharges are 43.8 and 98.7 cubic feet per second, respectively.

Sub-basin 2: This sub-basin is located at east corner of the property and is a direct flow basin to Spring Creek. This sub-basin lies within portion of the 100- and 500-year floodplain of Spring Creek. There will be no active operations associated with the recycling within this sub-basin. This sub-basin covers 1.4 acres and has slopes of 2 to 4 percent. The estimated 5- and 100-year discharges are .7 and 4.4 cubic feet per second, respectively.

Sub-basin 3: This sub-basin is located at southwest corner of the property and is a direct flow basin to Fountain Creek. This sub-basin lies within portion of the 100- and 500-year floodplain of Fountain Creek. There will be no active operations associated with the recycling within this sub-basin. This sub-basin covers 2.5 acres and has slopes of 2 to 4 percent. The estimated 5- and 100-year discharges are 1.2 and 7.9 cubic feet per second, respectively.

Sub-basin 4: This sub-basin is located at south corner of the property and is a direct flow basin to Fountain Creek. The Fountain Creek Greenway Trail passes through this sub-basin. This sub-basin lies within portion of the 100- and 500-year floodplain of Fountain Creek. There will be no active operations associated with the recycling within this sub-basin. This sub-basin covers 11.49 acres and has slopes of 2 to 5 percent. The estimated 5- and 100-year discharges are 3.6 and 23.6 cubic feet per second, respectively.

IV. Hydrology Calculations

Storm runoff for the site was estimated using the methods outlined in the *City of Colorado Springs and El Paso County, Drainage Criteria Manual.* Chapters 6 and 12 of DCM Volume 1 was used to assess the hydrologic characteristics of the site and for the design of the FSD. The topography for the site is presented with a one-foot contour interval at a horizontal scale of 1-inch to 100-feet. Exhibit 1 presents the existing drainage patterns for the area and Exhibit 2 presents the developed drainage patterns for the area, including the sub-basins and the corresponding flow rates. The flow rates for the sub-basins were estimated by using the Rational Method. The 5-year and 100-year recurrence intervals were determined. The calculations can be found within Appendix A of this report.

V. Hydraulic Calculations

The sizing of the onsite hydraulic structures was determined using the methods outlined in the *City of Colorado Springs and El Paso County, Drainage Criteria Manual.* The site will be drained primarily via sheet flow that is the collected within onsite swales and storm sewers. Runoff from the private street section will be collected using curb inlets and conveyed to the proposed FSD. Discharge from the FSD will be an existing swale that outfalls to the Spring Creek floodplain.

The capacities for proposed inlets and culverts were determined assuming inlet control, a 100-year storm and a maximum headwater to depth ratio of 1.2. The hydraulic capacities of the culverts were determined using the Urban Drainage and Flood Control District (UDFCD), UD-Culvert. The FSD outlet pipe is proposed to be reinforced concrete with flared-end section\. The outlets of all culverts will be protected with riprap which will be sized to meet the outlet velocity condition at each culvert. The riprap at the outlet of all the culverts has been sized to withstand the forces attributable to the 100-year design discharge. Inlets were sized using the UDFCD's UD-INLET spreadsheets. Hydraulic calculations are contained within Appendix B.

The size of the proposed FSD was determined using UDFCD's UD-Detention spreadsheets. The required water quality capture volume (WQCV), excess urban runoff volume (EURV) and the 100-year storage volume were estimated for the proposed. Per El Paso County

GEC outlet detail shows a 30" pipe. Revise.

requirements, one-half of the WQCV was added to the 100-year storage volume. The FSD'S will be designed in accordance with the City of Colorado Springs DCM Volume 1, in combination with the UDFCD DCM Volumes 2 and 3. The FSD's will have a forebay(s), a low flow trickle channel and an outlet structure that will control the discharge of the WCQV, EURV and 100-year detention volume. Discharge from the FSD's during a 100-year inflow event will be limited to the rates of runoff for Hydrologic Soil Groups A and B. The FSD will have a forebay(s) with the required discharge rate and storage volume per Table T5 of Volume III of the UDFCD DCM. The FSD will concrete trickle channel(s) to carry the discharge from the forebay(s) to the principal outlet structure. The principal outlet structures will have perforated plates that will be designed to control the discharge of the WQCV and the EURV (stages 1 and 2). The 100-year discharge (stage 3), will be controlled to pre-development conditions using a 24-inch RCP with a restrictive orifice plate. An emergency spillway will be provided over the crest of the FSD's embankment sized to convey the maximum 100-year un-detained inflow from sub-basin 1 estimated at 98.7 cubic feet per second. Calculations supporting the design of the FSD's are contained in Appendix B.

Earthwork at the site of the FSD basins will be completed initially to provide for sediment storage during the period of construction and the outlet works blocked accordingly.

VI. Floodplain Statement

The GEC shows grading within a small portion of the 100-year floodplain. Revise.

The Floodplain Insurance Rate Map (FIRM) for El Paso County Flood Insurance Study (FIS) panel 0741G dated December 7, 2018 was reviewed to determine any potential regulatory floodplains within the property. The property is impacted by the 100-year and 500-year floodplains of Fountain and Spring creeks. Only a small portion of the active recycling operations lies within the 500-year floodplain. Grading will not occur within the 100-year floodway of Fountain or Spring creeks. The FSD will lie outside of the 100- and 500-year floodplains. FIRM panel 0741G is shown on Figure 2.

A portion is within the 500-year floodplain. Revise.

VII. Grading and Erosion Control

The primary earth disturbing activity within the Rocky Top site will result from the construction of the FSD, new office building, driveways and parking areas. Outside of the areas of new construction no grading proposed to occur. It is the property owner's responsibility to monitor the condition of the temporary erosion control features. Should any of the erosion control facilities come into disrepair prior to the establishment of the native or natural erosion control measures, the developer is responsible for the maintenance and any associated costs. The developer is also responsible for the clean-up of offsite areas affected by any excessive erosion that may leave the site. Control of erosion from areas disturbed by utility construction or home building will be the responsibility of the respective contractor. All erosion control measures shall be installed and maintained in accordance with Volume 2 of the *City/County Drainage Criteria Manual*. Final grading and erosion control plans will be provided within the design plans to be prepared for this project.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242 or visit its website at http://www.ngs.noaa.gov/.

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, City of Fountain, Bureau of Land Management, National Oceanic and Atmospheric Administration, United States Geological Survey, and Anderson Consulting Engineers, Inc. These data are current as of 2006.

This map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

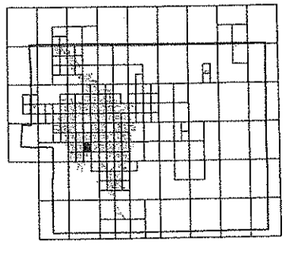
Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

If you have questions about this map or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

El Paso County Vertical Datum Offset Table

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

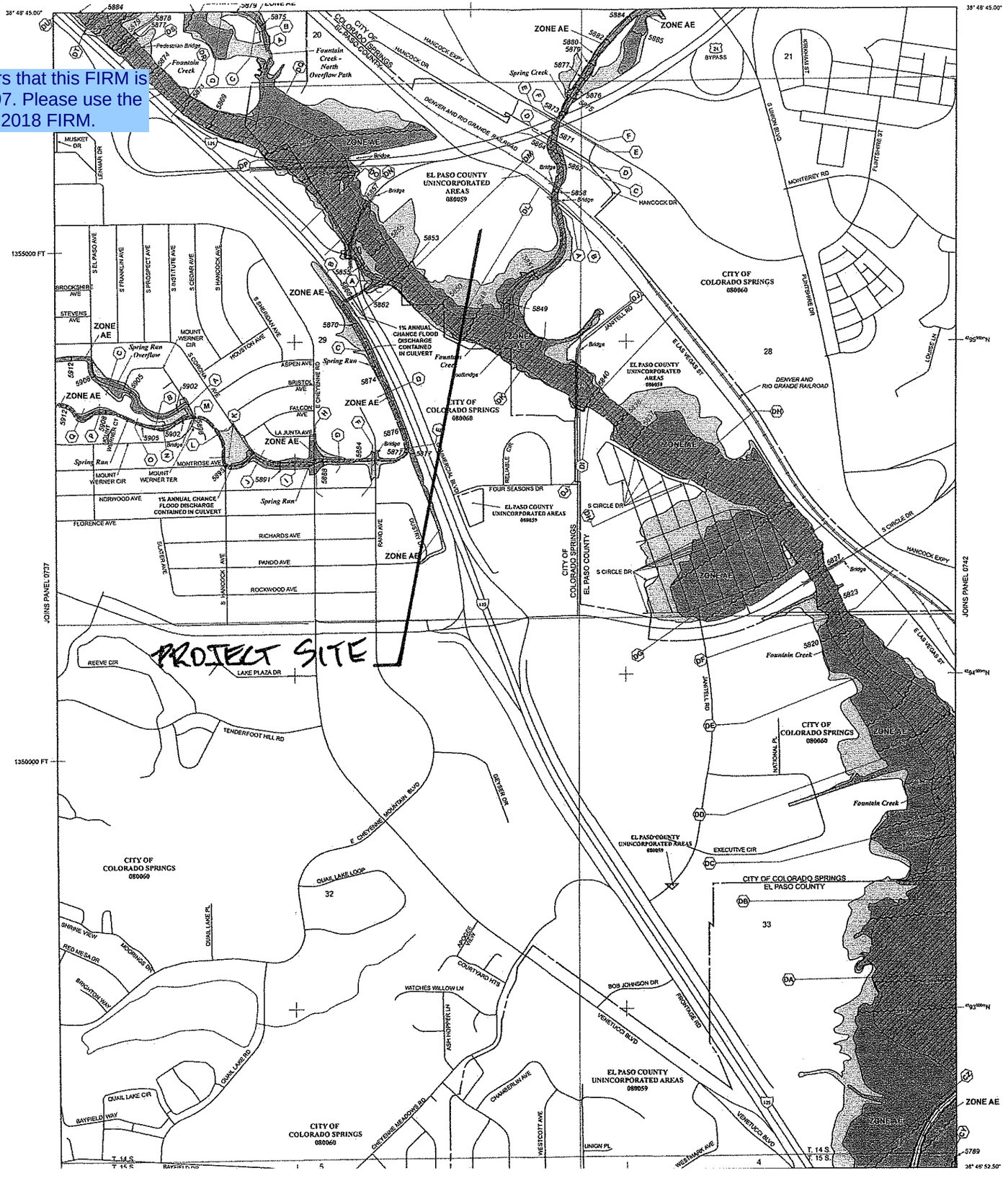
Panel Location Map



This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board (CWCB) and the Federal Emergency Management Agency (FEMA).

