Wolf Ranch
Master Development Drainage Plan Update

Colorado Springs, Colorado

Prepared for:
Nor'Wood Development
111 South Tejon Street Suite 222
Colorado Springs, Colorado 80903

Prepared by:

Kiowa Engineering Corporation
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Kiowa Project No. 17049

February 27, 2018

Revised April 12, 2018

Revised June 8, 2018

LIST OF TABLES

LIST OF FIGURES

Wolf Ranch Development
Master Development Drainage Plan Update

ENGINEER'S STATEMENT:

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

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

19310

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

DEVELOPER'S STATEMENT:

Nor'Wood Development hereby certifies that the drainage facilities for the Wolf Ranch Development shall be constructed according to the design presented in this report. I understand that the City of Colorado Springs does not and will not assume liability for the drainage facilities designed and/or certified by my engineer and that are submitted to the City of Colorado Springs pursuant to section 7.7.906 of the City Code; and cannot, on behalf of the Wolf Ranch Development, guarantee that final drainage design review will absolve Nor'wood Development and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the final plat does not imply approval of my engineer's drainage design.

Name of Developer: Nor'Wood Development

Authorized Signature: ______ 6/7/18
Date

Printed Name: Bobby L. Ingels Vice. Pres.
Title

ADDRESS: 111 South Tejon Suite 222
Colorado Springs, CO 80903

CITY OF COLORADO SPRINGS STATEMENT:

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

For City Engineer | Date

Conditions:

PROJECT DESCRIPTION

Wolf Ranch Development is a master planned community located in northeast Colorado Springs. The master development plan includes open space, parks, drainage, residential, office and commercial uses. The development covers approximately 1800 acres. The development is bordered by Black Forest Road on the east, Old Ranch Road on the north, the Cordera development on the west and Cowpoke Road on the south. The location of the site is presented on Figure 1.

The property subject to development is located within portions of Sections 30 and 31 Township 12 South, Range 65 West of the 6th Principal Meridian and Section 6 Township 13 South Range 65 West of the 6th Principal Meridian. The development subject to master drainage planning has a segment of Cottonwood Creek that passes through the southern portion of the site as well as a major sub-tributary designated as Tributary Four in this report. The property lies completely within the Cottonwood Creek basin.

The MDDP for Wolf Ranch was originally submitted to the City in July 2004, and the last resubmittal was February 2005. Comments were received from the City related to the February 2005 resubmittal however the comments were not addressed until the 2013 Update was prepared. Due to economic conditions that slowed the rate of development within Wolf Ranch, platting of land halted until late in 2012. The City expressed the need to resubmit the MDDP as development began to recommence. The MDDP was again updated and reapproved by the City in 2013.

The primary purpose of updating the MDDP is to allow for new filings to be submitted for development plan review and approval. The primary revisions contained within this Update are as follows:

1. Revision to the City's Drainage Criteria Manual (DCM), occurred in 2014. The methods for determining peak discharges were revised. The revisions involved changes to the rainfall depths and distributions that are applied when determining peak rates of runoff and volume.
2. The design criteria for full spectrum detention basins were updated in the 2014 DCM. The new criteria were applied in the design of the full spectrum detention basins that were not either under design or approved prior to 2015. The latest design spreadsheets published by the Urban Drainage and Flood Control District were used in the design of all the remaining full spectrum detention basins.
3. In the last version of the MDDP (2013), that was approved by the City, the MDDP reimbursable costs for storm sewer facilities were summarized. The reimbursable costs have been updated to include all storm sewers 42-inches in diameter and

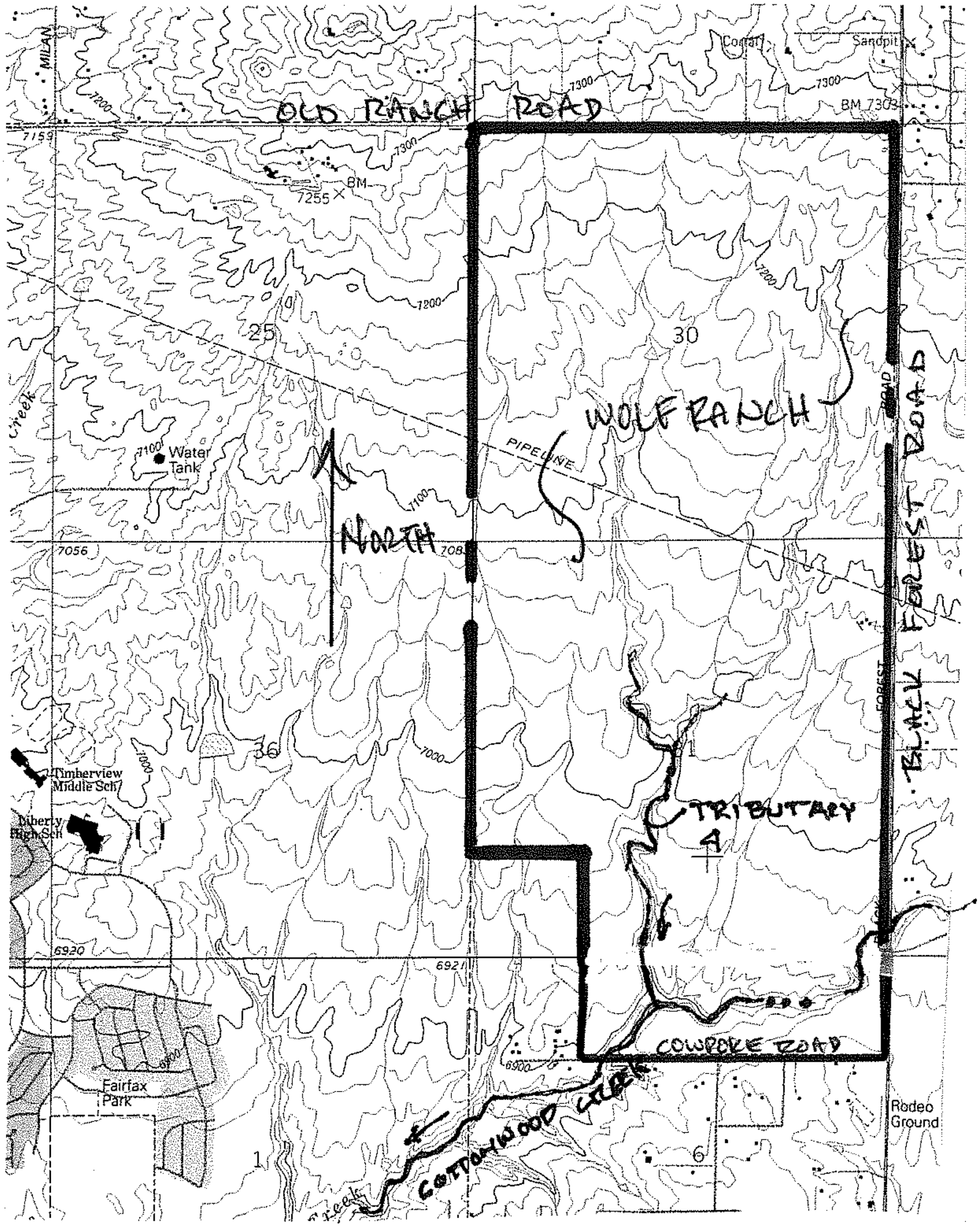


FIGURE 1
VICINITY MAP

greater. Public drainage facilities that have been considered reimbursable within the individual filing drainage reports have been identified in this Update along with the as-built costs of construction.

PREVIOUS REPORTS

The following reports and plans were reviewed in the process of preparing this master development drainage plan:

1. Soil Survey for El Paso County, Colorado, dated June 1981.
2. City of Colorado Springs/El Paso County Drainage Criteria Manual, prepared by City of Colorado Springs, El Paso County, dated May 1987, revised 1996.
3. City of Colorado Springs Drainage Criteria Manual, prepared by City of Colorado Springs, El Paso County, dated April 2014 with most current clarifications.
4. Urban Drainage and Flood Control District Drainage Criteria Manual Volume I-III, most current version.
5. Cottonwood Creek Drainage Basin Planning Study (DBPS) prepared by URS, Inc., dated 1994.
6. Cottonwood Creek Drainage Basin Planning Study prepared by Ayres Associates, Inc. dated June 2000.
7. Draft Cottonwood Creek Drainage Basin Planning Study prepared by Matrix Design Group, July 2017.
8. Westcreek at Wolf Ranch Subdivision Master Development Drainage Plan and Final Drainage Report for Westcreek at Wolf Ranch Filings Nos. 1, 2, 3, 4 and 5, prepared by Rockwell Consulting, dated September 2003.
9. Westcreek at Wolf Ranch Subdivision Master Development Drainage Plan and Final Drainage Report for Westcreek at Wolf Ranch Filings Nos. 6, 7, 8, 9, 10, 11 and 12 and Research Parkway at Wolf Ranch Filings 1, 2, and 3, prepared by Rockwell Consulting, dated December 2003.
10. Final Drainage Reports for Research Parkway Filing No. 5 and By the Creek Filing No. 1, prepared by Rockwell Consulting prepared 2014 and 2015.
11. HEC-1 Flood Hydrograph Package User's Manual, prepared by US Army Corps of Engineers Hydrologic Engineering Center, dated June 1998.
12. Prudent Line for Rural Areas in El Paso County Criteria prepared by Ayres Associates dated June 2000.

References 5, 6 and 7 were prepared for the overall Cottonwood Creek Drainage basin and were used to establish the selected drainageway improvements for the basin. Reference 7 represents the most current effort by the City to update the DBPS. Reference 7 incorporates the revisions to the hydrology criteria put forth in the 2014 DCM. The City adopted References 5 and 6 and used them in the establishment of the drainage and bridge fees for the basin. The primary difference between References 5 and 6 was that in Reference 6 the prudent line concept was incorporated into the DBPS as the preferred alternative channel design for the upper portions of Cottonwood Creek and for Tributary Four. The methodology for determining the location of the prudent line along natural drainageways is summarized in Reference 12. The drainage fee was modified in 2000 to account for the land costs associated with the creation of a prudent line setback. While the prudent line setback was established in the 2003 MDDP and is shown the approved development plan for Wolf Ranch, selective bank stabilization and grade control were identified for both Cottonwood Creek and Tributary Four in the 2013 MDDP and in this update. The peak discharges summarized in Reference 7 were applied in the design of bank improvements and grade controls for the portion of Cottonwood Creek that passes through the southern portion of the development.

References 6 through 10 were used to establish the proposed major drainage structures within the Filings covered by these master development drainage plans and final drainage reports. Storm sewer outfall sewers and detention basins shown recommended in these studies were considered when the hydrologic models were developed for this MDDP.

Presently, sub-watersheds B, C D and E are close to fully developed. Sub-watershed A is approximately two-third developed with only the upper portion of the watershed within Wolf Ranch remaining to be developed. Sub-watersheds F, G and H are still largely undeveloped. The portions of sub-watersheds G and H that lie south of Research Parkway is currently under development as an Academy School District 20 elementary through high school campus. Separate drainage reports have been prepared for the District 20 property and have been referenced on the basin maps contained in this report. Water quality facilities that serve sub-watersheds A through E have been constructed.

The purpose of this MDDP is to develop the hydrologic model of the onsite and offsite watersheds related to the Master Planned area. It is also the focus of this MDDP to evaluate the storm sewer infrastructure to be constructed as part of the Westcreek and greater Wolf Ranch developments, and to establish the size, type, and location of the major drainageway facilities for the remaining undeveloped portions of Wolf Ranch. It should however be expected that modifications in the size and location of the major drainageway facilities as shown herein might occur depending upon the actual development of the land within the Wolf Ranch property, particularly the locations of the sub-regional full spectrum detention basins may be shifted as alternatives are analyzed as part of the land development process.

HYDROLOGY

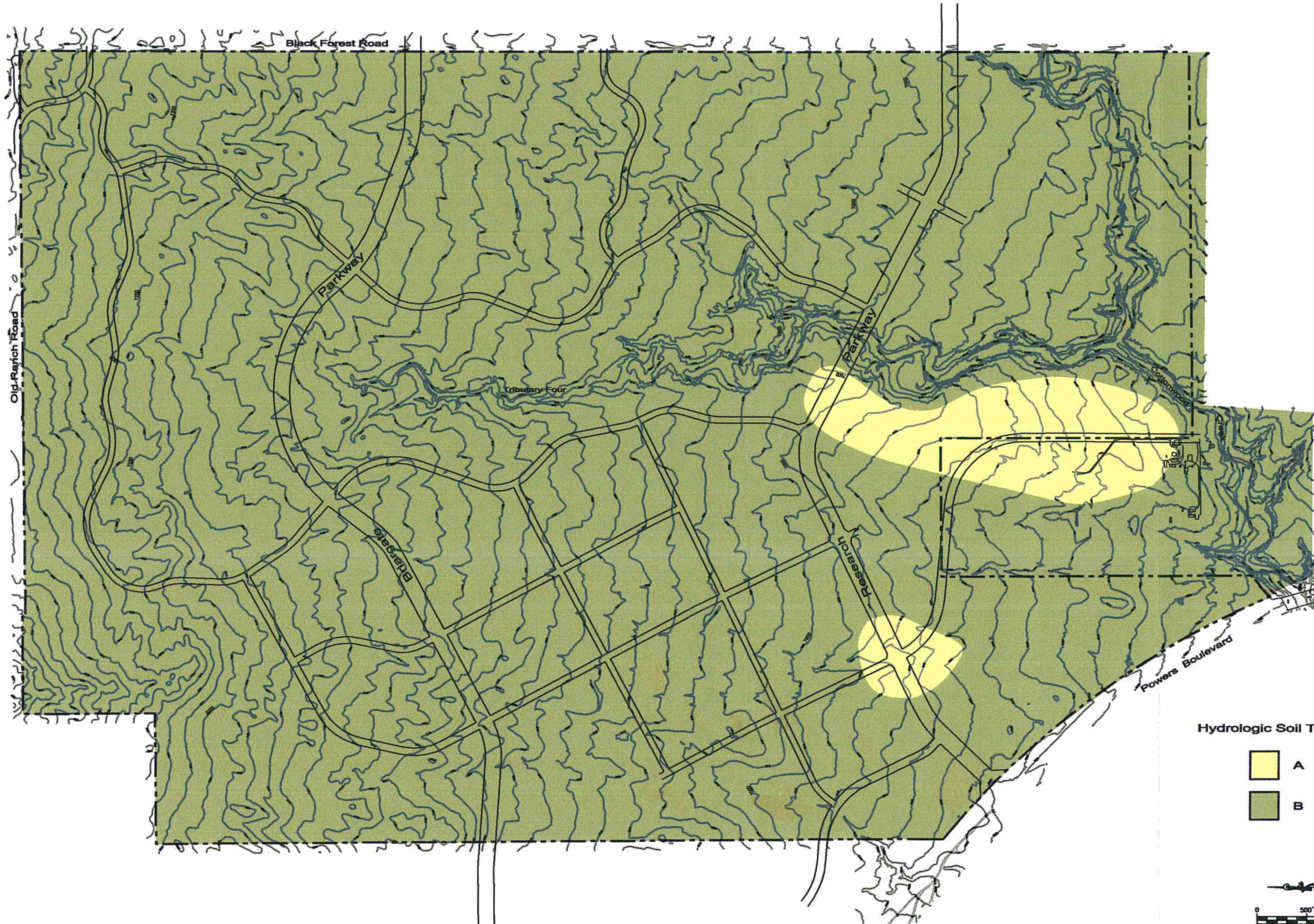
The offsite and onsite hydrology for the site was estimated using the methods outlined in the City/County Storm Drainage Criteria Manual. Topography for the site was compiled at a two-foot contour interval and a horizontal scale of one inch to 400-feet. This topography was used to verify the onsite sub-basin boundaries. Offsite sub-basin boundaries were determined using the above referenced reports, the City of Colorado Springs FIMS mapping base, and the USGS quadrangle maps for the area. Field inspections were also carried out to confirm or refine subdivision limits.

Existing and developed condition peak discharges for the sub-basins and design points along the major drainageway associated with Tributary Four and Cottonwood Creek shown on the various hydrologic sub-basin maps were determined using the criteria summarized in References 2 and 3. For major sub-watersheds the 5-year and 100-year peak discharges were determined for existing and development conditions. For sub-watersheds A through E, the 24-hour rainfall depths obtained from NOAA Atlas 2 were applied and modeled using a Type IIA rainfall distribution. The total 24-hour rainfall depth was 2.5 and 4.4 inches for the 5- and 100-year frequencies, respectively. No area reduction factor was applied to the rainfall distribution and total depths.

For sub-watershed F, the 24-hour rainfall depths obtained from NOAA Atlas 2 were applied and modeled using the Type II rainfall per the 2014 DCM. The total 24-hour rainfall depth was 2.5 and 4.4 inches for the 5- and 100-year frequencies, respectively. No area reduction factor was applied to the rainfall distribution and total depths.

For sub-watersheds G and H, the 2-hour rainfall depths obtained from NOAA Atlas 14 and listed in Reference 3 were applied and modeled using the rainfall distribution summarized in Reference 3. The total 2-hour rainfall depth was 1.55 and 2.77 inches for the 5- and 100-year frequencies, respectively. No area reduction factor was applied to the rainfall distribution and total depths.

Soils within the Wolf Ranch are mostly classified into hydrologic soils group B as shown in Reference 1. A small amount of hydrologic soil group A exists along the west-bank of Tributary Four in the southern portion of the development. For the purposes of modeling the developed conditions, all soils within the development were assumed to be hydrologic soil group B. Presented on Figure 2 are the hydrologic soil types that can be found within the Wolf Ranch development.



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WOLF RANCH
MASTER DEVELOPMENT DRAINAGE PLAN UPDATE
HYDROLOGIC SOILS MAP
COLORADO SPRINGS, COLORADO

Project No.: 12055
Date: 03/2013
Design: RNW
Drawn: EAK
Check: RNW
Revisions:

SHEET
Fig. 2

12055 Fig2.dwg/Mar 18, 2013

Land uses within the development were determined using the master development plan for Wolf Ranch. The development land will be of mixed uses. The land uses were used in the establishment of the curve numbers (CN values) that were input to the HEC-1 model. For the existing development condition and CN value of 61 was used for all existing sub-basins within the development. Presented on Figure 3 is the hydrologic land use map for Wolf Ranch and their associated CN-values.

The time of concentration for each of the sub-basins modeled was estimated. The time of concentration was computed from a combination of overland flow, channel and pipe flow for each sub-basin. The time lag for each sub-basin was computed by reducing the time of concentration by 60 percent. The time lag was input to the HEC-1 model.

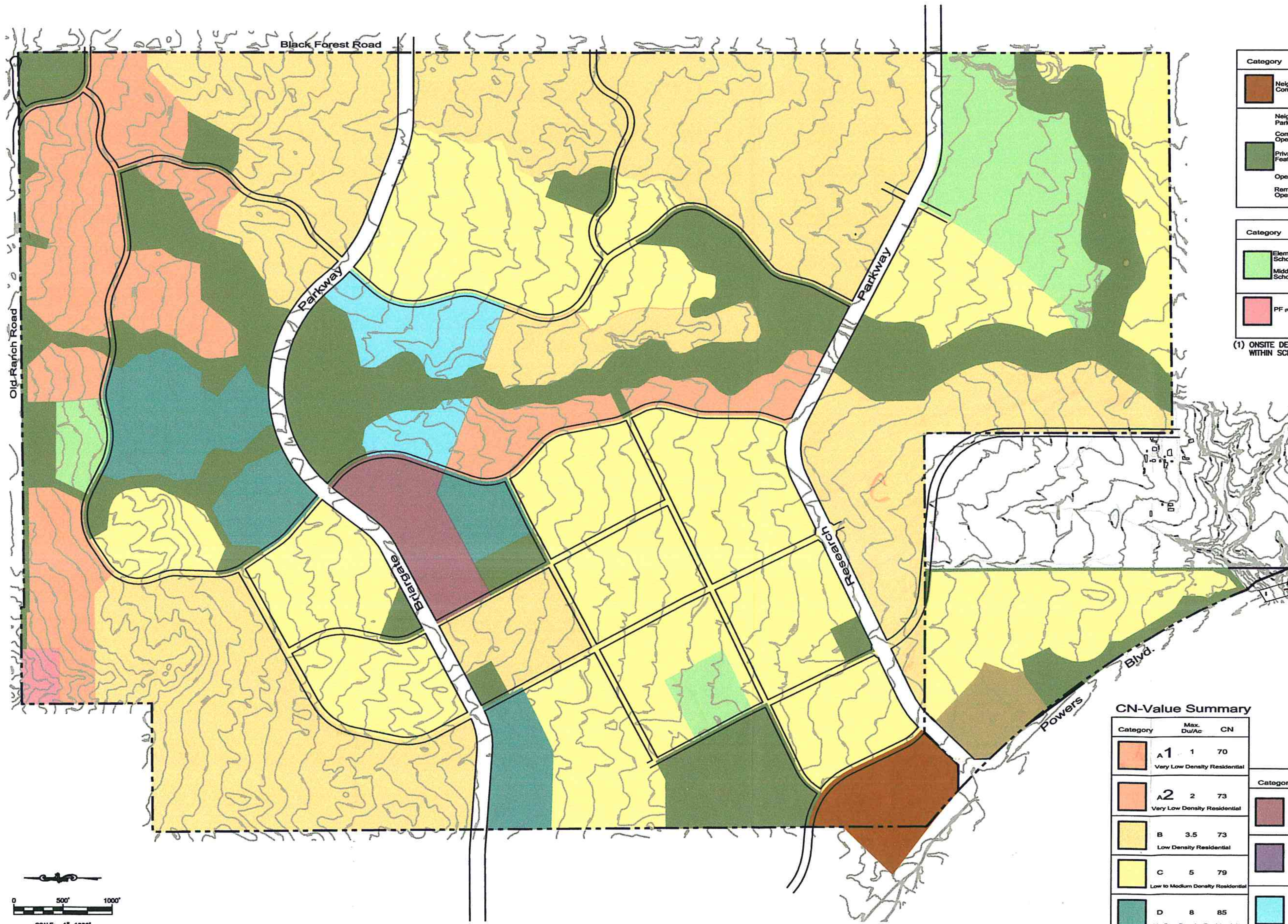
The Muskingum-Cunge routing technique was used to route the sub-basin hydrographs between design points. The majority of the routing elements were modeled as trapezoidal channel sections. Within the Westcreek portion of the development storm sewers were modeled. The longitudinal slope of each routing element was determined using the topographic mapping described above.

Hydrologic flow charts were prepared and are contained within Appendix A of this report. These flow charts were used to compile the HEC-1 model.

EXISTING MAJOR SUB-WATERSHED DESCRIPTIONS

The study area was divided into eight major sub-watersheds. These sub-watersheds are noted in the hydrologic analysis by using the designations A through H. The sub-basins were coded accordingly (i.e., A-1, A-2, B-1, etc). The sub-basins for the existing condition are presented on Figure 4. As shown on Figure 4 the "A" basins discharge to an existing concrete box culvert under Powers Boulevard. The sub-watershed drains a total of .42 square miles at its outfall point along the west boundary of the development. Slopes along the major drainageway range from 3 to 5 percent. Soils are entirely hydrologic soil group B. There is a portion of sub-basin A-1 that lies offsite from Wolf Ranch. The offsite portion of sub-basin A-1 is presently developed into large rural lots ranging in size from 5 to 40 acres. The watershed is well vegetated with native grasses. A small portion of sub-basin A-1 is forested. Sub-basin A is presently two-thirds developed.

The "B" basins discharge to an existing 54-inch reinforced concrete storm sewer that is within Research Parkway west of Powers Boulevard. The sub-watershed drains a total of .15 square miles at its outfall point at Powers Boulevard. Slopes along the major drainageway range from 2 to 5 percent. Soils are entirely hydrologic soil group B. Sub-



Category	CN
Neighborhood Commercial	92
Neighborhood Parks Comm. Parks/ Open Space Private Entry Features Open Space Remaining Open Space	61

Category		CN
Elementary School	(1)	72
Middle School	(1)	80
PF (Public Facility)		70

(1) ONSITE DETENTION ASSUMED WITHIN SCHOOL SITES

CN-Value Summary

Category	Max. Du/Ac	CN
A1 Very Low Density Residential	1	70
A2 Very Low Density Residential	2	73
B Low Density Residential	3.5	73
C Low to Medium Density Residential	5	79
D Medium Density Residential	8	85
E Medium to High Density Residential	12	88
F High Density Residential	25	92
Mixed Use	Up to 25.00	92

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WOLF RANCH
MASTER DEVELOPMENT DRAINAGE PLAN UPDATE
HYDROLOGIC LANDUSE MAP
COLORADO SPRINGS, COLORADO

Project No.: 12055
Date: 03/13/2013
Design: RNW
Drawn: EAK
Check: RNW
Revisions:

SHEET
Fig. 3

03094 Fig3.dwg/Mar 13, 2013

watershed B lies entirely within Wolf Ranch. The watershed is well vegetated with native grasses. Sub-basin B is presently fully developed.

The "C" basins discharge to an existing 72-inch reinforced concrete storm sewer that is under Powers Boulevard near the southwest corner of the property. The sub-watershed drains a total of .25 square miles at its outfall point at Powers Boulevard. Slopes along the major drainageway range from 2 to 5 percent. Soils are predominantly hydrologic soil group B however a small portion of type A soil exists within sub-basin C-1. Sub-watershed C lies entirely within Wolf Ranch. Most of sub-basin C-2 lies within the Westcreek subdivision Filings 1 through 3. The watershed is well vegetated with native grasses. Sub-basin C is presently two-thirds developed, with Filing 3 currently under review by the City.

The "D" basins discharge to Cottonwood Creek within an offsite property just upstream of Powers Boulevard. The sub-watershed drains a total of .36 square miles at its outfall point at Cottonwood Creek. Slopes along the major drainageway range from 2 to 5 percent. Soils are predominantly hydrologic soil group B. Sub-watershed D lies mostly within Wolf Ranch however sub-basin D-3 lies within the Goetsch property that lies south of Wolf Ranch. The watershed is well vegetated with native grasses. The major drainageway within sub-basin D-3 is stable and has no improvements such as grade controls or bank lining. The drainageway is poorly defined where it enters Cottonwood Creek. Sub-basin D is presently fully developed.

The "E" basins discharge to the Cottonwood Creek drainageway through an offsite property just upstream of Powers Boulevard. The sub-watershed drains a total of .32 square miles at its outfall point at Cottonwood Creek. Slopes along the major drainageway range from 2 to 5 percent. Soils are entirely hydrologic soil group B. Approximately 60-percent of sub-watershed E lies within Wolf Ranch however 40 percent lies within the Goetsch property south of Wolf Ranch. The watershed is well vegetated with native grasses. The major drainageway within sub-basin E-2 is stable and has no improvements such as grade controls or bank lining. A stock pond exists along the drainageway within the Goetsch property. Sub-basin D is presently fully developed.

"F" basins discharge to Cottonwood Creek approximately 4,000 feet upstream of the bridge over Powers Boulevard. The sub-watershed drains a total of 2 square miles at its outfall point. Slopes along the major drainageway range from 2 to 4 percent. Soils are mostly classified as hydrologic soil group B however a small area of Type A soil exist along the west overbank of Tributary Four south of Research Parkway. There is a portion of sub-watershed F that is offsite from Wolf Ranch. The offsite portion of the sub-watershed (i.e., sub-basins F-1 though F-7) is presently developed into large rural lots ranging in size from

5 to 40 acres. The watershed is well vegetated with native grasses. A small portion of the upper watershed is forested. The major drainageway in the F sub-watershed is Tributary 4. There are presently no improvements along the drainageway in the form of bank linings or grade controls. The low flow channels along some segments of the 100-year floodplain have cross-section that is well incised.

The "G" basins discharge to Cottonwood Creek approximately 500 feet upstream of the outfall of sub-watershed F. The sub-watershed drains a total of .32 square miles at its outfall point. Slopes along the major drainageway range from 2 to 3 percent. Soils are entirely hydrologic soil group B. A portion of sub-watershed G lays offsite from Wolf Ranch. The offsite portion of the sub-watershed (i.e., sub-basin G-1) is presently developed into large rural lots ranging in size from 2.5 to 5 acres. The watershed is well vegetated with native grasses. The portion of sub-watershed G that lies south of Research Parkway is presently under development as a school site.

The "H" basin discharges to Cottonwood Creek just downstream of Black Forest Road. This sub-watershed drains a total of .093 square miles at its outfall point. Slopes along the watershed range from 2 to 6 percent. Soils are entirely hydrologic soil group B. The sub-watershed is well vegetated with native grasses. The portion of sub-watershed H that lies south of Research Parkway is presently under development as a school site.

The J sub-basins are direct flow areas to Cottonwood Creek. Sub-basin J-1 is presently fully developed. This sub-watershed drains a total of .025 square miles. Slopes along the watershed range from 2 to 6 percent. Sub-basin J-2 is presently fully developed. This sub-watershed drains a total of .053 square miles. Slopes along the watershed range from 2 to 6 percent. Soils are entirely hydrologic soil group B.

It was assumed in this report that the portions of the A- and F-basins that lie north of Old Ranch Road will not develop to any higher land use densities than exist today. If denser development occurs north of Old Ranch Road, it has been further assumed that detention would be required so that the peak discharges flowing onto the Wolf Ranch development would not be increased over the existing condition rates calculated in this report.

DEVELOPED MAJOR SUB-WATERSHEDS

The study area was divided into nine major sub-watersheds. These sub-watersheds are noted in the hydrologic analysis by using the designations A through J. The sub-basins were coded accordingly (i.e., A-1, A-2, B-1, etc). The sub-basins for the developed condition existing condition are presented on Figure 5. For the most part the developed condition sub-watershed boundaries cover similar areas as compared to existing sub-watersheds.

The sub-basin divides were determined using the master development plan so that the basin boundaries and key design points could be evaluated at future major roads. Some minor sub-basin rerouting and diversions have occurred. The curve-numbers were revised for the developed conditions. The developed curve numbers ranged from 61 to 90. The time of concentration values and resulting time lags were evaluating using developed flow paths and storm sewers where applicable.

HYDROLOGY RESULTS

Presented of Figures 4 and 5 (contained in map pocket), are the peak discharges that resulted from the hydrology analysis for sub-basins as well as at key design points within the development. Presented on Table 1 is a comparison of the DBPS discharges summarized in Reference 7 at each common design point. The variances in the peak discharges are largely the result of the differences between the HEC-1 model developed in Reference 7 and this MDDP. The finer degree of sub-basin delineation has been applied in this MDDP that can cause differences in peak discharges. Differences in the sub-basin area can also produce variances between this MDDP and the DBPS. The input and output for the HEC-1 computer model for the existing and developed hydrologic analyses are contained within Appendix A of this report.

There was no analysis conducted in this MDDP for the main stem of Cottonwood Creek. Peak discharge data shown on Table 1 that was obtained from the draft 2017 DBPS applied in this MDDP for the estimation of the 100-year flood plain for Cottonwood Creek and the sizing selective of bank linings. The 100-year discharge estimated in the 2000 DBPS prepared by Ayres (Reference 6) compares favorably with the 1994 DBPS prepared by URS, Inc., (Reference 5), as well and the with the hydrology summarized for Cottonwood Creek in the City of Colorado Springs Flood Insurance Study. The assumptions in the draft 2017 DBPS regarding soils and future land uses within the Wolf Ranch are consistent for the most part with the Wolf Ranch overall development plan. Differences in the peak discharges between the Reference 7 and the previous DBPS's are the result of the application of a Type II rainfall distribution as opposed to a Type IIA as applied in References 5 and 6. Application of the Type II storm distribution usually results in a 5 to 10 percent decrease in peak discharges as compared to the Type IIA distribution.

At design point A the primary difference between the 100-year peak discharge reported in Reference 6 and this MDDP is due to the larger basin area applied in this MDDP for the developed condition. A modestly lower curve number was applied in this MDDP compared to Reference 6. The lower curve number yields a lower unit discharge at design point A for the MDDP hydrology (i.e., 1,490 cubic feet per second/square mile (DBPS)

TABLE 1:
COMPARISON OF 100-YEAR PEAK DISCHARGES
DEVELOPED CONDITION WITHOUT DETENTION
WOLF RANCH MASTER DEVELOPMENT DRAINAGE PLAN

DESIGN POINT	**DBPS (REFERENCE 6)**		**DBPS (REFERENCE 7)**		**MDDP (KIOWA)**	
	Q5	Q100	Q5	Q100	Q5	Q100
(cfs)	(cfs)		(cfs)		(cfs)	
A	n/r	553	287	982	287	982
F	n/r	1,450	289	1,612	289	1,612
COTTONWOOD CREEK AT POWERS BOULEVARD	n/r	2,730 (1)	750	2,410 (2)	ne	ne
COTTONWOOD CREEK UPSTREAM OF TRIBUTARY FOUR	n/r	860 (1)	690	2,370(2)	ne	ne

(1) Source: Cottonwood Creek DBPS, Ayres Associates, June 2000 (Reference 6)
(2) Source: Draft Cottonwood Creek DBPS, Matrix Design Group, July 2017 (reference 7)
n/r = not reported in this MDDP
ne = no estimate made in this MDDP

versus 1,280 cubic feet per second/square mile (MDDP)). This result is consistent with the application of a lower curve number. At design point F located at the confluence of Tributary Four and Cottonwood Creek the variance in the peak discharges is also the result of a larger area applied in the MDDP and differing curve numbers. The unit discharges compare well between the DBPS and this MDDP, (i.e., 760 cubic feet per second/square mile (DBPS) versus 810 cubic feet per second/square (MDDP).

REGIONAL DETENTION HYDROLOGY

Detention storage was determined through an iterative process where an initial volume was calculated based on the changes of SCS curve numbers between the existing and developed condition. The initial volume was refined using the HEC-1 model resulting in the storage volumes summarized in this report. The proposed development condition was modeled with sufficient detention storage so that the flow rates were maintained to historic levels at each outfall point along the development's southern and western boundaries. The implementation of detention storage will have the effect of reducing the size of major drainageway facilities that may lie downstream of a detention basin. Detention will extend the time and duration of peak discharges but significantly reduce the magnitude of the peak flow rates for the 5- and 100-year recurrence intervals.

Presented on Figure 6 are the locations and hydraulic characteristics of seven detention basins that are proposed within the Wolf Ranch development. Each detention basin would be built with an outlet structure that would control the 5-year and 100-year discharges from the detention basin to historic levels at the discharge points from the property. Detention basins within sub-watersheds A, E/D (Westcreek Filing 3 Basin) and A 4 were constructed in 2006, 2008 and 2014 were designed and built to function as full spectrum detention basins and include flood storage. The remainder of the detention basins shown on Figure 6, F28, F18/19, G3 and H, have been designed to be in conformance with Reference 3 and will operate as full spectrum detention basins and provide flood storage.

Water quality capture is provided for within the storage pool of each of the detention basins shown on Figure 6. Though detention basins A4 and F18/F19 are technically on-stream, they lie near the upstream limits of Tributary 4 and control relatively small watersheds suitable for the siting of full spectrum detention basins with mostly low density residential uses proposed. The need for onsite water quality facilities will be established during the development planning stage for each filing with details related to water quality capture outlined in the final drainage report. Full spectrum detention basins within the portions sub-watersheds G and H that lie within the proposed

Academy District 20 school campus have been designed by others and have not been shown on Figure 6. Sub-watershed J does not have the physical attributes to accommodate a for regional detention basin and therefore onsite water quality measures have been constructed.

All the detention basins have been sited to account for roadway embankments and natural storage areas that could be integrated into the design of the detention basin. Presented on Table 2 are peak flow comparisons at the discharge point of each sub-watershed for the existing, developed and detained hydrologic conditions.

At design point A an "allowable" discharge of 553 cubic feet per second was determined in Reference 5. The allowable discharge at design point A represents the maximum release rate from the developed A watershed. The allowable discharge of 553 cubic feet per second was used in the design of the Fairfax Detention basin and is well within the hydraulic capacity the existing box culvert under Powers Boulevard. The Fairfax detention basin lies downstream of Powers Boulevard and is a regional detention basin that receives runoff from sub-watershed A. The discharge in the detained condition at design point A is 236 cubic feet per second which includes the detained discharges from the Cordera detention basin, is well below the allowable discharge stated in Reference 6. The existing condition peak discharge for sub-basin A as estimated herein is 160 cubic feet per second and does not account for runoff from the existing Cordera property which joins sub-basin A just upstream of Powers Boulevard. The discharge from Detention Basin A is estimated at 114 cubic feet per second. The input and output for the HEC-1 computer model for the detained hydrologic analysis is contained within Appendix A of this report.

HYDRAULICS

The sizing of the major drainageway conveyances, storm sewer outfall lines and roadway culverts was accomplished using the discharge data produced for the detained hydrologic condition. Presented on Figure 6 are the sizes for each of the major roadway crossings. Roadway culverts were determined using the Federal Highways Administration HY-8 Culvert Analysis program. The input and output for the culvert analyses are contained within Appendix B. Storm sewers shown on Figure 6 were determined using normal flow equations and a minimum slope of 2 percent. The major storm sewers were modeled in the HEC-1 analysis. Excepting Cottonwood Creek and Tributary Four drainageways, the open channels shown on Figure 6 were sized using normal depth equations. For grass-lined channels a maximum 100-year velocity of five feet per second was assumed. For channels lined with riprap a maximum 100-year design velocity of nine feet per second was applied. The spacing of grade control along open channels, including

TABLE 2:

COMPARISON OF EXISTING, FUTURE AND DETAINED CONDITIONS PEAK DISCHARGES

WOLF RANCH MASTER DEVELOPMENT DRAINAGE PLAN

DESIGN POINT	NOTES	LOCATION	EXISTING CONDITION (cfs)		FUTURE CONDITION (cfs)		DETAINED CONDITION (cfs)	
			Q5	Q100	Q5	Q100	Q5	Q100
A	(3)	at West Property Line	11	157	279	995	154	236
A6	(3)	at existing stock pond	12	142	222	722	118	391
A3	(3)	at Briargate Boulevard	N/A	N/A	87	326	87	334
C	(3)	at Cottonwood Creek	8	94	104	314	104	314
D	(3)	at Cottonwood Creek	16	107	47	162	N/A	N/A
D2 (1)	(3)	at south property line	14	103	48	158	49	160
E	(3)	at Cottonwood Creek	18	124	94	304	N/A	N/A
E2 (1)	(3)	at south property line	9	61	98	309	13	157
F	(4)	Tributary 4 at Cottonwood Creek	48	599	165	1453	26	559
F28	(4)	Tributary 4 at Research Parkway	46	595	270	1408	26	536
F22	(4)	Tributary 4 1,000' south of Briargate	46	538	108	749	15	230
G	(2)	at Cottonwood Creek	4	60	55	271	N/A	N/A
H-1	(2)	at Research Parkway	1	11	6	48	N/A	N/A

(1) Detained design points D2 and E2 combine the discharges for existing basins E-1 and design point D2

(2) 2-hour design storm per 2014 DCM

(3) 24-hour design storm per NOAA Atlas 2 rainfall depths with Type IIA rainfall distrubution.

(4) 24-hour design storm per NOAA Atlas 2 rainfall depths with Type II rainfall distribution per 2014 DCM.

Cottonwood Creek and Tributary Four was determined using an assumption that the longitudinal slope would degrade to one-half of the existing longitudinal slope. Presented on plan and profiles PP4 through and PP6 contained within Appendix C are the proposed drainageway improvements for the segments of Cottonwood Creek within the development. Grade controls would be sloping boulder or soil cement drops with a maximum drop height of six vertical feet. A typical section of a boulder sloping drop is included with the plan and profiles. The drop structure would provide for the control of the 5-year as well as the 100-year discharge through the drop. Selective riprap bank lining is proposed along Cottonwood Creek. The locations proposed for bank lining are shown on the plan and profiles. A typical bank section and sloping drop has been provided for on the detail sheet PP7 as well.

Also contained within Appendix C are the final design drawings for Lower and Upper Tributary Four as prepared by Kiowa Engineering and as approved by the City. The selective bank lining and grade controls shown on the Lower Tributary Four design plans were constructed in 2016. The selective bank lining and grade controls shown on the Upper Tributary Four design plans are proposed for construction in 2018.

Presented on the plan and profile drawings is the 100-year floodplain and profile for Cottonwood Creek and Tributary Four. The 100-year water surface was determined using the U. S. Army Corps of Engineers HEC-2 water surface profile program. The hydrology used to determine the floodplain and profile was the developed condition without detention. The 100-year velocity along Cottonwood Creek through the Wolf Ranch development ranges 4 to 10 feet per second. The 100-year velocity for Tributary Four ranges from 6 to 10 feet per second. These velocity ranges were used when determining the average riprap size needed for the selective linings.

FLOODPLAIN STATEMENT

Floodplains for the 100-year existing condition have been delineated for Cottonwood Creek within the Colorado Springs and El Paso County Flood Insurance Study (FIS). Cottonwood Creek is the only drainageway within the Wolf Ranch development that has been studied by FEMA.

Shown on Figure 7 is the project site superimposed on the Flood Insurance Study FIRM panel 529F for this area of El Paso County. Portions of the Wolf Creek property lie within a 100-year floodplain and floodway as depicted in the in the City of Colorado Springs and El Paso County Flood Insurance Study (FIS), prepared by the Federal Emergency Management Agency (FEMA).

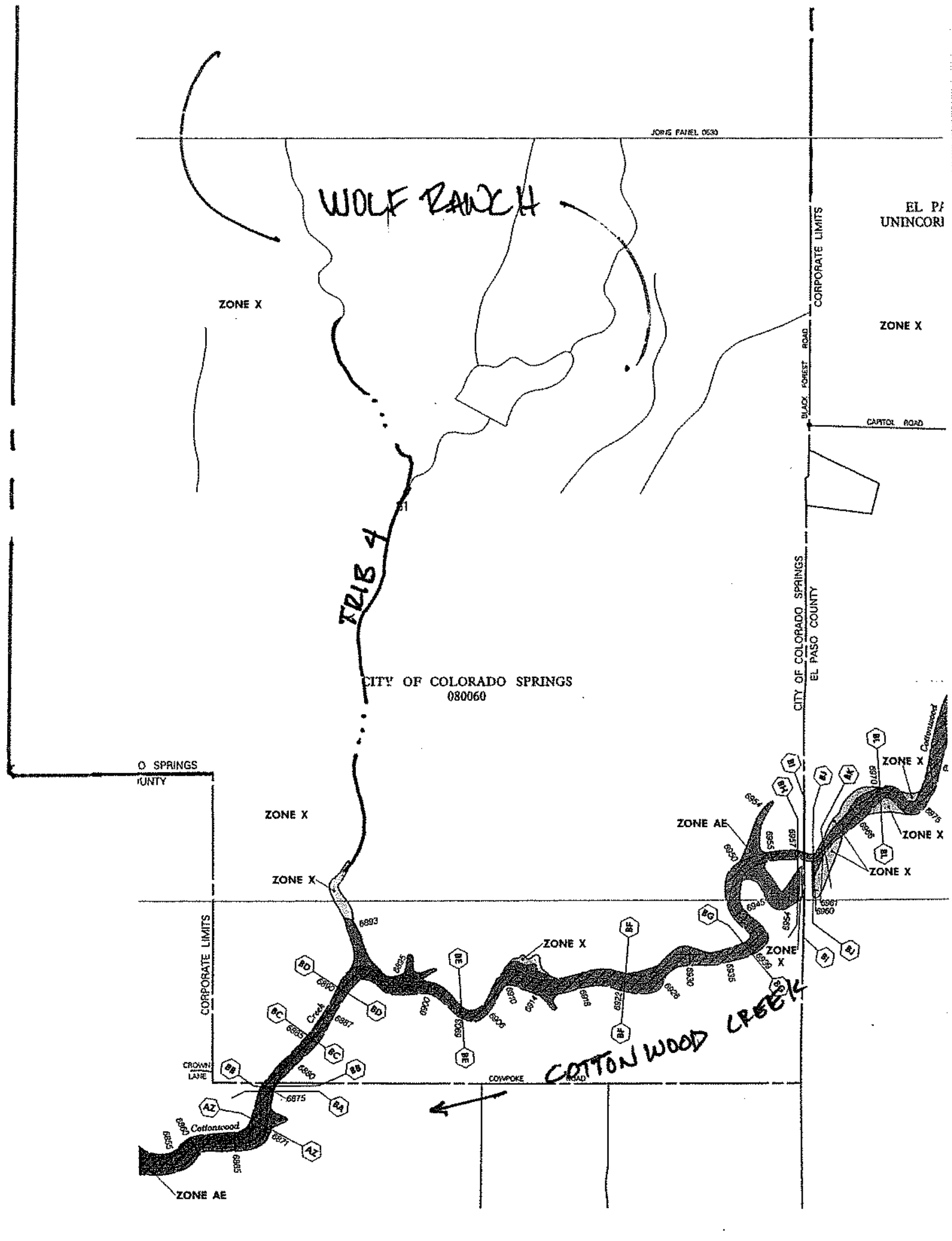


FIGURE 7
FLOODLAIN INFORMATION

PROPOSED FACILITIES

Detention

The primary conclusion of this MDDP is that regional full spectrum detention has been and will be required to maintain the historic flow conditions at the development's west and south property lines. A total of 7 full spectrum detention basin will serve the Wolf Ranch Development at full build-out. Four, detention basins A4, A, F28 and E./D, have been constructed and are functioning to provide full spectrum detention. Three, detention basins F18/19, G and H, will be constructed in 2018. City design approvals have been received for detention basins F18/19 and G. Onsite water quality storage is recommended for sub-watersheds C-3, G-4, J-1 and J-2. G-5, H and J. As discussed above, the detention basins shown on Figure 6 collectively reduce the 100-year peak discharge to at or below historic conditions, excepting sub-basin A where the detained discharges for Wolf Ranch and Cordera are below the 100-year discharge used for the design of the Powers Boulevard box culvert and the Fairfax detention basin.

It is the intent of this MDDP to incorporate full spectrum detention within the flood storage for each of the un-built detention basins. The HEC-1 models incorporating the FSD storage are contained within Appendix A of this report. The storage and outflow data for each of the detention basins are presented on Figure 6. Each detention basin will be designed to be in conformance with the City/County storm drainage technical criteria. Each detention basin will be required to have an emergency spillway. Easements or tracts dedicated for access and maintenance will be established at each detention basin site through the platting process.

Drainageways

The City of Colorado Springs, El Paso County Drainage Criteria Manual was used in the development of the typical sections and plans for the major drainageways within the Wolf Ranch development. The City storm drainage criteria manual was supplemented by the criteria as summarized in Reference 4.

The recommended channel sections for each reach of drainageway have been presented on Figure 6 at the rear of this report and on the final plan and profiles of Tributary Four and the preliminary pal and profile for Cottonwood Creek.

Drop and Check Structures

Drop structures have been sited along the Cottonwood Creek, and Tributary Four drainageways to maintain the channel invert at a stable gradient or to reduce the slope of the channel gradient so that lower velocities result along the drainageways. When determining the location of drop structures along Tributary 4, a degraded slope of no more than one-half of the existing slope was assumed. Design slopes for Cottonwood Creek should be developed in accordance with the 2014 DCM. In the case of Tributary Four the design slope applied was 1.0 percent. This assumption allows for the design to accommodate future channel degradation without modifying the existing channel section. The drops are designed to allow for a maximum drop of six feet and will have a sloping face of four to one. The design plan and profiles that were prepared for Upper and Lower Tributary Four are provided in Appendix C.

Check structures are needed along the invert of some of the natural and smaller improved drainageways shown on Figure 6. The check will allow for a three-foot degradation of the invert prior to undermining a given check. These checks will be constructed of either riprap or concrete. A typical check structure detail has been presented on detail sheet PP7. The interval between checks is shown for each drainageway on Figure 6.

Roadway Crossings

Shown on Figure 6 are the size, type and location of roadway crossings along the major drainageways. The location of future arterials and collector streets was obtained from the development plan for Wolf Ranch. A 100-year headwater to depth ratio of 1.1 was assumed in the sizing of the major roadway culverts.

The existing crossings at Cowpoke Road and Black Forest Road are proposed to remain until such time development within Wolf Ranch and surrounding areas warrant the widening of Black Forest Road and the extension of Tutt Boulevard. When Tutt Boulevard is constructed and when Cowpoke Road is realigned, the existing bridge at Cowpoke Road over Cottonwood Creek can be eliminated. The City is presently under design for a flood storage facility upstream of the proposed Tutt Boulevard embankment at Cottonwood Creek. The location of this facility is shown on the Cottonwood Creek plan and profile and on Figure 6. This facility is proposed for construction in 2018. This facility will not be designed to provide water quality storage, only flood storage ad flood routing.

When Black Forest Road is widened bridge will be installed replacing the existing box culvert. New culverts at Cottonwood Creek and Black Forest Road, and at future Tutt Boulevard are presently shown as future projects on the Pikes Peak Rural Transportation Authority capital improvement program. Construction responsibility for the culverts at future Tutt Boulevard and for Black Forest Road is not within the requirements of the Wolf Ranch annexation agreement. The existing structures on Cowpoke Road and Black Forest Road have sufficient capacity to pass the 100-year discharge without overtopping.

Several culverts exist under Old Ranch Road at this time. These culverts range in size from 18-inches to 48-inches and are all corrugated metal pipe. The culverts have adequate capacity to convey the existing five-year flow under the roadway without overtopping. Some of the culverts have a 100-year capacity. For those that do not, Old Ranch Road would be overtopped however the rate of the overflow would be low and it would not be anticipated that the roadway would be overtopped at a depth greater than 12-inches. It was assumed in the hydrologic analysis that the areas north of Old Ranch Road will not produce runoff greater than the existing condition rates calculated in this report. Most of the area north of Old Ranch Road is developed. If a denser land use takes place in the future, stormwater detention would be required so that an increase in the rates of runoff to the Wolf Ranch property does not occur. There is however no intention to replace the existing crossing under Old Ranch Road as part of the development of the Wolf Ranch property.

Trails

Trails for access to the detention basins and major drainageways need to be incorporated into the design of the improvements. For the Wolf Ranch a multi-purpose trail is proposed that is aligned along the Tributary Four. This trail will have to be accommodated at each of the roadway crossings by either an at-grade or sub-grade crossing. Where practical, this trail can accommodate maintenance access to the channel and the detention basins. If the trail encroaches into a 100-year floodplain, the trail design should account for hydraulic considerations, utilities in the area and access to dedicated parks and roadway crossings. Maintenance access to the drainageway and to existing utilities within the drainageway corridor can offer a multiple use aspect to a trail project.

Maintenance

Maintenance of drainageway facilities is essential in preventing long term degradation of the drainageway and overbank areas. Along the drainageway, clearing of debris and dead vegetation should be considered within the low flow area of the creek and its tributaries. On the overbanks, limited maintenance of the existing vegetative cover is recommended. Yearly clearing of trash and debris at roadway crossings is also recommended to ensure the design capacity of the crossing, and to enhance the crossings for trail users if a trail exists. Caution should be taken when clearing culverts of sediment so as not to leave the dredged soil within the channel or overbank area. This disturbs the native vegetation and creates a potential water quality concern if the dredged material is subsequently washed into the drainageway by natural erosion. For those reaches of drainageways that are designated for selective lining and the floodplain preservation, maintenance activities should be carried out while minimizing the disturbances to native vegetation.

The proposed detention basins will also require annual maintenance. The outlet structures will need to be cleared and the entry channel and forebays cleared of debris or silt. For those detention basins where water quality storage has been incorporated into the design, the clearing of sediment from the water quality pools will need to be carried out on a yearly basis as well, minimum.

All major drainageway, detention basins and bridge facilities within that portion of Wolf Ranch will be constructed and paid for either by the developer or a metropolitan district. The remaining portions of the Wolf Ranch will be subject to the City's standard drainage ordinances and procedures.

Because all property within Wolf Ranch lies within the City of Colorado Springs, all public drainage facilities within Wolf Ranch will be dedicated to, and maintained by, the City of Colorado Springs once accepted by the City.

Right-of-Way

It will be required for the main drainageways that pass through the development to be located within dedicated tracts, easements or right-of-ways. Access to these tracts or easement will be granted to the metropolitan district so that routine surface maintenance activities can be conducted. In the case of right-of-ways and tracts, these lands would be dedicated to the metropolitan district. For those segments of the drainageway where floodplain preservation is the recommended plan, a combination of open space dedication (such as park-land and greenbelts), in combination with a dedicated maintenance right-of-way along the low flow area of the drainageway should be obtained through the land development process. Land dedication will be required for the detention basins. The dedication of easements and right-of-way for the drainageways and detention basins would be accomplished at the time of development planning and/or platting of the parcels that lie adjacent to or upstream of the stormwater facility.

Permitting

Drainageway stabilization measures along Tributary Four and Cottonwood Creek as well as detention basin construction has been authorized by an individual 404 permit issued for Wolf Ranch in 2003. The original 404 has been amended of five separate occasion as work affecting wetlands and waters of the US within Wolf Ranch has proceeded. The 404 permit has recently been deactivated since the all work that could impact wetlands and waters of the US as identified in the 404 permit application have been completed. Future stabilization measures for Cottonwood creek above Tributary Four when required will be required to obtain a nationwide 404 permit authorization at the time of construction.

Floodplain development permits have been required for the lower portion of Tributary 4 and Cottonwood Creek that fall within the limits of the floodplain shown in the Colorado Springs Flood Insurance study. Letter(s) of Map Revisions may be required if the stabilization measures on Cottonwood Creek affect a rise in the 100-year water surface.

PUBLIC DRAINAGE FACILITIES

Summarized on the following tables are the as-built and proposed costs for construction of existing and future public drainage facilities that have been identified in this MDDP Update. In this case public drainage facilities include storm sewers equal to or greater than 42-inches in diameter, full spectrum detention basins and drainageway stabilization measures along Cottonwood Creek and Tributary Four. All public drainage facilities will be owned and maintained by the City once accepted through the normal subdivision certification process. Once the facilities have been accepted by the City, they become eligible for reimbursement through the drainage basin fee system.

The storm sewer facilities summarized on Table 3 have been installed and the costs shown represent the actual construction costs for each system over 42-inches in diameter. Presented on Table 4 is a summary of the costs associated with the four existing FSD basins shown on Figure 6. Listed on Table 5 are major drainageway facility costs for Tributary Four that have been constructed. The bank stabilization and grade control structures for Lower Tributary Four were constructed in 2017. Only one of the drop structures shown on the plan and profiles for Cottonwood Creek have been built at this time.

Presented on Table 6 are the proposed storm sewer systems that remain to be built. Listed on Table 7 are the proposed FSD basins, and on Table 8 the remaining proposed major drainageway stabilization measures for Tributary Four and Cottonwood Creek. These facilities are shown on Figure 6.

Presented on Table 9 are total costs for the reimbursable existing and proposed public storm water facilities. The total of the existing facilities subject to reimbursement is estimated at $3,055,415 after accounting for the deferred capital drainage fees posted to date for Wolf Ranch. Total reimbursable costs and proposed facilities are estimated at $13,455,909.

Presented on Table 10 is the cost of the land associated with the FSD basins. The cost of land associated with the existing and future detention basins is estimated at

TABLE 3
REIMBURSABLE EXISTING PUBLIC STORM SEWER FACILITIES SUMMARY- AS-BUILT
WOLF RANCH MASTER DEVELOPMENT DRAINAGE PLAN UPDATE
KIOWA PROJECT NUMBER 17049

ITEM	UNIT COST	UNIT	QUANTITY	TOTAL
WESTCREEK AT WOLF RANCH FILING 1				
42-INCH RCP	$63	LF	550	$34,375
48-INCH RCP	$73	LF	535	$39,055
54-INCH RCP	$92	LF	650	$59,800
54-INCH x 18-INCH WYE	$1,050	LF	1	$1,050
54-INCH BEND	$1,975	LF	3	$5,925
TYPE I MANHOLE	$4,450	EA	4	$17,800
SUBTOTAL				$123,630
WESTCREEK AT WOLF RANCH FILING 3				
54-INCH RCP 8-FT DEPTH	$92	LF	325	$29,900
54-INCH RCP 8-10-FOOT DEPTH	$95	LF	125	$11,813
54-INCH RCP < 10-FEET	$97	LF	210	$20,265
54-INCH BEND	$1,975	LF	10	$19,750
60-INCH RCP	$134	LF	106	$14,204
60-INCH RCP BEND	$2,208	EA	1	$2,208
REMOVE 60-INCH CMP	$800	LS	1	$800
TYPE I MANHOLE 11.5 FT DEPTH	$6,554	EA	1	$6,554
TYPE I MANHOLE 18-FT DEPTH	$7,690	EA	1	$7,690
TYPE I MANHOLE 9-FT DEPTH	$4,728	EA	1	$4,728
TYPE I MANHOLE 8.5-FT DEPTH	$4,675	EA	1	$4,675
SUBTOTAL	$0			$122,587
WESTCREEK AT WOLF RANCH FILING 4				
42-INCH RCP	$56	LF	1044	$58,464
42-INCH RCP AT 23%	$59	LF	117	$6,926
42-INCH RCP JT RESTRAINTS	$83	EA	15	$1,238
42-INCH RCP FES	$792	EA	1	$792
TYPE I MANHOLE	$4,670	EA	3	$14,010
SUBTOTAL				$81,430
WESTCREEK AT WOLF RANCH FILING 7				
54-INCH RCP	$86	LF	689	$58,910
54-INCH RCP BEND	$1,694	EA	2	$3,388
54-INCH RCP FES PLUG	$396	EA	1	$396
TYPE I MANHOLE	$4,561	EA	1	$4,561
SUBTOTAL				$67,255

WESTCREEK AT WOLF RANCH FILING 9				
54-INCH RCP	$85	LF	672	$57,402
54-INCH RCP BEND	$1,694	EA	2	$3,388
TYPE 1 MANHOLE	$4,561	EA	1	$4,561
SUBTOTAL				$65,351
WESTCREEK AT WOLF RANCH FILING 10				
54-INCH RCP	$86	LF	143	$12,227
54-INCH RCP BEND	$1,693	EA	1	$1,693
60-INCH RCP	$123	LF	327	$40,139
TYPE I MANHOLE 7.5-FT DEPTH	$5,266	EA	1	$5,266
TYPE I MANHOLE OVER-SIZED	$1,437	EA	1	$1,437
SUBTOTAL				$60,762
WESTCREEK AT WOLF RANCH FILING 11				
54-INCH RCP	$89	LF	207	$18,320
SUBTOTAL				$18,320
RESEARCH PARKWAY FILING 2				
42-INCH RCP	$56	LF	348	$19,314
42-INCH RCP BEND	$1,360	EA	3	$4,080
42-INCH RCP X 18-INCH WYE	$1,110	EA	1	$1,110
48-INCH RCP	$63	LF	53	$3,339
48-INCH RCP FES	$840	EA	1	$840
48-INCH RCP TRENCH ROCK EXCAVATION	$250	HR	1.5	$375
REMOVE 48-INCH RCP	$1,262	LS	1	$1,262
54-INCH RCP	$85	LF	137	$11,645
SUBTOTAL				$41,965
RESEARCH PARKWAY FILING 3				
42-INCH RCP	$56	LF	48	$2,674
54-INCH RCP	$93	LF	150	$13,950
SUBTOTAL				$16,624
VILLAGES AT WOLF RANCH FILING 4 - WOLF VILLAGE DRIVE				
42-INCH RCP	$58	LF	444	$25,708
48-INCH RCP	$68	LF	693	$47,124
TYPE I MANHOLE ON 48-INCH	$4,825	EA	3	$14,475
TYPE I MANHOLE OVER-SIZED	$4,498	EA	3	$13,494
SUBTOTAL				$100,801

VILLAGES AT WOLF RANCH FILING 11				
42-INCH RCP	$80	LF	360	$28,800
42-INCH RCP FES	$1,090	EA	1	$1,090
SUBTOTAL				$29,890
VILLAGES AT WOLF RANCH FILING 13 (LEON YOUNG DRIVE)				
48-INCH RCP	$68	LF	17	$1,158
48-INCH RCP BEND	$1,461	EA	1	$1,461
54-INCH RCP	$93	LF	1005	$93,164
48-INCH RCP TRENCH ROCK EXCAVATION	$250	HR	19	$4,750
TYPE 1 MANHOLE	$4,840	EA	2	$9,680
SUBTOTAL				$110,212
VILLAGES AT WOLF RANCH FILING 14				
54-INCH RCP	$140	LF	339	$47,392
54-INCH RCP BEND	$1,520	EA	1	$1,520
SUBTOTAL				$48,912
VILLAGES AT WOLF RANCH FILING 15				
42-INCH RCP	$80	LF	56	$4,480
42-INCH RCP BEND	$876	EA	1	$876
54-INCH RCP	$120	LF	343	$41,160
54-INCH RCP WYE	$766	EA	1	$766
60-INCH RCP	$170	LF	946	$160,347
60-INCH RCP X 18-INCH WYE	$766	EA	2	$1,532
60-INCH RCP	$170	LF	32	$5,424
TYPE I MANHOLE 6.7 FT DEPTH	$7,020	EA	3	$21,060
TYPE I MANHOLE 9-FT DEPTH	$7,250	EA	1	$7,250
SUBTOTAL				$242,895
WOLF CENTER DRIVE				
42-INCH RCP	$87	LF	16	$1,389
54-INCH RCP	$92	LF	50	$4,600
TYPE I MANHOLE OVER-SIZED	$4,790	EA	1	$4,790
SUBTOTAL				$10,779
VALEMOUNT DRIVE				
48-INCH RCP	$107	LF	330	$35,343
SUBTOTAL				$35,343
PARKWOOD FILING 2				
42-INCH RCP	$80	LF	38	$3,040
42-INCH RCP BEND	$876	EA	1	$876
SUBTOTAL				$3,916

VILLAGES AT WOLF RANCH FILING NO. 25A				
42-INCH RCP	$135	LF	473	$63,855
42-INCH RCP BEND	$1,150	EA	1	$1,150
42-INCH RCP X 42-INCH WYE	$800	EA	1	$800
42-INCH RCP X 18-INCH WYE	$800	EA	2	$1,600
SUBTOTAL				$67,405
VILLAGES AT WOLF RANCH FILING NO. 25B				
42-INCH RCP	$135	LF	1769	$238,815
42-INCH RCP BEND	$1,150	EA	1	$1,150
42-INCH RCP X 18-INCH WYE	$1,150	EA	1	$1,150
TYPE 1 MANHOLE	$7,800	EA	3	$23,400
SUBTOTAL				$264,515
VILLAGES AT WOLF RANCH FILING 30				
42-INCH RCP STUB	$135	EA	8	$1,080
48-INCH RCP	$165	LF	184	$30,360
66-INCH RCP	$250	LF	104	$26,000
66-INCH X 36-INCH RCP TEE	$1,400	EA	1	$1,400
72-INCH RCP	$301	LF	1045	$314,360
72-INCH w 48-INCH RISER	$3,700	EA	1	$3,700
72-INCH RCP BEND	$3,170	EA	1	$3,170
72-INCH X 36-INCH RCP WYE	$1,400	EA	1	$1,400
72-INCH X 30-INCH RCP WYE	$1,400	EA	1	$1,400
72-INCH X 24-INCH RCP WYE	$1,100	EA	1	$1,100
72-INCH RCP MANHOLE	$8,994	EA	1	$8,994
SUBTOTAL				$392,964
WOLF VILLAGE DRIVE GRAND CORDERA TO TUTT				
48-INCH RCP	$68	LF	852	$58,022
48-INCH X 30-INCH RCP WYE	$1,525	EA	1	$1,525
48-INCH BEND	$1,461	EA	1	$1,461
SUBTOTAL				$61,008
WOLF VILLAGE DRIVE TUTT BOULEVARD TO WOLF CENTER DRIVE				
42-INCH RCP	$58	LF	444	$25,708
48-INCH RCP	$68	EA	766	$52,088
TYPE 1 MANHOLE ON 42-INCH	$4,498	EA	3	$13,494
TYPE 1 MANHOLE ON 48-INCH	$4,825	EA	4	$19,300
SUBTOTAL				$110,590

WOLF RANCH TOWNHOMES				
42-INCH X 36-INCH RCP REDUCER	$1,100	EA	1	$1,100
SUBTOTAL				$1,100
DAYBREAK AT WOLF RANCH				
48\-INCH RCP	$152	LF	97	$14,744
54-INCH RCP	$195	EA	468	$91,260
54-INCH RCP WYE	$1,165	EA	2	$2,330
54-INCH RCP BEND	$1,905	EA	1	$1,905
TYPE 1 MANHOLE ON 48-INCH	$8,100	EA	1	$8,100
SUBTOTAL				$118,339
WOLF CENTER DRIVE AND BRIARGATE PARKWAY				
48-INCH RCP	$149	LF	136	$20,264
48-INCH RCP FES	$1,620	EA	1	$1,620
35-INCH X 53-INCH ELLIPTICAL RCP	$1,515	EA	1	$1,515
SUBTOTAL				$23,399
STORM SEWER IN VALEMOUNT				
48-INCH RCP	$146	LF	121	$17,666
48-INCH RCP BEND	$1,525	EA	1	$1,525
48-INCH RCP PLUG	$415	EA	1	$415
SUBTOTAL				$19,606
TOTAL REIMBURSABLE EXISTING PUBLIC STORM SEWERS				$2,239,595

TABLE 4
REIMBURSABLE EXISTING FULL SPECTRUM DETENTION BASINS
WOLF RANCH MASTER DEVELOPMENT DRAINAGE PLAN UPDATE
KIOWA PROJECT NUMBER 17049

ITEM	UNIT COST	UNIT	QUANTITY	TOTAL
DETENTION BASIN A- AS-BUILT COSTS				
48-INCH RCP 8-FT DEPTH	$107.00	LF	29	$3,103.00
48-INCH RCP 8 TO 10-FT DEPTH	$109.40	LF	10	$1,094.00
48-INCH RCP 10-12-FT DEPTH	$112.20	LF	229	$25,693.80
48-INCH RCP 12-14-FT DEPTH	$115.80	LF	552	$63,921.60
48-INCH RCP 14-16-FT DEPTH	$120.50	LF	191	$23,015.50
48-INCH RCP MANHOLE TEE	$3,635.00	EA	1	$3,635.00
48-INCH RCP BEND MANHOLE TEE/BEND	$4,840.00	EA	1	$4,840.00
60-INCH RCP	$184.00	LF	75	$13,800.00
EXCAVATION	$159,812.50	LS	1	$159,812.50
SPILLWAY	$32,671.53	LS	1	$32,671.53
OUTLET STRUCTURE	$12,632.50	EA	1	$12,632.50
FOREBAY	$16.00	SF	1100	$17,600.00
WINGWALLS AND HEADWALLS	$37,500.00	LS	1	$37,500.00
HANDDRAILS	$58.00	LF	85	$4,930.00
SOIL RIPRAP	$48.00	TONS	230	$11,040.00
SUBTOTAL				$415,289.43
DETENTION BASIN A4- AS-BUILT COSTS				
OUTLET STRUCTURE	$52,000.00	EA	1	$52,000.00
WINGWALLS AND HEADWALLS	$44,024.00	LS	1	$44,024.00
TRICKLE CHANNEL	$9.17	SF	4884	$44,770.00
RIPRAP RUNDOWN	$66.15	TONS	625	$41,344.00
SPILLWAY	$59.45	TONS	450	$26,752.00
EARTHWORK	$292,878.26	LS	1	$293,878.25
REVEGETATION	$37,129.00	LS	1	$37,129.00
MAINTENANCE ACCESS RAMP	$3,600.00	EA	1	$3,600.00
SUBTOTAL				$543,497.25
WESTCREEK FILING NO. 3 DETENTION BASIN E/D - AS-BULT COSTS				
ESTIMATED COST PER DESIGN REPORT	$492,878.00	LS	1	$492,878.00
SUBTOTAL				$492,878.00

BY THE CREEK FILING 1 DETENTION BASIN F28 - AS-BUILT COSTS

30-INCH RCP	$19.00	LF	282	$5,358.00
96-INCH RCP PIPE MATERIAL	$412.00	LF	282	$116,184.00
96-INCH RCP PIPE STRUCTURE EXCAVATION	$43.00	LF	282	$12,126.00
96-INCH RCP INSTALL	$50.00	LF	282	$14,100.00
TEMP ROADWAY CONSTRUCTION	$3,375.00	LS	1	$3,375.00
BOX CULVERT SUBGRADE STABILIZATION	$38.00	TONS	335	$12,730.00
WINGWALLS AND HEADWALLS	$62,500.00	EA	1	$62,500.00
FOREBAY	$4,715.00	EA	1	$4,715.00
OUTLET STRUCTURE	$23,630.00	LS	1	$23,630.00
GROUTED BOULDERS	$65.00	TONS	585	$38,025.00
GROUTED BOULDERS AT OUTLET	$50.00	TONS	585	$29,250.00
TYPE VL RIPRAP	$50.00	TONS	226	$11,300.00
TEMPORARY ROADWAY AT DOG PARK	$3,965.00	LS	1	$3,965.00
SUBGRADE STABILIZATION	$28.00	TONS	740	$20,720.00
EARFTHWORK	$778,970.00	LS	1	$918,226.50
SOIL CEMENT MATERIAL	$5,317.50	LS	1	$5,317.50
SUBTOTAL				$1,281,522.00

TOTAL REIMBURSABLE FSD BASIN FACILITIES	$2,733,187
WESTCREEK FILING NO. 3 DETENTION BASIN REIMBURSEMENT	$492,878
TOTAL REIMBURSABLE FSD BASIN FACILITIES	$2,240,309

TABLE 5
REIMBURSABLE EXISTING PUBLIC MAJOR DRAINAGEWAY FACILITIES
WOLF RANCH MASTER DEVELOPMENT DRAINAGE PLAN UPDATE
KIOWA PROJECT NUMBER 17049

ITEM	UNIT COST	UNIT	QUANTITY	TOTAL
WEST CREEK PHASE 3: LOWER TRIBUTARY 4 AND COTTONWOOD CREEK				
AS-BUILT COSTS	$1,784,522.00	LS	1	$1,784,522
TOTAL EXISTING PUBLIC MAJOR DRAINAGEWAY FACILITIES				$1,784,522

TABLE 6
REIMBURSABLE PROPOSED PUBLIC STORM SEWER FACILITIES SUMMARY
WOLF RANCH MASTER DEVELOPMENT DRAINAGE PLAN UPDATE
KIOWA PROJECT NUMBER 17049

ITEM	UNIT COST	UNIT	QUANTITY	TOTAL
SUB-BASIN A				
48-INCH RCP	$150.00	LF	1450	$217,500
TYPE I MANHOLE	$8,000	EA	4	$32,000
SUBTOTAL				$249,500
SUB-BASIN F				
48-INCH RCP	$150	LF	4930	$739,500
54-INCH BEND	$195	LF	1250	$243,750
60-INCH RCP	$225	LF	3450	$776,250
TYPE I MANHOLE	$8,000	EA	23	$184,000
SUBTOTAL				$1,943,500
SUB-BASIN G				
42-INCH RCP	$135	LF	600	$81,000
48-INCH RCP	$150	LF	1680	$252,000
54-INCH RCP	$225.00	LF	1400	$315,000
TYPE I MANHOLE	$8,000	EA	11	$88,000
SUBTOTAL				$736,000
TOTAL REIMBURSABLE FUTURE PUBLIC STORM SEWERS				$2,929,000

TABLE 7
REIMBURSABLE PROPOSED FULL SPECTRUM DETENTION BASINS
WOLF RANCH MASTER DEVELOPMENT DRAINAGE PLAN UPDATE
KIOWA PROJECT NUMBER 17049

ITEM	UNIT COST	UNIT	QUANTITY	TOTAL
DETENTION BASIN F18/19				
PER DESIGN REPORT	$1,920,891.00	LS	1	$1,920,891
SUBTOTAL				$1,920,891
RESEARCH PARKWAY FILING NO. 5- DETENTION BASIN G				
ESTIMATED COST PER DESIGN REPORT	$494,017.00	LS	1	$494,017
SUBTOTAL				$494,017
RESEARCH PARKWAY FILING NO. 5- DETENTION BASIN H				
ESTIMATED COST	$300,000.00	LS	1	$300,000
SUBTOTAL				$300,000
TOTAL REIMBURSABLE PROPOSED FSD BASIN FACILITIES				$2,714,908

TABLE 8
REIMBURSABLE PROPOSED MAJOR DRAINAGEWAY FACILITIES
WOLF RANCH MASTER DEVELOPMENT DRAINAGE PLAN UPDATE
KIOWA PROJECT NUMBER 17049

ITEM	UNIT COST	UNIT	QUANTITY	TOTAL
UPPER TRIBUTARY 4				
PER DESIGN REPORT	$1,900,000	LS	1	$1,900,000
SUBTOTAL				$1,900,000
COTTONWOOD CREEK ABOVE TRIBUTARY 4				
PER DESIGN REPORT	$1,500,000	LS	1	$1,500,000
SUBTOTAL				$1,500,000
TOTAL PUBLIC MAJOR DRAINAGEWAY FACILITIES				$3,400,000

TABLE 9
SUMMARY OF REIMBURSABLE PUBLIC DRAINAGE FACILITIES
WOLF RANCH MASTER DEVELOPMENT DRAINAGE PLAN UPDATE
KIOWA PROJECT NUMBER 17049

EXISTING

EXISTING STORM SEWERS FOR PLATTED FILINGS (TABLE 3)	$2,239,595
MAJOR DRAINAGEWAY (TABLE 5)	$1,784,522
FULL SPECTRUM DETENTION BASINS (TABLE 4)	$2,240,309
SUB -TOTAL	$6,264,426
ENGINEERING (10%)	$626,443
CONTINGENCY (5%)	$313,221
TOTAL	$7,204,090
DEFERRED CAPITAL DRAINAGE FEES	$4,148,675
REMAINING REIMBURSABLE CAPITAL DRAINAGE FACILITIES	$3,055,415

PROPOSED

PROPOSED STORM SEWERS (TABLE 6)	$2,929,000
MAJOR DRAINAGEWAY (TABLE 8)	$3,400,000
FULL SPECTRUM DETENTION BASINS (TABLE 7)	$2,714,908
SUB -TOTAL	$9,043,908
ENGINEERING (10%)	$904,391
CONTINGENCY (5%)	$452,195
TOTAL	$10,400,494
REMAINING REIMBURSABLE CAPITAL DRAINAGE FACILITIES	$3,055,415
TOTAL REIMBURSABLE AND PROPOSED FACILITIES	$13,455,909

TABLE 10
SUMMARY OF EXISTING AND FUTURE FSD BASIN LAND COSTS
WOLF RANCH MASTER DEVELOPMENT DRAINAGE PLAN UPDATE
KIOWA PROJECT NUMBER 17049

ITEM	UNIT COST	UNIT	QUANTITY	TOTAL
EXISTING FSD'S				
DETENTION BASIN F28	$76,602	AC	6.5	$497,913
DETENTION BASIN A4	$76,602	AC	2.5	$191,505
DETENTION BASIN A	$76,602	AC	8.2	$628,136
WESTCREEK DETENTION BASIN E/D	$76,602	AC	5	$383,010
TOTAL				$1,700,564

ITEM	UNIT COST	UNIT	QUANTITY	TOTAL
PROPOSED FSD'S				
DETENTION BASIN F18/19	$76,602	AC	10.3	$789,001
DETENTION BASIN H	$76,602	AC	1.5	$114,903
DETENTION BASIN G	$76,602	AC	2	$153,204
TOTAL				$1,057,108

$1,700,564 and $1,057,108 respectively. These costs are based upon the current park land dedication fee of $76,602 per acre. Presently the land fee is not being assessed in the Cottonwood Creek basin. Wolf Ranch has not paid a land fee since beginning development in 2003 or used the cost of land associated with the FSD basins to offset land fees.

Contained within Reference 6 were public facilities for Cottonwood Creek and Tributary 4 that lie within the Wolf Ranch development. The costs that were determined in the DBPS for public facilities were used in the estimation of the drainage basin and bridge fees that are still assessed today. Presented on Table 11 are the 2000 DBPS capital drainage and bridge costs brought forward to the present day by applying the fee adjustments that have occurred since 2000, as fees were periodically re-established for the Cottonwood Creek basin.

Since there are not any bridges anticipated within Wolf Ranch, the bridge anticipated within the 2000 DBPS will never be built. Removing the bridge anticipated in the DBPS at Research Parkway and Tributary 4 from the bridge fee calculation would not significantly change the bridge fee as the cost of the bridge for future Tutt Boulevard, which was not included in the 2000 DBPS, would have to be added back into the bridge facility estimate.

BASIN FEES

Land platted within Wolf Ranch will be subject to the drainage, bridge and land fees established for the Cottonwood Creek drainage basin. Presented on Table 12 is a summary of the fees that remain to be paid associated with the remaining developable acreage in Wolf Ranch. Also summarized on Table 12 is the acreage that has been platted and estimated acreage associated future development. At this time, of the original total of 1,474 plattable acres within Wolf Ranch, 608 acres has been platted, and 866 acres remain that would be subject to future platting.

As presented on Table 12, the cost of the capital drainage facilities shown in this MDDP update that remain to be constructed, in combination with the remaining reimbursable costs for existing facilities, is shown to exceed the remaining capital drainage fees.

Wolf Ranch has been paying the basin surcharge and bridge fees for the 608 acres that have already been platted and will continue to do so on the remaining acreage.