Additional Flood Hazard information and resources are

It appears that this FIRM is from 1997. Please use the updated 2018 FIRM.



NFIP

PANEL 0741G

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 741 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0741	G
EL PASO COUNTY	080059	0741	G

FIGURE 2

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
08041C0741G

NATIONAL FLOOD INSURANCE PROGRAM

requirements, one-half of the WQCV was added to the 100-year storage volume. The FSD'S will be designed in accordance with the City of Colorado Springs DCM Volume 1, in combination with the UDFCD DCM Volumes 2 and 3. The FSD's will have a forebay(s), a low flow trickle channel and an outlet structure that will control the discharge of the WCQV, EURV and 100-year detention volume. Discharge from the FSD's during a 100-year inflow event will be limited to the rates of runoff for Hydrologic Soil Groups A and B. The FSD will have a forebay(s) with the required discharge rate and storage volume per Table T5 of Volume III of the UDFCD DCM. The FSD will concrete trickle channel(s) to carry the discharge from the forebay(s) to the principal outlet structure. The principal outlet structures will have perforated plates that will be designed to control the discharge of the WQCV and the EURV (stages 1 and 2). The 100-year discharge (stage 3), will be controlled to pre-development conditions using a 24-inch RCP with a restrictive orifice plate. An emergency spillway will be provided over the crest of the FSD's embankment sized to convey the maximum 100-year un-detained inflow from sub-basin 1 estimated at 98.7 cubic feet per second. Calculations supporting the design of the FSD's are contained in Appendix B.

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TABLE 1: TRACT 7 VALLEY GARDEN SUBDIVISION
PRIVATE DRAINAGE IMPROVEMENT COST ESTIMATE
KIOWA PROJECT NUMBER 17066

ITEM	UNIT COST	UNIT	QUANTITY	TOTAL
PRIVATE DRAINAGE FACILITIES				
EDB DETENTION (1)	$35,000	AF	3	$105,000
30-INCH RCP	$94	LF	150	$14,100
CDOT TYPE D INLET	$3,908	EA	2	$7,816
SUBTOTAL				$126,916.00
CONTINGENCY (5 %)				$6,345.80
ENGINEERING (10 %)				$12,691.60
TOTAL				**$145,953.40**

(1) PER ACRE FOOT UNIT COST INCLUDES, GRADING, OUTLET STRUCTURE AND OUTLET STORM SEWER, FOREBAY, CONCRETE TRICKLE CHNNEL AND EMERGENCY SPILLWAY

runoff volume (EURV) and the 100-year runoff volume. The FSD is design to operate as an extended detention basin (EDB). The discharge of the WQCV, EURV and the 100-year will be managed by means of a water quality outlet structure. The FSD will have a concrete trickle channel and forebay(s). The FSD has been designed to be on conformance with El Paso County engineering and drainage criteria.

Step 4: Industrial and Commercial BMP's

All chemical and fuels used in the recycling operations that are routinely stored on the site will have spill containment measure provided. A separate spill prevention and containment plan will be prepared by the operators of the facility. Access to the retail mulch, aggregate and soil drop-off and pickup are restricted to designated RAP driveways. Access to areas not part of the recycling operation is limited by the property owner by fencing and signage.

It appears that you are missing pages here. The other three steps of the Four Step Process are missing. Please include those steps.

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

KIOWA ENGINEERING CORPORATION

JOB Rocky top Reserve
SHEET NO. OF 3/10/19
CALCULATED BY RJW DATE 17066
CHECKED BY DATE
SCALE Hydrology

Provide the calculations for your initial flow time.

Hydrology - Existing Conditions (Pre-development)

SB #	C_5	C_{100}	Area	T_c (L)
A	.09	.36	5.32	5
B			7.51	5
C			3.59	5
D			28.42	17.5

T_c: SB D $T = L/180 + 10$

$L = 1350'$ $T_c = 1350/180 + 10 = 17.5$ min

Rainfall Intensity (Figure 6-5)

SB #	I_5	I_{100}
A	5.2	8.8
B	5.2	8.8
C	5.2	8.8
D	2.6	5.4

(1) Subdivision < 10 Ac; T_c = 5 Min

Where is this located in the criteria? Chapter 6 of City DCM Vol. 1, Section 3.2.4 Minimum Time of Concentration shows a minimum of 10 minutes for undeveloped areas and a minimum of 5 minutes for urbanized areas. This is not an urbanized area and should have a minimum time of 10 minutes.

D PRODUCT 207

SUB-WATERSHED RUNOFF CALCULATIONS PRE-DEVELOPMENT CONDITIONS
PROJECT: Rocky Top Resources
PROJECT NO: 17066
RATIONAL METHOD FORMULA: Q=CIA

SUB-BASIN NO.	AREA (AC)	RUNOFF COEFFICIENTS C5	C100	RAINFALL INTENSITY I5	I100	RUNOFF (CFS) Q5	Q100
				(INCHES/HR)			
A	5.32	0.09	0.36	5.2	8.8	2.5	16.9
B	7.51	0.09	0.36	5.2	8.8	3.5	23.8
C	3.59	0.09	0.36	5.2	8.8	1.7	11.4
D	29.42	0.09	0.36	2.6	5.4	6.9	57.2

Where is this located in the criteria? Chapter 6 of City DCM Vol. 1, Section 3.2.4 Minimum Time of Concentration shows a minimum of 10 minutes for undeveloped areas and a minimum of 5 minutes for urbanized areas.

JOB Rocky Top Resources
SHEET NO. _____ OF 17061
CALCULATED BY _____ DATE 3/10/19
CHECKED BY Flow DATE _____
SCALE Hydrology - Proposed

Hydrology - Proposed Conditions

SB	Area(ac)	C_5	C_{100}	Tc(min)	I_5	I_{100}
1	30.45	.45	.60	18.1	3.2	5.4
2	1.40	.09	.36	5	5.2	8.8
3	2.50	.09	.36	5	5.2	8.8
4	11.49	.09	.36	15.3	3.45	5.7

Runoff Coefficients: SB 1

50% of Site: Light Industrial $C_5 = .59$ $C_{100} = .70$

50% of Site: poor to Fair grasses $C_5 = .30$ $C_{100} = .50$

SB #1 Wtd ~~Runoff Coeff.~~

5-YR $C_5 = .5(.59) + .30(.50) = .45$

$C_{100} = .5(.70) + .50(.50) = .60$

Tc: SB 1: $L = 1450'$ $T_c = 1450/180 + 10 = 18.1$

SB 4: $L = 950'$ $T_c = 950/180 + 10 = 15.3$

Provide the calculations for your initial flow time.

(1) Sub-basins < 10 Ac : $T_c = 5$ min

SUB-WATERSHED RUNOFF CALCULATIONS PROPOSED DEVELOPMENT CONDITIONS
PROJECT: Rocky Top Resources
PROJECT NO: 17066
RATIONAL METHOD FORMULA: Q=CIA

SUB-BASIN NO.	AREA (AC)	RUNOFF COEFFICIENTS C5	C100	RAINFALL INTENSITY I5	I100	RUNOFF (CFS) Q5	Q100
				(INCHES/HR)			
1	30.45	0.45	0.6	3.2	5.4	43.8	98.7
2	1.4	0.09	0.36	5.2	8.8	0.7	4.4
3	2.5	0.09	0.36	5.2	8.8	1.2	7.9
4	11.49	0.09	0.36	3.45	5.7	3.6	23.6

Table 6-6. Runoff Coefficients for Rational Method
(Source: UDFCD 2001)