TABLE 11: PRESENT DAY DBPS CAPITAL DRAINAGE AND BRIDGE COST ESTIMATION
COTTONWOOD CREEK DBPS, AYRES AND ASSOCIATES INC., 2000

CAPITAL DRAINAGE COSTS WITHIN WOLF RANCH

Year	ADJUSTMENT %	COST PER DBPS	
2000	0	$	3,510,170
2001	3	$	3,615,475
2002	3	$	3,723,939
2003	5	$	3,910,136
2004	5	$	4,105,643
2005	4	$	4,269,869
2006	10	$	4,696,856
2007	10	$	5,166,541
2008	1	$	5,218,207
2009	5	$	5,479,117
2010-2013	0	$	5,479,117
2014-2018	64	$	8,985,752

BRIDGE COSTS WITHIN WOLF RANCH

Year	ADJUSTMENT %	COST PER DBPS	
2000	0	$	314,944
2001	3	$	324,392
2002	3	$	334,124
2003	5	$	350,830
2004	5	$	368,372
2005	4	$	383,107
2006	10	$	421,417
2007	10	$	463,559
2008	1	$	468,195
2009	5	$	491,604
2010-2013	0	$	491,604
2014-2018	11	$	545,681

TABLE 12
SUMMARY OF WOLF RANCH DEVELOPABLE ACREAGE AND FEES
WOLF RANCH MASTER DEVELOPMENT DRAINAGE PLAN UPDATE
KIOWA PROJECT NUMBER 17049

DEVELOPABLE ACREAGE SUMMARY

GROSS ACREAGE	1894
REDUCTION FOR UNPLATTABLE ACREAGE	420
NET DEVELOPABLE ACREAGE	1474
PRESENTLY DEVELOPED	608
ACREAGE REMAINING TO BE PLATTED	866

REMAINING FEE SUMMARY	($/AC)	EST. FEES
BRIDGE	1059	$917,094
CAPITAL DRAINAGE	13241	$11,466,706
SURCHARGE	678	$587,148
REMAINING REIMBURSABLE AND PROPOSED CAPITAL DRAINAGE COST		$13,455,909
NET REMAINING CAPITAL DRAINAGE FEE		-$1,989,203

APPENDIX A

HYDROLOGIC CALCULATIONS

WOLF RANCH MASTER DEVELOPMENT DRAINAGE PLAN
WEIGHTED CN-VALUES
FUTURE DEVELOPMENT CONDITIONS

A-BASINS

SUB-BASIN NUMBER	BASIN AREA (AC)	CN-VALUES CN 1	CN 2	CN3	CN4	AREAS AREA 1	AREA 2	AREA 3	AREA 4	WEIGHTED CN-VALUE
A-1	38.2	61	0	0	0	38.2	0	0	0	61.0
A-3	96.0	73	0	0	0	96	0	0	0	73.0
A-4	55.1	78	73	0	0	36.9	18.2	0	0	76.3
A-5	71.3	78	55	85	0	31.6	29	10.7	0	69.7
A-6	29	78	85	0	0	17.4	11.6	0	0	80.8
A-7	32.0	61	73	0	0	2.7	29.3	0	0	72.0
A-8	33.3	85	88	61	0	7.5	21.6	4.2	0	83.9
A-9	37.8	78	72	0	0	27.4	10.4	0	0	76.3
A-10	5.5	92	61	0	0	3.3	2.2	0	0	79.6
A-11	51.8	61	78	0	0	3.8	48	0	0	76.8
A-12	30.7	78	0	0	0	30.7	0	0	0	78.0

Wolf Ranch Master Development Drainage Plan
Time of Concentration
A-basins

Basin	Slope			Length			Run Coef	Velocity			T_c			T_c	Basin
	O'land	Chan 1	Chan 2	O'land	Chan 1	Chan 2	(5-year)	O'land	Chan 1	Chan 2	O'land	Chan 1	Chan 2		
A-1	9.0 %	6.1 %	0 %	1,000 lf	1,650 lf	0 lf	0.20	8.0 ft/sec	8.0 ft/sec	0.0 ft/sec	1536 sec.	206 sec.	0 sec.	29.0 min.	A-1
A-3	6.0 %	2.1 %	0 %	300 lf	3,200 lf	0 lf	0.45	8.0 ft/sec	5.0 ft/sec	0.0 ft/sec	696 sec.	640 sec.	0 sec.	22.3 min.	A-3
A-4	2.0 %	4.1 %	3 %	300 lf	850 lf	1,650 lf	0.50	2.0 ft/sec	8.0 ft/sec	8.0 ft/sec	926 sec.	106 sec.	206 sec.	20.6 min.	A-4
A-5	2.0 %	3.1 %	1 %	300 lf	2,050 lf	1,120 lf	0.60	2.0 ft/sec	8.0 ft/sec	5.0 ft/sec	771 sec.	256 sec.	224 sec.	20.9 min.	A-5
A-6	2.0 %	1.6 %	0 %	300 lf	1,550 lf	0 lf	0.50	2.0 ft/sec	5.0 ft/sec	5.0 ft/sec	926 sec.	310 sec.	0 sec.	20.6 min.	A-6
A-7	2.0 %	2.0 %	0 %	100 lf	2,000 lf	0 lf	0.50	2.0 ft/sec	4.0 ft/sec	10.0 ft/sec	534 sec.	500 sec.	0 sec.	17.2 min.	A-7
A-8	3.3 %	2.3 %	0 %	300 lf	2,420 lf	0 lf	0.40	5.0 ft/sec	4.0 ft/sec	0.0 ft/sec	914 sec.	605 sec.	0 sec.	25.3 min.	A-8
A-9	2.0 %	2.0 %	0 %	300 lf	2,300 lf	0 lf	0.45	2.0 ft/sec	4.0 ft/sec	10.0 ft/sec	1003 sec.	575 sec.	0 sec.	26.3 min.	A-9
A-10	5.0 %	0.0 %	0 %	550 lf	0 lf	0 lf	0.20	5.0 ft/sec	4.0 ft/sec	10.0 ft/sec	1386 sec.	0 sec.	0 sec.	23.1 min.	A-10
A-11	4.7 %	3.4 %	0 %	300 lf	1,252 lf	0 lf	0.40	5.0 ft/sec	4.0 ft/sec	0.0 ft/sec	813 sec.	313 sec.	0 sec.	18.8 min.	A-11

Equations:

Time of Concentration (Overland) = $1.87(1.1 - C_5)L^{0.5} S^{-0.333}$

C_5 = Runoff coefficient for five-year flow

L = Length of overland flow in feet

S = Slope of flow path in percent

Velocity (Road) = $10(10^{(0.5\log S + 0.3)})$

S = Slope of flow path in percent

Velocity (Channel) = $(1.49/n)R_n^{2/3} S^{1/2}$

Slope (S) = Slope of the channel

n = Manning's number

R_n = Hydraulic Radius (Reynold's Number)

WOLF RANCH MASTER DEVELOPMENT DRAINAGE PLAN
WEIGHTED CN-VALUES
FUTURE DEVELOPMENT CONDITIONS

B-BASINS

SUB-BASIN NUMBER	BASIN AREA (AC)	CN-VALUES CN 1	CN 2	CN3	CN4	AREAS AREA 1	AREA 2	AREA 3	AREA 4	WEIGHTED CN-VALUE
B-1	25.6	92	85	73	0	25.6	0	0	0	92.0

Wolf Ranch Master Development Drainage Plan
Time of Concentration
B-basins

Basin	Slope			Length			Run Coef.	Velocity			T_c			T_c	Basin
	O'land	Chan. 1	Chan. 2	O'land	Chan. 1	Chan. 2	(5-year)	O'land	Chan. 1	Chan. 2	O'land	Chan. 1	Chan. 2		
B-1	2.0 %	2.0 %	0 %	100 lf	1,850 lf	0 lf	0.90	2.0 ft/sec	4.0 ft/sec	0.0 ft/sec	178 sec.	463 sec.	0 sec.	10.7 min.	B-1

Equations:

Time of Concentration (Overland) = $1.87(1.1-C_5)L^{0.5}S^{-0.333}$

C_5 = Runoff coefficient for five-year flow

L = Length of overland flow in feet

S = Slope of flow path in percent

Velocity (Road) = $10(10^{(0.5\log S+0.3)})$

S = Slope of flow path in percent

Velocity (Channel) = $(1.49/n)R_n^{2/3}S^{1/2}$

Slope (S) = Slope of the channel

n = Manning's number

R_n = Hydraulic Radius (Reynold's Number)

WOLF RANCH MASTER DEVELOPMENT DRAINAGE PLAN
WEIGHTED CN-VALUES
FUTURE DEVELOPMENT CONDITIONS

C-BASINS

SUB-BASIN NUMBER	BASIN AREA (AC)	CN-VALUES CN 1	CN 2	CN3	CN4	AREAS AREA 1	AREA 2	AREA 3	AREA 4	WEIGHTED CN-VALUE
C-1	29.4	79	0	0	0	29.4	0	0	0	79.0
C-2	70.4	79	92	61	0	35.0	21	14.4	0	79.2
C-3	35.2	79	0	0	0	35.2	0	0	0	79.0

Wolf Ranch Master Development Drainage Plan
Time of Concentration
C-basins

Basin	Slope			Length			Run Coef.	Velocity			T_c			T_c	Basin
	O'land	Chan. 1	Chan. 2	O'land	Chan. 1	Chan. 2	(5-year)	O'land	Chan. 1	Chan. 2	O'land	Chan. 1	Chan. 2		
C-1	2.0 %	3.0 %	0 %	100 lf	1,950 lf	0 lf	0.60	2.0 ft/sec	4.0 ft/sec	0.0 ft/sec	445 sec.	488 sec.	0 sec.	15.5 min.	C-1
C-2	3.0 %	4.0 %	0 %	100 lf	650 lf	3,450 lf	0.55	2.0 ft/sec	4.0 ft/sec	6.0 ft/sec	428 sec.	163 sec.	0 sec.	9.8 min.	C-2
C-3	2.5 %	2.0 %	0 %	100 lf	2,650 lf	0 lf	0.55	2.0 ft/sec	4.0 ft/sec	0.0 ft/sec	455 sec.	663 sec.	0 sec.	18.6 min.	C-3

Equations:

Time of Concentration (Overland) = $1.87(1.1-C_5)L^{0.5}S^{-0.333}$

C_5 = Runoff coefficient for five-year flow

L = Length of overland flow in feet

S = Slope of flow path in percent

Velocity (Road) = $10(10^{(0.5\log S+0.3)})$

S = Slope of flow path in percent

Velocity (Channel) = $(1.49/n)R_n^{2/3}S^{1/2}$

Slope (S) = Slope of the channel

n = Manning's number

R_n = Hydraulic Radius (Reynold's Number)

WOLF RANCH MASTER DEVELOPMENT DRAINAGE PLAN
WEIGHTED CN-VALUES
FUTURE DEVELOPMENT CONDITIONS

D-BASINS

SUB-BASIN NUMBER	BASIN AREA (AC)	CN-VALUES CN 1	CN 2	CN3	CN4	AREAS AREA 1	AREA 2	AREA 3	AREA 4	WEIGHTED CN-VALUE
D-1	39.4	79	61	0	0	36.5	2.9	0	0	77.7
D-2	23.0	73	0	0	0	23.0	0	0	0	73.0
D-3	15.4	61	0	0	0	15.4	0	0	0	61.0

Wolf Ranch Master Development Drainage Plan
Time of Concentration
D-basins

Basin	Slope O'land	Slope Chan. 1	Slope Chan. 2	Length O'land	Length Chan. 1	Length Chan. 2	Run Coef. (5-year)	Velocity O'land	Velocity Chan. 1	Velocity Chan. 2	T_c O'land	T_c Chan. 1	T_c Chan. 2	T_c	Basin
D-1	2.0 %	2.0 %	0 %	100 lf	2,350 lf	0 lf	0.55	2.0 ft/sec	4.0 ft/sec	0.0 ft/sec	490 sec.	588 sec.	0 sec.	**18.0 min.**	D-1
D-2	2.0 %	3.0 %	0 %	100 lf	1,350 lf	0 lf	0.55	2.0 ft/sec	6.0 ft/sec	0.0 ft/sec	490 sec.	225 sec.	0 sec.	**11.9 min.**	D-2
D-3	2.0 %	2.6 %	0 %	300 lf	2,450 lf	0 lf	0.15	7.0 ft/sec	3.0 ft/sec	0.0 ft/sec	1466 sec.	817 sec.	0 sec.	**38.0 min.**	D-3

Equations:

Time of Concentration (Overland) = $1.87(1.1\text{-}C_5)L^{0.5}S^{-0.333}$

C_5 = Runoff coefficient for five-year flow

L = Length of overland flow in feet

S = Slope of flow path in percent

Velocity (Road) = $10(10^{(0.5\log S+0.3)})$

S = Slope of flow path in percent

Velocity (Channel) = $(1.49/n)R_n^{2/3}S^{1/2}$

Slope (S) = Slope of the channel

n = Manning's number

R_n = Hydraulic Radius (Reynold's Number)

WOLF RANCH MASTER DEVELOPMENT DRAINAGE PLAN
WEIGHTED CN-VALUES
FUTURE DEVELOPMENT CONDITIONS

E-BASINS

SUB-BASIN NUMBER	BASIN AREA (AC)	CN-VALUES CN 1	CN 2	CN3	CN4	AREAS AREA 1	AREA 2	AREA 3	AREA 4	WEIGHTED CN-VALUE
E-1	25.8	79	0	0	0	25.8	0	0	0	79.0
E-2	33.3	73	0	0	0	33.3	0	0	0	73.0
E-3	63.7	61	0	0	0	63.7	0	0	0	61.0
E-4	27.1	73	0	0	0	27.1	0	0	0	73.0
E-5	25.6	79	0	0	0	25.6	0	0	0	79.0
E-6	30.6	79	0	0	0	30.6	0	0	0	79.0

Wolf Ranch Master Development Drainage Plan
Time of Concentration
E-basins

Basin	Slope O'land	Slope Chan. 1	Slope Chan. 2	Length O'land	Length Chan. 1	Length Chan. 2	Run Coef. (5-year)	Velocity O'land	Velocity Chan. 1	Velocity Chan. 2	T_c O'land	T_c Chan. 1	T_c Chan. 2	T_c	Basin
E-1	2.0 %	2.0 %	0 %	100 lf	1,700 lf	0 lf	0.60	2.0 ft/sec	4.0 ft/sec	0.0 ft/sec	445 sec.	425 sec.	0 sec.	14.5 min.	E-1
E-2	3.0 %	3.0 %	0 %	100 lf	2,250 lf	0 lf	0.55	2.0 ft/sec	6.0 ft/sec	0.0 ft/sec	428 sec.	375 sec.	0 sec.	13.4 min.	E-2
E-3	3.0 %	2.0 %	0 %	700 lf	3,150 lf	0 lf	0.25	2.0 ft/sec	5.0 ft/sec	0.0 ft/sec	1750 sec.	630 sec.	0 sec.	39.7 min.	E-3
E-4	2.0 %	2.0 %	0 %	100 lf	2,150 lf	0 lf	0.55	2.0 ft/sec	6.0 ft/sec	0.0 ft/sec	490 sec.	358 sec.	0 sec.	14.1 min.	E-4
E-5	3.0 %	3.0 %	0 %	100 lf	1,700 lf	0 lf	0.55	2.0 ft/sec	6.0 ft/sec	0.0 ft/sec	428 sec.	283 sec.	0 sec.	11.9 min.	E-5
E-6	2.0 %	2.0 %	0 %	100 lf	2,200 lf	0 lf	0.50	2.0 ft/sec	4.0 ft/sec	0.0 ft/sec	534 sec.	550 sec.	0 sec.	18.1 min.	E-6

Equations:

Time of Concentration (Overland) = $1.87(1.1 - C_5)L^{0.5} S^{-0.333}$

C_5 = Runoff coefficient for five-year flow

L = Length of overland flow in feet

S = Slope of flow path in percent

Velocity (Road) = $10(10^{(0.5 \log S + 0.3)})$

S = Slope of flow path in percent

Velocity (Channel) = $(1.49/n)R_n^{2/3} S^{1/2}$

Slope (S) = Slope of the channel

n = Manning's number

R_n = Hydraulic Radius (Reynold's Number)

WOLF RANCH MASTER DEVELOPMENT DRAINAGE PLAN UPDATE
WEIGHTED CN-VALUES
FUTURE DEVELOPMENT CONDITIONS

F-BASINS

SUB-BASIN NUMBER	BASIN AREA (AC)	CN-VALUES CN 1	CN 2	CN3	CN4	AREAS AREA 1	AREA 2	AREA 3	AREA 4	WEIGHTED CN-VALUE
F-1 to F-7										data taken from prior program compilations
F-8	57.8	70	73	0	0	28.9	28.9	0	0	71.5
F-9	27.5	70	0	0	0	27.5	0	0	0	70.0
F-10	11.5	61	75	0	0	6.6	4.9	0	0	67.0
F-11	29.4	61	70	0	0	5.9	23.5	0	0	68.2
F-12	37.2	61	70	0	0	3.1	34.1	0	0	69.3
F-13	9	61	0	0	0	9.0	0	0	0	61.0
F-14	82.6	61	70	73	0	0.0	0	82.6	0	73.0
F-15	13.4	61	70	73	0	2.7	6.7	4	0	69.1
F-16	17.3	70	73	0	0	0.9	16.4	0	0	72.8
F-17	24.9	61	70	73	0	23.1	0	1.2	0	60.1
F-18	63	61	70	85	0	9.5	22.1	31.4	0	76.1

F-19	65.3	61	73	85	0	20.9	22	22.2	0	73.0
F-22	41	61	92	0	0	36.9	4.1	0	0	64.1
F-23	19.8	0	73	0	0	0.0	19.8	0	0	73.0
F-24	57	79	0	0	0	57.0	0	0	0	79.0
F-25	57	61	73	79	0	6.0	29	22	0	74.1
F-27	153.6	61	73	92	0	31.0	77.4	45.2	0	76.2
F-28	24	61	78	79	0	14.0	10	0	0	68.1
F-29	16	61	79	0	0	8.0	8	0	0	70.0
F-30	14	79	73	0	0	11.0	3	0	0	77.7
F-31	44.1	61	0	0	0	44.1	0	0	0	61.0

Wolf Ranch Master Development Drainage Plan
Time of Concentration
F-basins

Basin	Slope O'land	Slope Chan. 1	Slope Chan. 2	Length O'land	Length Chan. 1	Length Chan. 2	Run Coef. (5-year)	Velocity O'land	Velocity Chan. 1	Velocity Chan. 2	T_t O'land	T_t Chan. 1	T_t Chan. 2	T_c	Basin
F-8	6.7 %	4.4 %	0 %	298 lf	2,323 lf	0 lf	0.40	4.0 ft/sec	4.0 ft/sec	0.0 ft/sec	720 sec.	581 sec.	0 sec.	21.7 min.	F-8
F-9	6.3 %	4.0 %	0 %	300 lf	927 lf	0 lf	0.40	4.0 ft/sec	4.0 ft/sec	0.0 ft/sec	737 sec.	232 sec.	0 sec.	16.1 min.	F-9
F-10	6.7 %	5.0 %	0 %	300 lf	600 lf	0 lf	0.40	4.0 ft/sec	4.0 ft/sec	0.0 ft/sec	722 sec.	150 sec.	0 sec.	14.5 min.	F-10
F-11	5.7 %	4.1 %	0 %	300 lf	918 lf	0 lf	0.40	4.0 ft/sec	4.0 ft/sec	0.0 ft/sec	762 sec.	230 sec.	0 sec.	16.5 min.	F-11
F-12	4.0 %	3.3 %	0 %	300 lf	1,290 lf	0 lf	0.40	4.0 ft/sec	4.0 ft/sec	0.0 ft/sec	857 sec.	323 sec.	0 sec.	19.7 min.	F-12
F-13	7.3 %	5.2 %	0 %	300 lf	498 lf	0 lf	0.40	4.0 ft/sec	4.0 ft/sec	0.0 ft/sec	702 sec.	125 sec.	0 sec.	13.8 min.	F-13
F-14	3.7 %	3.1 %	3 %	300 lf	1,081 lf	1,730 lf	0.40	4.0 ft/sec	4.0 ft/sec	8.0 ft/sec	880 sec.	270 sec.	216 sec.	22.8 min.	F-14
F-15	5.8 %	3.7 %	0 %	300 lf	931 lf	0 lf	0.40	4.0 ft/sec	4.0 ft/sec	0.0 ft/sec	758 sec.	233 sec.	0 sec.	16.5 min.	F-15
F-16	2.6 %	2.6 %	0 %	300 lf	1,085 lf	0 lf	0.40	4.0 ft/sec	4.0 ft/sec	0.0 ft/sec	990 sec.	271 sec.	0 sec.	21.0 min.	F-16
F-17	3.7 %	3.4 %	3 %	300 lf	945 lf	990 lf	0.40	5.0 ft/sec	4.0 ft/sec	8.0 ft/sec	880 sec.	236 sec.	124 sec.	20.7 min.	F-17
F-18	3.3 %	3.5 %	0 %	300 lf	1,465 lf	0 lf	0.40	5.0 ft/sec	4.0 ft/sec	0.0 ft/sec	914 sec.	366 sec.	0 sec.	21.3 min.	F-18
F-19	4.5 %	5.9 %	4 %	300 lf	634 lf	1,155 lf	0.40	5.0 ft/sec	4.0 ft/sec	8.0 ft/sec	824 sec.	159 sec.	144 sec.	18.8 min.	F-19
F-22	4.1 %	3.5 %	0 %	300 lf	1,705 lf	0 lf	0.40	5.0 ft/sec	4.0 ft/sec	0.0 ft/sec	850 sec.	426 sec.	0 sec.	21.3 min.	F-22
F-23	4.0 %	4.8 %	2 %	300 lf	414 lf	890 lf	0.40	5.0 ft/sec	4.0 ft/sec	8.0 ft/sec	857 sec.	104 sec.	111 sec.	17.9 min.	F-23
F-24	4.0 %	2.1 %	0 %	300 lf	2,765 lf	0 lf	0.40	5.0 ft/sec	4.0 ft/sec	0.0 ft/sec	857 sec.	691 sec.	0 sec.	25.8 min.	F-24
F-25	2.0 %	2.8 %	0 %	300 lf	2,270 lf	0 lf	0.40	5.0 ft/sec	4.0 ft/sec	0.0 ft/sec	1080 sec.	568 sec.	0 sec.	27.5 min.	F-25
F-27	2.7 %	3.8 %	2 %	300 lf	1,650 lf	4,150 lf	0.40	5.0 ft/sec	4.0 ft/sec	8.0 ft/sec	977 sec.	413 sec.	519 sec.	31.8 min.	F-27
F-28	3.3 %	4.7 %	0 %	300 lf	1,950 lf	0 lf	0.40	5.0 ft/sec	4.0 ft/sec	0.0 ft/sec	914 sec.	488 sec.	0 sec.	23.4 min.	F-28
F-29	2.7 %	4.3 %	0 %	300 lf	655 lf	0 lf	0.40	5.0 ft/sec	4.0 ft/sec	0.0 ft/sec	977 sec.	164 sec.	0.0 ft/sec	19.0 min.	F-29
F-30	3.3 %	4.1 %	0 %	300 lf	680 lf	0 lf	0.40	5.0 ft/sec	4.0 ft/sec	0.0 ft/sec	914 sec.	170 sec.	0.0 ft/sec	18.1 min.	F-30
F-31	3.3 %	5.0 %	3 %	300 lf	1,600 lf	1,110 lf	0.40	5.0 ft/sec	4.0 ft/sec	8.0 ft/sec	914 sec.	400 sec.	139 sec.	24.2 min.	F-31

Equations:

Time of Concentration (Overland) = $1.87(1.1-C_5)L^{0.5}S^{-0.333}$

C_5 = Runoff coefficient for five-year flow

L = Length of overland flow in feet

S = Slope of flow path in percent

Velocity (Road) = $10(10^{(0.5\log S + 0.3)})$

S = Slope of flow path in percent

Velocity (Channel) = $(1.49/n)R_n^{2/3}S^{1/2}$

Slope (S) = Slope of the channel

n = Manning's number

R_n = Hydraulic Radius (Reynold's Number)

WOLF RANCH MASTER DEVELOPMENT DRAINAGE PLAN
WEIGHTED CN-VALUES
FUTURE DEVELOPMENT CONDITIONS

G-BASINS

SUB-BASIN NUMBER	BASIN AREA (AC)	CN-VALUES CN 1	CN 2	CN3	CN4	AREAS AREA 1	AREA 2	AREA 3	AREA 4	WEIGHTED CN-VALUE
G-1										data taken from prior program compilations
G-2	22.4	73	0	0	0	22.4	0	0	0	73.0
G-3	113.3	73	0	0	0	113.3	0	0	0	73.0
G-4	27.6	79	0	0	0	27.6	0	0	0	79.0

Wolf Ranch Master Development Drainage Plan
Time of Concentration
G-basins

Basin	Slope O'land	Slope Chan. 1	Slope Chan. 2	Length O'land	Length Chan. 1	Length Chan. 2	Run Coef. (5-year)	Velocity O'land	Velocity Chan. 1	Velocity Chan. 2	T_t O'land	T_t Chan. 1	T_t Chan. 2	T_c	Basin
G-2	3.5 %	2.9 %	0 %	284 lf	1,796 lf	0 lf	0.40	4.0 ft/sec	4.0 ft/sec	0.0 ft/sec	872 sec.	449 sec.	0 sec.	22.0 min.	G-2
G-3	3.0 %	2.6 %	0 %	263 lf	3,376 lf	0 lf	0.40	4.0 ft/sec	4.0 ft/sec	0.0 ft/sec	883 sec.	844 sec.	0 sec.	28.8 min.	G-3
G-5	2.7 %	4.1 %	0 %	300 lf	1,900 lf	0 lf	0.40	4.0 ft/sec	4.0 ft/sec	0.0 ft/sec	977 sec.	475 sec.	0 sec.	24.2 min.	G-5

Equations:

Time of Concentration (Overland) = $1.87(1.1-C_5)L^{0.5}S^{-0.333}$

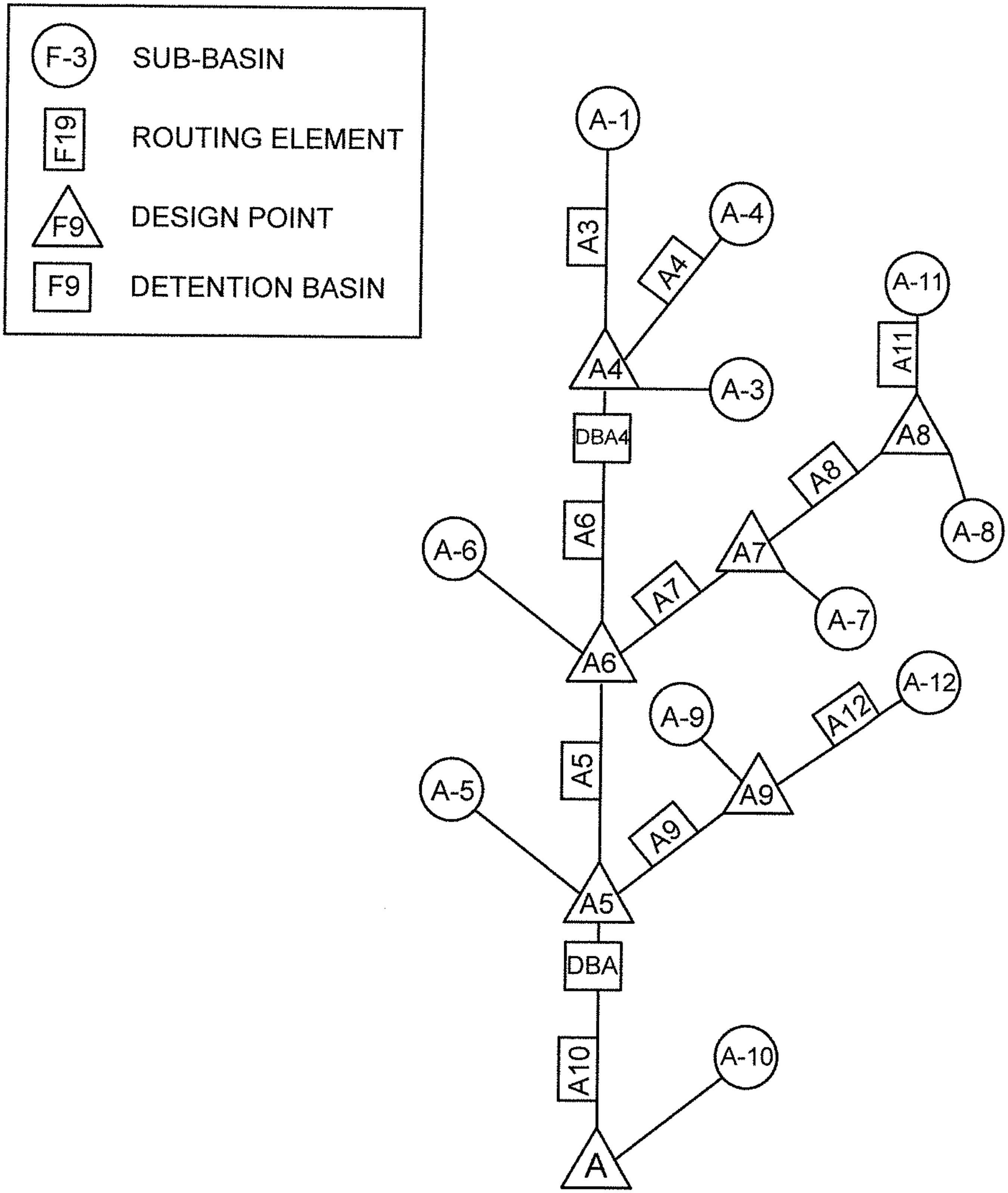
- C_5 = Runoff coefficient for five-year flow
- L = Length of overland flow in feet
- S = Slope of flow path in percent

Velocity (Road) = $10(10^{(0.5\log S + 0.3)})$

- S = Slope of flow path in percent

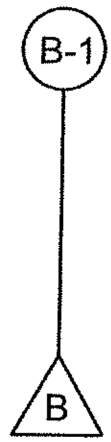
Velocity (Channel) = $(1.49/n)R_n^{2/3}S^{1/2}$

- Slope (S) = Slope of the channel
- n = Manning's number
- R_n = Hydraulic Radius (Reynold's Number)

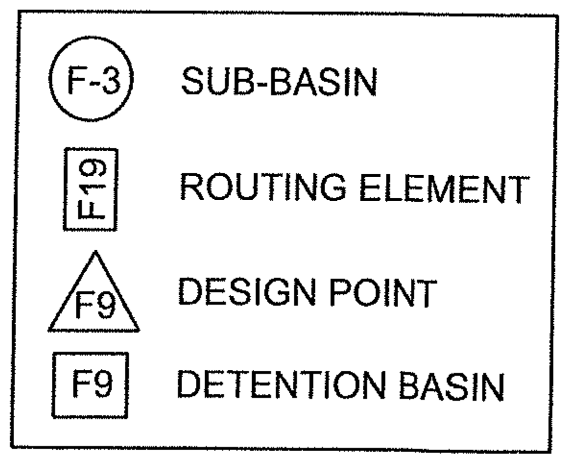


HEC1 FLOW SCHEMATIC
DEVELOPED CONDITION 'A' BASINS

Kiowa Engineering Corporation 1604 South 21st Street Colorado Springs, Colorado 80904-4208 (719) 630-7342	WOLF RANCH HYDROLOGIC MODEL SCHEMATIC COLORADO SPRINGS, COLORADO FIGURE A	PROJECT NO.: 17049 DATE: 06/08/18 DESIGN: RNW REVISIONS:



HEC1 FLOW SCHEMATIC
DEVELOPED CONDITION 'B' BASINS



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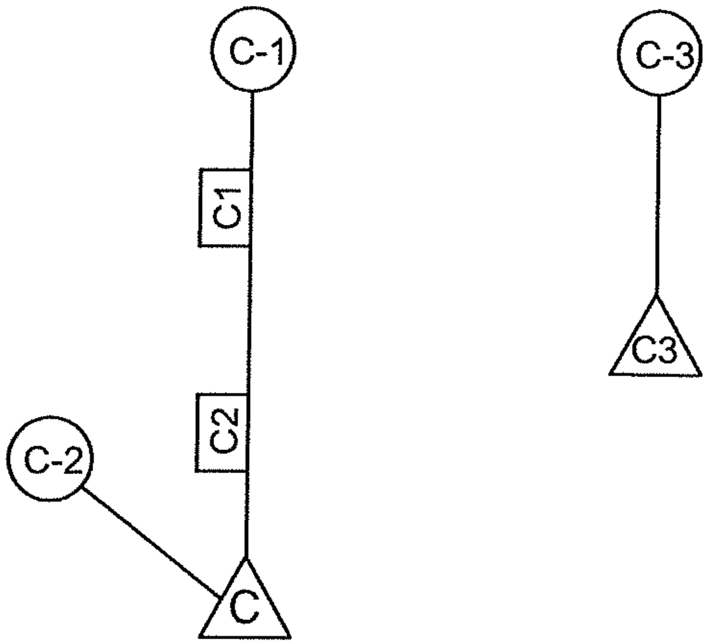
Colorado Springs, Colorado
80904-4208
(719) 630-7342

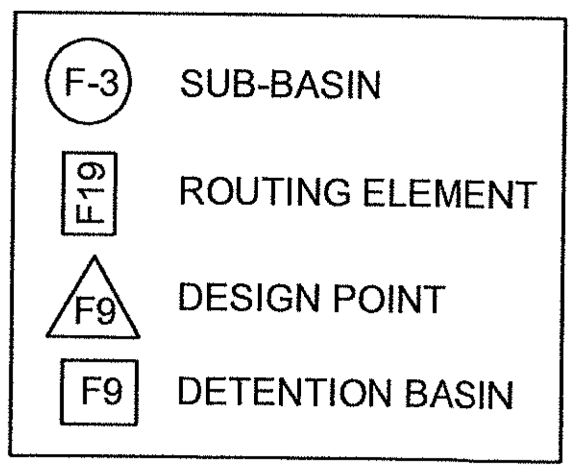
WOLF RANCH
HYDROLOGIC MODEL SCHEMATIC
COLORADO SPRINGS, COLORADO

FIGURE B

PROJECT NO.: 03094
DATE: 01/29/04
DESIGN: RNW
REVISIONS:



HEC1 FLOW SCHEMATIC
DEVELOPED CONDITION 'C' BASINS



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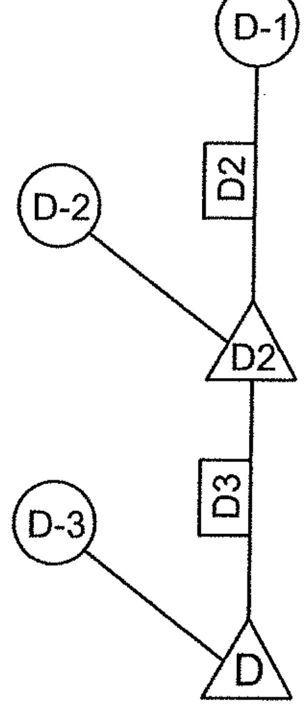
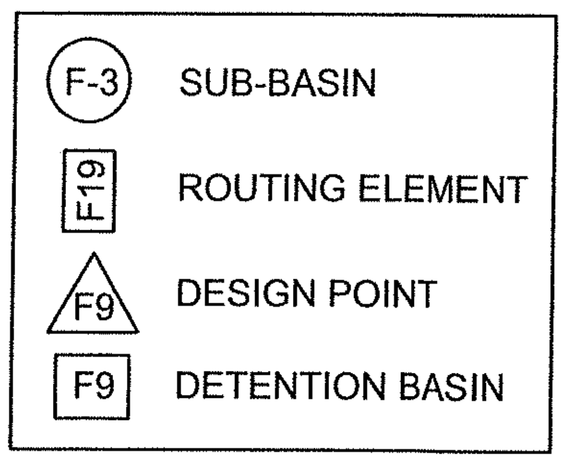
WOLF RANCH
HYDROLOGIC MODEL SCHEMATIC
COLORADO SPRINGS, COLORADO

FIGURE C

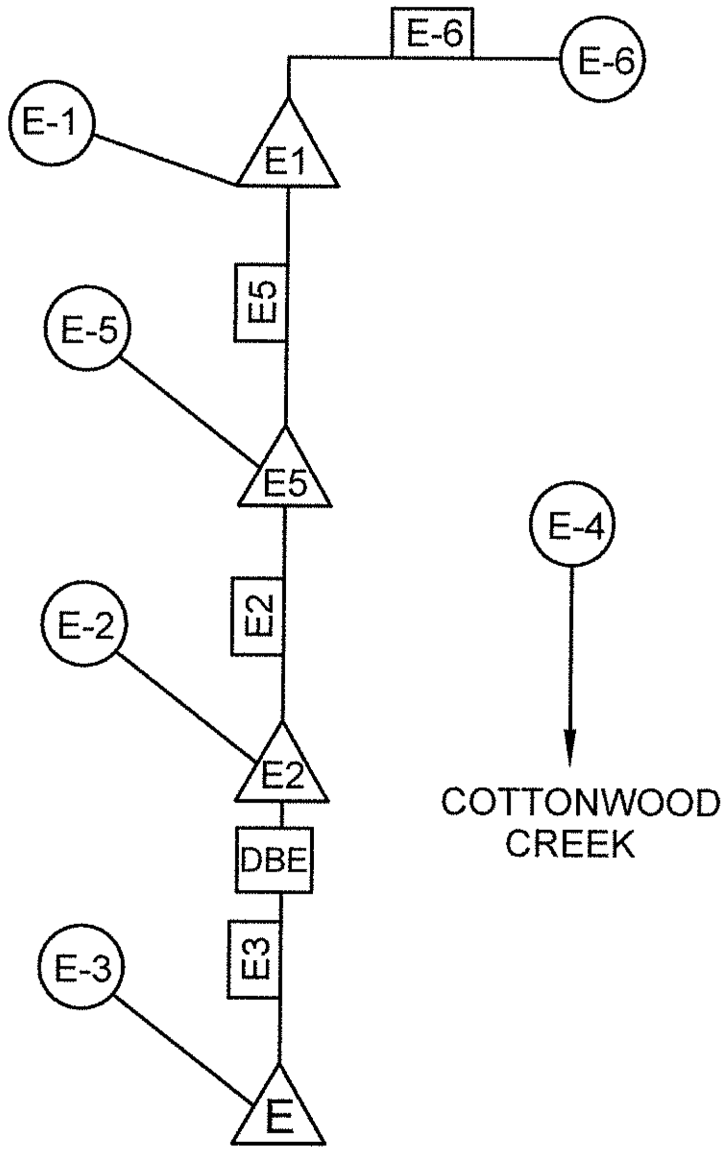
PROJECT NO.: 03094
DATE: 02/07/06
DESIGN: RNW
REVISIONS:



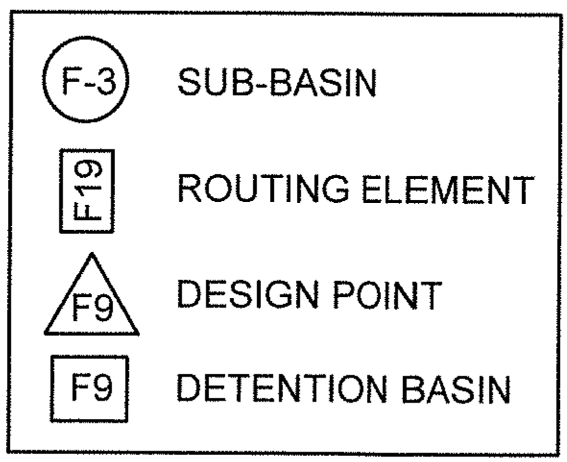
HEC1 FLOW SCHEMATIC
DEVELOPED CONDITION 'D' BASINS



Kiowa Engineering Corporation 1604 South 21st Street Colorado Springs, Colorado 80904-4208 (719) 630-7342	WOLF RANCH HYDROLOGIC MODEL SCHEMATIC COLORADO SPRINGS, COLORADO FIGURE D	PROJECT NO.: 03094 DATE: 01/29/04 DESIGN: RNW REVISIONS:



HEC1 FLOW SCHEMATIC
DEVELOPED CONDITION 'E' BASINS



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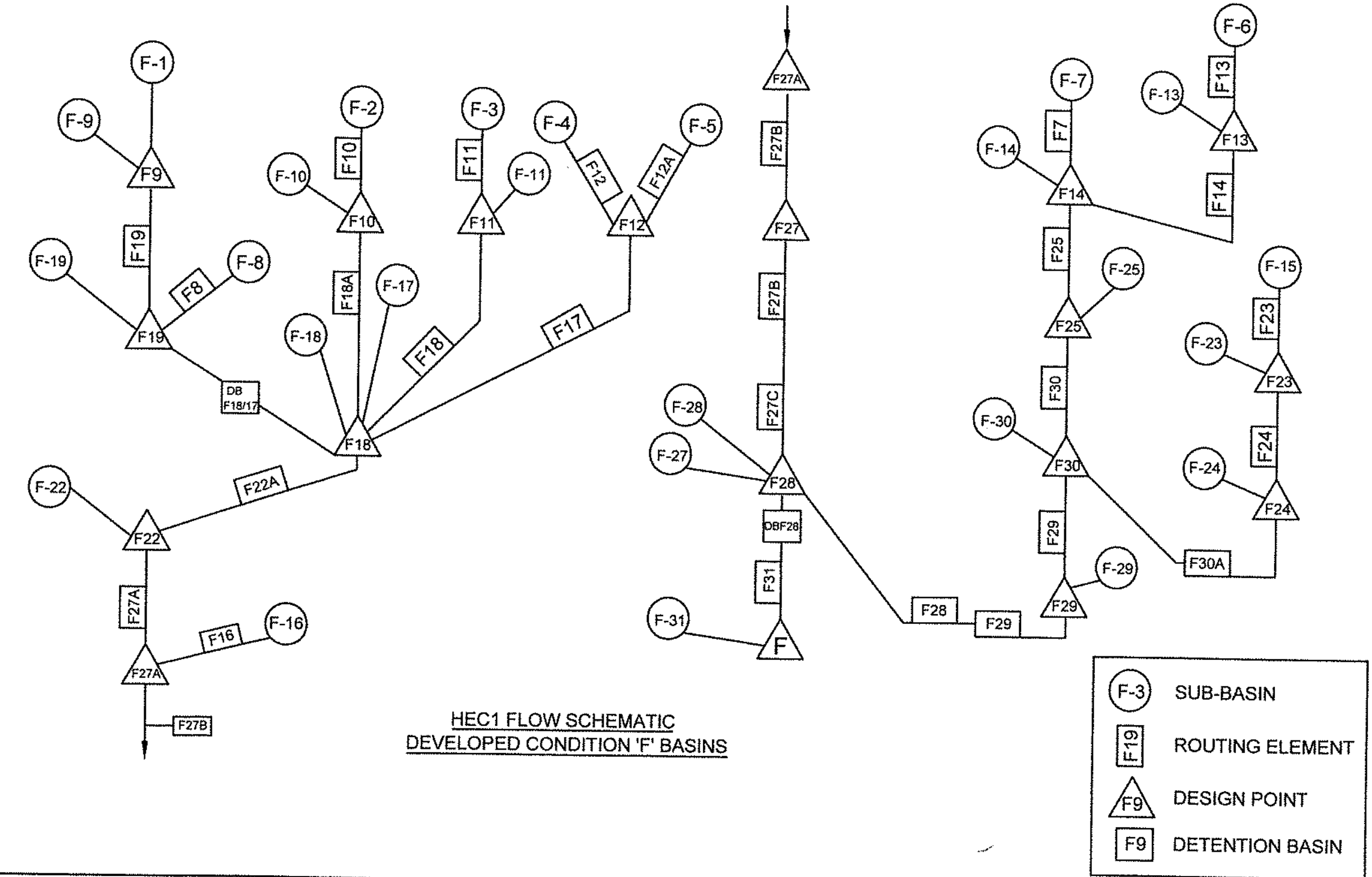
WOLF RANCH
HYDROLOGIC MODEL SCHEMATIC
COLORADO SPRINGS, COLORADO

FIGURE E

PROJECT NO.: 17049
DATE: 06/11/18
DESIGN: RNW
REVISIONS:



HEC1 FLOW SCHEMATIC
DEVELOPED CONDITION 'F' BASINS

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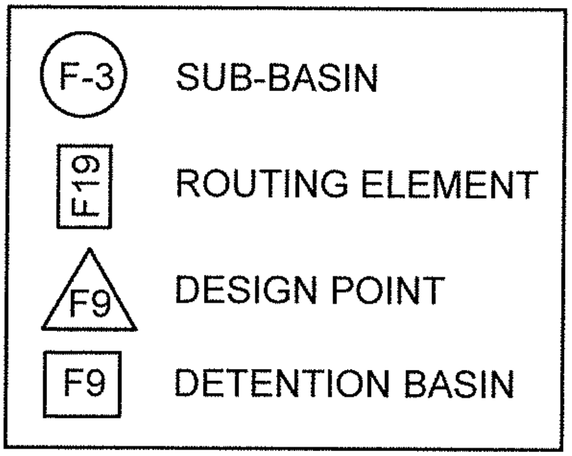
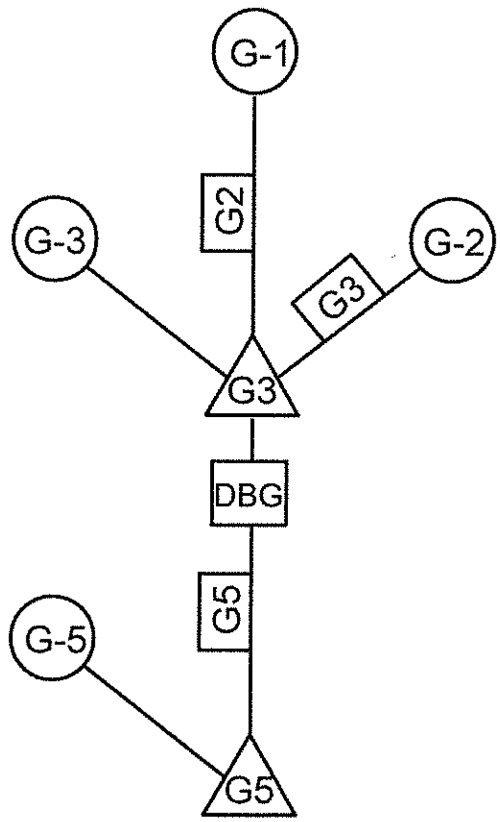
WOLF RANCH
HYDROLOGIC MODEL SCHEMATIC
FIGURE F
COLORADO SPRINGS, COLORADO

Project No.: 17049
Scale:
Date: 08/11/18
Design:
Drawn: JLK
Check:
Revisions:





HEC1 FLOW SCHEMATIC
DEVELOPED CONDITION 'G' BASINS

Kiowa Engineering Corporation 1604 South 21st Street Colorado Springs, Colorado 80904-4208 (719) 630-7342	WOLF RANCH HYDROLOGIC MODEL SCHEMATIC COLORADO SPRINGS, COLORADO FIGURE G	PROJECT NO.: 17049 DATE: 06/11/18 DESIGN: RNW REVISIONS:

*APPLIED FOR "F"- Basins

Table 6-4. NRCS 24-Hour Type II* Design Storm Distribution, <10 mi²
(Fraction of 24-Hour Rainfall Depth)

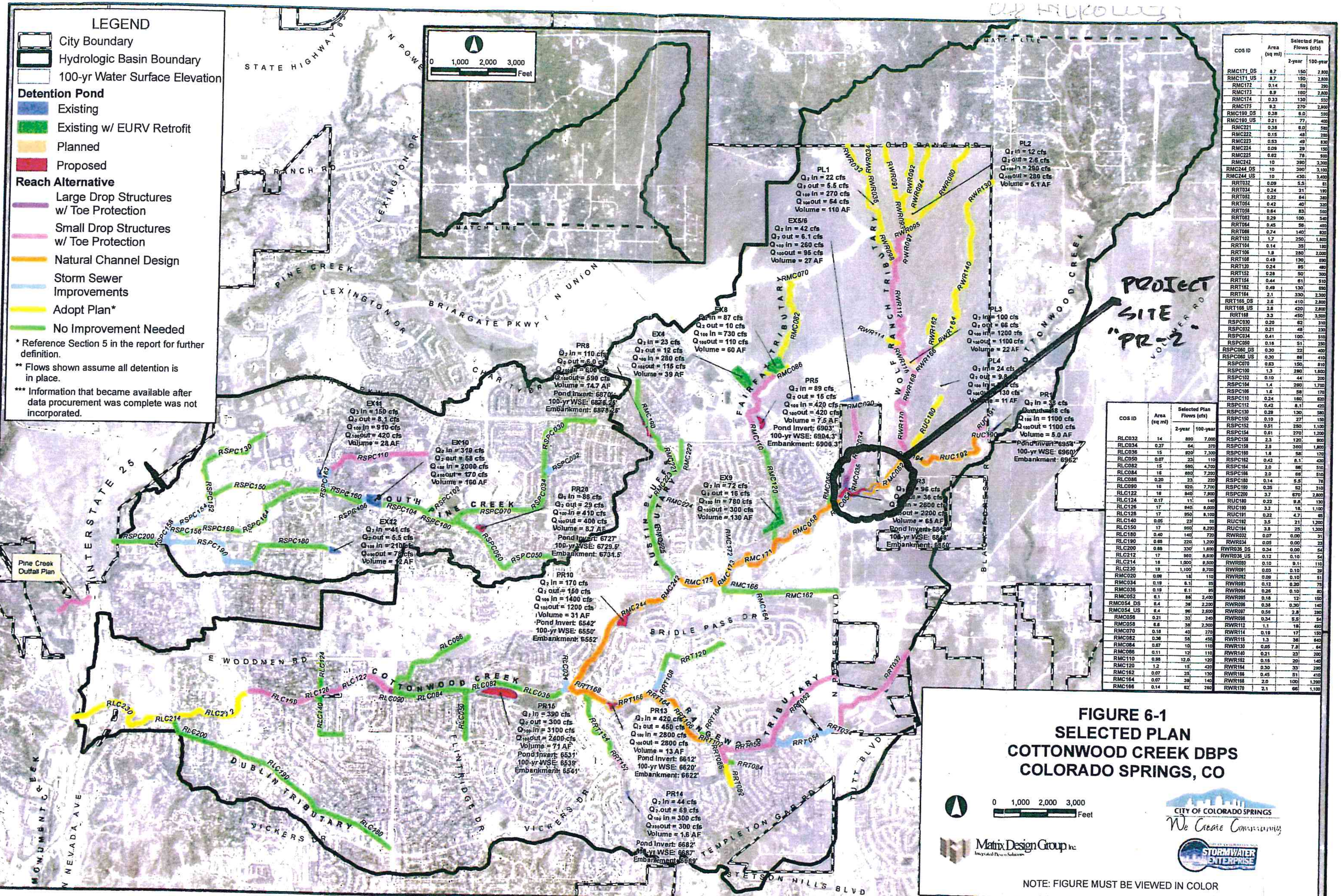
Hour	Minutes			
	0	15	30	45
0	0.000	0.0020	0.0050	0.0080
1	0.0110	0.0140	0.0170	0.0200
2	0.0230	0.0260	0.0290	0.0320
3	0.0350	0.0380	0.0410	0.0440
4	0.0480	0.0520	0.0560	0.0600
5	0.0604	0.0680	0.0720	0.0760
6	0.0800	0.0850	0.0900	0.0950
7	0.1000	0.1050	0.1100	0.1150
8	0.1200	0.1260	0.1330	0.1400
9	0.1470	0.1550	0.1630	0.1720
10	0.1810	0.1910	0.2030	0.2180
11	0.2360	0.2570	0.2830	0.3870
12	0.6630	0.7070	0.7350	0.7580
13	0.7760	0.7910	0.8040	0.8150
14	0.8250	0.8340	0.8420	0.8490
15	0.8560	0.8630	0.8690	0.8750
16	0.8810	0.8870	0.8930	0.8980
17	0.9030	0.9080	0.9130	0.9180
18	0.9220	0.9260	0.9300	0.9340
19	0.9380	0.9420	0.9460	0.9500
20	0.9530	0.9560	0.9590	0.9620
21	0.9650	0.9680	0.9710	0.9740
22	0.9770	0.9800	0.9830	0.9860
23	0.9890	0.9920	0.9950	0.9980

2.2.1 Depth-Area Reduction Factors (DARFs)

Depth Area Reduction Factors (DARFs) are used to adjust point rainfall depths to average depths as the size of drainage basins increase. As a part of the 2011 rainfall study, Carlton analyzed radar data to develop DARF curves applicable to the Fountain Creek watershed, El Paso County and eastern Colorado. However, these relationships were determined for short-duration thunderstorms and are not applicable to longer-duration frontal storms. Therefore, the DARFs provided in the NOAA Atlas will continue to be applied for the frontal-type storms.

- **Thunderstorm DARFs:** The Carlton study provided DARF curves for various storm return periods for short-duration thunderstorm events; however, the difference between the sets of curves was determined to be insignificant. As described in the technical memorandum *Stormwater Management Assessment and Standards Development Project, Proposed Rainfall and Standard Design Storms* (City of Colorado Springs 2012), the 5-year set of DARF curves was selected for the development of thunderstorm type design storms. These DARF curves for short-duration events are shown in Figure 6-21 at the end of this chapter.

  As described in the memorandum documenting the development of design storms, the HEC-HMS program provides guidance on the application of DARFs to define adjusted design storms as the



COS ID	Area (sq mi)	Selected Plan Flows (cfs)	
		2-year	100-year
RLC032	14	890	7,000
RLC034	0.27	64	370
RLC036	15	920	7,300
RLC050	0.07	23	110
RLC082	15	580	4,700
RLC084	16	880	7,200
RLC086	0.20	23	220
RLC090	16	920	7,700
RLC122	16	940	7,900
RLC124	0.17	11	140
RLC126	17	940	8,000
RLC128	17	950	8,100
RLC140	0.05	23	96
RLC150	17	960	8,200
RLC180	0.40	140	720
RLC190	0.68	220	1,200
RLC200	0.88	330	1,600
RLC212	17	960	8,600
RLC214	18	1,000	9,500
RLC230	19	1,100	9,700
RMC020	0.09	18	110
RMC034	0.19	6.1	95
RMC036	0.19	6.1	95
RMC052	6.1	88	2,400
RMC054_DS	6.4	38	2,200
RMC054_US	6.4	96	2,600
RMC056	0.21	33	240
RMC058	6.6	38	2,300
RMC070	0.18	40	270
RMC082	0.36	58	450
RMC084	0.67	10	110
RMC086	0.11	12	110
RMC110	0.98	12.0	120
RMC120	1.2	15	420
RMC162	0.07	25	130
RMC164	0.07	38	140
RMC166	0.14	62	260

COS ID	Area (sq mi)	Selected Plan Flows (cfs)	
		2-year	100-year
RMC171_DS	8.7	150	2,800
RMC171_US	8.7	150	2,800
RMC172	0.14	59	290
RMC173	8.9	160	2,800
RMC174	0.33	130	550
RMC175	9.2	270	2,900
RMC190_DS	0.38	6.0	590
RMC190_US	0.21	77	400
RMC221	0.38	6.0	580
RMC222	0.15	48	280
RMC223	0.53	49	830
RMC224	0.09	29	150
RMC225	0.62	78	980
RMC242	10	390	3,300
RMC244_DS	10	390	3,100
RMC244_US	10	430	3,400
RRT032	0.09	5.5	61
RRT034	0.24	21	190
RRT052	0.22	64	380
RRT054	0.42	40	320
RRT056	0.64	83	560
RRT082	0.29	100	540
RRT084	0.45	56	480
RRT086	0.74	140	820
RRT102	1.7	250	1,800
RRT104	0.14	35	190
RRT106	1.9	280	2,000
RRT108	0.49	130	690
RRT120	0.24	85	480
RRT152	0.28	50	300
RRT154	0.44	61	510
RRT162	0.49	130	690
RRT164	2.1	330	2,300
RRT166_DS	2.6	410	2,800
RRT166_US	2.6	420	2,800
RRT168	3.3	450	3,500
RSPC030	0.20	62	310
RSPC032	0.21	48	230
RSPC034	0.41	100	510
RSPC050	0.18	51	250
RSPC060_DS	0.30	22	400
RSPC060_US	0.30	86	410
RSPC070	0.63	150	810
RSPC100	1.3	260	1,600
RSPC102	0.10	44	200
RSPC104	1.4	290	1,700
RSPC106	1.6	58	170
RSPC110	0.24	160	620
RSPC112	0.42	8.1	420
RSPC130	0.29	130	580
RSPC150	0.10	27	150
RSPC152	0.51	250	1,100
RSPC154	0.61	270	1,200
RSPC156	2.3	120	900
RSPC158	2.9	360	1,800
RSPC160	1.6	58	170
RSPC162	0.42	8.1	420
RSPC164	2.0	66	510
RSPC166	2.0	66	510
RSPC180	0.14	5.5	78
RSPC190	0.35	52	310
RSPC200	3.7	670	2,800
RUC180	0.22	9.8	130
RUC190	3.2	18	1,100
RUC191	0.22	4.7	65
RUC192	3.5	21	1,200
RUC194	3.8	25	1,300
RWR032	0.07	0.00	31
RWR034	0.05	0.00	23
RWR036_DS	0.34	0.00	54
RWR036_US	0.12	0.10	54
RWR080	0.10	9.1	110
RWR091	0.03	0.10	29
RWR092	0.09	0.10	51
RWR093	0.12	0.20	75
RWR094	0.26	0.10	80
RWR095	0.16	12	150
RWR096	0.38	0.30	140
RWR097	0.56	2.8	280
RWR098	0.34	5.5	54
RWR112	1.1	18	490
RWR114	0.19	17	150
RWR116	1.3	38	640
RWR130	0.05	7.8	64
RWR140	0.21	23	200
RWR162	0.15	20	140
RWR164	0.30	33	290
RWR166	0.45	51	410
RWR168	2.0	100	1,200
RWR170	2.1	66	1,100

FIGURE 6-1
SELECTED PLAN
COTTONWOOD CREEK DBPS
COLORADO SPRINGS, CO

NOTE: FIGURE MUST BE VIEWED IN COLOR

HEC-1 INPUT & OUTPUT

EXISTING DEVELOPMENT CONDITIONS

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1***************************************                     ***************************************
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 *              JUN   1998              *                    *   HYDROLOGIC ENGINEERING CENTER     *
 *            VERSION 4.1               *                    *        609 SECOND STREET            *
 *                                     *                     *     DAVIS, CALIFORNIA 95616         *
 * RUN DATE   12MAR13  TIME  13:00:38  *                     *         (916) 756-1104              *
 *                                     *                     *                                     *
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                         X     X  X        X               X
                         XXXXXXX  XXXX     X       XXXXX   X
                         X     X  X        X               X
                         X     X  X        X     X         X
                         X     X  XXXXXXX   XXXXX         XXX


       THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

       THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
       THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
       NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
       DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
       KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                     HEC-1 INPUT                                              PAGE  1

      LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

        1           ID          Wolf Ranch, Master Developed Drainage Plan Update pn 12055
        2           ID           A Basins, existing development condition ABAS-E.DAT
        3           ID            5-year and 100 Year, 24 hr Type IIA  Storm
                    *DIAGRAM
        4           IT       5       0       0     300
        5           IO       5       0
        6           JR    PREC     .56     1.0

        7           KK     A-1
        8           KM         RUNOFF FROM SUB-BASIN A-1
        9           BA   .1819
       10           IN      15
```

A-Basins Existing

```
11    PB     4.4
12    PC  0.0000  0.0005  0.0015  0.0030  0.0045  0.0060  0.0080  0.0100  0.0120  0.0143
13    PC  0.0165  0.0188  0.0210  0.0233  0.0255  0.0278  0.0320  0.0390  0.0460  0.0530
14    PC  0.0600  0.0750  0.1000  0.4000  0.7000  0.7250  0.7500  0.7650  0.7800  0.7900
15    PC  0.8000  0.8100  0.8200  0.8250  0.8300  0.8350  0.8400  0.8450  0.8500  0.8550
16    PC  0.8600  0.8638  0.8675  0.8713  0.8750  0.8788  0.8825  0.8863  0.8900  0.8938
17    PC  0.8975  0.9013  0.9050  0.9083  0.9115  0.9148  0.9180  0.9210  0.9240  0.9270
18    PC  0.9300  0.9325  0.9350  0.9375  0.9400  0.9425  0.9450  0.9475  0.9500  0.9525
19    PC  0.9550  0.9575  0.9600  0.9625  0.9650  0.9675  0.9700  0.9725  0.9750  0.9775
20    PC  0.9800  0.9813  0.9825  0.9838  0.9850  0.9863  0.9875  0.9888  0.9900  0.9913
21    PC  0.9925  0.9938  0.9950  0.9963  0.9975  0.9988  1.0000
22    LS       0      61
23    UD     .36

24    KK              A-2
25    KM         RUNOFF FROM SUB-BASIN A-2
26    BA   .1098
27    LS       0      61
28    UD     .29

29    KK      1A
30    KM         DESIGN POINT 1 COMBINE A-1 AND A-2
31    HC       2

32    KK    DBA1
33    KM         ROUTE DP1A THROUGH EXISTING STOCK POND DBA1
34    RS       1    ELEV    7040
35    SA     .16     .34     .56     .77
36    SE    7040    7041    7042    7043
37    SS    7041      60     .49     1.5
38    ST    7041      60     .49     1.5
39    SW       0      10      70      90
40    SE    7043    7041    7041    4043

41    KK      A3
42    KM  ROUTE FLOW FROM DBA1 TO DP A
43    RD    3050     .03    0.04            TRAP       6       3
```


```
44    KK     A-3
45    KM  RUNOFF FROM SUB-BASIN A-3
46    BA   .1318
47    LS       0      61
48    UD    0.28

49    KK     DPA
50    KM  DESIGN POINT A COMBINE RUNOFF FROM SUB-BASIN A-3 AND A3
```

```
            51            HC        2
            52            ZZ
1
                SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE     (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.     (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    7        A-1
              .
              .
   24         .
              .           .
              .           .
   29        1A............
              V
              V
   32       DBA1
              V
              V
   41        A3
              .
              .
   44         .          A-3
              .           .
              .           .
   49        DPA............

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************
 *                                       *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
 *              JUN   1998               *
 *           VERSION 4.1                 *
 *                                       *
 *  RUN DATE   12MAR13  TIME  13:00:38   *
 *                                       *
 *****************************************

 *****************************************
 *                                       *
 *   U.S. ARMY CORPS OF ENGINEERS        *
 *   HYDROLOGIC ENGINEERING CENTER       *
 *        609 SECOND STREET              *
 *      DAVIS, CALIFORNIA 95616          *
 *          (916) 756-1104               *
 *                                       *
 *****************************************


                Wolf Ranch, Master Developed Drainage Plan Update pn 12055
                 A Basins, existing development condition ABAS-E.DAT
                  5-year and 100 Year, 24 hr Type IIA  Storm

   5 IO          OUTPUT CONTROL VARIABLES
                       IPRNT           5  PRINT CONTROL
```

```
                   IPLOT           0  PLOT CONTROL
                   QSCAL           0.  HYDROGRAPH PLOT SCALE

    IT         HYDROGRAPH TIME DATA
                    NMIN           5  MINUTES IN COMPUTATION INTERVAL
                   IDATE      1    0  STARTING DATE
                   ITIME        0000  STARTING TIME
                      NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                  NDDATE      2    0  ENDING DATE
                  NDTIME        0055  ENDING TIME
                  ICENT           19  CENTURY MARK

              COMPUTATION INTERVAL     .08 HOURS
                   TOTAL TIME BASE   24.92 HOURS

      ENGLISH UNITS
           DRAINAGE AREA          SQUARE MILES
           PRECIPITATION DEPTH    INCHES
           LENGTH, ELEVATION      FEET
           FLOW                   CUBIC FEET PER SECOND
           STORAGE VOLUME         ACRE-FEET
           SURFACE AREA           ACRES
           TEMPERATURE            DEGREES FAHRENHEIT

    JP         MULTI-PLAN OPTION
                   NPLAN           1  NUMBER OF PLANS

    JR         MULTI-RATIO OPTION
                 RATIOS OF PRECIPITATION
                 .56      1.00
1
```

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .56	RATIO 2 1.00
HYDROGRAPH AT						
+	A-1	.18	1	FLOW	7.	85.
				TIME	6.33	6.25
HYDROGRAPH AT						
+		.11	1	FLOW	5.	59.
				TIME	6.25	6.17
2 COMBINED AT						

```
+                  1A       .29    1   FLOW        12.     142.
                                       TIME        6.33    6.25

 ROUTED TO
+                DBA1       .29    1   FLOW         8.     116.
                                       TIME        6.75    6.33

                                   ** PEAK STAGES IN FEET **
                                   1   STAGE    7041.41 7043.50
                                       TIME        6.75    6.33

 ROUTED TO
+                  A3       .29    1   FLOW         8.     116.
                                       TIME        6.92    6.50

 HYDROGRAPH AT
+                 A-3       .13    1   FLOW         6.      72.
                                       TIME        6.25    6.17

  2 COMBINED AT
+                 DPA       .42    1   FLOW        11.     157.
                                       TIME        6.75    6.42

1
                       SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION     DBA1
                     (PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED  DURING BREACH FORMATION)

     PLAN  1 ...............
                                     INITIAL VALUE      SPILLWAY CREST      TOP OF DAM
                        ELEVATION       7040.00             7041.00            7041.00
                        STORAGE              0.                  0.                 0.
                        OUTFLOW              0.                  0.                 0.

               RATIO    MAXIMUM      MAXIMUM    MAXIMUM    MAXIMUM    DURATION     TIME OF     TIME OF
                 OF     RESERVOIR    DEPTH      STORAGE    OUTFLOW    OVER TOP   MAX OUTFLOW   FAILURE
                PMF     W.S.ELEV    OVER DAM     AC-FT       CFS        HOURS       HOURS       HOURS

                .56     7041.41        .41         0.          8.      18.58        6.75         .00
               1.00     7043.50       2.50         2.        116.      19.00        6.33         .00

*** NORMAL END OF HEC-1 ***
```

```
1***************************************
 *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1) *
 *              JUN   1998             *
 *            VERSION 4.1              *
 *                                     *
 *  RUN DATE   16JAN04  TIME  15:41:35 *
 *                                     *
 ***************************************
```

```
***************************************
*                                     *
*    U.S. ARMY CORPS OF ENGINEERS     *
*    HYDROLOGIC ENGINEERING CENTER    *
*         609 SECOND STREET           *
*       DAVIS, CALIFORNIA 95616       *
*           (916) 756-1104            *
*                                     *
***************************************
```

```
X     X  XXXXXXX   XXXXX           X
X     X  X        X     X         XX
X     X  X        X                X
XXXXXXX  XXXX     X        XXXXX   X
X     X  X        X                X
X     X  X        X     X          X
X     X  XXXXXXX   XXXXX          XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

```
1
                                        HEC-1 INPUT                                   PAGE  1

 LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1          ID              Wolf Ranch Master Development Drainage Plan
   2          ID                   B basins existing development condition PN 03094
   3          ID              5-year and 100 Year, 24 hr Type IIA  Storm  FN bbas-e.dat
              *DIAGRAM
   4          IT       5       0       0     300
   5          IO       4       0
   6          JR    PREC     .56     1.0

   7          KK     B-1
   8          KM          RUNOFF FOR SUB-BASIN B1
   9          BA   .1505
  10          IN      15
```

B Basins Existing

```
          11          PB     4.4
          12          PC  0.0000  0.0005  0.0015  0.0030  0.0045  0.0060  0.0080  0.0100  0.0120  0.0143
          13          PC  0.0165  0.0188  0.0210  0.0233  0.0255  0.0278  0.0320  0.0390  0.0460  0.0530
          14          PC  0.0600  0.0750  0.1000  0.4000  0.7000  0.7250  0.7500  0.7650  0.7800  0.7900
          15          PC  0.8000  0.8100  0.8200  0.8250  0.8300  0.8350  0.8400  0.8450  0.8500  0.8550
          16          PC  0.8600  0.8638  0.8675  0.8713  0.8750  0.8788  0.8825  0.8863  0.8900  0.8938
          17          PC  0.8975  0.9013  0.9050  0.9083  0.9115  0.9148  0.9180  0.9210  0.9240  0.9270
          18          PC  0.9300  0.9325  0.9350  0.9375  0.9400  0.9425  0.9450  0.9475  0.9500  0.9525
          19          PC  0.9550  0.9575  0.9600  0.9625  0.9650  0.9675  0.9700  0.9725  0.9750  0.9775
          20          PC  0.9800  0.9813  0.9825  0.9838  0.9850  0.9863  0.9875  0.9888  0.9900  0.9913
          21          PC  0.9925  0.9938  0.9950  0.9963  0.9975  0.9988  1.0000
          22          LS       0      61
          23          UD    0.50
          24          ZZ
1
                SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    7          B-1

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1****************************************                                             ***************************************
 *                                       *                                             *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                             *    U.S. ARMY CORPS OF ENGINEERS     *
 *              JUN   1998               *                                             *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1                 *                                             *          609 SECOND STREET          *
 *                                       *                                             *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   16JAN04  TIME  15:41:35   *                                             *           (916) 756-1104            *
 *                                       *                                             *                                     *
 ****************************************                                             ***************************************


                                   Wolf Ranch Master Development Drainage Plan
                                   B basins existing development condition PN 03094
                                   5-year and 100 Year, 24 hr Type IIA  Storm  FN bbas-e.dat

   5 IO          OUTPUT CONTROL VARIABLES
                       IPRNT          4  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE

     IT          HYDROGRAPH TIME DATA
                       NMIN           5  MINUTES IN COMPUTATION INTERVAL
                       IDATE      1   0  STARTING DATE
```

```
                  ITIME         0000  STARTING TIME
                     NQ          300  NUMBER OF HYDROGRAPH ORDINATES
                 NDDATE      2     0  ENDING DATE
                 NDTIME         0055  ENDING TIME
                 ICENT            19  CENTURY MARK

              COMPUTATION INTERVAL      .08 HOURS
                   TOTAL TIME BASE    24.92 HOURS

      ENGLISH UNITS
           DRAINAGE AREA          SQUARE MILES
           PRECIPITATION DEPTH    INCHES
           LENGTH, ELEVATION      FEET
           FLOW                   CUBIC FEET PER SECOND
           STORAGE VOLUME         ACRE-FEET
           SURFACE AREA           ACRES
           TEMPERATURE            DEGREES FAHRENHEIT

 JP         MULTI-PLAN OPTION
                  NPLAN            1  NUMBER OF PLANS

 JR         MULTI-RATIO OPTION
                RATIOS OF PRECIPITATION
                .56      1.00


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

        **************
        *            *
   7 KK *       B-1  *
        *            *
        **************
                         RUNOFF FOR SUB-BASIN B1

  10 IN     TIME DATA FOR INPUT TIME SERIES
                  JXMIN           15  TIME INTERVAL IN MINUTES
                 JXDATE      1     0  STARTING DATE
                 JXTIME            0  STARTING TIME

          SUBBASIN RUNOFF DATA

   9 BA     SUBBASIN CHARACTERISTICS
                  TAREA          .15  SUBBASIN AREA

            PRECIPITATION DATA

  11 PB           STORM         4.40  BASIN TOTAL PRECIPITATION
```

```
12 PI          INCREMENTAL PRECIPITATION PATTERN
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .01     .01     .01     .01     .01     .10     .10     .10     .10
                  .10     .10     .01     .01     .01     .01     .01     .01     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00

22 LS         SCS LOSS RATE
                    STRTL         1.28  INITIAL ABSTRACTION
                   CRVNBR        61.00  CURVE NUMBER
                    RTIMP          .00  PERCENT IMPERVIOUS AREA

23 UD         SCS DIMENSIONLESS UNITGRAPH
                     TLAG          .50  LAG

                                         ***

                                   UNIT HYDROGRAPH
                                32 END-OF-PERIOD ORDINATES
              9.      27.      55.      92.     120.     133.     133.     122.     106.      85.
             63.      49.      38.      30.      23.      18.      14.      11.       9.       7.
              5.       4.       3.       2.       2.       1.       1.       1.       1.       1.
              0.       0.
1
```

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .56	RATIO 2 1.00
HYDROGRAPH AT						
+	B-1	.15	1	FLOW	5.	55.
				TIME	6.58	6.42

*** NORMAL END OF HEC-1 ***

```
1*****************************************                    ***************************************
 *                                       *                    *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                    *   U.S. ARMY CORPS OF ENGINEERS      *
 *             JUN   1998                *                    *   HYDROLOGIC ENGINEERING CENTER     *
 *             VERSION 4.1               *                    *         609 SECOND STREET           *
 *                                       *                    *      DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   16JAN04  TIME  15:41:52   *                    *          (916) 756-1104             *
 *                                       *                    *                                     *
 *****************************************                    ***************************************


              X     X  XXXXXXX   XXXXX          X
              X     X  X        X     X        XX
              X     X  X        X               X
              XXXXXXX  XXXX     X       XXXXX   X
              X     X  X        X               X
              X     X  X        X     X         X
              X     X  XXXXXXX   XXXXX         XXX


     THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

     THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
     THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
     NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
     DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
     KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                          HEC-1 INPUT                                          PAGE  1

         LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

           1         ID             Wolf Ranch Master Development Drainage Plan
           2         ID                  C Basins existing development condition PN 03094
           3         ID             5-yaer and 100 Year, 24 hr Type IIA  Storm FN cbas-e.dat
                     *DIAGRAM
           4         IT       5       0       0     300
           5         IO       4       0
           6         JR    PREC     .56     1.0

           7         KK    C-1
           8         KM       RUNOFF FOR SUBIBASN C1
           9         BA    .1508
          10         IN      15
```

C-Basins Ex.

```
           11            PB     4.4
           12            PC  0.0000  0.0005  0.0015  0.0030  0.0045  0.0060  0.0080  0.0100  0.0120  0.0143
           13            PC  0.0165  0.0188  0.0210  0.0233  0.0255  0.0278  0.0320  0.0390  0.0460  0.0530
           14            PC  0.0600  0.0750  0.1000  0.4000  0.7000  0.7250  0.7500  0.7650  0.7800  0.7900
           15            PC  0.8000  0.8100  0.8200  0.8250  0.8300  0.8350  0.8400  0.8450  0.8500  0.8550
           16            PC  0.8600  0.8638  0.8675  0.8713  0.8750  0.8788  0.8825  0.8863  0.8900  0.8938
           17            PC  0.8975  0.9013  0.9050  0.9083  0.9115  0.9148  0.9180  0.9210  0.9240  0.9270
           18            PC  0.9300  0.9325  0.9350  0.9375  0.9400  0.9425  0.9450  0.9475  0.9500  0.9525
           19            PC  0.9550  0.9575  0.9600  0.9625  0.9650  0.9675  0.9700  0.9725  0.9750  0.9775
           20            PC  0.9800  0.9813  0.9825  0.9838  0.9850  0.9863  0.9875  0.9888  0.9900  0.9913
           21            PC  0.9925  0.9938  0.9950  0.9963  0.9975  0.9988  1.0000
           22            LS       0      61
           23            UD    0.46

           24            KK      C3
           25            KM    ROUTE SUB-BASIN C-1 TO DP C
           26            RD    3700     .032    0.04            TRAP      10        4

           27            KK     C-2
           28            KM         RUNOFF FOR SUB-BASIN C-2
           29            BA   .0991
           30            LS       0      61
           31            UD    0.43

           32            KK     DPC
           33            KM         COMBINE RUNOFF from C3 AND C-1
           34            HC       2
           35            ZZ
1
                SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.       (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

     7       C-1
                 V
                 V
    24          C3
                 .
                 .
    27           .          C-2
                 .            .
                 .            .
    32         DPC............

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                               *****************************************
 *                                       *                                               *                                       *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                               *    U.S. ARMY CORPS OF ENGINEERS       *
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*              JUN   1998                *                                              *    HYDROLOGIC ENGINEERING CENTER    *
*           VERSION 4.1                  *                                              *          609 SECOND STREET          *
*                                        *                                              *       DAVIS, CALIFORNIA 95616       *
*  RUN DATE   16JAN04  TIME  15:41:52    *                                              *          (916) 756-1104             *
*                                        *                                              *                                     *
******************************************                                              ***************************************


                                   Wolf Ranch Master Development Drainage Plan
                                    C Basins existing development condition PN 03094
                                   5-yaer and 100 Year, 24 hr Type IIA  Storm FN cbas-e.dat

  5 IO          OUTPUT CONTROL VARIABLES
                      IPRNT           4  PRINT CONTROL
                      IPLOT           0  PLOT CONTROL
                      QSCAL          0.  HYDROGRAPH PLOT SCALE

    IT          HYDROGRAPH TIME DATA
                       NMIN           5  MINUTES IN COMPUTATION INTERVAL
                      IDATE      1    0  STARTING DATE
                      ITIME        0000  STARTING TIME
                         NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      2    0  ENDING DATE
                     NDTIME        0055  ENDING TIME
                      ICENT          19  CENTURY MARK

                COMPUTATION INTERVAL     .08 HOURS
                     TOTAL TIME BASE   24.92 HOURS

       ENGLISH UNITS
            DRAINAGE AREA          SQUARE MILES
            PRECIPITATION DEPTH    INCHES
            LENGTH, ELEVATION      FEET
            FLOW                   CUBIC FEET PER SECOND
            STORAGE VOLUME         ACRE-FEET
            SURFACE AREA           ACRES
            TEMPERATURE            DEGREES FAHRENHEIT

    JP          MULTI-PLAN OPTION
                      NPLAN           1  NUMBER OF PLANS

    JR          MULTI-RATIO OPTION
                    RATIOS OF PRECIPITATION
                    .56      1.00
```

```
*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
  7 KK        *     C-1    *
              *            *
              **************
                                 RUNOFF FOR SUBIBASN C1

 10 IN              TIME DATA FOR INPUT TIME SERIES
                          JXMIN          15  TIME INTERVAL IN MINUTES
                         JXDATE      1     0  STARTING DATE
                         JXTIME            0  STARTING TIME

                  SUBBASIN RUNOFF DATA

  9 BA              SUBBASIN CHARACTERISTICS
                          TAREA         .15  SUBBASIN AREA

                    PRECIPITATION DATA

 11 PB                    STORM        4.40  BASIN TOTAL PRECIPITATION

 12 PI                INCREMENTAL PRECIPITATION PATTERN
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                          .00       .01       .01       .01       .01       .01       .10       .10       .10       .10
                          .10       .10       .01       .01       .01       .01       .01       .01       .00       .00
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                          .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
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                .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                .00       .00       .00       .00       .00       .00       .00       .00

  22 LS         SCS LOSS RATE
                      STRTL        1.28  INITIAL ABSTRACTION
                     CRVNBR       61.00  CURVE NUMBER
                      RTIMP         .00  PERCENT IMPERVIOUS AREA

  23 UD         SCS DIMENSIONLESS UNITGRAPH
                       TLAG         .46  LAG

                                                          ***

                                                    UNIT HYDROGRAPH
                                               30 END-OF-PERIOD ORDINATES
            11.       33.       68.      111.      138.      145.      138.      122.      100.       72.
            54.       41.       32.       25.       19.       14.       11.        8.        6.        5.
             4.        3.        2.        2.        1.        1.        1.        1.        0.        0.


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

           **************
           *            *
  24 KK    *        C3  *
           *            *
           **************
                          ROUTE SUB-BASIN C-1 TO DP C

            HYDROGRAPH ROUTING DATA

  26 RD         MUSKINGUM-CUNGE CHANNEL ROUTING
                           L       3700.  CHANNEL LENGTH
                           S       .0320  SLOPE
                           N        .040  CHANNEL ROUGHNESS COEFFICIENT
                          CA         .00  CONTRIBUTING AREA
                       SHAPE        TRAP  CHANNEL SHAPE
                          WD       10.00  BOTTOM WIDTH OR DIAMETER
                           Z        4.00  SIDE SLOPE

                                                          ***


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
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              **************
              *            *
27 KK         *     C-2    *
              *            *
              **************
                                  RUNOFF FOR SUB-BASIN C-2

                 SUBBASIN RUNOFF DATA

29 BA              SUBBASIN CHARACTERISTICS
                         TAREA         .10   SUBBASIN AREA

                   PRECIPITATION DATA

11 PB                    STORM        4.40   BASIN TOTAL PRECIPITATION

12 PI                INCREMENTAL PRECIPITATION PATTERN
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .01       .01       .01       .01       .01       .10       .10       .10       .10
                         .10       .10       .01       .01       .01       .01       .01       .01       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                         .00       .00       .00       .00       .00       .00       .00       .00

30 LS              SCS LOSS RATE
                         STRTL        1.28   INITIAL ABSTRACTION
```

```
                    CRVNBR       61.00  CURVE NUMBER
                     RTIMP         .00  PERCENT IMPERVIOUS AREA

   31 UD         SCS DIMENSIONLESS UNITGRAPH
                      TLAG         .43  LAG

                                                                 ***

                                                            UNIT HYDROGRAPH
                                                       28 END-OF-PERIOD ORDINATES
                8.        26.        53.        84.        99.       101.        92.        78.        58.        42.
               31.        24.        18.        13.        10.         8.         6.         4.         3.         2.
                2.         1.         1.         1.         1.         0.         0.         0.

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
   32 KK      *       DPC  *
              *            *
              **************
                                COMBINE RUNOFF from C3 AND C-1

   34 HC         HYDROGRAPH COMBINATION
                     ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                 ***
1

               PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                                TIME TO PEAK IN HOURS


                                                          RATIOS APPLIED TO PRECIPITATION
 OPERATION        STATION     AREA    PLAN          RATIO 1  RATIO 2
                                                        .56     1.00

 HYDROGRAPH AT
+                   C-1         .15      1   FLOW         5.      58.
                                             TIME       6.50     6.42

 ROUTED TO
+                    C3         .15      1   FLOW         5.      59.
                                             TIME       6.83     6.50

 HYDROGRAPH AT
```

```
+                    C-2        .10      1    FLOW          4.       41.
                                              TIME        6.50      6.33

  2 COMBINED AT
+                    DPC        .25      1    FLOW          8.       94.
                                              TIME        6.67      6.50
1



 *** NORMAL END OF HEC-1 ***
```

```
1****************************************                    ****************************************
 *                                      *                    *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                    *    U.S. ARMY CORPS OF ENGINEERS      *
 *              JUN   1998              *                    *    HYDROLOGIC ENGINEERING CENTER     *
 *           VERSION 4.1                *                    *          609 SECOND STREET           *
 *                                      *                    *       DAVIS, CALIFORNIA 95616        *
 * RUN DATE   11MAR04  TIME  12:41:53   *                    *           (916) 756-1104             *
 *                                      *                    *                                      *
 ****************************************                    ****************************************


                    X     X  XXXXXXX   XXXXX          X
                    X     X  X        X     X        XX
                    X     X  X        X               X
                    XXXXXXX  XXXX     X       XXXXX   X
                    X     X  X        X               X
                    X     X  X        X     X         X
                    X     X  XXXXXXX   XXXXX         XXX


          THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

          THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
          THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
          NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
          DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
          KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                       HEC-1 INPUT                                            PAGE  1

         LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

           1           ID              Wolf Ranch Master Development Drainage Plan
           2           ID                   D Basins existing development conditions  PN 03094
           3           ID              5-year and 100 Year, 24 hr Type IIA  Storm  FN dbas-e.dat
                       *DIAGRAM
           4           IT       5       0       0     300
           5           IO       4       0
           6           JR    PREC     .48     .61     .70     .93     1.0

           7           KK    D-1
           8           KM          RUNOFF FOR Sub-basin D-1
           9           BA   .1503
          10           IN      15
```

D-Basin Ex.

```
    11          PB    4.4
    12          PC 0.0000  0.0005  0.0015  0.0030  0.0045  0.0060  0.0080  0.0100  0.0120  0.0143
    13          PC 0.0165  0.0188  0.0210  0.0233  0.0255  0.0278  0.0320  0.0390  0.0460  0.0530
    14          PC 0.0600  0.0750  0.1000  0.4000  0.7000  0.7250  0.7500  0.7650  0.7800  0.7900
    15          PC 0.8000  0.8100  0.8200  0.8250  0.8300  0.8350  0.8400  0.8450  0.8500  0.8550
    16          PC 0.8600  0.8638  0.8675  0.8713  0.8750  0.8788  0.8825  0.8863  0.8900  0.8938
    17          PC 0.8975  0.9013  0.9050  0.9083  0.9115  0.9148  0.9180  0.9210  0.9240  0.9270
    18          PC 0.9300  0.9325  0.9350  0.9375  0.9400  0.9425  0.9450  0.9475  0.9500  0.9525
    19          PC 0.9550  0.9575  0.9600  0.9625  0.9650  0.9675  0.9700  0.9725  0.9750  0.9775
    20          PC 0.9800  0.9813  0.9825  0.9838  0.9850  0.9863  0.9875  0.9888  0.9900  0.9913
    21          PC 0.9925  0.9938  0.9950  0.9963  0.9975  0.9988  1.0000
    22          LS      0      61
    23          UD   0.44

    24          KK     D2
    25          KM       ROUTE FLOW FROM SUB-BASIN D-1 TP DP D2
    26          RD   5470   0.027    0.04            TRAP      10      10

    27          KK   D-2
    28          KM      RUNOFF FROM Sub-basin D-2
    29          BA   .1660
    30          LS      0      61
    31          UD   0.37

    32          KK   DPD2
    33          KM       COMBINE RUNOFF from D-2 AND D2
    34          HC      2

    35          KK     D3
    36          KM       ROUTE FLOW FROM DP D2 TO DP D
    37          RD   3000   0.035    0.04            TRAP      10      10

    38          KK    D-3
    39          KM      RUNOFF FROM Sub-basin D-3
    40          BA   .0450
    41          LS      0      61
    42          UD   0.12
1                                    HEC-1 INPUT                                                PAGE  2

    LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


    43          KK   DPD2
    44          KM       COMBINE RUNOFF from D-3 AND D3
    45          HC      2
    46          ZZ
1
            SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW
```

```
 NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   7       D-1
               V
               V
  24          D2
               .
               .
  27           .       D-2
               .          .
               .          .
  32         DPD2...........
               V
               V
  35          D3
               .
               .
  38           .         D-3
               .          .
               .          .
  43         DPD2...........

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```

```
1**************************************                  ***************************************
 *                                      *                 *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                 *    U.S. ARMY CORPS OF ENGINEERS     *
 *             JUN   1998               *                 *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1                *                 *          609 SECOND STREET          *
 *                                      *                 *       DAVIS, CALIFORNIA 95616       *
 * RUN DATE   11MAR04  TIME  12:41:53   *                 *          (916) 756-1104             *
 *                                      *                 *                                     *
****************************************                  ***************************************
```

```
                          Wolf Ranch Master Development Drainage Plan
                           D Basins existing development conditions  PN 03094
                          5-year and 100 Year, 24 hr Type IIA  Storm  FN dbas-e.dat

  5 IO        OUTPUT CONTROL VARIABLES
                    IPRNT          4  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

    IT        HYDROGRAPH TIME DATA
                     NMIN          5  MINUTES IN COMPUTATION INTERVAL
                    IDATE     1    0  STARTING DATE
```

```
                    ITIME         0000  STARTING TIME
                       NQ          300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE      2     0  ENDING DATE
                   NDTIME         0055  ENDING TIME
                   ICENT            19  CENTURY MARK

              COMPUTATION INTERVAL      .08 HOURS
                   TOTAL TIME BASE    24.92 HOURS

       ENGLISH UNITS
            DRAINAGE AREA          SQUARE MILES
            PRECIPITATION DEPTH    INCHES
            LENGTH, ELEVATION      FEET
            FLOW                   CUBIC FEET PER SECOND
            STORAGE VOLUME         ACRE-FEET
            SURFACE AREA           ACRES
            TEMPERATURE            DEGREES FAHRENHEIT

  JP          MULTI-PLAN OPTION
                    NPLAN              1  NUMBER OF PLANS

  JR          MULTI-RATIO OPTION
                  RATIOS OF PRECIPITATION
                   .48       .61       .70       .93      1.00


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          **************
          *            *
  7 KK    *     D-1    *
          *            *
          **************
                           RUNOFF FOR Sub-basin D-1

 10 IN        TIME DATA FOR INPUT TIME SERIES
                    JXMIN             15  TIME INTERVAL IN MINUTES
                   JXDATE      1       0  STARTING DATE
                   JXTIME              0  STARTING TIME

            SUBBASIN RUNOFF DATA

  9 BA        SUBBASIN CHARACTERISTICS
                    TAREA            .15  SUBBASIN AREA

              PRECIPITATION DATA

 11 PB              STORM           4.40  BASIN TOTAL PRECIPITATION
```

```
12 PI           INCREMENTAL PRECIPITATION PATTERN
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .01     .01     .01     .01     .01     .10     .10     .10     .10
                  .10     .10     .01     .01     .01     .01     .01     .01     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
                  .00     .00     .00     .00     .00     .00     .00     .00

22 LS         SCS LOSS RATE
                   STRTL        1.28  INITIAL ABSTRACTION
                  CRVNBR       61.00  CURVE NUMBER
                   RTIMP         .00  PERCENT IMPERVIOUS AREA

23 UD         SCS DIMENSIONLESS UNITGRAPH
                    TLAG         .44  LAG

                                        ***

                                  UNIT HYDROGRAPH
                              28 END-OF-PERIOD ORDINATES
             12.      37.      76.     122.     146.     150.     139.     120.      92.      66.
             50.      38.      29.      22.      16.      12.       9.       7.       5.       4.
              3.       2.       2.       1.       1.       1.       0.       0.
```

```
*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
  24 KK     *       D2   *
            *            *
            **************
                          ROUTE FLOW FROM SUB-BASIN D-1 TP DP D2

               HYDROGRAPH ROUTING DATA

  26 RD          MUSKINGUM-CUNGE CHANNEL ROUTING
                           L       5470.  CHANNEL LENGTH
                           S       .0270  SLOPE
                           N        .040  CHANNEL ROUGHNESS COEFFICIENT
                          CA         .00  CONTRIBUTING AREA
                       SHAPE        TRAP  CHANNEL SHAPE
                          WD       10.00  BOTTOM WIDTH OR DIAMETER
                           Z       10.00  SIDE SLOPE

                                                    ***

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
  27 KK     *     D-2    *
            *            *
            **************
                        RUNOFF FROM Sub-basin D-2

               SUBBASIN RUNOFF DATA

  29 BA          SUBBASIN CHARACTERISTICS
                      TAREA          .17  SUBBASIN AREA

                 PRECIPITATION DATA

  11 PB               STORM         4.40  BASIN TOTAL PRECIPITATION

  12 PI             INCREMENTAL PRECIPITATION PATTERN
                       .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                       .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
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                       .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
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                 .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                 .00      .01      .01      .01      .01      .01      .10      .10      .10      .10
                 .10      .10      .01      .01      .01      .01      .01      .01      .00      .00
                 .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
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                 .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                 .00      .00      .00      .00      .00      .00      .00      .00

30 LS        SCS LOSS RATE
                   STRTL        1.28  INITIAL ABSTRACTION
                  CRVNBR       61.00  CURVE NUMBER
                   RTIMP         .00  PERCENT IMPERVIOUS AREA

31 UD        SCS DIMENSIONLESS UNITGRAPH
                    TLAG         .37  LAG

                                              ***

                                             UNIT HYDROGRAPH
                                          24 END-OF-PERIOD ORDINATES
              20.      62.     131.     182.     195.     179.     149.     105.      73.      53.
              39.      28.      20.      14.      10.       7.       5.       4.       3.       2.
               2.       1.       1.       0.


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

        **************
        *            *
32 KK   *     DPD2   *
        *            *
```

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              **************
                                  COMBINE RUNOFF from D-2 AND D2

  34 HC            HYDROGRAPH COMBINATION
                        ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                        ***


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
  35 KK       *        D3  *
              *            *
              **************
                                  ROUTE FLOW FROM DP D2 TO DP D

                HYDROGRAPH ROUTING DATA

  37 RD            MUSKINGUM-CUNGE CHANNEL ROUTING
                              L       3000.  CHANNEL LENGTH
                              S       .0350  SLOPE
                              N        .040  CHANNEL ROUGHNESS COEFFICIENT
                             CA         .00  CONTRIBUTING AREA
                          SHAPE        TRAP  CHANNEL SHAPE
                             WD       10.00  BOTTOM WIDTH OR DIAMETER
                              Z       10.00  SIDE SLOPE

                                                                        ***


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
  38 KK       *       D-3  *
              *            *
              **************
                                  RUNOFF FROM Sub-basin D-3

                SUBBASIN RUNOFF DATA

  40 BA            SUBBASIN CHARACTERISTICS
                        TAREA          .05  SUBBASIN AREA
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PRECIPITATION DATA

11 PB STORM 4.40 BASIN TOTAL PRECIPITATION

12 PI INCREMENTAL PRECIPITATION PATTERN

.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.01	.01	.01	.01	.01	.10	.10	.10	.10
.10	.10	.01	.01	.01	.01	.01	.01	.00	.00
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
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.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
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.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
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.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.00	.00	.00	.00	.00	.00	.00		

41 LS SCS LOSS RATE

STRTL 1.28 INITIAL ABSTRACTION
CRVNBR 61.00 CURVE NUMBER
RTIMP .00 PERCENT IMPERVIOUS AREA

42 UD SCS DIMENSIONLESS UNITGRAPH

TLAG .12 LAG

***

UNIT HYDROGRAPH
9 END-OF-PERIOD ORDINATES

68.	135.	85.	35.	15.	7.	3.	1.	0.

*** ***

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          **************
          *            *
43 KK     *     DPD2   *
          *            *
          **************
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COMBINE RUNOFF from D-3 AND D3

45 HC HYDROGRAPH COMBINATION
ICOMP 2 NUMBER OF HYDROGRAPHS TO COMBINE

***

1

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .48	RATIO 2 .61	RATIO 3 .70	RATIO 4 .93	RATIO 5 1.00
HYDROGRAPH AT +	D-1	.15	1	FLOW	2.	9.	18.	49.	60.
				TIME	6.58	6.42	6.42	6.33	6.33
ROUTED TO +	D2	.15	1	FLOW	2.	9.	20.	49.	59.
				TIME	7.33	7.00	6.67	6.67	6.67
HYDROGRAPH AT +	D-2	.17	1	FLOW	2.	11.	22.	61.	75.
				TIME	6.50	6.33	6.33	6.25	6.25
2 COMBINED AT +	DPD2	.32	1	FLOW	4.	14.	33.	84.	103.
				TIME	7.33	6.92	6.67	6.50	6.50
ROUTED TO +	D3	.32	1	FLOW	3.	15.	31.	88.	103.
				TIME	7.67	7.17	6.92	6.67	6.67
HYDROGRAPH AT +	D-3	.05	1	FLOW	1.	6.	12.	30.	36.
				TIME	6.08	6.08	6.08	6.08	6.08

2 COMBINED AT									
+	DPD2	.36	1	FLOW	4.	16.	32.	92.	107.
				TIME	7.67	7.17	6.92	6.67	6.67

*** NORMAL END OF HEC-1 ***

```
1***************************************                                    ***************************************
 *                                      *                                    *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                    *   U.S. ARMY CORPS OF ENGINEERS      *
 *              JUN   1998              *                                    *   HYDROLOGIC ENGINEERING CENTER     *
 *            VERSION 4.1               *                                    *         609 SECOND STREET           *
 *                                      *                                    *      DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   11MAR04  TIME  12:43:42  *                                    *          (916) 756-1104             *
 *                                      *                                    *                                     *
 ****************************************                                    ***************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X               X
XXXXXXX  XXXX     X       XXXXX   X
X     X  X        X               X
X     X  X        X     X         X
X     X  XXXXXXX   XXXXX         XXX
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```
THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM
```

```
1                                          HEC-1 INPUT                                            PAGE  1

      LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

        1           ID              Wolf Ranch master Development Drainage Plan
        2           ID                   E Basins existing development condition PN 03094
        3           ID              5-year and 100 Year, 24 hr Type IIA  Storm  FN ebas-e.dat
                    *DIAGRAM
        4           IT       5       0       0     300
        5           IO       4       0
        6           JR    PREC     .48     .61     .70     .93     1.0

        7           KK     E-1
        8           KM        RUNOFF FOR SUB-BASIN E-1
        9           BA   .1640
       10           IN      15
```

E-BASINS EX

```
            11          PB     4.4
            12          PC  0.0000  0.0005  0.0015  0.0030  0.0045  0.0060  0.0080  0.0100  0.0120  0.0143
            13          PC  0.0165  0.0188  0.0210  0.0233  0.0255  0.0278  0.0320  0.0390  0.0460  0.0530
            14          PC  0.0600  0.0750  0.1000  0.4000  0.7000  0.7250  0.7500  0.7650  0.7800  0.7900
            15          PC  0.8000  0.8100  0.8200  0.8250  0.8300  0.8350  0.8400  0.8450  0.8500  0.8550
            16          PC  0.8600  0.8638  0.8675  0.8713  0.8750  0.8788  0.8825  0.8863  0.8900  0.8938
            17          PC  0.8975  0.9013  0.9050  0.9083  0.9115  0.9148  0.9180  0.9210  0.9240  0.9270
            18          PC  0.9300  0.9325  0.9350  0.9375  0.9400  0.9425  0.9450  0.9475  0.9500  0.9525
            19          PC  0.9550  0.9575  0.9600  0.9625  0.9650  0.9675  0.9700  0.9725  0.9750  0.9775
            20          PC  0.9800  0.9813  0.9825  0.9838  0.9850  0.9863  0.9875  0.9888  0.9900  0.9913
            21          PC  0.9925  0.9938  0.9950  0.9963  0.9975  0.9988  1.0000
            22          LS       0      61
            23          UD    0.44

            24          KK      E2
            25          KM         ROUTE FLOW FROM SUB-BASIN E-1` TO DP E
            26          RD    3050    .035    0.04            TRAP      10       5

            27          KK     E-2
            28          KM         RUNOFF FOR SUB-BASIN E-2
            29          BA   .1520
            30          LS       0      61
            31          UD    0.44

            32          KK     DPE
            33          KM         COMBINE RUNOFF FROM E2 AND E-2
            34          HC       2
            35          ZZ
1
                  SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    7          E-1
                V
                V
   24           E2
                .
                .
   27           .          E-2
                .            .
                .            .
   32          DPE...........