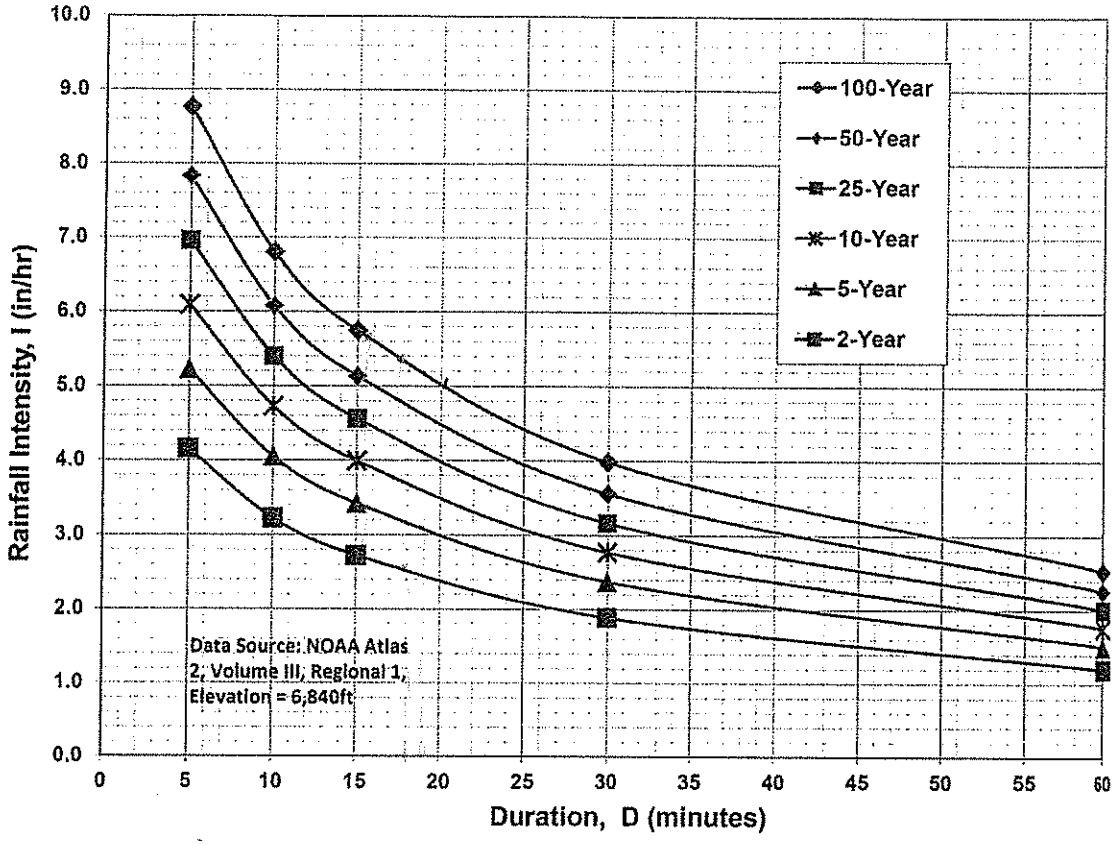
Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	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.

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.

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (Cubic Feet Per Second) 10-Year	50-Year	100-Year	500-Year
Sand Creek East Fork Subtributary					
At confluence with Sand Creek East Fork	5.92	610	1,480	1,970	3,800
Sand Creek West Fork					
At confluence with Sand Creek[1]	5.17	3,459	4,727	5,162	5,542
Above Platte Avenue	--[2]	3,510	5,490	6,810	9,600
Security Creek					
Upstream of confluence with Windmill Gulch	3.7	2,700	4,300	5,400	10,100
South Shooks Run					
At confluence with Fountain Creek	7.82	2,640	4,230	5,570	8,000
South Valley Dry Creek					
Above confluence with Dry Creek	0.15	--[2]	--[2]	162	229
Spring Creek					
At confluence with Fountain Creek	6.7	960	1,790	2,340	4,340
Spring Run					
At Interstate 25	3.63	890	1,350	1,660	2,340
Sutherland Creek					
At confluence with Fountain Creek	5.09	1,810	3,400	4,700	7,500
Templeton Gap Floodway					
At Academy Boulevard	2.49	2,820	4,180	5,040	6,800
Approximately 2,300 feet above Academy Boulevard	2.14	2,440	3,610	4,340	5,850

[1]Discharges are reduced because of losses at Platte Avenue

[2]Data not available

Appendix B
Hydraulic Calculations

MATCH EFFECTIVE FIRM BOUNDARIES
SPRING CREEK CROSS SECTION A
STA. 1700
BFE=5851.7

KIOWA NOTES:
1. CROSS SECTION LABELING THIS SHEET ADDED BY KIOWA ENGINEERING.
2. MATCH TO EFFECTIVE FIS FLOODPLAIN PROVIDED BY KIOWA ENGINEERING.

NOTE:

1. TOPOGRAPHY FROM CSU FIMS. VERTICAL DATUM NGVD 29.
2. CORRELATE WORKMAP STATIONS TO THE FLOOD PROFILE STATIONS BY ADDING THE FOLLOWING INCREMENTS TO THE APPROPRIATE ALIGNMENT.

FOUNTAIN CREEK	260,340 FEET
FOUNTAIN CREEK SOUTH OVERFLOW	625 FEET
FOUNTAIN CREEK NORTH OVERFLOW	1,036 FEET

LEGEND
- EFFECTIVE FLOODWAY
- ONE-FOOT PROPOSED FLOODWAY
- 100 YR EFFECTIVE FLOODPLAIN
- 100 YR PROPOSED FLOODPLAIN
- 100 YR PROPOSED OVERFLOW FLOODPLAIN
- 500 YR EFFECTIVE FLOODPLAIN
- 500 YR PROPOSED FLOODPLAIN
- 500 YR PROPOSED OVERFLOW FLOODPLAIN
- 5200 BASE FLOOD ELEVATION
- 123 OVERFLOW STATION
- 30150 CROSS SECTION NUMBER

200 0 200 400
1 inch = 200 feet

DR DQ DP DO DN DM DL DK

SPRING CREEK

CITY OF COLORADO SPRINGS
EL PASO COUNTY

E. LAS VEGAS ST.

S. CIRCLE DR.

CIRCLE MOBILE HOME PARK

JANITELL RD.

EL PASO COUNTY
CITY OF COLORADO SPRINGS

MATCHLINE
STA. 96+50
SEE DWG 5

SEE DWG 3
STA. 160+50
MATCHLINE

DESIGN:	CGS, LEH, JMB	PROJECT NUMBER:	501007	WHPacific	1536 Cole Blvd, Suite 150 Lakewood, Colorado 80401 Phone: 303.450.5550 Fax: 303.400.8765	CITY OF COLORADO SPRINGS DEPARTMENT OF PUBLIC WORKS ENGINEERING CITY OF COLORADO SPRINGS, COLORADO	FOUNTAIN CREEK FLOODPLAIN RESTUDY FLOODPLAIN BOUNDARIES
DETAIL:	LEH, KHM, RT	DATE:	JUNE 2013				STATION: 160+50 - 96+50
CHECK:	MRG						DRAWING NUMBER: 4

FOUNTAIN CREEK

HEC-RAS Plan: FC_Mar 2013 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
NOF to SOF	17515	10 YR	7900.00	5851.04	5858.87	5856.39	5859.29	0.001224	5.45	2056.30	746.04	0.40
NOF to SOF	17515	50 YR	14300.00	5851.04	5860.41	5858.45	5861.05	0.001583	7.08	3105.49	784.62	0.46
NOF to SOF	17515	100 YR	18000.00	5851.04	5861.09	5859.11	5861.86	0.001760	7.86	3572.82	799.56	0.49
NOF to SOF	17515	500 YR	29079.86	5851.04	5862.76	5860.70	5863.89	0.002178	9.78	4716.88	821.45	0.55
NOF to SOF	17430		Bridge									
NOF to SOF	17374	10 YR	7900.00	5851.07	5858.11	5856.01	5858.43	0.001865	5.17	1915.74	658.32	0.40
NOF to SOF	17374	50 YR	14300.00	5851.07	5859.71	5857.84	5860.16	0.001866	6.18	2827.19	671.72	0.42
NOF to SOF	17374	100 YR	18000.00	5851.07	5860.42	5858.23	5860.96	0.001934	6.72	3237.50	677.86	0.43
NOF to SOF	17374	500 YR	29079.86	5851.07	5862.19	5859.43	5862.97	0.002097	8.05	4342.69	809.28	0.46
NOF to SOF	17342	10 YR	7900.00	5851.00	5857.63	5856.99	5858.28	0.003165	7.47	1641.44	576.51	0.55
NOF to SOF	17342	50 YR	14300.00	5851.00	5859.29	5858.15	5860.02	0.002925	8.49	2630.63	602.51	0.55
NOF to SOF	17342	100 YR	18000.00	5851.00	5860.00	5858.68	5860.82	0.003005	9.14	3057.05	606.84	0.56
NOF to SOF	17342	500 YR	29079.86	5851.00	5861.71	5859.98	5862.82	0.003265	10.81	4117.32	650.83	0.61
NOF to SOF	17284	10 YR	7900.00	5849.90	5856.74	5856.74	5857.99	0.005437	10.07	1199.10	506.45	0.74
NOF to SOF	17284	50 YR	14300.00	5849.90	5858.09	5858.09	5859.72	0.006205	12.31	1897.40	541.28	0.82
NOF to SOF	17284	100 YR	18000.00	5849.90	5858.72	5858.72	5860.51	0.006367	13.21	2243.93	558.95	0.84
NOF to SOF	17284	500 YR	29079.86	5849.90	5860.20	5860.20	5862.47	0.006942	15.51	3103.63	604.52	0.90
NOF to SOF	17250	10 YR	7900.00	5846.00	5853.97	5852.49	5855.77	0.005717	10.77	733.68	201.62	0.72
NOF to SOF	17250	50 YR	14300.00	5846.00	5856.59	5855.32	5858.54	0.005658	12.03	1622.20	492.72	0.71
NOF to SOF	17250	100 YR	18000.00	5846.00	5857.71	5857.40	5859.52	0.005049	12.09	2182.25	507.56	0.67
NOF to SOF	17250	500 YR	29079.86	5846.00	5859.95	5859.16	5861.86	0.004676	13.25	3379.58	577.67	0.67
NOF to SOF	16973	10 YR	7900.00	5846.00	5851.63	5851.31	5853.27	0.015396	10.30	767.02	189.94	0.90
NOF to SOF	16973	50 YR	14300.00	5846.00	5853.29	5853.23	5855.93	0.017802	13.03	1097.60	204.59	0.99
NOF to SOF	16973	100 YR	18000.00	5846.00	5854.49	5854.49	5857.21	0.015127	13.27	1408.15	333.23	0.93
NOF to SOF	16973	500 YR	29079.86	5846.00	5856.95	5856.95	5859.86	0.011496	14.23	2407.92	461.67	0.85
NOF to SOF	16672	10 YR	7900.00	5845.00	5850.82	5848.92	5851.33	0.002679	5.71	1382.79	314.84	0.48
NOF to SOF	16672	50 YR	14300.00	5845.00	5852.93	5850.39	5853.66	0.002734	6.85	2101.63	377.85	0.49
NOF to SOF	16672	100 YR	18000.00	5845.00	5853.81	5851.09	5854.67	0.002849	7.49	2476.43	459.04	0.50
NOF to SOF	16672	500 YR	29079.86	5845.00	5856.15	5852.95	5857.31	0.002847	8.76	3597.06	491.92	0.51
NOF to SOF	16643	10 YR	7900.00	5845.00	5850.78	5848.99	5851.23	0.001953	5.51	1624.07	458.18	0.46
NOF to SOF	16643	50 YR	14300.00	5845.00	5852.95	5850.41	5853.50	0.001710	6.28	2739.78	581.51	0.43
NOF to SOF	16643	100 YR	18000.00	5845.00	5853.87	5851.06	5854.48	0.001700	6.72	3271.63	602.04	0.43
NOF to SOF	16643	500 YR	29079.86	5845.00	5856.29	5852.78	5857.04	0.001597	7.62	4721.54	627.38	0.42
NOF to SOF	16625		Bridge									
NOF to SOF	16607	10 YR	7900.00	5845.00	5850.64	5848.88	5851.01	0.004136	5.08	1618.90	476.35	0.45
NOF to SOF	16607	50 YR	14300.00	5845.00	5852.83	5850.24	5853.24	0.002943	5.28	2795.29	569.97	0.39
NOF to SOF	16607	100 YR	18000.00	5845.00	5853.73	5850.82	5854.20	0.002701	5.58	3314.58	581.52	0.38
NOF to SOF	16607	500 YR	29079.86	5845.00	5856.13	5852.26	5856.73	0.002267	6.29	4732.52	612.32	0.37
NOF to SOF	16560	10 YR	7900.00	5845.00	5848.89	5848.89	5850.40	0.008999	10.17	846.12	281.59	0.94
NOF to SOF	16560	50 YR	14300.00	5845.00	5850.45	5850.45	5852.52	0.008518	12.15	1341.66	357.77	0.95
NOF to SOF	16560	100 YR	18000.00	5845.00	5851.50	5851.35	5853.54	0.007024	12.23	1776.52	496.09	0.87
NOF to SOF	16560	500 YR	29079.86	5845.00	5855.14	5853.25	5856.42	0.002672	10.30	3826.99	591.11	0.58
NOF to SOF	16544	10 YR	7900.00	5843.00	5847.68	5847.68	5849.59	0.016934	11.09	712.37	236.42	1.02
NOF to SOF	16544	50 YR	14300.00	5843.00	5850.23	5849.59	5851.94	0.009038	10.78	1408.89	298.89	0.78
NOF to SOF	16544	100 YR	18000.00	5843.00	5851.74	5850.42	5853.28	0.006373	10.36	1948.21	451.88	0.67
NOF to SOF	16544	500 YR	29079.86	5843.00	5855.12	5852.77	5856.36	0.003454	9.82	3692.94	577.39	0.53
NOF to SOF	16431	10 YR	7900.00	5838.70	5847.05	5843.88	5847.80	0.002578	6.96	1135.11	175.60	0.46
NOF to SOF	16431	50 YR	14300.00	5838.70	5850.20	5846.25	5851.27	0.002542	8.39	1833.51	285.74	0.47
NOF to SOF	16431	100 YR	18000.00	5838.70	5851.55	5847.34	5852.76	0.002490	9.05	2254.68	358.75	0.48
NOF to SOF	16431	500 YR	29079.86	5838.70	5854.67	5850.62	5856.04	0.002259	10.15	3850.74	813.49	0.47
NOF to SOF	16191	10 YR	7900.00	5837.00	5846.06	5843.00	5847.07	0.003338	8.08	978.23	130.30	0.52
NOF to SOF	16191	50 YR	14300.00	5837.00	5848.75	5845.73	5850.43	0.004247	10.48	1461.61	254.72	0.59
NOF to SOF	16191	100 YR	18000.00	5837.00	5850.04	5847.08	5851.93	0.004164	11.28	1843.06	347.71	0.60
NOF to SOF	16191	500 YR	29079.86	5837.00	5853.45	5851.22	5855.34	0.003317	12.04	3334.51	664.89	0.56
Main DS	15913	10 YR	7900.00	5835.00	5844.97	5842.35	5846.03	0.004141	8.53	1069.94	208.30	0.55
Main DS	15913	50 YR	14300.00	5835.00	5847.72	5845.41	5849.21	0.004125	10.40	1681.86	248.32	0.57
Main DS	15913	100 YR	18000.00	5835.00	5849.07	5846.48	5850.73	0.004031	11.15	2032.61	270.62	0.58
Main DS	15913	500 YR	29400.00	5835.00	5851.87	5849.32	5854.22	0.004519	13.64	2827.58	292.77	0.63
Main DS	15241	10 YR	7900.00	5831.00	5841.41	5839.00	5842.41	0.007213	8.05	990.11	169.57	0.57
Main DS	15241	50 YR	14300.00	5831.00	5844.12	5841.57	5845.64	0.007064	9.97	1503.65	223.98	0.59
Main DS	15241	100 YR	18000.00	5831.00	5845.13	5842.64	5847.03	0.007817	11.19	1749.88	304.27	0.63
Main DS	15241	500 YR	29400.00	5831.00	5848.04	5846.29	5850.33	0.007578	12.79	2821.89	596.70	0.64
Main DS	14715	10 YR	7900.00	5828.82	5840.15	5835.08	5840.60	0.001748	5.50	1623.53	339.83	0.33
Main DS	14715	50 YR	14300.00	5828.82	5843.37	5837.75	5843.84	0.001554	6.02	3079.64	513.41	0.32

PROJECT SITE

KIOWA ENGINEERING CORPORATION

JOB Rocky Top Resources
SHEET NO. _____ OF 19006
CALCULATED BY _____ DATE 3/10/19
CHECKED BY _____ DATE _____
SCALE WQ Calculations

Total Acreage 44.8 Ac.

Area of Active Recycling operations = 30.5 Ac

Impervious Acreage

		% Imp.
- Concrete pads: Existing	3.38 Ac ✓	95
- Area of Bldgs		90
new Bldg 5400 sf		
- Bldgs to remain: 1500		
6900 sf = .16 Ac ✓		
- Concrete Drives:		95
- Las Vegas Access 5950 sf		
- Main parking + driveway 10400		
16350 = .37 Ac ✓		
- Recycled Asphalt:	3.44 Ac	80%

Total Paved / Bldgs: 7.35 Ac

Balance - piles, native grasses poor-to-fair = 23.1 30%
23.5 Ac

$$\text{Wtd \% Imp} = \frac{(3.38+.37).95 + .16(90) + 3.44(.80) + 23.5(.30)}{30.5 \text{ Ac}}$$

$$= 13.5 / 30.5 = .44 \quad \text{use } 44\%$$

for UD-Detention

Imp Ac = 3.38 + .16 + .37 = 3.91 Ac

Table EDB-4. EDB component criteria

	On-Site EDBs for Watersheds up to 1 Impervious Acre[1]	EDBs with Watersheds between 1 and 2 Impervious Acres[1]	EDBs with Watersheds up to 5 Impervious Acres	EDBs with Watersheds over 5 Impervious Acres	EDBs with Watersheds over 20 Impervious Acres
Forebay Release and Configuration	EDBs should not be used for watersheds with less than 1 impervious acre.	Release 2% of the undetained 100-year peak discharge by way of a wall/notch configuration	Release 2% of the undetained 100-year peak discharge by way of a wall/notch configuration	Release 2% of the undetained 100-year peak discharge by way of a wall/notch configuration	Release 2% of the undetained 100-year peak discharge by way of a wall/notch or berm/pipe[2] configuration
Minimum Forebay Volume		1% of the WQCV	2% of the WQCV	3% of the WQCV	3% of the WQCV
Maximum Forebay Depth		12 inches	18 inches	18 inches	30 inches
Trickle Channel Capacity		≥ the maximum possible forebay outlet capacity	≥ the maximum possible forebay outlet capacity	≥ the maximum possible forebay outlet capacity	≥ the maximum possible forebay outlet capacity
Micropool		Area ≥ 10 ft^2	Area ≥ 10 ft^2	Area ≥ 10 ft^2	Area ≥ 10 ft^2
Initial Surcharge Volume		Depth ≥ 4 inches	Depth ≥ 4 inches	Depth ≥ 4 in. Volume ≥ 0.3% WQCV	Depth ≥ 4 in. Volume ≥ 0.3% WQCV

[1] EDBs are not recommended for sites with less than 2 impervious acres. Consider a sand filter or rain garden.