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                        *****************************************
 *                                       *                                        *                                       *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                        *   U.S. ARMY CORPS OF ENGINEERS        *
```

```
*               JUN   1998              *                                        *    HYDROLOGIC ENGINEERING CENTER    *
*            VERSION 4.1                *                                        *         609 SECOND STREET           *
*                                       *                                        *      DAVIS, CALIFORNIA 95616        *
*  RUN DATE   11MAR04  TIME  12:43:42   *                                        *          (916) 756-1104             *
*                                       *                                        *                                     *
*****************************************                                        ***************************************
```

```
                                   Wolf Ranch master Development Drainage Plan
                                    E Basins existing development condition PN 03094
                                   5-year and 100 Year, 24 hr Type IIA  Storm  FN ebas-e.dat

  5 IO          OUTPUT CONTROL VARIABLES
                      IPRNT           4  PRINT CONTROL
                      IPLOT           0  PLOT CONTROL
                      QSCAL          0.  HYDROGRAPH PLOT SCALE

    IT          HYDROGRAPH TIME DATA
                       NMIN           5  MINUTES IN COMPUTATION INTERVAL
                      IDATE      1    0  STARTING DATE
                      ITIME        0000  STARTING TIME
                         NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      2    0  ENDING DATE
                     NDTIME        0055  ENDING TIME
                     ICENT           19  CENTURY MARK

                COMPUTATION INTERVAL       .08 HOURS
                     TOTAL TIME BASE     24.92 HOURS

        ENGLISH UNITS
             DRAINAGE AREA          SQUARE MILES
             PRECIPITATION DEPTH    INCHES
             LENGTH, ELEVATION      FEET
             FLOW                   CUBIC FEET PER SECOND
             STORAGE VOLUME         ACRE-FEET
             SURFACE AREA           ACRES
             TEMPERATURE            DEGREES FAHRENHEIT

    JP          MULTI-PLAN OPTION
                      NPLAN           1  NUMBER OF PLANS

    JR          MULTI-RATIO OPTION
                    RATIOS OF PRECIPITATION
                    .48       .61       .70       .93      1.00
```

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*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

           **************
           *            *
  7 KK     *       E-1  *
           *            *
           **************
                              RUNOFF FOR SUB-BASIN E-1

 10 IN          TIME DATA FOR INPUT TIME SERIES
                      JXMIN           15  TIME INTERVAL IN MINUTES
                     JXDATE       1    0  STARTING DATE
                     JXTIME            0  STARTING TIME

              SUBBASIN RUNOFF DATA

  9 BA          SUBBASIN CHARACTERISTICS
                      TAREA          .16  SUBBASIN AREA

                PRECIPITATION DATA

 11 PB                STORM         4.40  BASIN TOTAL PRECIPITATION

 12 PI            INCREMENTAL PRECIPITATION PATTERN
                      .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                      .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
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                      .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                      .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                      .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                      .00       .01       .01       .01       .01       .01       .10       .10       .10       .10
                      .10       .10       .01       .01       .01       .01       .01       .01       .00       .00
                      .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                      .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                      .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
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                .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                .00       .00       .00       .00       .00       .00       .00       .00

 22 LS          SCS LOSS RATE
                      STRTL        1.28  INITIAL ABSTRACTION
                     CRVNBR       61.00  CURVE NUMBER
                      RTIMP         .00  PERCENT IMPERVIOUS AREA

 23 UD          SCS DIMENSIONLESS UNITGRAPH
                       TLAG         .44  LAG

                                                         ***

                                                  UNIT HYDROGRAPH
                                             28 END-OF-PERIOD ORDINATES
           13.        40.        83.       133.       159.       164.       152.       130.       101.        72.
           54.        42.        32.        23.        18.        13.        10.         8.         6.         4.
            3.         2.         2.         2.         1.         1.         1.         0.


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

           **************
           *            *
 24 KK     *        E2  *
           *            *
           **************
                           ROUTE FLOW FROM SUB-BASIN E-1` TO DP E

              HYDROGRAPH ROUTING DATA

 26 RD          MUSKINGUM-CUNGE CHANNEL ROUTING
                          L       3050.  CHANNEL LENGTH
                          S       .0350  SLOPE
                          N        .040  CHANNEL ROUGHNESS COEFFICIENT
                         CA         .00  CONTRIBUTING AREA
                      SHAPE        TRAP  CHANNEL SHAPE
                         WD       10.00  BOTTOM WIDTH OR DIAMETER
                          Z        5.00  SIDE SLOPE

                                                         ***


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
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              **************
              *            *
   27 KK      *     E-2    *
              *            *
              **************
                                  RUNOFF FOR SUB-BASIN E-2

                SUBBASIN RUNOFF DATA

   29 BA          SUBBASIN CHARACTERISTICS
                        TAREA          .15   SUBBASIN AREA

                  PRECIPITATION DATA

   11 PB                STORM        4.40   BASIN TOTAL PRECIPITATION

   12 PI            INCREMENTAL PRECIPITATION PATTERN
                         .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                         .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                         .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                         .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                         .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                         .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                         .00      .01      .01      .01      .01      .01      .10      .10      .10      .10
                         .10      .10      .01      .01      .01      .01      .01      .01      .00      .00
                         .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
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                         .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                         .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                         .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                         .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                         .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                         .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                         .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                         .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                         .00      .00      .00      .00      .00      .00      .00      .00

   30 LS          SCS LOSS RATE
                        STRTL        1.28   INITIAL ABSTRACTION
```

```
                    CRVNBR       61.00  CURVE NUMBER
                     RTIMP         .00  PERCENT IMPERVIOUS AREA

  31 UD         SCS DIMENSIONLESS UNITGRAPH
                      TLAG         .44  LAG

                                                        ***

                                              UNIT HYDROGRAPH
                                          28 END-OF-PERIOD ORDINATES
            12.        37.        77.       123.       148.       152.       141.       121.        93.        67.
            50.        38.        29.        22.        16.        12.         9.         7.         5.         4.
             3.         2.         2.         1.         1.         1.         1.         0.

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
  32 KK     *      DPE   *
            *            *
            **************
                        COMBINE RUNOFF FROM E2 AND E-2

  34 HC         HYDROGRAPH COMBINATION
                     ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                        ***
1
```

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .48	RATIO 2 .61	RATIO 3 .70	RATIO 4 .93	RATIO 5 1.00
HYDROGRAPH AT									
+	E-1	.16	1	FLOW	2.	10.	19.	53.	66.
				TIME	6.58	6.42	6.42	6.33	6.33
ROUTED TO									
+	E2	.16	1	FLOW	2.	10.	19.	53.	66.
				TIME	6.92	6.67	6.58	6.50	6.50
HYDROGRAPH AT									

+	E-2	.15	1	FLOW	2.	9.	18.	49.	61.
				TIME	6.58	6.42	6.42	6.33	6.33
2 COMBINED AT									
+	DPE	.32	1	FLOW	3.	18.	35.	99.	124.
				TIME	6.92	6.58	6.50	6.42	6.42
1									

*** NORMAL END OF HEC-1 ***

```
1****************************************                        ****************************************
 *                                      *                        *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                        *    U.S. ARMY CORPS OF ENGINEERS      *
 *              JUN   1998              *                        *    HYDROLOGIC ENGINEERING CENTER     *
 *           VERSION 4.1                *                        *          609 SECOND STREET           *
 *                                      *                        *       DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   27FEB18  TIME  14:41:14  *                        *          (916) 756-1104              *
 *                                      *                        *                                      *
 ****************************************                        ****************************************


                     X     X  XXXXXXX   XXXXX          X
                     X     X  X        X     X        XX
                     X     X  X        X               X
                     XXXXXXX  XXXX     X       XXXXX   X
                     X     X  X        X               X
                     X     X  X        X     X         X
                     X     X  XXXXXXX   XXXXX         XXX


 THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

 THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
 THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
 NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
 DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
 KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                   HEC-1 INPUT                                        PAGE  1

 LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1         ID            Wolf Ranch Master Development Drainage Plan  FBASE24.DAT
   2         ID           F Basins Existing Development Condition  PN 17055
   3         ID           5-year and 100 Year, 24 hr NOAA ATLAS 2  PER 2014 DCM TYPE II
             *DIAGRAM
   4         IT       5       0       0     300
   5         IO       5       0
   6         JR    PREC     .56     1.0

   7         KK     F-1
   8         KM        RUNOFF SUB-BASIN F-1
   9         BA   .1659
  10         IN      15
```

FBASE Existing 24 hour Type II Atlas 2

```
 11      PB     4.4
 12      PC     0.0    .002    .005    .008    .011    .014    .017     .02    .023    .026
 13      PC    .029    .032    .035    .038    .041    .044    .048    .052    .056     .06
 14      PC   .0604    .068    .072    .076     .08    .085     .09    .095      .1    .105
 15      PC     .11    .115     .12    .126    .133     .14    .147    .155    .163    .172
 16      PC    .181    .191    .203    .218    .236    .257    .283    .387    .663    .707
 17      PC    .735    .758    .776    .791    .804    .815    .825    .834    .842    .849
 18      PC    .856    .863    .869    .875    .881    .887    .893    .898    .903    .908
 19      PC    .913    .918    .922    .926     .93   .9340    .938    .942    .946     .95
 20      PC    .953    .956    .959    .962    .965    .968    .971    .974    .977     .98
 21      PC    .986    .989    .992    .995    .998
 22      LS       0      61
 23      UD    0.20

 24      KK     1-8
 25      KM   ROUTE FLOW FROM F-1 THROUGH F-8
 26      RD    4620    0.04    0.04            TRAP       6       3

 27      KK     F-8
 28      KM   SCS RUNOFF F-8
 29      BA   .1499
 30      LS       0      61
 31      UD     .15

 32      KK      1F
 33      KM   COMBINE RUNOFF FROM F-1 AND F-8
 34      HC       2

 35      KK     F-2
 36      KM   SCS RUNOFF F-2
 37      BA   .0424
 38      LS       0      61
 39      UD     .20

 40      KK     F-3
 41      KM   SCS RUNOFF F-3
 42      BA   .0942
 43      LS       0      61
 44      UD     .22
1                                   HEC-1 INPUT                                            PAGE  2

LINE     ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 45      KK      2F
 46      KM   COMBINE RUNOFF FROM F-2 AND F-3
 47      HC       2

 48      KK   2F-5F
 49      KM   ROUTE FLOW FROM 2F THROUGH F-9
```

```
  50          RD    3087   0.036    0.04            TRAP       6       3

  51          KK     F-9
  52          KM   SCS RUNOFF F-9
  53          BA   .1953
  54          LS       0      61
  55          UD     .20

  56          KK      5F
  57          KM   COMBINE RUNOFF FROM 2F AND F-9
  58          HC       2

  59          KK   POND1
  60          KM   ROUTE FLOW THROUGH POND1
  61          RS       1    ELEV    7133               1
  62          SA    0.41    0.58    0.76    0.86
  63          SE    7133    7134    7135    7136
  64          ST    7133      10    0.50     1.5
  65          SS    7133      10    0.50     1.5
  66          SW       0      50      60      70     125
  67          SE    7136    7135    7133    7133    7136

  68          KK     F-4
  69          KM   SCS RUNOFF F-4
  70          BA   .2681
  71          LS       0      61
  72          UD     .22

  73          KK     F-5
  74          KM   SCS RUNOFF F-5
  75          BA   .1073
  76          LS       0      61
  77          UD     .24

  78          KK      3F
  79          KM   COMBINE RUNOFF FROM F-4 AND F-5
  80          HC       2

  81          KK   3F-6F
  82          KM   ROUTE FLOW FROM 3F THROUGH F-10
  83          RD    3790   0.034    0.04            TRAP      10      10

  84          KK    F-10
  85          KM   SCS RUNOFF F-10
  86          BA   .0883
  87          LS       0      61
  88          UD     .28
1                                      HEC-1 INPUT                                  PAGE  3

    LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10
```

```
KK      6F
KM   COMBINE RUNOFF FROM 3F AND F-10
HC       2

KK      8F
KM   COMBINE RUNOFF FROM 5F AND 6F
HC       2

KK   8F-9F
KM   ROUTE FLOW FROM 8F TO 9F
RD    1706   0.034    0.04             TRAP       6       2

KK      F9
KM   COMBINE RUNOFF FROM 1F AND 8F
HC       2

KK     F12
KM      ROUTE FLOW FROM DP F9 TO DP F12
RC     .04   0.035    0.04    5200   0.022
RX       0      20      33      37      43      47      60      80
RY    7014    7004    7004    7000    7000    7004    7004    7014

KK     F-6
KM   SCS RUNOFF F-6
BA   .0310
LS       0      61
UD     .19

KK     F-7
KM   SCS RUNOFF F-7
BA   .0782
LS       0      61
UD     .19

KK      4F
KM   COMBINE RUNOFF FROM F-6 AND F-7
HC       2

KK   4F-7F
KM   ROUTE FLOW FROM 4F THROUGH F-11
RD    3610    0.06    0.04             TRAP      10      10

KK    F-11
KM   SCS RUNOFF F-11
BA   .1136
LS       0      61
UD     .12
```

```
 127           KK      7F
 128           KM   COMBINE RUNOFF FROM 4F AND F-11
 129           HC       2
```



```
LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 130           KK  7F-10F
 131           KM   ROUTE FLOW FROM 7F THROUGH F-14
 132           RD    4970   0.023    0.04            TRAP       6       3

 133           KK    F-14
 134           KM   SCS RUNOFF F-14
 135           BA   .1493
 136           LS       0      61
 137           UD     .20

 138           KK    F-13
 139           KM        RUNOFF SUB-BASIN F-13
 140           BA   .1169
 141           LS       0      61
 142           UD     .30

 143           KK     F14
 144           KM        COMBINE RUNOFF FROM 7F, F-13, AND F-14
 145           HC       3

 146           KK   DBF13
 147           KM        ROUTE FLOW FROM DP F14 THROUGH POND DBF13
 148           RS       1    ELEV    7026               1
 149           SA    1.97    2.35    2.83    3.21    3.66     4.0    4.33
 150           SE    7026    7027    7028    7029    7030    7031    7032
 151           ST    7029      40    0.50     1.5
 152           SS    7029      40    0.50     1.5
 153           SW       0      80     120     150
 154           SE    7032    7029    7029    7032

 155           KK     F15
 156           KM        ROUTE FLOW FROM POND DB F13 TO DP F15
 157           RS       1    STOR      -1
 158           RC     .04   0.035    0.04    1194     0.5
 159           RX       0      20      33      37      43      47      60      80
 160           RY    7014    7004    7004    7000    7000    7004    7004    7014

 161           KK    F-15
 162           KM        RUNOFF SUB-BASIN F-15
 163           BA   .0321
 164           LS       0      61
 165           UD     .11
```

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 166           KK   DPF15
 167           KM        COMBINE RUNOFF FROM F15 AND SUB-BASIN F-15
 168           HC        2

 169           KK    F-12
 170           KM   SCS RUNOFF F-12
 171           BA   .2471
 172           LS        0       61
 173           UD       .2
1                                        HEC-1 INPUT                                            PAGE  5

LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 174           KK     F12
 175           KM        COMBINE RUNOFF FROM F12, DP F15 AND F-12
 176           HC        3

 177           KK     F16
 178           KM        ROUTE FLOW FROM DP F12 TO DP F16
 179           RC     .04   0.035    0.04    2091    0.02
 180           RX        0      20      33      37      43      47      60      80
 181           RY     7014    7004    7004    7000    7000    7004    7004    7014

 182           KK    F-16
 183           KM        RUNOFF SUB-BASIN F-16
 184           BA   .0570
 185           LS        0       61
 186           UD      .09

 187           KK   DPF16
 188           KM        COMBINE RUNOFF FROM F16 AND F-16
 189           HC        2

 190           KK     F17
 191           KM        ROUTE FLOW FROM DP F16 TO DP F
 192           RD     1950   0.025    0.04            TRAP      20       3

 193           KK    F-17
 194           KM        RUNOFF SUB-BASIN F-17
 195           BA   .0520
 196           LS        0       61
 197           UD      .27

 198           KK     DPF
 199           KM        COMBINE RUNOFF FROM F17 AND SUB-BASIN F-17
 200           HC        2
 201           ZZ
1
```

```
                SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    7         F-1
                V
                V
   24         1-8
                .
                .
   27           .         F-8
                .           .
                .           .
   32          1F............
                .
                .
   35           .         F-2
                .           .
                .           .
   40           .           .         F-3
                .           .           .
                .           .           .
   45           .          2F............
                .           V
                .           V
   48           .       2F-5F
                .           .
                .           .
   51           .           .         F-9
                .           .           .
                .           .           .
   56           .          5F............
                .           V
                .           V
   59           .       POND1
                .           .
                .           .
   68           .           .         F-4
                .           .           .
                .           .           .
   73           .           .           .         F-5
                .           .           .           .
                .           .           .           .
   78           .           .          3F............
                .           .           V
                .           .           V
   81           .           .       3F-6F
                .           .           .
```

```
              .           .           .
 84           .           .           .        F-10
              .           .           .           .
              .           .           .           .
 89           .           .          6F............
              .           .           .
              .           .           .
 92           .          8F............
              .           V
              .           V
 95           .       8F-9F
              .           .
              .           .
 98          F9............
              V
              V
101         F12
              .
              .
106           .         F-6
              .           .
              .           .
111           .           .         F-7
              .           .           .
              .           .           .
116           .          4F............
              .           V
              .           V
119           .       4F-7F
              .           .
              .           .
122           .           .        F-11
              .           .           .
              .           .           .
127           .          7F............
              .           V
              .           V
130           .      7F-10F
              .           .
              .           .
133           .           .        F-14
              .           .           .
              .           .           .
138           .           .           .        F-13
              .           .           .           .
              .           .           .           .
143           .         F14........................
              .           V
              .           V
146           .       DBF13
```

```
                 .           V
                 .           V
 155             .         F15
                 .           .
                 .           .
 161             .           .          F-15
                 .           .             .
                 .           .             .
 166             .       DPF15............
                 .           .
                 .           .
 169             .           .          F-12
                 .           .             .
                 .           .             .
 174           F12.......................
                 V
                 V
 177           F16
                 .
                 .
 182             .        F-16
                 .           .
                 .           .
 187         DPF16............
                 V
                 V
 190           F17
                 .
                 .
 193             .        F-17
                 .           .
                 .           .
 198           DPF............

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************
*                                        *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *
*              JUN   1998                *
*            VERSION 4.1                 *
*                                        *
*  RUN DATE   27FEB18  TIME  14:41:14    *
*                                        *
******************************************
```

```
******************************************
*                                        *
*    U.S. ARMY CORPS OF ENGINEERS        *
*    HYDROLOGIC ENGINEERING CENTER       *
*          609 SECOND STREET             *
*       DAVIS, CALIFORNIA 95616          *
*           (916) 756-1104               *
*                                        *
******************************************
```

```
                                   F Basins Existing Development Condition  PN 17055
                                   5-year and 100 Year, 24 hr NOAA ATLAS 2  PER 2014 DCM TYPE II

   5 IO          OUTPUT CONTROL VARIABLES
                       IPRNT          5  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE

     IT          HYDROGRAPH TIME DATA
                        NMIN          5  MINUTES IN COMPUTATION INTERVAL
                       IDATE      1   0  STARTING DATE
                       ITIME       0000  STARTING TIME
                          NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                      NDDATE      2   0  ENDING DATE
                      NDTIME       0055  ENDING TIME
                      ICENT          19  CENTURY MARK

                  COMPUTATION INTERVAL     .08 HOURS
                       TOTAL TIME BASE   24.92 HOURS

          ENGLISH UNITS
               DRAINAGE AREA          SQUARE MILES
               PRECIPITATION DEPTH    INCHES
               LENGTH, ELEVATION      FEET
               FLOW                   CUBIC FEET PER SECOND
               STORAGE VOLUME         ACRE-FEET
               SURFACE AREA           ACRES
               TEMPERATURE            DEGREES FAHRENHEIT

     JP          MULTI-PLAN OPTION
                       NPLAN          1  NUMBER OF PLANS

     JR          MULTI-RATIO OPTION
                     RATIOS OF PRECIPITATION
                     .56      1.00
1

               PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                               TIME TO PEAK IN HOURS


                                                                RATIOS APPLIED TO PRECIPITATION
 OPERATION       STATION     AREA    PLAN               RATIO 1  RATIO 2
                                                            .56     1.00

 HYDROGRAPH AT
+                   F-1        .17     1    FLOW          8.       94.
                                            TIME       12.25    12.08
```

```
 ROUTED TO
+                  1-8       .17     1   FLOW         10.      95.
                                         TIME       12.50    12.25

 HYDROGRAPH AT
+                  F-8       .15     1   FLOW          8.     101.
                                         TIME       12.17    12.08

  2 COMBINED AT
+                   1F       .32     1   FLOW         14.     155.
                                         TIME       12.50    12.17

 HYDROGRAPH AT
+                  F-2       .04     1   FLOW          2.      24.
                                         TIME       12.25    12.08

 HYDROGRAPH AT
+                  F-3       .09     1   FLOW          4.      52.
                                         TIME       12.25    12.17

  2 COMBINED AT
+                   2F       .14     1   FLOW          6.      75.
                                         TIME       12.25    12.17

 ROUTED TO
+                2F-5F       .14     1   FLOW          7.      75.
                                         TIME       12.33    12.25

 HYDROGRAPH AT
+                  F-9       .20     1   FLOW          9.     111.
                                         TIME       12.25    12.08

  2 COMBINED AT
+                   5F       .33     1   FLOW         14.     177.
                                         TIME       12.33    12.17

 ROUTED TO
+                POND1       .33     1   FLOW         14.     177.
                                         TIME       12.33    12.17

                                    ** PEAK STAGES IN FEET **
                                     1   STAGE    7134.13  7136.25
                                         TIME       13.42    12.17

 HYDROGRAPH AT
+                  F-4       .27     1   FLOW         12.     147.
                                         TIME       12.25    12.17

 HYDROGRAPH AT
+                  F-5       .11     1   FLOW          5.      57.
```

				TIME	12.25	12.17
2 COMBINED AT						
+	3F	.38	1	FLOW	16.	204.
				TIME	12.25	12.17
ROUTED TO						
+	3F-6F	.38	1	FLOW	16.	197.
				TIME	12.42	12.25
HYDROGRAPH AT						
+	F-10	.09	1	FLOW	3.	42.
				TIME	12.33	12.17
2 COMBINED AT						
+	6F	.46	1	FLOW	20.	239.
				TIME	12.42	12.25
2 COMBINED AT						
+	8F	.80	1	FLOW	32.	402.
				TIME	12.42	12.25
ROUTED TO						
+	8F-9F	.80	1	FLOW	32.	388.
				TIME	12.50	12.25
2 COMBINED AT						
+	F9	1.11	1	FLOW	46.	538.
				TIME	12.50	12.25
ROUTED TO						
+	F12	1.11	1	FLOW	44.	527.
				TIME	12.75	12.42
HYDROGRAPH AT						
+	F-6	.03	1	FLOW	1.	18.
				TIME	12.17	12.08
HYDROGRAPH AT						
+	F-7	.08	1	FLOW	4.	46.
				TIME	12.17	12.08
2 COMBINED AT						
+	4F	.11	1	FLOW	5.	65.
				TIME	12.17	12.08
ROUTED TO						
+	4F-7F	.11	1	FLOW	6.	64.
				TIME	12.50	12.25

```
 HYDROGRAPH AT
+                  F-11        .11     1   FLOW          7.       80.
                                           TIME      12.08     12.08

  2 COMBINED AT
+                    7F        .22     1   FLOW          9.      106.
                                           TIME      12.50     12.17

 ROUTED TO
+                7F-10F        .22     1   FLOW         10.      106.
                                           TIME      12.50     12.33

 HYDROGRAPH AT
+                  F-14        .15     1   FLOW          7.       85.
                                           TIME      12.25     12.08

 HYDROGRAPH AT
+                  F-13        .12     1   FLOW          4.       54.
                                           TIME      12.33     12.25

  3 COMBINED AT
+                   F14        .49     1   FLOW         18.      219.
                                           TIME      12.50     12.25

 ROUTED TO
+                 DBF13        .49     1   FLOW          0.       31.
                                           TIME        .00     13.92

                                      ** PEAK STAGES IN FEET **
                                       1   STAGE   7027.98   7030.35
                                           TIME      24.92     13.92

 ROUTED TO
+                   F15        .49     1   FLOW          0.       31.
                                           TIME        .00     13.92

                                      ** PEAK STAGES IN FEET **
                                       1   STAGE   7000.00   7000.21
                                           TIME        .00     13.92

 HYDROGRAPH AT
+                  F-15        .03     1   FLOW          2.       23.
                                           TIME      12.08     12.00

  2 COMBINED AT
+                 DPF15        .52     1   FLOW          2.       33.
                                           TIME      12.08     13.92

 HYDROGRAPH AT
+                  F-12        .25     1   FLOW         11.      140.
```

```
                                       TIME        12.25    12.08

  3 COMBINED AT
 +                  F12      1.88     1  FLOW          51.     596.
                                         TIME        12.75    12.42

 ROUTED TO
 +                  F16      1.88     1  FLOW          45.     587.
                                         TIME        12.92    12.42

                                     ** PEAK STAGES IN FEET **
                                      1  STAGE     7001.09  7004.47
                                         TIME        12.92    12.42

 HYDROGRAPH AT
 +                 F-16       .06     1  FLOW           4.      45.
                                         TIME        12.08    12.00

  2 COMBINED AT
 +                DPF16      1.94     1  FLOW          46.     595.
                                         TIME        12.92    12.42

 ROUTED TO
 +                  F17      1.94     1  FLOW          47.     585.
                                         TIME        13.00    12.50

 HYDROGRAPH AT
 +                 F-17       .05     1  FLOW           2.      26.
                                         TIME        12.33    12.17

  2 COMBINED AT
 +                  DPF      1.99     1  FLOW          48.     599.
                                         TIME        13.00    12.50
1
-.1


1                               SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION    POND1
                             (PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED  DURING BREACH FORMATION)

      PLAN  1 ..............                 INITIAL VALUE     SPILLWAY CREST     TOP OF DAM
                                ELEVATION      7133.00           7133.00          7133.00
                                STORAGE             0.                0.               0.
                                OUTFLOW             0.                0.               0.

                      RATIO     MAXIMUM      MAXIMUM    MAXIMUM    MAXIMUM    DURATION     TIME OF     TIME OF
                        OF     RESERVOIR      DEPTH     STORAGE    OUTFLOW    OVER TOP   MAX OUTFLOW   FAILURE
                       PMF     W.S.ELEV     OVER DAM     AC-FT       CFS       HOURS       HOURS        HOURS
```

.56	7134.13	1.13	1.	6.	13.08	13.42	.00
1.00	7136.25	3.25	2.	29.	13.42	12.17	.00

1

SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION DBF13
(PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED DURING BREACH FORMATION)

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	7026.00	7029.00	7029.00
STORAGE	0.	8.	8.
OUTFLOW	0.	0.	0.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.56	7027.98	.00	5.	0.	.00	.00	.00
1.00	7030.35	1.35	12.	31.	12.50	13.92	.00

*** NORMAL END OF HEC-1 ***

```
1****************************************                              ***************************************
 *                                      *                              *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                              *   U.S. ARMY CORPS OF ENGINEERS      *
 *              JUN   1998              *                              *   HYDROLOGIC ENGINEERING CENTER     *
 *            VERSION 4.1               *                              *         609 SECOND STREET           *
 *                                      *                              *      DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   18DEC17  TIME  10:42:42  *                              *          (916) 756-1104             *
 *                                      *                              *                                     *
 ****************************************                              ***************************************


                                        X     X  XXXXXXX   XXXXX         X
                                        X     X  X        X     X       XX
                                        X     X  X        X              X
                                        XXXXXXX  XXXX     X       XXXXX  X
                                        X     X  X        X              X
                                        X     X  X        X     X        X
                                        X     X  XXXXXXX   XXXXX        XXX


          THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

          THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
          THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
          NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
          DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
          KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                            HEC-1 INPUT                                            PAGE  1

          LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

             1           ID              Wolf Ranch Master Development Drainage Plan
             2           ID              G Basins Existing develkopment conditions  PN 03094
             3           ID              5-YEAR AND 100-YEAR 2-HOUR STROM PER DCM 2014 GBAS-E.DAT
                         *DIAGRAM
             4           IT       5       0       0     300
             5           IO       5       0
             6           JR    PREC     .56     1.0

             7           KK   G-1
             8           KM         RUNOFF - Sub-basin G-1
             9           BA   .0808
            10           IN       5
```

G-Basins Ex 2-Hour Storm

```
 11           PB    2.77
 12           PC       0     .024     .061     .101     .148     .223     .313     .442     .721     .981
 13           PC    .892     .943     .986    1.024     1.05    1.073    1.095    1.117    1.137    1.157
 14           PC   1.176    1.196    1.212    1.229    1.245
 15           LS       0       61
 16           UD    0.22

 17           KK      G2
 18           KM          ROUTE FLOW from SUB-BASIN G-1 TO DP G2
 19           RD    3700   0.029     0.04              TRAP       10       10

 20           KK     G-2
 21           KM          RUNOFF - Sub-basin G-2
 22           BA    .171
 23           LS       0       61
 24           UD    0.31

 25           KK    DPG2
 26           KM   COMBINE RUNOFF from G2 AND SUB-BASIN G-2
 27           HC       2

 28           KK      G3
 29           KM          ROUTE FLOW from DP G2 TOA DP G
 30           RD    1850   0.028     0.04              TRAP       10       10

 31           KK     G-3
 32           KM          RUNOFF - Sub-basin G-3
 33           BA    .068
 34           LS       0       61
 35           UD    0.44

 36           KK     DPG
 37           KM          COMBINE RUNOFF from G3 AND SUB-BASIN G-3
 38           HC       2
 39           ZZ
1
               SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

     7       G-1
                V
                V
    17         G2
                .
                .
    20          .          G-2
                .            .
```

```
                 .           .
   25        DPG2............
                  V
                  V
   28            G3
                  .
                  .
   31             .        G-3
                  .          .
                  .          .
   36         DPG............

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************
 *                                       *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
 *             JUN   1998                *
 *           VERSION 4.1                 *
 *                                       *
 *  RUN DATE   18DEC17  TIME  10:42:42   *
 *                                       *
 *****************************************

 ***************************************
 *                                     *
 *    U.S. ARMY CORPS OF ENGINEERS     *
 *    HYDROLOGIC ENGINEERING CENTER    *
 *          609 SECOND STREET          *
 *       DAVIS, CALIFORNIA 95616       *
 *           (916) 756-1104            *
 *                                     *
 ***************************************

                          Wolf Ranch Master Development Drainage Plan
                          G Basins Existing develkopment conditions  PN 03094
                          5-YEAR AND 100-YEAR 2-HOUR STROM PER DCM 2014 GBAS-E.DAT

   5 IO         OUTPUT CONTROL VARIABLES
                      IPRNT          5  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

     IT         HYDROGRAPH TIME DATA
                       NMIN          5  MINUTES IN COMPUTATION INTERVAL
                      IDATE      1    0  STARTING DATE
                      ITIME       0000  STARTING TIME
                         NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      2    0  ENDING DATE
                     NDTIME       0055  ENDING TIME
                      ICENT         19  CENTURY MARK

                 COMPUTATION INTERVAL     .08 HOURS
                      TOTAL TIME BASE   24.92 HOURS

        ENGLISH UNITS
             DRAINAGE AREA         SQUARE MILES
```

```
               PRECIPITATION DEPTH   INCHES
               LENGTH, ELEVATION     FEET
               FLOW                  CUBIC FEET PER SECOND
               STORAGE VOLUME        ACRE-FEET
               SURFACE AREA          ACRES
               TEMPERATURE           DEGREES FAHRENHEIT

     JP          MULTI-PLAN OPTION
                       NPLAN              1  NUMBER OF PLANS

     JR          MULTI-RATIO OPTION
                     RATIOS OF PRECIPITATION
                     .56       1.00
1
```

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .56	RATIO 2 1.00
HYDROGRAPH AT						
+	G-1	.08	1	FLOW	1.	18.
				TIME	2.00	1.00
ROUTED TO						
+	G2	.08	1	FLOW	1.	17.
				TIME	2.50	1.25
HYDROGRAPH AT						
+	G-2	.17	1	FLOW	3.	33.
				TIME	2.08	1.17
2 COMBINED AT						
+	DPG2	.25	1	FLOW	3.	49.
				TIME	2.08	1.25
ROUTED TO						
+	G3	.25	1	FLOW	3.	49.
				TIME	2.33	1.33
HYDROGRAPH AT						
+	G-3	.07	1	FLOW	1.	12.
				TIME	2.17	1.33
2 COMBINED AT						
+	DPG	.32	1	FLOW	4.	60.

*** NORMAL END OF HEC-1 ***

```
1****************************************                    ****************************************
 *                                      *                    *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                    *   U.S. ARMY CORPS OF ENGINEERS       *
 *              JUN   1998              *                    *   HYDROLOGIC ENGINEERING CENTER      *
 *            VERSION 4.1               *                    *         609 SECOND STREET            *
 *                                      *                    *      DAVIS, CALIFORNIA 95616         *
 *  RUN DATE   18DEC17  TIME  10:46:17  *                    *          (916) 756-1104              *
 *                                      *                    *                                      *
 ****************************************                    ****************************************


                    X     X  XXXXXXX   XXXXX          X
                    X     X  X        X     X        XX
                    X     X  X        X               X
                    XXXXXXX  XXXX     X        XXXXX  X
                    X     X  X        X               X
                    X     X  X        X     X         X
                    X     X  XXXXXXX   XXXXX         XXX


      THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

      THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
      THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
      NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
      DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
      KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                          HEC-1 INPUT                                              PAGE  1

      LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

        1           ID              Wolf Ranch master Development Drainage Plan
        2           ID              H-BASINS EXISTING DEVELOPMENT   PN17049
        3           ID              5-year and 100 Year, 2 HR STORM PER 2014 DCM HBAS-E.DAT
                    *DIAGRAM
        4           IT       5       0       0     300
        5           IO       4       0
        6           JR    PREC     .56     1.0

        7           KK     H-1
        8           KM          RUNOFF FROM SUB-BASIN H-1
        9           BA   .0370
       10           IN       5
```

H-BASINS
Existing
2-HR STORM

```
          11           PB    2.77
          12           PC       0     .024     .061     .101     .148     .223     .313     .442     .721     .881
          13           PC     .892     .943     .986    1.024     1.05    1.073    1.095    1.117    1.137    1.157
          14           PC    1.176    1.194    1.212    1.229    1.245
          15           LS       0       61
          16           UD    0.05

          17           KK     H-2
          18           KM          RUNOFF FROM SUB-BASIN H-2
          19           BA   .0931
          20           LS       0       61
          21           UD     .47
          22           ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.       (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    7          H-1
                .
                .
   17           .        H-2

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************
 *                                       *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
 *              JUN   1998               *
 *            VERSION 4.1                *
 *                                       *
 *  RUN DATE   18DEC17  TIME  10:46:17   *
 *                                       *
 *****************************************

 *****************************************
 *                                       *
 *    U.S. ARMY CORPS OF ENGINEERS       *
 *    HYDROLOGIC ENGINEERING CENTER      *
 *          609 SECOND STREET            *
 *       DAVIS, CALIFORNIA 95616         *
 *           (916) 756-1104              *
 *                                       *
 *****************************************


                          Wolf Ranch master Development Drainage Plan
                          H-BASINS EXISTING DEVELOPMENT   PN17049
                          5-year and 100 Year, 2 HR STORM PER 2014 DCM HBAS-E.DAT

   5 IO         OUTPUT CONTROL VARIABLES
                      IPRNT          4  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

     IT         HYDROGRAPH TIME DATA
```

```
                    NMIN           5  MINUTES IN COMPUTATION INTERVAL
                   IDATE      1    0  STARTING DATE
                   ITIME        0000  STARTING TIME
                      NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                  NDDATE      2    0  ENDING DATE
                  NDTIME        0055  ENDING TIME
                   ICENT          19  CENTURY MARK

              COMPUTATION INTERVAL     .08 HOURS
                   TOTAL TIME BASE   24.92 HOURS

        ENGLISH UNITS
             DRAINAGE AREA         SQUARE MILES
             PRECIPITATION DEPTH   INCHES
             LENGTH, ELEVATION     FEET
             FLOW                  CUBIC FEET PER SECOND
             STORAGE VOLUME        ACRE-FEET
             SURFACE AREA          ACRES
             TEMPERATURE           DEGREES FAHRENHEIT

   JP          MULTI-PLAN OPTION
                     NPLAN           1  NUMBER OF PLANS

   JR          MULTI-RATIO OPTION
                   RATIOS OF PRECIPITATION
                   .56      1.00


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          **************
          *            *
   7 KK   *      H-1   *
          *            *
          **************
                              RUNOFF FROM SUB-BASIN H-1

  10 IN        TIME DATA FOR INPUT TIME SERIES
                     JXMIN           5  TIME INTERVAL IN MINUTES
                    JXDATE      1    0  STARTING DATE
                    JXTIME           0  STARTING TIME

             SUBBASIN RUNOFF DATA

   9 BA        SUBBASIN CHARACTERISTICS
                     TAREA         .04  SUBBASIN AREA

               PRECIPITATION DATA
```

```
 11 PB              STORM        2.77  BASIN TOTAL PRECIPITATION

 12 PI          INCREMENTAL PRECIPITATION PATTERN
                     .02       .04       .04       .05       .08       .09       .13       .28       .16       .01
                     .05       .04       .04       .03       .02       .02       .02       .02       .02       .02
                     .02       .02       .02       .02

 15 LS          SCS LOSS RATE
                    STRTL        1.28  INITIAL ABSTRACTION
                   CRVNBR       61.00  CURVE NUMBER
                    RTIMP         .00  PERCENT IMPERVIOUS AREA

 16 UD          SCS DIMENSIONLESS UNITGRAPH
                     TLAG         .05  LAG

                                                                  ***

                                                            UNIT HYDROGRAPH
                                                        5 END-OF-PERIOD ORDINATES
              192.       73.       17.        4.        1.


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
 17 KK      *      H-2   *
            *            *
            **************
                                 RUNOFF FROM SUB-BASIN H-2

             SUBBASIN RUNOFF DATA

 19 BA          SUBBASIN CHARACTERISTICS
                    TAREA         .09  SUBBASIN AREA

                PRECIPITATION DATA

 11 PB              STORM        2.77  BASIN TOTAL PRECIPITATION

 12 PI          INCREMENTAL PRECIPITATION PATTERN
                     .02       .04       .04       .05       .08       .09       .13       .28       .16       .01
                     .05       .04       .04       .03       .02       .02       .02       .02       .02       .02
                     .02       .02       .02       .02

 20 LS          SCS LOSS RATE
                    STRTL        1.28  INITIAL ABSTRACTION
```

```
                  CRVNBR       61.00  CURVE NUMBER
                   RTIMP         .00  PERCENT IMPERVIOUS AREA

   21 UD           SCS DIMENSIONLESS UNITGRAPH
                    TLAG         .47  LAG

                                                        ***

                                                   UNIT HYDROGRAPH
                                              30 END-OF-PERIOD ORDINATES
                7.       19.       40.       65.       83.       88.       85.       75.       63.       47.
               35.       27.       21.       16.       12.        9.        7.        5.        4.        3.
                2.        2.        1.        1.        1.        1.        1.        0.        0.        0.
1

             PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                  FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                                  TIME TO PEAK IN HOURS


                                                                RATIOS APPLIED TO PRECIPITATION
 OPERATION         STATION      AREA     PLAN              RATIO 1  RATIO 2
                                                               .56     1.00

 HYDROGRAPH AT
+                     H-1        .04       1    FLOW          0.       11.
                                                TIME        2.00       .75

 HYDROGRAPH AT
+                     H-2        .09       1    FLOW          1.       12.
                                                TIME        2.25      1.42


 *** NORMAL END OF HEC-1 ***
```

HEC-1 INPUT & OUTPUT
DEVELOPED CONDITIONS

```
1*****************************************
 *                                       *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
 *              JUN   1998               *
 *            VERSION 4.1                *
 *                                       *
 *  RUN DATE   13MAR13  TIME  09:44:12   *
 *                                       *
 *****************************************
```

```
***************************************
*                                     *
*   U.S. ARMY CORPS OF ENGINEERS      *
*   HYDROLOGIC ENGINEERING CENTER     *
*         609 SECOND STREET           *
*      DAVIS, CALIFORNIA 95616        *
*          (916) 756-1104             *
*                                     *
***************************************
```

```
X     X  XXXXXXX   XXXXX           X
X     X  X        X     X         XX
X     X  X        X                X
XXXXXXX  XXXX     X        XXXXX   X
X     X  X        X                X
X     X  X        X     X          X
X     X  XXXXXXX   XXXXX          XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID        Wolf Ranch, Master Developed Drainage Plan   PN 12055
  2           ID        A Basins, future development condition ABAS-F.DAT
  3           ID        5-year and 100 Year, 24 hr Type IIA  Storm
  4           ID        LAND USES UPDATED TO MATCH REVISED DEVELOPMENT PLAN
              *DIAGRAM
  5           IT       5       0       0     300
  6           IO       5       0
  7           JR    PREC     .56     1.0

  8           KK     A-1
  9           KM      RUNOFF FROM SUB-BASIN A-1
 10           BA    .060
```

A. Basin Future/ Developed

```
  11          IN      15
  12          PB     4.4
  13          PC  0.0000  0.0005  0.0015  0.0030  0.0045  0.0060  0.0080  0.0100  0.0120  0.0143
  14          PC  0.0165  0.0188  0.0210  0.0233  0.0255  0.0278  0.0320  0.0390  0.0460  0.0530
  15          PC  0.0600  0.0750  0.1000  0.4000  0.7000  0.7250  0.7500  0.7650  0.7800  0.7900
  16          PC  0.8000  0.8100  0.8200  0.8250  0.8300  0.8350  0.8400  0.8450  0.8500  0.8550
  17          PC  0.8600  0.8638  0.8675  0.8713  0.8750  0.8788  0.8825  0.8863  0.8900  0.8938
  18          PC  0.8975  0.9013  0.9050  0.9083  0.9115  0.9148  0.9180  0.9210  0.9240  0.9270
  19          PC  0.9300  0.9325  0.9350  0.9375  0.9400  0.9425  0.9450  0.9475  0.9500  0.9525
  20          PC  0.9550  0.9575  0.9600  0.9625  0.9650  0.9675  0.9700  0.9725  0.9750  0.9775
  21          PC  0.9800  0.9813  0.9825  0.9838  0.9850  0.9863  0.9875  0.9888  0.9900  0.9913
  22          PC  0.9925  0.9938  0.9950  0.9963  0.9975  0.9988  1.0000
  23          LS       0      61
  24          UD    .292

  25          KK      A3
  26          KM   ROUTE FLOW FROM SUB-BASIN A-1 TO DP A3
  27          RD    3500    .021    0.04            TRAP      10       4

  28          KK     A-4
  29          KM   RUNOFF FROM SUB-BASIN A-4
  30          BA   .0861
  31          LS       0    76.3
  32          UD    0.21

  33          KK      A4
  34          KM   ROUTE FLOW FROM SB A-4 TO DP A3
  35          RD     450     .02    .013            CIRC     3.5

  36          KK     A-3
  37          KM   RUNOFF FROM SUB-BASIN A-3
  38          BA   .1500
  39          LS       0      73
  40          UD    .221

  41          KK    DPA3
  42          KM   DESIGN POINT A3 COMBINE RUNOFF FROM SUB-BASIN A-3, A3 AND A4
  43          HC       3
1                                        HEC-1 INPUT                                            PAGE  2

 LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


  44          KK      A6
  45          KM   ROUTE FLOW FROM DP A3 TO DP A6
  46          RD    1550    .016    0.04            TRAP      10       4

  47          KK    A-11
  48          KM   RUNOFF FROM SUB-BASIN A-11
  49          BA    .081
```

```
    50          LS        0    76.8
    51          UD      .19

    52          KK      A11
    53          KM    ROUTE RUNOFF FROM SB A-11 TO DPA8
    54          RD     1400     .02    .013            CIRC     3.5

    55          KK      A-8
    56          KM    RUNOFF FROM SUB-BASIN A-8
    57          BA     .079
    58          LS        0    83.9
    59          UD     .250

    60          KK    DP A8
    61          KM    COMBINE RUNOFF FROM SB A-8 AND A11
    62          HC        2

    63          KK       A8
    64          KM    ROUTE RUNOFF FROM DP A8 TO DP A7
    65          RD     1100     .02    .013            CIRC     4.5

    66          KK    A-7
    67          KM    RUNOFF FROM SUB-BASIN A-7
    68          BA    .0500
    69          LS        0      72
    70          UD     .172

    71          KK    DP A7
    72          KM    COMBINE RUNOFF FROM SUB-BASIN A-7 AND A8
    73          HC        2

    74          KK       A7
    75          KM    ROUTE FLOW FROM SUB-BASIN A-7 TO DP A6
    76          RD      800    0.02   0.013            CIRC       5

    77          KK    A-6
    78          KM    RUNOFF FROM SUB-BASIN A-6
    79          BA     .045
    80          LS        0    80.8
    81          UD      .21

    82          KK     DPA6
    83          KM    DESIGN POINT A6 COMBINE RUNOFF FROM SUB-BASIN A-6, A6 AND A7
    84          HC        3
1                                       HEC-1 INPUT                                                PAGE  3

  LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

    85          KK       A5
```

```
 86   KM   ROUTE FLOW FROM DESIGN POINT A6 TO DP A5
 87   RD    2200    .011     .04             TRAP      10        4

 88   KK    A-12
 89   KM     RUNOFF FROM SUB-BASIN A-12
 90   BA    .048
 91   LS       0       78
 92   UD    .181

 93   KK     A12
 94   KM   ROUTE RUNOFF FROM A-12 TO DP A9
 95   RD    1950     .02    .013             CIRC       3

 96   KK   A-9
 97   KM   RUNOFF FROM SUB-BASIN A-9
 98   BA   .0590
 99   LS       0    76.3
100   UD    .263

101   KK   DP A9
102   KM   COMBINE RUNOFF FROM SUB-BASIN A-9 AND A12
103   HC       2

104   KK      A9
105   KM   ROUTE FLOW FROM DES POINT A9 TO DESIGN POINT A5
106   RD     500     .02    .016             CIRC       4

107   KK   A-5
108   KM   RUNOFF FROM SUB-BASIN A-5
109   BA   .1114
110   LS       0    69.7
111   UD    .209

112   KK    DPA5
113   KM   DESIGN POINT A5 COMBINE RUNOFF FROM SUB-BASIN A-5, A5 AND A9
114   HC       3

115   KK     A10
116   KM   ROUTE FLOW FROM DESIGN POINT A5 TO DESIGN POINT A
117   RD     720    .021     .04             TRAP      15        4

118   KK    A-10
119   KM   RUNOFF FROM SUB-BASIN A-10
120   BA   .0086
121   LS       0    79.6
122   UD    .231

123   KK     DPA
124   KM   DESIGN POINT A COMBINE RUNOFF SUB-BASIN A-10 AND A10
125   HC       2
```

```
        126           ZZ

             SCHEMATIC DIAGRAM OF STREAM NETWORK
PUT
INE     (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

NO.     (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

  8        A-1
             V
             V
 25         A3
             .
             .
 28          .         A-4
             .           V
             .           V
 33          .          A4
             .           .
             .           .
 36          .           .          A-3
             .           .            .
             .           .            .
 41       DPA3.........................
             V
             V
 44         A6
             .
             .
 47          .        A-11
             .           V
             .           V
 52          .         A11
             .           .
             .           .
 55          .           .          A-8
             .           .            .
             .           .            .
 60          .       DP A8............
             .           V
             .           V
 63          .          A8
             .           .
             .           .
 66          .           .        A-7
             .           .            .
             .           .            .
 71          .       DP A7............
             .           V
             .           V
```

```
  74          .          A7
              .           .
              .           .
  77          .           .        A-6
              .           .           .
              .           .           .
  82       DPA6.......................
              V
              V
  85         A5
              .
              .
  88          .        A-12
              .           V
              .           V
  93          .         A12
              .           .
              .           .
  96          .           .        A-9
              .           .           .
              .           .           .
 101          .       DP A9............
              .           V
              .           V
 104          .          A9
              .           .
              .           .
 107          .           .        A-5
              .           .           .
              .           .           .
 112       DPA5.......................
              V
              V
 115        A10
              .
              .
 118          .        A-10
              .           .
              .           .
 123        DPA............
```

```
 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1***************************************
 *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
 *              JUN   1998              *
 *           VERSION 4.1                *
 *                                      *
 *  RUN DATE   13MAR13  TIME  09:44:12  *
 *                                      *
```

```
***************************************
*                                     *
*    U.S. ARMY CORPS OF ENGINEERS     *
*    HYDROLOGIC ENGINEERING CENTER    *
*          609 SECOND STREET          *
*      DAVIS, CALIFORNIA 95616        *
*          (916) 756-1104             *
*                                     *
```

```
*****************************************                               ***************************************

                                  Wolf Ranch, Master Developed Drainage Plan   PN 12055
                                  A Basins, future development condition ABAS-F.DAT
                                  5-year and 100 Year, 24 hr Type IIA  Storm
                                  LAND USES UPDATED TO MATCH REVISED DEVELOPMENT PLAN

   6 IO          OUTPUT CONTROL VARIABLES
                       IPRNT          5  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE

     IT          HYDROGRAPH TIME DATA
                        NMIN          5  MINUTES IN COMPUTATION INTERVAL
                       IDATE     1    0  STARTING DATE
                       ITIME       0000  STARTING TIME
                          NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                      NDDATE     2    0  ENDING DATE
                      NDTIME       0055  ENDING TIME
                      ICENT          19  CENTURY MARK

                   COMPUTATION INTERVAL     .08 HOURS
                        TOTAL TIME BASE   24.92 HOURS

          ENGLISH UNITS
               DRAINAGE AREA          SQUARE MILES
               PRECIPITATION DEPTH    INCHES
               LENGTH, ELEVATION      FEET
               FLOW                   CUBIC FEET PER SECOND
               STORAGE VOLUME         ACRE-FEET
               SURFACE AREA           ACRES
               TEMPERATURE            DEGREES FAHRENHEIT

     JP          MULTI-PLAN OPTION
                       NPLAN          1  NUMBER OF PLANS

     JR          MULTI-RATIO OPTION
                     RATIOS OF PRECIPITATION
                     .56      1.00
1

               PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                 FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                                TIME TO PEAK IN HOURS
```

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .56	RATIO 2 1.00
HYDROGRAPH AT						
+	A-1	.06	1	FLOW	3.	32.
				TIME	6.25	6.17
ROUTED TO						
+	A3	.06	1	FLOW	3.	31.
				TIME	6.75	6.42
HYDROGRAPH AT						
+	A-4	.09	1	FLOW	39.	133.
				TIME	6.08	6.08
ROUTED TO						
+	A4	.09	1	FLOW	38.	132.
				TIME	6.08	6.08
HYDROGRAPH AT						
+	A-3	.15	1	FLOW	49.	194.
				TIME	6.17	6.08
3 COMBINED AT						
+	DPA3	.30	1	FLOW	87.	326.
				TIME	6.17	6.08
ROUTED TO						
+	A6	.30	1	FLOW	86.	318.
				TIME	6.17	6.17
HYDROGRAPH AT						
+	A-11	.08	1	FLOW	41.	134.
				TIME	6.08	6.08
ROUTED TO						
+	A11	.08	1	FLOW	39.	131.
				TIME	6.08	6.08
HYDROGRAPH AT						
+	A-8	.08	1	FLOW	57.	152.
				TIME	6.17	6.08
2 COMBINED AT						
+	DP A8	.16	1	FLOW	95.	283.
				TIME	6.08	6.08
ROUTED TO						
+	A8	.16	1	FLOW	94.	278.

				TIME	6.17	6.08
HYDROGRAPH AT						
+	A-7	.05	1	FLOW	18.	69.
				TIME	6.08	6.08
2 COMBINED AT						
+	DP A7	.21	1	FLOW	109.	347.
				TIME	6.17	6.08
ROUTED TO						
+	A7	.21	1	FLOW	109.	343.
				TIME	6.17	6.08
HYDROGRAPH AT						
+	A-6	.05	1	FLOW	29.	84.
				TIME	6.08	6.08
3 COMBINED AT						
+	DPA6	.55	1	FLOW	222.	722.
				TIME	6.17	6.08
ROUTED TO						
+	A5	.55	1	FLOW	218.	712.
				TIME	6.25	6.17
HYDROGRAPH AT						
+	A-12	.05	1	FLOW	27.	84.
				TIME	6.08	6.08
ROUTED TO						
+	A12	.05	1	FLOW	26.	82.
				TIME	6.08	6.08
HYDROGRAPH AT						
+	A-9	.06	1	FLOW	24.	81.
				TIME	6.17	6.17
2 COMBINED AT						
+	DP A9	.11	1	FLOW	49.	161.
				TIME	6.17	6.08
ROUTED TO						
+	A9	.11	1	FLOW	49.	159.
				TIME	6.17	6.08
HYDROGRAPH AT						
+	A-5	.11	1	FLOW	27.	126.
				TIME	6.17	6.08

```
  3 COMBINED AT
+                  DPA5       .77      1    FLOW          281.      983.
                                            TIME          6.25      6.17

 ROUTED TO
+                   A10       .77      1    FLOW          275.      968.
                                            TIME          6.25      6.17

 HYDROGRAPH AT
+                  A-10       .01      1    FLOW            5.       15.
                                            TIME          6.08      6.08

  2 COMBINED AT
+                   DPA       .78      1    FLOW          279.      982.
                                            TIME          6.25      6.17


 *** NORMAL END OF HEC-1 ***
```

```
1***************************************                                       ***************************************
 *                                     *                                       *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                      *    U.S. ARMY CORPS OF ENGINEERS     *
 *              JUN   1998              *                                      *    HYDROLOGIC ENGINEERING CENTER    *
 *            VERSION 4.1               *                                      *         609 SECOND STREET           *
 *                                     *                                       *      DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   14APR04  TIME  14:59:56  *                                      *          (916) 756-1104             *
 *                                     *                                       *                                     *
***************************************                                        ***************************************


                    X     X  XXXXXXX   XXXXX          X
                    X     X  X        X     X        XX
                    X     X  X        X               X
                    XXXXXXX  XXXX     X        XXXXX  X
                    X     X  X        X               X
                    X     X  X        X     X         X
                    X     X  XXXXXXX   XXXXX         XXX


        THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

        THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
        THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
        NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
        DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
        KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM
```



```
       LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

         1           ID          Wolf Ranch Master Development Drainage Plan
         2           ID                         B basins future development condition PN 03094
         3           ID          5-year and 100 year, 24 hr Type IIA  Storm
                     *DIAGRAM
         4           IT        5       0       0     300
         5           IO        5       0
         6           JR     PREC     .56     1.0

         7           KK      B-1
         8           KM   RUNOFF FOR SUB-BASIN B-1
         9           BA    .0400
        10           IN       15
```

B. Basin Future

```
          11          PB    4.4
          12          PC  0.0000  0.0005  0.0015  0.0030  0.0045  0.0060  0.0080  0.0100  0.0120  0.0143
          13          PC  0.0165  0.0188  0.0210  0.0233  0.0255  0.0278  0.0320  0.0390  0.0460  0.0530
          14          PC  0.0600  0.0750  0.1000  0.4000  0.7000  0.7250  0.7500  0.7650  0.7800  0.7900
          15          PC  0.8000  0.8100  0.8200  0.8250  0.8300  0.8350  0.8400  0.8450  0.8500  0.8550
          16          PC  0.8600  0.8638  0.8675  0.8713  0.8750  0.8788  0.8825  0.8863  0.8900  0.8938
          17          PC  0.8975  0.9013  0.9050  0.9083  0.9115  0.9148  0.9180  0.9210  0.9240  0.9270
          18          PC  0.9300  0.9325  0.9350  0.9375  0.9400  0.9425  0.9450  0.9475  0.9500  0.9525
          19          PC  0.9550  0.9575  0.9600  0.9625  0.9650  0.9675  0.9700  0.9725  0.9750  0.9775
          20          PC  0.9800  0.9813  0.9825  0.9838  0.9850  0.9863  0.9875  0.9888  0.9900  0.9913
          21          PC  0.9925  0.9938  0.9950  0.9963  0.9975  0.9988  1.0000
          22          LS       0      92
          23          UD   .1070
          24          ZZ
1
               SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE     (V) ROUTING         (--->) DIVERSION OR PUMP FLOW

   NO.     (.) CONNECTOR       (<---) RETURN OF DIVERTED OR PUMPED FLOW

     7          B-1

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                      *****************************************
 *                                       *                                      *                                       *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                      *    U.S. ARMY CORPS OF ENGINEERS       *
 *             JUN   1998                *                                      *    HYDROLOGIC ENGINEERING CENTER      *
 *           VERSION 4.1                 *                                      *          609 SECOND STREET            *
 *                                       *                                      *       DAVIS, CALIFORNIA 95616         *
 *  RUN DATE   14APR04  TIME  14:59:56   *                                      *           (916) 756-1104              *
 *                                       *                                      *                                       *
 *****************************************                                      *****************************************



                              Wolf Ranch Master Development Drainage Plan
                                    B basins future development condition PN 03094
                              5-year and 100 year, 24 hr Type IIA  Storm

   5 IO          OUTPUT CONTROL VARIABLES
                       IPRNT          5  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE

     IT          HYDROGRAPH TIME DATA
                       NMIN           5  MINUTES IN COMPUTATION INTERVAL
                       IDATE      1   0  STARTING DATE
```

```
                 ITIME        0000  STARTING TIME
                    NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                NDDATE      2    0  ENDING DATE
                NDTIME        0055  ENDING TIME
                 ICENT          19  CENTURY MARK

          COMPUTATION INTERVAL     .08 HOURS
               TOTAL TIME BASE   24.92 HOURS

      ENGLISH UNITS
           DRAINAGE AREA          SQUARE MILES
           PRECIPITATION DEPTH    INCHES
           LENGTH, ELEVATION      FEET
           FLOW                   CUBIC FEET PER SECOND
           STORAGE VOLUME         ACRE-FEET
           SURFACE AREA           ACRES
           TEMPERATURE            DEGREES FAHRENHEIT

JP           MULTI-PLAN OPTION
                   NPLAN            1  NUMBER OF PLANS

JR           MULTI-RATIO OPTION
                 RATIOS OF PRECIPITATION
                  .56      1.00
1

          PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                              FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                                TIME TO PEAK IN HOURS


                                                               RATIOS APPLIED TO PRECIPITATION
 OPERATION       STATION     AREA    PLAN              RATIO 1  RATIO 2
                                                           .56     1.00

 HYDROGRAPH AT
+                    B-1       .04     1    FLOW           60.     122.
                                            TIME          6.00     6.00


 *** NORMAL END OF HEC-1 ***
```

```
1***************************************                               ***************************************
 *                                     *                               *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                               *   U.S. ARMY CORPS OF ENGINEERS      *
 *             JUN   1998              *                               *   HYDROLOGIC ENGINEERING CENTER     *
 *           VERSION 4.1               *                               *         609 SECOND STREET           *
 *                                     *                               *      DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   24JAN05  TIME  09:53:48  *                               *          (916) 756-1104             *
 *                                     *                               *                                     *
 ***************************************                               ***************************************


                           X     X  XXXXXXX   XXXXX         X
                           X     X  X        X     X       XX
                           X     X  X        X              X
                           XXXXXXX  XXXX     X       XXXXX  X
                           X     X  X        X              X
                           X     X  X        X     X        X
                           X     X  XXXXXXX   XXXXX        XXX


        THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

        THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
        THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
        NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
        DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
        KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                         HEC-1 INPUT                                                    PAGE  1

      LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

        1           ID           Wolf Ranch Master Development Drainage Plan
        2           ID                          C basins future development condition PN 03094
        3           ID              5-year and 100 year, 24 hr Type IIA Storm
                    *DIAGRAM
        4           IT       5       0       0     300
        5           IO       5       0
        6           JR    PREC     .56     1.0

        7           KK     C-1
        8           KM   RUNOFF FOR SUB-BASIN C-1
        9           BA   .0460
       10           IN      15
       11           PB     4.4
       12           PC  0.0000  0.0005  0.0015  0.0030  0.0045  0.0060  0.0080  0.0100  0.0120  0.0143
```

C-BASIN DESIGN

```
 13          PC  0.0165  0.0188  0.0210  0.0233  0.0255  0.0278  0.0320  0.0390  0.0460  0.0530
 14          PC  0.0600  0.0750  0.1000  0.4000  0.7000  0.7250  0.7500  0.7650  0.7800  0.7900
 15          PC  0.8000  0.8100  0.8200  0.8250  0.8300  0.8350  0.8400  0.8450  0.8500  0.8550
 16          PC  0.8600  0.8638  0.8675  0.8713  0.8750  0.8788  0.8825  0.8863  0.8900  0.8938
 17          PC  0.8975  0.9013  0.9050  0.9083  0.9115  0.9148  0.9180  0.9210  0.9240  0.9270
 18          PC  0.9300  0.9325  0.9350  0.9375  0.9400  0.9425  0.9450  0.9475  0.9500  0.9525
 19          PC  0.9550  0.9575  0.9600  0.9625  0.9650  0.9675  0.9700  0.9725  0.9750  0.9775
 20          PC  0.9800  0.9813  0.9825  0.9838  0.9850  0.9863  0.9875  0.9888  0.9900  0.9913
 21          PC  0.9925  0.9938  0.9950  0.9963  0.9975  0.9988  1.0000
 22          LS       0      79
 23          UD   .1550

 24          KK      C1
 25          KM   ROUTE FLOW FROM SUB-BASIN C-1 TO C2
 26          RD    2500    0.02    .013            CIRC     4.0

 27          KK      C2
 28          KM   ROUTE FLOW FROM C1 TO DP C
 29          RD    1450    0.02    .013            CIRC     6.0

 30          KK     C-2
 31          KM   RUNOFF FROM SUB-BASIN C-2
 32          BA   .1110
 33          LS       0    79.2
 34          UD    .098

 35          KK     DPC
 36          KM   DESIGN POINT C COMBINE RUNOFF FROM SUB-BASIN C-2 AND C2
 37          HC       2

 38          KK     C-3
 39          KM   RUNOFF FROM SUB-BASIN C-3
 40          BA   .0550
 41          LS       0      79
 42          UD    .186
 43          ZZ
1
                SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE     (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.     (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

     7       C-1
               V
               V
    24        C1
               V
               V
    27        C2
               .
               .
```

```
 30          .          C-2
             .            .
             .            .
 35        DPC............
             .
             .
 38          .          C-3

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1***************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*            JUN   1998                *
*           VERSION 4.1                *
*                                      *
*  RUN DATE   24JAN05  TIME  09:53:48  *
*                                      *
****************************************

****************************************
*                                      *
*    U.S. ARMY CORPS OF ENGINEERS      *
*    HYDROLOGIC ENGINEERING CENTER     *
*         609 SECOND STREET            *
*      DAVIS, CALIFORNIA 95616         *
*          (916) 756-1104              *
*                                      *
****************************************


                 Wolf Ranch Master Development Drainage Plan
                     C basins future development condition PN 03094
                  5-year and 100 year, 24 hr Type IIA Storm

 5 IO         OUTPUT CONTROL VARIABLES
                    IPRNT          5  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT         HYDROGRAPH TIME DATA
                     NMIN          5  MINUTES IN COMPUTATION INTERVAL
                    IDATE     1    0  STARTING DATE
                    ITIME       0000  STARTING TIME
                       NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE     2    0  ENDING DATE
                   NDTIME       0055  ENDING TIME
                    ICENT         19  CENTURY MARK

               COMPUTATION INTERVAL    .08 HOURS
                    TOTAL TIME BASE  24.92 HOURS

      ENGLISH UNITS
           DRAINAGE AREA          SQUARE MILES
           PRECIPITATION DEPTH    INCHES
           LENGTH, ELEVATION      FEET
           FLOW                   CUBIC FEET PER SECOND
           STORAGE VOLUME         ACRE-FEET
           SURFACE AREA           ACRES
           TEMPERATURE            DEGREES FAHRENHEIT
```

JP MULTI-PLAN OPTION
NPLAN 1 NUMBER OF PLANS

JR MULTI-RATIO OPTION
RATIOS OF PRECIPITATION
.56 1.00

1

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .56	RATIO 2 1.00
HYDROGRAPH AT						
+	C-1	.05	1	FLOW	30.	86.
				TIME	6.08	6.08
ROUTED TO						
+	C1	.05	1	FLOW	29.	86.
				TIME	6.08	6.08
ROUTED TO						
+	C2	.05	1	FLOW	27.	84.
				TIME	6.08	6.08
HYDROGRAPH AT						
+	C-2	.11	1	FLOW	84.	240.
				TIME	6.00	6.00
2 COMBINED AT						
+	DPC	.16	1	FLOW	104.	314.
				TIME	6.00	6.00
HYDROGRAPH AT						
+	C-3	.05	1	FLOW	33.	100.
				TIME	6.08	6.08

1

SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
(FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)

ISTAQ	ELEMENT	DT	PEAK	TIME TO PEAK	VOLUME	INTERPOLATED TO COMPUTATION INTERVAL DT	PEAK	TIME TO PEAK	VOLUME
		(MIN)	(CFS)	(MIN)	(IN)	(MIN)	(CFS)	(MIN)	(IN)

FOR PLAN = 1 RATIO= .00

```
1****************************************                    ***************************************
 *                                      *                    *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                    *   U.S. ARMY CORPS OF ENGINEERS      *
 *             JUN   1998               *                    *   HYDROLOGIC ENGINEERING CENTER     *
 *             VERSION 4.1              *                    *        609 SECOND STREET            *
 *                                      *                    *     DAVIS, CALIFORNIA 95616         *
 *  RUN DATE   24JAN05  TIME  10:06:30  *                    *         (916) 756-1104              *
 *                                      *                    *                                     *
****************************************                     ***************************************


              X     X  XXXXXXX   XXXXX          X
              X     X  X        X     X        XX
              X     X  X        X               X
              XXXXXXX  XXXX     X       XXXXX   X
              X     X  X        X               X
              X     X  X        X     X         X
              X     X  XXXXXXX   XXXXX         XXX


 THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

 THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
 THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
 NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
 DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
 KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                  HEC-1 INPUT                                          PAGE  1

        LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

          1       ID         Wolf Ranch Master Development Drainage Plan
          2       ID                       D Basins future development condition pn 03094
          3       ID            5-year and 100 Year, 24 hr Type IIA  Storm
                  *DIAGRAM
          4       IT       5       0       0     300
          5       IO       5       0
          6       JR    PREC     .56     1.0

          7       KK     D-1
          8       KM    RUNOFF FOR SUB-BASIN D-1
          9       BA    .0620
         10       IN      15
         11       PB     4.4
         12       PC  0.0000  0.0005  0.0015  0.0030  0.0045  0.0060  0.0080  0.0100  0.0120  0.0143
```

D-Basins Developed

```
 13          PC  0.0165  0.0188  0.0210  0.0233  0.0255  0.0278  0.0320  0.0390  0.0460  0.0530
 14          PC  0.0600  0.0750  0.1000  0.4000  0.7000  0.7250  0.7500  0.7650  0.7800  0.7900
 15          PC  0.8000  0.8100  0.8200  0.8250  0.8300  0.8350  0.8400  0.8450  0.8500  0.8550
 16          PC  0.8600  0.8638  0.8675  0.8713  0.8750  0.8788  0.8825  0.8863  0.8900  0.8938
 17          PC  0.8975  0.9013  0.9050  0.9083  0.9115  0.9148  0.9180  0.9210  0.9240  0.9270
 18          PC  0.9300  0.9325  0.9350  0.9375  0.9400  0.9425  0.9450  0.9475  0.9500  0.9525
 19          PC  0.9550  0.9575  0.9600  0.9625  0.9650  0.9675  0.9700  0.9725  0.9750  0.9775
 20          PC  0.9800  0.9813  0.9825  0.9838  0.9850  0.9863  0.9875  0.9888  0.9900  0.9913
 21          PC  0.9925  0.9938  0.9950  0.9963  0.9975  0.9988  1.0000
 22          LS       0    77.7
 23          UD    .180

 24          KK   D2
 25          KM   ROUTE FLOW FROM SUB-BASIN D-1 TO DP D2
 26          RD    1230    0.01    .013            CIRC     4.5

 27          KK     D-2
 28          KM   RUNOFF FROM SUB-BASIN D-2
 29          BA   .0360
 30          LS       0      73
 31          UD    .119

 32          KK    DPD2
 33          KM   DESIGN POINT D2 COMBINE RUNOFF FROM SUB-BASIN D-2 AND D2
 34          HC       2

 35          KK      D3
 36          KM   ROUTE FLOW FROM DP D2 TO DP D
 37          RD    3100    .026    .040            TRAP       4

 38          KK     D-3
 39          KM   RUNOFF FROM SUB-BASIN D-3
 40          BA   .0240
 41          LS       0      61
 42          UD    .380
1                                   HEC-1 INPUT                                          PAGE  2

LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 43          KK     DPD
 44          KM   DESIGN POINT D COMBINE RUNOFF FROM SUB-BASINS D-3 AND D2
 45          HC       2
 46          ZZ
1
          SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE     (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.     (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   7        D-1
```

```
              V
              V
 24        D2
              .
              .
 27           .          D-2
              .            .
              .            .
 32        DPD2............
              V
              V
 35          D3
              .
              .
 38           .          D-3
              .            .
              .            .
 43         DPD............

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```

```
1***************************************
 *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
 *              JUN   1998             *
 *           VERSION 4.1               *
 *                                     *
 *  RUN DATE   24JAN05  TIME  10:06:30  *
 *                                     *
 ***************************************
```

```
***************************************
*                                     *
*     U.S. ARMY CORPS OF ENGINEERS    *
*     HYDROLOGIC ENGINEERING CENTER   *
*           609 SECOND STREET         *
*       DAVIS, CALIFORNIA 95616       *
*            (916) 756-1104           *
*                                     *
***************************************
```

```
                 Wolf Ranch Master Development Drainage Plan
                          D Basins future development condition pn 03094
                    5-year and 100 Year, 24 hr Type IIA  Storm

 5 IO         OUTPUT CONTROL VARIABLES
                    IPRNT          5  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT         HYDROGRAPH TIME DATA
                     NMIN          5  MINUTES IN COMPUTATION INTERVAL
                    IDATE      1   0  STARTING DATE
                    ITIME       0000  STARTING TIME
                       NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE      2   0  ENDING DATE
                   NDTIME       0055  ENDING TIME
                    ICENT         19  CENTURY MARK
```

COMPUTATION INTERVAL .08 HOURS
TOTAL TIME BASE 24.92 HOURS

ENGLISH UNITS

DRAINAGE AREA	SQUARE MILES
PRECIPITATION DEPTH	INCHES
LENGTH, ELEVATION	FEET
FLOW	CUBIC FEET PER SECOND
STORAGE VOLUME	ACRE-FEET
SURFACE AREA	ACRES
TEMPERATURE	DEGREES FAHRENHEIT

JP MULTI-PLAN OPTION
NPLAN 1 NUMBER OF PLANS

JR MULTI-RATIO OPTION
RATIOS OF PRECIPITATION
.56 1.00

1

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .56	RATIO 2 1.00
HYDROGRAPH AT						
+	D-1	.06	1	FLOW	35.	108.
				TIME	6.08	6.08
ROUTED TO						
+	D2	.06	1	FLOW	33.	105.
				TIME	6.08	6.08
HYDROGRAPH AT						
+	D-2	.04	1	FLOW	15.	57.
				TIME	6.08	6.00
2 COMBINED AT						
+	DPD2	.10	1	FLOW	48.	158.
				TIME	6.08	6.08
ROUTED TO						
+	D3	.10	1	FLOW	47.	155.
				TIME	6.17	6.08
HYDROGRAPH AT						
+	D-3	.02	1	FLOW	1.	11.
				TIME	6.42	6.25

```
  2 COMBINED AT
. +                    DPD        .12      1   FLOW         47.      162.
                                               TIME         6.17     6.08
 1

 *** NORMAL END OF HEC-1 ***
```

```
1***************************************                    ***************************************
 *                                     *                    *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                    *   U.S. ARMY CORPS OF ENGINEERS      *
 *             JUN   1998              *                    *   HYDROLOGIC ENGINEERING CENTER     *
 *           VERSION 4.1               *                    *         609 SECOND STREET           *
 *                                     *                    *      DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   24JAN05  TIME  10:25:27 *                    *          (916) 756-1104             *
 *                                     *                    *                                     *
***************************************                    ***************************************


                    X     X  XXXXXXX   XXXXX         X
                    X     X  X        X     X       XX
                    X     X  X        X              X
                    XXXXXXX  XXXX     X       XXXXX  X
                    X     X  X        X              X
                    X     X  X        X     X        X
                    X     X  XXXXXXX   XXXXX        XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


```
 LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1           ID          Wolf Ranch Master Development Drainage Plan
   2           ID       E basins future development condition PN 03094
   3           ID             5-year and 100 year, 24hr Type IIA Storm
               *DIAGRAM
   4           IT       5       0       0     300
   5           IO       5       0
   6           JR    PREC     .56     1.0

   7           KK     E-1
   8           KM   RUNOFF FOR SUB-BASIN E-1
   9           BA   .0403
  10           IN      15
  11           PB     4.4
  12           PC  0.0000  0.0005  0.0015  0.0030  0.0045  0.0060  0.0080  0.0100  0.0120  0.0143
```

E Basins Devel[illegible]

```
PC  0.0165  0.0188  0.0210  0.0233  0.0255  0.0278  0.0320  0.0390  0.0460  0.0530
PC  0.0600  0.0750  0.1000  0.4000  0.7000  0.7250  0.7500  0.7650  0.7800  0.7900
PC  0.8000  0.8100  0.8200  0.8250  0.8300  0.8350  0.8400  0.8450  0.8500  0.8550
PC  0.8600  0.8638  0.8675  0.8713  0.8750  0.8788  0.8825  0.8863  0.8900  0.8938
PC  0.8975  0.9013  0.9050  0.9083  0.9115  0.9148  0.9180  0.9210  0.9240  0.9270
PC  0.9300  0.9325  0.9350  0.9375  0.9400  0.9425  0.9450  0.9475  0.9500  0.9525
PC  0.9550  0.9575  0.9600  0.9625  0.9650  0.9675  0.9700  0.9725  0.9750  0.9775
PC  0.9800  0.9813  0.9825  0.9838  0.9850  0.9863  0.9875  0.9888  0.9900  0.9913
PC  0.9925  0.9938  0.9950  0.9963  0.9975  0.9988  1.0000
LS       0      79
UD   .1450

KK      E5
KM   ROUTE FLOW FROM SUB-BASIN E-1 TO DP E5
RD     360   0.010    .035              TRAP      10       4

KK     E-6
KM   RUNOFF FROM SUB-BASIN E-6
BA   .0478
LS       0      79
UD    .181

KK      E6
KM   ROUTE FLOW FROM SUB-BASIN E-6 TO DP E5
RD    1450    .010    .013              CIRC       3

KK     E-5
KM   RUNOFF FROM SUB-BASIN E-5
BA   .0400
LS       0      79
UD    .119

KK    DPE5
KM   DESIGN POINT E5 COMBINE RUNOFF FROM SUB-BASIN E-5, E6 AND E5
HC       3
```



```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

KK      E2
KM   ROUTE FLOW FROM DESIGN POINT E5 TO DP E2
RD    1850    .010    .013              CIRC     4.5

KK     E-2
KM   RUNOFF FROM SUB-BASIN E-2
BA   .0520
LS       0      73
UD    .134

KK    DPE2
KM   DESIGN POINT E2 COMBINE RUNOFF FROM SUB-BASIN E-2 AND E2
```

```
         53           HC        2

         54           KK       E3
         55           KM    ROUTE FLOW FROM DP E2 TO DP E
         56           RD     3150     .010     .040            TRAP       10        4

         57           KK      E-3
         58           KM    RUNOFF FROM SUB-BASIN E-3
         59           BA    .0095
         60           LS        0        61
         61           UD     .397

         62           KK      DPE
         63           KM    DESIGN POINT E COMBINE RUNOFF FROM SUB-BASIN E-3 AND E3
         64           HC        2

         65           KK      E-4
         66           KM    RUNOFF FROM SUB-BASIN E-4
         67           BA    .0423
         68           LS        0        73
         69           UD     .141
         70           ZZ
1
                SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING           (--->) DIVERSION OR PUMP FLOW

  NO.       (.) CONNECTOR         (<---) RETURN OF DIVERTED OR PUMPED FLOW

    7         E-1
               V
               V
   24          E5
               .
               .
   27          .          E-6
               .            V
               .            V
   32          .           E6
               .            .
               .            .
   35          .            .          E-5
               .            .            .
               .            .            .
   40        DPE5.......................
               V
               V
   43          E2
               .
               .
   46          .          E-2
               .            .
```

```
                .       .        .
 51          DPE2............
                V
                V
 54            E3
                .
                .
 57             .          E-3
                .                .
                .                .
 62           DPE............
                .
                .
 65             .          E-4

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```

```
1**************************************
*                                     *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1) *
*              JUN   1998             *
*           VERSION 4.1               *
*                                     *
* RUN DATE   24JAN05  TIME  10:25:27  *
*                                     *
***************************************
```

```
***************************************
*                                     *
*   U.S. ARMY CORPS OF ENGINEERS      *
*   HYDROLOGIC ENGINEERING CENTER     *
*        609 SECOND STREET            *
*      DAVIS, CALIFORNIA 95616        *
*          (916) 756-1104             *
*                                     *
***************************************
```

```
                       Wolf Ranch Master Development Drainage Plan
                      E basins future development condition PN 03094
                         5-year and 100 year, 24hr Type IIA Storm

 5 IO        OUTPUT CONTROL VARIABLES
                   IPRNT          5  PRINT CONTROL
                   IPLOT          0  PLOT CONTROL
                   QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT        HYDROGRAPH TIME DATA
                    NMIN          5  MINUTES IN COMPUTATION INTERVAL
                   IDATE     1    0  STARTING DATE
                   ITIME       0000  STARTING TIME
                      NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                  NDDATE     2    0  ENDING DATE
                  NDTIME       0055  ENDING TIME
                   ICENT         19  CENTURY MARK

              COMPUTATION INTERVAL     .08 HOURS
                   TOTAL TIME BASE   24.92 HOURS

      ENGLISH UNITS
```

DRAINAGE AREA	SQUARE MILES
PRECIPITATION DEPTH	INCHES
LENGTH, ELEVATION	FEET
FLOW	CUBIC FEET PER SECOND
STORAGE VOLUME	ACRE-FEET
SURFACE AREA	ACRES
TEMPERATURE	DEGREES FAHRENHEIT

```
JP          MULTI-PLAN OPTION
                  NPLAN              1  NUMBER OF PLANS

JR          MULTI-RATIO OPTION
                RATIOS OF PRECIPITATION
                 .56       1.00
1
```

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .56	RATIO 2 1.00
HYDROGRAPH AT						
+	E-1	.04	1	FLOW	26.	77.
				TIME	6.08	6.00
ROUTED TO						
+	E5	.04	1	FLOW	26.	76.
				TIME	6.08	6.08
HYDROGRAPH AT						
+	E-6	.05	1	FLOW	29.	87.
				TIME	6.08	6.08
ROUTED TO						
+	E6	.05	1	FLOW	28.	85.
				TIME	6.08	6.08
HYDROGRAPH AT						
+	E-5	.04	1	FLOW	28.	82.
				TIME	6.00	6.00
3 COMBINED AT						
+	DPE5	.13	1	FLOW	80.	233.
				TIME	6.08	6.08
ROUTED TO						
+	E2	.13	1	FLOW	76.	232.
				TIME	6.08	6.08

```
 HYDROGRAPH AT
+                  E-2      .05     1   FLOW         22.      79.
                                        TIME         6.08     6.00

  2 COMBINED AT
+                 DPE2      .18     1   FLOW         98.     309.
                                        TIME         6.08     6.08

 ROUTED TO
+                   E3      .18     1   FLOW         94.     301.
                                        TIME         6.25     6.17

 HYDROGRAPH AT
+                  E-3      .01     1   FLOW          0.       4.
                                        TIME         6.42     6.33

  2 COMBINED AT
+                  DPE      .19     1   FLOW         94.     304.
                                        TIME         6.25     6.17

 HYDROGRAPH AT
+                  E-4      .04     1   FLOW         18.      63.
                                        TIME         6.08     6.08
1
*** NORMAL END OF HEC-1 ***
```

```
1***************************************                                          ***************************************
 *                                     *                                          *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                          *   U.S. ARMY CORPS OF ENGINEERS      *
 *             JUN   1998              *                                          *   HYDROLOGIC ENGINEERING CENTER     *
 *            VERSION 4.1              *                                          *        609 SECOND STREET            *
 *                                     *                                          *     DAVIS, CALIFORNIA 95616         *
 *  RUN DATE   27FEB18  TIME  14:49:44  *                                          *          (916) 756-1104             *
 *                                     *                                          *                                     *
 ***************************************                                          ***************************************


                              X     X  XXXXXXX   XXXXX          X
                              X     X  X        X     X        XX
                              X     X  X        X               X
                              XXXXXXX  XXXX     X       XXXXX   X
                              X     X  X        X               X
                              X     X  X        X     X         X
                              X     X  XXXXXXX   XXXXX         XXX


 THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

 THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
 THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
 NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
 DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
 KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                          HEC-1 INPUT                                            PAGE  1

      LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

         1         ID         Wolf Ranch Master Development Drainage Plan
         2         ID       F basins future development conditions PN 17049  TYPE II
         3         ID             5-year and 100 year, 24hr NOAA ATLAS  2  FN: FBAS-F.DAT
                   *DIAGRAM
         4         IT       5       0       0     300
         5         IO       5       0
         6         JR    PREC     .56     1.0

         7         KK     F-8
         8         KM   RUNOFF FOR SUB-BASIN F-8
         9         BA   .0630
        10         IN      15
```

F-Basin Developed Type II: Atlas 2

```
 11          PB     4.4
 12          PC       0    .002    .005    .008    .011    .014    .017     .02    .023    .026
 13          PC    .029    .032    .035    .038    .041    .044    .048    .052    .056     .06
 14          PC   .0604    .068    .072    .076     .08    .085     .09    .095      .1    .105
 15          PC     .11    .115     .12    .126    .133     .14    .147    .155    .163    .172
 16          PC    .181    .181    .203    .218    .236    .257    .283    .387    .663    .707
 17          PC    .735    .758    .776    .791    .804    .815    .825    .834    .842    .849
 18          PC    .856    .863    .869    .875    .881    .887    .893    .898    .903    .908
 19          PC    .913    .918    .922    .926     .93    .934    .938    .942    .946     .95
 20          PC    .953    .956    .959    .962    .965    .968    .971    .974    .977     .98
 21          PC    .983    .986    .989    .992    .995    .998
 22          LS       0    71.5
 23          UD    0.22

 24          KK    RF-8
 25          KM   ROUTE FLOW FROM SUB-BASIN F-8 TO DESIGN POINT F19
 26          RD    1800   0.033    0.04            TRAP      10       6

 27          KK     F-1
 28          KM   RUNOFF FOR BASIN F-1
 29          BA   .1659
 30          LS       0      61
 31          UD     .20

 32          KK    RF-9
 33          KM   ROUTE FLOW FROM SUB-BASIN F-1 TO DESIGN POINT F9
 34          RD     700   0.037    0.04            TRAP      10       6

 35          KK     F-9
 36          KM   RUNOFF FOR BASIN F-9
 37          BA   .0430
 38          LS       0      70
 39          UD     .16

 40          KK    DPF9
 41          KM   COMBINE FLOW FROM SUB-BASIN F-9 AND RF-9
 42          HC       2
1                                    HEC-1 INPUT                                        PAGE  2

LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 43          KK   RF-19
 44          KM   ROUTE FLOW FROM DESIGN POINT DP F9 TO DESIGN POINT F19
 45          RD    2300   0.035    0.04            TRAP      20       6

 46          KK    F-19
 47          KM   RUNOFF FOR BASIN F-19
 48          BA   .1020
 49          LS       0    73.2
```

```
 50           UD     .19

 51           KK   DPF19
 52           KM   COMBINE FLOW FROM SUB-BASIN F-19, RF-8 AND RF19
 53           HC       3

 54           KK   RF-22
 55           KM   ROUTE FLOW FROM DESIGN POINT DP F19 TO DESIGN POINT F22
 56           RD    1800   0.033    0.04            TRAP      20       3

 57           KK     F-2
 58           KM   RUNOFF FOR BASIN F-2
 59           BA   .0424
 60           LS       0      61
 61           UD     .19

 62           KK   RF-10
 63           KM   ROUTE FLOW FROM SUB-BASIN F-2 TO DESIGN POINT F10
 64           RD     850   0.059    0.04            TRAP      10       6

 65           KK    F-10
 66           KM   RUNOFF FOR BASIN F-10
 67           BA   .0180
 68           LS       0      67
 69           UD     .15

 70           KK   DPF10
 71           KM   COMBINE FLOW FROM SUB-BASIN F-10 AND RF10
 72           HC       2

 73           KK  RF-18A
 74           KM   ROUTE FLOW FROM DESIGN POINT DP F10 TO DESIGN POINT F18
 75           RD    1800   0.037    0.04            TRAP      10       6

 76           KK     F-3
 77           KM   RUNOFF FOR SUB-BASIN F-3
 78           BA   .0942
 79           LS       0      61
 80           UD     .22

 81           KK   RF-11
 82           KM   ROUTE FLOW FROM SUB-BASIN F-3 TO DESIGN POINT F11
 83           RD     950   0.038    0.04            TRAP      10       6
```