[2] Round up to the first standard pipe size (minimum 8 inches).

KIOWA ENGINEERING CORPORATION

JOB Rocky Top Resources

SHEET NO. _____ OF 17066

CALCULATED BY _____ DATE 3/10/19

CHECKED BY _____ DATE RLW

SCALE Water Quality Calcs

Per Table EDB-4, UDFCD Vol 3.

Watershed with over 5 imp. Acres (Includes RAP)

Forebay Release = 2% of Undetained Inflow

$Q_{undetained} = 98.7$ ∴ Release = .02(98.7) = 2.0 cfs

Forebay Volume =

.03(WQCV) = .015AI = 632 cf.

Maximum Forebay depth = 18"

Trickle Channel Cap:

≥ Forebay Release 2.0 cfs

Micropool Area ≥ 10sf

Initial Surcharge ≥ 4", use 6

Volume = .3%(WQCV) = .00145

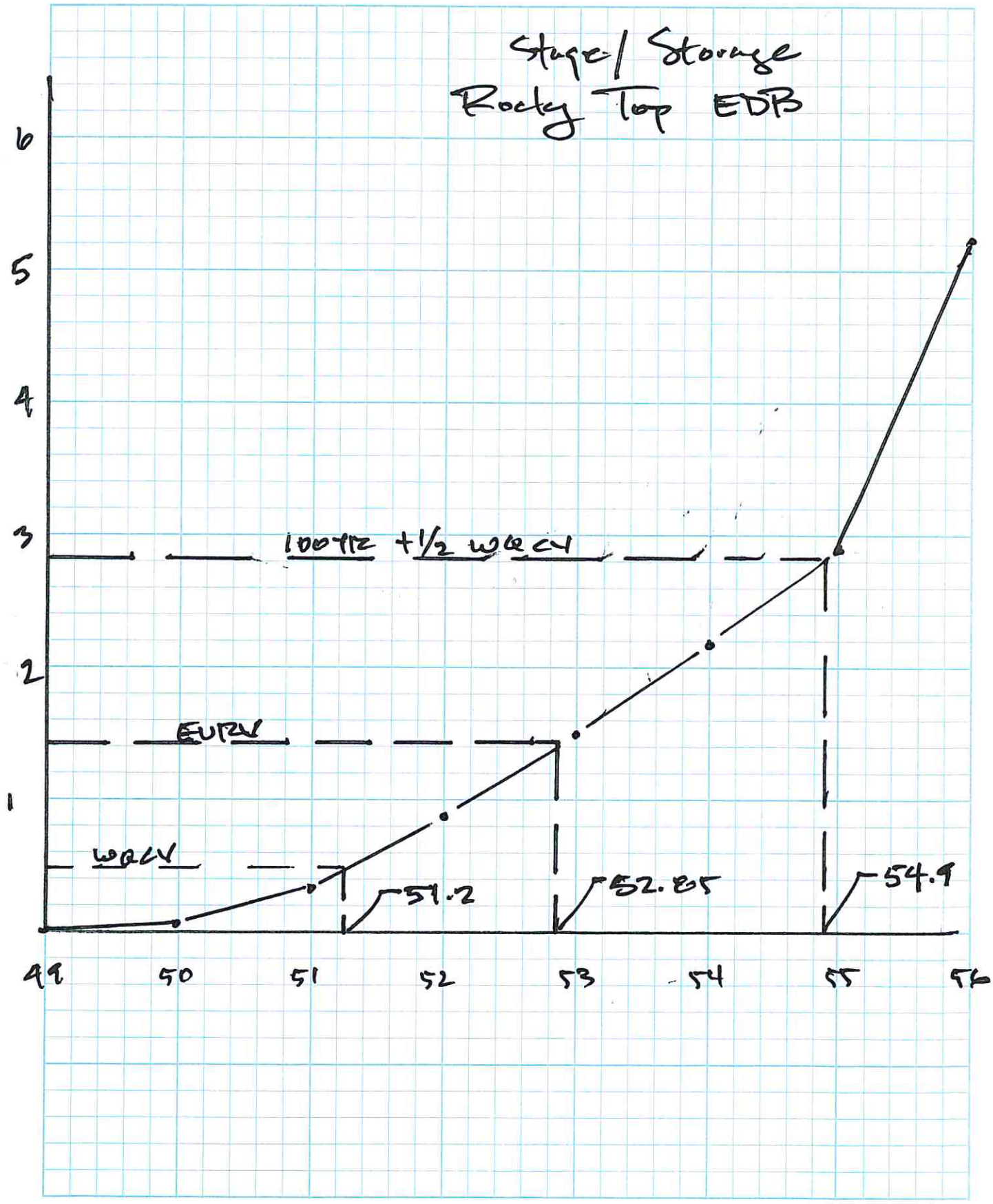
= 63.2 ft³

Rocky Top Resoruces
Volume Calculation

Stage	Elevation	Area sq. ft.	Area Acres	Avg. Area	Increment	Incremental Volume	Cumulative Volume
0	49	0	0.00				
				0.05	1	0.05	0.05
1	50	4,477	0.10				
				0.29	1	0.29	0.34
2	51	20,885	0.48				
				0.52	1	0.52	0.86
3	52	24,510	0.56				
				0.61	1	0.61	1.47
4	53	28235	0.65				
				0.69	1	0.69	2.16
5	54	32060	0.74				
				0.78	1	0.78	2.94
6	55	35987	0.83				
				2.34	1	2.34	5.28
7	56	168000	3.86				

Kiowa Engineering Corporation

CLIENT Rocky Top Resources JOB NO. 17066 PAGE
PROJECT DATE CHECKED DATE 3/10/19
DETAIL EDB Stage/Storage CHECKED BY COMPUTED BY RLW



Provide the UD Spreadsheet calculations for the outlet structure.

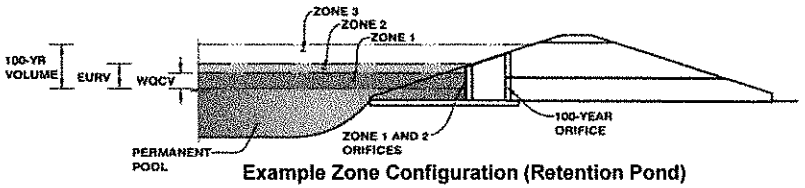
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

Input the optional override data based on the actually dimensions of the pond in the GEC.

UD-Detention, Version 3.07 (February 2017)

Project: Rocky Top Resources

Basin ID: FSD Design Drainage area 29.1 ac



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	30.45	acres
Watershed Length =	1,350	ft
Watershed Slope =	0.015	ft/ft
Watershed Imperviousness =	44.00%	percent
Percentage Hydrologic Soil Group A =	15.0%	percent
Percentage Hydrologic Soil Group B =	85.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Denver - Capitol Building	
Water Quality Capture Volume (WQCV) =	0.483	acre-feet
Excess Urban Runoff Volume (EURV) =	1.429	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	1.111	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	1.524	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	2.089	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	2.991	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	3.648	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	4.499	acre-feet
500-yr Runoff Volume (P1 = 3.2 in.) =	6.381	acre-feet
Approximate 2-yr Detention Volume =	1.040	acre-feet
Approximate 5-yr Detention Volume =	1.432	acre-feet
Approximate 10-yr Detention Volume =	1.914	acre-feet
Approximate 25-yr Detention Volume =	2.148	acre-feet
Approximate 50-yr Detention Volume =	2.272	acre-feet
Approximate 100-yr Detention Volume =	2.579	acre-feet

Optional User Override 1-hr Precipitation	
1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
3.20	inches

Depth Increment = 0.1 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		11.2	11.2	126		0.003		
ISV	0.50		11.2	11.2	126		0.003	62	0.001
	0.60		11.2	11.2	126		0.003	74	0.002
	0.70		11.2	11.2	126		0.003	87	0.002
	0.80		11.2	11.2	126		0.003	100	0.002
	0.90		11.2	11.2	126		0.003	112	0.003
	1.00		11.2	11.2	126		0.003	125	0.003
	1.10		29.6	17.2	510		0.012	153	0.004
	1.20		50.0	23.9	1,195		0.027	236	0.005
	1.30		70.4	30.6	2,152		0.049	401	0.009
	1.40		90.8	37.2	3,381		0.078	676	0.016
	1.50		111.2	43.9	4,882		0.112	1,086	0.025
	1.60		131.6	50.6	6,655		0.153	1,661	0.038
	1.70		152.0	57.2	8,699		0.200	2,426	0.056
	1.80		172.4	63.9	11,016		0.253	3,410	0.078
	1.90		192.8	70.6	13,605		0.312	4,639	0.106
	2.00		213.2	77.2	16,466		0.378	6,140	0.141
Floor	2.01		215.2	77.9	16,767		0.385	6,306	0.145
	2.10		217.3	79.1	17,186		0.395	8,012	0.184
	2.20		218.1	79.9	17,423		0.400	9,743	0.224
	2.30		218.9	80.7	17,662		0.405	11,497	0.264
	2.40		219.7	81.5	17,903		0.411	13,275	0.305
	2.50		220.5	82.3	18,144		0.417	15,077	0.346
	2.60		221.3	83.1	18,387		0.422	16,904	0.388
	2.70		222.1	83.9	18,631		0.428	18,755	0.431
	2.80		222.9	84.7	18,877		0.433	20,630	0.474
Zone 1 (WQCV)	2.83		223.1	84.9	18,951		0.435	21,198	0.487