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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 84           KK    F-11
 85           KM   RUNOFF FOR SUB-BASIN F-11
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BA   .0460
LS       0    68.2
UD     .17

KK   DPF11
KM   COMBINE FLOW FROM SUB-BASIN F-11 AND RF-11
HC       2

KK   RF-18
KM   ROUTE FLOW FROM DESIGN POINT F11 TO DESIGN POINT F18
RD    1800   0.037    0.04            TRAP      10       6

KK     F-4
KM   RUNOFF FOR SUB-BASIN F-4
BA   .2681
LS       0      61
UD     .28

KK   RF-12
KM   ROUTE FLOW FROM SUB-BASIN F-4 TO DESIGN POINT F12
RD    1150   0.044    0.04            TRAP      10       6

KK     F-5
KM   RUNOFF FOR SUB-BASIN F-5
BA   .1073
LS       0      61
UD     .34

KK  RF-12A
KM   ROUTE FLOW FROM SUB-BASIN F-5 TO DESIGN POINT F12
RD    1600   0.035    0.04            TRAP      10       6

KK    F-12
KM   RUNOFF FOR SUB-BASIN F-12
BA   .0590
LS       0    69.3
UD     .20

KK   DPF12
KM   COMBINE FLOW FROM SUB-BASIN RF-12, RF-12A, AND F-12
HC       3

KK   RF-17
KM   ROUTE FLOW FROM DESIGN POINT F-12 TO DESIGN POINT F18
RD    1900   0.028    0.04            TRAP      10       6

KK    F-17
KM   RUNOFF FOR SUB-BASIN F-17
BA   .0380
LS       0    60.1
```

```
126          UD     .21
1                                         HEC-1 INPUT                                          PAGE  4

LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


127          KK    F-18
128          KM   RUNOFF FOR SUB-BASIN F-18
129          BA   .0980
130          LS       0    73.1
131          UD     .21

132          KK   DPF18
133          KM   COMBINE FLOW FROM SUB-BASINS F-18 AND F17, AND RF-18A, RF-18 AND RF-17
134          HC       5

135          KK  RF-22A
136          KM   ROUTE FLOW FROM DESIGN POINT F-18 TO DESIGN POINT F22
137          RD    1800   0.027    0.04            TRAP      10       6

138          KK    F-22
139          KM   RUNOFF FOR SUB-BASIN F-22
140          BA   .0640
141          LS       0    64.1
142          UD     .21

143          KK   DPF22
144          KM   COMBINE FLOW FROM SUB-BASIN F-22, RF-22 AND RF-22A
145          HC       3

146          KK  RF-27A
147          KM   ROUTE FLOW FROM DESIGN POINT F-22 TO DESIGN POINT F27A
148          RD     500   0.029    0.04            TRAP      10       6

149          KK    F-16
150          KM   RUNOFF FOR SUB-BASIN F-16
151          BA   .0270
152          LS       0    72.8
153          UD     .21

154          KK   RF-16
155          KM   ROUTE FLOW FROM SUB-BASIN F-16 TO DESIGN POINT F27A
156          RD    2000   0.030    0.04            TRAP      10       6

157          KK  DPF27A
158          KM   COMBINE FLOW FROM RF-16 AND RF-27A
159          HC       2

160          KK  RF-27B
161          KM   ROUTE FLOW FROM DESIGN POINT F27A TO DESIGN POINT F27
```

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       162            RD    3150   0.020    0.04            TRAP      10       6

       163            KK  RF-27C
       164            KM   ROUTE FLOW FROM RF27B TO DESIGN POINT F28
       165            RD    1400   0.019    0.04            TRAP      50       3
1                                                      HEC-1 INPUT                                                 PAGE  5

      LINE            ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


       166            KK     F-7
       167            KM   RUNOFF FOR SUB-BASIN F-7
       168            BA   .0782
       169            LS       0      61
       170            UD     .19

       171            KK    RF-7
       172            KM   ROUTE FLOW FROM SUB-BASIN F-7 TO DESIGN POINT F14
       173            RD    1200   0.033    0.04            TRAP      10       6

       174            KK    F-14
       175            KM   RUNOFF FOR SUB-BASIN F-14
       176            BA   .1290
       177            LS       0    73.0
       178            UD     .23

       179            KK     F-6
       180            KM   RUNOFF FOR SUB-BASIN F-6
       181            BA   .0310
       182            LS       0      61
       183            UD     .19

       184            KK   RF-13
       185            KM   ROUTE FLOW FROM SUB-BASIN F-6 TO DESIGN POINT F13
       186            RD     800   0.038    0.04            TRAP      10       6

       187            KK    F-13
       188            KM   RUNOFF FOR SUB-BASIN F-13
       189            BA   .0140
       190            LS       0      61
       191            UD     .14

       192            KK   DPF13
       193            KM   COMBINE FLOW FROM RF-13 AND F-13
       194            HC       2

       195            KK   RF-14
       196            KM   ROUTE FLOW FROM DESIGN POINT F13 TO DESIGN POINT F14
       197            RD    3600   0.027    0.04            TRAP      20       6
```

```
 198          KK   DPF14
 199          KM   COMBINE FLOW FROM RF-7, F-14, AND RF-14
 200          HC       3

 201          KK   RF-25
 202          KM   ROUTE FLOW FROM DESIGN POINT F14 TO DESIGN POINT F25
 203          RD    2600   0.023    0.04            TRAP      20       6

 204          KK    F-25
 205          KM   RUNOFF FOR SUB-BASIN F-25
 206          BA   .0890
 207          LS       0    74.1
 208          UD     .28
```



```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 209          KK   DPF25
 210          KM   COMBINE FLOW FROM RF-25 AND RF-14
 211          HC       2

 212          KK   RF-30
 213          KM   ROUTE FLOW FROM DESIGN POINT F25 TO DESIGN POINT F30
 214          RD     900   0.027   0.024            TRAP      20       6

 215          KK    F-15
 216          KM   RUNOFF FOR SUB-BASIN F-15
 217          BA    .021
 218          LS       0    69.1
 219          UD     .16

 220          KK   RF-23
 221          KM   ROUTE FLOW FROM SUB-BASIN F15 TO DESIGN POINT F23
 222          RD    1200   0.023    0.04            TRAP      10       3

 223          KK    F-23
 224          KM   RUNOFF FOR SUB-BASIN F-23
 225          BA   .0310
 226          LS       0    73.0
 227          UD     .18

 228          KK   DPF23
 229          KM   COMBINE FLOW FROM RF-23 AND F-23
 230          HC       2

 231          KK   RF-24
 232          KM   ROUTE FLOW FROM DESIGN POINT F23 TO DESIGN POINT F24
 233          RD    2250   0.026   0.04             TRAP      10       6
```

```
 234        KK    F-24
 235        KM   RUNOFF FOR SUB-BASIN F-24
 236        BA   .0890
 237        LS       0      79
 238        UD     .26

 239        KK   DPF24
 240        KM   COMBINE FLOW FROM RF-24 AND F-24
 241        HC       2

 242        KK  RF-30A
 243        KM   ROUTE FLOW FROM DESIGN POINT F24 TO DESIGN POINT F30
 244        RD    1100   0.033   0.04              TRAP      10       6

 245        KK    F-30
 246        KM   RUNOFF FOR SUB-BASIN F-30
 247        BA   .0220
 248        LS       0    77.7
 249        UD     .18
```



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LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 250        KK   DPF30
 251        KM   COMBINE FLOW FROM RF-30, RF-30A, AND F-30
 252        HC       3

 253        KK   RF-29
 254        KM   ROUTE FLOW FROM DESIGN POINT F30 TO DESIGN POINT F29
 255        RD    2350   0.027   0.04              TRAP       6       3

 256        KK    F-29
 257        KM   RUNOFF FOR SUB-BASIN F-29
 258        BA   .0250
 259        LS       0      70
 260        UD     .19

 261        KK   DPF29
 262        KM   COMBINE FLOW FROM RF-29 AND F-29
 263        HC       2

 264        KK   RF-28
 265        KM   ROUTE FLOW FROM DESIGN POINT F29 TO DESIGN POINT F28
 266        RD     750   0.015   0.04              TRAP      20       3

 267        KK    F-28
 268        KM   RUNOFF FOR SUB-BASIN F-28
 269        BA    .042
 270        LS       0      68
```

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         271            UD      .23

         272            KK     F-27
         273            KM    RUNOFF FOR SUB-BASIN F-27
         274            BA     .213
         275            LS        0     76.2
         276            UD      .32

         277            KK    DPF28
         278            KM    COMBINE FLOW FROM RF-27C, RF-28, F-28 AND F-27
         279            HC        4

         280            KK    RF-31
         281            KM    ROUTE FLOW FROM DESIGN POINT F28 TO DESIGN POINT F
         282            RD     3500    0.023    0.04             TRAP      100       3

         283            KK     F-31
         284            KM    RUNOFF FOR SUB-BASIN F-31
         285            BA    .0810
         286            LS        0     67.8
         287            UD      .24

         288            KK     DP F
         289            KM    COMBINE FLOW FROM RF-31 AND F-31
         290            HC        2
         291            ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

     7         F-8
                 V
                 V
    24        RF-8
                 .
                 .
    27           .           F-1
                 .             V
                 .             V
    32           .          RF-9
                 .             .
                 .             .
    35           .             .           F-9
                 .             .             .
                 .             .             .
    40           .          DPF9............
                 .             V
```

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              .           V
 43           .       RF-19
              .           .
              .           .
 46           .           .           F-19
              .           .           .
              .           .           .
 51       DPF19........................
              V
              V
 54       RF-22
              .
              .
 57           .         F-2
              .           V
              .           V
 62           .       RF-10
              .           .
              .           .
 65           .           .           F-10
              .           .           .
              .           .           .
 70           .       DPF10............
              .           V
              .           V
 73           .      RF-18A
              .           .
              .           .
 76           .           .         F-3
              .           .           V
              .           .           V
 81           .           .       RF-11
              .           .           .
              .           .           .
 84           .           .           .        F-11
              .           .           .           .
              .           .           .           .
 89           .           .       DPF11............
              .           .           V
              .           .           V
 92           .           .       RF-18
              .           .           .
              .           .           .
 95           .           .           .         F-4
              .           .           .           V
              .           .           .           V
100           .           .           .       RF-12
              .           .           .           .
              .           .           .           .
103           .           .           .           .         F-5
```

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              .           .           .           .           V
              .           .           .           .           V
108           .           .           .           .      RF-12A
              .           .           .           .           .
              .           .           .           .           .
111           .           .           .           .           .        F-12
              .           .           .           .           .           .
              .           .           .           .           .           .
116           .           .           .       DPF12........................
              .           .           .           V
              .           .           .           V
119           .           .           .       RF-17
              .           .           .           .
              .           .           .           .
122           .           .           .           .        F-17
              .           .           .           .           .
              .           .           .           .           .
127           .           .           .           .           .        F-18
              .           .           .           .           .           .
              .           .           .           .           .           .
132           .       DPF18................................................
              .           V
              .           V
135           .      RF-22A
              .           .
              .           .
138           .           .        F-22
              .           .           .
              .           .           .
143       DPF22........................
              V
              V
146      RF-27A
              .
              .
149           .        F-16
              .           V
              .           V
154           .       RF-16
              .           .
              .           .
157      DPF27A............
              V
              V
160      RF-27B
              V
              V
163      RF-27C
              .
              .
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166           .         F-7
              .           V
              .           V
171           .        RF-7
              .           .
              .           .
174           .           .        F-14
              .           .           .
              .           .           .
179           .           .           .         F-6
              .           .           .           V
              .           .           .           V
184           .           .           .       RF-13
              .           .           .           .
              .           .           .           .
187           .           .           .           .        F-13
              .           .           .           .           .
              .           .           .           .           .
192           .           .           .       DPF13............
              .           .           .           V
              .           .           .           V
195           .           .           .       RF-14
              .           .           .           .
              .           .           .           .
198           .       DPF14........................
              .           V
              .           V
201           .       RF-25
              .           .
              .           .
204           .           .        F-25
              .           .           .
              .           .           .
209           .       DPF25............
              .           V
              .           V
212           .       RF-30
              .           .
              .           .
215           .           .        F-15
              .           .           V
              .           .           V
220           .           .       RF-23
              .           .           .
              .           .           .
223           .           .           .        F-23
              .           .           .           .
              .           .           .           .
228           .           .       DPF23............
              .           .           V
```

```
                 .           .           V
   231           .           .       RF-24
                 .           .           .
                 .           .           .
   234           .           .           .        F-24
                 .           .           .           .
                 .           .           .           .
   239           .           .       DPF24............
                 .           .           V
                 .           .           V
   242           .           .      RF-30A
                 .           .           .
                 .           .           .
   245           .           .           .        F-30
                 .           .           .           .
                 .           .           .           .
   250           .       DPF30........................
                 .           V
                 .           V
   253           .       RF-29
                 .           .
                 .           .
   256           .           .        F-29
                 .           .           .
                 .           .           .
   261           .       DPF29............
                 .           V
                 .           V
   264           .       RF-28
                 .           .
                 .           .
   267           .           .        F-28
                 .           .           .
                 .           .           .
   272           .           .           .        F-27
                 .           .           .           .
                 .           .           .           .
   277      DPF28....................................
                 V
                 V
   280      RF-31
                 .
                 .
   283           .        F-31
                 .           .
                 .           .
   288        DP F............

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                             ***************************************
```

```
*                                       *                                                  *                                     *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                  *    U.S. ARMY CORPS OF ENGINEERS     *
*             JUN   1998                *                                                  *    HYDROLOGIC ENGINEERING CENTER    *
*          VERSION 4.1                  *                                                  *         609 SECOND STREET           *
*                                       *                                                  *      DAVIS, CALIFORNIA 95616        *
*  RUN DATE   27FEB18  TIME  14:49:44   *                                                  *          (916) 756-1104             *
*                                       *                                                  *                                     *
*****************************************                                                  ***************************************



                                   Wolf Ranch Master Development Drainage Plan
                                 F basins future development conditions PN 17049  TYPE II
                                       5-year and 100 year, 24hr NOAA ATLAS  2  FN: FBAS-F.DAT

   5 IO           OUTPUT CONTROL VARIABLES
                        IPRNT           5  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

     IT           HYDROGRAPH TIME DATA
                         NMIN           5  MINUTES IN COMPUTATION INTERVAL
                        IDATE      1    0  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE      2    0  ENDING DATE
                       NDTIME        0055  ENDING TIME
                       ICENT           19  CENTURY MARK

                    COMPUTATION INTERVAL     .08 HOURS
                         TOTAL TIME BASE   24.92 HOURS

         ENGLISH UNITS
              DRAINAGE AREA         SQUARE MILES
              PRECIPITATION DEPTH   INCHES
              LENGTH, ELEVATION     FEET
              FLOW                  CUBIC FEET PER SECOND
              STORAGE VOLUME        ACRE-FEET
              SURFACE AREA          ACRES
              TEMPERATURE           DEGREES FAHRENHEIT

     JP           MULTI-PLAN OPTION
                        NPLAN           1  NUMBER OF PLANS

     JR           MULTI-RATIO OPTION
                      RATIOS OF PRECIPITATION
                      .56      1.00
1
```

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .56	RATIO 2 1.00
HYDROGRAPH AT +	F-8	.06	1	FLOW	16.	64.
				TIME	12.17	12.08
ROUTED TO +	RF-8	.06	1	FLOW	15.	64.
				TIME	12.25	12.17
HYDROGRAPH AT +	F-1	.17	1	FLOW	8.	94.
				TIME	12.25	12.08
ROUTED TO +	RF-9	.17	1	FLOW	8.	93.
				TIME	12.25	12.17
HYDROGRAPH AT +	F-9	.04	1	FLOW	11.	48.
				TIME	12.08	12.08
2 COMBINED AT +	DPF9	.21	1	FLOW	16.	134.
				TIME	12.17	12.08
ROUTED TO +	RF-19	.21	1	FLOW	16.	134.
				TIME	12.33	12.25
HYDROGRAPH AT +	F-19	.10	1	FLOW	32.	123.
				TIME	12.08	12.08
3 COMBINED AT +	DPF19	.37	1	FLOW	53.	308.
				TIME	12.25	12.17
ROUTED TO +	RF-22	.37	1	FLOW	52.	293.
				TIME	12.33	12.25

HYDROGRAPH AT						
+	F-2	.04	1	FLOW	2.	25.
				TIME	12.17	12.08
ROUTED TO						
+	RF-10	.04	1	FLOW	2.	25.
				TIME	12.25	12.17
HYDROGRAPH AT						
+	F-10	.02	1	FLOW	3.	18.
				TIME	12.08	12.08
2 COMBINED AT						
+	DPF10	.06	1	FLOW	4.	40.
				TIME	12.17	12.08
ROUTED TO						
+	RF-18A	.06	1	FLOW	4.	37.
				TIME	12.33	12.17
HYDROGRAPH AT						
+	F-3	.09	1	FLOW	4.	52.
				TIME	12.25	12.17
ROUTED TO						
+	RF-11	.09	1	FLOW	4.	51.
				TIME	12.33	12.17
HYDROGRAPH AT						
+	F-11	.05	1	FLOW	9.	46.
				TIME	12.08	12.08
2 COMBINED AT						
+	DPF11	.14	1	FLOW	11.	90.
				TIME	12.17	12.17
ROUTED TO						
+	RF-18	.14	1	FLOW	11.	86.
				TIME	12.33	12.25
HYDROGRAPH AT						
+	F-4	.27	1	FLOW	11.	128.
				TIME	12.33	12.17
ROUTED TO						
+	RF-12	.27	1	FLOW	10.	128.
				TIME	12.42	12.25
HYDROGRAPH AT						
+	F-5	.11	1	FLOW	4.	46.

				TIME	12.42	12.25
ROUTED TO						
+	RF-12A	.11	1	FLOW	4.	45.
				TIME	12.58	12.33
HYDROGRAPH AT						
+	F-12	.06	1	FLOW	12.	57.
				TIME	12.17	12.08
3 COMBINED AT						
+	DPF12	.43	1	FLOW	20.	211.
				TIME	12.33	12.25
ROUTED TO						
+	RF-17	.43	1	FLOW	20.	204.
				TIME	12.50	12.33
HYDROGRAPH AT						
+	F-17	.04	1	FLOW	1.	20.
				TIME	12.25	12.17
HYDROGRAPH AT						
+	F-18	.10	1	FLOW	29.	111.
				TIME	12.17	12.08
5 COMBINED AT						
+	DPF18	.77	1	FLOW	53.	427.
				TIME	12.25	12.25
ROUTED TO						
+	RF-22A	.77	1	FLOW	52.	420.
				TIME	12.42	12.25
HYDROGRAPH AT						
+	F-22	.06	1	FLOW	6.	44.
				TIME	12.17	12.08
3 COMBINED AT						
+	DPF22	1.21	1	FLOW	108.	749.
				TIME	12.33	12.25
ROUTED TO						
+	RF-27A	1.21	1	FLOW	106.	740.
				TIME	12.33	12.25
HYDROGRAPH AT						
+	F-16	.03	1	FLOW	8.	30.
				TIME	12.17	12.08

```
 ROUTED TO
+                  RF-16        .03       1    FLOW           8.       30.
                                               TIME       12.33     12.25

  2 COMBINED AT
+                 DPF27A       1.24       1    FLOW         113.      771.
                                               TIME       12.33     12.25

 ROUTED TO
+                 RF-27B       1.24       1    FLOW         111.      776.
                                               TIME       12.50     12.33

 ROUTED TO
+                 RF-27C       1.24       1    FLOW         117.      753.
                                               TIME       12.50     12.42

 HYDROGRAPH AT
+                    F-7        .08       1    FLOW           4.       46.
                                               TIME       12.17     12.08

 ROUTED TO
+                   RF-7        .08       1    FLOW           4.       46.
                                               TIME       12.33     12.17

 HYDROGRAPH AT
+                   F-14        .13       1    FLOW          37.      138.
                                               TIME       12.17     12.17

 HYDROGRAPH AT
+                    F-6        .03       1    FLOW           1.       18.
                                               TIME       12.17     12.08

 ROUTED TO
+                  RF-13        .03       1    FLOW           1.       18.
                                               TIME       12.25     12.17

 HYDROGRAPH AT
+                   F-13        .01       1    FLOW           1.       10.
                                               TIME       12.08     12.08

  2 COMBINED AT
+                  DPF13        .05       1    FLOW           2.       25.
                                               TIME       12.25     12.17

 ROUTED TO
+                  RF-14        .05       1    FLOW           3.       25.
                                               TIME       12.83     12.42

  3 COMBINED AT
+                  DPF14        .25       1    FLOW          39.      184.
```

				TIME	12.17	12.17
ROUTED TO						
+	RF-25	.25	1	FLOW	38.	188.
				TIME	12.33	12.25
HYDROGRAPH AT						
+	F-25	.09	1	FLOW	25.	92.
				TIME	12.17	12.17
2 COMBINED AT						
+	DPF25	.34	1	FLOW	60.	274.
				TIME	12.33	12.25
ROUTED TO						
+	RF-30	.34	1	FLOW	59.	269.
				TIME	12.33	12.25
HYDROGRAPH AT						
+	F-15	.02	1	FLOW	5.	22.
				TIME	12.08	12.08
ROUTED TO						
+	RF-23	.02	1	FLOW	4.	22.
				TIME	12.25	12.17
HYDROGRAPH AT						
+	F-23	.03	1	FLOW	10.	38.
				TIME	12.08	12.08
2 COMBINED AT						
+	DPF23	.05	1	FLOW	13.	58.
				TIME	12.17	12.08
ROUTED TO						
+	RF-24	.05	1	FLOW	13.	59.
				TIME	12.33	12.25
HYDROGRAPH AT						
+	F-24	.09	1	FLOW	39.	117.
				TIME	12.17	12.17
2 COMBINED AT						
+	DPF24	.14	1	FLOW	48.	171.
				TIME	12.25	12.17
ROUTED TO						
+	RF-30A	.14	1	FLOW	47.	166.
				TIME	12.25	12.25

```
 HYDROGRAPH AT
+                  F-30        .02      1   FLOW          11.      33.
                                            TIME        12.08    12.08

  3 COMBINED AT
+                 DPF30        .50      1   FLOW         110.     455.
                                            TIME        12.33    12.25

 ROUTED TO
+                 RF-29        .50      1   FLOW         111.     435.
                                            TIME        12.42    12.33

 HYDROGRAPH AT
+                  F-29        .03      1   FLOW           6.      26.
                                            TIME        12.08    12.08

  2 COMBINED AT
+                 DPF29        .53      1   FLOW         114.     450.
                                            TIME        12.42    12.25

 ROUTED TO
+                 RF-28        .53      1   FLOW         112.     447.
                                            TIME        12.42    12.33

 HYDROGRAPH AT
+                  F-28        .04      1   FLOW           7.      35.
                                            TIME        12.17    12.17

 HYDROGRAPH AT
+                  F-27        .21      1   FLOW          67.     221.
                                            TIME        12.25    12.25

  4 COMBINED AT
+                 DPF28       2.02      1   FLOW         270.    1408.
                                            TIME        12.50    12.33

 ROUTED TO
+                 RF-31       2.02      1   FLOW         260.    1418.
                                            TIME        12.67    12.42

 HYDROGRAPH AT
+                  F-31        .08      1   FLOW          12.      66.
                                            TIME        12.17    12.17

  2 COMBINED AT
+                  DP F       2.10      1   FLOW         265.    1453.
                                            TIME        12.67    12.42

 *** NORMAL END OF HEC-1 ***
```

```
1*****************************************                    ****************************************
 *                                       *                    *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                    *    U.S. ARMY CORPS OF ENGINEERS      *
 *              JUN   1998               *                    *    HYDROLOGIC ENGINEERING CENTER     *
 *             VERSION 4.1               *                    *          609 SECOND STREET           *
 *                                       *                    *       DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   18DEC17  TIME  12:31:30   *                    *           (916) 756-1104             *
 *                                       *                    *                                      *
 *****************************************                    ****************************************


                         X     X  XXXXXXX   XXXXX           X
                         X     X  X        X     X         XX
                         X     X  X        X                X
                         XXXXXXX  XXXX     X        XXXXX   X
                         X     X  X        X                X
                         X     X  X        X     X          X
                         X     X  XXXXXXX   XXXXX          XXX


 THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

 THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
 THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
 NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
 DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
 KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                   HEC-1 INPUT                                             PAGE  1

 LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

    1         ID              Wolf Ranch Master Development Drainage Plan
    2         ID              G BASINS DEVELOPED CONDITIONS       PN 17049
    3         ID              5-year and 100 Year, 2 HOUR STORM PER 2014 DCM Gbas-f.dat
              *DIAGRAM
    4         IT       5       0       0     300
    5         IO       5       0
    6         JR    PREC     .56     1.0

    7         KK     G-1
    8         KM       RUNOFF - Sub-basin G-1
    9         BA   .0808
   10         IN       5
```

G-BASINS DEVELOPED

```
          11            PB    2.77
          12            PC       0    .024    .061    .101    .148    .228    .313    .442    .721    .981
          13            PC    .892    .943    .986   1.024    1.05   1.073   1.095   1.117   1.127   1.157
          14            PC   1.176   1.196   1.212   1.229   1.245
          15            LS       0      61
          16            UD    0.22

          17            KK      G2
          18            KM          ROUTE FLOW from SUB-BASIN G-1 TO DP G3
          19            RD    3200   0.027    0.04            TRAP      10       4

          20            KK     G-2
          21            KM          RUNOFF - Sub-basin G-2
          22            BA    .035
          23            LS       0      73
          24            UD    0.22

          25            KK      G3
          26            KM          ROUTE FLOW from SUB-BASIN G-2 TO DP G3
          27            RD    2730   0.024    0.04            TRAP      10       4

          28            KK     G-3
          29            KM          RUNOFF - Sub-basin G-3
          30            BA    .177
          31            LS       0      73
          32            UD    0.29

          33            KK    DPG3
          34            KM   COMBINE RUNOFF from G2, G3 AND SUB-BASIN G-3
          35            HC       3

          36            KK      G5
          37            KM          ROUTE FLOW from DP G3 TO DP G5
          38            RD    2200    0.02    .013            CIRC     4.5

          39            KK     G-5
          40            KM          RUNOFF - Sub-basin G-5
          41            BA    .153
          42            LS       0    79.8
          43            UD    0.26
1                                                 HEC-1 INPUT                                                   PAGE  2

        LINE            ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


          44            KK     DPG
          45            KM          COMBINE RUNOFF from G5 AND SUB-BASIN G-5
          46            HC       2
          47            ZZ
1
```

```
                SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE       (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.       (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    7          G-1
                V
                V
   17          G2
                .
                .
   20           .          G-2
                .            V
                .            V
   25           .           G3
                .            .
                .            .
   28           .            .          G-3
                .            .            .
                .            .            .
   33        DPG3.......................
                V
                V
   36          G5
                .
                .
   39           .          G-5
                .            .
                .            .
   44          DPG...........

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1****************************************                                        ****************************************
 *                                      *                                        *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                        *   U.S. ARMY CORPS OF ENGINEERS       *
 *             JUN   1998               *                                        *   HYDROLOGIC ENGINEERING CENTER      *
 *          VERSION 4.1                 *                                        *         609 SECOND STREET            *
 *                                      *                                        *      DAVIS, CALIFORNIA 95616         *
 *  RUN DATE   18DEC17  TIME  12:31:30  *                                        *          (916) 756-1104              *
 *                                      *                                        *                                      *
 ****************************************                                        ****************************************


                                    Wolf Ranch Master Development Drainage Plan
                                    G BASINS DEVELOPED CONDITIONS      PN 17049
                                    5-year and 100 Year, 2 HOUR STORM PER 2014 DCM Gbas-f.dat
```

```
    5 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           5  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

      IT          HYDROGRAPH TIME DATA
                         NMIN           5  MINUTES IN COMPUTATION INTERVAL
                        IDATE      1    0  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE      2    0  ENDING DATE
                       NDTIME        0055  ENDING TIME
                        ICENT          19  CENTURY MARK

                 COMPUTATION INTERVAL     .08 HOURS
                      TOTAL TIME BASE   24.92 HOURS

          ENGLISH UNITS
               DRAINAGE AREA          SQUARE MILES
               PRECIPITATION DEPTH    INCHES
               LENGTH, ELEVATION      FEET
               FLOW                   CUBIC FEET PER SECOND
               STORAGE VOLUME         ACRE-FEET
               SURFACE AREA           ACRES
               TEMPERATURE            DEGREES FAHRENHEIT

      JP          MULTI-PLAN OPTION
                        NPLAN           1  NUMBER OF PLANS

      JR          MULTI-RATIO OPTION
                      RATIOS OF PRECIPITATION
                       .56      1.00
1

               PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                 FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                                 TIME TO PEAK IN HOURS


                                                                  RATIOS APPLIED TO PRECIPITATION
 OPERATION        STATION      AREA    PLAN              RATIO 1  RATIO 2
                                                             .56     1.00

 HYDROGRAPH AT
+                    G-1        .08      1   FLOW             1.      18.
                                             TIME           2.00     1.00

 ROUTED TO
+                     G2        .08      1   FLOW             1.      18.
```

				TIME	2.42	1.17
HYDROGRAPH AT						
+	G-2	.04	1	FLOW	4.	25.
				TIME	1.00	.92
ROUTED TO						
+	G3	.04	1	FLOW	5.	25.
				TIME	1.17	1.08
HYDROGRAPH AT						
+	G-3	.18	1	FLOW	18.	108.
				TIME	1.17	1.00
3 COMBINED AT						
+	DPG3	.29	1	FLOW	23.	144.
				TIME	1.17	1.08
ROUTED TO						
+	G5	.29	1	FLOW	22.	138.
				TIME	1.25	1.08
HYDROGRAPH AT						
+	G-5	.15	1	FLOW	40.	157.
				TIME	1.00	.92
2 COMBINED AT						
+	DPG	.45	1	FLOW	55.	271.
				TIME	1.00	1.00

1

*** NORMAL END OF HEC-1 ***

```
1****************************************                             ****************************************
 *                                      *                             *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                             *  U.S. ARMY CORPS OF ENGINEERS        *
 *             JUN   1998               *                             *  HYDROLOGIC ENGINEERING CENTER       *
 *            VERSION 4.1               *                             *       609 SECOND STREET              *
 *                                      *                             *    DAVIS, CALIFORNIA 95616           *
 *  RUN DATE   18DEC17  TIME  13:39:22  *                             *        (916) 756-1104                *
 *                                      *                             *                                      *
 ****************************************                             ****************************************


                          X     X  XXXXXXX   XXXXX         X
                          X     X  X        X     X       XX
                          X     X  X        X              X
                          XXXXXXX  XXXX     X       XXXXX  X
                          X     X  X        X              X
                          X     X  X        X     X        X
                          X     X  XXXXXXX   XXXXX        XXX


          THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

          THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
          THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
          NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
          DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
          KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                                 HEC-1 INPUT                                                 PAGE  1

          LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

             1           ID           Wolf Ranch master Development Drainage Plan
             2           ID           H AND J BASINS DEVELOPED CONDITIONS PN 17049
             3           ID           5-year and 100 Year, 2 HOUR STORM PER 2014 DCM FN: HBAS-F.DAT
                         *DIAGRAM
             4           IT       5       0       0     300
             5           IO       5       0
             6           JR    PREC     .56     1.0

             7           KK     H-1
             8           KM         RUNOFF FROM SUB-BASIN H-1
             9           BA   .0370
            10           IN       5
```

H/J Basins
Developed
2-HR Storm

```
           11            PB    2.77
           12            PC       0     .024     .061     .101     .148     .223     .313     .442     .721     .981
           13            PC    .892     .943     .986    1.024     1.05    1.073    1.095    1.117    1.137    1.157
           14            PC   1.176    1.196    1.212    1.229    1.245
           15            LS       0       73
           16            UD    0.10

           17            KK     H-2
           18            KM          RUNOFF FROM SUB-BASIN H-2
           19            BA   .0700
           20            LS       0       73
           21            UD     .20

           22            KK     J-1
           23            KM          RUNOFF FROM SUB-BASIN J-1
           24            BA   .0250
           25            LS       0       79
           26            UD     .10

           27            KK    J-2
           28            KM          RUNOFF FROM SUB-BASIN J-2
           29            BA   .0530
           30            LS       0       77
           31            UD     .15
           32            ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

     7         H-1
                 .
                 .
    17           .         H-2
                 .           .
                 .           .
    22           .           .          J-1
                 .           .            .
                 .           .            .
    27           .           .            .          J-2

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                              *****************************************
 *                                       *                                              *                                       *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                              *    U.S. ARMY CORPS OF ENGINEERS       *
 *              JUN   1998               *                                              *    HYDROLOGIC ENGINEERING CENTER      *
 *            VERSION 4.1                *                                              *          609 SECOND STREET            *
 *                                       *                                              *       DAVIS, CALIFORNIA 95616         *
```

```
                              Wolf Ranch master Development Drainage Plan
                              H AND J BASINS DEVELOPED CONDITIONS PN 17049
                              5-year and 100 Year, 2 HOUR STORM PER 2014 DCM FN: HBAS-F.DAT

  5 IO         OUTPUT CONTROL VARIABLES
                     IPRNT           5  PRINT CONTROL
                     IPLOT           0  PLOT CONTROL
                     QSCAL          0.  HYDROGRAPH PLOT SCALE

    IT         HYDROGRAPH TIME DATA
                      NMIN           5  MINUTES IN COMPUTATION INTERVAL
                     IDATE      1    0  STARTING DATE
                     ITIME        0000  STARTING TIME
                        NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                    NDDATE      2    0  ENDING DATE
                    NDTIME        0055  ENDING TIME
                    ICENT           19  CENTURY MARK

                COMPUTATION INTERVAL     .08 HOURS
                     TOTAL TIME BASE   24.92 HOURS

       ENGLISH UNITS
            DRAINAGE AREA         SQUARE MILES
            PRECIPITATION DEPTH   INCHES
            LENGTH, ELEVATION     FEET
            FLOW                  CUBIC FEET PER SECOND
            STORAGE VOLUME        ACRE-FEET
            SURFACE AREA          ACRES
            TEMPERATURE           DEGREES FAHRENHEIT

    JP          MULTI-PLAN OPTION
                      NPLAN           1  NUMBER OF PLANS

    JR          MULTI-RATIO OPTION
                    RATIOS OF PRECIPITATION
                    .56      1.00
1

            PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                              FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                               TIME TO PEAK IN HOURS
```

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .56	RATIO 2 1.00
HYDROGRAPH AT						
+	H-1	.04	1	FLOW	6.	38.
				TIME	.83	.75
HYDROGRAPH AT						
+	H-2	.07	1	FLOW	8.	53.
				TIME	.92	.92
HYDROGRAPH AT						
+	J-1	.03	1	FLOW	10.	40.
				TIME	.83	.75
HYDROGRAPH AT						
+	J-2	.05	1	FLOW	14.	65.
				TIME	.83	.83

*** NORMAL END OF HEC-1 ***

HEC-1 INPUT & OUTPUT
DEVELOPED CONDITIONS WITH DETENTION

```
1****************************************                    ****************************************
 *                                      *                    *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                    *   U.S. ARMY CORPS OF ENGINEERS       *
 *             JUN   1998               *                    *   HYDROLOGIC ENGINEERING CENTER      *
 *           VERSION 4.1                *                    *        609 SECOND STREET             *
 *                                      *                    *     DAVIS, CALIFORNIA 95616          *
 *  RUN DATE   20MAY15  TIME  11:38:50  *                    *         (916) 756-1104               *
 *                                      *                    *                                      *
 ****************************************                    ****************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X               X
XXXXXXX  XXXX     X        XXXXX  X
X     X  X        X               X
X     X  X        X     X         X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


```
LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1        ID          Wolf Ranch, Master Development Drainage Plan Update
  2        ID          A Basins, future development condition w/detention DETA-AR.DAT
  3        ID          OUTFLOW FROM CORDERA DETENTION BASIN MODELED   PN 12055
  4        ID          AS-BUILT CONDITION DET BASIN A MARCH 15, 2010
  5        ID          FSD MODELED AT DESIGN POINT A4
  6        ID          5-year and 100 Year, 24 hr Type IIA  Storm
  7        ID          HYDROGRAPH FROM CORDERA DETENTION BASIN INPUT TO RUN
           *DIAGRAM
  8        IT       5       0       0     300
  9        IO       5       0
 10        JR    PREC     .56       1
```

```
KK     A-1
KM       RUNOFF FROM SUB-BASIN A-1
BA    .060
IN      15
PB     4.4
PC  0.0000  0.0005  0.0015  0.0030  0.0045  0.0060  0.0080  0.0100  0.0120  0.0143
PC  0.0165  0.0188  0.0210  0.0233  0.0255  0.0278  0.0320  0.0390  0.0460  0.0530
PC  0.0600  0.0750  0.1000  0.4000  0.7000  0.7250  0.7500  0.7650  0.7800  0.7900
PC  0.8000  0.8100  0.8200  0.8250  0.8300  0.8350  0.8400  0.8450  0.8500  0.8550
PC  0.8600  0.8638  0.8675  0.8713  0.8750  0.8788  0.8825  0.8863  0.8900  0.8938
PC  0.8975  0.9013  0.9050  0.9083  0.9115  0.9148  0.9180  0.9210  0.9240  0.9270
PC  0.9300  0.9325  0.9350  0.9375  0.9400  0.9425  0.9450  0.9475  0.9500  0.9525
PC  0.9550  0.9575  0.9600  0.9625  0.9650  0.9675  0.9700  0.9725  0.9750  0.9775
PC  0.9800  0.9813  0.9825  0.9838  0.9850  0.9863  0.9875  0.9888  0.9900  0.9913
PC  0.9925  0.9938  0.9950  0.9963  0.9975  0.9988  1.0000
LS       0      61
UD    .292

KK     A3A
KM   ROUTE FLOW FROM SUB-BASIN A-1 TO A3B
RD    1800    .021     .04             TRAP      10       4

KK     A3B
KM       ROUTE  FLOW FROM A3A TO DP3  48" RCP
RK    1700     .02    .013             CIRC       4

KK     A-3
KM      RUNOFF FROM SUB-BASIN A-3
BA     .15
LS       0      73
UD    .221

KK     A-4
KM   RUNOFF FROM SUB-BASIN A-4
BA   .0861
LS       0    76.3
UD    0.21
```

1 HEC-1 INPUT PAGE 2

```
LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

KK    DPA4
KM        COMBINE FLOW FROM A3B AND SUB-BASINS A-4 AND A-3
HC       3

KK   DB A4
KM         ROUTE DP A4 THROUGH FSD AT DP A4
RS       1    ELEV     100
SV       0       1       3       5      14      20
```

```
  51          SE     100      102      104      106      108      110
  52          SQ       0        1        3       20      120      150

  53          KK      A6
  54          KM    ROUTE FLOW FROM DB A4 TO DP 6  42" RCP
  55          RD    1650     .010     .013               CIRC      3.5

  56          KK     A-11
  57          KM    RUNOFF FROM SUB-BASIN A-11
  58          BA     .081
  59          LS       0     76.8
  60          UD      .19

  61          KK     A11
  62          KM    ROUTE SUB-BASIN A-11 TO DP A8   42" RCP
  63          RD     1400     .02     .013               CIRC      3.5

  64          KK     A-8
  65          KM    RUNOFF FROM BASIN A-8
  66          BA     .052
  67          LS       0     83.9
  68          UD     .250

  69          KK    DP A8
  70          KM    COMBINE RUNOFF FROM SB A-8 AND A11
  71          HC       2

  72          KK      A8
  73          KM    ROUTE FLOW FROM DES POINT A8 TO DP A7  48" RCP
  74          RD     1100     .026     .013               CIRC      4.0

  75          KK     A-7
  76          KM    RUNOFF FROM SUB-BASIN A-7
  77          BA    .0500
  78          LS       0        72
  79          UD     .172

  80          KK    DP A7
  81          KM    COMBINE RUNOFF FROM SUB-BASIN A-7 AND A8
  82          HC       2
1                                        HEC-1 INPUT                                         PAGE  3

 LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


  83          KK      A7
  84          KM    ROUTE FLOW FROM DP A7 TO DP A6   54" RCP
  85          RD      800    0.022    0.013              CIRC      4.5

  86          KK     A-6
```

```
KM   RUNOFF FROM SUB-BASIN A-6
BA    .045
LS       0    80.8
UD     .21

KK    DPA6
KM   DESIGN POINT A6 COMBINE RUNOFF FROM SUB-BASIN A-6, A6 AND A7
HC       3

KK      A5
KM   ROUTE FLOW FROM DESIGN POINT A6 TO DP A5    66" RCP
RD    1400    .014    .013             CIRC     5.5

KK    A-12
KM   RUNOFF FROM SUB-BASIN A-12
BA    .048
LS       0      78
UD    .181

KK     A12
KM   ROUTE RUNOFF FROM SUB-BASIN A-12 TO DP A936" RCP
RD    1950     .02    .013             CIRC       3

KK   A-9
KM   RUNOFF FROM SUB-BASIN A-9
BA    .059
LS       0    76.3
UD    .263

KK   DP A9
KM   COMBINE RUNOFF FROM SUB-BASIN A-9 AND A12
HC       2

KK      A9
KM   ROUTE FLOW FROM SUB-BASIN A-9 TO DESIGN POINT A5   48-INCH RCP
RD     500    .013    .016             CIRC       4

KK   A-5
KM   RUNOFF FROM SUB-BASIN A-5
BA   .1114
LS       0    69.7
UD    .209

KK    DPA5
KM   DP A5 COMBINE RUNOFF FROM SUB-BASIN A-5, A5 AND A9 THIS IS INFLOW
KM   TO DETENTION BASIN A
HC       3
```

```
          125          KK     DBA
          126          KM   ROUTE DP A5 THROUGH DETENTION BASIN A
          127          RS       1     ELEV  6975.5
          128          SV       0      .15     1.47     4.46     8.09    12.01    16.16    20.48    24.96    29.64
          129          SV      35       41
          130          SE  6975.5     6977     6978     6979     6980     6981     6982     6983     6984     6985
          131          SE    6986     6987
          132          SQ       0       10       15       20       30       40       60       80      100      120
          133          SQ     160      900
          134          SS    6987      250      2.6      1.5
          135          ST    6988       15      2.6      1.5

          136          KK     A10
          137          KM   ROUTE FLOW FROM DET BASIN DBA TO DESIGN POINT A1   48" RCP
          138          RD    1100     .028     .013              CIRC        4

          139          KK      GC
          140          KM           OUTFLOW HYDROGRAPH FROM CORDERA DETENTION BASIN
          141          BA     .27
          142          QI       0        0        0        0        0        0        0        0        0        0
          143          QI       0        0        0        0        0        0        0        0        0        0
          144          QI       0        0        0        1       37      127      128      126      101       77
          145          QI      60       51       45       40       38       37       37       30       24       21

          146          KK   DP A1
          147          KM       COMBINE OUTFLOW FROM GRAND CORDERA DETENTION BASIN AND A10
          148          HC       2

          149          KK    A-10
          150          KM   RUNOFF FROM SUB-BASIN A-10
          151          BA   .0096
          152          LS       0     79.6
          153          UD    .231

          154          KK     DPA
          155          KM   DESIGN POINT A COMBINE RUNOFF SUB-BASIN A-10 AND DP A1
          156          HC       2
          157          ZZ
1
               SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING           (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR         (<---) RETURN OF DIVERTED OR PUMPED FLOW

    11         A-1
                V
                V
```

```
28         A3A
             V
             V
31         A3B
             .
             .
34           .         A-3
             .           .
             .           .
39           .           .         A-4
             .           .           .
             .           .           .
44        DPA4........................
             V
             V
47       DB A4
             V
             V
53          A6
             .
             .
56           .        A-11
             .           V
             .           V
61           .         A11
             .           .
             .           .
64           .           .         A-8
             .           .           .
             .           .           .
69           .       DP A8............
             .           V
             .           V
72           .          A8
             .           .
             .           .
75           .           .         A-7
             .           .           .
             .           .           .
80           .       DP A7............
             .           V
             .           V
83           .          A7
             .           .
             .           .
86           .           .         A-6
             .           .           .
             .           .           .
91        DPA6........................
             V
```

```
                 V
   94           A5
                 .
                 .
   97            .         A-12
                 .            V
                 .            V
  102            .          A12
                 .            .
                 .            .
  105            .            .       A-9
                 .            .            .
                 .            .            .
  110            .        DP A9............
                 .            V
                 .            V
  113            .           A9
                 .            .
                 .            .
  116            .            .       A-5
                 .            .            .
                 .            .            .
  121         DPA5.........................
                 V
                 V
  125          DBA
                 V
                 V
  136          A10
                 .
                 .
  139            .           GC
                 .            .
                 .            .
  146        DP A1............
                 .
                 .
  149            .         A-10
                 .            .
                 .            .
  154          DPA............
```

```
(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************
 *                                       *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
 *             JUN   1998                *
 *           VERSION 4.1                 *
 *                                       *
 *  RUN DATE   20MAY15  TIME  11:38:50   *
```

```
******************************************
*                                        *
*    U.S. ARMY CORPS OF ENGINEERS        *
*    HYDROLOGIC ENGINEERING CENTER       *
*          609 SECOND STREET             *
*       DAVIS, CALIFORNIA 95616          *
*           (916) 756-1104               *
```

```
*                                         *                                                    *                                       *
*******************************************                                                    *****************************************

                                                 Wolf Ranch, Master Development Drainage Plan Update
                                                 A Basins, future development condition w/detention DETA-AR.DAT
                                                 OUTFLOW FROM CORDERA DETENTION BASIN MODELED   PN 12055
                                                 AS-BUILT CONDITION DET BASIN A MARCH 15, 2010
                                                 FSD MODELED AT DESIGN POINT A4
                                                 5-year and 100 Year, 24 hr Type IIA  Storm
                                                 HYDROGRAPH FROM CORDERA DETENTION BASIN INPUT TO RUN

   9 IO         OUTPUT CONTROL VARIABLES
                      IPRNT          5  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

     IT         HYDROGRAPH TIME DATA
                       NMIN          5  MINUTES IN COMPUTATION INTERVAL
                      IDATE     1    0  STARTING DATE
                      ITIME       0000  STARTING TIME
                         NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE     2    0  ENDING DATE
                     NDTIME       0055  ENDING TIME
                      ICENT         19  CENTURY MARK

                  COMPUTATION INTERVAL      .08 HOURS
                       TOTAL TIME BASE    24.92 HOURS

        ENGLISH UNITS
             DRAINAGE AREA          SQUARE MILES
             PRECIPITATION DEPTH    INCHES
             LENGTH, ELEVATION      FEET
             FLOW                   CUBIC FEET PER SECOND
             STORAGE VOLUME         ACRE-FEET
             SURFACE AREA           ACRES
             TEMPERATURE            DEGREES FAHRENHEIT

     JP          MULTI-PLAN OPTION
                      NPLAN          1  NUMBER OF PLANS

     JR          MULTI-RATIO OPTION
                    RATIOS OF PRECIPITATION
                    .56      1.00
1

             PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
```

FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .56	RATIO 2 1.00
HYDROGRAPH AT +	A-1	.06	1	FLOW	3.	32.
				TIME	6.25	6.17
ROUTED TO +	A3A	.06	1	FLOW	3.	31.
				TIME	6.42	6.33
ROUTED TO +	A3B	.06	1	FLOW	3.	31.
				TIME	6.50	6.33
HYDROGRAPH AT +	A-3	.15	1	FLOW	49.	194.
				TIME	6.17	6.08
HYDROGRAPH AT +	A-4	.09	1	FLOW	39.	133.
				TIME	6.08	6.08
3 COMBINED AT +	DPA4	.30	1	FLOW	87.	334.
				TIME	6.08	6.08
ROUTED TO +	DB A4	.30	1	FLOW	8.	87.
				TIME	7.42	6.58
			** PEAK STAGES IN FEET **			
			1	STAGE	104.64	107.34
				TIME	7.42	6.58
ROUTED TO +	A6	.30	1	FLOW	8.	87.
				TIME	7.50	6.58
HYDROGRAPH AT +	A-11	.08	1	FLOW	41.	134.
				TIME	6.08	6.08
ROUTED TO +	A11	.08	1	FLOW	39.	131.

				TIME	6.08	6.08
HYDROGRAPH AT						
+	A-8	.05	1	FLOW	37.	100.
				TIME	6.17	6.08
2 COMBINED AT						
+	DP A8	.13	1	FLOW	76.	231.
				TIME	6.08	6.08
ROUTED TO						
+	A8	.13	1	FLOW	75.	227.
				TIME	6.17	6.08
HYDROGRAPH AT						
+	A-7	.05	1	FLOW	18.	69.
				TIME	6.08	6.08
2 COMBINED AT						
+	DP A7	.18	1	FLOW	91.	296.
				TIME	6.08	6.08
ROUTED TO						
+	A7	.18	1	FLOW	90.	292.
				TIME	6.17	6.08
HYDROGRAPH AT						
+	A-6	.05	1	FLOW	29.	84.
				TIME	6.08	6.08
3 COMBINED AT						
+	DPA6	.52	1	FLOW	118.	391.
				TIME	6.17	6.08
ROUTED TO						
+	A5	.52	1	FLOW	118.	385.
				TIME	6.17	6.17
HYDROGRAPH AT						
+	A-12	.05	1	FLOW	27.	84.
				TIME	6.08	6.08
ROUTED TO						
+	A12	.05	1	FLOW	26.	82.
				TIME	6.08	6.08
HYDROGRAPH AT						
+	A-9	.06	1	FLOW	24.	81.
				TIME	6.17	6.17

```
  2 COMBINED AT
+                 DP A9       .11     1   FLOW         49.      161.
                                          TIME        6.17      6.08

 ROUTED TO
+                    A9       .11     1   FLOW         49.      158.
                                          TIME        6.17      6.08

 HYDROGRAPH AT
+                 A-5         .11     1   FLOW         27.      126.
                                          TIME        6.17      6.08

  3 COMBINED AT
+                  DPA5       .74     1   FLOW        193.      663.
                                          TIME        6.17      6.08

 ROUTED TO
+                   DBA       .74     1   FLOW         27.      114.
                                          TIME        7.25      7.33

                                    ** PEAK STAGES IN FEET **
                                      1   STAGE    6979.67   6984.69
                                          TIME        7.25      7.33

 ROUTED TO
+                   A10       .74     1   FLOW         27.      114.
                                          TIME        7.33      7.33

 HYDROGRAPH AT
+                    GC       .27     1   FLOW        128.      128.
                                          TIME        6.50      6.50

  2 COMBINED AT
+                 DP A1      1.01     1   FLOW        152.      234.
                                          TIME        6.58      6.75

 HYDROGRAPH AT
+                  A-10       .01     1   FLOW          5.       16.
                                          TIME        6.08      6.08

  2 COMBINED AT
+                   DPA      1.02     1   FLOW        154.      236.
                                          TIME        6.50      6.75
1

 *** NORMAL END OF HEC-1 ***
```

```
1****************************************                    ****************************************
 *                                      *                    *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                    *   U.S. ARMY CORPS OF ENGINEERS       *
 *              JUN   1998              *                    *   HYDROLOGIC ENGINEERING CENTER      *
 *            VERSION 4.1               *                    *         609 SECOND STREET            *
 *                                      *                    *      DAVIS, CALIFORNIA 95616         *
 * RUN DATE   14MAR13  TIME  15:58:14   *                    *          (916) 756-1104              *
 *                                      *                    *                                      *
 ****************************************                    ****************************************


                      X     X  XXXXXXX   XXXXX          X
                      X     X  X        X     X        XX
                      X     X  X        X               X
                      XXXXXXX  XXXX     X       XXXXX   X
                      X     X  X        X               X
                      X     X  X        X     X         X
                      X     X  XXXXXXX   XXXXX         XXX


 THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

 THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
 THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
 NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
 DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
 KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                   HEC-1 INPUT                                          PAGE  1

 LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1       ID        Wolf Ranch Master Development Drainage Plan   pn 12055
   2       ID        E basins future development condition with detention
   3       ID          5-year and 100 year, 24hr Type IIA Storm fn:eddet.dat
   4       ID       *WESTCREEK DETENTION BASIN PER FINAL DESIGN*
   5       ID        WATER QUALTY BASIN ASUMED HALF FULL
           *DIAGRAM
   6       IT       5       0       0     300
   7       IO       5       0
   8       JR    PREC     .56     1.0

   9       KK     E-6
  10       KM   RUNOFF FOR SUB-BASIN E-6
```

```
 11          BA   .0520
 12          IN      15
 13          PB     4.4
 14          PC  0.0000  0.0005  0.0015  0.0030  0.0045  0.0060  0.0080  0.0100  0.0120  0.0143
 15          PC  0.0165  0.0188  0.0210  0.0233  0.0255  0.0278  0.0320  0.0390  0.0460  0.0530
 16          PC  0.0600  0.0750  0.1000  0.4000  0.7000  0.7250  0.7500  0.7650  0.7800  0.7900
 17          PC  0.8000  0.8100  0.8200  0.8250  0.8300  0.8350  0.8400  0.8450  0.8500  0.8550
 18          PC  0.8600  0.8638  0.8675  0.8713  0.8750  0.8788  0.8825  0.8863  0.8900  0.8938
 19          PC  0.8975  0.9013  0.9050  0.9083  0.9115  0.9148  0.9180  0.9210  0.9240  0.9270
 20          PC  0.9300  0.9325  0.9350  0.9375  0.9400  0.9425  0.9450  0.9475  0.9500  0.9525
 21          PC  0.9550  0.9575  0.9600  0.9625  0.9650  0.9675  0.9700  0.9725  0.9750  0.9775
 22          PC  0.9800  0.9813  0.9825  0.9838  0.9850  0.9863  0.9875  0.9888  0.9900  0.9913
 23          PC  0.9925  0.9938  0.9950  0.9963  0.9975  0.9988  1.0000
 24          LS       0      79
 25          UD     .19

 26          KK     E6A
 27          KM   ROUTE SUB-BASIN E-6 TO E6B
 28          RD     750     .02    .013            CIRC     3.5

 29          KK     E6B
 30          KM         ROUTE E6A TO DP  E5
 31          RK     950     .02    .013            CIRC     4.5

 32          KK     E-1
 33          KM   RUNOFF FROM BASIN E-1
 34          BA   .0403
 35          LS       0      79
 36          UD   .1450

 37          KK      E1
 38          KM        ROUTE SB E-1 TO DP E5
 39          RK     400     .02    .013            CIRC       2
 40          RD     360   0.010    .035            TRAP      10       4

 41          KK     E-5
 42          KM   RUNOFF FROM SUB-BASIN E-5
 43          BA   .0400
 44          LS       0      79
 45          UD    .119
1                                      HEC-1 INPUT                                              PAGE  2

LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 46          KK    DPE5
 47          KM   COMBINE RUNOFF FROM SUB-BASIN E-5, E6B AND E1
 48          HC       3

 49          KK     E2A
```

```
50            KM   ROUTE FLOW FROM DESIGN POINT E5 TO E2B
51            RD     600      .01     .013              CIRC      4.5

52            KK     E2B
53            KM          ROUTE E2A TO DP E2
54            RK     600      .01     .013              CIRC        5

55            KK     E-2
56            KM   RUNOFF FROM SUB-BASIN E-2
57            BA   .0520
58            LS       0       79
59            UD    .134

60            KK    DPE2
61            KM   DESIGN POINT E2 COMBINE RUNOFF FROM SUB-BASIN E-2 AND E2B
62            HC       2

63            KK     D-1
64            KM   SUB-BASIN D-1
65            BA    .062
66            LS       0     78.1
67            UD    .180

68            KK      D2
69            KM   ROUTE RUNOFF FROM SUB-BASIN D-1 TO DP D2
70            RD    1230      .01     .013              CIRC      4.5

71            KK     D-2
72            KM   RUNOFF FROM SUB-BASIN D-2
73            BA    .036
74            LS       0       73
75            UD    .119

76            KK    DPD2
77            KM   COMBINE RUNOFF FROM SUB-BASIN D-2 AND DP D2
78            HC       2

79            KK   DPE-D
80            KM   COMBINE RUNOFF FROM DP D2 AND DP E2
81            HC       2

82            KK   DBE-D
83            KM   DETENTION BASIN E-D
84            KM   THIS OUTFLOW FROM DETENTION BASIN E-D
85            RS       1     ELEV  6953.5
86            SQ       0      2.2       11       15    109.2    162.9    179.9      509
87            SE    6952 6954.25   6954.5  6956.33     6957     6958     6959     6960
88            SA       0      1.5     2.08     3.04     3.59     3.86        4      4.2
89            SE    6952     6953     6954     6955     6957     6959     6960     6961
```

```
            LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

              90          ZZ
1
                   SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE       (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.       (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

     9          E-6
                  V
                  V
    26          E6A
                  V
                  V
    29          E6B
                  .
                  .
    32            .        E-1
                  .          V
                  .          V
    37            .         E1
                  .          .
                  .          .
    41            .          .          E-5
                  .          .            .
                  .          .            .
    46         DPE5.......................
                  V
                  V
    49          E2A
                  V
                  V
    52          E2B
                  .
                  .
    55            .        E-2
                  .          .
                  .          .
    60         DPE2...........
                  .
                  .
    63            .        D-1
                  .          V
                  .          V
    68            .         D2
                  .          .
                  .          .
```

```
 71             .           .         D-2
                .           .           .
                .           .           .
 76             .        DPD2............
                .           .
                .           .
 79         DPE-D............
                V
                V
 82         DBE-D

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************
 *                                       *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
 *              JUN   1998               *
 *             VERSION 4.1               *
 *                                       *
 *  RUN DATE   14MAR13  TIME  15:59:14   *
 *                                       *
 *****************************************

 *****************************************
 *                                       *
 *    U.S. ARMY CORPS OF ENGINEERS       *
 *    HYDROLOGIC ENGINEERING CENTER      *
 *          609 SECOND STREET            *
 *       DAVIS, CALIFORNIA 95616         *
 *           (916) 756-1104              *
 *                                       *
 *****************************************
```

```
                  Wolf Ranch Master Development Drainage Plan   pn 12055
                  E basins future development condition with detention
                    5-year and 100 year, 24hr Type IIA Storm fn:eddet.dat
                  WESTCREEK DETENTION BASIN PER FINAL DESIGN
                  WATER QUALTY BASIN ASUMED HALF FULL

  7 IO          OUTPUT CONTROL VARIABLES
                      IPRNT          5  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL          0. HYDROGRAPH PLOT SCALE

    IT          HYDROGRAPH TIME DATA
                       NMIN          5  MINUTES IN COMPUTATION INTERVAL
                      IDATE      1   0  STARTING DATE
                      ITIME       0000  STARTING TIME
                         NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      2   0  ENDING DATE
                     NDTIME       0055  ENDING TIME
                      ICENT         19  CENTURY MARK

                 COMPUTATION INTERVAL     .08 HOURS
                      TOTAL TIME BASE   24.92 HOURS

       ENGLISH UNITS
```

DRAINAGE AREA	SQUARE MILES
PRECIPITATION DEPTH	INCHES
LENGTH, ELEVATION	FEET
FLOW	CUBIC FEET PER SECOND
STORAGE VOLUME	ACRE-FEET
SURFACE AREA	ACRES
TEMPERATURE	DEGREES FAHRENHEIT

JP MULTI-PLAN OPTION
NPLAN 1 NUMBER OF PLANS

JR MULTI-RATIO OPTION
RATIOS OF PRECIPITATION
.56 1.00

1

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .56	RATIO 2 1.00
HYDROGRAPH AT						
+	E-6	.05	1	FLOW	31.	94.
				TIME	6.08	6.08
ROUTED TO						
+	E6A	.05	1	FLOW	30.	93.
				TIME	6.08	6.08
ROUTED TO						
+	E6B	.05	1	FLOW	30.	92.
				TIME	6.08	6.08
HYDROGRAPH AT						
+	E-1	.04	1	FLOW	26.	77.
				TIME	6.08	6.00
ROUTED TO						
+	E1	.04	1	FLOW	26.	76.
				TIME	6.08	6.08
HYDROGRAPH AT						
+	E-5	.04	1	FLOW	28.	82.
				TIME	6.00	6.00
3 COMBINED AT						

```
+                    DPE5       .13      1    FLOW          82.      240.
                                              TIME        6.08      6.08

 ROUTED TO
+                     E2A       .13      1    FLOW          80.      239.
                                              TIME        6.08      6.08

 ROUTED TO
+                     E2B       .13      1    FLOW          80.      239.
                                              TIME        6.08      6.08

 HYDROGRAPH AT
+                     E-2       .05      1    FLOW          34.      102.
                                              TIME        6.08      6.00

  2 COMBINED AT
+                    DPE2       .18      1    FLOW         114.      335.
                                              TIME        6.08      6.08

 HYDROGRAPH AT
+                     D-1       .06      1    FLOW          36.      109.
                                              TIME        6.08      6.08

 ROUTED TO
+                      D2       .06      1    FLOW          34.      107.
                                              TIME        6.08      6.08

 HYDROGRAPH AT
+                     D-2       .04      1    FLOW          15.       57.
                                              TIME        6.08      6.00

  2 COMBINED AT
+                    DPD2       .10      1    FLOW          49.      160.
                                              TIME        6.08      6.08

  2 COMBINED AT
+                   DPE-D       .28      1    FLOW         163.      495.
                                              TIME        6.08      6.08

 ROUTED TO
+                   D3E-D       .28      1    FLOW          13.      157.
                                              TIME        7.17      6.33

                                         ** PEAK STAGES IN FEET **
                                         1    STAGE    6955.41   6957.88
                                              TIME        7.17      6.33
1
*** NORMAL END OF HEC-1 ***
```

```
1*****************************************                        ***************************************
 *                                       *                        *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                        *   U.S. ARMY CORPS OF ENGINEERS      *
 *             JUN   1998                *                        *   HYDROLOGIC ENGINEERING CENTER     *
 *           VERSION 4.1                 *                        *         609 SECOND STREET           *
 *                                       *                        *     DAVIS, CALIFORNIA 95616         *
 * RUN DATE   27FEB18  TIME  15:01:53    *                        *         (916) 756-1104              *
 *                                       *                        *                                     *
 *****************************************                        ***************************************


                         X      X  XXXXXXX   XXXXX          X
                         X      X  X        X     X        XX
                         X      X  X        X               X
                         XXXXXXX  XXXX      X       XXXXX   X
                         X      X  X        X               X
                         X      X  X        X     X         X
                         X      X  XXXXXXX   XXXXX         XXX


          THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

          THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
          THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
          NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
          DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
          KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                        HEC-1 INPUT                                                PAGE  1

          LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

            1       ID           Wolf Ranch Tributary Four   FN F18-24HR.DAT  F18-24T2
            2       ID           F-Basins future developed condition with detention   PN 17004
            3       ID           Final design of detention basin F18/19  Briargate Parkway
            4       ID           5-year and 100 Year, 24HR RAINFALL NOAA ATLAS 2 TYPE II STORM
                    *DIAGRAM
            5       IT       5       0       0     300
            6       IO       5       0
            7       JR    PREC     .56     1.0

            8       KK     F-8
            9       KM         RUNOFF FOR SUB-BASIN F-8
           10       BA   .0630
```

F. Basins Detained
Type II - Atlas II

```
 11          IN      15
 12          PB     4.4
 13          PC       0   .002   .005   .008   .011  .0104  .0170    .02   .023   .026
 14          PC    .029   .032   .035   .038   .041   .044   .048   .052   .056    .06
 15          PC   .0604   .068   .072   .076    .08   .085    .09   .095     .1   .105
 16          PC     .11   .115    .12   .126   .133    .14   .147   .155   .163   .172
 17          PC    .181   .191   .203   .218   .236   .257   .283   .387   .663   .707
 18          PC    .735   .758   .776   .791   .804   .815   .825   .834   .842   .849
 19          PC    .856   .863   .869   .875   .881   .887   .893   .898   .903   .908
 20          PC    .913   .918   .922   .926    .93   .934   .938   .942   .946    .95
 21          PC    .953   .956   .959   .962   .965   .968   .971   .974   .977    .98
 22          PC    .983   .986   .989   .992   .995   .998
 23          LS       0   71.5
 24          UD    0.22

 25          KK    RF-8
 26          KM           ROUTE FLOW FROM SUB-BASIN F-8 TO DETENTION BASIN DB 19
 27          RD    1800  0.037   0.04          TRAP     15      4

 28          KK     F-1
 29          KM           RUNOFF FOR BASIN F-1
 30          BA   .1659
 31          LS       0     61
 32          UD     .20

 33          KK    RF-9
 34          KM           ROUTE FLOW FROM SUB-BASIN F-1 TO DESIGN POINT F9
 35          RD     700  0.037   0.04          TRAP     10      6

 36          KK     F-9
 37          KM           RUNOFF FOR BASIN F-9
 38          BA   .0430
 39          LS       0     70
 40          UD     .16

 41          KK    DPF9
 42          KM          COMBINE FLOW FROM SUB-BASIN F-9 AND RF-9
 43          HC       2
1                                     HEC-1 INPUT                                          PAGE  2

LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 44          KK   RF-19
 45          KM           ROUTE FLOW FROM DESIGN POINT DP F9 TO RF-19A
 46          RD    1600  0.018  0.013          CIRC      4

 47          KK  RF-19A
 48          KM           ROUTE FLOW FROM RF-=19 TO DP F19
 49          RK     400    .02   .013          CIRC      5
```

```
50            KK    F-19
51            KM         RUNOFF FOR BASIN F-19
52            BA   .1020
53            LS       0    73.2
54            UD     .19

55            KK   DPF19
56            KM        COMBINE FLOW FROM SUB-BASIN F-19, RF-8 AND RF19
57            HC       3

58            KK     F-2
59            KM         RUNOFF FOR BASIN F-2
60            BA   .0424
61            LS       0      61
62            UD     .19

63            KK   RF-10
64            KM         ROUTE FLOW FROM SUB-BASIN F-2 TO DESIGN POINT F10
65            RD     850   0.059    0.04            TRAP      10       6

66            KK    F-10
67            KM         RUNOFF FOR BASIN F-10
68            BA   .0180
69            LS       0      67
70            UD     .15

71            KK   DPF10
72            KM        COMBINE FLOW FROM SUB-BASIN F-10 AND RF10
73            HC       2

74            KK  RF-18A
75            KM        ROUTE FLOW FROM DESIGN POINT DP F10 TO DETENTION BASIN DB 18
76            RD    1600   0.050    0.04            TRAP      15       4

77            KK     F-3
78            KM         RUNOFF FOR SUB-BASIN F-3
79            BA   .0942
80            LS       0      61
81            UD     .22

82            KK   RF-11
83            KM        ROUTE FLOW FROM SUB-BASIN F-3 TO DESIGN POINT F11
84            RD     950   0.038    0.04            TRAP      10       6
```



```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

85            KK    F-11
```

```
KM        RUNOFF FOR SUB-BASIN F-11
BA   .0460
LS       0    68.2
UD     .17

KK   DPF11
KM       COMBINE FLOW FROM SUB-BASIN F-11 AND RF-11
HC       2

KK   RF-18
KM       ROUTE FLOW FROM DESIGN POINT F11 TO DETENTION BASIN DB 18
RD    1600   0.029    0.04            TRAP      15       4

KK     F-4
KM        RUNOFF FOR SUB-BASIN F-4
BA   .2681
LS       0      61
UD     .28

KK   RF-12
KM       ROUTE FLOW FROM SUB-BASIN F-4 TO DESIGN POINT F12
RD    1150   0.044    0.04            TRAP      10       6

KK     F-5
KM        RUNOFF FOR SUB-BASIN F-5
BA   .1073
LS       0      61
UD     .34

KK  RF-12A
KM       ROUTE FLOW FROM SUB-BASIN F-5 TO DESIGN POINT F12
RD    1600   0.035    0.04            TRAP      10       6

KK    F-12
KM        RUNOFF FOR SUB-BASIN F-12
BA   .0590
LS       0    69.3
UD     .20

KK   DPF12
KM       COMBINE FLOW FROM SUB-BASIN RF-12 RF-12A, AND F-12
HC       3

KK   RF-17
KM       ROUTE FLOW FROM DESIGN POINT F-12 TO DETENTION BASIN DB 18
RD    1600   0.020   0.013            CIRC     4.5

KK    F-17
KM        RUNOFF FOR SUB-BASIN F-17
BA   .0380
```

```
 126          LS       0    60.1
 127          UD     .21
```



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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 128          KK    F-18
 129          KM          RUNOFF FOR SUB-BASIN F-18
 130          BA   .0980
 131          LS       0    73.1
 132          UD     .21

 133          KK   DPF18
 134          KM         COMBINE FLOW FROM SUB-BASINS F-18, F17, RF-18A, RF-18, RF-17
 135          KM         THIS IS INFLOW TO DETENTION BASIN F-18
 136          HC       5

 137          KK  DP1819
 138          KM          COMBINE DPF18 AND F19
 139          KM         INFLOW TO DET BASIN F18-19
 140          HC       2

 141          KK  DF1819
 142          KM           ROUTE DPF1819  THROUGH DETENTION BASIN F 18-19
 143          KM           THIS IS OUTFLOW FROM DETENTION BASIN F 18-19
 144          RS       1    ELEV  7132.7
 145          SV       0     .01     .02      .1     .52    1.76    4.43    8.72    14.3   20.74
 146          SV   27.65      37   42.64    48.9    58.8    65.0    69.1
 147          SE  7132.7  7133.5    7134    7135    7136    7137    7138    7139    7140    7141
 148          SE    7142    7143    7144    7145    7146    7147  7147.5
 149          SQ       0      .4      .5      .8     1.1     1.5     1.9     2.2    41.3   133.8
 150          SQ   217.3   230.4   242.8   253.3   257.1   268.2   271.7

 151          KK  RF-22A
 152          KM         ROUTE FLOW FROM DETENTION BASIN F1819 TO DESIGN POINT DP F22
 153          RD    1800   0.027    0.02            TRAP      10       6

 154          KK    F-22
 155          KM          RUNOFF FOR SUB-BASIN F-22
 156          BA   .0640
 157          LS       0    64.1
 158          UD     .21

 159          KK    F-16
 160          KM             RUNOFF FROM SUB-BASIN F-16
 161          BA    .027
 162          LS       0    72.8
 163          UD     .21
```

```
 164          KK   RF-16
 165          KM          ROUTE FLOW FROM SUB-BASIN F-16 TO DP F22
 166          RD    1800    .045    .013            CIRC     2.5

 167          KK   DPF22
 168          KM       COMBINE FLOW FROM SUB-BASIN F-22, RF-16 AND RF-22A
 169          HC       3
1                                        HEC-1 INPUT                                               PAGE  5

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 170          KK  RF-27
 171          KM       ROUTE FLOW FROM DESIGN POINT DPF22 TO DESIGN POINT F27
 172          RD    3700   0.020    0.04            TRAP      50       3

 173          KK  RF-27C
 174          KM       ROUTE FLOW FROM RF-27 TO DESIGN POINT F28
 175          RD    1400   0.019    0.04            TRAP      50       3

 176          KK    F-7
 177          KM        RUNOFF FOR SUB-BASIN F-7
 178          BA   .0782
 179          LS       0      61
 180          UD     .19

 181          KK   RF-7
 182          KM       ROUTE FLOW FROM SUB-BASIN F-7 TO DESIGN POINT F14
 183          RD    1200   0.033    0.04            TRAP      10       6

 184          KK    F-14
 185          KM        RUNOFF FOR SUB-BASIN F-14
 186          BA   .1290
 187          LS       0    73.0
 188          UD     .23

 189          KK    F-6
 190          KM        RUNOFF FOR SUB-BASIN F-6
 191          BA   .0310
 192          LS       0      61
 193          UD     .19

 194          KK   RF-13
 195          KM       ROUTE FLOW FROM SUB-BASIN F-6 TO DESIGN POINT F13
 196          RD     800   0.038    0.04            TRAP      10       6

 197          KK    F-13
 198          KM        RUNOFF FOR SUB-BASIN F-13
 199          BA   .0140
 200          LS       0      61
```

```
 201          UD     .14

 202          KK  DPF13
 203          KM        COMBINE FLOW FROM RF-13 AND F-13
 204          HC       2

 205          KK   RF-14
 206          KM        ROUTE FLOW FROM DESIGN POINT F13 TO RF-14A
 207          RD    2400   0.027    0.04            TRAP      20       6

 208          KK  RF-14A
 209          KM         ROUTE FLOW FROM RF-14 TO DP F14
 210          RK     800     .02    .013            CIRC       4
1                                    HEC-1 INPUT                                                    PAGE  6

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 211          KK  DPF14
 212          KM        COMBINE FLOW FROM RF-7, F-14, AND RF-14
 213          HC       3

 214          KK   RF-25
 215          KM        ROUTE FLOW FROM DESIGN POINT F14 TO DESIGN POINT F25
 216          RD    2600   0.023   0.013            CIRC       5

 217          KK    F-25
 218          KM         RUNOFF FOR SUB-BASIN F-25
 219          BA   .0890
 220          LS       0    74.1
 221          UD     .28

 222          KK  DPF25
 223          KM        COMBINE FLOW FROM RF-25 AND RF-14
 224          HC       2

 225          KK   RF-30
 226          KM        ROUTE FLOW FROM DESIGN POINT F25 TO DESIGN POINT F30
 227          RD     900   0.027   0.013            CIRC       5

 228          KK    F-15
 229          KM         RUNOFF FOR SUB-BASIN F-15
 230          BA   .0210
 231          LS       0    69.1
 232          UD     .15

 233          KK   RF-23
 234          KM        ROUTE FLOW FROM SUB-BASIN F15 TO DESIGN POINT F23
 235          RD    1200   0.023    0.04            TRAP      10       3
```

```
 236            KK    F-23
 237            KM         RUNOFF FOR SUB-BASIN F-23
 238            BA   .0310
 239            LS       0    73.0
 240            UD     .18

 241            KK   DPF23
 242            KM        COMBINE FLOW FROM RF-23 AND F-23
 243            HC       2

 244            KK   RF-24
 245            KM        ROUTE FLOW FROM DESIGN POINT F23 TO DESIGN POINT F24
 246            RD    2250   0.026   0.013            CIRC       4

 247            KK    F-24
 248            KM         RUNOFF FOR SUB-BASIN F-24
 249            BA   .0890
 250            LS       0      79
 251            UD     .26
```



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LINE            ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 252            KK   DPF24
 253            KM        COMBINE FLOW FROM RF-24 AND F-24
 254            HC       2

 255            KK   RF-30A
 256            KM        ROUTE FLOW FROM DESIGN POINT F24 TO DESIGN POINT F30
 257            RD    1100   0.033   0.013           CIRCD       4

 258            KK    F-30
 259            KM         RUNOFF FOR SUB-BASIN F-30
 260            BA   .0220
 261            LS       0    77.7
 262            UD     .18

 263            KK   DPF30
 264            KM        COMBINE FLOW FROM RF-30, RF-30A AND F-30
 265            HC       3

 266            KK   RF-29
 267            KM        ROUTE FLOW FROM DESIGN POINT F30 TO DESIGN POINT F29
 268            RD    2350   0.027    0.04            TRAP       6       3

 269            KK    F-29
 270            KM         RUNOFF FOR SUB-BASIN F-29
 271            BA   .0250
 272            LS       0      70
```

```
 273          UD     .19

 274          KK  DPF29
 275          KM       COMBINE FLOW FROM RF-29 AND F-29
 276          HC       2

 277          KK   RF-28
 278          KM       ROUTE FLOW FROM DESIGN POINT F29 TO DESIGN POINT F28
 279          RD     750   0.015    0.04            TRAP      20       3

 280          KK    F-28
 281          KM        RUNOFF FOR SUB-BASIN F-28
 282          BA    .042
 283          LS       0      68
 284          UD     .23

 285          KK    F-27
 286          KM        RUNOFF FOR SUB-BASIN F-27
 287          BA    .240
 288          LS       0    76.2
 289          UD     .32

 290          KK   DPF28
 291          KM       COMBINE FLOW FROM RF-27C, RF-28, F-28 AND F-27
 292          KM       THIS IS INFLOW TO DETENTION BASIN F-28
 293          HC       4
```



```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 294          KK   DBF28
 295          KM       ROUTE DPF28 THROUGH DETENTION BASIN F-28
 296          KM       THIS IS OUTFLOW FROM DETENTION BASIN F-28
 297          KM       FINAL DESIGN STAGE DISCHARGE
 298          RS       1    ELEV    6968
 299          SV       0    1.07    5.23   10.56    16.7    20.2      24   32.76      43
 300          SE    6968    6970    6972    6974    6976    6977    6978    6980    6982
 301          SQ       0     1.5     4.8    10.2    15.6     340     520     880    1000

 302          KK   RF-31
 303          KM       ROUTE FLOW FROM DPF TO DESIGN POINT F
 304          RD    3500   0.023    0.04            TRAP      20       3

 305          KK    F-31
 306          KM        RUNOFF FOR SUB-BASIN F-31
 307          BA    .069
 308          LS       0      61
 309          UD     .34
```

```
         310           KK    DP F
         311           KM       COMBINE FLOW FROM RF-31 AND F-31
         312           HC       2
         313           ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING         (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR       (<---) RETURN OF DIVERTED OR PUMPED FLOW

    8          F-8
                 V
                 V
   25         RF-8
                 .
                 .
   28            .          F-1
                 .            V
                 .            V
   33            .          RF-9
                 .            .
                 .            .
   36            .            .          F-9
                 .            .            .
                 .            .            .
   41            .          DPF9............
                 .            V
                 .            V
   44            .         RF-19
                 .            V
                 .            V
   47            .        RF-19A
                 .            .
                 .            .
   50            .            .         F-19
                 .            .            .
                 .            .            .
   55        DPF19.......................
                 .
                 .
   58            .          F-2
                 .            V
                 .            V
   63            .         RF-10
                 .            .
                 .            .
   66            .            .         F-10
                 .            .            .
                 .            .            .
```

```
  71           .       DPF10.............
               .           V
               .           V
  74           .      RF-18A
               .           .
               .           .
  77           .           .          F-3
               .           .            V
               .           .            V
  82           .           .        RF-11
               .           .            .
               .           .            .
  85           .           .            .        F-11
               .           .            .           .
               .           .            .           .
  90           .           .        DPF11............
               .           .            V
               .           .            V
  93           .           .        RF-18
               .           .            .
               .           .            .
  96           .           .            .         F-4
               .           .            .           V
               .           .            .           V
 101           .           .            .       RF-12
               .           .            .           .
               .           .            .           .
 104           .           .            .           .         F-5
               .           .            .           .           V
               .           .            .           .           V
 109           .           .            .           .      RF-12A
               .           .            .           .           .
               .           .            .           .           .
 112           .           .            .           .           .        F-12
               .           .            .           .           .           .
               .           .            .           .           .           .
 117           .           .            .       DPF12........................
               .           .            .           V
               .           .            .           V
 120           .           .            .       RF-17
               .           .            .           .
               .           .            .           .
 123           .           .            .           .        F-17
               .           .            .           .           .
               .           .            .           .           .
 128           .           .            .           .           .        F-18
               .           .            .           .           .           .
               .           .            .           .           .           .
 133           .       DPF18.................................................
               .           .
```

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              .           .
137      DP1819............
              V
              V
141      DF1819
              V
              V
151      RF-22A
              .
              .
154           .        F-22
              .           .
              .           .
159           .           .        F-16
              .           .           V
              .           .           V
164           .           .       RF-16
              .           .           .
              .           .           .
167       DPF22........................
              V
              V
170      RF-27
              V
              V
173      RF-27C
              .
              .
176           .        F-7
              .           V
              .           V
181           .       RF-7
              .           .
              .           .
184           .           .        F-14
              .           .           .
              .           .           .
189           .           .           .       F-6
              .           .           .          V
              .           .           .          V
194           .           .           .      RF-13
              .           .           .          .
              .           .           .          .       F-13
197           .           .           .          .          .
              .           .           .          .          .
202           .           .           .     DPF13 ...........
              .           .           .          V
              .           .           .          V
205           .           .           .      RF-14
```

```
               .           .           .           V
               .           .           .           V
208            .           .           .      RF-14A
               .           .           .           .
               .           .           .           .
211            .      DPF14 ........................
               .           V
               .           V
214            .       RF-25
               .           .
               .           .
217            .           .        F-25
               .           .           .
               .           .           .
222            .      DPF25 ............
               .           V
               .           V
225            .       RF-30
               .           .
               .           .
228            .           .        F-15
               .           .           V
               .           .           V
233            .           .       RF-23
               .           .           .
               .           .           .
236            .           .           .        F-23
               .           .           .           .
               .           .           .           .
241            .           .      DPF23 ............
               .           .           V
               .           .           V
244            .           .       RF-24
               .           .           .
               .           .           .
247            .           .           .        F-24
               .           .           .           .
               .           .           .           .
252            .           .      DPF24 ............
               .           .           V
               .           .           V
255            .           .      RF-30A
               .           .           .
               .           .           .
258            .           .           .        F-30
               .           .           .           .
               .           .           .           .
263            .      DPF30 ........................
               .           V
               .           V
```

```
 266          .       RF-29
              .            .
              .            .
 269          .            .           F-29
              .            .              .
              .            .              .
 274          .      DPF29 ............
              .            V
              .            V
 277          .       RF-28
              .            .
              .            .
 280          .            .           F-28
              .            .              .
              .            .              .
 285          .            .              .            F-27
              .            .              .               .
              .            .              .               .
 290      DPF28....................................
              V
              V
 294      DBF28
              V
              V
 302      RF-31
              .
              .
 305          .        F-31
              .            .
              .            .
 310        DP F...........

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```

```
1****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*              JUN   1998               *
*            VERSION 4.1                *
*                                       *
*  RUN DATE   27FEB18  TIME  15:01:53   *
*                                       *
*****************************************
```

```
****************************************
*                                      *
*    U.S. ARMY CORPS OF ENGINEERS      *
*    HYDROLOGIC ENGINEERING CENTER     *
*          609 SECOND STREET           *
*       DAVIS, CALIFORNIA 95616        *
*           (916) 756-1104             *
*                                      *
****************************************
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```
Wolf Ranch Tributary Four   FN F18-24HR.DAT
F-Basins future developed condition with detention   PN 17004
Final design of detention basin F18/19  Briargate Parkway
```

5-year and 100 Year, 24HR RAINFALL NOAA ATLAS 2 TYPE II STORM

```
 6 IO         OUTPUT CONTROL VARIABLES
                    IPRNT           5  PRINT CONTROL
                    IPLOT           0  PLOT CONTROL
                    QSCAL          0.  HYDROGRAPH PLOT SCALE

   IT         HYDROGRAPH TIME DATA
                     NMIN           5  MINUTES IN COMPUTATION INTERVAL
                    IDATE      1    0  STARTING DATE
                    ITIME        0000  STARTING TIME
                       NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE      2    0  ENDING DATE
                   NDTIME        0055  ENDING TIME
                    ICENT          19  CENTURY MARK

                COMPUTATION INTERVAL     .08 HOURS
                     TOTAL TIME BASE   24.92 HOURS

        ENGLISH UNITS
             DRAINAGE AREA          SQUARE MILES
             PRECIPITATION DEPTH    INCHES
             LENGTH, ELEVATION      FEET
             FLOW                   CUBIC FEET PER SECOND
             STORAGE VOLUME         ACRE-FEET
             SURFACE AREA           ACRES
             TEMPERATURE            DEGREES FAHRENHEIT

   JP          MULTI-PLAN OPTION
                    NPLAN           1  NUMBER OF PLANS

   JR          MULTI-RATIO OPTION
                 RATIOS OF PRECIPITATION
                  .56      1.00
1
```

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .56	RATIO 2 1.00
HYDROGRAPH AT						
+	F-8	.06	1	FLOW	16.	64.
				TIME	12.17	12.08
ROUTED TO						

+	RF-8	.06	1	FLOW	16.	65.
				TIME	12.25	12.17
HYDROGRAPH AT						
+	F-1	.17	1	FLOW	8.	94.
				TIME	12.25	12.08
ROUTED TO						
+	RF-9	.17	1	FLOW	8.	93.
				TIME	12.25	12.17
HYDROGRAPH AT						
+	F-9	.04	1	FLOW	11.	48.
				TIME	12.08	12.08
2 COMBINED AT						
+	DPF9	.21	1	FLOW	16.	134.
				TIME	12.17	12.08
ROUTED TO						
+	RF-19	.21	1	FLOW	15.	132.
				TIME	12.17	12.17
ROUTED TO						
+	RF-19A	.21	1	FLOW	15.	131.
				TIME	12.25	12.17
HYDROGRAPH AT						
+	F-19	.10	1	FLOW	32.	123.
				TIME	12.08	12.08
3 COMBINED AT						
+	DPF19	.37	1	FLOW	58.	306.
				TIME	12.17	12.17
HYDROGRAPH AT						
+	F-2	.04	1	FLOW	2.	25.
				TIME	12.17	12.08
ROUTED TO						
+	RF-10	.04	1	FLOW	2.	25.
				TIME	12.25	12.17
HYDROGRAPH AT						
+	F-10	.02	1	FLOW	3.	18.
				TIME	12.08	12.08
2 COMBINED AT						
+	DPF10	.06	1	FLOW	4.	40.
				TIME	12.17	12.08

ROUTED TO						
+	RF-18A	.06	1	FLOW	4.	38.
				TIME	12.33	12.17
HYDROGRAPH AT						
+	F-3	.09	1	FLOW	4.	52.
				TIME	12.25	12.17
ROUTED TO						
+	RF-11	.09	1	FLOW	4.	51.
				TIME	12.33	12.17
HYDROGRAPH AT						
+	F-11	.05	1	FLOW	9.	46.
				TIME	12.08	12.08
2 COMBINED AT						
+	DPF11	.14	1	FLOW	11.	90.
				TIME	12.17	12.17
ROUTED TO						
+	RF-18	.14	1	FLOW	11.	87.
				TIME	12.33	12.25
HYDROGRAPH AT						
+	F-4	.27	1	FLOW	11.	128.
				TIME	12.33	12.17
ROUTED TO						
+	RF-12	.27	1	FLOW	11.	128.
				TIME	12.42	12.25
HYDROGRAPH AT						
+	F-5	.11	1	FLOW	4.	46.
				TIME	12.42	12.25
ROUTED TO						
+	RF-12A	.11	1	FLOW	4.	46.
				TIME	12.58	12.33
HYDROGRAPH AT						
+	F-12	.06	1	FLOW	12.	57.
				TIME	12.17	12.08
3 COMBINED AT						
+	DPF12	.43	1	FLOW	20.	211.
				TIME	12.33	12.25
ROUTED TO						

```
+              RF-17       .43     1   FLOW        20.     209.
                                       TIME      12.42    12.25

 HYDROGRAPH AT
+               F-17       .04     1   FLOW         1.      20.
                                       TIME      12.25    12.17

 HYDROGRAPH AT
+               F-18       .10     1   FLOW        29.     111.
                                       TIME      12.17    12.08

  5 COMBINED AT
+              DPF18       .77     1   FLOW        57.     443.
                                       TIME      12.25    12.17

  2 COMBINED AT
+             DP1819      1.14     1   FLOW       113.     750.
                                       TIME      12.17    12.17

 ROUTED TO
+             DF1819      1.14     1   FLOW        12.     215.
                                       TIME      17.00    12.75

                                   ** PEAK STAGES IN FEET **
                                   1   STAGE   7139.26  7141.97
                                       TIME      17.00    12.75

 ROUTED TO
+             RF-22A      1.14     1   FLOW        12.     214.
                                       TIME      17.08    12.83

 HYDROGRAPH AT
+               F-22       .06     1   FLOW         6.      44.
                                       TIME      12.17    12.08

 HYDROGRAPH AT
+               F-16       .03     1   FLOW         8.      30.
                                       TIME      12.17    12.08

 ROUTED TO
+              RF-16       .03     1   FLOW         8.      29.
                                       TIME      12.17    12.17

  3 COMBINED AT
+              DPF22      1.24     1   FLOW        15.     230.
                                       TIME      12.17    12.75

 ROUTED TO
+             RF-27       1.24     1   FLOW        20.     230.
                                       TIME      12.58    12.92
```

ROUTED TO						
+	RF-27C	1.24	1	FLOW	16.	230.
				TIME	12.83	13.00
HYDROGRAPH AT						
+	F-7	.08	1	FLOW	4.	46.
				TIME	12.17	12.08
ROUTED TO						
+	RF-7	.08	1	FLOW	4.	46.
				TIME	12.33	12.17
HYDROGRAPH AT						
+	F-14	.13	1	FLOW	37.	138.
				TIME	12.17	12.17
HYDROGRAPH AT						
+	F-6	.03	1	FLOW	1.	18.
				TIME	12.17	12.08
ROUTED TO						
+	RF-13	.03	1	FLOW	1.	18.
				TIME	12.25	12.17
HYDROGRAPH AT						
+	F-13	.01	1	FLOW	1.	10.
				TIME	12.08	12.08
2 COMBINED AT						
+	DPF13	.05	1	FLOW	2.	25.
				TIME	12.25	12.17
ROUTED TO						
+	RF-14	.05	1	FLOW	2.	25.
				TIME	12.67	12.25
ROUTED TO						
+	RF-14A	.05	1	FLOW	2.	25.
				TIME	12.75	12.33
3 COMBINED AT						
+	DPF14	.25	1	FLOW	39.	199.
				TIME	12.17	12.17
ROUTED TO						
+	RF-25	.25	1	FLOW	38.	190.
				TIME	12.25	12.17
HYDROGRAPH AT						

+	F-25	.09	1	FLOW	25.	92.
				TIME	12.17	12.17
2 COMBINED AT						
+	DPF25	.34	1	FLOW	62.	282.
				TIME	12.25	12.17
ROUTED TO						
+	RF-30	.34	1	FLOW	62.	278.
				TIME	12.25	12.17
HYDROGRAPH AT						
+	F-15	.02	1	FLOW	5.	23.
				TIME	12.08	12.08
ROUTED TO						
+	RF-23	.02	1	FLOW	5.	23.
				TIME	12.17	12.17
HYDROGRAPH AT						
+	F-23	.03	1	FLOW	10.	38.
				TIME	12.08	12.08
2 COMBINED AT						
+	DPF23	.05	1	FLOW	14.	59.
				TIME	12.17	12.08
ROUTED TO						
+	RF-24	.05	1	FLOW	13.	57.
				TIME	12.17	12.17
HYDROGRAPH AT						
+	F-24	.09	1	FLOW	40.	117.
				TIME	12.17	12.17
2 COMBINED AT						
+	DPF24	.14	1	FLOW	53.	174.
				TIME	12.17	12.17
ROUTED TO						
+	RF-30A	.14	1	FLOW	52.	173.
				TIME	12.17	12.17
HYDROGRAPH AT						
+	F-30	.02	1	FLOW	11.	33.
				TIME	12.08	12.08
3 COMBINED AT						
+	DPF30	.50	1	FLOW	121.	478.
				TIME	12.17	12.17

```
 ROUTED TO
+              RF-29      .50     1   FLOW        117.    468.
                                      TIME       12.25   12.25

 HYDROGRAPH AT
+               F-29      .03     1   FLOW          6.     26.
                                      TIME       12.08   12.08

  2 COMBINED AT
+             DPF29       .53     1   FLOW        121.    486.
                                      TIME       12.25   12.25

 ROUTED TO
+              RF-28      .53     1   FLOW        120.    478.
                                      TIME       12.33   12.25

 HYDROGRAPH AT
+               F-28      .04     1   FLOW          7.     35.
                                      TIME       12.17   12.17

 HYDROGRAPH AT
+               F-27      .24     1   FLOW         76.    249.
                                      TIME       12.25   12.25

  4 COMBINED AT
+              DPF28     2.05     1   FLOW        196.    770.
                                      TIME       12.33   12.25

 ROUTED TO
+              DBF28     2.05     1   FLOW         26.    536.
                                      TIME       17.92   12.58

                                ** PEAK STAGES IN FEET **
                                  1   STAGE    6976.03 6978.09
                                      TIME       17.92   12.58

 ROUTED TO
+              RF-31     2.05     1   FLOW         26.    544.
                                      TIME       18.08   12.67

 HYDROGRAPH AT
+               F-31      .07     1   FLOW          3.     30.
                                      TIME       12.42   12.25

  2 COMBINED AT
+               DP F     2.12     1   FLOW         26.    559.
                                      TIME       18.08   12.67
*** NORMAL END OF HEC-1 ***
```

```
1*****************************************                  ***************************************
 *                                       *                  *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                  *   U.S. ARMY CORPS OF ENGINEERS      *
 *              JUN   1998               *                  *   HYDROLOGIC ENGINEERING CENTER     *
 *            VERSION 4.1                *                  *         609 SECOND STREET           *
 *                                       *                  *      DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   18DEC17  TIME  16:32:41   *                  *         (916) 756-1104              *
 *                                       *                  *                                     *
*****************************************                  ***************************************


                    X     X  XXXXXXX   XXXXX         X
                    X     X  X        X     X       XX
                    X     X  X        X              X
                    XXXXXXX  XXXX     X      XXXXX   X
                    X     X  X        X              X
                    X     X  X        X     X        X
                    X     X  XXXXXXX   XXXXX        XXX


THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                          HEC-1 INPUT                                        PAGE  1

 LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1         ID           Wolf Ranch Master Development Drainage Plan
   2         ID           G Basins Future developed condition with detention  PN 17020
   3         ID           FINAL DESIGN DETENTION BASIN G  DRAFT FCW RAINFALL EVALUATION
   4         ID           5-year and 100 Year, 1 hr RAINFALL  Storm  FN DETGFR.DAT
             *DIAGRAM
   5         IT       5       0       0     300
   6         IO       5       0
   7         JR    PREC     .56     1.0

   8         KK    G-1
   9         KM        RUNOFF - Sub-basin G-1
  10         BA    .0808
```

G-Basins Retained
2HR Storm

```
 11          IN       5
 12          PB    2.77
 13          PC       0    .024    .061    .101    .148    .223    .313    .442    .721    .881
 14          PC    .892    .943    .986   1.024    1.05   1.073   1.095   1.117   1.137   1.157
 15          PC   1.176   1.194   1.212   1.229   1.245
 16          LS       0      61
 17          UD    0.22

 18          KK      G2
 19          KM          ROUTE FLOW from SUB-BASIN G-1 TO DP G3
 20          RD    3200   0.027    0.04            TRAP      10       4

 21          KK     G-2
 22          KM          RUNOFF - Sub-basin G-2
 23          BA    .035
 24          LS       0      73
 25          UD    0.22

 26          KK      G3
 27          KM          ROUTE FLOW from SUB-BASIN G-2 TO DP G3
 28          RD    2500   0.025   0.013            CIRC     4.5

 29          KK     G-3
 30          KM          RUNOFF - Sub-basin G-3
 31          BA    .177
 32          LS       0      73
 33          UD    0.29

 34          KK    DPG3
 35          KM   COMBINE RUNOFF from G2, G3 AND SUB-BASIN G-3
 36          HC       3

 37          KK    DB G
 38          KM   DESIGN POIUNT G3 INTO DETENTION BASIN G
 39          RS       1    ELEV    6970
 40          SQ       0      .4      .6       1     1.3       5      13    22.5      72      90
 41          SQ     110     115     120     130     140
 42          SE    6970    6971    6972    6973    6974    6975    6976    6977    6978    6979
 43          SE    6980    6981    6982    6983    6984
 44          SV       0    .112    .601    1.61    2.93    4.30    5.79    7.38    9.08   10.89
 45          SV    12.8    14.8    17.0    19.2    21.6
1                                        HEC-1 INPUT                                        PAGE  2

LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 46          KK      G4
 47          KM   ROUTE OUTFLOW FORM DETENTION BASIN G TO TRIB 4
 48          RD     440     .04    .013            CIRC       3
```

```
              49           KK     G-4
              50           KM   RUNOFF FROM SUB-BASIN G-4
              51           BA    .043
              52           LS       0      79
              53           UD    .212
              54           ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    8        G-1
                V
                V
   18          G2
                .
                .
   21           .          G-2
                .            V
                .            V
   26           .           G3
                .            .
                .            .
   29           .            .          G-3
                .            .            .
                .            .            .
   34         DPG3.........................
                V
                V
   37         DB G
                V
                V
   46          G4
                .
                .
   49           .          G-4

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************
 *                                       *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
 *              JUN   1998               *
 *           VERSION 4.1                 *
 *                                       *
 *  RUN DATE   18DEC17  TIME  16:32:41   *
 *                                       *
 *****************************************

 *****************************************
 *                                       *
 *    U.S. ARMY CORPS OF ENGINEERS       *
 *    HYDROLOGIC ENGINEERING CENTER      *
 *          609 SECOND STREET            *
 *       DAVIS, CALIFORNIA 95616         *
 *           (916) 756-1104              *
 *                                       *
 *****************************************
```

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                              Wolf Ranch Master Development Drainage Plan
                              G Basins Future developed condition with detention  PN 17020
                              FINAL DESIGN DETENTION BASIN G  DRAFT FCW RAINFALL EVALUATION
                              5-year and 100 Year, 1 hr RAINFALL  Storm  FN DETGFR.DAT

  6 IO        OUTPUT CONTROL VARIABLES
                    IPRNT          5  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

    IT        HYDROGRAPH TIME DATA
                    NMIN           5  MINUTES IN COMPUTATION INTERVAL
                    IDATE      1   0  STARTING DATE
                    ITIME       0000  STARTING TIME
                       NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE      2   0  ENDING DATE
                   NDTIME       0055  ENDING TIME
                   ICENT          19  CENTURY MARK

                COMPUTATION INTERVAL     .08 HOURS
                     TOTAL TIME BASE   24.92 HOURS

       ENGLISH UNITS
            DRAINAGE AREA          SQUARE MILES
            PRECIPITATION DEPTH    INCHES
            LENGTH, ELEVATION      FEET
            FLOW                   CUBIC FEET PER SECOND
            STORAGE VOLUME         ACRE-FEET
            SURFACE AREA           ACRES
            TEMPERATURE            DEGREES FAHRENHEIT

    JP        MULTI-PLAN OPTION
                    NPLAN          1  NUMBER OF PLANS

    JR        MULTI-RATIO OPTION
                  RATIOS OF PRECIPITATION
                  .56      1.00
1

           PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                            FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                            TIME TO PEAK IN HOURS


                                                               RATIOS APPLIED TO PRECIPITATION
OPERATION       STATION     AREA    PLAN             RATIO 1  RATIO 2
```

```
                                                                     .56      1.00
   HYDROGRAPH AT
  +                   G-1          .08     1   FLOW              1.       12.
                                               TIME            2.08      1.17

   ROUTED TO
  +                     G2         .08     1   FLOW              1.       12.
                                               TIME            2.50      1.33

   HYDROGRAPH AT
  +                    G-2         .04     1   FLOW              3.       19.
                                               TIME            1.17       .92

   ROUTED TO
  +                     G3         .04     1   FLOW              3.       18.
                                               TIME            1.25      1.00

   HYDROGRAPH AT
  +                    G-3         .18     1   FLOW             13.       83.
                                               TIME            1.25      1.00

    3 COMBINED AT
  +                   DPG3         .29     1   FLOW             16.      102.
                                               TIME            1.25      1.08

   ROUTED TO
  +                   DB G         .29     1   FLOW              1.       23.
                                               TIME            2.75      2.33

                                          ** PEAK STAGES IN FEET **
                                           1   STAGE        6972.95   6977.02
                                               TIME            2.83      2.33

   ROUTED TO
  +                     G4         .29     1   FLOW              1.       23.
                                               TIME            2.75      2.33

   HYDROGRAPH AT
  +                    G-4         .04     1   FLOW              8.       37.
 1                                             TIME             .92       .92


  *** NORMAL END OF HEC-1 ***
```

APPENDIX B

HYDRAULIC CALCULATIONS

Kiowa Engineering Corporation

CLIENT Retention Basin A JOB NO. 05089 PAGE 1
PROJECT DATE CHECKED DATE 12/15/05
DETAIL CHECKED BY PEW 3-10-13 COMPUTED BY

INFLOW STRUCTURE DESIGN

DET BASIN CONSTRUCTED 2008

Routing Element 'A5' : $Q_5 = 216$ cfs.

$Q_{100} = 705$ cfs

Create sump condition for drop inlet to pick up 5-year :

i.) ~~Assume~~ 2' sump condition.

$$Q = CC_B A\sqrt{2gH}$$

$$C = .63 \quad C_B = .50 \quad \therefore CC_B = .32$$

$$Q = .32A\sqrt{2g(2)} = 3.63A$$

Req'd Opening = $216/3.63 = 59.5$ sf.

Too large for park area.

ii) Try H = 3'

$$\therefore Q = .32A\sqrt{2g(3)}$$

$$A = 216/4.45 = 48.5; \text{ say } 50 \text{ sf}$$

$\therefore$ 5' x 10' drop inlet.

Kiowa Engineering Corporation

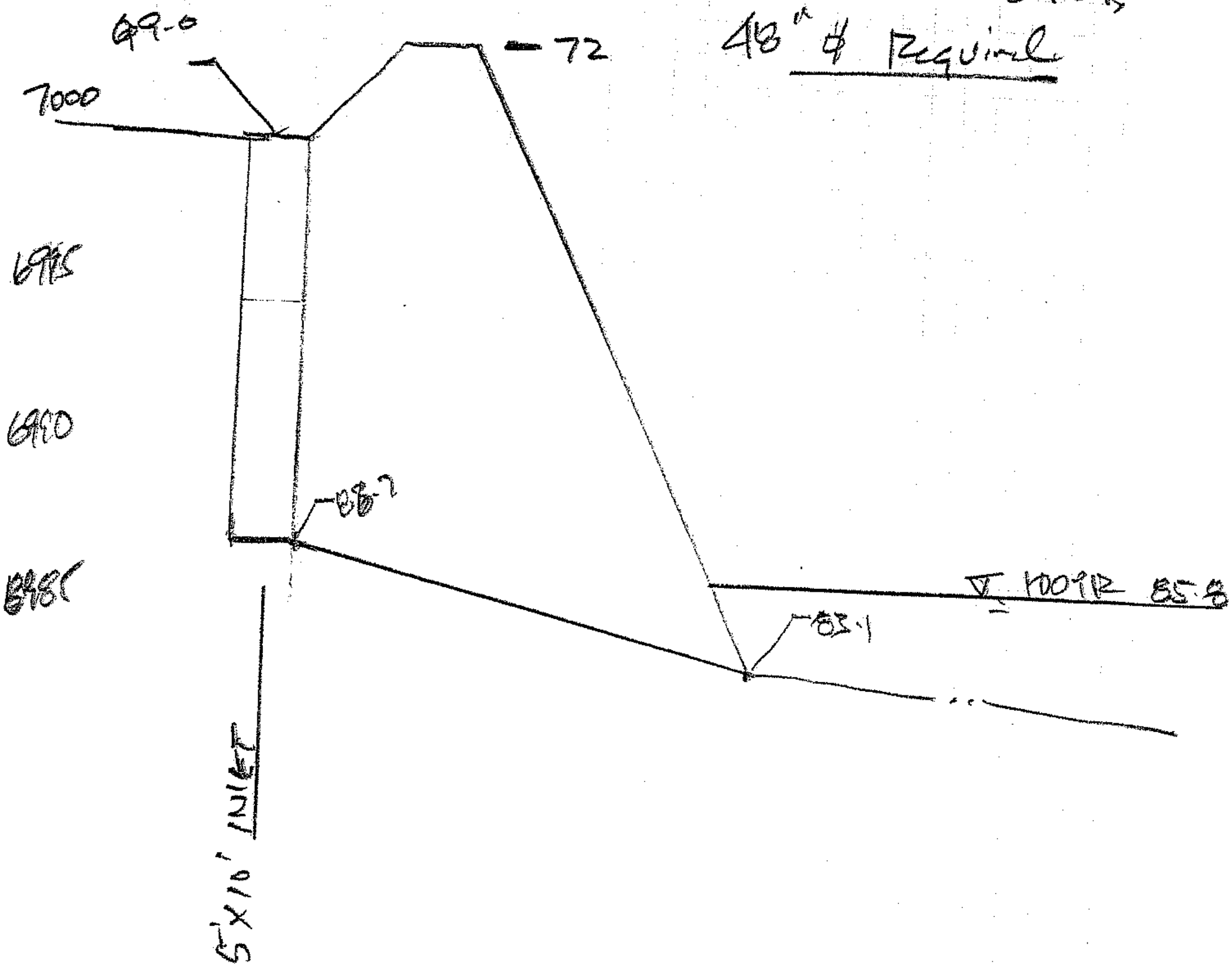
CLIENT Detention Basin A | JOB NO. 050899 | PAGE 2
PROJECT | DATE CHECKED | DATE 12/15/05
DETAIL | CHECKED BY | COMPUTED BY RJW

Req'd Pipe Size out: Assume 4% out

∴ 42 RCP @ 4.0% = 210 cfs full ∴ ok

Check as culvert w/ 100-year pool full.
El = 6985.8

Under inlet control,
48" ∅ Required



Overflow Weir.

Residual Flow over Weir : $Q_{100} - Q_5$

$705 - 216 = 489$ cfs.

w/ 1' crest ∴ H = 1

$Q = 2.6 L H^{3/2}$

$L = 489/2.6 = 188'$ too long

increase to 2' H.

$\therefore Q = 2.6 L (2)^{3/2} =$

$L = 489/7.35 = 66'$

CURRENT DATE: 12-19-2005
CURRENT TIME: 09:27:27

FILE DATE: 12-19-2005
FILE NAME: DBAINL

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

CULV NO.	SITE DATA: INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	86.70	83.10	90.07	1 RCP	4.00	4.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

OK: BELOW OVERFLOW.

SUMMARY OF CULVERT FLOWS (cfs) FILE: DBAINL DATE: 12-19-2005

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
86.70	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
88.62	24.0	24.0	0.0	0.0	0.0	0.0	0.0	0.00	1
89.70	48.0	48.0	0.0	0.0	0.0	0.0	0.0	0.00	1
90.62	72.0	72.0	0.0	0.0	0.0	0.0	0.0	0.00	1
91.63	96.0	96.0	0.0	0.0	0.0	0.0	0.0	0.00	1
92.90	120.0	120.0	0.0	0.0	0.0	0.0	0.0	0.00	1
94.48	144.0	144.0	0.0	0.0	0.0	0.0	0.0	0.00	1
96.38	168.0	168.0	0.0	0.0	0.0	0.0	0.0	0.00	1
98.58	192.0	192.0	0.0	0.0	0.0	0.0	0.0	0.00	1
100.40	210.0	210.0	0.0	0.0	0.0	0.0	0.0	0.00	1
102.14	240.0	225.9	0.0	0.0	0.0	0.0	0.0	0.00	1
102.00	224.7	224.7	0.0	0.0	0.0	0.0	0.0	13.32	8
							0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: DBAINL DATE: 12-19-2005

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
86.70	0.000	0.00	0.00	0.00
88.62	0.000	24.00	0.00	0.00
89.70	0.000	48.00	0.00	0.00
90.62	0.000	72.00	0.00	0.00
91.63	0.000	96.00	0.00	0.00
92.90	0.000	120.00	0.00	0.00
94.48	0.000	144.00	0.00	0.00
96.38	0.000	168.00	0.00	0.00
98.58	0.000	192.00	0.00	0.00
100.40	0.000	210.00	0.00	0.00
102.14	-0.004	240.00	0.80	0.33

<1> TOLERANCE (ft) = 0.010

<2> TOLERANCE (%) = 1.000

CURRENT DATE: 12-19-2005
(RENT TIME: 09:27:27

FILE DATE: 12-19-2005
FILE NAME: DBAINL

PERFORMANCE CURVE FOR CULVERT 1 - 1(4.00 (ft) BY 4.00 (ft)) RCP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	86.70	0.00	0.00	0-NF	0.00	0.00	0.00	2.70	0.00	0.00
24.00	88.62	1.92	1.92	1-S2n	0.74	1.43	0.79	2.70	13.56	0.00
48.00	89.70	3.00	3.00	1-S2n	1.05	2.07	1.17	2.70	15.63	0.00
72.00	90.62	3.92	3.92	1-S2n	1.30	2.56	1.50	2.70	16.73	0.00
96.00	91.63	4.93	4.93	5-S2n	1.52	2.96	1.80	2.70	17.51	0.00
120.00	92.90	6.20	6.20	5-S2n	1.72	3.28	2.06	2.70	18.39	0.00
144.00	94.48	7.78	7.78	5-S2n	1.91	3.53	2.31	2.70	19.15	0.00
168.00	96.38	9.68	9.68	5-S2n	2.09	3.78	2.54	2.70	19.97	0.00
192.00	98.58	11.88	7.20	6-S2n	2.27	4.00	2.75	2.70	20.86	0.00
210.00	100.40	13.70	8.54	6-S2n	2.40	4.00	2.90	2.70	21.56	0.00
225.88	102.14	15.44	9.81	6-S2n	2.53	4.00	3.04	2.70	22.09	0.00

El. inlet face invert 86.70 ft El. outlet invert 83.10 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

* `** SITE DATA ***** CULVERT INVERT **************

INLET STATION	100.00 ft
INLET ELEVATION	86.70 ft
OUTLET STATION	190.00 ft
OUTLET ELEVATION	83.10 ft
NUMBER OF BARRELS	1
SLOPE (V/H)	0.0400
CULVERT LENGTH ALONG SLOPE	90.07 ft

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	CIRCULAR
BARREL DIAMETER	4.00 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE WITH HEADWALL
INLET DEPRESSION	NONE

CURRENT DATE: 12-19-2005
(RENT TIME: 09:27:27

FILE DATE: 12-19-2005
FILE NAME: DBAINL

TAILWATER

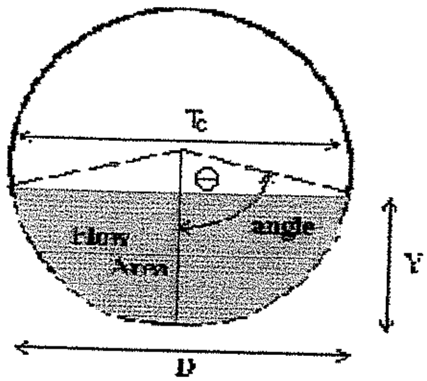
CONSTANT WATER SURFACE ELEVATION
85.80

ROADWAY OVERTOPPING DATA

WEIR COEFFICIENT	2.60
EMBANKMENT TOP WIDTH	0.00 ft
CREST LENGTH	100.00 ft
OVERTOPPING CREST ELEVATION	102.00 ft

Circular Pipe Flow

Project: 05104 Detention basin A, Wolf Ranch
Pipe ID: outlet storm sewer 48" RCP



Design Information (Input)		
Pipe Invert Slope	So =	0.0125 ft/ft ← MIN. SLOPE
Pipe Manning's N	N =	0.0130
Pipe Diameter	D =	4.00 ft
Design discharge	Q =	**157.0 cfs**
Full-flow Capacity (Calculated)		
Full-flow area	Af =	12.57 sq ft
Full-flow wetted perimeter	Pf =	12.57 ft
Half Central Angle	Theta =	3.14 rad
Full-flow capacity	**Qf =**	**161.0** cfs
Calculation of Normal Flow Condition		
Half Central angle (0<Theta<3.14)	Theta =	2.21 rad
Flow area	An =	10.76 sq ft
Wetted perimeter	Pn =	8.84 ft
Flow depth	Yn =	1.60 ft
Flow velocity	Vn =	14.60 fps
Discharge	Qn =	**157.1** cfs
Calculation of Critical Flow Condition		
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.54 rad
Critical flow area	Ac =	12.02 sq ft
Critical top width	Tc =	2.27 ft
Critical flow depth	Yc =	1.82 ft
Critical flow velocity	Vc =	13.06 fps
Froude number	Fr =	**1.00**

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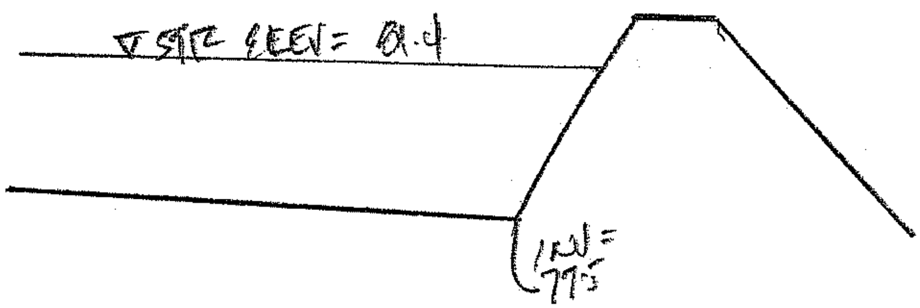
CLIENT
PROJECT
DETAIL

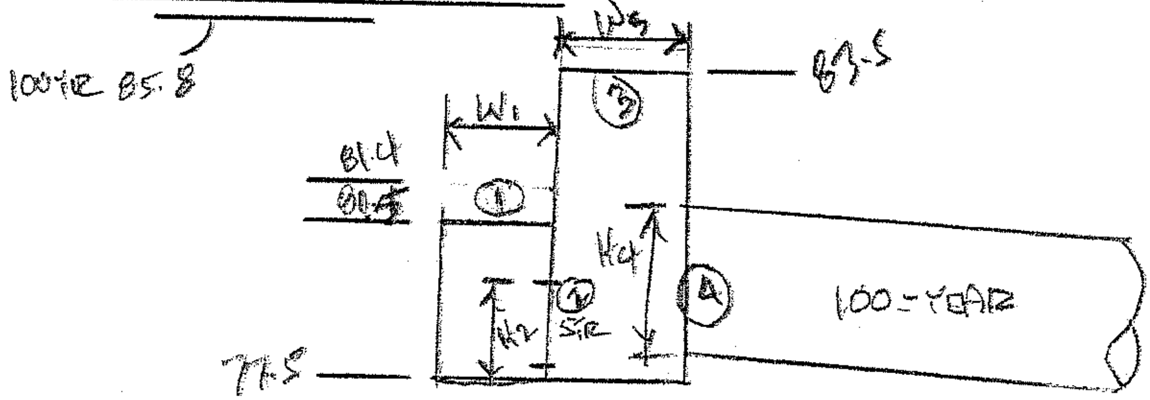
JOB NO. 05104
DATE CHECKED
CHECKED BY

PAGE 1/4
DATE 10/12/05
COMPUTED BY RAM

5 year Outlet Design



USE DUAL CHAMBER:



Check opening @ 1 :

Assume Orifice w/ C = .63 Block = 25%

$\therefore Q = C C_B A \sqrt{2gH}$ w/ H = 1'

$Q = .47A(8.02) = 3.77A$

w/ Q = 64 cfs $\therefore A = 64/3.77 = \underline{17.0\ sf}$

w/ W_1 = 2'; need 8.5' opening. 2'x8.5'

Check Openy @ ②

Assume orifice: $C_c = .63$ Blockage: 0%

$H = 81.4 - 77.5 - \frac{1}{2}H_2$

Assume $H_2 = 2'$ ∴ $H = 81.4 - 77.5 - 1 = 2.9'$

$Q = .63\,A\sqrt{2g(2.9)} = 8.6\,A$

w/ $Q = 64$ cfs ∴ $A = 64/8.6 = 7.44$

if $H_2 = 2'$ ∴ $W_2 = 7.44/2 = 3.72'$ say 3.75'

∴ Openy in baffle wall = 2'H × 3.75' Long.

Check openy @ ③ : 100 year.

$H = 85.8 - 83.5 = 2.3'$

$C_c = .63$ $C_B = .75$

$Q = .63(.75)A\sqrt{2g(2.3)} = 5.75\,A$

w/ $Q = 157$ cfs $A = 157/5.75 = 27$ sf.

with width of structure = 8.5'; ∴ $W_3 = 27/8.5 = 3.2'$, say 3.25'

Check Opening (4)

Control with pipe; assuming orifice control's.

$H = 85.8 - 77.5 - \frac{1}{2}$ openg height. =

$C = .63 \quad C_B = 1.0$

$$Q = .63A\sqrt{2g(H)}$$

try 48"ϕ RCP ∴ $H = 8.3' - \frac{1}{2}(4) = 6.3$

$$Q = .63A\sqrt{2g(8.3)} = 14.6\ A \quad \therefore A = 157/14.6 = 10.8$$

Area of 48" Pipe = 12.57 sf; too large

try 42" RCP;

$$H = 8.3 - \frac{1}{2}(3.5) = 6.55'$$

$$Q = .63A\sqrt{2g(6.55')} = 12.94\ A$$

$$A = 157/12.94 = 12.1\ sf.$$

Area of 42" RCP = 9.62 sf ∴ <u>too small</u>

use 48" RCP w/ orifice Plate over openg.

Leave $H_4 = 4'$

∴ $Q = 14.6A \quad \therefore A = 10.8$ sf

w $H_4 = 4'$ ∴ $W_4 = 10.8/4 = \underline{2.7'}$ say 2.75'

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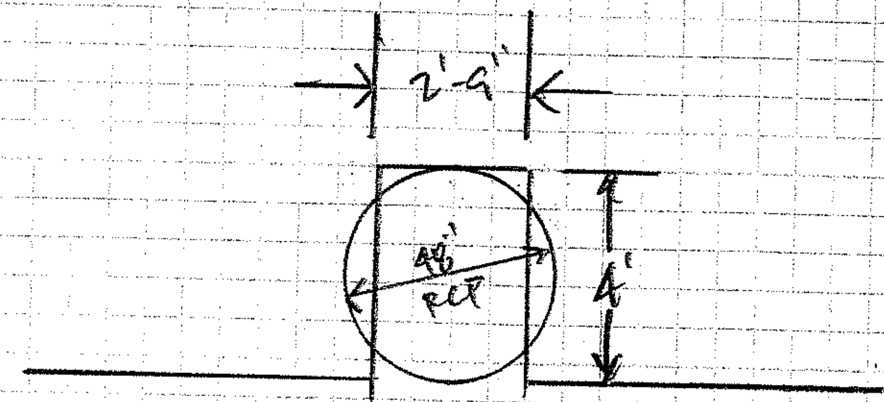
CLIENT ______ JOB NO. 05105 PAGE 4/4

PROJECT ______ DATE CHECKED ______ DATE 10/12/05

DETAIL ______ CHECKED BY ______ COMPUTED BY [illegible]



Check minimum slope for 48" RCP to carry 157 cfs:

48" @ Qfull ; S = 1.2% min Qfull = 157 cfs

KIOWA ENGINEERING CORPORATION

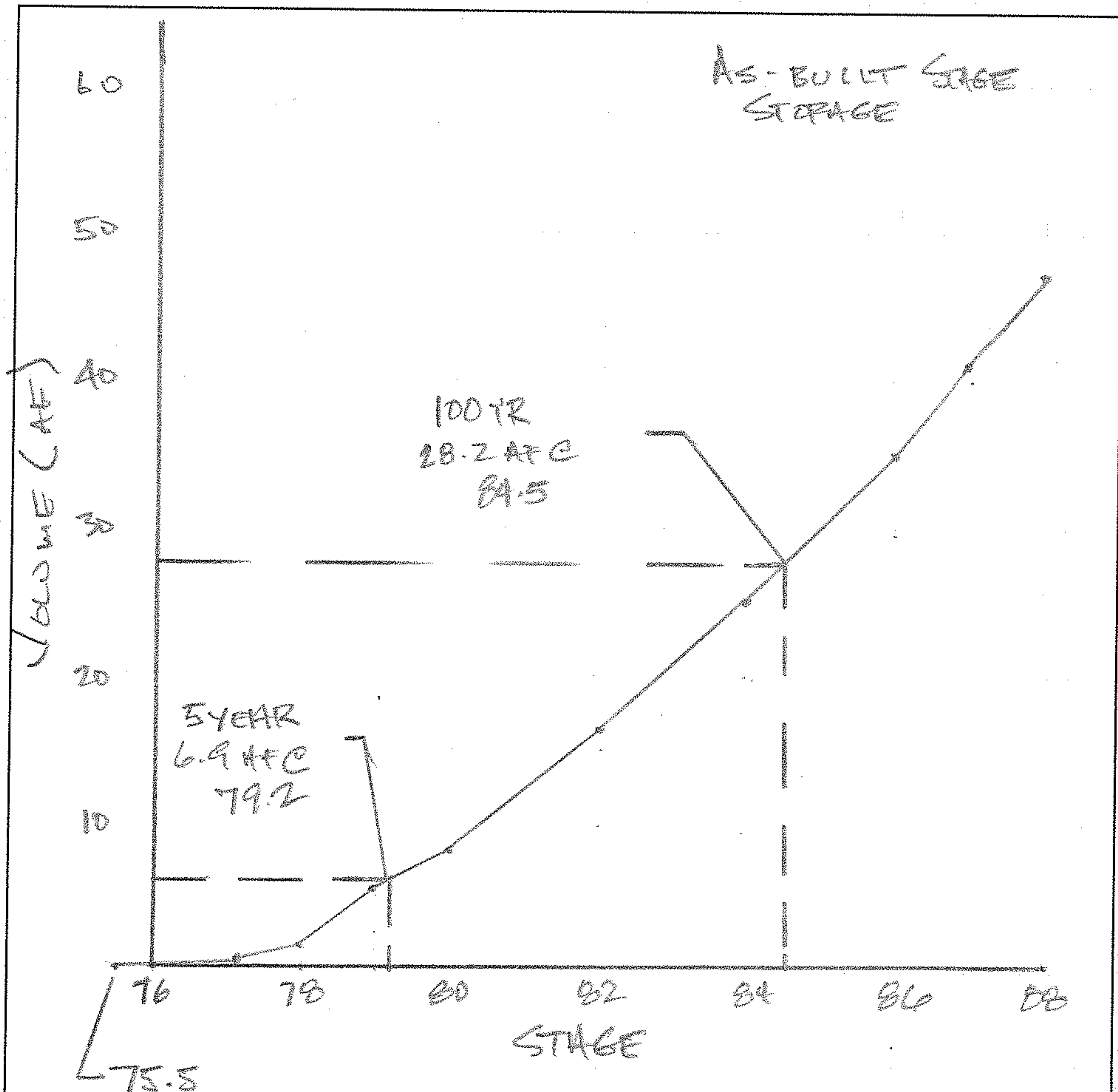
JOB Wolf Ranch MDDP

SHEET NO. Det A OF

CALCULATED BY As-built DATE 5-20-15

CHECKED BY DATE

SCALE



EXCESS URBAN RUNOFF CONTROL (FULL-SPECTRUM) DETENTION SIZING

Project: WOLF RANCH DETENTION BASIN AT DP A4
Basin ID: Full Spectrum Basin Calcs

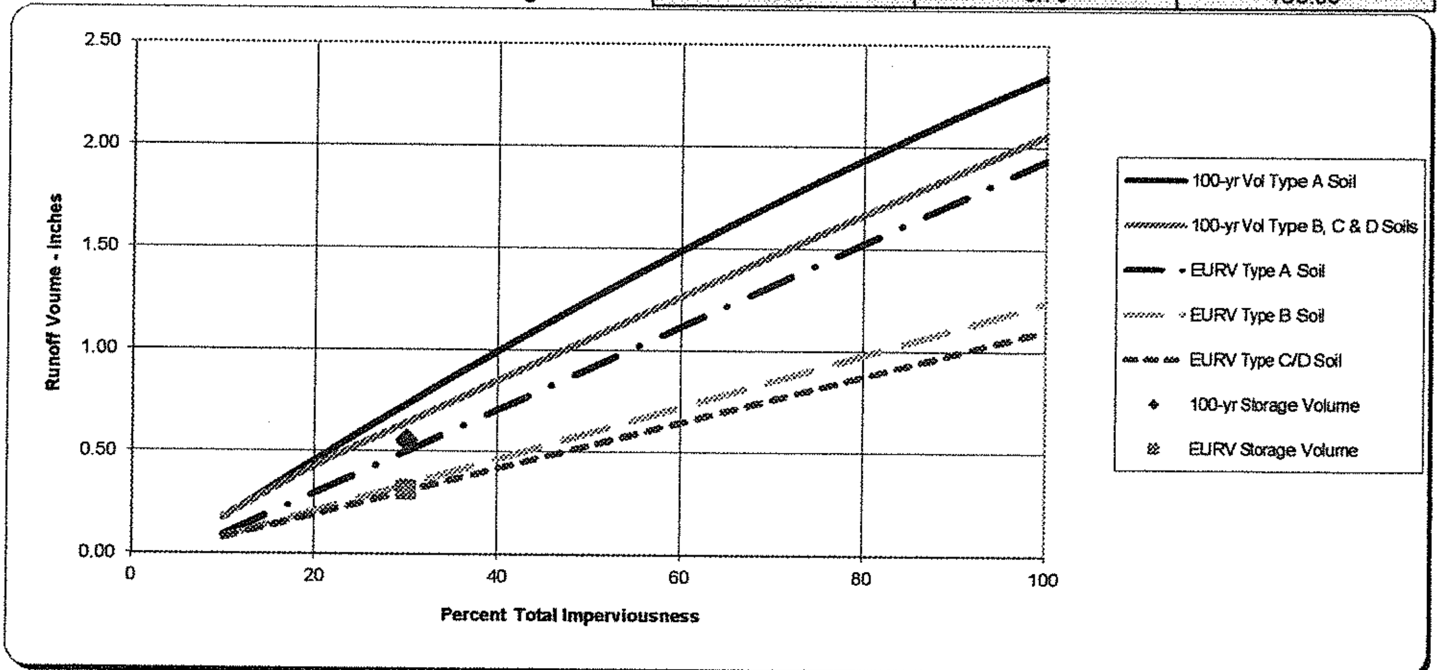
* User input data shown in blue.

Area of Watershed (acres)	189.00	
Subwatershed Imperviousness	30.0%	
Level of Minimizing Directly Connected Impervious Area (MDCIA)	1	1
Effective Imperviousness[1]	25.9%	

Hydrologic Soil Type	Percentage of Area	Area (acres)
Type A	0.0%	0.0
Type B	100.0%	189.0
Type C or D	0.0%	0.0

Recommended Horton's Equation Parameters for CUHP		
Infiltration (inches per hour)		Decay Coefficient--α
Initial--f_i	Final--fo	
4.5	0.6	0.0018

	Detention Volumes [2,5]		Maximum Allowable Release Rate, cfs[3]
	(watershed inches)	(acre-feet)	
Excess Urban Runoff Volume[4]	0.31	4.96	Design Oulet to Empty EURV in 72 Hours
100-year Detention Volume Including WQCV [5]	0.56	8.76	160.65



Notes:

1) Effective imperviousness is based on Figure ND-1 of the Urban Storm Drainage Criteria Manual (USDCM).
2) Results shown reflect runoff reduction from Level 1 or 2 MDCIA and are plotted at the watershed's total imperviousness value; the impact of MDCIA is reflected by the results being below the curves.
3) Maximum allowable release rates for 100-year event are based on Table SO-1. Outlet for the Excess Urban Runoff Volume (EURV) to be designed to empty out the EURV in 72 hours. Outlet design is similar to one for the WQCV outlet of an extended detention basin (i.e., perforated plate with a micro-pool) and extends to top of EURV water surface elevation.
4) EURV approximates the difference between developed and pre-developed runoff volume.
5) 100-yr detention volume includes EURV. No need to add more volume for WQCV or EURV

EXCESS URBAN RUNOFF CONTROL (FULL-SPECTRUM) DETENTION SIZING

Project: WOLF RANCH DETENTION BASIN A WITH FSD AT A4
Basin ID: Full Spectrum Basin Calcs

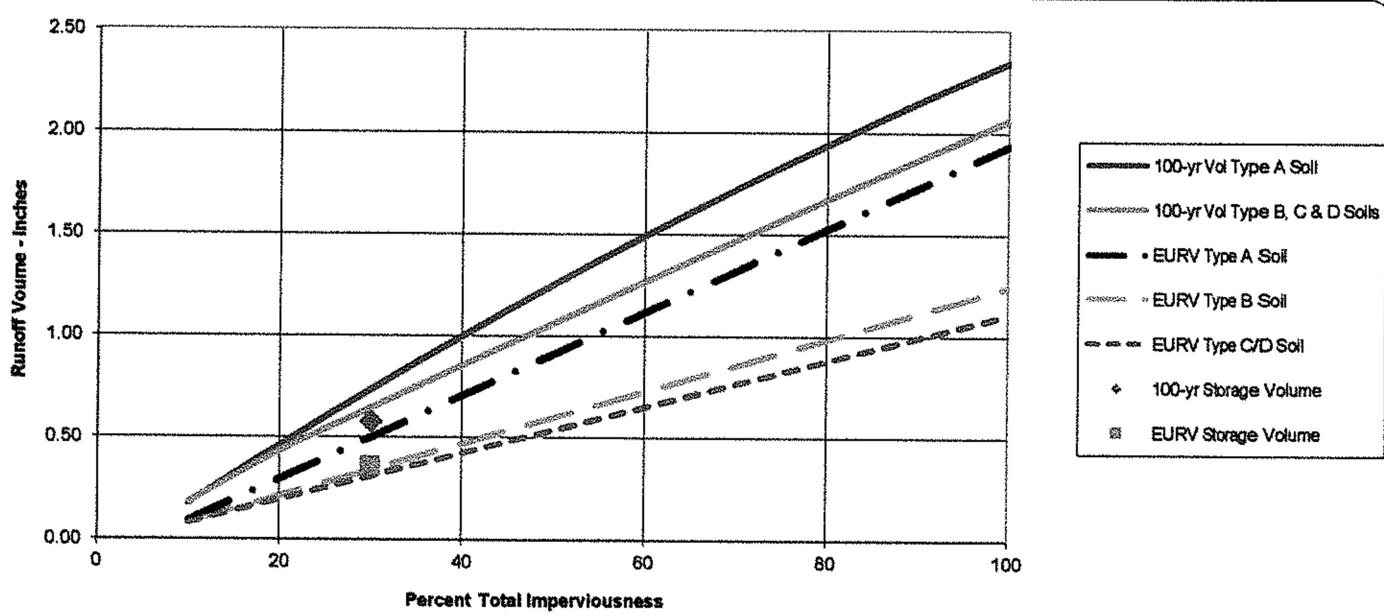
* User input data shown in blue.

Area of Watershed (acres)	303.00	
Subwatershed Imperviousness	30.0%	
Level of Minimizing Directly Connected Impervious Area (MDCIA)	1	1
Effective Imperviousness[1]	25.9%	

Hydrologic Soil Type	Percentage of Area	Area (acres)
Type A	30.0%	90.9
Type B	70.0%	212.1
Type C or D	0.0%	0.0

Recommended Horton's Equation Parameters for CUHP		
Infiltration (inches per hour)		Decay
Initial--f_i	Final--f_o	Coefficient--α
4.65	0.7	0.0015

	Detention Volumes[2,6] (watershed inches)	(acre-feet)	Maximum Allowable Release Rate, cfs[3]
Excess Urban Runoff Volume[4]	0.36	9.05	Design Oulet to Empty EURV in 72 Hours
100-year Detention Volume Including WQCV[5]	0.58	14.55	225.74



Notes:

1) Effective imperviousness is based on Figure ND-1 of the Urban Storm Drainage Criteria Manual (USDCM).
2) Results shown reflect runoff reduction from Level 1 or 2 MDCIA and are plotted at the watershed's total imperviousness value; the impact of MDCIA is reflected by the results being below the curves.
3) Maximum allowable release rates for 100-year event are based on Table SO-1. Outlet for the Excess Urban Runoff Volume (EURV) to be designed to empty out the EURV in 72 hours. Outlet design is similar to one for the WQCV outlet of an extended detention basin (i.e., perforated plate with a micro-pool) and extends to top of EURV water surface elevation.
4) EURV approximates the difference between developed and pre-developed runoff volume.
5) 100-yr detention volume includes EURV. No need to add more volume for WQCV or EURV

Kiowa Engineering Corporation

CLIENT Wolf Ranch MDDP JOB No. 03094 PAGE 1
PROJECT DATE CHECKED DATE 2/2/04
DETAIL CHECKED BY COMPUTED BY RLW

3-10-13

Detention Basin "E/D" "Westcreek"

DETENTION BASIN CONSTRUCTED 2005

- Historic Data:

BA = .164 SM (SD 'E') + .32 SM (DP D2) = .48 SM = 307 A

CN = 61 Runoff 5 yr = .2" 100 yr = 1.02"

D Basin Ex Q_5 = 10; Q_{100} = 103 E-Basin Ex: Q_5 = 6 Q_{100} = 66

Total E&D: Q_5 = 16 cfs Q_{100} = 169

- Developed Data:

BA = .10 SM (DP 'D2') + .18 (DP 'E2') = .28 SM = 179 Ac

CN = [.048(79) + .04(81.8) + .04(79) + .062(78.1) + .052(79) + .036(79)] / .28 = 79.2

- Existing E/D Basin Volume of Runoff

Vol(5) = 307 (.2/12) = 5.2 AF

Vol(100) = 307 (1.02/12) = 26.1 AF

- Developed E/D Volume of Runoff

Runoff 5-year = .84" 100-year = 2.29"

Vol 5 = 179 (.84/12) = 12.5 AF

Vol 100 = 179 (2.29/12) = 34.2 AF

- Required Storage

Δ Vol 5 = 12.5 - 5.2 = 7.3 AF

Δ Vol 100 = 34.2 - 26.1 = 8.1 AF

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CLIENT: Wolf Ranch MDDP | JOB NO. 03094 | PAGE 2
PROJECT: | DATE CHECKED: | DATE 2/2/04
DETAIL: | CHECKED BY: | COMPUTED BY:

- Required Storage Volume

Vol 5-year = 18.6 − 4.5 = 14.1 AF
Vol 100-year = 57.8 − 23.0 = 34.8 AF

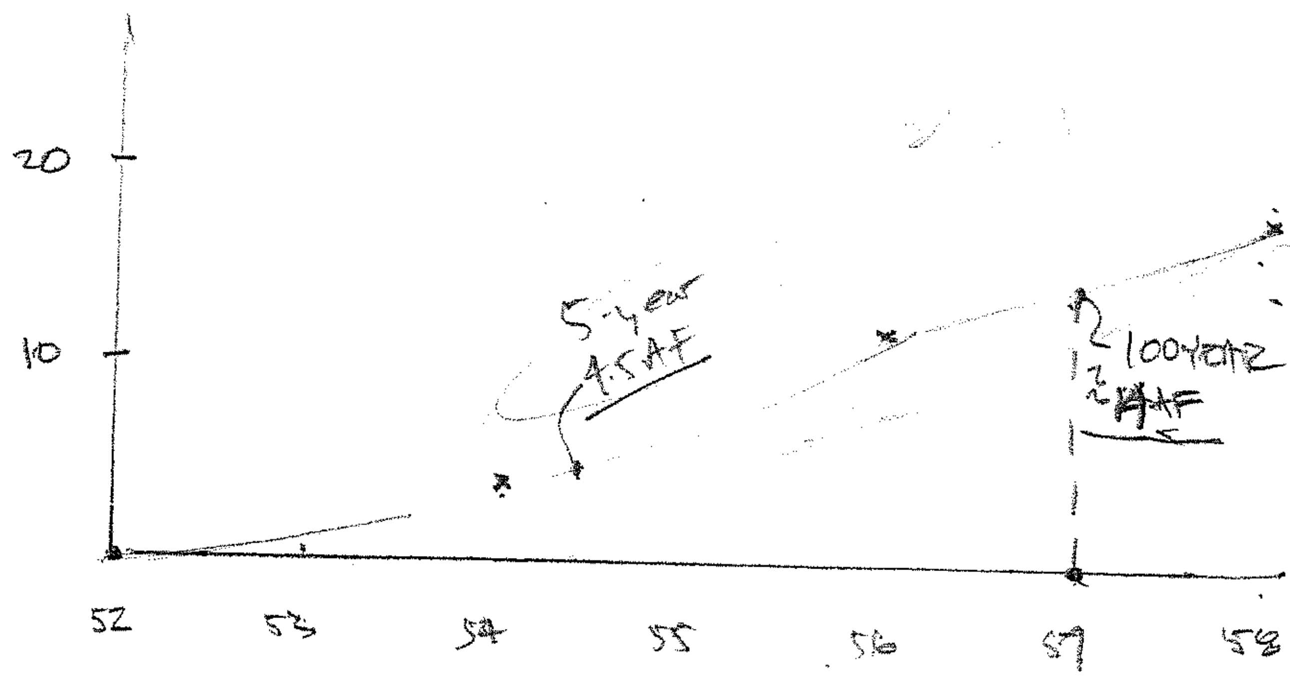
Above values are conservative & do not include channel storage due to routing.

- INFLOW TO DET. BASIN

Q_5 = 173 cfs Q_{100} = 509 cfs

- Allowable Release Rates

Q_5 = 16 cfs Q_{100} = 164 cfs.



Kiowa Engineering Corporation

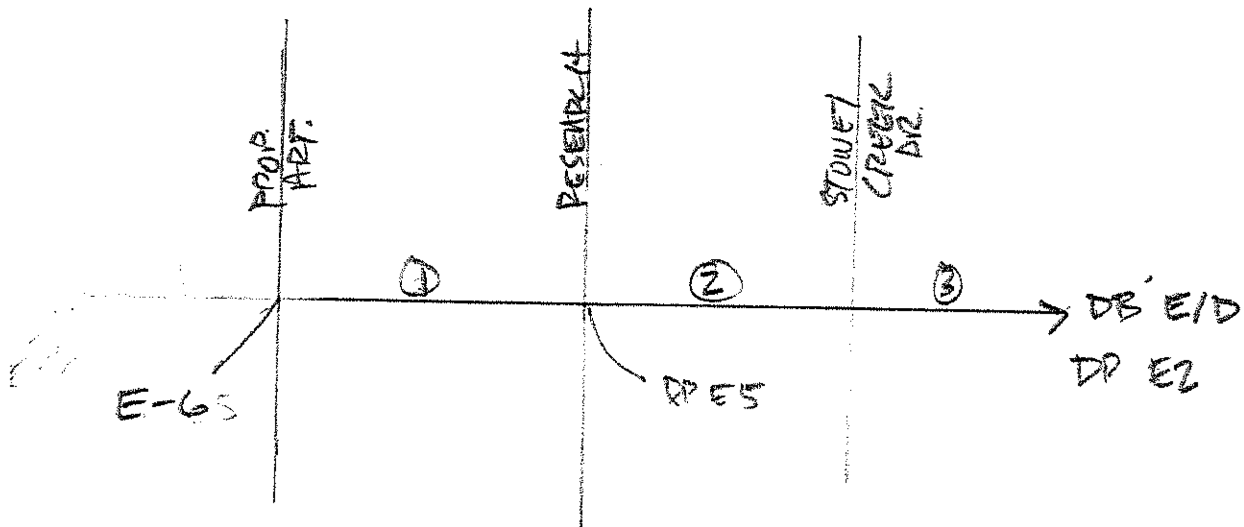
CLIENT: WOLF RANCH MDDP — JOB NO. 03094 — PAGE 3/3/04
PROJECT: — DATE CHECKED: — DATE:
DETAIL: — CHECKED BY: — COMPUTED BY:

'E/D' BASIN HYDRAULICS 3/18/13

Outfall Storm Sewer Sizing

DETENTION BASIN CONSTRUCTED 2005

East Outfall to Detention Basin E/D



From Summary

	Q_5	Q_{100}
@ E-6	29	87
@ DP E5	85	241
@ Stony Creek	95	270
@ DB E/D	116	336

Segment 1 E6 to Research Pkwy

Ex ground slope along prop Road = 40/1300 = .03%

use 2.5% & pick up 100-year

∴ 36" RCP @ 2% = 94 cfs ∴ ok

<u>Segment 2</u> Research to Stoney Creek Q_{100} = 241 cfs
use slope of Roy Creek Street 4/140 = .029'/1
use slope of 2.4%

∴ 48" RCP @ 2.4% = 227 cfs. probably ok since
slope can probably be made <u>steeper</u> than 2.4%

<u>Segment 3</u> Stoney Creek to D/B ED
Q_{100} = 270
· use slope from DB to int of Abby Rd & Rony Creek.
Elev @ DB = 52.0 est. Elev of inv. @ intersection
= 60 ∴ slope = 60-52/350 = .023'/1

- check Rony Creek 6/330 = .019'/1 <u>use</u> .018'/1

60" RCP @ .018 = Q = 349; too much
54" RCP @ .018 = 264 cfs, probably <u>ok</u> (Seg 3A)

Seg 3b (Abby Road Lane) Q = 336
54" @ 2.3% Q = 305 cfs no good
60" @ 2.3% Q = 404 <u>ok</u>.

DET BASIN F18/F19

100 Year Detention Summary

Detention Area	Total Acres	% Imperv.	Soil Group		HEC 1 Required Detention Volume V100
100yr Detention F18+F19	750.02 ac	12.4%	B		31.16 ac-ft
					1,357,330 cf

Detention Basin Earthwork

Elevation	Area (A)	Avg. Area	Volume	Depth	Cumulative Volume		Elev.
7132.7	250sf	Lowest Orifice			0cf	0.00ac-ft	7132.7
7134	766sf	508sf	661cf	1.3 ft	661cf	0.02ac-ft	7134
7135	6,208sf	3,487sf	3,487cf	2.3 ft	4,148cf	0.10ac-ft	7135
7136	30,405sf	18,307sf	18,307cf	3.3 ft	22,454cf	0.52ac-ft	7136
7137	77,973sf	54,189sf	54,189cf	4.3 ft	76,644cf	1.76ac-ft	7137
7138	155,035sf	116,504sf	116,504cf	5.3 ft	193,148cf	4.43ac-ft	7138
7139	218,066sf	186,550sf	186,550cf	6.3 ft	379,698cf	8.72ac-ft	7139
7140	268,166sf	243,116sf	243,116cf	7.3 ft	622,814cf	14.30ac-ft	7140
7141	292,639sf	280,403sf	280,403cf	8.3 ft	903,217cf	20.74ac-ft	7141
7142	309,808sf	301,224sf	301,224cf	9.3 ft	1,204,441cf	27.65ac-ft	7142
7143	327,554sf	318,681sf	318,681cf	10.3 ft	1,523,122cf	34.97ac-ft	7143
7144	341,309sf	334,432sf	334,432cf	11.3 ft	1,857,554cf	42.64ac-ft	7144
7145	352,435sf	346,872sf	346,872cf	12.3 ft	2,204,426cf	50.61ac-ft	7145
7146	363,566sf	358,000sf	358,000cf	13.3 ft	2,562,426cf	58.83ac-ft	7146
7147	374,944sf	369,255sf	369,255cf	14.3 ft	2,931,681cf	67.30ac-ft	7147
7147.5	380,240sf	377,592sf	188,796cf	14.8 ft	3,120,477cf	71.64ac-ft	7147.5
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Average End Area Formula: V = (A1+A2)/2 x Elev Difference

				Depth
Lowest Orifice =			7132.70 ft	0.00 ft
100yr Volume =	1,357,330 cf	31.16 ac-ft	7142.48 ft	9.77975
Detention Freeboard Depth =			0.52	
Emergency Grate Crest =	1,523,122 cf	34.97 ac-ft	7143.00 ft	10.30 ft
Emergency Grate Max. W.S. El =	2,401,326 cf	55.13 ac-ft	7145.55 ft	12.85 ft
Top of Embankment =	3,120,477 cf	71.64 ac-ft	7147.50 ft	14.80 ft

Detention Basin F18/F19

Detention Basin Outlet Structure Sizing

F18/F19 Outlet Structure Calculations

Orifice Coefficient	0.6
Water Surf. Increment	0.40 ft
100yr Front Grate Elev	7139.00
EURV Orifice 1	Slot
Orifice Ht	1.00 inch
Orifice Width	6.000 inch
Opening/Orifice Area	6.0 sq-in 0.042 sf
Number of Openings	1 ea
Orifice Centerline El	7132.70
EURV Orifice 2	Slot
Orifice Ht	1.00 inch
Orifice Width	6.000 inch
Opening/Orifice Area	6.0 sq-in 0.042 sf
Number of Openings	1 ea
Orifice Centerline El	7134.70
EURV Orifice 3	Slot
Orifice Ht	1.00 inch
Orifice Width	7.500 inch
Opening/Orifice Area	7.5 sq-in 0.052 sf
Number of Openings	1 ea
Orifice Centerline El	7136.70
EURV Orif 4	
Orifice Dia	
Opening/Orifice Area	N/A #VALUE!
Number of Openings	
Orifice Centerline El	

100Yr Grate

H_o	7139.00	L_o	15.0 ft
W_o	8.0 ft	S_o	0:1
R-Value	70%	Clog Factor	50%
C_d	0.63	C_o	0.60
H_b	0.0 ft	Hypotenuse	8.0 ft
Open Area	120.00sf	Area w/R	84.00sf

Water Surf. El	WQCV / EURV Plate: EURV Orifice 1 Head	EURV Orifice 1 Flow	EURV Orifice 2 Head	EURV Orifice 2 Flow	EURV Orifice 3 Head	EURV Orifice 3 Flow	EURV Orif 4 Head	EURV Orif 4 Flow	EURV Flow	100Yr Grate: H	Max. Qgrate	Flow in grate	Vgrate	EURV + Grate	100Yr Orifice: Head	100Yr Orifice Flow	Total Flow
7132.70	0.00ft	0.0cfs	0.00ft	0.0cfs	0.00ft	0.0cfs	---	0.0cfs	**0.0cfs**	0.0 ft	0.0cfs	0.0cfs	0.0ft/s	0.0cfs	0.0ft	0.0cfs	**0.0cfs**
7133.10	0.40ft	0.1cfs	0.00ft	0.0cfs	0.00ft	0.0cfs	---	0.0cfs	**0.1cfs**	0.0 ft	0.0cfs	0.0cfs	0.0ft/s	0.1cfs	0.0ft	0.0cfs	**0.1cfs**
7133.50	0.80ft	0.2cfs	0.00ft	0.0cfs	0.00ft	0.0cfs	---	0.0cfs	**0.2cfs**	0.0 ft	0.0cfs	0.0cfs	0.0ft/s	0.2cfs	0.0ft	0.0cfs	**0.2cfs**
7133.90	1.20ft	0.2cfs	0.00ft	0.0cfs	0.00ft	0.0cfs	---	0.0cfs	**0.2cfs**	0.0 ft	0.0cfs	0.0cfs	0.0ft/s	0.2cfs	0.0ft	0.0cfs	**0.2cfs**
7134.30	1.60ft	0.3cfs	0.00ft	0.0cfs	0.00ft	0.0cfs	---	0.0cfs	**0.3cfs**	0.0 ft	0.0cfs	0.0cfs	0.0ft/s	0.3cfs	0.2ft	0.0cfs	**0.3cfs**
7134.70	2.00ft	0.3cfs	0.00ft	0.0cfs	0.00ft	0.0cfs	---	0.0cfs	**0.3cfs**	0.0 ft	0.0cfs	0.0cfs	0.0ft/s	0.3cfs	0.6ft	0.0cfs	**0.3cfs**
7135.10	2.40ft	0.3cfs	0.40ft	0.1cfs	0.00ft	0.0cfs	---	0.0cfs	**0.4cfs**	0.0 ft	0.0cfs	0.0cfs	0.0ft/s	0.4cfs	1.0ft	0.0cfs	**0.4cfs**
7135.50	2.80ft	0.3cfs	0.80ft	0.2cfs	0.00ft	0.0cfs	---	0.0cfs	**0.5cfs**	0.0 ft	0.0cfs	0.0cfs	0.0ft/s	0.5cfs	1.4ft	0.0cfs	**0.5cfs**
7135.90	3.20ft	0.4cfs	1.20ft	0.2cfs	0.00ft	0.0cfs	---	0.0cfs	**0.6cfs**	0.0 ft	0.0cfs	0.0cfs	0.0ft/s	0.6cfs	1.8ft	0.0cfs	**0.6cfs**
7136.30	3.60ft	0.4cfs	1.60ft	0.3cfs	0.00ft	0.0cfs	---	0.0cfs	**0.6cfs**	0.0 ft	0.0cfs	0.0cfs	0.0ft/s	0.6cfs	2.2ft	0.0cfs	**0.6cfs**
7136.70	4.00ft	0.4cfs	2.00ft	0.3cfs	0.00ft	0.0cfs	---	0.0cfs	**0.7cfs**	0.0 ft	0.0cfs	0.0cfs	0.0ft/s	0.7cfs	2.6ft	0.0cfs	**0.7cfs**
7137.10	4.40ft	0.4cfs	2.40ft	0.3cfs	0.40ft	0.2cfs	---	0.0cfs	**0.9cfs**	0.0 ft	0.0cfs	0.0cfs	0.0ft/s	0.9cfs	3.0ft	0.0cfs	**0.9cfs**
7137.50	4.80ft	0.4cfs	2.80ft	0.3cfs	0.80ft	0.2cfs	---	0.0cfs	**1.0cfs**	0.0 ft	0.0cfs	0.0cfs	0.0ft/s	1.0cfs	3.4ft	0.0cfs	**1.0cfs**
7137.90	5.20ft	0.5cfs	3.20ft	0.4cfs	1.20ft	0.3cfs	---	0.0cfs	**1.1cfs**	0.0 ft	0.0cfs	0.0cfs	0.0ft/s	1.1cfs	3.8ft	0.0cfs	**1.1cfs**
7138.30	5.60ft	0.5cfs	3.60ft	0.4cfs	1.60ft	0.3cfs	---	0.0cfs	**1.2cfs**	0.0 ft	0.0cfs	0.0cfs	0.0ft/s	1.2cfs	4.2ft	0.0cfs	**1.2cfs**
7138.70	6.00ft	0.5cfs	4.00ft	0.4cfs	2.00ft	0.4cfs	---	0.0cfs	**1.2cfs**	0.0 ft	0.0cfs	0.0cfs	0.0ft/s	1.2cfs	4.6ft	0.0cfs	**1.2cfs**
7139.10	6.40ft	0.5cfs	4.40ft	0.4cfs	2.40ft	0.4cfs	---	0.0cfs	**1.3cfs**	0.1 ft	1.7cfs	1.7cfs	0.0ft/s	3.0cfs	5.0ft	170.9cfs	**3.0cfs**
7139.50	6.80ft	0.5cfs	4.80ft	0.4cfs	2.80ft	0.4cfs	---	0.0cfs	**1.4cfs**	0.5 ft	19.2cfs	19.2cfs	0.2ft/s	20.6cfs	5.4ft	177.6cfs	**20.6cfs**
7139.90	7.20ft	0.5cfs	5.20ft	0.5cfs	3.20ft	0.4cfs	---	0.0cfs	**1.4cfs**	0.9 ft	46.3cfs	46.3cfs	0.6ft/s	47.8cfs	5.8ft	184.1cfs	**47.8cfs**
7140.30	7.60ft	0.6cfs	5.60ft	0.5cfs	3.60ft	0.5cfs	---	0.0cfs	**1.5cfs**	1.3 ft	80.4cfs	80.4cfs	1.0ft/s	81.9cfs	6.2ft	190.4cfs	**81.9cfs**
7140.70	8.00ft	0.6cfs	6.00ft	0.5cfs	4.00ft	0.5cfs	---	0.0cfs	**1.6cfs**	1.7 ft	120.3cfs	120.3cfs	1.4ft/s	121.8cfs	6.6ft	196.4cfs	**121.8cfs**
7141.10	8.40ft	0.6cfs	6.40ft	0.5cfs	4.40ft	0.5cfs	---	0.0cfs	**1.6cfs**	2.1 ft	165.1cfs	165.1cfs	2.0ft/s	166.8cfs	7.0ft	202.3cfs	**166.8cfs**
7141.50	8.80ft	0.6cfs	6.80ft	0.5cfs	4.80ft	0.5cfs	---	0.0cfs	**1.7cfs**	2.5 ft	214.5cfs	206.4cfs	2.6ft/s	216.2cfs	7.4ft	208.0cfs	**208.0cfs**
7141.90	9.20ft	0.6cfs	7.20ft	0.5cfs	5.20ft	0.6cfs	---	0.0cfs	**1.7cfs**	2.9 ft	268.0cfs	211.9cfs	3.2ft/s	269.7cfs	7.8ft	213.6cfs	**213.6cfs**
7142.30	9.60ft	0.6cfs	7.60ft	0.6cfs	5.60ft	0.6cfs	---	0.0cfs	**1.8cfs**	3.3 ft	325.3cfs	217.3cfs	3.9ft/s	327.1cfs	8.2ft	219.0cfs	**219.0cfs**
7142.70	10.00ft	0.6cfs	8.00ft	0.6cfs	6.00ft	0.6cfs	---	0.0cfs	**1.8cfs**	3.7 ft	386.2cfs	222.5cfs	4.6ft/s	388.0cfs	8.6ft	224.3cfs	**224.3cfs**
7143.10	10.40ft	0.6cfs	8.40ft	0.6cfs	6.40ft	0.6cfs	---	0.0cfs	**1.9cfs**	4.1 ft	409.5cfs	227.6cfs	4.9ft/s	411.3cfs	9.0ft	229.5cfs	**229.5cfs**
7143.50	10.80ft	0.7cfs	8.80ft	0.6cfs	6.80ft	0.7cfs	---	0.0cfs	**1.9cfs**	4.5 ft	429.0cfs	232.6cfs	5.1ft/s	430.9cfs	9.4ft	234.5cfs	**234.5cfs**
7143.90	11.20ft	0.7cfs	9.20ft	0.6cfs	7.20ft	0.7cfs	---	0.0cfs	**2.0cfs**	4.9 ft	447.7cfs	237.5cfs	5.3ft/s	449.6cfs	9.8ft	239.5cfs	**239.5cfs**
7144.30	11.60ft	0.7cfs	9.60ft	0.6cfs	7.60ft	0.7cfs	---	0.0cfs	**2.0cfs**	5.3 ft	465.6cfs	242.3cfs	5.5ft/s	467.6cfs	10.2ft	244.3cfs	**244.3cfs**
7144.70	12.00ft	0.7cfs	10.00ft	0.6cfs	8.00ft	0.7cfs	---	0.0cfs	**2.0cfs**	5.7 ft	482.8cfs	247.0cfs	5.7ft/s	484.9cfs	10.6ft	249.1cfs	**249.1cfs**
7145.10	12.40ft	0.7cfs	10.40ft	0.6cfs	8.40ft	0.7cfs	---	0.0cfs	**2.1cfs**	6.1 ft	499.5cfs	251.7cfs	5.9ft/s	501.5cfs	11.0ft	253.8cfs	**253.8cfs**
7145.50	12.80ft	0.7cfs	10.80ft	0.7cfs	8.80ft	0.7cfs	---	0.0cfs	**2.1cfs**	6.5 ft	515.6cfs	256.2cfs	6.1ft/s	517.7cfs	11.4ft	258.3cfs	**258.3cfs**
7145.90	13.20ft	0.7cfs	11.20ft	0.7cfs	9.20ft	0.8cfs	---	0.0cfs	**2.2cfs**	6.9 ft	531.2cfs	260.7cfs	6.3ft/s	533.4cfs	11.8ft	262.8cfs	**262.8cfs**
7146.30	13.60ft	0.7cfs	11.60ft	0.7cfs	9.60ft	0.8cfs	---	0.0cfs	**2.2cfs**	7.3 ft	546.4cfs	265.1cfs	6.5ft/s	548.6cfs	12.2ft	267.3cfs	**267.3cfs**
7146.70	14.00ft	0.8cfs	12.00ft	0.7cfs	10.00ft	0.8cfs	---	0.0cfs	**2.2cfs**	7.7 ft	561.2cfs	269.4cfs	6.7ft/s	563.4cfs	12.6ft	271.6cfs	**271.6cfs**
7147.10	14.40ft	0.8cfs	12.40ft	0.7cfs	10.40ft	0.8cfs	---	0.0cfs	**2.3cfs**	8.1 ft	575.6cfs	273.6cfs	6.9ft/s	577.8cfs	13.0ft	275.9cfs	**275.9cfs**

Detention Basin F18/F19

Detention Basin Outlet Structure Sizing

		WQCV / EURV Plate									100Yr Grate					100Yr Orifice		
	Water Surf. El	EURV Orifice 1 Head	EURV Orifice 1 Flow	EURV Orifice 2 Head	EURV Orifice 2 Flow	EURV Orifice 3 Head	EURV Orifice 3 Flow	EURV Orif 4 Head	EURV Orif 4 Flow	EURV Flow	H	Max. Qgrate	Flow in grate	Vgrate	EURV + Grate	100Yr Orifice Head	100Yr Orifice Flow	Total Flow
Lowest Orifice Elev	7132.70																	
WQCV Water Surf Elev	7137.52	4.82ft	0.4cfs	2.82ft	0.3cfs	0.82ft	0.2cfs	---	0.0cfs	**1.0cfs**	0.0 ft	0.0cfs	0.0cfs	0.0ft/s	1.0cfs	3.4ft	0.0cfs	**1.0cfs**
EURV Water Surf Elev	7138.17	5.47ft	0.5cfs	3.47ft	0.4cfs	1.47ft	0.3cfs	---	0.0cfs	**1.1cfs**	0.0 ft	0.0cfs	0.0cfs	0.0ft/s	1.1cfs	4.1ft	0.0cfs	**1.1cfs**
100 Year Water Surf Elev	7142.66	9.96ft	0.6cfs	7.96ft	0.6cfs	5.96ft	0.6cfs	---	0.0cfs	**1.8cfs**	3.7 ft	380.0cfs	222.0cfs	2.6ft/s	381.8cfs	8.5ft	223.8cfs	**223.8cfs**
Spillway Grate Elev	7143.00	10.30ft	0.6cfs	8.30ft	0.6cfs	6.30ft	0.6cfs	---	0.0cfs	**1.9cfs**	4.0 ft	404.5cfs	226.3cfs	2.7ft/s	406.3cfs	8.9ft	228.2cfs	**228.2cfs**
Top of Embankment Elev	7144.00	11.30ft	0.7cfs	9.30ft	0.6cfs	7.30ft	0.7cfs	---	0.0cfs	**2.0cfs**	5.0 ft	452.2cfs	238.7cfs	2.8ft/s	454.2cfs	9.9ft	240.7cfs	**240.7cfs**

100Yr Orifice	Restrictor	
Pipe Dia	54.0 inch	
Pipe Radius	2.25-ft	
Opening/Orifice Area	---	
	15.904 sf	
Outlet Invert Elev	7131.87	
Orifice Centerline El	7134.12	Theta
Ht from Inv to Plate Bott	4.50-ft	0.00
Restrict Plate Bottom El	7136.37	
Req'd Release Rate	224.0 cfs	

Orifice Equation:

$Q = CA(2gH)^{0.5}$

C = Orifice coefficient

A = Area of opening (sf)

$g = 32.2\ ft/sec^2$

H = Head above pipe centerline (ft)

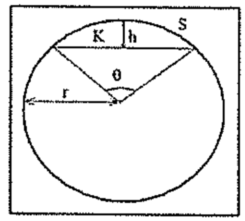
Circle	0:1
Slot	4:1
Restrictor	3:1

Equations: Restrictor Plate Orifice

$\theta = 2 \arccos((r-h)/r)$

$A = \pi r^2 - (r^2(\theta - \sin\theta)/2)$

h = restrictor plate height below top of pipe



Orifice Dia		Area
7/16"	0.438	0.1503
1/2"	0.5	0.1963
9/16"	0.563	0.2485
5/8"	0.625	0.3068
11/16"	0.688	0.3712
3/4"	0.75	0.4418
13/16"	0.813	0.5185
7/8"	0.875	0.6013
15/16"	0.938	0.6903
1"	1	0.7854
1-1/16"	1.063	0.8866
1-1/8"	1.125	0.994

Equations for 100 Yr Grate/Overflow Grate:

(Equations taken from "USBR, Physical Modeling of Overflow Outlets for Extended Detention Stormwater Basins", Sept 2014)

100yr Orifice: $Q_o = C_o A_o (2gH)^{0.5}$

Flat Weir: $Qflat = {}^2/_3 nC_d(2L_o+2W_o)(2g)^{0.5}H^{1.5}$

Sloped Un-Submerged Weir ($H<H_b$):

$Q_{ws} = {}^4/_{15} nC_d(2g)^{0.5} \cot\phi\ H^{2.5}$

$Q_{wb} = {}^2/_3 nC_d(2g)^{0.5} L_o H^{1.5}$

$Q_{us} = 2Q_{ws} + Q_{wb}$

Sloped Submerged Weir ($H>=H_b$):

$Q_{ws} = {}^4/_{15} nC_d(2g)^{0.5} \cos\phi\ ((H^{2.5}-(H-H_b)^{2.5})/H_b)$

$Q_{wb} = {}^2/_3 nC_d(2g)^{0.5} L_o H^{1.5}$

$Q_s = 2Q_{ws} + Q_{wb}$

H_o=Overflow Weir Front Edge Elevation

L_o=Overflow Weir Front Edge Length

W_o=Overflow Weir Width (horizontal front to back dimension)

S_o=Overflow Weir Side Slope (Typically matches embankment slope)

R-Value=Open area ratio for the grate (Typically 70%, can be between 50-85%)

C_d=Discharge coefficient based on slope and grate type

H_b=Grate height

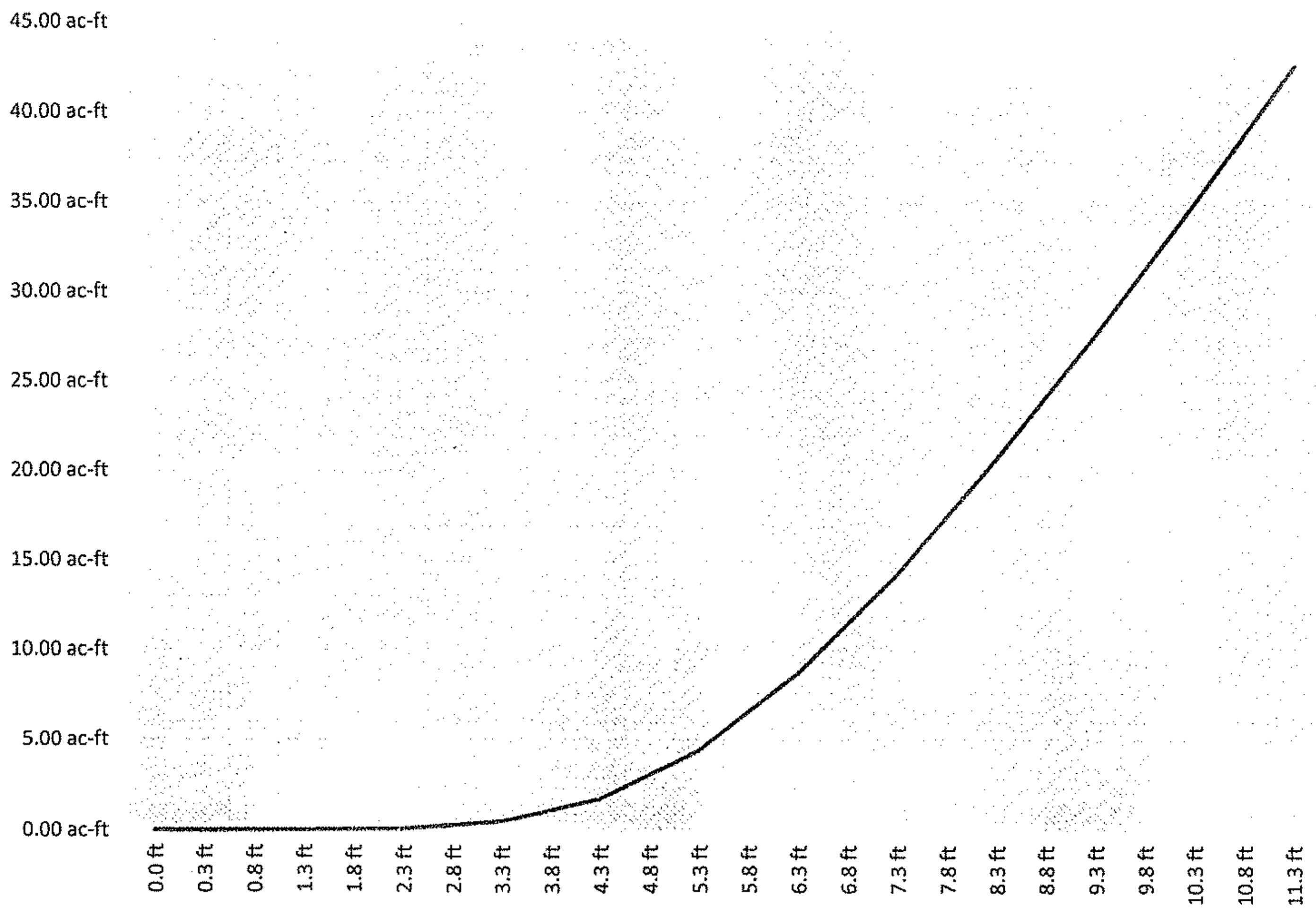
H=Water surface depth above overflow grate front edge (crest)

cot ϕ = adjacent/opposite

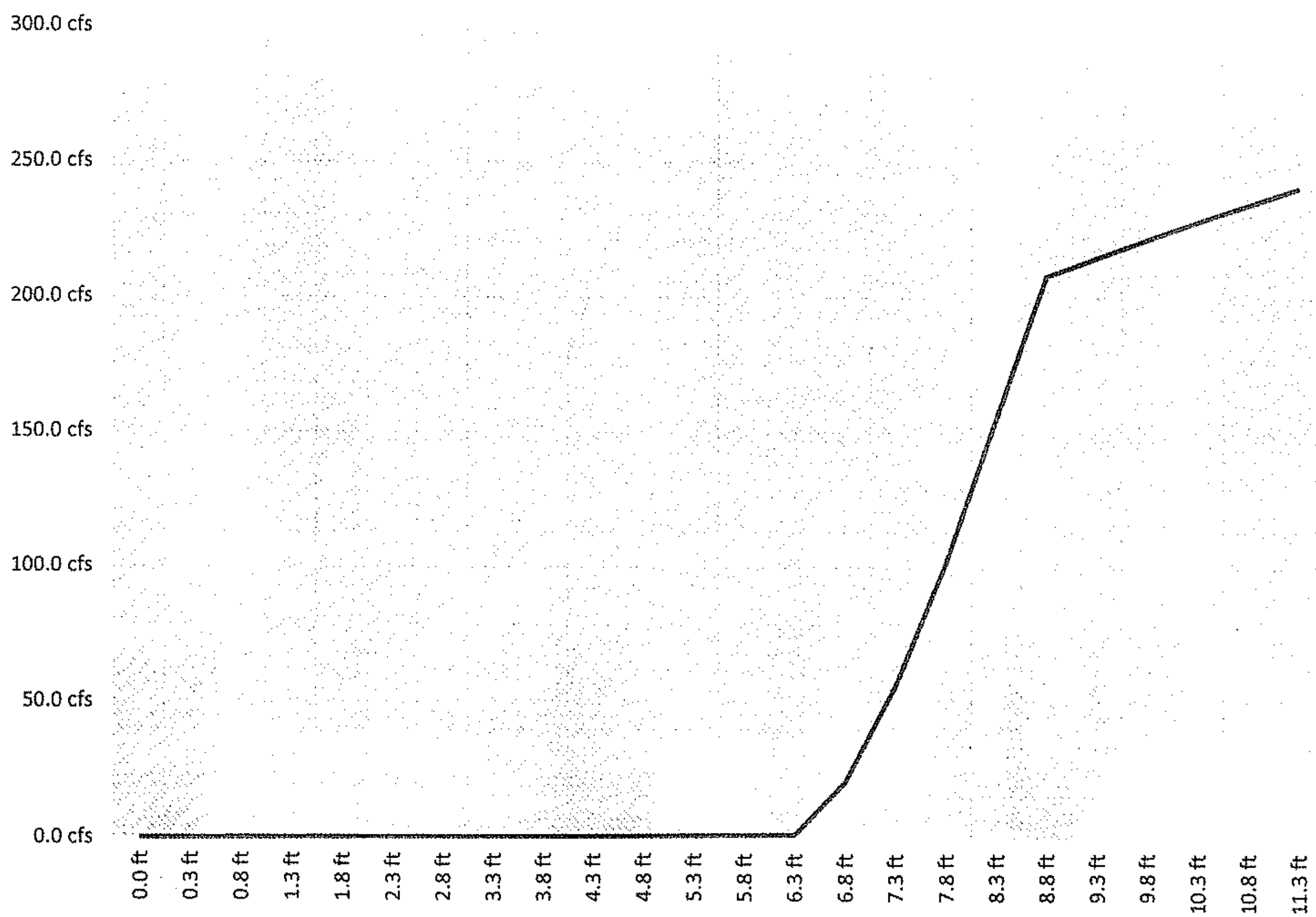
cos ϕ = adjacent/hypotenuse

C_d	Overflow Grate Type
0.62	1:0 (Flat) Slope - Close Mesh
0.60	1:0 (Flat) Slope - Type C Grate
0.63	4:1 Slope - Close Mesh
0.62	4:1 Slope - Type C Grate
0.60	3:1 Slope - Close Mesh
0.58	3:1 Slope - Type C Grate

Detention F18/F19 - Primary Outlet Structure
Stage - Storage Curve



Detention F18/F19 - Primary Outlet Structure
Stage - Discharge Curve



Detention Basin F18/F19
Detention Calculations

F19 Presedementation / Forebay Sizing

Forebay	100 Yr Flow	Detention WQCV	Total Req'd Forebay Vol 3.0% WQCV		% of Total 100yr Flow	Required Forebay Volume	Forebay Design (30"max depth for over 25 ac) Area	Forebay Design Depth	Forebay Design Volume	Discharge Design Flow 2.0% 100yr	Slot Outlet Design Calc'd Width (1"min)	Slot Outlet Design Design Width	Pipe Outlet Design Pipe Diameter	Pipe Outlet Design # of Pipes	Pipe Outlet Design Pipe Flow
Fore F19	116cfs	92,544 cf	2,776cf		100.0%	2,776cf	1,120sf	2.50-ft	2,800 cf	2.32 cfs	8.3-inch		8.0-inch	1ea	**2.47cfs**
					0.0%	---			---	---	---				---
Totals	116cfs	92,544 cf	2,776cf		100.0%										

F18 Presedementation / Forebay Sizing

Forebay	100 Yr Flow	Detention WQCV	Total Req'd Forebay Vol 3.0% WQCV		% of Total 100yr Flow	Required Forebay Volume	Forebay Design (30"max depth for over 25 ac) Area	Forebay Design Depth	Forebay Design Volume	Discharge Design Flow 2.0% 100yr	Slot Outlet Design Calc'd Width (1"min)	Slot Outlet Design Design Width	Pipe Outlet Design Pipe Diameter	Pipe Outlet Design # of Pipes	Pipe Outlet Design Pipe Flow
Fore F18	55cfs	122,783 cf	3,683cf		30.2%	839cf	420sf	2.00-ft	840 cf	1.10 cfs	6.4-inch		6.0-inch	1ea	**1.25cfs**
Fore F17	107cfs				58.8%	1,632cf	740sf	2.50-ft	1,850 cf	2.14 cfs	8.2-inch		8.0-inch	1ea	**2.47cfs**
Fore BG1	20cfs				11.0%	305cf	160sf	2.00-ft	320 cf	0.40 cfs	5.4-inch	**5.0-inch**			---
					0.0%	---			---	---	---				---
					0.0%	---			---	---	---				---
Totals	182cfs	122,783 cf	3,683cf		100.0%										

Opening Width Equation for Rectangular Opening

$L = Q / (CH^{1.5}) \times 12 + 0.2 \times H$ (UD-BMP Spreadsheet -- EDB tab) C = 3.0

Design based on Extended Detention Basin design recommendations from Volume 3, USDCM

Orifice Equation:

$Q = CA(2gH)^{0.5}$

C = Orifice coefficient

A = Area of opening (sf)

$g = 32.2$ ft/sec^2

H = Head above pipe centerline (ft)

Trickle Channel Calculation

Location	100yr Flow	Req'd Flow 1.0% 100yr	Bottom Width	Flow Depth	Side Slope	Slope	Manning 'n'	Top Width	Flow Area	Wetted Perimeter	Hydraulic Radius	Flow Velocity	Capacity
Fore F19	116cfs	1.2cfs	7.0 ft	0.50 ft	0.0:1	0.5%	0.013	7.0 ft	3.50 sf	8.0 ft	0.44 ft	4.7 ft/sec	**16.3 cfs**
Fore F18	55cfs	0.6cfs	7.0 ft	0.50 ft	0.0:1	0.5%	0.013	7.0 ft	3.50 sf	8.0 ft	0.44 ft	4.7 ft/sec	**16.3 cfs**
F19+F18	171cfs	1.7cfs	7.0 ft	0.50 ft	0.0:1	0.5%	0.013	7.0 ft	3.50 sf	8.0 ft	0.44 ft	4.7 ft/sec	**16.3 cfs**
Fore F17	107cfs	1.1cfs	7.0 ft	0.50 ft	0.0:1	0.5%	0.013	7.0 ft	3.50 sf	8.0 ft	0.44 ft	4.7 ft/sec	**16.3 cfs**
Fore BG1	20cfs	0.2cfs	7.0 ft	0.50 ft	0.0:1	0.5%	0.013	7.0 ft	3.50 sf	8.0 ft	0.44 ft	4.7 ft/sec	**16.3 cfs**
All	116cfs	1.2cfs	7.0 ft	0.50 ft	0.0:1	0.5%	0.013	7.0 ft	3.50 sf	8.0 ft	0.44 ft	4.7 ft/sec	**16.3 cfs**

Equations:

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

b = width

d = depth

Perimeter (P) = $b+2d*(1+z^2)^{0.5}$

z = side slope

Hydraulic Radius = A/P

Velocity = $(1.49/n)R_h^{2/3} S^{1/2}$

S = Slope of the channel

n = Manning's number

R_h = Hydraulic Radius (Reynold's Number)

Flow = $(1.49/n)AR_h^{2/3} S^{1/2}$

Detention Basin Outlet Structure - Initial Surcharge Sizing

Detention Basin	Tributary Area (A)	Impervious (I)	TIA	SA	ISV (4" depth)	ISD	Modified SA	
F18	510.72ac	9.86%	50.4 ac	205 sf	68 cf	12 in	68 cf	Minimum surface area
F19	239.30ac	17.9%	42.7 ac	178 sf	59 cf	9 in	79 cf	Minimum surface area

WQCV and ISV Equations (City of Colo Springs, Policy Statement and Clarification, Micropool/Initial Surcharge Volume Sizing Criteria, January 9, 2017):

TIA = I x A
- TIA = Tributary Impervious Area
- I = Imperviousness (fraction)
- A = Tributary catchment area upstream (acres)

ISV = SA x 4 inches
- ISV = Initial Surcharge Volume (cf)
- SA = Surface area (from Figure 1, sf)

Modified SA = Modified Surface Area if ISV depth is greater than 4 inches
- Modified SA = SA x (4 inch/ISD)
- ISD = Initial Surcharge Depth

F17 - Drop Inlet Structure Calculations

Orifice Coefficient	0.6
Water Surf. Increment	0.20 ft
Outlet Pipe Invert El	7138.00
Grate Flowline In El	7149.00
Spillway Crest El	7152.00
Design Release Rate	25 cfs

Developed 5yr flow RF17 (MDDP HEC1 model)

Grate			
H_o	7149.00	L_o	10.0'
W_o	4.0 ft	S_o	4:1
R-Value	75%	Clog Factor	50%
C_d	0.62	C_o	0.60
H_b	1.0 ft	Hypotenuse	4.1'
Open Area	41.23sf	Area w/R	30.9sf

Pipe Outlet	Circle
Orifice Dia	30.0 inch
Pipe Radius	1.25-ft
Orifice Area	706.9 sq-in
	4.909 sf
Outlet Invert Elev	7138.00
Orifice Centerline El	7139.25

Circle	0:1
Slot	4:1
Restrictor	3:1

C_d	Overflow Grate Type
0.62	1:0 (Flat) Slope - Close Mesh
0.60	1:0 (Flat) Slope - Type C Grate
0.63	4:1 Slope - Close Mesh
0.62	4:1 Slope - Type C Grate
0.60	3:1 Slope - Close Mesh
0.58	3:1 Slope - Type C Grate

		Grate				Pipe Outlet		
Water Surf. El	H	Max. Qgrate	Flow in grate	Vgrate	Head	Max. Qorifice	**Flow Out**
7149.00	0.0'	0.0cfs	0.0cfs	0.0ft/s	9.8'	73.8cfs	**0.0cfs**
7149.20	0.2'	1.2cfs	1.2cfs	0.0ft/s	9.9'	74.6cfs	**1.2cfs**
7149.40	0.4'	3.5cfs	3.5cfs	0.1ft/s	10.1'	75.3cfs	**3.5cfs**
7149.60	0.6'	6.9cfs	6.9cfs	0.2ft/s	10.3'	76.0cfs	**6.9cfs**
7149.80	0.8'	11.2cfs	11.2cfs	0.4ft/s	10.5'	76.8cfs	**11.2cfs**
7150.00	1.0'	16.4cfs	16.4cfs	0.5ft/s	10.7'	77.5cfs	**16.4cfs**
7150.20	1.2'	22.4cfs	22.4cfs	0.7ft/s	10.9'	78.2cfs	**22.4cfs**
7150.40	1.4'	29.2cfs	29.2cfs	0.9ft/s	11.1'	78.9cfs	**29.2cfs**
7150.60	1.6'	36.6cfs	36.6cfs	1.2ft/s	11.3'	79.6cfs	**36.6cfs**
7150.80	1.8'	44.6cfs	44.6cfs	1.4ft/s	11.5'	80.3cfs	**44.6cfs**
7151.00	2.0'	53.2cfs	53.2cfs	1.7ft/s	11.7'	81.0cfs	**53.2cfs**
7151.20	2.2'	62.2cfs	62.2cfs	2.0ft/s	11.9'	81.7cfs	**62.2cfs**
7151.40	2.4'	71.8cfs	71.8cfs	2.3ft/s	12.1'	82.4cfs	**71.8cfs**
7151.60	2.6'	81.7cfs	81.7cfs	2.6ft/s	12.3'	83.1cfs	**81.7cfs**
7151.80	2.8'	92.2cfs	83.7cfs	3.0ft/s	12.5'	83.7cfs	**83.7cfs**
7152.00	3.0'	103.0cfs	84.4cfs	3.3ft/s	12.7'	84.4cfs	**84.4cfs**
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Spillway Crest El 7152.00	3.0'	103.0cfs	84.4cfs	3.3ft/s	12.8'	84.4cfs	**84.4cfs**

Equations for Grate:
(Equations taken from "USBR, Physical Modeling of Overflow Outlets Outlets for Extended Detention Stormwater Basins", Sept 2014)

H_o=Overflow Weir Front Edge Elevation
L_o=Overflow Weir Front Edge Length
W_o=Overflow Weir Width (horizontal front to back dimension)
S_o=Overflow Weir Side Slope (Typically matches embankment slope)
R-Value=Open area ratio for the grate (Typically 70%, can be between 50-85%)
C_d=Discharge coefficient based on slope and grate type

Detention Basin F18/F19
Detention Basin Calculations

F18 - Drop Inlet Structure Calculations

Orifice Coefficient	0.6
Water Surf. Increment	0.20 ft
Outlet Pipe Invert El	7139.00
Grate Flowline In El	7147.00
Spillway Crest El	7149.50
Design Release Rate	50 cfs

Developed 5yr flow DPF18 (MDDP HEC1 model)

Grate			
H_o	7147.00	L_o	10.0'
W_o	4.0 ft	S_o	4:1
R-Value	75%	Clog Factor	50%
C_d	0.62	C_o	0.60
H_b	1.0 ft	Hypotenuse	4.1'
Open Area	41.23sf	Area w/R	30.9sf

Pipe Outlet	Circle
Orifice Dia	30.0 inch
Pipe Radius	1.25-ft
Orifice Area	706.9 sq-in
	4.909 sf
Outlet Invert Elev	7139.00
Orifice Centerline El	7140.25

Circle	0:1
Slot	4:1
Restrictor	3:1

C_d	Overflow Grate Type
0.62	1:0 (Flat) Slope - Close Mesh
0.60	1:0 (Flat) Slope - Type C Grate
0.63	4:1 Slope - Close Mesh
0.62	4:1 Slope - Type C Grate
0.60	3:1 Slope - Close Mesh
0.58	3:1 Slope - Type C Grate

		Grate				Pipe Outlet		
	Water Surf. El	H	Max. Qgrate	Flow in grate	Vgrate	Head	Max. Qorifice	**Flow Out**
	7147.00	0.0'	0.0cfs	0.0cfs	0.0ft/s	6.8'	61.4cfs	**0.0cfs**
	7147.20	0.2'	1.2cfs	1.2cfs	0.0ft/s	6.9'	62.3cfs	**1.2cfs**
	7147.40	0.4'	3.5cfs	3.5cfs	0.1ft/s	7.1'	63.2cfs	**3.5cfs**
	7147.60	0.6'	6.9cfs	6.9cfs	0.2ft/s	7.3'	64.1cfs	**6.9cfs**
	7147.80	0.8'	11.2cfs	11.2cfs	0.4ft/s	7.5'	64.9cfs	**11.2cfs**
	7148.00	1.0'	16.4cfs	16.4cfs	0.5ft/s	7.7'	65.8cfs	**16.4cfs**
	7148.20	1.2'	22.4cfs	22.4cfs	0.7ft/s	7.9'	66.6cfs	**22.4cfs**
	7148.40	1.4'	29.2cfs	29.2cfs	0.9ft/s	8.1'	67.5cfs	**29.2cfs**
	7148.60	1.6'	36.6cfs	36.6cfs	1.2ft/s	8.3'	68.3cfs	**36.6cfs**
	7148.80	1.8'	44.6cfs	44.6cfs	1.4ft/s	8.5'	69.1cfs	**44.6cfs**
	7149.00	2.0'	53.2cfs	53.2cfs	1.7ft/s	8.7'	69.9cfs	**53.2cfs**
	7149.20	2.2'	62.2cfs	62.2cfs	2.0ft/s	8.9'	70.7cfs	**62.2cfs**
	7149.40	2.4'	71.8cfs	71.5cfs	2.3ft/s	9.1'	71.5cfs	**71.5cfs**
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Spillway Crest El	7149.50	2.5'	76.7cfs	71.9cfs	2.5ft/s	9.3'	71.9cfs	**71.9cfs**

Equations for Grate:

(Equations taken from "USBR, Physical Modeling of Overflow Outlets Outlets for Extended Detention Stormwater Basins", Sept 2014)

H_o=Overflow Weir Front Edge Elevation

L_o=Overflow Weir Front Edge Length

W_o=Overflow Weir Width (horizontal front to back dimension)

S_o=Overflow Weir Side Slope (Typically matches embankment slope)

R-Value=Open area ratio for the grate (Typically 70%, can be between 50-85%)

C_d=Discharge coefficient based on slope and grate type

Detention F18/F19
Swale and Channel Capacity Calculations

Description	5 Yr Flow	100 Yr Flow	Bottom Width	Channel Side Slope Left	Channel Side Slope Right	Flow Depth	Channel Slope	Manning "n"	Top Width	Channel Area	Wetted Perimeter	Hydraulic Radius	Flow Velocity	Channel Flow Capacity	Unit Discharge	Riprap Size
F17 (100yr) to Inlet	25.0 cfs	107.0 cfs	8.0 ft	3:1	3:1	0.87 ft	12.5%	0.035	13.2 ft	9.23 sf	13.5 ft	0.68 ft	11.7 ft/sec	**107.8 cfs**	13 cfs/ft	**H**
F18 (100yr) to Inlet	50.0 cfs	204.0 cfs	10.0 ft	3:1	3:1	1.24 ft	12.5%	0.035	17.4 ft	17.01 sf	17.8 ft	0.95 ft	14.6 ft/sec	**248.1 cfs**	20 cfs/ft	**H**
F19 (100yr) to low tail	32.0 cfs	116.0 cfs	8.0 ft	3:1	3:1	0.92 ft	12.5%	0.035	13.5 ft	9.90 sf	13.8 ft	0.72 ft	12.1 ft/sec	**119.3 cfs**	15 cfs/ft	**H**
F17 (100yr) Spillway*		23.0 cfs	10.0 ft	3:1	3:1	0.26 ft	25.0%	0.035	11.6 ft	2.80 sf	11.6 ft	0.24 ft	8.2 ft/sec	**23.1 cfs**	2 cfs/ft	**H**
F18 (100yr) Spillway*		132.0 cfs	10.0 ft	3:1	3:1	0.72 ft	25.0%	0.035	14.3 ft	8.76 sf	14.6 ft	0.60 ft	15.2 ft/sec	**132.8 cfs**	13 cfs/ft	**H**
Basin F19 (100yr) Spillway		116.0 cfs	60.0 ft	4:1	4:1	0.30 ft	12.0%	0.035	62.4 ft	18.36 sf	62.5 ft	0.29 ft	6.5 ft/sec	**119.7 cfs**	2 cfs/ft	**M**

Equations:

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

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

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

Riprap Size: Riprap size determined from Figures 13-12c and 13-12d, Volume 1, City of Colorado Springs Drainage Criteria Manual
* Flow reduced to account for flow into drop inlet and pipe. Drop inlet captures greater than the 5 year flow.