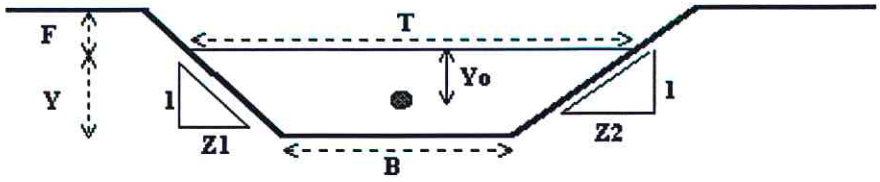
Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.483	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.946	acre-feet
Zone 3 (100yr + 1 / 2 WQCV - Zones 1 & 2) =	1.392	acre-feet
Total Detention Basin Volume =	2.820	acre-feet
Initial Surcharge Volume (ISV) =	63	ft^3
Initial Surcharge Depth (ISD) =	0.50	ft
Total Available Detention Depth (H_{total}) =	7.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.005	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	3	

Initial Surcharge Area (A_{ISV}) =	126	ft^2
Surcharge Volume Length (L_{ISV}) =	11.2	ft
Surcharge Volume Width (W_{ISV}) =	11.2	ft
Depth of Basin Floor (H_{FLOOR}) =	1.01	ft
Length of Basin Floor (L_{FLOOR}) =	216.6	ft
Width of Basin Floor (W_{FLOOR}) =	78.3	ft
Area of Basin Floor (A_{FLOOR}) =	16,964	ft^2
Volume of Basin Floor (V_{FLOOR}) =	6,225	ft^3
Depth of Main Basin (H_{MAIN}) =	4.99	ft
Length of Main Basin (L_{MAIN}) =	256.5	ft
Width of Main Basin (W_{MAIN}) =	118.3	ft
Area of Main Basin (A_{MAIN}) =	30,341	ft^2
Volume of Main Basin (V_{MAIN}) =	116,502	ft^3
Calculated Total Basin Volume (V_{total}) =	**2.820**	acre-feet

Critical Flow Analysis - Trapezoidal Channel

Project: 17066 Rocky Top Resources
Channel ID: Spillway design Q over spillway =100 cfs



Design Information (Input)			
Bottom Width	B =	20.00	ft
Left Side Slope	Z1 =	6.00	ft/ft
Right Side Slope	Z2 =	6.00	ft/ft
Design Discharge	Q =	**102.00**	cfs

Critical Flow Condition (Calculated)			
Critical Flow Depth	Y =	**0.85**	ft
Critical Flow Area	A =	21.34	sq ft
Critical Top Width	T =	30.20	ft
Critical Hydraulic Depth	D =	0.71	ft
Critical Flow Velocity	V =	4.78	fps
Froude Number	Fr =	**1.00**	
Critical Wetted Perimeter	P =	30.34	ft
Critical Hydraulic Radius	R =	0.70	ft
Critical (min) Specific Energy	Esc =	1.20	ft
Centroid on the Critical Flow Area	Yoc =	0.37	ft
Critical (min) Specific Force	Fsc =	1.44	kip

$Q/b = 100/20 = 5.0$

Figure 13-12c. Emergency Spillway Protection

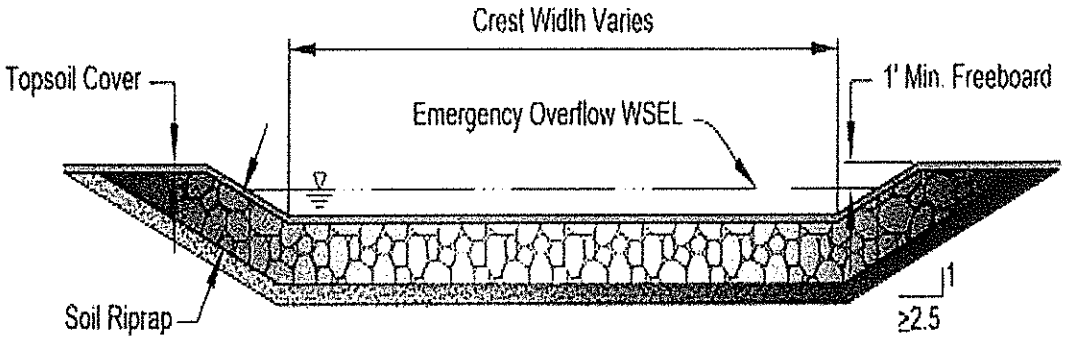
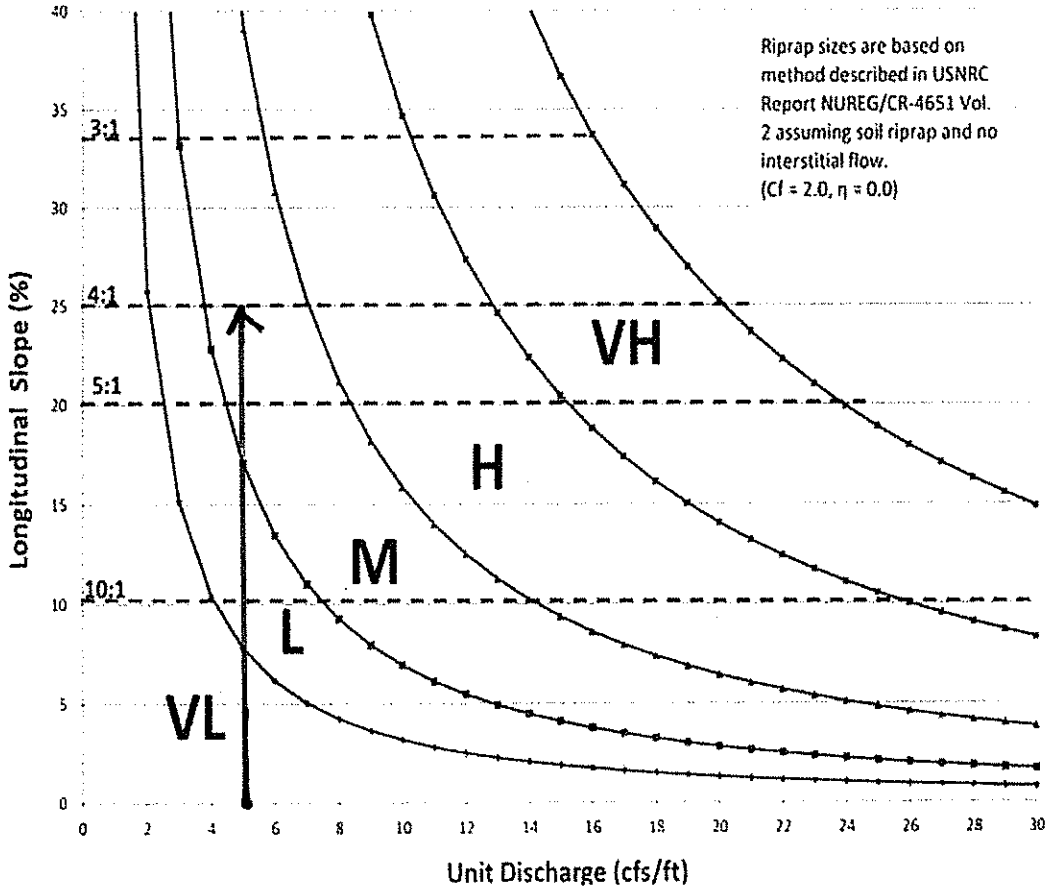


Figure 13-12d. Riprap Types for Emergency Spillway Protection



* TYPE M SOIL/RIPRAP

KIOWA ENGINEERING CORPORATION

JOB Rocky Top Resources

SHEET NO. _____ OF 17066

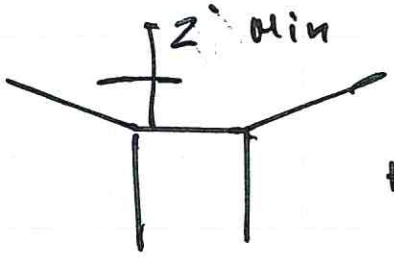
CALCULATED BY _____ DATE 5-10-19

CHECKED BY _____ DATE RDW

SCALE Hydraulics

Type 'C' Inlet @ entries to EDB

Assume 50 cfs (1/2 Q_{100} to each inlet)



35" x 35" opening; std grate

$A = 5.83$ sf

$Q = C C_B A \sqrt{2gH}$ $\quad C = .6$; $C_B = .75$

$Q = .6(.75)\sqrt{2g(2)}\,(5.83) = 29.7$ cfs low

Try Type D inlet

35" x 80" = 19.4 sf.

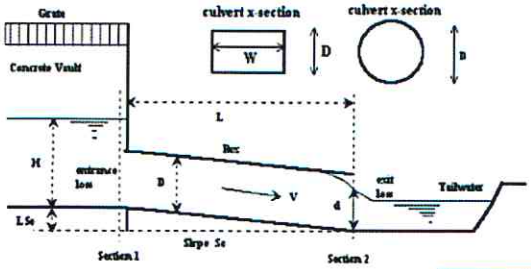
Level grate: $H = 1.5$

$Q = .6(.75)(19.4)\sqrt{2g(1.5)} = 86$ cfs ∴ ok

use 30" RCP out: @ 5% elev. Q = 48 cfs

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

Project: Rocky Top Resources
Basin ID: 30-inch RCP
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	30	inches
	Inlet Edge Type (choose from pull-down list)		Square 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)		1.5 : 1 Bevel w/ 45 Deg. Flared Wingwall	
	Number of Barrels	No =	1	
	Inlet Elevation at Culvert Invert	Inlet Elev =	49.5	ft. elev.
	Outlet Elevation at Culvert Invert OR Slope of Culvert (ft v./ft h.)	Outlet Elev =	49	ft. elev.
	Culvert Length in Feet	L =	60	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 =	0.47
Sum of All Loss Coefficients	K_s =	1.97
Orifice Inlet Condition Coefficient	C_d =	0.85
Minimum Energy Condition Coefficient	KE_{low} =	0.0152

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
50.00	49.00	1.40	10.45	**1.40**	Min. Energy. Eqn.	INLET
51.00	49.00	10.00	14.34	**10.00**	Regression Eqn.	INLET
52.00	49.00	22.40	17.99	**17.99**	Regression Eqn.	OUTLET
53.00	49.00	33.40	28.17	**28.17**	Regression Eqn.	OUTLET
54.00	49.00	41.70	36.16	**36.16**	Regression Eqn.	OUTLET
55.00	49.00	48.40	42.77	**42.77**	Regression Eqn.	OUTLET
56.00	49.00	54.20	48.51	**48.51**	Regression Eqn.	OUTLET
57.00	49.00	59.50	53.63	**53.63**	Regression Eqn.	OUTLET
58.00	49.00	64.10	58.29	**58.29**	Orifice Eqn.	OUTLET
59.00	49.00	68.40	62.63	**62.63**	Orifice Eqn.	OUTLET
60.00	49.00	72.40	66.67	**66.67**	Orifice Eqn.	OUTLET
61.00	49.00	76.20	70.48	**70.48**	Orifice Eqn.	OUTLET
62.00	49.00	79.90	74.09	**74.09**	Orifice Eqn.	OUTLET
63.00	49.00	83.30	77.54	**77.54**	Orifice Eqn.	OUTLET
64.00		86.70	80.84	**80.84**	Orifice Eqn.	OUTLET
65.00		89.90	84.01	**84.01**	Orifice Eqn.	OUTLET
66.00		93.00	87.07	**87.07**	Orifice Eqn.	OUTLET
67.00		96.00	90.01	**90.01**	Orifice Eqn.	OUTLET
68.00		98.90	92.87	**92.87**	Orifice Eqn.	OUTLET
69.00		101.70	95.65	**95.65**	Orifice Eqn.	OUTLET
70.00		104.50	98.35	**98.35**	Orifice Eqn.	OUTLET
71.00		107.20	100.96	**100.96**	Orifice Eqn.	OUTLET
72.00		109.80	103.52	**103.52**	Orifice Eqn.	OUTLET
73.00		112.30	106.01	**106.01**	Orifice Eqn.	OUTLET
74.00		114.80	108.45	**108.45**	Orifice Eqn.	OUTLET
75.00		117.30	110.84	**110.84**	Orifice Eqn.	OUTLET
76.00		119.60	113.17	**113.17**	Orifice Eqn.	OUTLET
77.00		122.00	115.46	**115.46**	Orifice Eqn.	OUTLET
78.00		124.30	117.70	**117.70**	Orifice Eqn.	OUTLET
79.00		126.50	119.91	**119.91**	Orifice Eqn.	OUTLET

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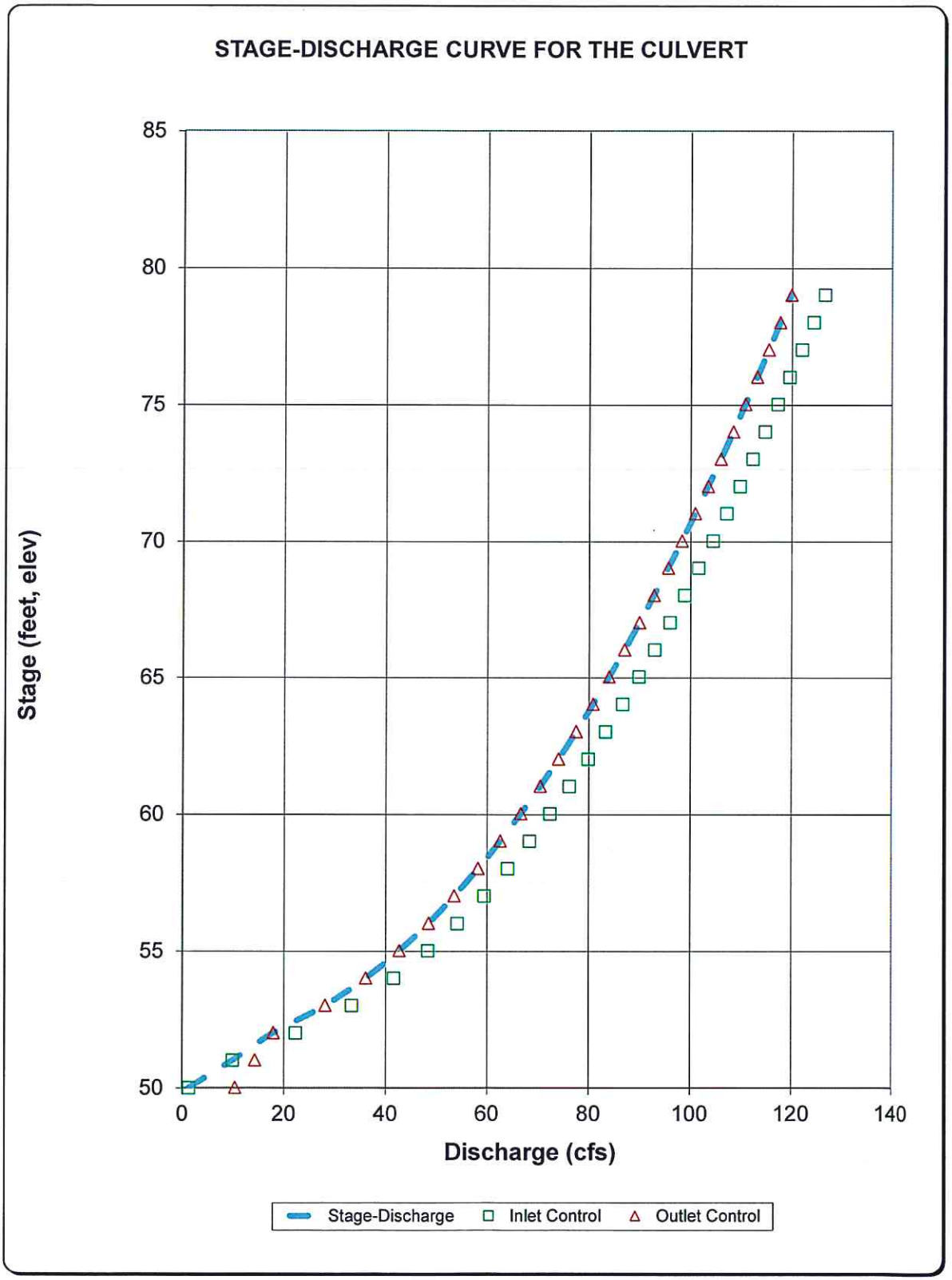
CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Rocky Top Resources
Basin ID: 30-inch RCP



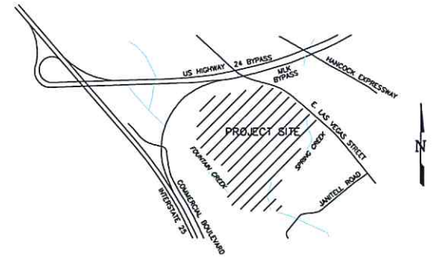


FIGURE 1
VICINITY MAP
NO SCALE

SPRING CREEK HYDROLOGY
Q_{10} = 960 cfs
Q_{50} = 1,790 cfs
Q_{100} = 2,340 cfs
Q_{500} = 4,340 cfs

FOUNTAIN CREEK HYDROLOGY
Q_{10} = 7,900 cfs
Q_{50} = 14,300 cfs
Q_{100} = 18,000 cfs
Q_{500} = 29,080 cfs

SUMMARY OF DISCHARGES-PREDEVELOPMENT

SUB-BASIN	AREA	Q5	Q100
	ac	cfs	cfs
A	5.32	2.5	16.9
B	7.51	3.5	23.8
C	3.59	1.7	11.4
D	29.42	6.9	57.2

LEGEND
- BASIN BOUNDARY
- A / XX ac — BASIN # / AREA IN ACRES
- DP1 — DESIGN POINT
- FLOW DIRECTION
- 100 YEAR FLOODPLAIN
- 500 YEAR FLOODPLAIN
- FLOWPATH