APPENDIX B.1

Spillway Outlet Structure Calculations

HEC1 Output (Assumes Primary Outlet Structure is Plugged)

Detention Basin F18/F19
Detention Basin Calculations

Spillway Structure Calculations

Orifice Coefficient	0.6
Water Surf. Increment	0.50 ft
Outlet Pipe Invert El	7130.20
100yr Water Surf El	7142.48
Spillway Grate El	7143.00
Top of Embankment El	7147.50
Maximum W.S. El (HEC1)	7145.55

Spillway Grate			
H_o	7143.00	L_o	15.0'
W_o	8.0 ft	S_o	0:1
R-Value	70%	Clog Factor	35%
C_d	0.62	C_o	0.60
H_b	0.0 ft	Hypotenuse	8.0'
Open Area	120.00sf	Area w/R	84.0sf

Pipe Outlet	Circle
Orifice Dia	60.0 inch
Pipe Radius	2.50-ft
Orifice Area	2827.4 sq-in
	19.635 sf
Outlet Invert Elev	7130.20
Orifice Centerline El	7132.70

Circle	0:1
Slot	4:1
Restrictor	3:1

C_d	Overflow Grate Type
0.62	1:0 (Flat) Slope - Close Mesh
0.60	1:0 (Flat) Slope - Type C Grate
0.63	4:1 Slope - Close Mesh
0.62	4:1 Slope - Type C Grate
0.60	3:1 Slope - Close Mesh
0.58	3:1 Slope - Type C Grate

	Spillway Grate				Pipe Outlet			
Water Surf. El	H	Max. Qgrate	Flow in grate	Vgrate	Head	Max. Qorifice	**Flow Out**	
7143.00	0.0'	0.0cfs	0.0cfs	0.0ft/s	10.3'	303.4cfs	**0.0cfs**	
7143.50	0.5'	24.5cfs	24.5cfs	0.3ft/s	10.8'	310.7cfs	**24.5cfs**	
7144.00	1.0'	69.4cfs	69.4cfs	0.8ft/s	11.3'	317.8cfs	**69.4cfs**	
7144.50	1.5'	127.5cfs	127.5cfs	1.5ft/s	11.8'	324.8cfs	**127.5cfs**	
7145.00	2.0'	196.4cfs	196.4cfs	2.3ft/s	12.3'	331.6cfs	**196.4cfs**	
7145.50	2.5'	274.4cfs	274.4cfs	3.3ft/s	12.8'	338.2cfs	**274.4cfs**	
7146.00	3.0'	360.7cfs	344.8cfs	4.3ft/s	13.3'	344.8cfs	**344.8cfs**	
7146.50	3.5'	454.6cfs	351.2cfs	5.4ft/s	13.8'	351.2cfs	**351.2cfs**	
7147.00	4.0'	525.8cfs	357.5cfs	6.3ft/s	14.3'	357.5cfs	**357.5cfs**	
7147.50	4.5'	557.7cfs	363.7cfs	6.6ft/s	14.8'	363.7cfs	**363.7cfs**	
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7145.55	2.6'	282.7cfs	282.7cfs	3.4ft/s	12.9'	338.9cfs	**282.7cfs**	Max. W.S. Elev
7147.50	4.5'	557.7cfs	363.7cfs	6.6ft/s	14.8'	363.7cfs	**363.7cfs**	Top Embankment

Equations for Spillway Grate:

(Equations taken from "USBR, Physical Modeling of Overflow Outlets Outlets for Extended Detention Stormwater Basins", Sept 2014)

H_o=Overflow Weir Front Edge Elevation

L_o=Overflow Weir Front Edge Length

W_o=Overflow Weir Width (horizontal front to back dimension)

S_o=Overflow Weir Side Slope (Typically matches embankment slope)

R-Value=Open area ratio for the grate (Typically 70%, can be between 50-85%)

C_d=Discharge coefficient based on slope and grate type

KIOWA ENGINEERING CORPORATION

JOB WdF Zunde Det Basin F28
SHEET NO. WQ calcs OF 1 of 5
CALCULATED BY RJW DATE 11/15/15
CHECKED BY REA DATE 3/30/16
SCALE

Detention Basin F-28

DETENTION BASIN CONSTRUCTED 2017

Total Tributary Area = 2.05 SM
= 1312 Ac

Total WQ Storage Area =

Trib WQ Basin Reach		Area (sm)	CN	% Imp.
F 13	RF28	.014	81	70%
F-14	"	.129	79	69
F-15	"	.021	69.1	20
...				
F-23	RF28	.031	73	24
F-22	RF27C	.064	64.1	15
F-24	RF28	.089	79	69
F-25	"	.089	74.1	26
F-27	RF27C	.240	76.2	41
F-30	RF-28	.022	77.7	44
F-29	"	.025	70	20
~~F~~ F-28	"	.042	68	18

Area to RF 27C = .304
" " RF 28 = .186

~~.793~~ SM .765
~~507.5~~ Ac 490 ac

KIOWA ENGINEERING CORPORATION

JOB Wolf Ranch Det. Basin F28
SHEET NO. WQ Calcs OF 2 of
CALCULATED BY RDW DATE 11/15/15
CHECKED BY REV DATE 3/30/16
SCALE

Wtd % Imp.

Wtd CN = [.7(.014) + .69(.129) + .2(.021) + .24(.027) + .24(.031)
+ .15(.014) + .69(.089) + .26(.089) + .41(.24)
+ .44(.022) + .02(.025) + .18(.042)] ÷ .317 / .793

= .40 40% Imp

EURV : Per spreadsheet

EURV = 18.4 AF

City Requires 100 year to be routed using routing model for basin of this size.

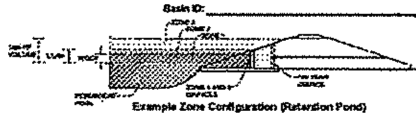
100 year release dictated by flow @ DP F for historic condition.

DP F Q_{100} Ex = 661 cfs
Rev. MDDP, w/ Det Q_{100} = 475 cfs

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

Project: wolf ranch detention basin (2)

Basin ID:



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	490.00	acres
Watershed Length =	9,503	ft
Watershed Slope =	0.036	ft/ft
Watershed Imperviousness =	35.50%	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
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	UDFCD Default	
Water Quality Capture Volume (WQCV) =	6.845	acre-feet
Excess Urban Runoff Volume (EURV) =	18.093	acre-feet
2-yr Runoff Volume (P1 = 1 in.) =	12.219	acre-feet
5-yr Runoff Volume (P1 = 1.34 in.) =	22.544	acre-feet
10-yr Runoff Volume (P1 = 1.84 in.) =	37.547	acre-feet
25-yr Runoff Volume (P1 = 2.02 in.) =	50.010	acre-feet
50-yr Runoff Volume (P1 = 2.32 in.) =	62.973	acre-feet
100-yr Runoff Volume (P1 = 2.61 in.) =	77.073	acre-feet
500-yr Runoff Volume (P1 = 3.29 in.) =	108.044	acre-feet
Approximate 2-yr Detention Volume =	11.513	acre-feet
Approximate 5-yr Detention Volume =	19.947	acre-feet
Approximate 10-yr Detention Volume =	23.081	acre-feet
Approximate 25-yr Detention Volume =	28.553	acre-feet
Approximate 50-yr Detention Volume =	31.659	acre-feet
Approximate 100-yr Detention Volume =	40.582	acre-feet

Optional User Input 1-hr Precipitation

1.00	inches
	inches
	inches
	inches
	inches
	inches
	inches

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	6.845	acre-feet
Zone 2 Volume (EURV - Zone 1) =	11.248	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	22.489	acre-feet
Total Detention Basin Volume =	40.582	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Micropool	--	0.00	--	--	--	0	0.000		
ISV @0.33	--	0.33	--	--	--	508	0.011	78	0.002
69	--	1.00	--	--	--	10,000	0.230	3,508	0.080
70	--	2.00	--	--	--	73,529	1.083	44,534	1.022
72	--	4.00	--	--	--	107,674	2.472	226,257	5.194
74	--	6.00	--	--	--	124,598	2.860	458,531	10.527
76	--	8.00	--	--	--	142,924	3.281	725,057	16.668
78	--	10.00	--	--	--	174,646	4.009	1,043,829	23.958
80	--	12.00	--	--	--	207,420	4.762	1,425,897	32.729
82	--	14.00	--	--	--	239,485	5.498	1,872,612	42.989
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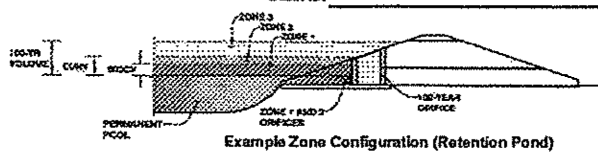
Detention Basin Outlet Structure Design

Project: Wolf Ranch Detention Basin F28
Basin ID:



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	4.66	6.845	Orifice Plate
Zone 2 (EURV)	8.43	11.248	Orifice Plate
Zone 3 (100-year)	13.56	22.469	
		40.562	Total

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

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

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to bottom of basin at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	8.43	ft (relative to bottom of basin at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	33.70	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

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

* ORIFICE PLATE DESIGN

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	2.81	5.62					
Orifice Area (sq. inches)	29.65	29.65	20.00					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected
Vertical Orifice Area =		
Vertical Orifice Centroid =		

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

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

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected
Height of Grate Upper Edge, H_t =		
Over Flow Weir Slope Length =		
Grate Open Area / 100-yr Orifice Area =		
Overflow Grate Open Area w/o Debris =		
Overflow Grate Open Area with Debris =		

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

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below bottom of basin at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Not Selected	Not Selected
Outlet Orifice Area =		
Outlet Orifice Centroid =		
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

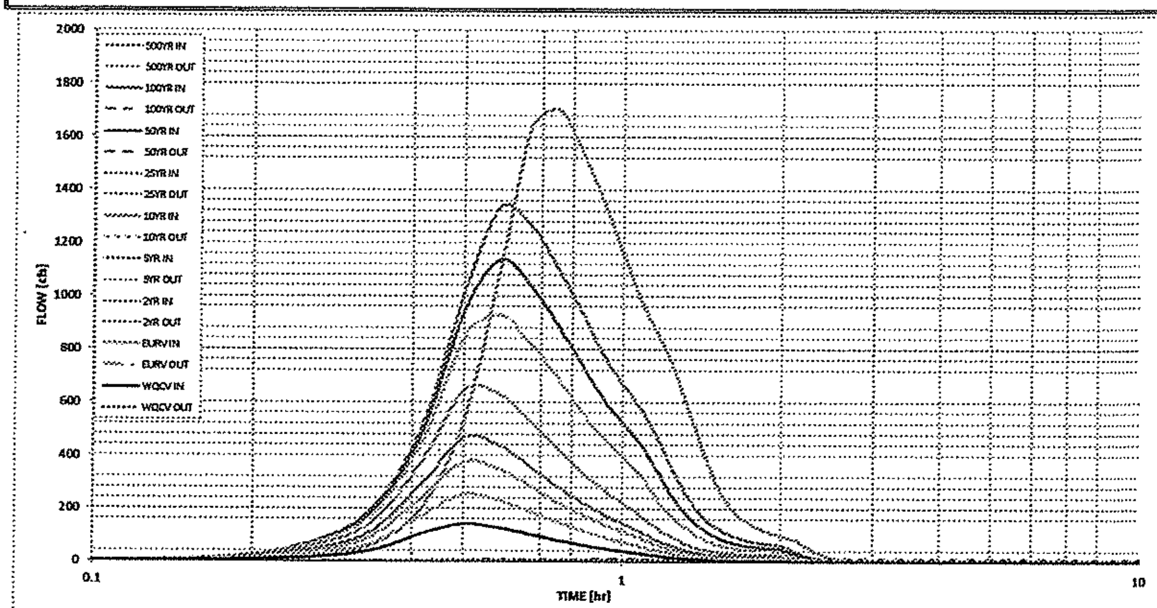
Calculated Parameters for Spillway

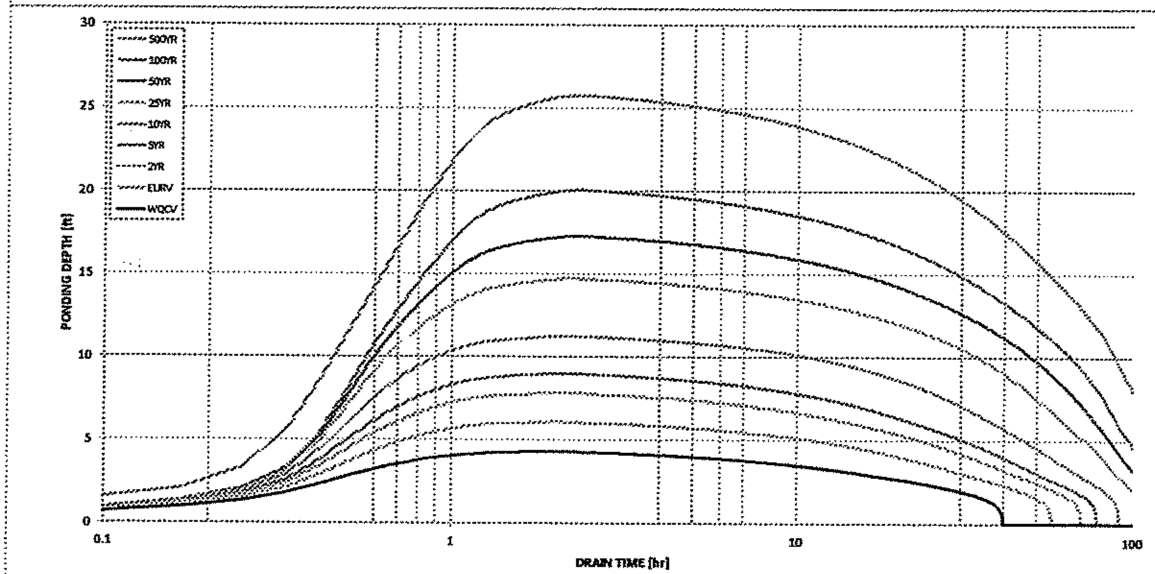
Spillway Design Flow Depth=		feet
Stage at Top of Freeboard =		feet
Basin Area at Top of Freeboard =		acres

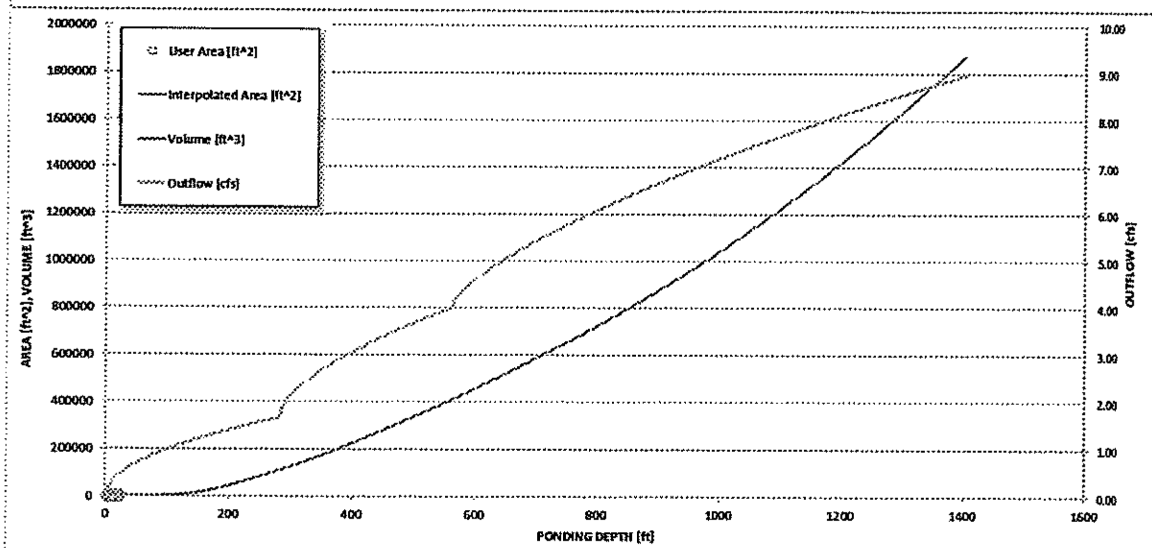
Routed Hydrograph Results

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.00	1.34	1.64	2.02	2.32	2.61
Calculated Runoff Volume (acre-ft) =	6.845	18.093	12.215	22.544	32.542	50.010	62.973	77.073
OPTIONAL Override Runoff Volume (acre-ft) =								
Inflow Hydrograph Volume (acre-ft) =	6.836	18.084	12.206	22.541	32.536	50.007	62.967	77.037
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.18	0.36	0.82	1.06	1.35
Predevelopment Peak Q (cfs) =	0.0	0.0	5.8	88.0	175.7	402.0	519.7	663.9
Peak Inflow Q (cfs) =	142.8	375.0	254.3	465.4	643.2	929.4	1136.9	1331.9
Peak Outflow Q (cfs) =	3.3	6.0	4.7	6.7	7.8	9.3	10.5	11.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.0	0.0	0.0	0.0
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	N/A	N/A	N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	40	67	55	75	89	109	119	>120
Time to Drain 99% of Inflow Volume (hours) =	40	67	55	75	90	113	>120	>120
Maximum Ponding Depth (ft) =	4.29	7.81	6.08	8.99	11.25	14.70	17.26	20.04
Area at Maximum Ponding Depth (acres) =	2.53	3.24	2.88	3.64	4.48	5.50	5.50	5.50
Maximum Volume Stored (acre-ft) =	5.919	16.048	10.756	20.095	29.219	42.989	42.989	42.989

Detention Basin Outlet Structure Design







KIOWA ENGINEERING CORPORATION

JOB Detention Basin F28

SHEET NO. Perf. Plate OF

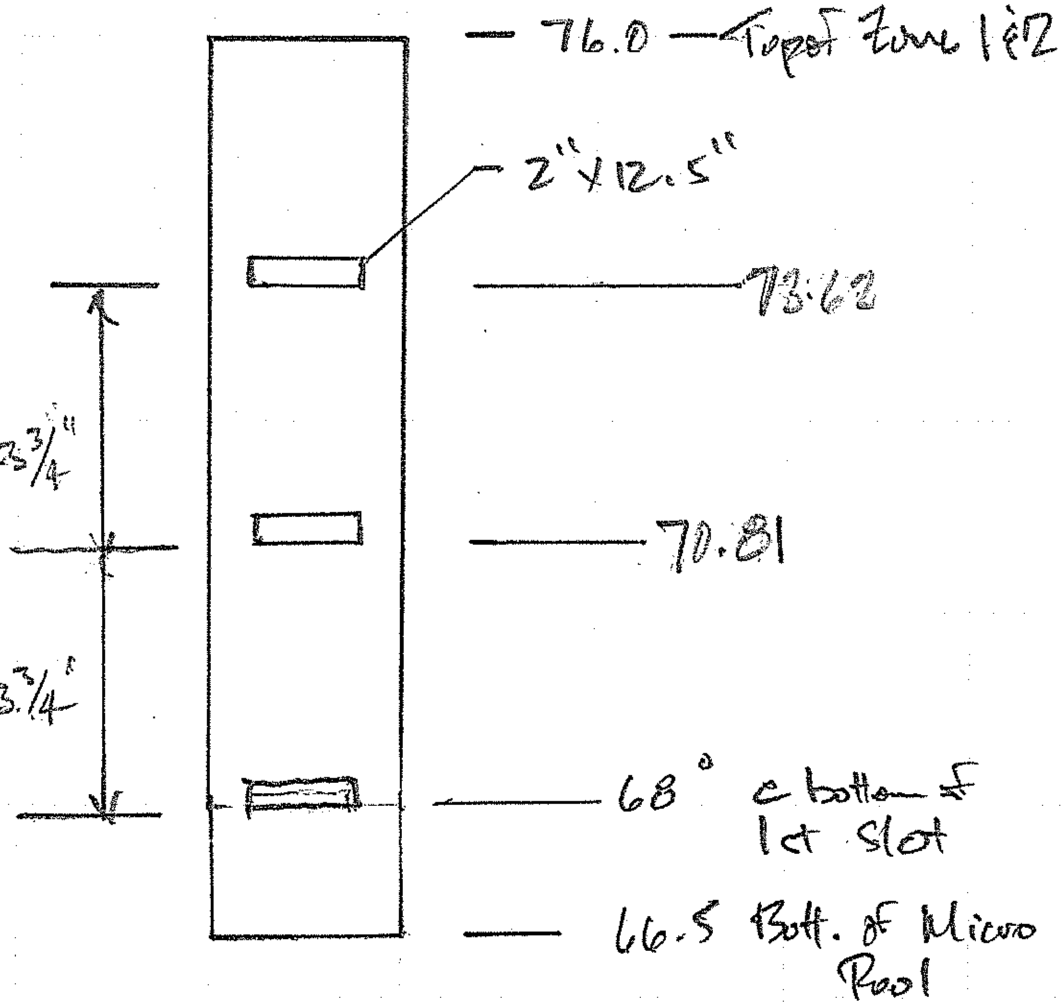
CALCULATED BY Design DATE

CHECKED BY DATE

SCALE

Perforated plate Per UDFCD Detail 25 sq in/slot; 3 @ 32"

Use 2" x 12.5" Slots



Stormwater Detention and Infiltration Design Data Sheet

Stormwater Facility Name: Wolf Ranch Detention Basin F28

Facility Location & Jurisdiction: Research Parkway at Tributary Four, Colorado Springs, Colorado

User Input: Watershed Characteristics

Watershed Slope =	0.035	ft/ft
Watershed Length =	8500	ft
Watershed Area =	490.00	acres
Watershed Imperviousness =	35.5%	percent
Percentage Hydrologic Soil Group A =		percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =		percent

Location for 1-hr Rainfall Depths (use dropdown): UDFCD Default

WQCV Treatment Method = Extended Detention

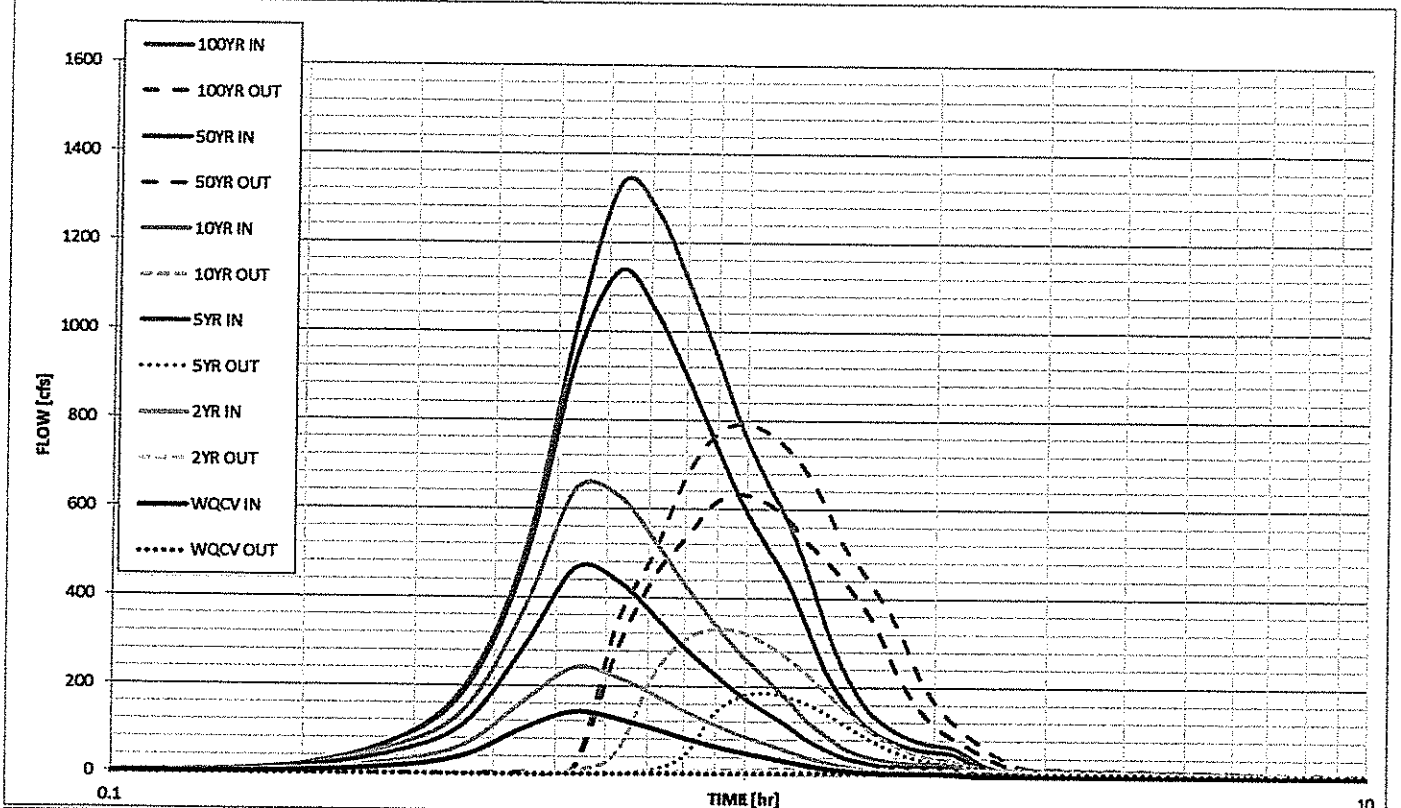
User Defined Stage [ft]	User Defined Area [ft^2]	User Defined Stage [ft]	User Defined Discharge [cfs]
0.00	0	0.00	0.00
0.33	500	0.33	0.00
1.00	10,000	1.00	0.50
2.00	73,929	2.00	1.00
4.00	107,674	4.00	4.50
6.00	124,596	6.00	15.60
8.00	142,924	8.00	340.00
10.00	174,648	10.00	520.00
12.00	207,420	12.00	880.00
14.00	239,495	14.00	1000.00

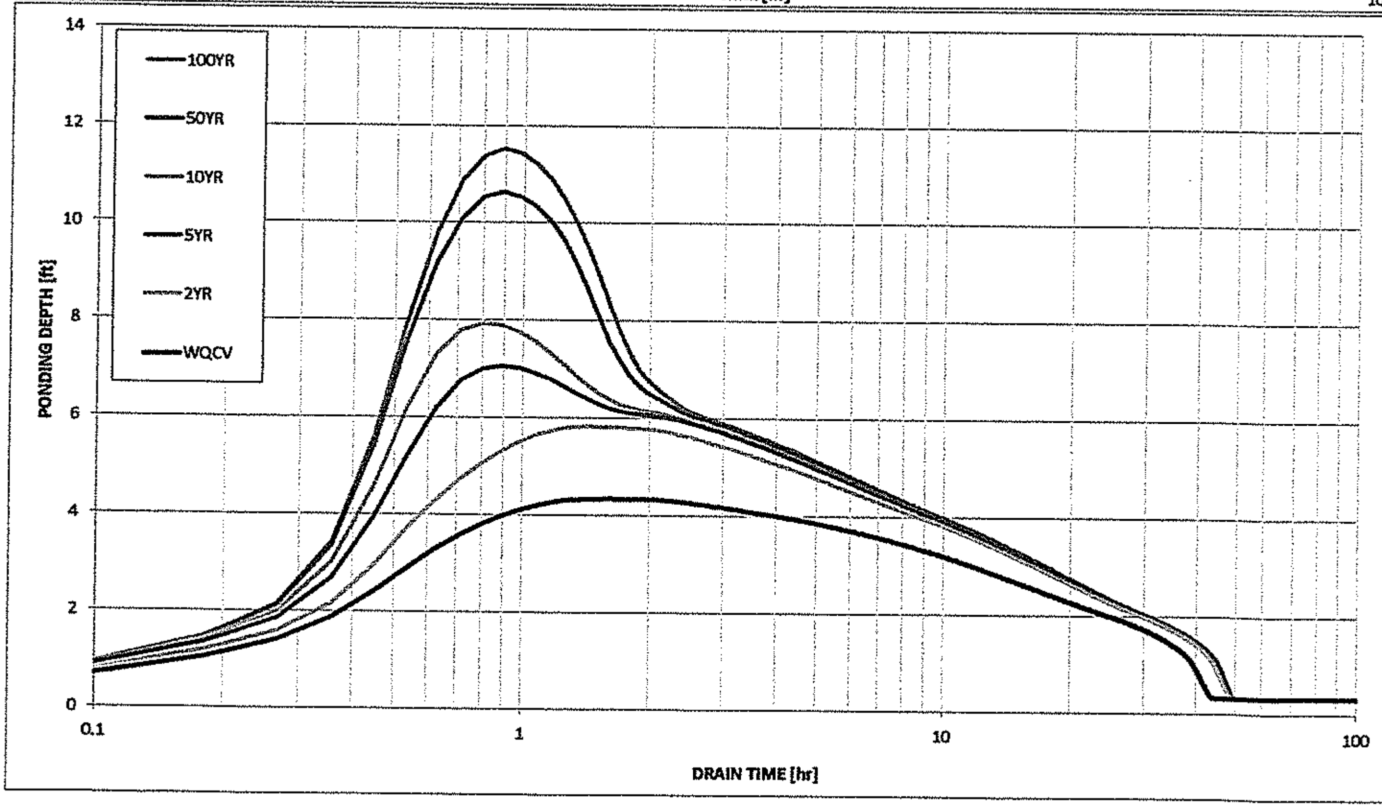
After completing and printing this worksheet to a pdf, go to:
https://maperture.digitaldataservices.com/gvh/?viewer=cswdif
create a new stormwater facility, and
attach the pdf of this worksheet to that record.

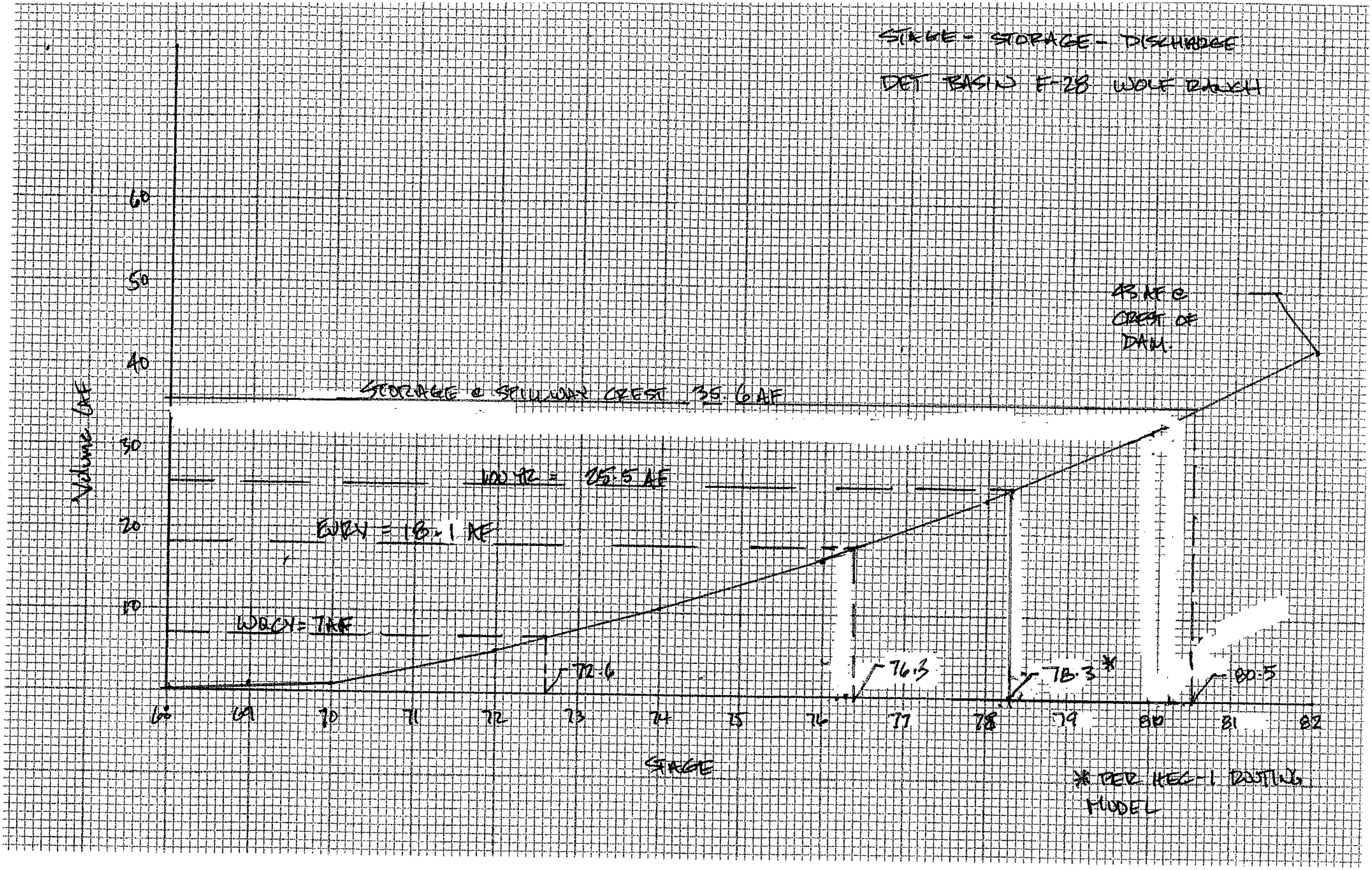
Routed Hydrograph Results

Design Storm Return Period =	WQCV	2 Year	5 Year	10 Year	50 Year	100 Year	
One-Hour Rainfall Depth =	0.53	0.95	1.34	1.64	2.32	2.61	in
Calculated Runoff Volume =	6.845	11.604	22.544	32.542	62.973	77.073	acre-ft
OPTIONAL Override Runoff Volume =							acre-ft
Inflow Hydrograph Volume =	6.836	11.599	22.541	32.536	62.967	77.037	acre-ft
Time to Drain 97% of Inflow Volume =	37.0	39.1	34.9	31.2	23.1	20.6	hours
Time to Drain 99% of Inflow Volume =	39.9	43.5	42.0	40.3	36.0	34.1	hours
Maximum Ponding Depth =	4.35	5.82	7.06	7.94	10.64	11.52	ft
Maximum Ponded Area =	2.54	2.82	3.08	3.27	4.24	4.58	acres
Maximum Volume Stored =	6.045	10.015	13.644	16.449	26.562	30.461	acre-ft

Stormwater Detention and Infiltration Design Data Sheet

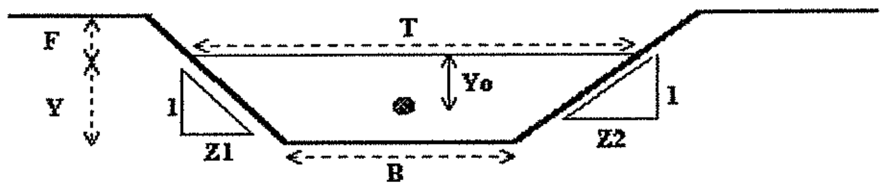





STAGE - STORAGE - DISCHARGE
DET BASIN F-28 WOLF RANCH
Volume (AF)
60
50
40
30
20
10
STORAGE @ SPILLWAY CREST 35.6 AF
43 AF @ CREST OF DAM.
100 YR = 25.5 AF
EURV = 18.1 AF
WQCV = 7 AF
72.6
76.3
78.3 *
80.5
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
STAGE
* PER HEC-1 ROUTING MODEL

Normal Flow Analysis - Trapezoidal Channel

Project: 15012 Wolf Ranch Detention Basin F28
Channel ID: Channel section at crest of inflow drop

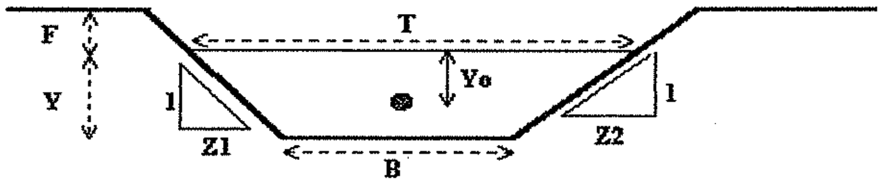


Design Information (Input)			
Channel Invert Slope	So =	0.0050	ft/ft
Manning's n	n =	0.035	
Bottom Width	B =	20.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Slope	Z2 =	4.00	ft/ft
Freeboard Height	F =	1.00	ft
Design Water Depth	Y =	2.20	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**267.52**	cfs
Froude Number	**Fr =**	**0.57**	
Flow Velocity	**V =**	**4.22**	fps
Flow Area	A =	63.36	sq ft
Top Width	T =	37.60	ft
Wetted Perimeter	P =	38.14	ft
Hydraulic Radius	R =	1.66	ft
Hydraulic Depth	D =	1.69	ft
Specific Energy	Es =	2.48	ft
Centroid of Flow Area	Yo =	0.99	ft
Specific Force	Fs =	6.09	kip

Critical Flow Analysis - Trapezoidal Channel

Project: 15012 Wolf Ranch Detention Basin F28
Channel ID: Channel section at crest of inflow drop



Design Information (Input)			
Bottom Width	B =	20.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Slope	Z2 =	4.00	ft/ft
Design Discharge	Q =	237.00	cfs

Critical Flow Condition (Calculated)			
Critical Flow Depth	**Y =**	1.47	ft
Critical Flow Area	A =	38.04	sq ft
Critical Top Width	T =	31.76	ft
Critical Hydraulic Depth	D =	1.20	ft
Critical Flow Velocity	V =	6.23	fps
Froude Number	**Fr =**	1.00	
Critical Wetted Perimeter	P =	32.12	ft
Critical Hydraulic Radius	R =	1.18	ft
Critical (min) Specific Energy	Esc =	2.07	ft
Centroid on the Critical Flow Area	Yoc =	0.62	ft
Critical (min) Specific Force	Fsc =	4.34	kip

HY-8 Culvert Analysis Report

8' x 6' CBC

Table 1 - Summary of Culvert Flows at Crossing: f28 outlet

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
62.00	0.00	0.00	0.00	1
64.58	88.00	88.00	0.00	1
66.08	176.00	176.00	0.00	1
67.36	264.00	264.00	0.00	1
68.60	352.00	352.00	0.00	1
69.93	440.00	440.00	0.00	1
70.93	500.00	500.00	0.00	1
73.20	616.00	616.00	0.00	1
75.24	704.00	704.00	0.00	1
77.59	792.00	792.00	0.00	1
80.25	880.00	880.00	0.00	1
82.00	929.05	929.05	0.00	Overtopping

Rating Curve Plot for Crossing: f28 outlet

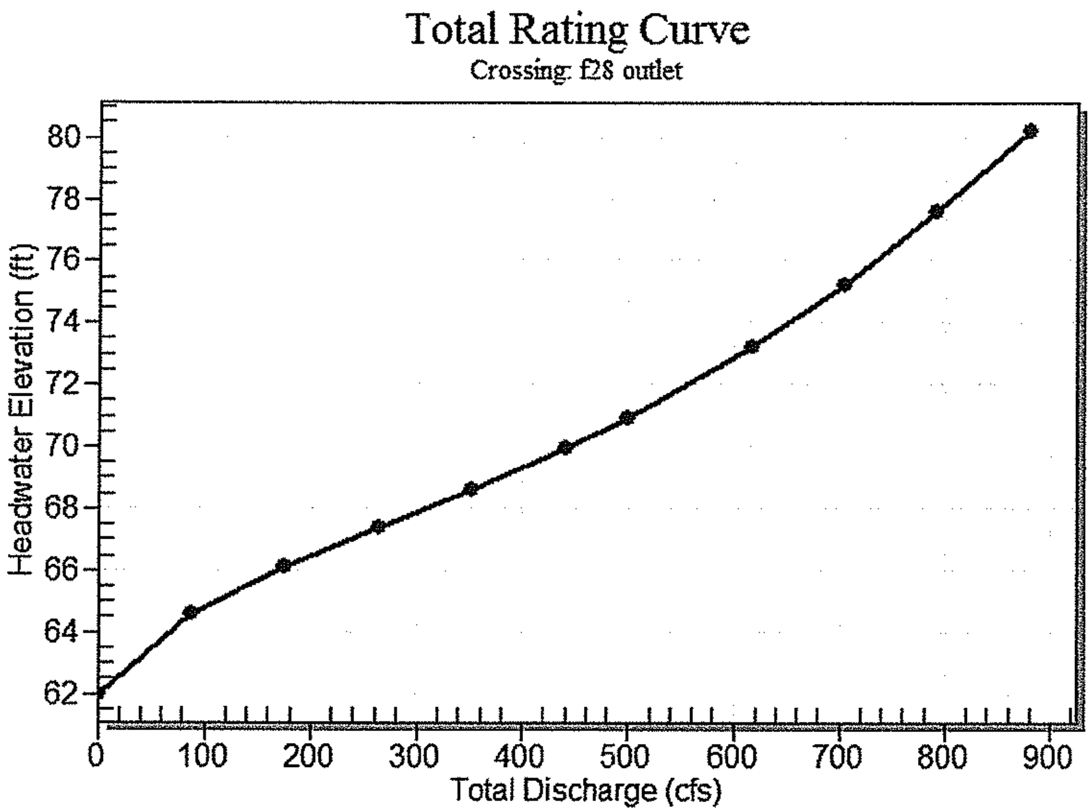


Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	62.00	0.000	0.0*	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
88.00	88.00	64.58	2.577	0.0*	1-S2n	0.658	1.558	0.667	1.170	16.491	5.014
176.00	176.00	66.08	4.081	0.0*	1-S2n	1.028	2.473	1.063	1.826	20.692	6.425
264.00	264.00	67.36	5.362	0.0*	1-S2n	1.357	3.241	1.361	2.384	24.250	7.383
352.00	352.00	68.60	6.599	0.0*	5-S2n	1.651	3.926	1.780	2.890	24.720	8.119
440.00	440.00	69.93	7.926	0.0*	5-S2n	1.928	4.556	2.116	3.364	25.996	8.721
500.00	500.00	70.93	8.933	0.0*	5-S2n	2.105	4.961	2.341	3.673	26.699	9.076
616.00	616.00	73.20	11.198	0.0*	5-S2n	2.444	5.701	2.767	4.247	27.825	9.670
704.00	704.00	75.24	13.243	1.221	6-FFc	2.684	6.000	3.080	4.666	28.571	10.059
792.00	792.00	77.59	15.586	3.140	6-FFc	2.925	6.000	3.386	5.074	29.238	10.406
880.00	880.00	80.25	18.252	5.283	6-FFc	3.156	6.000	3.670	5.473	29.973	10.719

* theoretical depth is impractical. Depth reported is corrected.

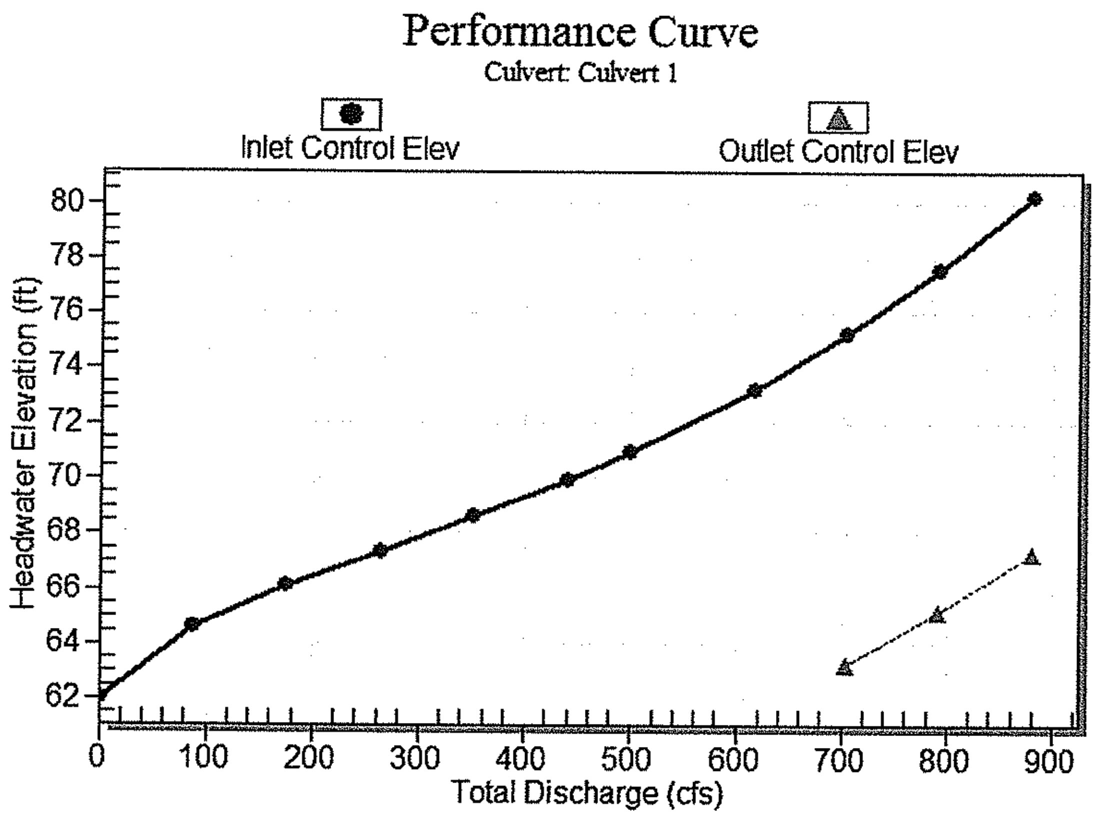
****

Inlet Elevation (invert): 62.00 ft, Outlet Elevation (invert): 50.00 ft

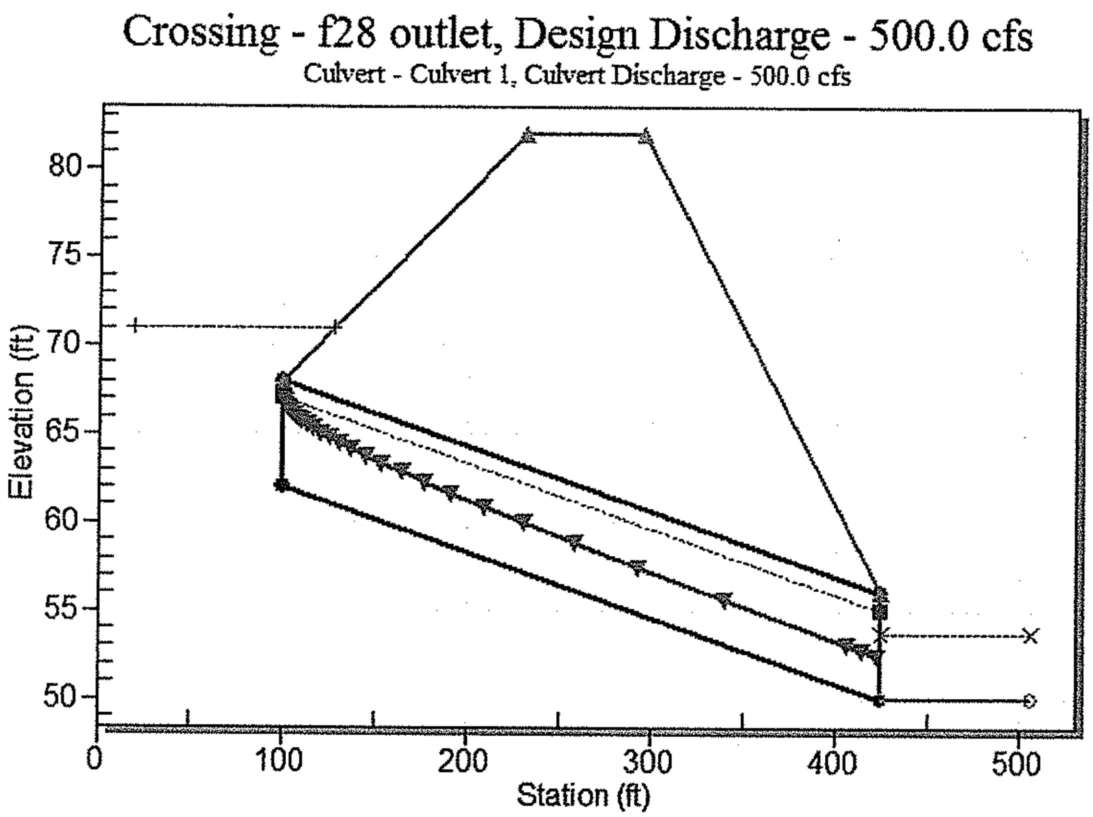
Culvert Length: 325.22 ft, Culvert Slope: 0.0369

****

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 100.00 ft

Inlet Elevation: 62.00 ft

Outlet Station: 425.00 ft

Outlet Elevation: 50.00 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge (90°) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: f28 outlet)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	50.00	0.00	0.00	0.00	0.00
88.00	51.17	1.17	5.01	0.51	0.82
176.00	51.83	1.83	6.43	0.80	0.84
264.00	52.38	2.38	7.38	1.04	0.84
352.00	52.89	2.89	8.12	1.26	0.84
440.00	53.36	3.36	8.72	1.47	0.84
500.00	53.67	3.67	9.08	1.60	0.83
616.00	54.25	4.25	9.67	1.86	0.83
704.00	54.67	4.67	10.06	2.04	0.82
792.00	55.07	5.07	10.41	2.22	0.81
880.00	55.47	5.47	10.72	2.39	0.81

Tailwater Channel Data - f28 outlet

Tailwater Channel Option: Rectangular Channel

Bottom Width: 15.00 ft

Channel Slope: 0.0070

Channel Manning's n: 0.0250

Channel Invert Elevation: 50.00 ft

Roadway Data for Crossing: f28 outlet

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 82.00 ft

Roadway Surface: Paved

Roadway Top Width: 64.00 ft

KIOWA ENGINEERING CORPORATION

JOB: WR Det. Basin F28
SHEET NO. 1 OF 2
CALCULATED BY: Reo W DATE: 1/16/16
CHECKED BY: DATE:
SCALE: Foreby Design

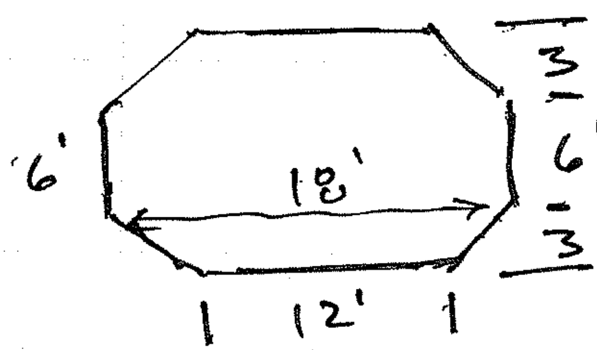
Foreby Layout

36" RCP @ SW Corner of basin.

Per Figure 13-9, UDFCD

L = 2D + 4D = 2(3) + 4(3) = 18'

W = 2D + 2D = 2(3) + 2(3) = 12

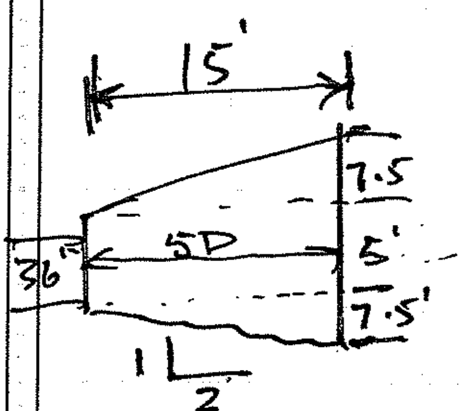


Area per 13-9 calc.

A = 2(½ (18+12)(3)) + 18(6)

A = 90 + 108 = 198, say 200 sf.

Vol @ 18" depth = 300 cf



@ 5' HEADWALL WIDTH

Vol = (½ (5' + 20')(15)) 1.5

= 280 sf low

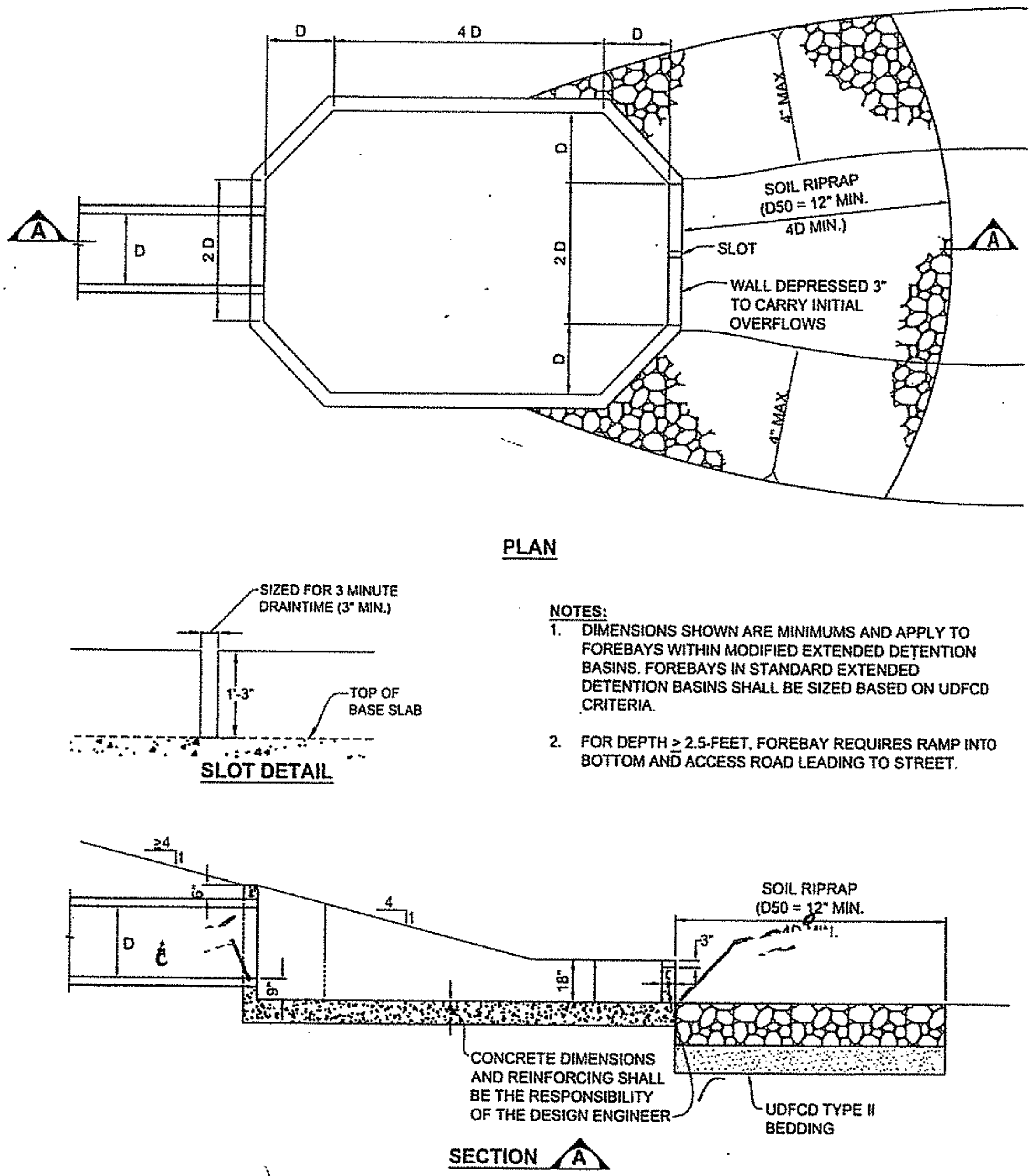
w/ 6' HEADWALL WIDTH

Vol = (½ (5 + 23)(18)) 1.5 = 378 sf

∴ OK

Z

Figure 13-9. Concept for Integral Forebay at Pipe Outfall



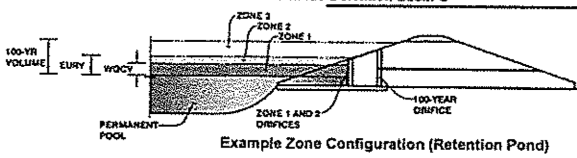
DETENTION BASIN G

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Wolf Ranch Development Research Parkway Filing No. 5

Basin ID: Detention Basin G



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.50	2.237	Orifice Plate
Zone 2 (EURV)	5.68	3.050	Orifice Plate
Zone 3 (100-year)	9.48	6.493	Weir&Pipe (Restrict)
		11.780	Total

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

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

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	5.68	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	22.70	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

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

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.89	3.79					
Orifice Area (sq. inches)	9.62	9.62	9.62					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	6.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	6.50	N/A	feet
Overflow Weir Slope =	3.60	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	5.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	7.39	N/A	feet
Over Flow Weir Slope Length =	5.19	N/A	feet
Grate Open Area / 100-yr Orifice Area =	7.52	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	23.61	N/A	ft^2
Overflow Grate Open Area w/ Debris =	11.81	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	4.08	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	24.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	24.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

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

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	15.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	40.00	feet
Spillway End Slopes =	10.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.84	feet
Stage at Top of Freeboard =	16.84	feet
Basin Area at Top of Freeboard =	2.56	acres

Routed Hydrograph Results

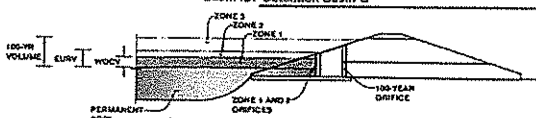
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.20
Calculated Runoff Volume (acre-ft) =	2.237	5.287	4.025	5.761	8.961	15.407	19.614	25.119	36.751
OPTIONAL Override Runoff Volume (acre-ft) =				1.560				7.640	
Inflow Hydrograph Volume (acre-ft) =	2.235	5.278	4.022	1.558	8.950	15.392	19.601	7.626	36.731
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.17	0.58	0.81	1.09	1.65
Predevelopment Peak Q (cfs) =	0.0	0.0	1.9	3.3	31.7	107.6	149.0	201.7	304.5
Peak Inflow Q (cfs) =	32.9	76.5	58.6	23.0	128.0	215.9	271.8	109.5	489.8
Peak Outflow Q (cfs) =	1.0	1.8	1.5	0.9	20.2	52.6	55.9	9.3	68.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.3	0.6	0.5	0.4	0.0	0.2
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Overflow Grate 1	#REF!
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.8	2.1	2.2	0.3	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) =	41	64	56	34	69	64	61	70	55
Time to Drain 99% of Inflow Volume (hours) =	43	68	60	35	75	73	73	75	70
Maximum Ponding Depth (ft) =	3.37	5.47	4.64	2.84	7.09	9.02	10.60	6.65	17.10
Area at Maximum Ponding Depth (acres) =	1.28	1.49	1.41	1.17	1.66	1.86	2.04	1.61	2.56
Maximum Volume Stored (acre-ft) =	2.064	4.984	3.768	1.417	7.515	10.926	13.987	6.813	24.104

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Wolf Ranch Development Research Parkway Filing No. 5

Basin ID: Detention Basin G



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	185.00	acres
Watershed Length =	5,150	ft
Watershed Slope =	0.027	ft/ft
Watershed Imperviousness =	28.00%	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
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	2.237	acre-feet
Excess Urban Runoff Volume (EURV) =	5.287	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	4.025	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	5.761	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	8.961	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	15.407	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	19.614	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	25.119	acre-feet
500-yr Runoff Volume (P1 = 3.2 in.) =	36.751	acre-feet
Approximate 2-yr Detention Volume =	3.755	acre-feet
Approximate 5-yr Detention Volume =	5.405	acre-feet
Approximate 10-yr Detention Volume =	8.007	acre-feet
Approximate 25-yr Detention Volume =	9.382	acre-feet
Approximate 50-yr Detention Volume =	9.893	acre-feet
Approximate 100-yr Detention Volume =	11.780	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

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	2.237	acre-feet
Zone 2 Volume (EURV - Zone 1) =	3.050	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	6.493	acre-feet
Total Detention Basin Volume =	11.780	acre-feet

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	--	--	--	15	0.000		
	--	1.00	--	--	--	9,920	0.228	4,869	0.112
	--	2.00	--	--	--	33,140	0.761	28,167	0.601
	--	3.00	--	--	--	54,124	1.243	70,129	1.610
	--	4.00	--	--	--	58,500	1.343	126,441	2.903
	--	5.00	--	--	--	62,810	1.442	187,096	4.295
	--	6.00	--	--	--	67,218	1.543	252,110	5.788
	--	7.00	--	--	--	71,728	1.647	321,583	7.383
	--	8.00	--	--	--	76,338	1.752	395,616	9.082
	--	9.00	--	--	--	81,048	1.861	474,309	10.889
	--	10.00	--	--	--	85,859	1.971	557,763	12.804
	--	11.00	--	--	--	90,770	2.084	646,077	14.832
	--	12.00	--	--	--	95,782	2.199	739,353	16.973
	--	13.00	--	--	--	100,895	2.316	837,692	19.231
	--	14.00	--	--	--	106,108	2.436	941,193	21.607
	--	15.00	--	--	--	111,421	2.558	1,049,958	24.104
	--		--	--	--				
	--		--	--	--				
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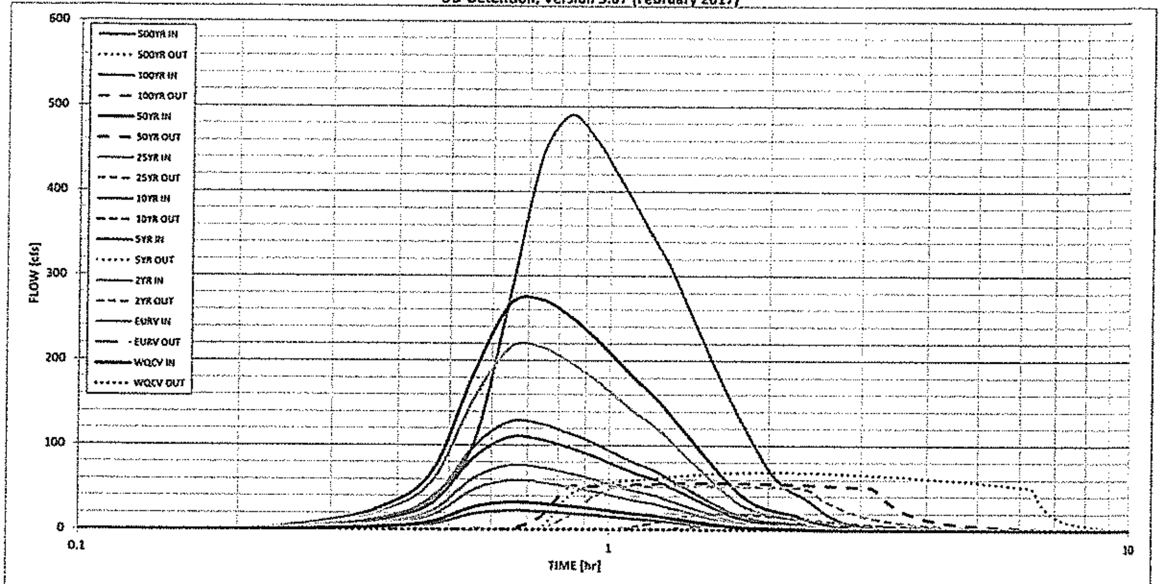
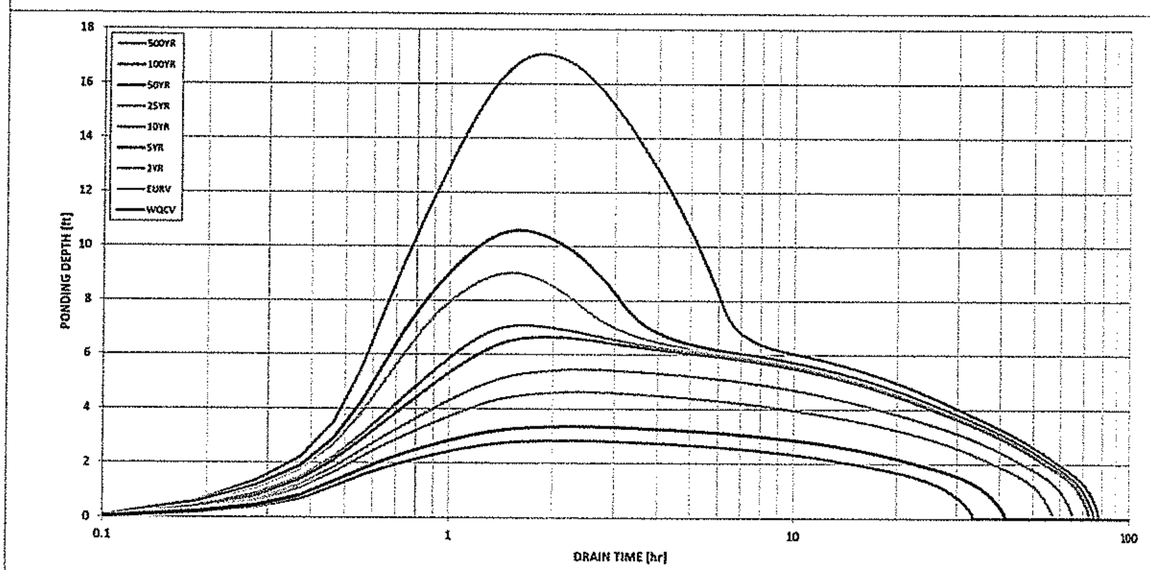
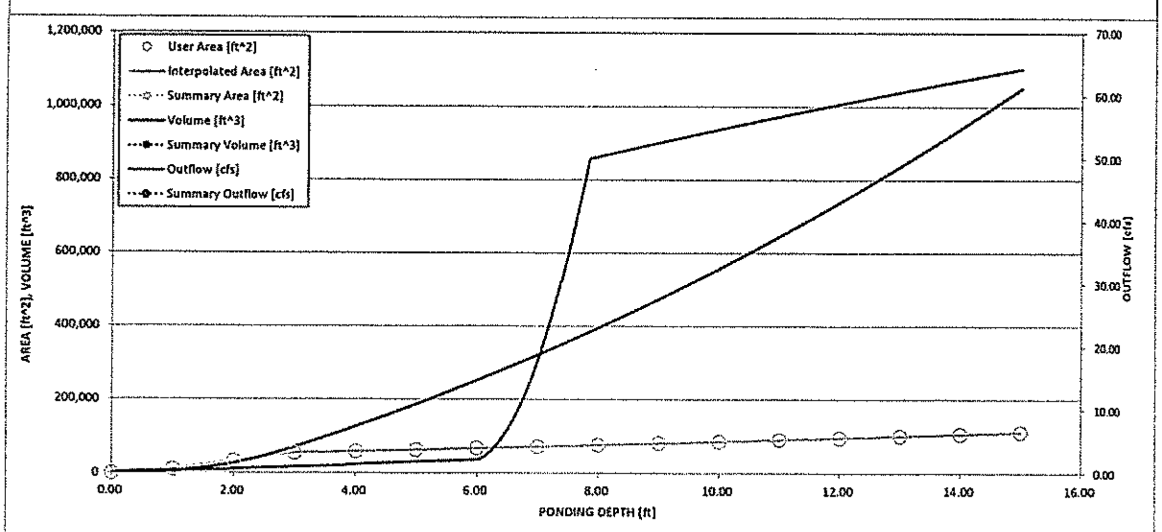
Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







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

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename: ____________________

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

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

	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.56 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrograph	0:11:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant	0:16:41	1.41	3.10	2.44	1.00	4.80	7.19	8.30	4.22	10.97
0.899	0:22:14	3.85	8.72	6.77	2.71	14.01	22.26	26.62	12.16	38.94
	0:27:48	9.89	22.38	17.39	6.97	35.98	57.27	68.68	31.22	103.48
	0:33:22	27.16	61.32	47.68	19.15	98.37	156.08	186.88	85.44	279.36
	0:38:55	32.87	76.51	58.65	23.03	127.96	215.80	267.19	109.53	441.06
	0:44:29	31.49	73.92	56.40	22.03	125.33	215.87	271.80	106.76	489.76
	0:50:02	28.66	67.46	51.36	20.06	114.96	199.42	253.23	97.76	464.38
	0:55:36	25.75	60.79	46.26	17.99	103.72	180.11	229.34	88.17	423.91
	1:01:10	22.41	53.27	40.46	15.61	91.25	159.15	203.86	77.48	383.34
	1:06:43	19.49	46.56	35.32	13.57	79.89	139.50	179.49	67.80	344.66
	1:12:17	17.66	41.95	31.89	12.30	71.66	124.40	159.38	60.90	309.60
	1:17:50	14.73	35.26	26.72	10.24	60.70	106.45	137.35	51.45	268.36
	1:23:24	12.16	29.25	22.14	8.43	50.48	88.73	115.29	42.77	229.56
	1:28:58	9.55	23.26	17.53	6.58	40.48	71.78	94.42	34.21	193.42
	1:34:31	7.30	18.03	13.53	4.99	31.58	56.32	75.09	26.63	160.94
	1:40:05	5.38	13.52	10.10	3.65	23.88	42.99	58.46	20.10	132.36
	1:45:38	4.08	10.10	7.58	2.78	17.68	31.83	44.08	14.92	107.06
	1:51:12	3.31	8.09	6.10	2.27	14.05	24.97	33.80	11.88	84.34
	1:56:46	2.79	6.80	5.13	1.92	11.77	20.80	27.77	9.97	65.12
	2:02:19	2.44	5.91	4.47	1.68	10.19	17.91	23.74	8.64	52.99
	2:07:53	2.19	5.28	4.00	1.51	9.08	15.90	20.96	7.70	45.33
	2:13:26	2.01	4.83	3.66	1.39	8.29	14.47	18.96	7.04	40.11
	2:19:00	1.48	3.62	2.73	1.02	6.34	11.36	15.12	5.35	33.15
	2:24:34	1.08	2.62	1.97	0.75	4.57	8.19	10.97	3.86	25.12
	2:30:07	0.79	1.94	1.46	0.55	3.39	6.07	8.08	2.86	18.33
	2:35:41	0.59	1.44	1.09	0.41	2.52	4.50	6.02	2.13	13.50
	2:41:14	0.43	1.06	0.79	0.29	1.86	3.34	4.48	1.57	10.22
	2:46:48	0.31	0.76	0.57	0.21	1.35	2.42	3.29	1.13	7.70
	2:52:22	0.22	0.55	0.41	0.15	0.97	1.75	2.39	0.82	5.78
	2:57:55	0.15	0.39	0.29	0.10	0.69	1.26	1.75	0.58	4.33
	3:03:29	0.10	0.25	0.19	0.06	0.46	0.85	1.22	0.38	3.28
	3:09:02	0.05	0.15	0.11	0.03	0.27	0.52	0.78	0.22	2.37
	3:14:36	0.02	0.07	0.05	0.01	0.13	0.27	0.44	0.11	1.61
	3:20:10	0.00	0.02	0.01	0.00	0.04	0.10	0.19	0.03	0.99
	3:25:43	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.00	0.52
	3:31:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20
	3:36:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
	3:42:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:47:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:53:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:59:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:04:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:21:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:26:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:32:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:38:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:43:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:49:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:54:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:11:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:16:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:22:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:28:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:33:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:39:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:44:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:01:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:06:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:12:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:18:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:23:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:29:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:34:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:40:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Presedementation / Forebay Sizing

Forebay	100 Yr Flow	Detention WQCV	Total Req'd Forebay Vol 3.0% WQCV	Tributary Area	% Total Trib Area	Required Forebay Volume	Forebay Design Area	Forebay Design Depth	Forebay Design Volume	Discharge Design Flow 2.0% 100yr	Calc'd Open Width (1" min)	**Design Width**
1	102.0cfs	97,429cf	2,923cf	185.00ac	100.0%	2,923cf	1,000sf	2.50-ft	2,500 cf	2.04 cfs	8.1-inch	**8.1-inch**
Totals		97,429cf	2,923cf	185.00ac	100.0%							

Opening Width Equation for Rectangular Opening

$L = Q / (CH^{1.5}) \times 12 + 0.2xHx12$ (UD-BMP Spreadsheet -- EDB tab)

C = 3.0

A = Area of opening (sf)

Forebay Overflow Calculation

Forebay	Water Surf Elev	Crest Elev	Crest Length	Flow Depth	**Calc'd Flow**
1	74.80	74.5	8.0 ft	0.33 ft	4.5 cfs

Weir Equation:

$Q = CLH^{1.5}$

C = 3.0

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

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

Trickle Channel Calculation

Location	100yr Flow	Req'd Flow 1.0% 100yr	Bottom Width	Flow Depth	Side Slope	Slope	Manning 'n'	Top Width	Flow Area	Wetted Perimeter	Hydraulic Radius	Flow Velocity	**Capacity**
Det G	102.0cfs	1.0cfs	8.0 ft	1.00 ft	0.0:1	0.5%	0.013	8.0 ft	8.00 sf	10.0 ft	0.80 ft	7.0 ft/sec	**55.9 cfs**

Equations:

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

Perimeter $(P) = b+2d*(1+z^2)^{0.5}$
- z = side slope

Hydraulic Radius = A/P

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

Flow $= (1.49/n)AR_n^{2/3} S^{1/2}$

Emergency Spillway Calculation

Detention Area	100-yr Flow	120% 100yr Flow	Water Surf Elev	Crest Elev	Crest Length	Z	C	Flow Depth (H)	**Calc'd Flow**	Check
G	102 cfs	122 cfs	6,985	6,984	40 ft	10:1	3.0	1.00 ft	144 cfs	OK

Broad Crested Weir Equation (USDCM Eqn 12-20 and 12-21):

$Q = CLH^{1.5} + 2x((2/5)CZH^{5/2})$

H = Head above weir crest, in ft

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

Z = Side slope (horizontal:vertical)

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

Detention Basin Outlet - Initial Surcharge Sizing

Detention Basin	WQCV	Initial Surcharge Volume				
		Minimum Required		Design		
		0.3% WQCV	Min. Depth	Area	Depth	Volume
G	83,243 cf	250 cf	4.0-in	256 sf	12.0-in	256 cf

17020
Riprap and Boulder Design Calculation

Station	Description	Riprap or Boulder	Straight or Curved Section	Flow Velocity	Channel Slope	For Curved Sections			Velocity for Calc	Super-elevation dY	Rock Sizing Parameter	Calculated Riprap Type	Calculated Boulder Size	Riprap or Boulder Classification	Note
						rc	T	V_a							
22+03	Outlet of 24" Pipe	Riprap	Straight	14.5ft/sec	0.50%				14.5ft/sec		4.4	M	---	M	

Equations:

Rock Sizing Parameter = $VS^{0.17}/(G_s-1)^{0.66}$

V = Mean channel flow velocity for Riprap Sizing

V = Critical Velocity for Grouted Boulder Sizing

S = Longitudinal channel slope

G_s = Specific Gravity of stone (minimum G_s = 2.50)

G_s = 2.55 (UDFCD Recommended) (2'x3' is about 1 ton, able to be moved by skid steer)

G_s = 2.55

Equations taken from *UDFCD USDCM (Eqn MD-13 & HS-9)* and *City of Colorado Springs & El Paso County Drainage Criteria Manual*

Rock Sizing Parameter		Riprap Type	D50
0.00	3.29	VL	6 inches
3.30	3.99	L	9 inches
4.00	4.59	M	12 inches
4.60	5.59	H	18 inches
5.60	6.40	VH	24 inches

Rock Sizing Parameter		Grouted Boulder	Grouted Boulder Min
0.00	4.49	B18	18 inches
4.50	4.99	B18	18 inches
5.00	5.59	B24	24 inches
5.60	6.39	B30	30 inches
6.40	6.99	B36	36 inches
7.00	7.49	B42	42 inches
7.50	8.00	B48	48 inches

$V_a = (-0.147\ r_c/T + 2.176)V$ (Eqn UDFCD MD-10)

V_a = Adjusted channel velocity for riprap sizing along outside of channel bends

r_c = channel centerline radius

T = Top width of water during the major design flood

Superelevation (dY) = $V^2T/2gr_c$ (Eqn UDFCD MD-9)

V = Mean channel flow velocity

T = Top Width of the channel under design flow conditions

g = Gravitational constant = 32.2 ft/sec^2

r_c = channel centerline radius

Notes:
1. Type M Riprap is minimum size recommended for areas immediately upstream of drop structures (water surface drawdown area).
2. Type M Riprap is minimum size recommended for areas immediately downstream of drop structures (hydraulic jump area).
3. Type L Riprap is minimum size recommended for bank lining/toe protection.