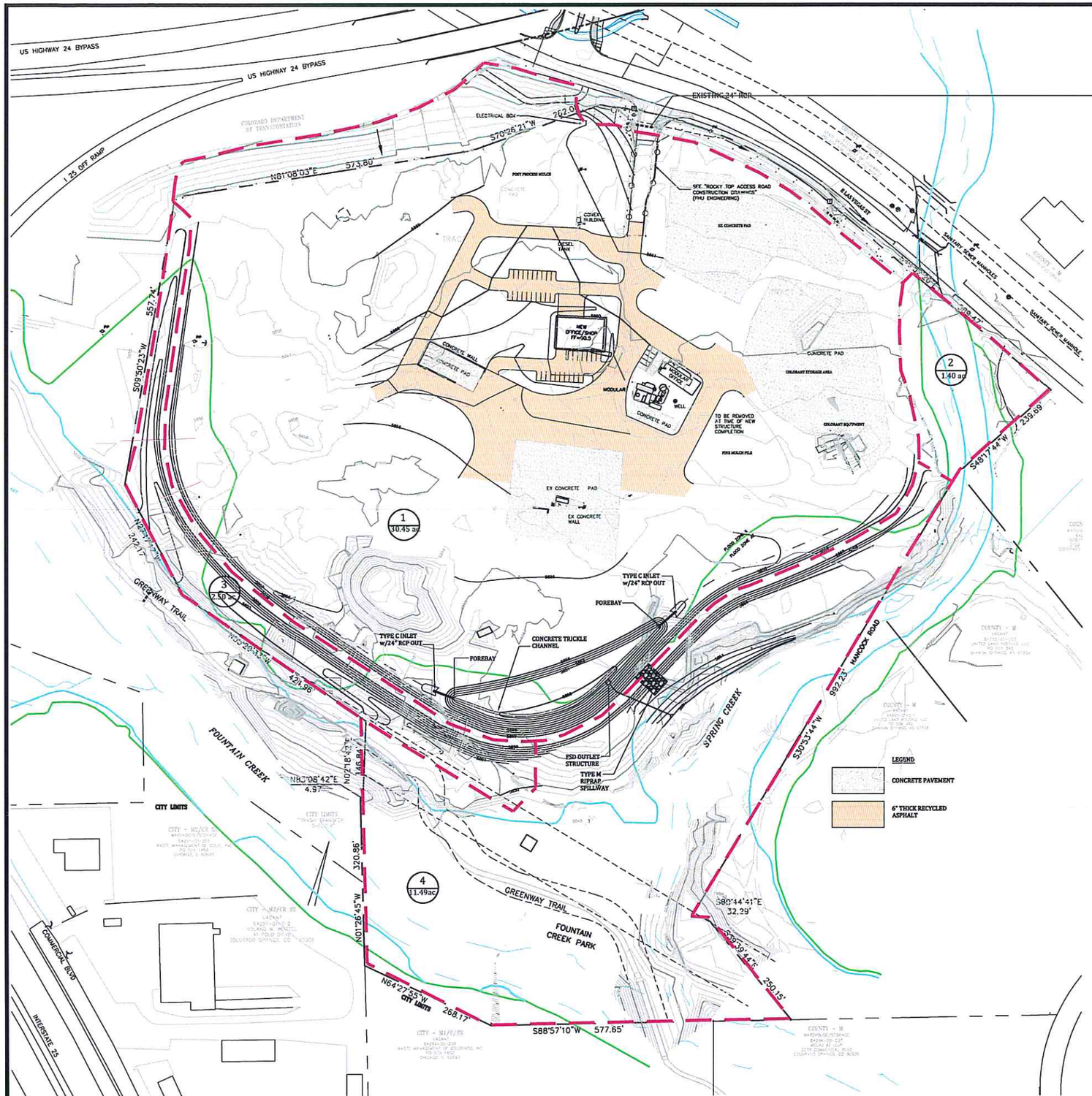
0 100' 200'
SCALE: 1"=200'

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

ROCKY TOP RESOURCES
EXISTING DRAINAGE PLAN
TRACT 7 GARDEN VALLEY SUBDIVISION
1755 EAST LAS VEGAS STREET
COLORADO SPRINGS, COLORADO

Project No.:	17066
Date:	March 2019
Design:	RNW
Drawn:	EAK
Check:	RNW
Revisions:	

EXH. 1



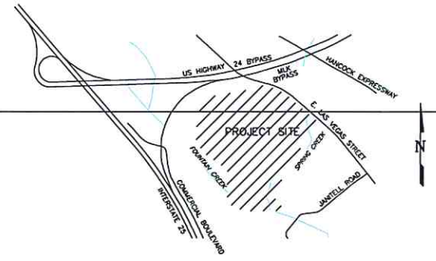


FIGURE 1
VICINITY MAP
NO SCALE

SPRING CREEK HYDROLOGY
Q_{10} = 960 cfs
Q_{50} = 1,790 cfs
Q_{100} = 2,340 cfs
Q_{500} = 4,340 cfs

FOUNTAIN CREEK HYDROLOGY
Q_{10} = 7,900 cfs
Q_{50} = 14,300 cfs
Q_{100} = 18,000 cfs
Q_{500} = 29,080 cfs

SUMMARY OF DISCHARGES

SUB-BASIN	AREA ac	Q5 cfs	Q100 cfs
1	30.45	43.8	98.7
2	1.40	0.7	4.4
3	2.50	1.2	7.9
4	11.49	3.6	23.6

LEGEND
- BASIN BOUNDARY
- A / XX ac — BASIN # / AREA IN ACRES
- DP1 — DESIGN POINT
- FLOW DIRECTION
- 100 YEAR FLOODPLAIN
- 500 YEAR FLOODPLAIN
- FLOWPATH

Where are the flow paths for Basin 1 and 4 located on this map? Please provide.

0 100' 200'
SCALE: 1"=200'

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

ROCKY TOP RESOURCES
PROPOSED DRAINAGE PLAN
TRACT 7 VALLEY GARDEN SUBDIVISION
1755 EAST LAS VEGAS STREET
COLORADO SPRINGS, COLORADO

Project No.:	17066
Date:	March 2019
Design:	RNW
Drawn:	EAK
Check:	RNW
Revisions:	

EXH. 2

Markup Summary

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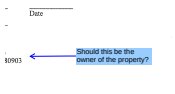

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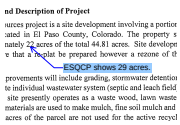
Should this be the owner of the property?



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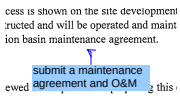
ESQCP shows 29 acres.



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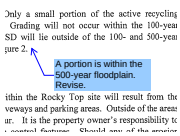
submit a maintenance agreement and O&M



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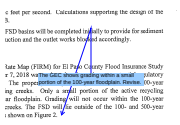
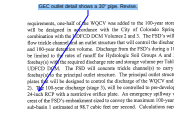
Color:

A portion is within the 500-year floodplain. Revise.



Subject: Engineer
Page Label: 9
Lock: Locked
Author: dsdgrimm
Date: 4/24/2019 1:39:19 PM
Color:

The GEC shows grading within a small portion of the 100-year floodplain. Revise.

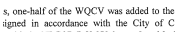


Subject: Engineer
Page Label: 9
Lock: Locked
Author: dsdgrimm
Date: 4/24/2019 1:39:20 PM
Color:

GEC outlet detail shows a 30" pipe. Revise.

Subject: Engineer
Page Label: 10
Lock: Locked
Author: dsdgrimm
Date: 4/24/2019 1:39:21 PM
Color:

It appears that this FIRM is from 1997. Please use the updated 2018 FIRM.

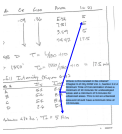


Subject: Engineer
Page Label: 11
Lock: Locked
Author: dsdgrimm
Date: 4/24/2019 1:39:22 PM
Color:

Note: This is a duplicate page

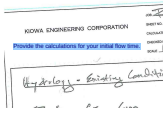
Subject: Engineer
Page Label: 13
Lock: Locked
Author: dsdgrimm
Date: 4/24/2019 1:39:23 PM
Color:

It appears that you are missing pages here. The other three steps of the Four Step Process are missing. Please include those steps.



Subject: Engineer
Page Label: 15
Lock: Locked
Author: dsdgrimm
Date: 4/24/2019 1:39:26 PM
Color:

Where is this located in the criteria? Chapter 6 of City DCM Vol. 1, Section 3.2.4 Minimum Time of Concentration shows a minimum of 10 minutes for undeveloped areas and a minimum of 5 minutes for urbanized areas. This is not an urbanized area and should have a minimum time of 10 minutes.

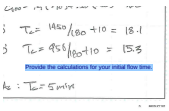


Subject: Engineer
Page Label: 15
Lock: Locked
Author: dsdgrimm
Date: 4/24/2019 1:39:27 PM
Color:

Provide the calculations for your initial flow time.

Subject: Engineer
Page Label: 17
Lock: Locked
Author: dsdgrimm
Date: 4/24/2019 1:39:28 PM
Color:

Where is this located in the criteria? Chapter 6 of City DCM Vol. 1, Section 3.2.4 Minimum Time of Concentration shows a minimum of 10 minutes for undeveloped areas and a minimum of 5 minutes for urbanized areas.



Subject: Engineer
Page Label: 17
Lock: Locked
Author: dsdgrimm
Date: 4/24/2019 1:39:29 PM
Color:

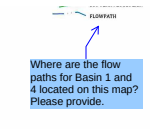
Provide the calculations for your initial flow time.

Subject: Engineer
Page Label: 30
Lock: Locked
Author: dsdgrimm
Date: 4/24/2019 1:39:31 PM
Color:

Input the optional override data based on the actually dimensions of the pond in the GEC.

Subject: Engineer
Page Label: 30
Lock: Locked
Author: dsdgrimm
Date: 4/24/2019 1:39:32 PM
Color:

Provide the UD Spreadsheet calculations for the outlet structure.



Subject: Engineer
Page Label: 38
Lock: Locked
Author: dsdgrimm
Date: 4/24/2019 1:39:33 PM
Color:

Where are the flow paths for Basin 1 and 4 located on this map? Please provide.