XXXXXXXXX

Pipe Diameter Calculations

Pipe #	100yr Flow	Design Flow	Contributing Flows	Manning 'n'	Pipe Slope	Calculated Pipe Diameter	**Pipe Diameter**	Minimum Slope of Pipe	Full Pipe Flow Velocity	Head above Pipe Flowline	H	Pipe Inlet Control Capacity	**Mannings Pipe Capacity**	Capacity Check
Outlet	23.0 cfs	23.0 cfs	24" Storm Outlet	0.013	**2.0%**	21-inch	**24-inch**	1.03%	10.2 ft/sec		----	----	**32.1 cfs**	OK

Equations:

Pipe Dia=$((2.16Qn)/(S^{0.5}))^{0.375}$
- Q = Discharge in cubic feet per second
- n = Manning's roughness coefficient
  - RCP=0.013, CMP=0.024, HDPE (smooth)=0.012
- S = Slope of the pipe
- R_h = Hydraulic Radius

Flow Velocity = $(1.49/n)R_h^{2/3} S^{1/2}$

Pipe Capacity = $(1.49/n)AR_h^{2/3} S^{1/2}$
- A = Cross-sectional area of pipe
- A=p $(D^2/4)$
- D = Inside Diameter of Pipe

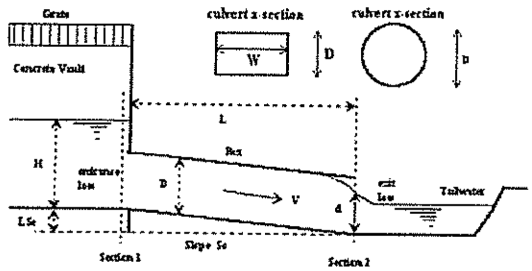
$R_h = A_w/W_p$
- $A_w = p(d^2/4)$
  - A_w = Water Cross Sectional Area
  - d = Water (Flow) Depth Within Pipe
- W_p = pd (For Capacity Calculation)
  - W_p=Wetted Perimeter of Pipe

Orifice Equation:

Q = $CA(2gH)^{0.5}$
- C = Orifice coefficient (dimensionless)
  - C = 0.65
- A = Cross-sectional area of opening, in sf
- g = Gravitational accel constant, 32.2 ft/sec^2
- H = Head above centerline of pipe, ft

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

Project: Wolf Ranch Development Research Parkway Filing No. 5
Basin ID: Detention Basin G
Status:



Design Information (Input):

Circular Culvert: Barrel Diameter in Inches — D = 24 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) — Square Edge w/ 30-78 deg. Flared Wingwall

Number of Barrels — No = 1
Inlet Elevation at Culvert Invert — Inlet Elev = 64.92 ft. elev.
Outlet Elevation at Culvert Invert OR Slope of Culvert (ft v./ft h.) — Outlet Elev = 62.6 ft. elev.
Culvert Length in Feet — L = 232 ft.
Manning's Roughness — n = 0.012
Bend Loss Coefficient — K_b = 0
Exit Loss Coefficient — K_x = 1

Design Information (calculated):

Entrance Loss Coefficient — K_e = 0.50
Friction Loss Coefficient — K_f = 2.44
Sum of All Loss Coefficients — K_s = 3.94
Orifice Inlet Condition Coefficient — C_d = 0.86
Minimum Energy Condition Coefficient — KE_{low} = 0.0121

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
64.90	61.60	0.00	0.00	0.00	No Flow (WS < inlet)	N/A
66.00	62.50	4.90	17.33	4.90	Regression Eqn.	INLET
67.00	63.60	13.60	19.68	13.60	Regression Eqn.	INLET
68.00	63.60	21.00	23.43	21.00	Regression Eqn.	INLET
69.00	63.60	26.30	26.64	26.30	Regression Eqn.	INLET
70.00	63.60	30.60	29.52	29.52	Regression Eqn.	OUTLET
71.00	63.60	34.40	32.13	32.13	Orifice Eqn.	OUTLET
72.00	63.60	37.70	34.56	34.56	Orifice Eqn.	OUTLET
73.00	63.60	40.60	36.81	36.81	Orifice Eqn.	OUTLET
74.00	63.60	43.40	38.94	38.94	Orifice Eqn.	OUTLET
75.00	63.60	46.00	40.96	40.96	Orifice Eqn.	OUTLET
76.00	63.60	48.50	42.89	42.89	Orifice Eqn.	OUTLET

Program: UDSEWER Math Model Interface 2.1.1.4 **Run Date:** 11/7/2017 2:29:54 PM	**UDSewer Results Summary** **Project Title:** New UDSEWER System Module **Project Description:** Default system

System Input Summary

Rainfall Parameters

Rainfall Return Period: 100
Rainfall Calculation Method: Formula

One Hour Depth (in):
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20
Maximum Rural Overland Len. (ft): 500
Maximum Urban Overland Len. (ft): 300
Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 6947.60

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
OUTFALL 1	6946.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 1 SWR 1 - 1	6959.00	23.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 2 SWR 2 - 1	6979.90	23.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 3 SWR 3 - 1	6987.70	23.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 4 SWR 4 - 1	6976.80	23.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
OUTFALL 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Surface Water Present (Upstream)
MH 1 SWR 1 - 1	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	23.00	Surface Water Present (Downstream)
MH 2 SWR 2 - 1	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	23.00	
MH 3 SWR 3 - 1	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	23.00	
MH 4 SWR 4 - 1	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	23.00	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)

MH 1 SWR 1 - 1	83.50	6944.00	4.0	6947.34	0.013	0.03	0.00	CIRCULAR	24.00 in	24.00 in
MH 2 SWR 2 - 1	256.30	6947.64	2.7	6954.60	0.013	0.05	0.00	CIRCULAR	24.00 in	24.00 in
MH 3 SWR 3 - 1	241.50	6954.90	2.0	6959.73	0.013	0.13	0.00	CIRCULAR	24.00 in	24.00 in
MH 4 SWR 4 - 1	244.50	6960.03	2.0	6964.90	0.013	0.56	0.00	CIRCULAR	24.00 in	24.00 in

Sewer Flow Summary:

	Full Flow Capacity		**Critical Flow**		**Normal Flow**						
Element Name	**Flow (cfs)**	**Velocity (fps)**	**Depth (in)**	**Velocity (fps)**	**Depth (in)**	**Velocity (fps)**	**Froude Number**	**Flow Condition**	**Flow (cfs)**	**Surcharged Length (ft)**	**Comment**
MH 1 SWR 1 - 1	45.37	14.44	20.47	8.06	12.10	14.49	2.87	Supercritical Jump	23.00	53.84	
MH 2 SWR 2 - 1	37.38	11.90	20.47	8.06	13.61	12.51	2.29	Supercritical	23.00	0.00	
MH 3 SWR 3 - 1	32.08	10.21	20.47	8.06	15.04	11.10	1.89	Supercritical	23.00	0.00	
MH 4 SWR 4 - 1	32.01	10.19	20.47	8.06	15.06	11.09	1.89	Supercritical	23.00	0.00	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		**Calculated**		**Used**			
Element Name	**Peak Flow (cfs)**	**Cross Section**	**Rise**	**Span**	**Rise**	**Span**	**Rise**	**Span**	**Area (ft^2)**	**Comment**
MH 1 SWR 1 - 1	23.00	CIRCULAR	24.00 in	24.00 in	21.00 in	21.00 in	24.00 in	24.00 in	3.14	
MH 2 SWR 2 - 1	23.00	CIRCULAR	24.00 in	24.00 in	21.00 in	21.00 in	24.00 in	24.00 in	3.14	
MH 3 SWR 3 - 1	23.00	CIRCULAR	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	3.14	
MH 4 SWR 4 - 1	23.00	CIRCULAR	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	3.14	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

Grade Line Summary:

Tailwater Elevation (ft): 6947.60

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	**Downstream (ft)**	**Upstream (ft)**	**Bend Loss (ft)**	**Lateral Loss (ft)**	**Downstream (ft)**	**Upstream (ft)**	**Downstream (ft)**	**Friction Loss (ft)**	**Upstream (ft)**
MH 1 SWR 1 - 1	6944.00	6947.34	0.00	0.00	6947.60	6949.05	6948.43	1.62	6950.05
MH 2 SWR 2 - 1	6947.64	6954.60	0.04	0.00	6949.09	6956.31	6951.20	6.11	6957.31
MH 3 SWR 3 - 1	6954.90	6959.73	0.11	0.00	6956.41	6961.44	6958.07	4.38	6962.44
MH 4 SWR 4 - 1	6960.03	6964.90	0.47	0.00	6961.90	6966.61	6963.19	4.42	6967.61

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

Excavation Estimate:

The trench side slope is 1.0 ft/ft
The minimum trench width is 2.00 ft

					Downstream			Upstream				
Element Name	**Length (ft)**	**Wall (in)**	**Bedding (in)**	**Bottom Width (ft)**	**Top Width (ft)**	**Trench Depth (ft)**	**Cover (ft)**	**Top Width (ft)**	**Trench Depth (ft)**	**Cover (ft)**	**Volume (cu. yd)**	**Comment**
MH 1 SWR 1 - 1	83.50	3.00	4.00	5.50	0.00	3.15	0.32	22.32	12.24	9.41	237.59	Sewer Too Shallow
MH 2 SWR 2 - 1	256.30	3.00	4.00	5.50	21.72	11.94	9.11	49.60	25.88	23.05	3607.28	

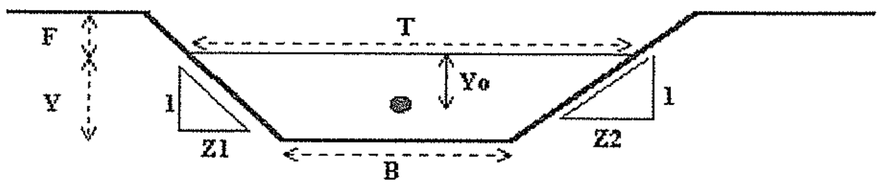
MH 3 SWR 3 - 1	241.50	3.00	4.00	5.50	49.00	25.58	22.75	54.94	28.55	25.72	6180.15	
MH 4 SWR 4 - 1	244.50	3.00	4.00	5.50	54.34	28.25	25.42	22.80	12.48	9.65	4053.34	

Total earth volume for sewer trenches = 14078 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.
  - Six inches for pipes less than 60 inches.
  - Eight inches for all larger sizes.

Critical Flow Analysis - Trapezoidal Channel

Project: 17020 Detention Basin G
Channel ID: Spillway design Q over spillway =102



Design Information (Input)		
Bottom Width	B =	40.00 ft
Left Side Slope	Z1 =	10.00 ft/ft
Right Side Slope	Z2 =	10.00 ft/ft
Design Discharge	Q =	**102.00** cfs

Critical Flow Condition (Calculated)		
Critical Flow Depth	Y =	**0.56** ft
Critical Flow Area	A =	25.28 sq ft
Critical Top Width	T =	51.10 ft
Critical Hydraulic Depth	D =	0.49 ft
Critical Flow Velocity	V =	4.03 fps
Froude Number	Fr =	**1.01**
Critical Wetted Perimeter	P =	51.16 ft
Critical Hydraulic Radius	R =	0.49 ft
Critical (min) Specific Energy	Esc =	0.81 ft
Centroid on the Critical Flow Area	Yoc =	0.25 ft
Critical (min) Specific Force	Fsc =	1.20 kip

Riprap Sizing per Equation 13-9; DCM Vol I Chapt 13

$D_{50} = 5.23\, S^{.43} (1.35\, C_f\, q)^{.56}$

$q = 102/40 = 2.55$ $C_f = 2.0$ for soil riprap

$S = 1/4 = .25$

$D_{50} = 5.23(.25)^{.43}(1.35(2)(2.55))^{.56} = 8.5"$

Type L ok; will use Type H.

Kiowa Engineering Corporation

CLIENT WOLF RANCH JOB NO. 03014 PAGE 1 of 3

PROJECT DATE CHECKED DATE 5/10/04

DETAIL MDDP CHECKED BY COMPUTED BY [illegible]

BASIN 'A'

REV 1/24/06
REV 3/10/13

OUTFALL CHANNELS.

- Try to achieve Velocity 5-year 5fps or less
- 100 year Velocity < 7 fps for grasslined

OUTFALL - Channel A3 / A3A

Q = A3 + 80% of SB A-3
Q_5 = 3 + .5 ~~.8~~(49) = ~~42~~ cfs 27.5
Q_{100} = 31 + ~~.8~~ .5 (194) = ~~186~~.2 cfs 128cfs

@ inlet to A3B 48"

- Existing Slope ~~DP~~. A1 → A3
  L = ~~2700~~' 1700' ΔH = 7228 − 7112 = 116'
  Slope = 116/2700 = .043 %
  @ Slope = .043% V_5 = 6.5 fps no good.

  if Slope = 2.4 % V_5 = 4.9 .. ok
  V_{100} = 6.3 fps. .. ok) SEE 2 & 3 of 3

Required grade control:

L = 2700' ΔS = .043 − .024 = .019
H = 51.3' say 52
w/ 3' each check /drop = 17 checks
Spacing = 2700/17 = 159' say 160'

FOR REVISED 1700' LENGTH, NEED 11 checks

A3B: Q 48" RCP @ 1% Q = 144 cfs

~~INCREASE TO 54" u/s BOUNDARY BLVD.~~

Wolf Ranch MDDP
Swale Capacity Calculation

Structure A3: Grasslined channel 5-year

Trapezoidal Channel Capacity Calculation (Values to be Input)			
Design Flow	42 cfs	Channel Side Slope	4:1
Bottom Width	10.0 ft	Channel Longitudinal Slope	2.4 %
Depth of Flow	0.80 ft	Manning's Roughness Coef.	0.035

Channel Area	10.6 sf
Channel Wetted Perimeter	16.6 ft
Hydraulic Radius	0.64 ft

Channel Flow Velocity	4.9 ft/sec
Channel Flow Capacity	52 cfs
Capacity Check	Okay

Freeboard	1.1 ft
Swale Depth	1.9 ft
Top Width	25.3 ft

Equations:

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

Velocity = $(1.49/n)R_n^{2/3}\ S^{1/2}$
Slope (S) = Slope of the channel
n = Manning's number
R_n = Hydraulic Radius (Reynold's Number)
Flow = $(1.49/n)AR_n^{2/3}\ S^{1/2}$
Freeboard = $1.0+0.025(v)d^{0.33}$

Wolf Ranch MDDP

Swale Capacity Calculation

Structure A3: Grasslined channel 100-year

Trapezoidal Channel Capacity Calculation (Values to be Input)			
Design Flow	186 cfs	Channel Side Slope	4:1
Bottom Width	10.0 ft	Channel Longitudinal Slope	1.7 %
Depth of Flow	1.75 ft	Manning's Roughness Coef.	0.035

Channel Area	29.8 sf
Channel Wetted Perimeter	24.4 ft
Hydraulic Radius	1.22 ft

Channel Flow Velocity	6.3 ft/sec
Channel Flow Capacity	188 cfs
Capacity Check	Okay

Freeboard	1.2 ft
Swale Depth	2.9 ft
Top Width	33.5 ft

Equations:

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

Velocity = $(1.49/n)R_n^{2/3} S^{1/2}$
Slope (S) = Slope of the channel
n = Manning's number
R_n = Hydraulic Radius (Reynold's Number)
Flow = $(1.49/n)AR_n^{2/3} S^{1/2}$
Freeboard = $1.0+0.025(v)d^{0.33}$

Kiowa Engineering Corporation

CLIENT Wolf Ranch MDDP JOB NO. 12055 PAGE 1
PROJECT Update DATE CHECKED ______ DATE 3/18/13
DETAIL Hydraulics CHECKED BY ______ COMPUTED BY RW

REV 5-20-15
REFLECT DB A4 (FSD)

REACH A6 to A4

- Element A4: From SB A-4:

Q_{100} = 133 cfs

42" RCP @ 2.0% : Q_{full} = 145 cfs ∴ ok

- Element A6

Q_{100} @ A4 = ~~374~~ 87 cfs

~~Per Rockwell FDR, need 78" RCP~~

~~72" @ 1.0% = Q_{full} = 424 ∴ ok~~

42" @ 1.0% = Q_{full} = 104 cfs ∴ ok

- Element A5

Q_{100} @ DP A6 = ~~748~~ 394 cfs

66" ~~84"~~ RCP @ 1.0% Q_{full} = ~~750~~ 397 cfs ∴ ok ✓

Element A12

Per Rockwell; FDR Villages @ WR Phase 2 ✓

48" RCP

Kiowa Engineering Corporation

CLIENT: Wolf Ranch MDDP
PROJECT:
DETAIL: Hydraulics

JOB NO. 03094
DATE CHECKED:
CHECKED BY:
PAGE: 1
DATE: 5/11/04
COMPUTED BY: RJW

REV ✓ 2/10/05
REV 1/24/06
REV 3/10/13
REV 5-20-15

Outfall Storm Sewers

Assume all Storm Sewers @ 2.0%, RCP, Except where otherwise noted.

- Storm Sewer A7

Q_{100} = ~~360~~ cfs 292 cfs

@ ~~2.0%~~ 2.2%, Q = ~~368~~ 292 cfs for ~~60"~~ 54" RCP ∴ ok ✓

- ~~Storm Sewer A9 A12~~

Q_{100} = ~~76~~ 84 cfs

use 2.0% ± since grade may be a problem.

~~∴ @ 2.0%, Q = ~~ 94 ~~cfs for 36" RCP ∴ Ok~~ ok

- ~~Storm Sewer Branch 'A3A' to Briargate Blvd.~~

~~Q_{100} = 184 cfs~~

~~48" @ 2.0% Q full = 203 cfs ∴ ok~~

- ~~Storm Sewer A4 @ DP A4.~~

~~Q_{100} = 332 cfs~~

~~54" RCP @ 2.8% Q full = 339 cfs ∴ ok~~

Kiowa Engineering Corporation

CLIENT: Wolf Ranch MDD? JOB NO. 03094 PAGE 2
PROJECT: DATE CHECKED DATE 11/19/04
DETAIL: Hydraulics CHECKED BY COMPUTED BY RAW

REV 5-20-15

✓ Storm Sewer A-11 @ SB A-11

Q_{100} = ~~150 cfs~~ 131 cfs

42" RCP @ 2.0% Cap = 142 cfs ∴ ok ✓

✓ Storm Sewer A8

Q_{100} = ~~282 cfs~~ 231 cfs

~~@ 2.0%~~ ~~54" RCP~~ ~~Q = 298 cfs~~ ∴ ok ✓

2.6% 48" RCP Q = 232 cfs ✓

Storm Sewer A9

Q_{100} DP A9 = 161 cfs

48" RCP @ 2.0% Q_{100} = 205 cfs ∴ ok

48" RCP @ 1.3% Q_{100} = 157 cfs ∴ ok

Kiowa Engineering Corporation

CLIENT: Wolf Ranch MDDP | JOB NO. 12055 | PAGE 1
PROJECT: | DATE CHECKED: | DATE: 8/11/13
DETAIL: Hydraulics | CHECKED BY: | COMPUTED BY: RJW

Basin E Outfall Storm Sewer.

E2B: Existing 60" RCP @ 1.0% ✓

E2A: Existing 54" RCP @ 1.0% ✓

E1: Outfall Storm from SB E1

Q_{100} = 76 cfs

36" RCP @ 1.4% Q_{Full} = 78 cfs ∴ ok

E6A: Outfall Storm Sewer for SB E6

Q_{100} = 94 cfs

42" RCP @ 1.0% Q_{Full} = 101 cfs ∴ ok

E6B: this picks up 1/2 of SB E5

Q_{100} SB E5 = 82 cfs

∴ Q_{100} = 94 cfs + .5(82) = 135 cfs

Per rockwell FDR, Φ = 54"

54" @ 1.0% Q_{Full} = 197 cfs ∴ ok

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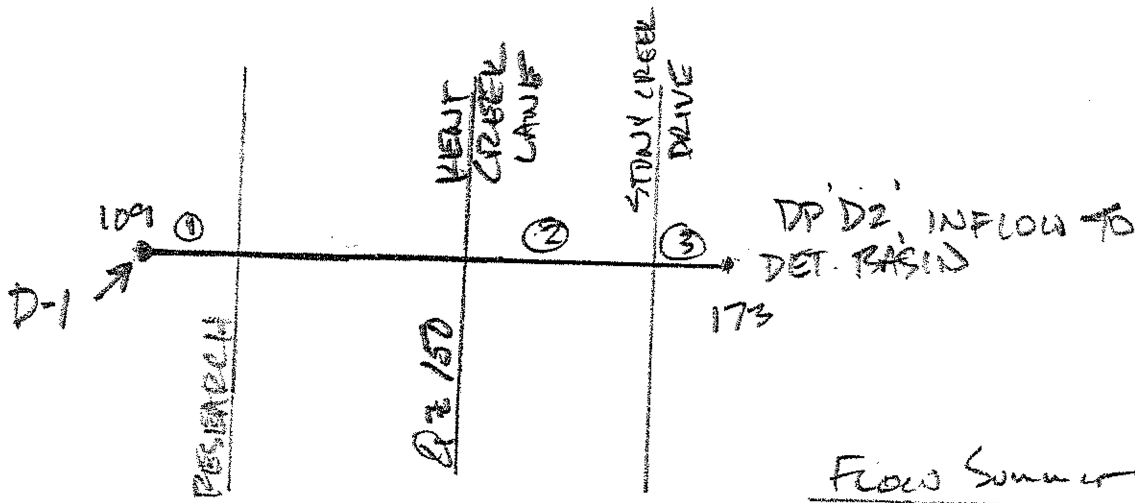
CLIENT Wolf Ranch MDDP JOB NO. 03094 PAGE 1
PROJECT DATE CHECKED DATE 3/3/04
DETAIL CHECKED BY COMPUTED BY

3-11-13

SYSTEM CONSTRUCTED 2005

Outfall Storm Sewer Sizing,

West outfall to Detention Basin E/D



Flow Summary

@ D-1	36	109
@ DPD2	57	173

Segment 1 : Q = 109 cfs

assume minimum slope of 2% across Research

∴ Need 42" RCP Q = 142 cfs ←
36" RCP Q = 94 cfs ∴ no good

Segment 2 : Kent Creek Drive to Stoney Creek Q = 150 cfs.
Use slope of Comet Lane, 2%

48" RCP @ 2% = 203 cfs ; ample ←
42" RCP @ 2% = 140 ∴ no good

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CLIENT: Wax Ranch MDDP JOB NO. 03094 PAGE 2/2
PROJECT: DATE CHECKED: DATE:
DETAIL: CHECKED BY: COMPUTED BY:

Segment 3:

Stoney Creek to Def. Basin E/D $Q = 170$ cfs

Bottom of Pond @ 52± . L = 160'
appears the slope will be 2/120 = .0167, say .016

48" RCP Q @ 1.6% = 182 cfs ∴ ok.

BASIN F HYDRAULICS REVISED 3-10-13

Roadway Culverts (See HY8 results)

~~DP F9 Q_{100} = 152 cfs L = 80'~~
~~HW/D = 4.2/4 = 1.05 ∴ ok 4'x6' CBC~~

- SB F8 Q_{100} = 69 cfs L = 80'
HW/D = 3.8/4 = .95 ∴ ok 48" RCP

DP F10 Q_{100} = 48 cfs L = 80'
HW/D = 3.3/3.5 = .94 ∴ ok 42" RCP

DP F11 Q_{100} = 102 cfs L = 80'
HW/D = 4.25/4 = 1.06 ∴ ok 4'x4' CBC

~~DP F12 Q_{100} = 236 cfs L = 80'~~
~~HW/D = 4/4 = 1 ∴ ok 4'x10' CBC~~

SB F15 Q_{100} = 4 cfs use 18" RCP

DP F13 Q_{100} = 30 cfs L = 80'
HW/D = 2.7/3 = .9 ∴ ok use 36" RCP

~~SB F20 (Briargate Blvd) Q_{100} = 140 cfs L = 160'~~
~~HW/D = 3.97/4 = 1.0 ∴ ok use 4'x6' CBC~~

Kiowa Engineering Corporation

CLIENT Wolf Ranch MDDP JOB NO. 03094 PAGE 2/3
PROJECT DATE CHECKED DATE
DETAIL CHECKED BY COMPUTED BY

REVISED 3-11-13

Roadway Culverts Cont'd.

DB19 : This is outlet of Det. Basin 19 L = 240' ±
Q_{100} out = 89 cfs.
Assume HW depth of 7' can be obtained w/ 42" RCP, HW/D = 6.6/3.5 = 1.9.
6.6' HW depth consistent w/ DB 19 HW requirements.
* DET. BASIN OUTLET RECONF. TO FUNCTION AS FSD

DB 18 : This is outlet of Det. Basin 18, L = 240' ±
Q_{100} Out = 141 cfs
Assume HW depth ≥ 7', same as DB 19
w/ 48" RCP, HW = 7.5' ∴ ok.
HW/D = 7.5/4 = 1.88
* DET. BASIN OUTLET RECONF. TO FUNCTION AS FSD

DP F23 : Q_{100} = 69 cfs L = 160'
(Briargate)
HW/D = 3.8/4 = .95 ∴ use 48" RCP

~~DP F14 : Q_{100} = 210 cfs L = 160'~~
~~HW/D = 4.35/4 = 1.08 ∴ ok use 4'x8' CBC~~

~~DP F24 : Q_{100} = 181 cfs L = 80'~~
~~HW/D = 3.9/4 = .98 ∴ ok use 4'x8' CBC~~

@ SB 8 & Upper Collector

CURRENT DATE: 05-19-2004
CURRENT TIME: 13:20:42

FILE DATE: 05-19-2004
FILE NAME: SB8

FHWA CULVERT ANALYSIS
HY-8, VERSION 3.2

CULV #	SITE DATA: INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	100.00	98.40	80.02	1 RCP	4.00	4.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (CFS) FILE: SB8 DATE: 05-19-2004

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
100.00	0	0	0	0	0	0	0	0	1
101.59	16	16	0	0	0	0	0	0	1
102.36	32	32	0	0	0	0	0	0	1
103.04	48	48	0	0	0	0	0	0	1
103.65	64	64	0	0	0	0	0	0	1
104.28	80	80	0	0	0	0	0	0	1
104.97	96	96	0	0	0	0	0	0	1
105.78	112	112	0	0	0	0	0	0	1
106.73	128	128	0	0	0	0	0	0	1
107.82	144	144	0	0	0	0	0	0	1
108.42	152	152	0	0	0	0	0	0	1
110.00	171	171	0	0	0	0	0	OVERTOPPING	

HW/D = .85

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: SB8 DATE: 05-19-2004

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
100.00	0.00	0	0	0.00
101.59	0.00	16	0	0.00
102.36	0.00	32	0	0.00
103.04	0.00	48	0	0.00
103.65	0.00	64	0	0.00
104.28	0.00	80	0	0.00
104.97	0.00	96	0	0.00
105.78	0.00	112	0	0.00
106.73	0.00	128	0	0.00
107.82	0.00	144	0	0.00
108.42	0.00	152	0	0.00

<1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 05-19-2004
CURRENT TIME: 13:20:42

FILE DATE: 05-19-2004
FILE NAME: SB8

****
************************* CULVERT # 1 *************************
****

PERFORMANCE CURVE FOR 1 BARREL(S)

Q (cfs)	HWE (ft)	TWE (ft)	ICH (ft)	OCH (ft)	FLOW TYPE	CCE (ft)	FCE (ft)	TCE (ft)	VO (fps)
0	100.00	98.40	0.00	-1.60	0-NF	0.00	100.00	0.00	0.00
16	101.59	98.83	1.59	1.03	6-FF	0.00	0.00	0.00	10.43
32	102.36	99.03	2.36	1.42	6-FF	0.00	0.00	0.00	11.10
48	103.04	99.18	3.04	1.85	6-FF	0.00	0.00	0.00	12.11
64	103.65	99.31	3.65	2.34	6-FF	0.00	0.00	0.00	12.87
80	104.28	99.42	4.28	2.91	6-FF	0.00	0.00	0.00	13.59
96	104.97	99.52	4.97	3.54	6-FF	0.00	0.00	0.00	14.13
112	105.78	99.61	5.78	4.26	6-FF	0.00	0.00	0.00	14.67
128	106.73	99.69	6.73	5.04	6-FF	0.00	0.00	0.00	15.23
144	107.82	99.77	7.82	5.91	6-FF	0.00	0.00	0.00	15.78
152	108.42	99.81	8.42	6.37	6-FF	0.00	0.00	0.00	16.04

El. inlet face invert 100.00 ft El. outlet invert 98.40 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

****

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION (FT)	100.00
INLET ELEVATION (FT)	100.00
OUTLET STATION (FT)	180.00
OUTLET ELEVATION (FT)	98.40
NUMBER OF BARRELS	1.00
SLOPE (V-FT/H-FT)	0.0200
CULVERT LENGTH ALONG SLOPE (FT)	80.02

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	CIRCULAR
BARREL DIAMETER	4.00 FT
BARREL MATERIAL	CONCRETE
BARREL MANNING'S N	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE WITH HEADWALL
INLET DEPRESSION	NONE

****

CURRENT DATE: 05-19-2004
CURRENT TIME: 13:20:42

FILE DATE: 05-19-2004
FILE NAME: SB8

****
**************************   TAILWATER   **************************
****

******* REGULAR CHANNEL CROSS SECTION ***************

BOTTOM WIDTH (FT)	10.00
SIDE SLOPE H/V (X:1)	6.0
CHANNEL SLOPE V/H (FT/FT)	0.020
MANNING'S N (.01-0.1)	0.035
CHANNEL INVERT ELEVATION (FT)	98.40
CULVERT NO.1 OUTLET INVERT ELEVATION	98.40 FT

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (CFS)	W.S.E. (FT)	FROUDE NUMBER	VEL. (FPS)	SHEAR (PSF)
0.00	98.40	0.000	0.00	0.00
16.00	98.83	0.808	2.99	0.53
32.00	99.03	0.830	3.72	0.78
48.00	99.18	0.840	4.21	0.97
64.00	99.31	0.847	4.58	1.13
80.00	99.42	0.852	4.88	1.27
96.00	99.52	0.856	5.14	1.40
112.00	99.61	0.859	5.36	1.51
128.00	99.69	0.862	5.57	1.62
144.00	99.77	0.865	5.75	1.71
152.00	99.81	0.866	5.83	1.76

****
************************* ROADWAY OVERTOPPING DATA *************************
****

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	30.00
CREST LENGTH (FT)	100.00
OVERTOPPING CREST ELEVATION (FT)	110.00

****

DP F10 Upper Collector

CURRENT DATE: 05-19-2004
CURRENT TIME: 13:25:46

FILE DATE: 05-19-2004
FILE NAME: F10

FHWA CULVERT ANALYSIS
HY-8, VERSION 3.2

C U L V #	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	100.00	98.40	80.02	1 RCP	3.50	3.50	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (CFS) FILE: F10 DATE: 05-19-2004

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
100.00	0	0	0	0	0	0	0	0	1
100.99	6	6	0	0	0	0	0	0	1
101.43	12	12	0	0	0	0	0	0	1
101.77	18	18	0	0	0	0	0	0	1
102.13	24	24	0	0	0	0	0	0	1
102.45	30	30	0	0	0	0	0	0	1
102.74	36	36	0	0	0	0	0	0	1
103.02	42	42	0	0	0	0	0	0	1
103.30	48	48	0 HW/D= .94	0	0	0	0	0	1
103.58	54	54	0	0	0	0	0	0	1
103.88	60	60	0	0	0	0	0	0	1
110.00	134	134	0	0	0	0	0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: F10 DATE: 05-19-2004

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
100.00	0.00	0	0	0.00
100.99	0.00	6	0	0.00
101.43	0.00	12	0	0.00
101.77	0.00	18	0	0.00
102.13	0.00	24	0	0.00
102.45	0.00	30	0	0.00
102.74	0.00	36	0	0.00
103.02	0.00	42	0	0.00
103.30	0.00	48	0	0.00
103.58	0.00	54	0	0.00
103.88	0.00	60	0	0.00

<1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 05-19-2004
CURRENT TIME: 13:25:46

FILE DATE: 05-19-2004
FILE NAME: F10

****
************************* CULVERT # 1 *************************
****

PERFORMANCE CURVE FOR 1 BARREL(S)

Q (cfs)	HWE (ft)	TWE (ft)	ICH (ft)	OCH (ft)	FLOW TYPE	CCE (ft)	FCE (ft)	TCE (ft)	VO (fps)
0	100.00	98.40	0.00	-1.60	0-NF	0.00	100.00	0.00	0.00
6	100.99	98.64	0.99	0.53	6-FF	0.00	0.00	0.00	7.45
12	101.43	98.76	1.43	0.72	6-FF	0.00	0.00	0.00	9.15
18	101.77	98.85	1.77	0.90	6-FF	0.00	0.00	0.00	9.72
24	102.13	98.93	2.13	1.08	6-FF	0.00	0.00	0.00	10.65
30	102.45	99.00	2.45	1.28	6-FF	0.00	0.00	0.00	11.03
36	102.74	99.07	2.74	1.49	6-FF	0.00	0.00	0.00	11.67
42	103.02	99.12	3.02	1.72	6-FF	0.00	0.00	0.00	11.94
48	103.30	99.18	3.30	1.96	6-FF	0.00	0.00	0.00	12.33
54	103.58	99.23	3.58	2.22	6-FF	0.00	0.00	0.00	12.70
60	103.88	99.28	3.88	2.51	6-FF	0.00	0.00	0.00	12.94

El. inlet face invert 100.00 ft El. outlet invert 98.40 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

****

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION (FT)	100.00
INLET ELEVATION (FT)	100.00
OUTLET STATION (FT)	180.00
OUTLET ELEVATION (FT)	98.40
NUMBER OF BARRELS	1.00
SLOPE (V-FT/H-FT)	0.0200
CULVERT LENGTH ALONG SLOPE (FT)	80.02

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	CIRCULAR
BARREL DIAMETER	3.50 FT
BARREL MATERIAL	CONCRETE
BARREL MANNING'S N	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE WITH HEADWALL
INLET DEPRESSION	NONE

****

C"RENT DATE: 05-19-2004
(RENT TIME: 13:25:46

FILE DATE: 05-19-2004
FILE NAME: F10

****
************************* TAILWATER *************************
****

******* REGULAR CHANNEL CROSS SECTION ***************

BOTTOM WIDTH (FT)	10.00
SIDE SLOPE H/V (X:1)	6.0
CHANNEL SLOPE V/H (FT/FT)	0.020
MANNING'S N (.01-0.1)	0.035
CHANNEL INVERT ELEVATION (FT)	98.40
CULVERT NO.1 OUTLET INVERT ELEVATION	98.40 FT

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (CFS)	W.S.E. (FT)	FROUDE NUMBER	VEL. (FPS)	SHEAR (PSF)
0.00	98.40	0.000	0.00	0.00
6.00	98.64	0.769	2.15	0.30
12.00	98.76	0.798	2.72	0.45
18.00	98.85	0.812	3.11	0.57
24.00	98.93	0.821	3.41	0.67
30.00	99.00	0.828	3.65	0.75
36.00	99.07	0.833	3.86	0.83
42.00	99.12	0.837	4.04	0.90
48.00	99.18	0.840	4.21	0.97
54.00	99.23	0.843	4.35	1.03
60.00	99.28	0.845	4.49	1.09

****
************************* ROADWAY OVERTOPPING DATA *************************
****

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	30.00
CREST LENGTH (FT)	100.00
OVERTOPPING CREST ELEVATION (FT)	110.00

****

DP F11 · upper collector

CURRENT DATE: 05-19-2004
CURRENT TIME: 13:46:47

FILE DATE: 05-19-2004
FILE NAME: F11

FHWA CULVERT ANALYSIS
HY-8, VERSION 3.2

C U L V #	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	100.00	98.40	80.02	1 RCB	4.00	4.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (CFS) FILE: F11 DATE: 05-19-2004

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
100.00	0	0	0	0	0	0	0	0	1
100.93	11	11	0	0	0	0	0	0	1
101.48	22	22	0	0	0	0	0	0	1
101.94	33	33	0	0	0	0	0	0	1
102.36	44	44	0	0	0	0	0	0	1
102.75	55	55	0	0	0	0	0	0	1
103.11	66	66	0	0	0	0	0	0	1
103.46	77	77	0	0	0	0	0	0	1
103.80	88	88	0	0	0	0	0	0	1
104.15	99	99	0	0	0	0	0	0	1
104.25	102	102	0	0	0	0	0	0	1
110.00	223	223	0	0	0	0	0	OVERTOPPING	

HW/D ≈ 1.06

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: F11 DATE: 05-19-2004

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
100.00	0.00	0	0	0.00
100.93	0.00	11	0	0.00
101.48	0.00	22	0	0.00
101.94	0.00	33	0	0.00
102.36	0.00	44	0	0.00
102.75	0.00	55	0	0.00
103.11	0.00	66	0	0.00
103.46	0.00	77	0	0.00
103.80	0.00	88	0	0.00
104.15	0.00	99	0	0.00
104.25	0.00	102	0	0.00

<1> TOLERANCE (FT) = 0.010
<2> TOLERANCE (%) = 1.000

CURRENT DATE: 05-19-2004 FILE DATE: 05-19-2004
CURRENT TIME: 13:46:47 FILE NAME: F11

****
************************ CULVERT # 1 ************************
****

PERFORMANCE CURVE FOR 1 BARREL(S)

Q (cfs)	HWE (ft)	TWE (ft)	ICH (ft)	OCH (ft)	FLOW TYPE	CCE (ft)	FCE (ft)	TCE (ft)	VO (fps)
0	100.00	98.40	0.00	-1.60	0-NF	0.00	100.00	0.00	0.00
11	100.93	98.74	0.93	0.72	6-FF	0.00	0.00	0.00	7.77
22	101.48	98.91	1.48	0.94	6-FF	0.00	0.00	0.00	10.28
33	101.94	99.04	1.94	1.16	6-FF	0.00	0.00	0.00	10.58
44	102.36	99.14	2.36	1.38	6-FF	0.00	0.00	0.00	11.52
55	102.75	99.24	2.75	1.62	6-FF	0.00	0.00	0.00	12.11
66	103.11	99.32	3.11	1.88	6-FF	0.00	0.00	0.00	12.60
77	103.46	99.40	3.46	2.15	6-FF	0.00	0.00	0.00	13.14
88	103.80	99.47	3.80	2.45	6-FF	0.00	0.00	0.00	13.47
99	104.15	99.54	4.15	2.77	6-FF	0.00	0.00	0.00	13.87
102	104.25	99.55	4.25	2.86	6-FF	0.00	0.00	0.00	13.97

El. inlet face invert 100.00 ft El. outlet invert 98.40 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

****

** SITE DATA ***** CULVERT INVERT **************

INLET STATION (FT)	100.00
INLET ELEVATION (FT)	100.00
OUTLET STATION (FT)	180.00
OUTLET ELEVATION (FT)	98.40
NUMBER OF BARRELS	1.00
SLOPE (V-FT/H-FT)	0.0200
CULVERT LENGTH ALONG SLOPE (FT)	80.02

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	BOX
BARREL SPAN	4.00 FT
BARREL RISE	4.00 FT
BARREL MATERIAL	CONCRETE
BARREL MANNING'S N	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE (30-75 DEG. FLARE)
INLET DEPRESSION	NONE

****

CURRENT DATE: 05-19-2004
CURRENT TIME: 13:46:47

FILE DATE: 05-19-2004
FILE NAME: F11

****
************************* TAILWATER *************************
****

******* REGULAR CHANNEL CROSS SECTION ****************

BOTTOM WIDTH (FT)	10.00
SIDE SLOPE H/V (X:1)	6.0
CHANNEL SLOPE V/H (FT/FT)	0.020
MANNING'S N (.01-0.1)	0.035
CHANNEL INVERT ELEVATION (FT)	98.40
CULVERT NO.1 OUTLET INVERT ELEVATION	98.40 FT

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (CFS)	W.S.E. (FT)	FROUDE NUMBER	VEL. (FPS)	SHEAR (PSF)
0.00	98.40	0.000	0.00	0.00
11.00	98.74	0.795	2.65	0.43
22.00	98.91	0.819	3.31	0.63
33.00	99.04	0.830	3.76	0.79
44.00	99.14	0.838	4.10	0.93
55.00	99.24	0.843	4.38	1.04
66.00	99.32	0.848	4.62	1.15
77.00	99.40	0.851	4.83	1.25
88.00	99.47	0.854	5.01	1.33
99.00	99.54	0.857	5.18	1.42
102.00	99.55	0.857	5.23	1.44

****
************************* ROADWAY OVERTOPPING DATA *************************
****

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	30.00
CREST LENGTH (FT)	100.00
OVERTOPPING CREST ELEVATION (FT)	110.00

****

DP F13 upper local roadway

(RENT DATE: 05-19-2004
CURRENT TIME: 14:17:54

FILE DATE: 05-19-2004
FILE NAME: F13

FHWA CULVERT ANALYSIS
HY-8, VERSION 3.2

CULV #	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	100.00	98.40	80.02	1 RCP	3.00	3.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (CFS) FILE: F13 DATE: 05-19-2004

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
100.00	0	0	0	0	0	0	0	0	1
100.78	4	4	0	0	0	0	0	0	1
101.12	7	7	0	0	0	0	0	0	1
101.39	11	11	0	0	0	0	0	0	1
101.66	14	14	0	0	0	0	0	0	1
101.91	18	18	0	0	0	0	0	0	1
102.14	21	21	0	0	0	0	0	0	1
102.35	25	25	0	0	0	0	0	0	1
102.56	28	28	0	0	0	0	0	0	1
102.67	30	30	0	0 HW/Do= .9	0	0	0	0	1
102.96	35	35	0	0	0	0	0	0	1
110.00	100	100	0	0	0	0	0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: F13 DATE: 05-19-2004

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
100.00	0.00	0	0	0.00
100.78	0.00	4	0	0.00
101.12	0.00	7	0	0.00
101.39	0.00	11	0	0.00
101.66	0.00	14	0	0.00
101.91	0.00	18	0	0.00
102.14	0.00	21	0	0.00
102.35	0.00	25	0	0.00
102.56	0.00	28	0	0.00
102.67	0.00	30	0	0.00
102.96	0.00	35	0	0.00

<1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 05-19-2004
CURRENT TIME: 14:17:54

FILE DATE: 05-19-2004
FILE NAME: F13

****
************************* CULVERT # 1 **************************
****

PERFORMANCE CURVE FOR 1 BARREL(S)

Q (cfs)	HWE (ft)	TWE (ft)	ICH (ft)	OCH (ft)	FLOW TYPE	CCE (ft)	FCE (ft)	TCE (ft)	VO (fps)
0	100.00	98.40	0.00	-1.60	0-NF	0.00	100.00	0.00	0.00
4	100.78	98.58	0.78	0.20	6-FF	0.00	0.00	0.00	7.07
7	101.12	98.67	1.12	0.34	6-FF	0.00	0.00	0.00	8.51
11	101.39	98.74	1.39	0.48	6-FF	0.00	0.00	0.00	8.51
14	101.66	98.79	1.66	0.62	6-FF	0.00	0.00	0.00	10.30
18	101.91	98.85	1.91	0.75	6-FF	0.00	0.00	0.00	9.88
21	102.14	98.90	2.14	0.90	6-FF	0.00	0.00	0.00	10.57
25	102.35	98.94	2.35	1.06	6-FF	0.00	0.00	0.00	10.75
28	102.56	98.98	2.56	1.24	6-FF	0.00	0.00	0.00	11.08
30	102.67	99.00	2.67	1.34	6-FF	0.00	0.00	0.00	11.32
35	102.96	99.06	2.96	1.62	6-FF	0.00	0.00	0.00	11.76

El. inlet face invert 100.00 ft El. outlet invert 98.40 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

****

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION (FT)	100.00
INLET ELEVATION (FT)	100.00
OUTLET STATION (FT)	180.00
OUTLET ELEVATION (FT)	98.40
NUMBER OF BARRELS	1.00
SLOPE (V-FT/H-FT)	0.0200
CULVERT LENGTH ALONG SLOPE (FT)	80.02

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	CIRCULAR
BARREL DIAMETER	3.00 FT
BARREL MATERIAL	CONCRETE
BARREL MANNING'S N	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE WITH HEADWALL
INLET DEPRESSION	NONE

****

CURRENT DATE: 05-19-2004
CURRENT TIME: 14:17:54

FILE DATE: 05-19-2004
FILE NAME: F13

****
************************ TAILWATER ************************
****

******* REGULAR CHANNEL CROSS SECTION ****************

BOTTOM WIDTH (FT)	10.00
SIDE SLOPE H/V (X:1)	6.0
CHANNEL SLOPE V/H (FT/FT)	0.020
MANNING'S N (.01-0.1)	0.035
CHANNEL INVERT ELEVATION (FT)	98.40
CULVERT NO.1 OUTLET INVERT ELEVATION	98.40 FT

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (CFS)	W.S.E. (FT)	FROUDE NUMBER	VEL. (FPS)	SHEAR (PSF)
0.00	98.40	0.000	0.00	0.00
3.50	98.58	0.744	1.78	0.22
7.00	98.67	0.776	2.27	0.33
10.50	98.74	0.793	2.61	0.42
14.00	98.79	0.804	2.87	0.49
17.50	98.85	0.811	3.08	0.56
21.00	98.90	0.817	3.27	0.62
24.50	98.94	0.822	3.43	0.67
28.00	98.98	0.826	3.57	0.73
30.00	99.00	0.828	3.65	0.75
35.00	99.06	0.832	3.83	0.82

****
************************ ROADWAY OVERTOPPING DATA ************************
****

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	30.00
CREST LENGTH (FT)	100.00
OVERTOPPING CREST ELEVATION (FT)	110.00

****

F23 Bridgegate Blvd

CURRENT DATE: 05-21-2004
CURRENT TIME: 09:22:08

FILE DATE: 05-19-2004
FILE NAME: F23

FHWA CULVERT ANALYSIS
HY-8, VERSION 3.2

CULV #	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	100.00	96.80	160.03	1 RCP	4.00	4.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

FILE: F23 CULVERT HEADWATER ELEVATION (FT) DATE: 05-19-2004

DISCHARGE	1	2	3	4	5	6	ROADWAY
0	100.00	0.00	0.00	0.00	0.00	0.00	110.00
8	101.07	0.00	0.00	0.00	0.00	0.00	110.09
15	101.53	0.00	0.00	0.00	0.00	0.00	110.14
23	101.90	0.00	0.00	0.00	0.00	0.00	110.18
30	102.27	0.00	0.00	0.00	0.00	0.00	110.22
38	102.61	0.00	0.00	0.00	0.00	0.00	110.25
45	102.92	0.00	0.00	0.00	0.00	0.00	110.28
53	103.22	0.00	0.00	0.00	0.00	0.00	110.31
60	103.50	0.00	0.00	0.00	0.00	0.00	110.34
68	103.79	0.00	0.00	0.00	0.00	0.00	110.37
69	103.84	0.00	0.00	0.00	0.00	0.00	110.37

HW/D=.95

C̈URRENT DATE: 05-21-2004 FILE DATE: 05-19-2004
(RENT TIME: 09:22:08 FILE NAME: F23

****
************************* CULVERT # 1 *************************
****

PERFORMANCE CURVE FOR 1 BARREL(S)

Q (cfs)	HWE (ft)	TWE (ft)	ICH (ft)	OCH (ft)	FLOW TYPE	CCE (ft)	FCE (ft)	TCE (ft)	VO (fps)
0	100.00	96.80	0.00	-3.20	0-NF	0.00	100.00	0.00	0.00
8	101.07	97.08	1.07	-0.79	6-FF	0.00	0.00	0.00	8.55
15	101.53	97.21	1.53	-0.59	6-FF	0.00	0.00	0.00	10.30
23	101.90	97.32	1.90	-0.40	6-FF	0.00	0.00	0.00	11.40
30	102.27	97.40	2.27	-0.20	6-FF	0.00	0.00	0.00	12.46
38	102.61	97.48	2.61	0.00	6-FF	0.00	0.00	0.00	12.37
45	102.92	97.55	2.92	0.23	6-FF	0.00	0.00	0.00	12.87
53	103.22	97.62	3.22	0.47	6-FF	0.00	0.00	0.00	13.50
60	103.50	97.68	3.50	0.73	6-FF	0.00	0.00	0.00	13.83
68	103.79	97.73	3.79	1.01	6-FF	0.00	0.00	0.00	14.28
69	103.84	97.74	3.84	1.07	6-FF	0.00	0.00	0.00	14.37

El. inlet face invert 100.00 ft El. outlet invert 96.80 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

****

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION (FT)	100.00
INLET ELEVATION (FT)	100.00
OUTLET STATION (FT)	260.00
OUTLET ELEVATION (FT)	96.80
NUMBER OF BARRELS	1.00
SLOPE (V-FT/H-FT)	0.0200
CULVERT LENGTH ALONG SLOPE (FT)	160.03

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	CIRCULAR
BARREL DIAMETER	4.00 FT
BARREL MATERIAL	CONCRETE
BARREL MANNING'S N	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE WITH HEADWALL
INLET DEPRESSION	NONE

****

CURRENT DATE: 05-21-2004
CURRENT TIME: 09:22:08

FILE DATE: 05-19-2004
FILE NAME: F23

****
************************* TAILWATER *************************
****

******* REGULAR CHANNEL CROSS SECTION ****************

BOTTOM WIDTH (FT)	10.00
SIDE SLOPE H/V (X:1)	6.0
CHANNEL SLOPE V/H (FT/FT)	0.020
MANNING'S N (.01-0.1)	0.035
CHANNEL INVERT ELEVATION (FT)	96.80
CULVERT NO.1 OUTLET INVERT ELEVATION	96.80 FT

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (CFS)	W.S.E. (FT)	FROUDE NUMBER	VEL. (FPS)	SHEAR (PSF)
0.00	96.80	0.000	0.00	0.00
7.50	97.08	0.779	2.32	0.35
15.00	97.21	0.806	2.93	0.51
22.50	97.32	0.819	3.34	0.64
30.00	97.40	0.828	3.65	0.75
37.50	97.48	0.834	3.91	0.85
45.00	97.55	0.839	4.13	0.94
52.50	97.62	0.842	4.32	1.02
60.00	97.68	0.845	4.49	1.09
67.50	97.73	0.848	4.65	1.16
69.00	97.74	0.849	4.68	1.18

****
************************* ROADWAY OVERTOPPING DATA *************************
****

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	30.00
CREST LENGTH (FT)	100.00
OVERTOPPING CREST ELEVATION (FT)	110.00

****

Kiowa Engineering Corporation

CLIENT Wolf Ranch MDDP	JOB NO. 03094	PAGE 1
PROJECT	DATE CHECKED	DATE 5/19/04
DETAIL	CHECKED BY	COMPUTED BY [illegible]

REVISED 3-12-13

CHANNEL DESIGN - BASIN 'F'

Design guidelines.

Side Tributaries: Try to get 5-year velocity 5 fps or less for grasslined.

Try to get 100 year velocity ≤ 7 fps for grasslined /w riprap invert. > 7 fps, need riprap sides.

- Since perimeter of Wolf Ranch is low density (ie, 2.5 ac and greater lots), natural drainageways could be left as is. Check structures @ most along steep sections.

"Nat. Drainageway"	Ex. Slope	τ @ 1' depth (1)
SB F-8	.04	2.5 ✓
~~SB F-[illegible]~~	~~.021~~	~~1.5~~
F9	.057	3.6 ✓
F10	.04	2.5 ✓
F11	.038	2.4 ✓
F12	.042	2.6 ✓
F12A	.036	2.2 ✓
F13	.05	3.1 ✓
F7	.031	1.9 ✓
F14	.042	2.6 ✓

$\tau = \gamma d s = \gamma s$ for $d = 1'$

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CLIENT: Wolf Ranch MDDP | JOB NO. 03094 | PAGE 2
PROJECT: | DATE CHECKED: | DATE:
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✓ - Channel SB F-8 Q_{100} = 69 cfs τ = 2.5 @ 12"
69 cfs would be < 12" deep ∴ τ < 2.5
recommend leave as is.

~~Channel SB F-20 τ < 2.1 allowable for grassline~~
~~∴ leave as is.~~

✓ - Channel F9 Q_{100} = 152 cfs
drainageway is very wide, > 50 BW
∴ τ << 3.6 ∴ leave as is.

✓ - Channel F10: Q_{100} = 48 cfs τ = 2.5 psf
low flow, τ << 2.5 ∴ leave as is.

✓ - Channel F11: Q_{100} = 102 cfs τ = 2.4 psf
d << 12" ∴ τ < 2.4
∴ leave as is.

✓ - Channel F12: Q_{100} = 144 cfs τ = 2.6 psf
very broad flow path, >> 50'
∴ d << 12", τ << 2.6 ∴ leave as is

✓ - Channel 12A: Q_{100} = 51 cfs τ = 2.2 psf
very broad flow path; >> 50'
∴ d << 12", τ << 2.2 psf
∴ leave as is.

Kiowa Engineering Corporation | CLIENT Wolf Ranch MDDP | JOB NO. 03094 | PAGE 3
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REVISED 3-12-13

✓ - channel F13 : Q_{100} = 21 cfs ↑ = 3-1
very low flow; may be a roadside swale.
w/ d = .5 (ok for 21 cfs) τ = 1.55 psf
∴ leave as is or grasslined swale.

Improved drainageways

✓ - F8 (to confluence w/ F18)
Q_5 range 15 → 25 cfs ±
Q_{100} range. 69 cfs → 80 cfs ±
Slope = .037 %
- area has broad flow path; cutting through low density residential
∴ use BW 15'
5 yr Velocity = 4.2 fps ∴ ok for grasslined
100 yr = 6.1 fps " need riprap invert
No grade control proposed.

~~- F14 Q_5 = 18 → 56~~
~~Q_{100} = 152 → 338 cfs S = .035 %~~
~~fairly defined flowpath. use BW = 20'~~
~~@ S = .035, V_5 5.2 fps ∴ no good.~~
~~Flatten w/ grade control.~~
~~@ S = 2.5% V_5 4.8 ok, V_{100} = 8 fps ∴ no good~~
~~flatten to 1.8% V_5 = 4 V_{100} = 7.2 ∴ ok~~

REPLACED W/ CLOSED CONDUIT PER ROCKWELL FDR'S

Kiowa Engineering Corporation

CLIENT Wolf Ranch MDDP   JOB NO. 03094   PAGE 4
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REVISED 3-12-13

F19 cont'd.

~~Grade control. Design Slope = 1.8% L = 1850'~~
~~Ex Slope = 3.5%~~
~~$\therefore \Delta H = 1850(.035 - .018) = 31.5'$ Say 32~~
~~Assume 6' of drop into DB forebay(s)~~
~~$\therefore 32 - 6 = 26'$ 9 drops/checks~~
~~Space @ 3' each 1850/9 = 205'~~
~~Space @ 200' i-t.~~

✓ F18A : $Q_5 = 16$ L = 1100'
$Q_{100} = 48$

wide flow path. use BW=15'
Slope ex. = .05'/'
100 year velocity w/ 15' BW = 5.9 ∴ ok
5 year velocity = 3.1 ∴ ok
No grade control required

✓ F18 : $Q_5 = 13$, $Q_{100} = 102$ @ u/s. L = 1500'
Q_5 = F10 + F11 = 6 + 13 = 19 cfs
Q_{100} = 48 + 102 = 150 cfs.
Slope = 50/1500 = .033'/'
Assume 6' of drop can be achieved in DB forebays
$\therefore \Delta H = 50 - 6 = 44$
$\therefore S = 44/1500 = .029'/'$ $V_5 = 3.7$ fps
$V_{100} = 6.9$ fps ∴ ok

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REVISED 3-12-13

F17 Q_5 = 24 cfs + SB F17 = 24 + 3 = 27 cfs L = 1600'

Q_{100} = 236 cfs + 25 cfs = 261 cfs

S = 54/1600 = .034'/'

Assume 6' of drop into DB Forebays.

∴ S_{eff} = 54-6/1600 = .03'/'

@ Slope = .03'/', V_{100} w/ 15' BW 8.5 fps. no good.

Flatten with grade control:

@ S = .02'/', V_{100} = 7.1 fps ∴ ok,

V_5 = 3.5 fps ∴ ok

Required grade control:

ΔS = .03-.02 = .01 × L = 16'

@ 3'/drop, need 3.1 drops, say 3

Spacing = 1600/3 = 533'

✓ F16 This would be piped to DB18

Q_{100} = 31 cfs

w/ 2% storm sewer slope need 24" RCP.

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REVISED 3-12-13

✓ Lower Portion, F14/F7

Q_5 = RF14 + RF7 = 5 + 2 = 7 cfs

Q_{100} = 53 + 30 = 83 cfs   L = 750'

S = 46.24/750' = .029'/1

w/ 10' BW, S = 2.9% V_5 = 3 fps ∴ ok

V_{100} = 7.1 fps ∴ ok

No grade control required.

✓ F23

Q_5 = 6 → 16

Q_{100} = 26 → 69   L = 1050'

S = 28/1050 = .027'/1

w/ 10' BW, V_5 = 3.5 fps ∴ ok

V_{100} = 5.7 fps ∴ ok

no grade control req'd.

~~F24~~

~~Q_5 = 16 → 44   L = 2200'~~

~~Q_{100} = 69 → 181~~

~~S = 60/2200 = .027'/1~~

~~w/ 15' BW, V_5 = 4.5 fps V_{100} = 7.1 ∴ ok~~

~~no grade control req'd.~~

REPLACED W/ CLOSED CONDUIT PER ROCKWELL FDR

Kiowa Engineering Corporation

CLIENT Wolf Ranch MDDP | JOB NO. 03094 | PAGE 7
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REVISED 3-12-13

~~F25~~

$Q_5 = 45 \rightarrow 66$

$Q_{100} = 210 \rightarrow 303$

L = 2400'

S = 66/2400 = .028'/1

w/ BW = 20', S = .028, V_{100} = 8.2 ∴ no good.

Try S = .018, V_{100} = 6.4 fps ∴ ok.

V_5 =

Need Grade control

ΔS = .028 - .018 = .01 × L = 24'

w/ 3' per GC, Need 8 drop/checks,

Spacing @ 300' int.

REPLACED W/ CLOSED CONDUIT PER ROCKWELL FDR

~~F30~~

Q_5 = 66

Q_{100} = 303

L = 900'

S = 28/900 = .031'/1

Use same section as F25

S req'd = 1.8% for V_{100} < 7 fps.

∴ (.031 - .018)900 = 11.7' say 12

Need 4, 3' GC/drops

Spacing 900/4 = 225'

Kiowa Engineering Corporation

CLIENT: Wolf Ranch MDDP JOB NO. 03094 PAGE 8
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✓ **F29** $Q_5 = 112$ $Q_{100} = 480$ $L = 750'$

$S = \frac{30 - 00}{750} = .04'/1$

try BW = 20', $Velocity_{100} = 10.5$ fps ∴ no good.
cut to 2%, still need riprap. $V_{100} = 8.2$ fps.
go with riprap swale.

GC: $\Delta S = .04 - .02 = .02 \times L = 15'$
∴ need 5, 3' drops @ 150' interval to close.
use 2 - 6' sloping drops.
∴ Slope of channel =
$750(.04 - X) = 12'$
$X = .024'/1$

Riprap Size
$VS^{.17}/1.36 = 8.8(.024)^{.17}/1.36 = 3.4$
Type 'L'

~~**F21** $Q_5 = 45 \rightarrow 120$~~
~~$Q_{100} = 140 \rightarrow 313$ $L = 1750'$~~
~~$S = 50/1750 = .029'/1$~~
~~Try BW = 20': @ S = .029, $V_{100} = 8.2$ ∴ no good~~
~~w/ S = 1.8% $V_{100} = 6.9$ fps ∴ ok~~
~~GC: $(.029 - .018)1750 = .011(1750) = 19.25$~~
~~say 21:~~
~~w/ 3'/GC, need 7 drops : Int = 1750/7 = 250'~~

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CLIENT Wolf Ranch MDDP JOB NO. 03094 PAGE 9
PROJECT ____ DATE CHECKED ____ DATE 5/19/04
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✓ **F22**

$Q_5 = 20 + \frac{1}{2}\ \overset{SB}{F22} = 20 + \frac{1}{2}(7) = 24$ cfs

$Q_{100} = 89 + \frac{1}{2}\ \overset{SB}{F22} = 89 + \frac{1}{2}(51) = 115$ cfs

L = 1850' S = 60/1850 = .032'/'

Try BW = 15', S = .032'/' , V_{100} = 6.5 ∴ ok V_5 =

no gc required

✓ **F22A**

$Q_5 = 26 + \frac{1}{2}$ SB F22 = 30 cfs

$Q_{100} = 141 + \frac{1}{2}$ SB F22 = 167 cfs

L = 2050' S = 60/2050 = .029'/'

Try 20' BW, S = .029'/' V_{100} = 6.7 ∴ ok

V_5 = 3.7 fps ∴ ok

No GC req'd.

Wolf Ranch MDDP
Swale Capacity Calculation

Structure F8: Grasslined channel 5-year

Trapezoidal Channel Capacity Calculation (Values to be Input)			
Design Flow	25 cfs	Channel Side Slope	4:1
Bottom Width	15.0 ft	Channel Longitudinal Slope	3.7 %
Depth of Flow	0.40 ft	Manning's Roughness Coef.	0.035

Channel Area	6.6 sf
Channel Wetted Perimeter	18.3 ft
Hydraulic Radius	0.36 ft

Channel Flow Velocity	4.2 ft/sec
Channel Flow Capacity	28 cfs
Capacity Check	Okay

Freeboard	1.1 ft
Swale Depth	1.48 ft
Top Width	26.8 ft

Equations:

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

Velocity = $(1.49/n)R_n^{2/3}\,S^{1/2}$
Slope (S) = Slope of the channel
n = Manning's number
R_n = Hydraulic Radius (Reynold's Number)
Flow = $(1.49/n)AR_n^{2/3}\,S^{1/2}$
Freeboard = $1.0+0.025(v)d^{0.33}$

Structure F8: Grasslined channel 100-year

Trapezoidal Channel Capacity Calculation (Values to be Input)			
Design Flow	80 cfs	Channel Side Slope	4:1
Bottom Width	15.0 ft	Channel Longitudinal Slope	3.7 %
Depth of Flow	0.75 ft	Manning's Roughness Coef.	0.035

Channel Area	13.5 sf
Channel Wetted Perimeter	21.2 ft
Hydraulic Radius	0.64 ft

Channel Flow Velocity	6.1 ft/sec
Channel Flow Capacity	82 cfs
Capacity Check	Okay

Freeboard	1.1 ft
Swale Depth	1.89 ft
Top Width	30.1 ft

Equations:

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

Velocity = $(1.49/n)R_n^{2/3} S^{1/2}$
Slope (S) = Slope of the channel
n = Manning's number
R_n = Hydraulic Radius (Reynold's Number)
Flow = $(1.49/n)AR_n^{2/3} S^{1/2}$
Freeboard = $1.0+0.025(v)d^{0.33}$

Wolf Ranch MDDP
Swale Capacity Calculation

Structure F18A: Grasslined channel 5-year

Trapezoidal Channel Capacity Calculation (Values to be Input)			
Design Flow	6 cfs	Channel Side Slope	4:1
Bottom Width	15.0 ft	Channel Longitudinal Slope	5.0 %
Depth of Flow	0.20 ft	Manning's Roughness Coef.	0.035

Channel Area	3.2 sf
Channel Wetted Perimeter	16.6 ft
Hydraulic Radius	0.19 ft

Channel Flow Velocity	3.1 ft/sec
Channel Flow Capacity	10 cfs
Capacity Check	Okay

Freeboard	1.0 ft
Swale Depth	1.25 ft
Top Width	25.0 ft

Equations:

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

Velocity = $(1.49/n)R_n^{2/3}\,S^{1/2}$
Slope (S) = Slope of the channel
n = Manning's number
R_n = Hydraulic Radius (Reynold's Number)
Flow = $(1.49/n)AR_n^{2/3}\,S^{1/2}$
Freeboard = $1.0+0.025(v)d^{0.33}$

Wolf Ranch MDDP
Swale Capacity Calculation

Structure F18A: Grasslined channel 100-year

Trapezoidal Channel Capacity Calculation (Values to be Input)			
Design Flow	48 cfs	Channel Side Slope	4:1
Bottom Width	15.0 ft	Channel Longitudinal Slope	5.0 %
Depth of Flow	0.55 ft	Manning's Roughness Coef.	0.035

Channel Area	9.5 sf
Channel Wetted Perimeter	19.5 ft
Hydraulic Radius	0.48 ft

Channel Flow Velocity	5.9 ft/sec
Channel Flow Capacity	56 cfs
Capacity Check	Okay

Freeboard	1.1 ft
Swale Depth	1.67 ft
Top Width	28.4 ft

Equations:

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

Velocity = $(1.49/n)R_n^{2/3}\ S^{1/2}$
Slope (S) = Slope of the channel
n = Manning's number
R_n = Hydraulic Radius (Reynold's Number)
Flow = $(1.49/n)AR_n^{2/3}\ S^{1/2}$
Freeboard = $1.0+0.025(v)d^{0.33}$

Structure F18: Grasslined channel 5-year

Trapezoidal Channel Capacity Calculation (Values to be Input)			
Design Flow	19 cfs	Channel Side Slope	4:1
Bottom Width	15.0 ft	Channel Longitudinal Slope	2.9 %
Depth of Flow	0.40 ft	Manning's Roughness Coef.	0.035

Channel Area	6.6 sf
Channel Wetted Perimeter	18.3 ft
Hydraulic Radius	0.36 ft

Channel Flow Velocity	3.7 ft/sec
Channel Flow Capacity	24 cfs
Capacity Check	Okay

Freeboard	1.1 ft
Swale Depth	1.47 ft
Top Width	26.7 ft

Equations:

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

Velocity = $(1.49/n)R_n^{2/3} S^{1/2}$
Slope (S) = Slope of the channel
n = Manning's number
R_n = Hydraulic Radius (Reynold's Number)
Flow = $(1.49/n)AR_n^{2/3} S^{1/2}$
Freeboard = $1.0+0.025(v)d^{0.33}$

Wolf Ranch MDDP
Swale Capacity Calculation

Structure F18: Grasslined channel 100-year

Trapezoidal Channel Capacity Calculation (Values to be Input)			
Design Flow	150 cfs	Channel Side Slope	4:1
Bottom Width	15.0 ft	Channel Longitudinal Slope	2.9 %
Depth of Flow	1.15 ft	Manning's Roughness Coef.	0.035

Channel Area	22.5 sf
Channel Wetted Perimeter	24.5 ft
Hydraulic Radius	0.92 ft

Channel Flow Velocity	6.9 ft/sec
Channel Flow Capacity	155 cfs
Capacity Check	Okay

Freeboard	1.2 ft
Swale Depth	2.33 ft
Top Width	33.6 ft

Equations:

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

Velocity = $(1.49/n)R_n^{2/3} S^{1/2}$
Slope (S) = Slope of the channel
n = Manning's number
R_n = Hydraulic Radius (Reynold's Number)
Flow = $(1.49/n)AR_n^{2/3} S^{1/2}$
Freeboard = $1.0+0.025(v)d^{0.33}$

Wolf Ranch MDDP
Swale Capacity Calculation

Structure F14: Grasslined channel 5-year

Trapezoidal Channel Capacity Calculation (Values to be Input)			
Design Flow	7 cfs	Channel Side Slope	4:1
Bottom Width	10.0 ft	Channel Longitudinal Slope	2.9 %
Depth of Flow	0.30 ft	Manning's Roughness Coef.	0.035

Channel Area	3.4 sf
Channel Wetted Perimeter	12.5 ft
Hydraulic Radius	0.27 ft

Channel Flow Velocity	3.0 ft/sec
Channel Flow Capacity	10 cfs
Capacity Check	Okay

Freeboard	1.1 ft
Swale Depth	1.35 ft
Top Width	20.8 ft

Equations:

Area (A) = b(d)

b = width

d = depth

Perimeter (P) = $b+2d*(1+z^2)^{0.5}$

z = side slope

Hydraulic Radius = A/P

Velocity = $(1.49/n)R_n^{2/3} S^{1/2}$

Slope (S) = Slope of the channel

n = Manning's number

R_n = Hydraulic Radius (Reynold's Number)

Flow = $(1.49/n)AR_n^{2/3} S^{1/2}$

Freeboard = $1.0+0.025(v)d^{0.33}$

Wolf Ranch MDDP
Swale Capacity Calculation

Structure F14: Grasslined channel 100-year

Trapezoidal Channel Capacity Calculation (Values to be Input)			
Design Flow	83 cfs	Channel Side Slope	4:1
Bottom Width	10.0 ft	Channel Longitudinal Slope	2.9 %
Depth of Flow	0.95 ft	Manning's Roughness Coef.	0.029

Channel Area	13.1 sf
Channel Wetted Perimeter	17.8 ft
Hydraulic Radius	0.74 ft

Channel Flow Velocity	7.1 ft/sec
Channel Flow Capacity	93 cfs
Capacity Check	Okay

Freeboard	1.2 ft
Swale Depth	2.13 ft
Top Width	27.0 ft

Equations:

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

Velocity = $(1.49/n)R_n^{2/3}\ S^{1/2}$
Slope (S) = Slope of the channel
n = Manning's number
R_n = Hydraulic Radius (Reynold's Number)
Flow = $(1.49/n)AR_n^{2/3}\ S^{1/2}$
Freeboard = $1.0+0.025(v)d^{0.33}$

Wolf Ranch MDDP
Swale Capacity Calculation

Structure F23: Grasslined channel 5-year

Trapezoidal Channel Capacity Calculation (Values to be Input)			
Design Flow	16 cfs	Channel Side Slope	4:1
Bottom Width	10.0 ft	Channel Longitudinal Slope	2.7 %
Depth of Flow	0.40 ft	Manning's Roughness Coef.	0.035

Channel Area	4.6 sf
Channel Wetted Perimeter	13.3 ft
Hydraulic Radius	0.35 ft

Channel Flow Velocity	3.5 ft/sec
Channel Flow Capacity	16 cfs
Capacity Check	Okay

Freeboard	1.1 ft
Swale Depth	1.46 ft
Top Width	21.7 ft

Equations:

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

Velocity = $(1.49/n)R_n^{2/3}\,S^{1/2}$
Slope (S) = Slope of the channel
n = Manning's number
R_n = Hydraulic Radius (Reynold's Number)
Flow = $(1.49/n)AR_n^{2/3}\,S^{1/2}$
Freeboard = $1.0+0.025(v)d^{0.33}$

Wolf Ranch MDDP
Swale Capacity Calculation

Structure F23: Grasslined channel 100-year

Trapezoidal Channel Capacity Calculation (Values to be Input)			
Design Flow	69 cfs	Channel Side Slope	4:1
Bottom Width	10.0 ft	Channel Longitudinal Slope	2.7 %
Depth of Flow	0.95 ft	Manning's Roughness Coef.	0.035

Channel Area	13.1 sf
Channel Wetted Perimeter	17.8 ft
Hydraulic Radius	0.74 ft

Channel Flow Velocity	5.7 ft/sec
Channel Flow Capacity	75 cfs
Capacity Check	Okay

Freeboard	1.1 ft
Swale Depth	2.09 ft
Top Width	26.7 ft

Equations:

Area (A) = b(d)

b = width

d = depth

Perimeter (P) = $b+2d*(1+z^2)^{0.5}$

z = side slope

Hydraulic Radius = A/P

Velocity = $(1.49/n)R_n^{2/3}\,S^{1/2}$

Slope (S) = Slope of the channel

n = Manning's number

R_n = Hydraulic Radius (Reynold's Number)

Flow = $(1.49/n)AR_n^{2/3}\,S^{1/2}$

Freeboard = $1.0+0.025(v)d^{0.33}$

Wolf Ranch MDDP
Swale Capacity Calculation

Structure F29: Riprap channel 100-year

Trapezoidal Channel Capacity Calculation (Values to be Input)			
Design Flow	490 cfs	Channel Side Slope	4:1
Bottom Width	20.0 ft	Channel Longitudinal Slope	2.4 %
Depth of Flow	2.00 ft	Manning's Roughness Coef.	0.035

Channel Area	56.0 sf
Channel Wetted Perimeter	36.5 ft
Hydraulic Radius	1.53 ft

Channel Flow Velocity	8.8 ft/sec
Channel Flow Capacity	491 cfs
Capacity Check	Okay

Freeboard	1.3 ft
Swale Depth	3.28 ft
Top Width	46.2 ft

Equations:

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

Velocity = $(1.49/n)R_n^{2/3}\ S^{1/2}$
Slope (S) = Slope of the channel
n = Manning's number
R_n = Hydraulic Radius (Reynold's Number)
Flow = $(1.49/n)AR_n^{2/3}\ S^{1/2}$
Freeboard = $1.0+0.025(v)d^{0.33}$

Wolf Ranch MDDP
Swale Capacity Calculation

Structure F22: Grasslined channel 5-year

Trapezoidal Channel Capacity Calculation (Values to be Input)			
Design Flow	24 cfs	Channel Side Slope	4:1
Bottom Width	15.0 ft	Channel Longitudinal Slope	3.2 %
Depth of Flow	0.40 ft	Manning's Roughness Coef.	0.035

Channel Area	6.6 sf
Channel Wetted Perimeter	18.3 ft
Hydraulic Radius	0.36 ft

Channel Flow Velocity	3.9 ft/sec
Channel Flow Capacity	26 cfs
Capacity Check	Okay

Freeboard	1.1 ft
Swale Depth	1.47 ft
Top Width	26.8 ft

Equations:

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

Velocity = $(1.49/n)R_n^{2/3}\,S^{1/2}$
Slope (S) = Slope of the channel
n = Manning's number
R_n = Hydraulic Radius (Reynold's Number)
Flow = $(1.49/n)AR_n^{2/3}\,S^{1/2}$
Freeboard = $1.0+0.025(v)d^{0.33}$

Wolf Ranch MDDP
Swale Capacity Calculation

Structure F22: Grasslined channel 100-year

Trapezoidal Channel Capacity Calculation (Values to be Input)			
Design Flow	115 cfs	Channel Side Slope	4:1
Bottom Width	15.0 ft	Channel Longitudinal Slope	3.2 %
Depth of Flow	0.95 ft	Manning's Roughness Coef.	0.035

Channel Area	17.9 sf
Channel Wetted Perimeter	22.8 ft
Hydraulic Radius	0.78 ft

Channel Flow Velocity	6.5 ft/sec
Channel Flow Capacity	115 cfs
Capacity Check	Okay

Freeboard	1.2 ft
Swale Depth	2.11 ft
Top Width	31.9 ft

Equations:

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

Velocity = $(1.49/n)R_n^{2/3}\ S^{1/2}$
Slope (S) = Slope of the channel
n = Manning's number
R_n = Hydraulic Radius (Reynold's Number)
Flow = $(1.49/n)AR_n^{2/3}\ S^{1/2}$
Freeboard = $1.0+0.025(v)d^{0.33}$

Wolf Ranch MDDP
Swale Capacity Calculation

Structure F22A: Grasslined channel 5-year

Trapezoidal Channel Capacity Calculation (Values to be Input)			
Design Flow	30 cfs	Channel Side Slope	4:1
Bottom Width	20.0 ft	Channel Longitudinal Slope	2.9 %
Depth of Flow	0.40 ft	Manning's Roughness Coef.	0.035

Channel Area	8.6 sf
Channel Wetted Perimeter	23.3 ft
Hydraulic Radius	0.37 ft

Channel Flow Velocity	3.7 ft/sec
Channel Flow Capacity	32 cfs
Capacity Check	Okay

Freeboard	1.1 ft
Swale Depth	1.47 ft
Top Width	31.8 ft

Equations:

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

Velocity = $(1.49/n)R_n^{2/3}\, S^{1/2}$
Slope (S) = Slope of the channel
n = Manning's number
R_n = Hydraulic Radius (Reynold's Number)
Flow = $(1.49/n)AR_n^{2/3}\, S^{1/2}$
Freeboard = $1.0+0.025(v)d^{0.33}$

Wolf Ranch MDDP
Swale Capacity Calculation

Structure F22A: Grasslined channel 100-year

Trapezoidal Channel Capacity Calculation (Values to be Input)			
Design Flow	167 cfs	Channel Side Slope	4:1
Bottom Width	20.0 ft	Channel Longitudinal Slope	2.9 %
Depth of Flow	1.05 ft	Manning's Roughness Coef.	0.035

Channel Area	25.4 sf
Channel Wetted Perimeter	28.7 ft
Hydraulic Radius	0.89 ft

Channel Flow Velocity	6.7 ft/sec
Channel Flow Capacity	170 cfs
Capacity Check	Okay

Freeboard	1.2 ft
Swale Depth	2.22 ft
Top Width	37.8 ft

Equations:

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

Velocity = $(1.49/n)R_n^{2/3}\,S^{1/2}$
Slope (S) = Slope of the channel
n = Manning's number
R_n = Hydraulic Radius (Reynold's Number)
Flow = $(1.49/n)AR_n^{2/3}\,S^{1/2}$
Freeboard = $1.0+0.025(v)d^{0.33}$

Kiowa Engineering Corporation

CLIENT: WOLF RANCH MDDP JOB NO.: 03094 PAGE: 1
PROJECT: DATE CHECKED: DATE: 5/20/08
DETAIL: CHECKED BY: COMPUTED BY: RAW

G - BASIN HYDRAULICS

Outfall Channels

Use same criteria as previous basins.

~~G3 Q_5 = 12 + 1/2(G3) = 12 + 25 = 37 cfs~~
~~Q_{100} = 45 + 100 = 145 cfs~~
~~L = 3150' S = (164 - 82)/3150 = .026'/'~~

~~w/ TBW = 15', S = .026 V_{100} = 6.5 fps ∴ ok~~
~~V_5 = 4.2 fps ∴ ok~~

~~No grade control required.~~

REPLACED W/ CLOSED CONDUIT PER ROCKWELL FDR

G2 Q_5 = SBG1 + 1/2 G3 = 5 + 25 = 30 cfs
Q_{100} = 50 + 100 = 150 cfs
L = 3250' S = (166 - 82)/3250 = .026'/'
w/ 15' TBW ; S = .026'/' V_{100} = 6.7 fps ∴ ok
V_5 = 4.0 fps ∴ ok

No grade control Req'd.

Wolf Ranch MDDP
Swale Capacity Calculation

Structure G2: Grasslined channel 5-year

Trapezoidal Channel Capacity Calculation (Values to be Input)			
Design Flow	30 cfs	Channel Side Slope	4:1
Bottom Width	15.0 ft	Channel Longitudinal Slope	2.6 %
Depth of Flow	0.50 ft	Manning's Roughness Coef.	0.035

Channel Area	8.5 sf
Channel Wetted Perimeter	19.1 ft
Hydraulic Radius	0.44 ft

Channel Flow Velocity	4.0 ft/sec
Channel Flow Capacity	34 cfs
Capacity Check	Okay

Freeboard	1.1 ft
Swale Depth	1.58 ft
Top Width	27.6 ft

Equations:

Area (A) = b(d)

b = width

d = depth

Perimeter (P) = $b+2d*(1+z^2)^{0.5}$

z = side slope

Hydraulic Radius = A/P

Velocity = $(1.49/n)R_n^{2/3} S^{1/2}$

Slope (S) = Slope of the channel

n = Manning's number

R_n = Hydraulic Radius (Reynold's Number)

Flow = $(1.49/n)AR_n^{2/3} S^{1/2}$

Freeboard = $1.0+0.025(v)d^{0.33}$

Wolf Ranch MDDP
Swale Capacity Calculation

Structure G2: Grasslined channel 100-year

Trapezoidal Channel Capacity Calculation (Values to be Input)			
Design Flow	150 cfs	Channel Side Slope	4:1
Bottom Width	15.0 ft	Channel Longitudinal Slope	2.6 %
Depth of Flow	1.20 ft	Manning's Roughness Coef.	0.035

Channel Area	23.8 sf
Channel Wetted Perimeter	24.9 ft
Hydraulic Radius	0.95 ft

Channel Flow Velocity	6.7 ft/sec
Channel Flow Capacity	158 cfs
Capacity Check	Okay

Freeboard	1.2 ft
Swale Depth	2.38 ft
Top Width	34.0 ft

Equations:

Area (A) = b(d)

b = width

d = depth

Perimeter (P) = $b+2d*(1+z^2)^{0.5}$

z = side slope

Hydraulic Radius = A/P

Velocity = $(1.49/n)R_n^{2/3}\ S^{1/2}$

Slope (S) = Slope of the channel

n = Manning's number

R_n = Hydraulic Radius (Reynold's Number)

Flow = $(1.49/n)AR_n^{2/3}\ S^{1/2}$

Freeboard = $1.0+0.025(v)d^{0.33}$

```
1*****************************************************          ***************************************
 *  WATER SURFACE PROFILES                           *          *  U.S. ARMY CORPS OF ENGINEERS       *
 *  VERSION OF SEPTEMBER 1988                        *          *  THE HYDROLOGIC ENGINEERING CENTER  *
 *  ERROR: 01,02                                     *          *  609 SECOND STREET, SUITE D         *
 *  UPDATED:  4 APRIL    1989                        *          *  DAVIS, CALIFORNIA 95616-4687      *
 *  RUN DATE     7/12/ 4   TIME   16:41:24           *          *  (916) 756-1104, (916) 551-1748    *
 *****************************************************          ***************************************


                                   X     X  XXXXXXX   XXXXX            XXXXX
                                   X     X  X        X     X          X     X
                                   X     X  X        X                      X
                                   XXXXXXX  XXXX     X          XXXXX  XXXXX
                                   X     X  X        X                X
                                   X     X  X        X     X          X
                                   X     X  XXXXXXX   XXXXX           XXXXXXX
 END OF BANNER
1
     7/12/ 4      16:41:24                                                                   PAGE    1
```

```
                                                                         THIS RUN EXECUTED  7/12/ 4    16:41:24
 **************************************************
   HEC2 RELEASE DATED SEP 88 UPDATED APR  1989


   ERROR CORR -  01,02
   MODIFICATION -
 **************************************************


 T1      WOLF RANCH MDDP, KIOWA ENGINEERING 2004 PN 03094
 T2      100-YEAR DISCHARGES FROM DBPS X-SECTIONS L TO R LOOKING UPSTREAM
 T3      COTTONWOOD CREEK FILENAME CC.DAT

 J1   ICHECK     INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

         0         2         0         0         0         0         0         0      6810         0

 J2   NPROF     IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE

        1         0        -1         0         0         0         0         0         0         0


 QT        1       3477
```

EXISTING FLOODPLAIN
COTTONWOOD CREEK

NC	0.020	0.020	0.045	0.100	0.300	0	0	0	0	0
	POWERS BOULEVARD									
X1	1040.1	14	1120	1204	0	0	0	0	0	0
GR	6860	1000	6838	1055	6836	1072	6824	1100	6822	1108
GR	6820	1120	6814	1130	6814	1140	6816	1165	6818	1204
GR	6826	1240	6834	1276	6840	1310	6846	1350		
QT	1	2733								
X1	1040.2	10	1055	1078	550	550	550	0	0	0
GR	6864	1000	6824	1055	6822	1060	6824	1068	6826	1078
GR	6828	1105	6830	1118	6838	1165	6850	1198	6854	1210
X1	1040.3	14	1195	1333	675	675	675	0	0	0
GR	6870	1000	6862	1045	6854	1150	6852	1170	6840	1195
GR	6838	1222	6834	1230	6836	1240	6838	1262	6840	1333
GR	6842	1355	6850	1410	6860	1423	6870	1462		
X1	1040.4	10	1127	1250	525	525	525	0	0	0
GR	6878	1000	6870	1050	6862	1127	6850	1155	6848	1180
GR	6846	1238	6862	1250	6872	1295	6874	1310	6876	1380
X1	1040.5	12	1142	1195	550	550	550	0	0	0
GR	6884	1000	6878	1050	6862	1115	6858	1142	6856	1165
GR	6854	1170	6852	1172	6854	1180	6856	1195	6860	1215
GR	6876	1230	6880	1290						
	COWPOKE ROAD									
X1	1050.1	12	1058	1160	785	785	785	0	0	0
GR	6898	1000	6890	1030	6880	1058	6874	1080	6868	1095
GR	6868	1105	6872	1112	6876	1140	6884	1160	6892	1200
GR	6894	1215	6896	1232						

X1	1050.2	11	1124	1215	400	400	400	0	0	0
GR	6904	1000	6894	1072	6886	1090	6884	1110	6880	1124
GR	6876	1148	6872	1162	6874	1178	6880	1215	6898	1230
GR	6910	1290								
X1	1050.3	8	1090	1175	405	405	405	0	0	0
GR	6910	1000	6882	1090	6880	1120	6878	1150	6880	1158
GR	6886	1175	6900	1195	6912	1275				
QT	1	857								
X1	1050.4	13	1100	1160	540	540	540	0	0	0
GR	6920	1000	6914	1035	6896	1050	6892	1075	6912	1090
GR	6912	1100	6892	1112	6890	1120	6890	1135	6892	1160
GR	6900	1205	6912	1228	6920	1278				
X1	1050.5	15	1262	1380	490	490	490	0	0	0

GR	6930	1000	6924	1045	6923	1065	6924	1080	6926	1110
GR	6926	1142	6920	1190	6912	1262	6904	1290	6902	1302
GR	6900	1318	6900	1358	6904	1366	6910	1380	6922	1405

CSAGRICULTURAL

X1	1060.1	11	1107	1275	580	580	580	0	0	0
GR	6934	1000	6924	1075	6922	1088	6922	1107	6910	1123
GR	6908	1130	6910	1140	6910	1253	6914	1275	6924	1293
GR	6934	1345								
X1	1060.2	11	1100	1215	428	428	428	0	0	0
GR	6940	1000	6930	1085	6922	1100	6916	1140	6912	1155
GR	6914	1160	6916	1180	6918	1205	6920	1215	6930	1228
GR	6934	1268								
X1	1060.3	15	1065	1245	562	562	562	0	0	0
GR	6944	1000	6942	1025	6940	1065	6922	1098	6920	1108
GR	6922	1118	6924	1152	6926	1192	6932	1220	6934	1245
GR	6934	1300	6936	1320	6942	1340	6944	1362	6950	1410
X1	1060.4	8	1052	1136	443	443	443	0	0	0
GR	6950	1000	6948	1018	6932	1052	6930	1082	6926	1092
GR	6928	1100	6940	1136	6950	1153				
X1	1060.5	9	1026	1115	517	517	517	0	0	0
GR	6960	1000	6958	1015	6950	1026	6938	1032	6936	1040
GR	6938	1048	6940	1097	6950	1115	6956	1150		
X1	1060.6	10	1070	1111	300	300	300	0	0	0
GR	6962	1000	6950	1030	6946	1045	6942	1070	6938	1076
GR	6937	1090	6938	1105	6940	1111	6954	1145	6960	1203

X1	1060.7	10	1103	1153	314	314	314	0	0	0
GR	6970	1000	6968	1060	6966	1078	6950	1103	6942	1118
GR	6941	1121	6942	1124	6948	1128	6950	1153	6966	1170

BLACK FOREST ROAD

X1	1070.1	9	1155	1167	196	196	196	0	0	0
GR	6976	1000	6974	1135	6972	1145	6950	1155	6946	1158
GR	6946	1162	6950	1167	6972	1184	6974	1219		

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV

```
     Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA   LEFT/RIGHT
     TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN       SSTA
     SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID      ENDST


 *PROF 1
0

 CCHV=      .100 CEHV=      .300
 *SECNO 1040.100
 3720 CRITICAL DEPTH ASSUMED
         POWERS BOULEVARD
   1040.10      5.80  6819.80  6819.80  6810.00  6821.61      1.81       .00       .00  6820.00
     3477.        0.     3409.      68.       0.     315.        7.        0.        0.   6818.00
       .00       .00    10.82     9.35     .000     .045      .020      .000   6814.00  1120.34
   .018826        0.       0.       0.        0       20         0       .00     91.76  1212.09
0
 *SECNO 1040.200
 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
   1040.20      7.85  6829.85  6829.85      .00  6831.81      1.96      6.92       .05  6824.00
     2733.      283.    1332.    1118.      24.     138.       88.        4.        1.   6826.00
       .01     12.02     9.68    12.67     .020     .045      .020      .000   6822.00  1046.95
   .008293      550.     550.     550.        3       14         0       .00     70.09  1117.04
0
 *SECNO 1040.300

 3301 HV CHANGED MORE THAN HVINS

 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
   1040.30      6.59  6840.59  6840.59      .00  6841.66      1.07      8.34       .09  6840.00
     2733.        2.    2723.       9.       0.     327.        2.        8.        3.   6840.00
       .04      4.37     8.32     4.67     .020     .045      .020      .000   6834.00  1193.78
   .020369      675.     675.     675.       16       10         0       .00    145.69  1339.46
0
 *SECNO 1040.400
   1040.40      4.85  6850.85  6850.76      .00  6852.34      1.49     10.55       .12  6862.00
     2733.        0.    2733.       0.       0.     279.        0.       12.        4.   6862.00
       .05       .00     9.79      .00     .000     .045      .000      .000   6846.00  1153.02
   .019828      525.     525.     525.        7       19         0       .00     88.62  1241.64
0
 *SECNO 1040.500
 7185 MINIMUM SPECIFIC ENERGY
1
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     SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS   BANK ELEV
     Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA   LEFT/RIGHT
     TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN       SSTA
     SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID      ENDST
```

```
 3720 CRITICAL DEPTH ASSUMED
   1040.50      7.75  6859.75  6859.75       .00  6861.39      1.64      8.82       .05  6858.00
     2733.       80.    2203.     450.       10.     226.       35.       15.        5.  6856.00
       .07      7.75     9.77    12.82      .020     .045      .020      .000   6852.00  1130.21
   .013225      550.     550.     550.         5       14         0       .00     83.52  1213.73
0
 *SECNO 1050.100
 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
          COWPOKE ROAD
   1050.10      7.79  6875.79  6875.79       .00  6877.70      1.91     12.70       .08  6880.00
     2733.        0.    2733.       0.        0.     246.        0.       20.        7.  6884.00
       .09       .00    11.10      .00      .000     .045      .000      .000   6868.00  1073.45
   .020229      785.     785.     785.        11        5         0       .00     65.06  1138.51
0
 *SECNO 1050.200

 3301 HV CHANGED MORE THAN HVINS


 3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  2.01

   1050.20      8.75  6880.75      .00       .00  6881.40       .64      3.57       .13  6880.00
     2733.        3.    2730.       0.        1.     424.        0.       23.        7.  6880.00
       .10      2.67     6.44     2.04      .020     .045      .020      .000   6872.00  1121.36
   .005004      400.     400.     400.         4        0         0       .00     94.27  1215.63
0
 *SECNO 1050.300

 3301 HV CHANGED MORE THAN HVINS


 3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =   .53

   1050.30      5.59  6883.59      .00       .00  6885.13      1.55      3.46       .27  6882.00
     2733.       33.    2700.       0.        4.     270.        0.       26.        8.  6886.00
       .11      8.24    10.00      .00      .020     .045      .000      .000   6878.00  1084.90
   .017840      405.     405.     405.         3        0         0       .00     83.26  1168.16
0
1
     7/12/ 4      16:41:24                                                                             PAGE     6


    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN      SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST


 *SECNO 1050.400
```

```
 3265 DIVIDED FLOW


 3301 HV CHANGED MORE THAN HVINS


 3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =   .39

   1050.40     3.23  6893.23  6892.88       .00  6893.89      .66     8.66      .09  6912.00
      857.      30.     803.      25.        5.     123.       4.      29.       9.   6892.00
       .14     5.62     6.55     5.79     .020      .045     .020     .000  6890.00  1067.31
   .011827     540.     540.     540.       11        11        0      .00    64.28  1166.92
0
 *SECNO 1050.500
 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
   1050.50     2.19  6902.19  6902.19       .00  6903.11      .92     8.13      .08  6912.00
      857.       0.     857.       0.        0.     111.       0.      30.      10.   6910.00
       .16      .00     7.70      .00     .000      .045     .000     .000  6900.00  1300.88
   .024976     490.     490.     490.        8        14        0      .00    61.49  1362.37
0
 *SECNO 1060.100

 3301 HV CHANGED MORE THAN HVINS


 3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  1.61

         CSAGRICULTURAL
   1060.10     3.40  6911.40      .00       .00  6911.68      .27     8.50      .06  6922.00
      857.       0.     857.       0.        0.     205.       0.      32.      11.   6914.00
       .19      .00     4.17      .00     .000      .045     .000     .000  6908.00  1121.14
   .009631     580.     580.     580.        6         0        0      .00   139.55  1260.69
0
 *SECNO 1060.200

 3301 HV CHANGED MORE THAN HVINS

1
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    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST


 3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =   .66
```

```
   1060.20      4.98  6916.98       .00       .00  6917.87       .89      6.01       .18  6922.00
      857.        0.     857.        0.        0.     113.        0.       34.       12.   6920.00
       .21       .00     7.55       .00      .000      .045      .000      .000   6912.00  1133.46
   .022335      428.     428.      428.         4         0         0       .00     58.80  1192.26
0
 *SECNO 1060.300

 3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  1.58

   1060.30      5.04  6925.04       .00       .00  6925.44       .40      7.52       .05  6940.00
      857.        0.     857.        0.        0.     169.        0.       36.       13.   6934.00
       .24       .00     5.07       .00      .000      .045      .000      .000   6920.00  1092.43
   .008900      562.     562.      562.         5         0         0       .00     80.29  1172.72
0
 *SECNO 1060.400

 3301 HV CHANGED MORE THAN HVINS

 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
   1060.40      5.44  6931.44   6931.44       .00  6932.51      1.07      6.19       .20  6932.00
      857.        0.     857.        0.        0.     103.        0.       37.       14.   6940.00
       .26       .00     8.30       .00      .000      .045      .000      .000   6926.00  1060.38
   .025000      443.     443.      443.         4         8         0       .00     49.95  1110.32
0
 *SECNO 1060.500

 3301 HV CHANGED MORE THAN HVINS


 3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  1.44

   1060.50      4.70  6940.70       .00       .00  6941.24       .54      8.68       .05  6950.00
      857.        0.     857.        0.        0.     145.        0.       38.       14.   6950.00
       .28       .00     5.90       .00      .000      .045      .000      .000   6936.00  1030.65
   .012051      517.     517.      517.         6         0         0       .00     67.63  1098.27
0
1
     7/12/ 4      16:41:24                                                                              PAGE     8

    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS    BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST

 *SECNO 1060.600

 3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  2.07

   1060.60      5.48  6942.48       .00       .00  6942.80       .32      1.53       .02  6942.00
```

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    857.        1.     824.      32.        1.     180.       7.      40.      15.   6940.00
     .30      1.50     4.57     4.31      .020     .045     .020     .000  6937.00  1067.01
  .002806     300.     300.     300.         4        0        0      .00    50.01  1117.02
0
 *SECNO 1060.700

 3301 HV CHANGED MORE THAN HVINS

 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
   1060.70      6.50  6947.50  6947.50       .00  6949.56     2.05     2.03      .52  6950.00
    857.        0.     857.       0.        0.      75.       0.      41.      15.   6950.00
     .31       .00    11.50      .00      .000     .045     .000     .000  6941.00  1107.68
  .027701     314.     314.     314.        20       11        0      .00    19.99  1127.67
0
 *SECNO 1070.100
 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
        BLACK FOREST ROAD
   1070.10      6.81  6952.81  6952.81       .00  6955.14     2.33     4.62      .08  6950.00
    857.       13.     814.      29.        2.      66.       3.      41.      15.   6950.00
     .31      7.38    12.39     9.58      .020     .045     .020     .000  6946.00  1153.72
  .020333     196.     196.     196.         1        8        0      .00    15.45  1169.17
0
1
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THIS RUN EXECUTED 7/12/ 4   16:41:24

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**************************************************
  HEC2 RELEASE DATED SEP 88 UPDATED APR  1989

  ERROR CORR -  01,02
  MODIFICATION -
**************************************************
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NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

COTTONWOOD CREEK FILENAM

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
*	1040.100	.00	.00	.00	6814.00	3477.00	6819.80	6819.80	6821.61	188.26	10.82	322.37	253.41

*	1040.200	550.00	.00	.00	6822.00	2733.00	6829.85	6829.85	6831.81	82.93	9.68	249.36	300.12
*	1040.300	675.00	.00	.00	6834.00	2733.00	6840.59	6840.59	6841.66	203.69	8.32	329.32	191.49
	1040.400	525.00	.00	.00	6846.00	2733.00	6850.85	6850.76	6852.34	198.28	9.79	279.09	194.09
*	1040.500	550.00	.00	.00	6852.00	2733.00	6859.75	6859.75	6861.39	132.25	9.77	270.96	237.65
*	1050.100	785.00	.00	.00	6868.00	2733.00	6875.79	6875.79	6877.70	202.29	11.10	246.24	192.16
*	1050.200	400.00	.00	.00	6872.00	2733.00	6880.75	.00	6881.40	50.04	6.44	424.93	386.36
*	1050.300	405.00	.00	.00	6878.00	2733.00	6883.59	.00	6885.13	178.40	10.00	274.10	204.62
*	1050.400	540.00	.00	.00	6890.00	857.00	6893.23	6892.88	6893.89	118.27	6.55	132.11	78.80
*	1050.500	490.00	.00	.00	6900.00	857.00	6902.19	6902.19	6903.11	249.76	7.70	111.33	54.23
*	1060.100	580.00	.00	.00	6908.00	857.00	6911.40	.00	6911.68	96.31	4.17	205.41	87.33
*	1060.200	428.00	.00	.00	6912.00	857.00	6916.98	.00	6917.87	223.35	7.55	113.46	57.34
*	1060.300	562.00	.00	.00	6920.00	857.00	6925.04	.00	6925.44	89.00	5.07	169.14	90.84
*	1060.400	443.00	.00	.00	6926.00	857.00	6931.44	6931.44	6932.51	250.00	8.30	103.29	54.20
*	1060.500	517.00	.00	.00	6936.00	857.00	6940.70	.00	6941.24	120.51	5.90	145.30	78.07
*	1060.600	300.00	.00	.00	6937.00	857.00	6942.48	.00	6942.80	28.06	4.57	188.29	161.79
*	1060.700	314.00	.00	.00	6941.00	857.00	6947.50	6947.50	6949.56	277.01	11.50	74.54	51.49

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
*	1070.100	196.00	.00	.00	6946.00	857.00	6952.81	6952.81	6955.14	203.33	12.39	70.59	60.10

COTTONWOOD CREEK FILENAM

SUMMARY PRINTOUT TABLE 150

SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH

*	1040.100	3477.00	6819.80	.00	.00	9.80	91.76	.00
*	1040.200	2733.00	6829.85	.00	10.05	.00	70.09	550.00
*	1040.300	2733.00	6840.59	.00	10.73	.00	145.69	675.00
	1040.400	2733.00	6850.85	.00	10.26	.00	88.62	525.00
*	1040.500	2733.00	6859.75	.00	8.90	.00	83.52	550.00
*	1050.100	2733.00	6875.79	.00	16.04	.00	65.06	785.00
*	1050.200	2733.00	6880.75	.00	4.97	.00	94.27	400.00
*	1050.300	2733.00	6883.59	.00	2.83	.00	83.26	405.00
*	1050.400	857.00	6893.23	.00	9.64	.00	64.28	540.00
*	1050.500	857.00	6902.19	.00	8.96	.00	61.49	490.00
*	1060.100	857.00	6911.40	.00	9.22	.00	139.55	580.00
*	1060.200	857.00	6916.98	.00	5.58	.00	58.80	428.00
*	1060.300	857.00	6925.04	.00	8.05	.00	80.29	562.00
*	1060.400	857.00	6931.44	.00	6.40	.00	49.95	443.00
*	1060.500	857.00	6940.70	.00	9.26	.00	67.63	517.00
*	1060.600	857.00	6942.48	.00	1.77	.00	50.01	300.00
*	1060.700	857.00	6947.50	.00	5.03	.00	19.99	314.00
*	1070.100	857.00	6952.81	.00	5.31	.00	15.45	196.00

1

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1*****************************************************
 *  WATER SURFACE PROFILES                            *
 *  VERSION OF SEPTEMBER 1988                         *
 *  ERROR: 01,02                                      *
 *  UPDATED:  4 APRIL    1989                         *
 *  RUN DATE     7/12/ 4   TIME   16:39:20            *
 *****************************************************
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**************************************
*  U.S. ARMY CORPS OF ENGINEERS      *
*  THE HYDROLOGIC ENGINEERING CENTER *
*  609 SECOND STREET, SUITE D        *
*  DAVIS, CALIFORNIA 95616-4687      *
*  (916) 756-1104, (916) 551-1748    *
**************************************
```

```
X     X  XXXXXXX   XXXXX               XXXXX
X     X  X        X     X             X     X
X     X  X        X                         X
XXXXXXX  XXXX     X          XXXXX     XXXXX
X     X  X        X                   X
X     X  X        X     X             X
X     X  XXXXXXX   XXXXX              XXXXXXX
```

END OF BANNER
1
7/12/ 4   16:39:20   PAGE   1

THIS RUN EXECUTED 7/12/ 4   16:39:20

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**************************************************
  HEC2 RELEASE DATED SEP 88 UPDATED APR  1989

  ERROR CORR -  01,02
  MODIFICATION -
**************************************************
```

T1   TRIBUTARY FOUR WOLF RANCH MDDP KIOWA ENGINEERING PN 03094
T2   100-YEAR FREQUENCY DEVELOPED W/O DETETNION X-SECTIONS L TO R UPSTREA
T3   FILENAME TRIB4.DAT

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	2	0	0	.02	0	0	0	6878	0

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	1	0	-1	0	0	0	0	0	0	0

QT   1   1870

EXISTING FLOODPLAIN
TRIBUTARY FOUR

NC	0.050	0.050	0.045	0.100	0.300	0	0	0	0	0

TRIBUTARY FOUR

X1	1	12	1013	1115	0	0	0	0	0	0
GR	6910	1000	6900	1013	6892	1021	6890	1039	6892	1048
GR	6894	1080	6896	1099	6898	1108	6900	1115	6902	1120
GR	6906	1124	6910	1129						
X1	2	16	1061	1177	425	425	425	0	0	0
GR	6920	1000	6918	1007	6916	1013	6914	1025	6912	1034
GR	6912	1047	6912	1058	6910	1061	6908	1067	6906	1088
GR	6904	1106	6902	1135	6900	1152	6902	1163	6910	1177
GR	6920	1186								
X1	3	14	1009	1114	384	384	384	0	0	0
GR	6930	1000	6920	1009	6914	1013	6912	1014	6910	1031
GR	6911	1053	6912	1101	6914	1108	6916	1111	6918	1113
GR	6920	1114	6922	1116	6926	1118	6930	1121		
X1	4	16	1023	1127	433	433	433	0	0	0
GR	6940	1000	6934	1008	6932	1010	6932	1019	6930	1023
GR	6928	1029	6926	1035	6924	1042	6922	1060	6920	1117
GR	6930	1127	6932	1129	6934	1131	6936	1135	6938	1145
GR	6940	1158								
X1	5	17	1048	1176	363	363	363	0	0	0
GR	6948	1000	6946	1011	6944	1023	6942	1040	6940	1048
GR	6930	1061	6928	1067	6930	1081	6932	1133	6934	1146
GR	6936	1159	6938	1168	6940	1176	6942	1180	6944	1189
GR	6946	1197	6948	1211						

X1	6	12	1016	1119	668	668	668	0	0	0
GR	6964	1000	6962	1011	6960	1016	6950	1023	6946	1025
GR	6944	1028	6946	1067	6948	1087	6950	1097	6960	1119
GR	6962	1123	6964	1135						
X1	7	20	1213	1298	389	389	389	0	0	0
GR	6975	1000	6974	1017	6973	1039	6972	1075	6973	1100
GR	6972	1151	6970	1168	6968	1193	6960	1213	6956	1221
GR	6954	1283	6952	1292	6954	1293	6960	1298	6964	1300
GR	6968	1304	6970	1312	6972	1336	6974	1347	6975	1353

SOUTH RESEARCH PARKWAY

X1	8	21	1043	1123	320	320	320	0	0	0
GR	6981	1000	6980	1005	6978	1017	6976	1028	6974	1035
GR	6972	1039	6970	1043	6964	1054	6961	1072	6961	1084
GR	6961	1091	6962	1097	6964	1108	6966	1115	6970	1123
GR	6972	1128	6974	1138	6976	1147	6978	1155	6980	1160
GR	6981	1166								

QT	1	1830								

NORTH RESEARCH PARKWAY

X1	9	23	1086	1149	162	162	162	0	0	0
GR	6983	1000	6982	1006	6980	1018	6978	1033	6976	1059
GR	6974	1076	6972	1081	6970	1086	6968	1090	6966	1095
GR	6964	1104	6963	1112	6964	1119	6966	1141	6968	1146
GR	6970	1149	6972	1151	6974	1154	6976	1156	6978	1159
GR	6980	1161	6982	1163	6983	1164				

X1	10	20	1017	1091	411	411	411	0	0	0
GR	6990	1000	6988	1005	6986	1008	6984	1012	6982	1014
GR	6980	1017	6978	1019	6976	1024	6974	1029	6972	1037
GR	6970	1048	6972	1055	6974	1070	6976	1076	6978	1083
GR	6980	1091	6982	1099	6986	1110	6988	1126	6990	1141

X1	11	31	1048	1132	407	407	407	0	0	0
GR	7004	1000	7002	1012	7000	1018	7002	1022	7004	1025
GR	7006	1033	7008	1038	6990	1048	6988	1056	6986	1064
GR	6984	1074	6982	1081	6980	1087	6980	1090	6981	1099
GR	6980	1107	6978	1115	6978	1118	6980	1123	6982	1124
GR	6984	1126	6986	1127	6988	1129	6990	1132	6992	1135
GR	6994	1139	6996	1143	6998	1146	7000	1153	7002	1164
GR	7004	1173								

QT	1	1160								

X1	12	29	1077	1291	585	585	585	0	0	0
GR	7020	1000	7018	1015	7016	1034	7014	1048	7012	1061
GR	7010	1077	7008	1096	7006	1112	7004	1134	7004	1181
GR	7002	1198	7000	1216	7000	1238	7002	1268	7004	1275
GR	7006	1279	7008	1282	7010	1291	7012	1304	7014	1325

GR	7015	1332	7014	1340	7013	1345	7014	1346	7016	1351
GR	7018	1356	7020	1362	7021	1380	7020	1409		

X1	13	23	1018	1195	443	443	443	0	0	0
GR	7028	1000	7026	1003	7024	1008	7022	1013	7020	1018
GR	7018	1022	7016	1025	7014	1041	7012	1046	7010	1053
GR	7008	1063	7007	1077	7008	1093	7010	1119	7012	1157
GR	7014	1168	7016	1177	7018	1186	7020	1195	7022	1202
GR	7024	1213	7026	1224	7028	1237				

X1	14	22	1037	1135	634	634	634	0	0	0
GR	7042	1000	7040	1009	7038	1022	7036	1033	7034	1034
GR	7032	1036	7030	1037	7028	1038	7026	1041	7024	1048

GR	7022	1066	7023	1092	7024	1114	7026	1121	7028	1127
GR	7030	1135	7032	1144	7034	1176	7036	1191	7038	1201
GR	7040	1248	7042	1263						
X1	15	26	1112	1197	438	438	438	0	0	0
GR	7054	1000	7053	1017	7053	1043	7052	1068	7050	1070
GR	7048	1074	7046	1081	7044	1086	7044	1097	7042	1106
GR	7040	1112	7038	1118	7036	1127	7035	1139	7034	1154
GR	7035	1177	7036	1188	7038	1192	7040	1197	7042	1211
GR	7044	1225	7046	1246	7046	1291	7047	1310	7050	1358
GR	7054	1392								
X1	16	18	1161	1259	352	352	352	0	0	0
GR	7060	1000	7054	1057	7053	1104	7052	1159	7050	1161
GR	7042	1173	7040	1177	7041	1200	7042	1222	7044	1233
GR	7046	1244	7048	1252	7050	1259	7052	1267	7054	1280
GR	7056	1296	7058	1315	7060	1335				
X1	17	18	1067	1163	382	382	382	0	0	0
GR	7068	1000	7064	1034	7060	1067	7058	1079	7056	1087
GR	7054	1092	7052	1097	7050	1101	7049	1111	7048	1125
GR	7049	1137	7050	1144	7054	1152	7060	1163	7062	1180
GR	7064	1209	7066	1243	7068	1285				
X1	18	21	1165	1261	416	416	416	0	0	0
GR	7076	1000	7074	1020	7073	1042	7072	1080	7072	1136
GR	7072	1153	7070	1165	7068	1173	7060	1182	7058	1185
GR	7057	1189	7056	1195	7057	1214	7058	1228	7060	1232
GR	7066	1243	7068	1249	7070	1261	7072	1277	7074	1297
GR	7076	1307								
X1	19	27	1178	1337	480	480	480	0	0	0
GR	7088	1000	7086	1038	7084	1080	7083	1096	7083	1101
GR	7083	1140	7082	1175	7080	1178	7072	1190	7070	1198
GR	7069	1206	7068	1217	7069	1223	7070	1227	7074	1235
GR	7076	1240	7078	1248	7079	1277	7078	1314	7079	1326
GR	7080	1337	7084	1371	7085	1382	7086	1395	7086	1473
GR	7087	1505	7088	1531						

TRIBUTARY FOUR LIMITS

X1	20	19	1054	1085	363	363	363	0	0	.0
GR	7094	1000	7090	1024	7086	1040	7084	1044	7076	1054
GR	7075	1057	7074	1060	7075	1074	7076	1085	7078	1089
GR	7080	1093	7082	1096	7084	1100	7086	1104	7088	1108
GR	7090	1116	7092	1128	7093	1140	7094	1153		

```
     SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS    BANK ELEV
     Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
     TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
     SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST

 *PROF 1

 CCHV=     .100 CEHV=     .300
 *SECNO 1.000
         TRIBUTARY FOUR
      1.00      5.35   6895.35       .00   6878.00   6896.62      1.27       .00       .00   6900.00
     1870.        0.     1870.        0.        0.      207.        0.        0.        0.   6900.00
       .00       .00      9.03       .00      .000      .045      .000      .000   6890.00   1017.65
   .020013        0.        0.        0.         0         0         8       .00     75.20   1092.84
0
 *SECNO 2.000
 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
      2.00      5.24   6905.24   6905.24       .00   6906.60      1.36      8.88       .03   6910.00
     1870.        0.     1870.        0.        0.      200.        0.        2.        1.   6910.00
       .01       .00      9.36       .00      .000      .045      .000      .000   6900.00   1094.85
   .021833      425.      425.      425.         4         8         0       .00     73.82   1168.67
0
 *SECNO 3.000
      3.00      3.65   6913.65       .00       .00   6914.74      1.08      8.11       .03   6920.00
     1870.        0.     1870.        0.        0.      224.        0.        4.        1.   6920.00
       .03       .00      8.36       .00      .000      .045      .000      .000   6910.00   1013.17
   .020447      384.      384.      384.         2         0         0       .00     93.63   1106.80
0
 *SECNO 4.000
 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
      4.00      4.09   6924.09   6924.09       .00   6925.39      1.30      9.29       .07   6930.00
     1870.        0.     1870.        0.        0.      204.        0.        6.        2.   6930.00
       .04       .00      9.16       .00      .000      .045      .000      .000   6920.00   1041.68
   .022526      433.      433.      433.         3         8         0       .00     79.41   1121.09
0
 *SECNO 5.000
 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
      5.00      5.16   6933.16   6933.16       .00   6934.43      1.27      8.28       .00   6940.00
     1870.        0.     1870.        0.        0.      207.        0.        8.        3.   6940.00
       .05       .00      9.05       .00      .000      .045      .000      .000   6928.00   1056.89
   .023082      363.      363.      363.         5        11         0       .00     83.68   1140.56
0
1
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  SECNO     DEPTH     CWSEL     CRIWS     WSELK      EG        HV        HL       OLOSS   BANK ELEV
  Q         QLOB      QCH       QROB      ALOB       ACH       AROB      VOL      TWA   LEFT/RIGHT
  TIME      VLOB      VCH       VROB      XNL        XNCH      XNR       WTN      ELMIN      SSTA
  SLOPE     XLOBL     XLCH      XLOBR     ITRIAL     IDC       ICONT     CORAR    TOPWID     ENDST


*SECNO 6.000
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
     6.00     4.69  6948.69  6948.69       .00  6950.17      1.47     15.16       .06  6960.00
    1870.       0.    1870.       0.        0.     192.        0.       11.        4.  6960.00
      .07      .00     9.74      .00      .000     .045      .000      .000   6944.00  1023.65
   .022331    668.     668.     668.         3       11         0       .00     66.82  1090.47
0
*SECNO 7.000
     7.00     5.48  6957.48  6957.41       .00  6958.75      1.27      8.57       .02  6960.00
    1870.       0.    1870.       0.        0.     206.        0.       13.        5.  6960.00
      .08      .00     9.06      .00      .000     .045      .000      .000   6952.00  1218.02
   .021726    389.     389.     389.         5       11         0       .00     77.88  1295.91
0
*SECNO 8.000
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
        SOUTH RESEARCH PARKWAY
     8.00     4.33  6965.33  6965.33       .00  6966.89      1.56      6.86       .08  6970.00
    1870.       0.    1870.       0.        0.     187.        0.       14.        5.  6970.00
      .09      .00    10.01      .00      .000     .045      .000      .000   6961.00  1051.55
   .021184    320.     320.     320.         3       15         0       .00     61.12  1112.67
0
*SECNO 9.000
        NORTH RESEARCH PARKWAY
     9.00     5.51  6968.51      .00       .00  6969.82      1.31      2.90       .03  6970.00
    1830.       0.    1830.       0.        0.     200.        0.       15.        6.  6970.00
      .09      .00     9.17      .00      .000     .045      .000      .000   6963.00  1088.98
   .015283    162.     162.     162.         2        0         0       .00     57.79  1146.77
0
*SECNO 10.000
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
    10.00     6.10  6976.10  6976.10       .00  6977.79      1.69      7.30       .12  6980.00
    1830.       0.    1830.       0.        0.     175.        0.       16.        6.  6980.00
      .11      .00    10.44      .00      .000     .045      .000      .000   6970.00  1023.75
   .020892    411.     411.     411.         2        8         0       .00     52.61  1076.35
0
1
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  SECNO     DEPTH     CWSEL     CRIWS     WSELK      EG        HV        HL       OLOSS   BANK ELEV
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     Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA   LEFT/RIGHT
     TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
     SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST


 *SECNO 11.000
      11.00       6.06   6984.06        .00        .00    6985.53       1.48       7.72        .02    6990.00
      1830.         0.     1830.         0.         0.       188.         0.        18.         7.    6990.00
        .12        .00      9.75        .00       .000       .045       .000       .000    6978.00    1073.69
    .017284       407.      407.       407.          3          0          0        .00      52.34    1126.03
0
 *SECNO 12.000

 3301 HV CHANGED MORE THAN HVINS

 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
      12.00       2.75   7002.75    7002.75        .00    7003.71        .95      11.50        .05    7010.00
      1160.         0.     1160.         0.         0.       148.         0.        20.         7.    7010.00
        .14        .00      7.84        .00       .000       .045       .000       .000    7000.00    1191.61
    .024520       585.      585.       585.         10         14          0        .00      79.02    1270.63
0
 *SECNO 13.000
      13.00       3.97   7010.97        .00        .00    7011.57        .61       7.83        .03    7020.00
      1160.         0.     1160.         0.         0.       185.         0.        22.         8.    7020.00
        .16        .00      6.26        .00       .000       .045       .000       .000    7007.00    1049.61
    .013353       443.      443.       443.          5          0          0        .00      87.76    1137.38
0
 *SECNO 14.000
 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
      14.00       3.09   7025.09    7025.09        .00    7026.10       1.00      11.19        .12    7030.00
      1160.         0.     1160.         0.         0.       144.         0.        25.         9.    7030.00
        .18        .00      8.04        .00       .000       .045       .000       .000    7022.00    1044.18
    .024389       634.      634.       634.         10         15          0        .00      73.65    1117.82
0
 *SECNO 15.000
 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
      15.00       3.13   7037.13    7037.13        .00    7038.17       1.04      10.47        .01    7040.00
      1160.         0.     1160.         0.         0.       142.         0.        26.        10.    7040.00
        .19        .00      8.18        .00       .000       .045       .000       .000    7034.00    1121.90
    .023422       438.      438.       438.          4          5          0        .00      68.37    1190.27
0
1
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     SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS   BANK ELEV
     Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA   LEFT/RIGHT
     TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
     SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST
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 *SECNO 16.000
     16.00      3.92  7043.92      .00       .00  7044.77      .86      6.58       .02  7050.00
     1160.       0.    1160.       0.        0.     156.       0.       27.        11.   7050.00
      .21       .00     7.42      .00      .000     .045     .000      .000  7040.00  1170.13
   .015269      352.     352.     352.        5        0        0       .00    62.42  1232.54
0
 *SECNO 17.000
 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
     17.00      3.71  7051.71  7051.71       .00  7053.01     1.30      7.04       .13  7060.00
     1160.       0.    1160.       0.        0.     127.       0.       28.        11.   7060.00
      .22       .00     9.15      .00      .000     .045     .000      .000  7048.00  1097.58
   .022673      382.     382.     382.        3       11        0       .00    49.84  1147.42
0
 *SECNO 18.000
     18.00      4.00  7060.00      .00       .00  7061.07     1.07      8.04       .02  7070.00
     1160.       0.    1160.       0.        0.     140.       0.       30.        12.   7070.00
      .23       .00     8.31      .00      .000     .045     .000      .000  7056.00  1182.00
   .016680      416.     416.     416.        5        0        0       .00    50.01  1232.00
0
 *SECNO 19.000
 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
     19.00      4.46  7072.46  7072.46       .00  7073.89     1.43      9.13       .11  7080.00
     1160.       0.    1160.       0.        0.     121.       0.       31.        12.   7080.00
      .25       .00     9.60      .00      .000     .045     .000      .000  7068.00  1189.31
   .021908      480.     480.     480.       10        8        0       .00    42.62  1231.92
0
 *SECNO 20.000
        TRIBUTARY FOUR LIMITS
     20.00      4.78  7078.78      .00       .00  7080.09     1.31      6.18       .01  7076.00
     1160.      18.    1108.      35.        5.     119.       8.       32.        13.   7076.00
      .26      3.66     9.34     4.49      .050     .045     .050      .000  7074.00  1050.53
   .013610      363.     363.     363.        4        0        0       .00    40.02  1090.55
0
1
     7/12/ 4      16:39:20                                                                                  PAGE    9


                                                                   THIS RUN EXECUTED  7/12/ 4    16:39:20
**************************************************
  HEC2 RELEASE DATED SEP 88 UPDATED APR  1989


  ERROR CORR -  01,02
  MODIFICATION -
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NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

FILENAME TRIB4.DAT

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
	1.000	.00	.00	.00	6890.00	1870.00	6895.35	.00	6896.62	200.13	9.03	207.07	132.18
*	2.000	425.00	.00	.00	6900.00	1870.00	6905.24	6905.24	6906.60	218.33	9.36	199.69	126.56
	3.000	384.00	.00	.00	6910.00	1870.00	6913.65	.00	6914.74	204.47	8.36	223.76	130.78
*	4.000	433.00	.00	.00	6920.00	1870.00	6924.09	6924.09	6925.39	225.26	9.16	204.15	124.60
*	5.000	363.00	.00	.00	6928.00	1870.00	6933.16	6933.16	6934.43	230.82	9.05	206.68	123.08
*	6.000	668.00	.00	.00	6944.00	1870.00	6948.69	6948.69	6950.17	223.31	9.74	192.07	125.14
	7.000	389.00	.00	.00	6952.00	1870.00	6957.48	6957.41	6958.75	217.26	9.06	206.48	126.87
*	8.000	320.00	.00	.00	6961.00	1870.00	6965.33	6965.33	6966.89	211.84	10.01	186.81	128.48
	9.000	162.00	.00	.00	6963.00	1830.00	6968.51	.00	6969.82	152.83	9.17	199.56	148.03
*	10.000	411.00	.00	.00	6970.00	1830.00	6976.10	6976.10	6977.79	208.92	10.44	175.29	126.61
	11.000	407.00	.00	.00	6978.00	1830.00	6984.06	.00	6985.53	172.84	9.75	187.74	139.20
*	12.000	585.00	.00	.00	7000.00	1160.00	7002.75	7002.75	7003.71	245.20	7.84	148.03	74.08
	13.000	443.00	.00	.00	7007.00	1160.00	7010.97	.00	7011.57	133.53	6.26	185.37	100.39
*	14.000	634.00	.00	.00	7022.00	1160.00	7025.09	7025.09	7026.10	243.89	8.04	144.27	74.28
*	15.000	438.00	.00	.00	7034.00	1160.00	7037.13	7037.13	7038.17	234.22	8.18	141.84	75.80
	16.000	352.00	.00	.00	7040.00	1160.00	7043.92	.00	7044.77	152.69	7.42	156.26	93.88
*	17.000	382.00	.00	.00	7048.00	1160.00	7051.71	7051.71	7053.01	226.73	9.15	126.83	77.04

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
18.000	416.00	.00	.00	7056.00	1160.00	7060.00	.00	7061.07	166.80	8.31	139.62	89.82

*	19.000	480.00	.00	.00	7068.00	1160.00	7072.46	7072.46	7073.89	219.08	9.60	120.83	78.37
	20.000	363.00	.00	.00	7074.00	1160.00	7078.78	.00	7080.09	136.10	9.34	131.11	99.43

FILENAME TRIB4.DAT

SUMMARY PRINTOUT TABLE 150

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
	1.000	1870.00	6895.35	.00	.00	17.35	75.20	.00
*	2.000	1870.00	6905.24	.00	9.89	.00	73.82	425.00
	3.000	1870.00	6913.65	.00	8.42	.00	93.63	384.00
*	4.000	1870.00	6924.09	.00	10.44	.00	79.41	433.00
*	5.000	1870.00	6933.16	.00	9.07	.00	83.68	363.00
*	6.000	1870.00	6948.69	.00	15.53	.00	66.82	668.00
	7.000	1870.00	6957.48	.00	8.79	.00	77.88	389.00
*	8.000	1870.00	6965.33	.00	7.85	.00	61.12	320.00
	9.000	1830.00	6968.51	.00	3.18	.00	57.79	162.00
*	10.000	1830.00	6976.10	.00	7.59	.00	52.61	411.00
	11.000	1830.00	6984.06	.00	7.96	.00	52.34	407.00
*	12.000	1160.00	7002.75	.00	18.70	.00	79.02	585.00
	13.000	1160.00	7010.97	.00	8.21	.00	87.76	443.00
*	14.000	1160.00	7025.09	.00	14.13	.00	73.65	634.00
*	15.000	1160.00	7037.13	.00	12.04	.00	68.37	438.00
	16.000	1160.00	7043.92	.00	6.78	.00	62.42	352.00
*	17.000	1160.00	7051.71	.00	7.79	.00	49.84	382.00
	18.000	1160.00	7060.00	.00	8.29	.00	50.01	416.00

*	19.000	1160.00	7072.46	.00	12.46	.00	42.62	480.00
	20.000	1160.00	7078.78	.00	6.32	.00	40.02	363.00

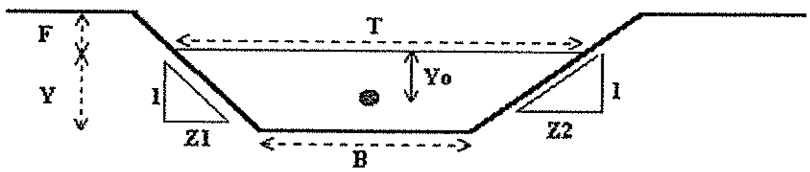
1

HYDRAULIC CALC'S
LOWER TRIB. FOUR

Normal Flow Analysis - Trapezoidal Channel

Project: Wolf Ranch

Channel ID: Tributary Four Below Research Pkwy

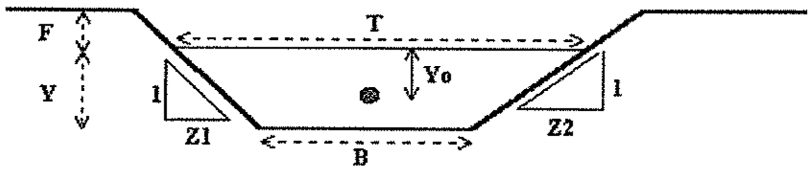


Design Information (Input)			
Channel Invert Slope	So =	0.0068	ft/ft
Manning's n	n =	0.041	
Bottom Width	B =	16.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Slope	Z2 =	4.00	ft/ft
Freeboard Height	F =	1.00	ft
Design Water Depth	Y =	**3.33**	ft

Normal Flow Condtion (Calculated)			
Discharge	Q =	**501.89**	cfs
Froude Number	Fr =	**0.60**	
Flow Velocity	V =	**5.14**	fps
Flow Area	A =	97.64	sq ft
Top Width	T =	42.64	ft
Wetted Perimeter	P =	43.46	ft
Hydraulic Radius	R =	2.25	ft
Hydraulic Depth	D =	2.29	ft
Specific Energy	Es =	3.74	ft
Centroid of Flow Area	Yo =	1.41	ft
Specific Force	Fs =	13.58	kip

Critical Flow Analysis - Trapezoidal Channel

Project: Wolf Ranch
Channel ID: Tributary Four Below Research Pkwy

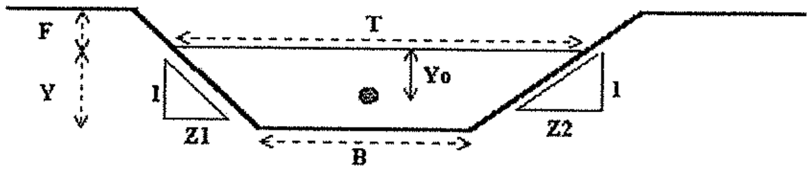


Design Information (Input)			
Bottom Width	B =	16.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Slope	Z2 =	4.00	ft/ft
Design Discharge	Q =	**500.00**	cfs

Critical Flow Condition (Calculated)			
Critical Flow Depth	**Y =**	**2.51**	ft
Critical Flow Area	A =	65.36	sq ft
Critical Top Width	T =	36.08	ft
Critical Hydraulic Depth	D =	1.81	ft
Critical Flow Velocity	V =	7.65	fps
Froude Number	**Fr =**	**1.00**	
Critical Wetted Perimeter	P =	36.70	ft
Critical Hydraulic Radius	R =	1.78	ft
Critical (min) Specific Energy	Esc =	3.42	ft
Centroid on the Critical Flow Area	Yoc =	0.93	ft
Critical (min) Specific Force	Fsc =	11.22	kip

Normal Flow Analysis - Trapezoidal Channel

Project: Wolf Ranch
Channel ID: Tributary Four Below Research Pkwy



Design Information (Input)			
Channel Invert Slope	So =	0.0068	ft/ft
Manning's n	n =	0.030	
Bottom Width	B =	16.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Slope	Z2 =	4.00	ft/ft
Freeboard Height	F =	1.00	ft
Design Water Depth	Y =	**2.85**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**503.77**	cfs
Froude Number	**Fr =**	**0.80**	
Flow Velocity	**V =**	**6.45**	fps
Flow Area	A =	78.09	sq ft
Top Width	T =	38.80	ft
Wetted Perimeter	P =	39.50	ft
Hydraulic Radius	R =	1.98	ft
Hydraulic Depth	D =	2.01	ft
Specific Energy	Es =	3.50	ft
Centroid of Flow Area	Yo =	1.22	ft
Specific Force	Fs =	12.27	kip

KIOWA ENGINEERING CORPORATION

JOB 15012 - WOLF RANCH

SHEET NO. 1 OF

CALCULATED BY CJC DATE 9/03/15

CHECKED BY DATE

SCALE

COTTONWOOD CRK. CHANNEL SECTION -

FROM CITY OF COLO. SPRINGS DCM, VOL. 1 :

$A_{LOW-FLOW} = 21.3\ DA^{0.34}$

FROM DBPS, DA = 6.1 SQ.MI.

$A_{LOW-FLOW} = 21.3\,(6.1)^{0.34}$

= 39.4 SQ.FT. MIN.

$A_{LOW-FLOW}$ = DESIGN LOW-FLOW CROSS-SECTIONAL AREA (SQ.FT.)

DA = TRIBUTARY DRAINAGE BASIN AREA (SQ.MI.)

COTTONWOOD CRK. FLOWRATES JUST DOWNSTREAM OF CONFLUENCE W/ TRIBUTARY FOUR (FROM DBPS) :

$Q_{100} = 2{,}730$ CFS

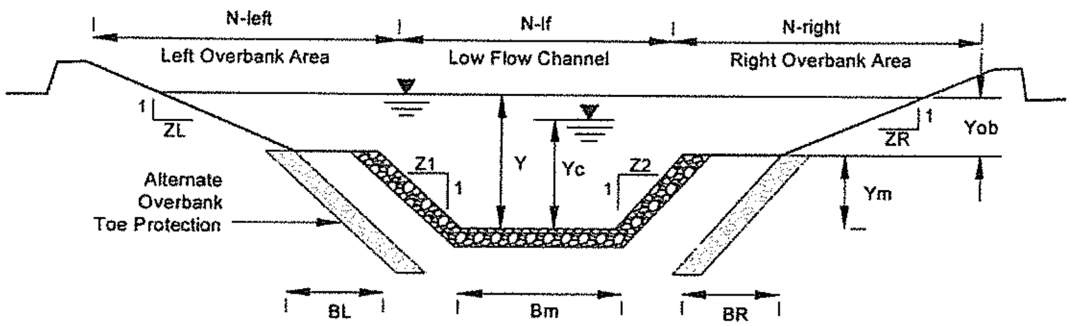
$Q_2 = 88$ CFS

D PRODUCT 207

Capacity Analysis of Composite Channel

Project: Wolf Ranch

Channel ID: Cottonwood Creek Below Tributary Four Confluence - Drop Crest Section



Design Information (Input)

Channel Invert Slope	So = 0.00400 ft/ft	Left Overbank Bottom Width	BL = 16.00 ft
		Left Overbank Side Slope	ZL = 4.00 ft/ft
Low Flow Channel Bottom Width	Bm = 14.00 ft	Left Overbank Manning's n	n-left = 0.0350
Low Flow Channel Left Side Slope	Z1 = 3.00 ft/ft	Right Overbank Bottom Width	BR = 16.00 ft
Low Flow Channel Right Side Slope	Z2 = 3.00 ft/ft	Right Overbank Side Slope	ZR = 4.00 ft/ft
Low Flow Channel Manning's Nn for Qd	n-lf = 0.0650	Right Overbank Manning's n	n-right = 0.0350
Low Flow Channel Manning's Nn for Q100	n-m-Q100 = 0.0380		
(See USDCM Vol. II, n vs. Depth Graph)			
Low Flow Channel Bank-full depth	Ym = 2.00 ft	Overbank Flow Depth Yob (Y - Ym)	Yob = 4.70 ft

Low Flow Channel Condition for Qd		**Low Flow Channel Flow Condition for Q100**	
Top width	Tlf = 26.0 ft	Top width	Tm = 26.0 ft
Flow area	Alf = 40.0 sq ft	Flow area	Am = 162.2 sq ft
Wetted perimeter	Plf = 26.7 ft	Wetted perimeter	Pm = 26.7 ft
Discharge (Calculated)	Qlf = 76.0 cfs	Discharge	Qm = 1,340.9 cfs
Velocity	Vlf= 1.9 fps	Velocity	Vm = 8.3 fps
Froude number	Fr-lf = 0.27	Froude number	Frm = 0.58
Qd Critical Velocity	Vlfc = 5.01 fps	100-Yr. Critical Velocity	Vmc = 11.9 fps
Qd Critical Depth	Ylfc = 0.91 ft	100-Yr. Critical Depth	Ymc = 4.8 ft
Left Overbank Flow Condition for Q100		**Right Overbank Flow Condition for Q100**	
Top width	TL = 34.8 ft	Top width	TR = 34.8 ft
Flow area	AL = 119.3800 sq ft	Flow area	AR = 119.3800 sq ft
Wetted perimeter	PL = 35.3800 ft	Wetted perimeter	PR = 35.3800 ft
Discharge	QL = 723.1 cfs	Discharge	QR = 723.1 cfs
Velocity	VL = 6.1 fps	Velocity	VR = 6.1 fps
Froude number	FrL = 0.58	Froude number	FrR = 0.58
100-Yr. Critical Velocity	VLc = 9.2 fps	100-Yr. Critical Velocity	VRc = 9.2 fps
100-Yr. Critical Depth in Overbanks	YLc = 3.4 ft	100-Yr. Critical Depth in Overbanks	YRc = 3.4 ft

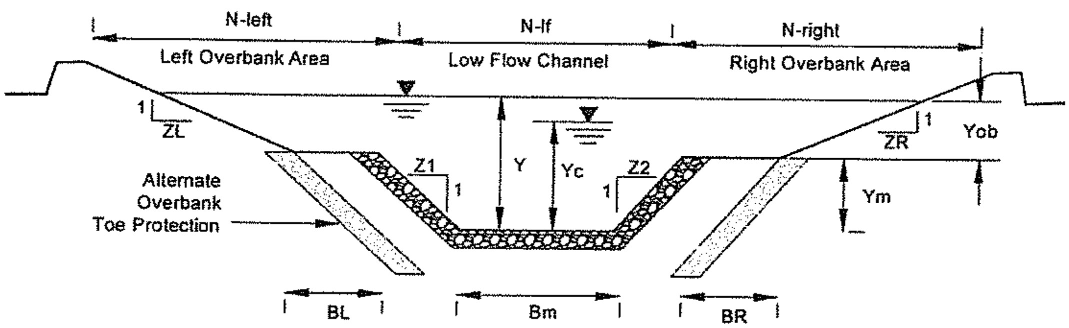
Composite Cross-Section Flow Condition for Q100

Top width	T = 95.6 ft	Discharge	Q = 2,787.1 cfs
Channel Depth Y	Y = 6.70 ft	Velocity	V = 7.0 fps
Flow area	A = 401.0 sq ft	Froude number	Fr = 0.60
Wetted perimeter	P = 97.4 ft	100-Yr. Critical Velocity	Vc = 10.2 fps
Cross-Sectional Manning's n (Calculated)	n = 0.0348	100-Yr. Critical Depth in Overbanks	Yc = 3.27 ft

Capacity Analysis of Composite Channel

Project: Wolf Ranch

Channel ID: Cottonwood Creek Below Tributary Four Confluence - Drop Sill Section



Design Information (Input)

Channel Invert Slope	So = 0.00400 ft/ft	Left Overbank Bottom Width	BL = 0.00 ft
		Left Overbank Side Slope	ZL = 2.50 ft/ft
Low Flow Channel Bottom Width	Bm = 14.00 ft	Left Overbank Manning's n	n-left = 0.0350
Low Flow Channel Left Side Slope	Z1 = 2.00 ft/ft	Right Overbank Bottom Width	BR = 0.00 ft
Low Flow Channel Right Side Slope	Z2 = 2.00 ft/ft	Right Overbank Side Slope	ZR = 4.00 ft/ft
Low Flow Channel Manning's Nn for Qd	n-lf = 0.0530	Right Overbank Manning's n	n-right = 0.0350
Low Flow Channel Manning's Nn for Q100	n-m-Q100 = 0.0360		
(See USDCM Vol. II, n vs. Depth Graph)			
Low Flow Channel Bank-full depth	Ym = 3.00 ft	Overbank Flow Depth Yob (Y - Ym)	Yob = 5.80 ft

Low Flow Channel Condition for Qd		Low Flow Channel Flow Condition for Q100	
Top width	Tlf = 26.0 ft	Top width	Tm = 26.0 ft
Flow area	Alf = 60.0 sq ft	Flow area	Am = 210.8 sq ft
Wetted perimeter	Plf = 27.4 ft	Wetted perimeter	Pm = 27.4 ft
Discharge (Calculated)	Qlf = 179.8 cfs	Discharge	Qm = 2,149.6 cfs
Velocity	Vlf= 3.0 fps	Velocity	Vm = 10.2 fps
Froude number	Fr-lf = 0.35	Froude number	Frm = 0.63
Qd Critical Velocity	Vlfc = 6.58 fps	100-Yr. Critical Velocity	Vmc = 13.9 fps
Qd Critical Depth	Ylfc = 1.59 ft	100-Yr. Critical Depth	Ymc = 6.7 ft

Left Overbank Flow Condition for Q100		Right Overbank Flow Condition for Q100	
Top width	TL = 14.5 ft	Top width	TR = 23.2 ft
Flow area	AL = 42.0500 sq ft	Flow area	AR = 67.2800 sq ft
Wetted perimeter	PL = 15.6200 ft	Wetted perimeter	PR = 23.9100 ft
Discharge	QL = 219.1 cfs	Discharge	QR = 361.0 cfs
Velocity	VL = 5.2 fps	Velocity	VR = 5.4 fps
Froude number	FrL = 0.54	Froude number	FrR = 0.56
100-Yr. Critical Velocity	VLc = 8.5 fps	100-Yr. Critical Velocity	VRc = 8.6 fps
100-Yr. Critical Depth in Overbanks	YLc = 4.5 ft	100-Yr. Critical Depth in Overbanks	YRc = 4.6 ft

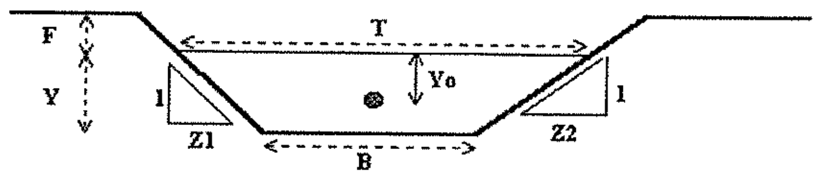
Composite Cross-Section Flow Condition for Q100

Top width	T = 63.7 ft	Discharge	Q = 2,729.7 cfs
Channel Depth Y	Y = 8.80 ft	Velocity	V = 8.5 fps
Flow area	A = 320.1 sq ft	Froude number	Fr = 0.67
Wetted perimeter	P = 67.0 ft	100-Yr. Critical Velocity	Vc = 11.6 fps
Cross-Sectional Manning's n (Calculated)	n = 0.0314	100-Yr. Critical Depth in Overbanks	Yc = 4.30 ft

Normal Flow Analysis - Trapezoidal Channel

Project: Wolf Ranch

Channel ID: Tributary Four Below Research Parkway - Riprap Rundown



Design Information (Input)

Channel Invert Slope	So =	0.0763	ft/ft
Manning's n	n =	0.042	
Bottom Width	B =	3.00	ft
Left Side Slope	Z1 =	3.00	ft/ft
Right Side Slope	Z2 =	3.00	ft/ft
Freeboard Height	F =	1.00	ft
Design Water Depth	Y =	**1.34**	ft

Normal Flow Condtion (Calculated)

Discharge	Q =	**80.74**	cfs
Froude Number	Fr =	**1.64**	
Flow Velocity	V =	**8.58**	fps
Flow Area	A =	9.41	sq ft
Top Width	T =	11.04	ft
Wetted Perimeter	P =	11.47	ft
Hydraulic Radius	R =	0.82	ft
Hydraulic Depth	D =	0.85	ft
Specific Energy	Es =	2.48	ft
Centroid of Flow Area	Yo =	0.54	ft
Specific Force	Fs =	1.66	kip

Tributary Four Drop Structures Below Research Parkway
Hydraulic Jump and Basin Length Calculations

6' High Drop Structure

Hec Ras Mixed Flow Analysis (100-year)

	River Sta	Q Total	Min Ch El	Supercritical Analysis W.S. Elev	Crit W.S.	Vel Chnl	Froude # Chl	Max Chl Dpth	Specif Force	Subcritical Analysis W.S. Elev	Crit W.S.	Vel Chnl	Froude # Chl	Max Chl Dpth	Specif Force
		(cfs)	(ft)	(ft)	(ft)	(ft/s)		(ft)	(cu ft)	(ft)	(ft)	(ft/s)		(ft)	(cu ft)
Drop Crest	3600	500	6947.20	6949.71	6949.71	7.66	1.00	2.51	190.27	6949.71	6949.71	7.67	1.00	2.51	190.27
	3565	500	6941.37	6942.70	6943.97	18.69	3.14	1.32	306.72	6944.61	6943.97	5.89	0.68	3.24	210.92
	3564	500	6941.20	6942.52	6943.80	18.85	3.18	1.32	308.92	6944.65	6943.80	5.41	0.61	3.45	221.80
	3563	500	6941.03	6942.34	6943.63	19.00	3.21	1.31	311.10	6944.68	6943.64	5.01	0.55	3.65	234.57
	3562	500	6940.87	6942.17	6943.48	19.13	3.24	1.30	312.99	6944.70	6943.48	4.69	0.50	3.83	248.03
	3561	500	6940.70	6942.00	6943.31	19.28	3.27	1.30	315.02	6944.72	6943.31	4.39	0.46	4.02	263.89
	3560	500	6940.53	6941.82	6943.14	19.42	3.30	1.29	317.07	6944.74	6943.14	4.12	0.43	4.21	281.22
	3559	500	6940.37	6941.66	6942.99	19.55	3.32	1.29	318.89	6944.75	6942.98	3.90	0.40	4.38	298.67
Drop Toe	3558	500	6940.20	6941.48	6942.81	19.68	3.35	1.28	320.86	6944.76	6942.81	3.69	0.37	4.56	318.60
Jump Begins	3557	500	6940.19	6941.48	6942.81	19.46	3.30	1.29	317.73	6944.76	6942.81	3.68	0.37	4.57	319.80
	3556	500	6940.19	6941.50	6942.80	19.21	3.24	1.31	314.18	6944.76	6942.81	3.68	0.37	4.57	319.74
	3555	500	6940.18	6941.50	6942.80	19.00	3.19	1.32	311.20	6944.76	6942.79	3.67	0.37	4.58	320.95
	3554	500	6940.17	6941.50	6942.79	18.79	3.14	1.33	308.28	6944.76	6942.79	3.66	0.36	4.59	322.16
	3553	500	6940.17	6941.52	6942.78	18.54	3.09	1.35	304.86	6944.76	6942.79	3.66	0.36	4.59	322.11
	3552	500	6940.16	6941.52	6942.78	18.34	3.04	1.36	302.08	6944.76	6942.77	3.65	0.36	4.60	323.27
	3551	500	6940.15	6941.52	6942.77	18.15	3.00	1.37	299.37	6944.76	6942.77	3.63	0.36	4.61	324.55
	3528	500	6940.00	6941.65	6942.62	14.50	2.21	1.65	251.35	6944.76	6942.62	3.47	0.34	4.76	342.70

Jump begins at Sta. 35+57 which is 1' downstream of the drop toe (Sta. 35+58) so add 1' to 60%L for Culvert Outlet Protection

Hydraulic Jump Length, Figure 15-4 (Chow)

F_1 =	3.35	L/Y_2 =	5.5
Y_2 (ft)=	4.76	L (ft)=	26.18
		60%L (ft)=	15.71

(Minimum required length from toe for protection, minimum Basin Length) = 16.7' | use 20'

Note: Calculations provided are for a 6' high drop structure. River Stations are arbitrary (do not match the drawing plan and profiles) and are relative to the drop crest.

- Froude No. at beginning of hydraulic jump
- Specific Force (cu ft) at beginning of hydraulic jump (at location where Specific Force (subcritical) > Specific Force (supercritical))
- Maximum Channel Depth (ft) at approximate downstream end of hydraulic jump

Tributary Four Drop Structures Below Research Parkway
Hydraulic Jump and Basin Length Calculations

3' High Drop Structure

Hec Ras Mixed Flow Analysis (100-year)

	River Sta	Q Total	Min Ch El	Supercritical Analysis W.S. Elev	Crit W.S.	Vel Chnl	Froude # Chl	Max Chl Dpth	Specif Force	Subcritical Analysis W.S. Elev	Crit W.S.	Vel Chnl	Froude # Chl	Max Chl Dpth	Specif Force
		(cfs)	(ft)	(ft)	(ft)	(ft/s)		(ft)	(cu ft)	(ft)	(ft)	(ft/s)		(ft)	(cu ft)
Drop Crest	3390	500	6940.28	6942.77	6942.78	7.75	1.02	2.49	190.30	6942.78	6942.78	7.68	1.01	2.50	190.28
	3375	500	6937.78	6939.38	6940.35	14.63	2.28	1.60	252.16	6940.57	6940.35	7.05	0.87	2.79	196.21
	3374	500	6937.61	6939.19	6940.19	14.90	2.33	1.58	255.61	6940.64	6940.19	6.31	0.75	3.03	202.67
	3373	500	6937.45	6939.01	6940.04	15.15	2.38	1.56	258.88	6940.69	6940.03	5.78	0.67	3.24	211.22
	3372	500	6937.28	6938.82	6939.86	15.41	2.43	1.54	262.39	6940.73	6939.87	5.33	0.60	3.45	222.39
	3371	500	6937.11	6938.64	6939.71	15.67	2.48	1.53	265.78	6940.76	6939.70	4.95	0.54	3.65	235.27
	3370	500	6936.95	6938.46	6939.55	15.89	2.53	1.51	268.76	6940.78	6939.55	4.64	0.50	3.83	248.76
	3369	500	6936.78	6938.28	6939.39	16.13	2.57	1.50	271.90	6940.80	6939.38	4.36	0.46	4.02	264.56
Jump Begins	3368	500	6936.61	6938.10	6939.22	16.35	2.61	1.49	274.91	6940.82	6939.22	4.10	0.42	4.21	281.73
	3367	500	6936.45	6937.93	6939.07	16.55	2.65	1.47	277.66	6940.83	6939.06	3.89	0.40	4.38	298.96
Drop Toe	3366	500	6936.28	6937.74	6938.90	16.76	2.69	1.46	280.56	6940.84	6938.90	3.69	0.37	4.56	318.54
	3365	500	6936.27	6937.75	6938.88	16.59	2.65	1.48	278.22	6940.84	6938.88	3.68	0.37	4.57	319.69
	3364	500	6936.27	6937.76	6938.89	16.40	2.61	1.49	275.67	6940.84	6938.89	3.68	0.37	4.57	319.57
	3363	500	6936.26	6937.76	6938.88	16.23	2.58	1.50	273.52	6940.84	6938.88	3.67	0.37	4.58	320.78
	3362	500	6936.25	6937.77	6938.86	16.07	2.54	1.51	271.34	6940.84	6938.86	3.66	0.36	4.59	321.93
	3361	500	6936.25	6937.78	6938.87	15.89	2.51	1.53	269.04	6940.84	6938.87	3.66	0.36	4.59	321.87
	3360	500	6936.24	6937.78	6938.86	15.74	2.47	1.54	267.04	6940.84	6938.86	3.65	0.36	4.60	323.03
	3336	500	6936.08	6937.87	6938.70	13.08	1.93	1.79	234.43	6940.84	6938.70	3.47	0.34	4.76	342.51

Jump begins at Sta. 33+68 which is 2' upstream of the drop toe (Sta. 33+66) so subtract 2' from 60%L for Basin Length Protection

Hydraulic Jump Length, Figure 15-4 (Chow)

F_1 =	2.61	L/Y_2 =	5.0
Y_2 (ft)=	4.76	L (ft)=	23.80
		60%L (ft)=	14.28

(Minimum required length from toe for protection, minimum Basin Length) = 12.3' | use 15'

Note: Calculations provided are for a 3' high drop structure. River Stations are arbitrary (do not match the drawing plan and profiles) and are relative to the drop crest.

- Froude No. at beginning of hydraulic jump
- Specific Force (cu ft) at beginning of hydraulic jump (at location where Specific Force (subcritical) > Specific Force (supercritical))
- Maximum Channel Depth (ft) at approximate downstream end of hydraulic jump

Tributary Four Drop Structures Below Research Parkway
Hydraulic Jump and Basin Length Calculations

Hydraulic jump locations were calculated using criteria from the Urban Storm Drainage Criteria Manual Vol. II, Hydraulic Structures section 2.3.4
Hydraulic jump lengths were calculated using criteria from the Urban Storm Drainage Criteria Manual Vol. II, Hydraulic Structures section 2.3.5
and from Open Channel Hydraulics by Ven Te Chow
HEC-RAS was used for the frontwater (supercirtical profile analysis) and for the backwater (subcritical profile analysis)

To determine the location of the hydraulic jump, a tailwater elevation has to be established by water surface profile analysis that starts from a downstream control point and works upstream to the drop basin. This backwater analysis is based upon entire cross sections for the downstream waterway. The hydraulic jump, in either the low-flow, trickle channel, or the main drop, will begin to form where the unit specific force of the downstream tailwater is greater than the specific force of the supercritical flow below the drop. Special consideration must be given to submerged hydraulic jumps because it is here that reverse rollers are most common. For submerged jumps, the resulting downstream hydraulics should be evaluated (Cotton 1995).

The determination of the jump location is usually accomplished through the comparison of specific force between supercritical inflow and the downstream subcritical flow (i.e., tailwater) conditions:

$$F = \left(\frac{q^2}{gy}\right) + \left(\frac{y^2}{2}\right) \qquad \text{(HS-6)}$$

in which:

F = specific force (ft²)

q = unit discharge (determined at crest, for low-flow, trickle, and main channel zones) (cfs/ft)

y = depth at analysis point (ft)

g = acceleration of gravity = 32.2 ft/sec²

The depth, y, for downstream specific energy determination is the tailwater water surface elevation minus the ground elevation at the point of interest, which is typically the main basin elevation or the trickle channel invert (if the jump is to occur in the basin). The depth, for the upstream specific energy (supercritical flow), is the supercritical flow depth at the point in question.

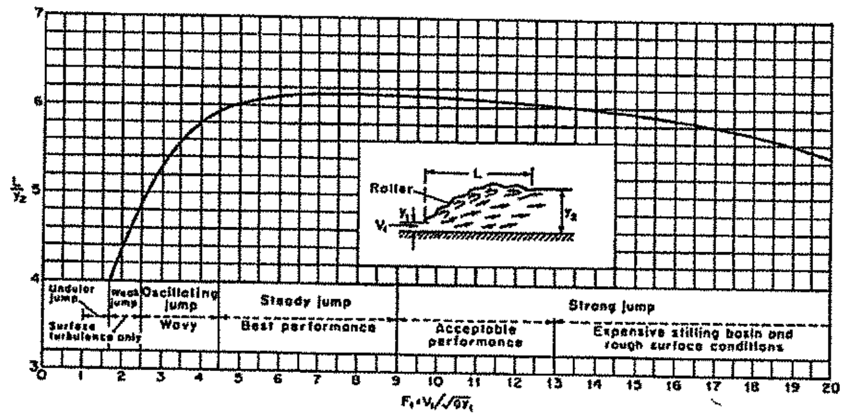


FIG. 15-4. Length in terms of sequent depth y_2 of jumps in horizontal channels. *(Based on data and recommendations of U.S. Bureau of Reclamation* [34].)

Figure 15-4 (Chow), Used to determine the length of the hydraulic jump

Cottonwood Creek Drop Structure
Hydraulic Jump and Basin Length Calculations

5.5' High Drop Structure

Hec Ras Mixed Flow Analysis (100-year)

	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	Vel Chnl	Froude # Chl	Max Chl Dpth	Specif Force	W.S. Elev	Crit W.S.	Vel Chnl	Froude # Chl	Max Chl Dpth	Specif Force
				Supercritical Analysis						Subcritical Analysis					
		(cfs)	(ft)	(ft)	(ft)	(ft/s)		(ft)	(cu ft)	(ft)	(ft)	(ft/s)		(ft)	(cu ft)
Drop Crest	766	2730	6880.50	6885.96	6885.96	11.95	0.94	5.46	1420.07	6885.96	6885.96	11.93	0.94	5.46	1420.18
	755	2730	6878.67	6884.64	6884.85	12.88	0.97	5.96	1507.12	6884.85	6884.85	12.17	0.90	6.18	1508.23
	754	2730	6878.50	6884.74	6884.75	12.19	0.90	6.24	1517.21	6884.75	6884.75	12.15	0.90	6.25	1517.54
	753	2730	6878.33	6884.42	6884.64	12.94	0.97	6.09	1524.37	6884.64	6884.64	12.18	0.89	6.31	1525.82
	752	2730	6878.17	6884.53	6884.54	12.24	0.90	6.36	1533.29	6884.54	6884.54	12.21	0.89	6.37	1533.57
Jump Begins	751	2730	6878.00	6884.20	6884.43	12.98	0.96	6.20	1540.92	6884.43	6884.43	12.23	0.89	6.43	1542.53
	750	2730	6877.83	6884.30	6884.30	12.32	0.89	6.47	1550.54	6884.31	6884.30	12.29	0.89	6.48	1550.79
	749	2730	6877.67	6883.97	6884.21	13.04	0.96	6.30	1557.25	6884.37	6884.21	11.80	0.84	6.70	1565.87
	748	2730	6877.50	6884.08	6884.08	12.36	0.89	6.58	1567.34	6884.43	6884.08	11.35	0.79	6.93	1586.90
	747	2730	6877.33	6883.75	6883.98	13.09	0.95	6.42	1574.65	6884.49	6883.98	10.96	0.75	7.16	1611.40
	746	2730	6877.17	6883.86	6883.87	12.40	0.88	6.69	1583.73	6884.54	6883.87	10.61	0.72	7.37	1638.12
	745	2730	6877.00	6883.52	6883.74	13.14	0.95	6.52	1590.84	6884.58	6883.74	10.30	0.69	7.58	1667.96
Drop Toe	727	2730	6874.00	6881.26	6881.51	13.75	0.95	7.26	1734.91	6884.88	6881.51	7.33	0.41	10.88	2427.26
	726	2730	6874.00	6881.26	6881.51	13.75	0.95	7.26	1734.91	6884.88	6881.51	7.34	0.41	10.88	2426.90
	725	2730	6873.99	6881.25	6881.50	13.73	0.94	7.26	1734.82	6884.88	6881.50	7.32	0.40	10.89	2430.77
	724	2730	6873.99	6881.25	6881.50	13.73	0.94	7.26	1734.82	6884.88	6881.50	7.33	0.40	10.88	2430.40
	697	2730	6873.88	6881.39	6881.42	13.06	0.88	7.51	1735.47	6884.87	6881.42	7.21	0.40	10.99	2470.48

Jump begins at Sta. 7+51 which is 24' upstream of the drop toe (Sta. 7+27)

Hydraulic Jump Length, Figure 15-4 (Chow)

F_1 = 0.96 L/Y_2 = 3.2

Y_2 (ft)= 10.99 L (ft)= 35.17

60%L (ft)= 21.10

(Minimum required length from toe for protection, minimum Basin Length) = 21.1'	use 25'

Note: Calculations provided are for a 5.5' high drop structure. River Stations are arbitrary (do not match the drawing plan and profiles) and are relative to the drop crest.

(shaded)	Froude No. at beginning of hydraulic jump
	Specific Force (cu ft) at beginning of hydraulic jump (at location where Specific Force (subcritical) > Specific Force (supercritical))
	Maximum Channel Depth (ft) at approximate downstream end of hydraulic jump

Cottonwood Creek Drop Structure
Hydraulic Jump and Basin Length Calculations

Hydraulic jump locations were calculated using criteria from the Urban Storm Drainage Criteria Manual Vol. II, Hydraulic Structures section 2.3.4
Hydraulic jump lengths were calculated using criteria from the Urban Storm Drainage Criteria Manual Vol. II, Hydraulic Structures section 2.3.5 and from Open Channel Hydraulics by Ven Te Chow
HEC-RAS was used for the frontwater (supercirtical profile analysis) and for the backwater (subcritical profile analysis)

To determine the location of the hydraulic jump, a tailwater elevation has to be established by water surface profile analysis that starts from a downstream control point and works upstream to the drop basin. This backwater analysis is based upon entire cross sections for the downstream waterway. The hydraulic jump, in either the low-flow, trickle channel, or the main drop, will begin to form where the unit specific force of the downstream tailwater is greater than the specific force of the supercritical flow below the drop. Special consideration must be given to submerged hydraulic jumps because it is here that reverse rollers are most common. For submerged jumps, the resulting downstream hydraulics should be evaluated (Cotton 1995).

The determination of the jump location is usually accomplished through the comparison of specific force between supercritical inflow and the downstream subcritical flow (i.e., tailwater) conditions:

$$F = \left(\frac{q^2}{gy}\right) + \left(\frac{y^2}{2}\right) \qquad \text{(HS-6)}$$

in which:

F = specific force (ft^2)

q = unit discharge (determined at crest, for low-flow, trickle, and main channel zones) (cfs/ft)

y = depth at analysis point (ft)

g = acceleration of gravity = 32.2 ft/sec^2

The depth, y, for downstream specific energy determination is the tailwater water surface elevation minus the ground elevation at the point of interest, which is typically the main basin elevation or the trickle channel invert (if the jump is to occur in the basin). The depth, for the upstream specific energy (supercritical flow), is the supercritical flow depth at the point in question.

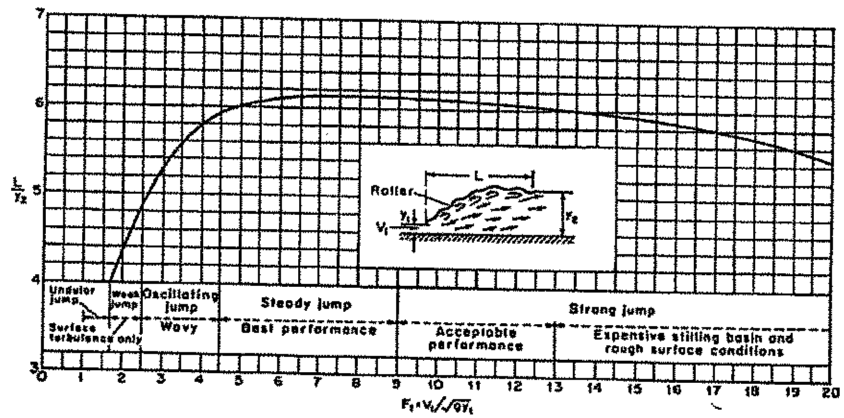


FIG. 15-4. Length in terms of sequent depth y_2 of jumps in horizontal channels. ***(Based on data and recommendations of U.S. Bureau of Reclamation* [34].)**

Figure 15-4 (Chow), Used to determine the length of the hydraulic jump

Tributary Four Improvements Below Research Parkway
Seepage Analysis and Cutoff Wall Calculations

Seepage Analysis (Lane's Weighted Creep Method Calculation)

Location	C_w	Weep Drain System	C_w	H_s	Drop Height	L_a	L_f	L_s	L_H	Required $L_{v\text{-calc}}$	$L_{v\text{-Struct}}$	L_v Difference $L_{v\text{-calc}}$ and $L_{v\text{-Struct}}$	Additional Calculated Cut off Wall Depth	Additional Cut off Wall Depth
Sta. 7+76.89	5.0	No	5.0	7.1 ft	5.5 ft	13.0ft	39.0ft	38.0ft	90.0 ft	5.5 ft	12.0 ft	0.0 ft	0.0 ft	0 ft
Sta. 11+15.79	5.0	No	5.0	5.6 ft	5.1 ft	13.0ft	30.6ft	33.2ft	76.8 ft	2.4 ft	12.0 ft	0.0 ft	0.0 ft	0 ft
Sta. 14+07.65	5.0	No	5.0	6.9 ft	5.0 ft	13.0ft	30.0ft	33.2ft	76.2 ft	9.1 ft	12.0 ft	0.0 ft	0.0 ft	0 ft
Sta. 16+61.34	5.0	No	5.0	7.9 ft	6.0 ft	13.0ft	36.0ft	33.2ft	82.2 ft	12.1 ft	12.0 ft	0.1 ft	0.0 ft	0 ft
Sta. 19+51.22	5.0	No	5.0	6.8 ft	5.0 ft	13.0ft	30.0ft	33.2ft	76.2 ft	8.6 ft	12.0 ft	0.0 ft	0.0 ft	0 ft
Sta. 21+18.34	5.0	No	5.0	5.7 ft	3.9 ft	13.0ft	23.4ft	28.2ft	64.6 ft	7.0 ft	12.0 ft	0.0 ft	0.0 ft	0 ft
Sta. 24+53.34	5.0	No	5.0	6.3 ft	4.5 ft	13.0ft	27.0ft	33.2ft	73.2 ft	7.1 ft	12.0 ft	0.0 ft	0.0 ft	0 ft
Sta. 25+93.34	5.0	No	5.0	5.8 ft	4.0 ft	13.0ft	24.0ft	33.2ft	70.2 ft	5.6 ft	12.0 ft	0.0 ft	0.0 ft	0 ft
Sta. 28+36.02	5.0	No	5.0	7.9 ft	6.0 ft	13.0ft	36.0ft	33.2ft	82.2 ft	12.1 ft	12.0 ft	0.1 ft	0.0 ft	0 ft
Sta. 31+63.02	5.0	No	5.0	7.9 ft	6.0 ft	13.0ft	36.0ft	33.2ft	82.2 ft	12.1 ft	12.0 ft	0.1 ft	0.0 ft	0 ft
Sta. 34+18.36	5.0	No	5.0	5.7 ft	4.0 ft	13.0ft	24.0ft	33.2ft	70.2 ft	5.1 ft	12.0 ft	0.0 ft	0.0 ft	0 ft
Sta. 35+78.02	5.0	No	5.0	6.2 ft	4.4 ft	13.0ft	26.4ft	33.2ft	72.6 ft	6.8 ft	12.0 ft	0.0 ft	0.0 ft	0 ft

Equations:

$C_w = [(L_H/3)+L_v] / H_s$ (USDCM Eqn 9-5)

C_w = Lane's Weighted Creep Ratio

Table 9-3: Lane's Weighted Creep Recommended Ratios (USDCM)

- C_w = 8.5 Very fine sand or silt
- C_w = 7.0 Fine Sand
- C_w = 6.0 Medium Sand
- C_w = 5.0 Coarse Sand
- C_w = 4.0 Fine Gravel
- C_w = 3.0 Coarse gravel including cobbles or Soft Clay
- C_w = 2.0 Medium Clay

Weep Drain System: 10% Reduction is C_w if weep drain system is used

H_s = Head Differential between analysis points -- Taken from HEC-Ras

Drop Height = Difference between Crest and Sill

L_H = Sum of the Horizontal Creep Distances (Less than 45 degrees)

$L_H = L_s + L_f$

- L_a = Approach Length
- L_s = Length of stilling basin (Toe to Sill)
- L_f = Drop Face Length (Crest to Toe)

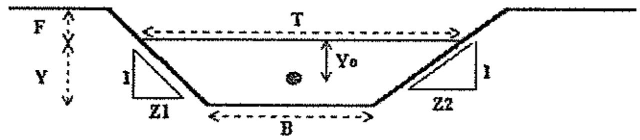
L_v = Sum of the Vertical Creep Distances (Steeper than 45 degrees)

$L_{v\text{-Struct}}$ = Vertical creep distances of structure w/o cut off wall

Additional Calculated Cutoff Wall Depth = Half of L_v Difference if Sheet Pile

Design of Riprap Channel Cross Section

Project: **Wolf Ranch**
Channel ID: **Tributary Four Below Research Pkwy**



Design Information (Input)			
Channel Invert Slope	So =	0.0068	ft/ft
Bottom Width	B =	16.0	ft
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Specific Gravity of Rock	Ss =	2.50	
Radius of Channel Centerline	Ccr =	85.0	ft
Design Disharge	**Q =**	**500.0**	**cfs**

Flow Condition (Calculated)			
Riprap Type (Straight Channel)	**Type =**	**L**	
Intermediate Rock Diameter (Straight Channel)	**D50 =**	**9**	**inches**
Calculated Manning's n (Straight Channel)	**n =**	**0.0377**	
Riprap Type (Outside Bend of Curved Channel)	**Type =**	**L**	
Intermediate Rock Dia. (O.B. of Curved Channel)	**D50 =**	**9**	**inches**
Calculated Manning's N (Curved Channel)	**n =**	**0.0377**	
Water Depth	Y =	3.19	ft
Top Width of Flow	T =	41.5	ft
Flow Area	A =	91.7	sq ft
Wetted Perimeter	P =	42.3	ft
Hydraulic Radius (A/P)	R =	2.2	ft
Average Flow Velocity (Q/A)	V =	5.5	fps
Hydraulic Depth (A/T)	D =	2.2	ft
Froude Number (max. = 0.8)	Fr =	0.65	
Channel Radius / Top Width	Ccr/T =	2.05	
Riprap Design Velocity Factor For Curved Channel	Kv =	1.88	
Riprap Sizing Velocity For Curved Channel	V_{Kv} =	10.3	fps
Riprap Sizing Paramenter for Straight Channel	**K =**	**1.79**	
Riprap Sizing Paramenter for Outside Bend of Curve	**K_{curve} =**	**3.36**	
*** Superelevation (dh)	dh =	0.23	ft
Discharge (Check)	**Q =**	**501.6**	**cfs**

***** Superelevation to be carried from the beginning of the channel bend to a distance of two times the top width (T) downstream of the channel bend.**

Check on Rock Size for Riprap

Range of K, K_{curve}	Riprap	D50
< 3.3	VL	6 inch
≥ 3.3 to < 4.0	L	9 inch
≥ 4.0 to < 4.6	M	12 inch
≥ 4.6 to < 5.6	H	18 inch
≥ 5.6 to 6.4	VH	24 inch

Tributary Four Improvements Below Research Parkway
Riprap Design Calculation

Station	Description	Riprap or Boulder	Straight or Curved Section	Flow Velocity	Channel Slope	For Curved Sections: rc	For Curved Sections: T	For Curved Sections: V_a	Velocity for Calc	Rock Sizing Parameter	Calculated Riprap Type	Calculated Boulder Size	Riprap or Boulder Classification	Note
39+76	Riprap Rundown	Riprap	Straight	8.6ft/sec	7.63%				8.6ft/sec	4.2	M	---	M	
33+58	Trib Four Channel, Downstream of Dop Sill	Riprap	Straight	8.9ft/sec	0.68%				8.9ft/sec	2.9	VL	---	M	1
33+00	Trib Four Channel	Riprap	Curve	8.2ft/sec	0.70%	85ft	38ft	15.1ft/sec	15.1ft/sec	4.9	H	---	H	
31+63	Trib Four Channel, Upstream of Drop Crest	Riprap	Straight	8.7ft/sec	0.68%				8.7ft/sec	2.8	VL	---	L	2
29+73	Wolf Ranch Rec Center Det Basin Outlet Pipe	Riprap	Straight	6.0ft/sec	16.67%				6.0ft/sec	3.3	L	---	M	
29+65	Trib Four Channel	Riprap	Curve	7.7ft/sec	0.70%	100ft	42ft	14.1ft/sec	14.1ft/sec	4.5	M	---	M	
17+15	Trib Four Channel	Riprap	Curve	8.9ft/sec	0.70%	85ft	33ft	16.0ft/sec	16.0ft/sec	5.1	H	---	H	
12+09	Trib Four Channel	Riprap	Curve	8.8ft/sec	0.70%	200ft	35ft	11.7ft/sec	11.7ft/sec	3.8	L	---	L	
8+02	Cottonwood Creek, Inside Bend	Riprap	Curve	8.1ft/sec	0.42%	200ft	105ft	15.4ft/sec	15.4ft/sec	4.5	M	---	M	
8+02	Cottonwood Creek, Outside Bend	Riprap	Curve	8.1ft/sec	0.42%	100ft	105ft	16.5ft/sec	16.5ft/sec	4.9	H	---	H	
7+77	Cottonwood Creek, Upstream of Drop Crest	Riprap	Straight	12.9ft/sec	1.22%				12.9ft/sec	4.6	M	---	M	
7+11	Cottonwood Creek, Downstream of Drop Sill	Riprap	Straight	10.9ft/sec	1.22%				10.9ft/sec	3.9	L	---	M	1
6+20	Cottonwood Creek, Transtion to Exist. Grades	Riprap	Straight	15.7ft/sec	1.22%				15.7ft/sec	5.6	H	---	M	3

Equations:

Rock Sizing Parameter = $VS^{0.17}/(G_s-1)^{0.66}$

V = Mean channel flow velocity for Riprap Sizing

V = Critical Velocity for Grouted Boulder Sizing

S = Longitudinal channel slope

G_s = Specific Gravity of stone (minimum G_s = 2.50)

G_s = 2.55 (UDFCD Recommended)

G_s = 2.55

Equations taken from *UDFCD USDCM (Eqn MD-13 & HS-9)* and *City of Colorado Springs & El Paso County Drainage Criteria Manual*

$v_a = (-0.147\ r_c/T + 2.176)V$ (Eqn UDFCD MD-10)

V_a = Adjusted channel velocity for riprap sizing along outside of channel bends

r_c = channel centerline radius

T = Top width of water during the major design flood

Rock Sizing Parameter		Riprap Type	D50
0.00	3.29	VL	6 inches
3.30	3.99	L	9 inches
4.00	4.59	M	12 inches
4.60	5.59	H	18 inches
5.60	6.40	VH	24 inches

Rock Sizing Parameter		Grouted Boulder Classification	Grouted Boulder Min. Dimension
0.00	4.49	B18	18 inches
4.50	4.99	B18	18 inches
5.00	5.59	B24	24 inches
5.60	6.39	B30	30 inches
6.40	6.99	B36	36 inches
7.00	7.49	B42	42 inches
7.50	8.00	B48	48 inches

Notes:
1. Type M Riprap is minimum size recommended for areas immediately downstream of drop structures (hydraulic jump area).
2. Type L Riprap is minimum size recommended for areas immediately upstream of drop structures (water surface drawdown area).
3. Proposed channel slope of 1.22% is for interim condition only - future anticipated grade will be flatter and stable.

Tributary Four Drop Structures Below Research Parkway

Hydraulic Jump and Basin Length Calculations

6' High Drop Structure

Hec Ras Mixed Flow Analysis (100-year)

				Supercritical Analysis						Subcritical Analysis					
	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	Vel Chnl	Froude # Chl	Max Chl Dpth	Specif Force	W.S. Elev	Crit W.S.	Vel Chnl	Froude # Chl	Max Chl Dpth	Specif Force
		(cfs)	(ft)	(ft)	(ft)	(ft/s)		(ft)	(cu ft)	(ft)	(ft)	(ft/s)		(ft)	(cu ft)
Drop Crest	3600	500	6947.20	6949.71	6949.71	7.66	1.00	2.51	190.27	6949.71	6949.71	7.67	1.00	2.51	190.27
	3565	500	6941.37	6942.70	6943.97	18.69	3.14	1.32	306.72	6944.61	6943.97	5.89	0.68	3.24	210.92
	3564	500	6941.20	6942.52	6943.80	18.85	3.18	1.32	308.92	6944.65	6943.80	5.41	0.61	3.45	221.80
	3563	500	6941.03	6942.34	6943.63	19.00	3.21	1.31	311.10	6944.68	6943.64	5.01	0.55	3.65	234.57
	3562	500	6940.87	6942.17	6943.48	19.13	3.24	1.30	312.99	6944.70	6943.48	4.69	0.50	3.83	248.03
	3561	500	6940.70	6942.00	6943.31	19.28	3.27	1.30	315.02	6944.72	6943.31	4.39	0.46	4.02	263.89
	3560	500	6940.53	6941.82	6943.14	19.42	3.30	1.29	317.07	6944.74	6943.14	4.12	0.43	4.21	281.22
	3559	500	6940.37	6941.66	6942.99	19.55	3.32	1.29	318.89	6944.75	6942.98	3.90	0.40	4.38	298.67
Drop Toe	3558	500	6940.20	6941.48	6942.81	19.68	3.35	1.28	320.86	6944.76	6942.81	3.69	0.37	4.56	318.60
Jump Begins	3557	500	6940.19	6941.48	6942.81	19.46	3.30	1.29	317.73	6944.76	6942.81	3.68	0.37	4.57	319.80
	3556	500	6940.19	6941.50	6942.80	19.21	3.24	1.31	314.18	6944.76	6942.81	3.68	0.37	4.57	319.74
	3555	500	6940.18	6941.50	6942.80	19.00	3.19	1.32	311.20	6944.76	6942.79	3.67	0.37	4.58	320.95
	3554	500	6940.17	6941.50	6942.79	18.79	3.14	1.33	308.28	6944.76	6942.79	3.66	0.36	4.59	322.16
	3553	500	6940.17	6941.52	6942.78	18.54	3.09	1.35	304.86	6944.76	6942.79	3.66	0.36	4.59	322.11
	3552	500	6940.16	6941.52	6942.78	18.34	3.04	1.36	302.08	6944.76	6942.77	3.65	0.36	4.60	323.27
	3551	500	6940.15	6941.52	6942.77	18.15	3.00	1.37	299.37	6944.76	6942.77	3.63	0.36	4.61	324.55
	3528	500	6940.00	6941.65	6942.62	14.50	2.21	1.65	251.35	6944.76	6942.62	3.47	0.34	4.76	342.70

Jump begins at Sta. 35+57 which is 1' downstream of the drop toe (Sta. 35+58) so add 1' to 60%L for Culvert Outlet Protection

Hydraulic Jump Length, Figure 15-4 (Chow)

F_1 =	3.35	L/Y_2 =	5.5
Y_2 (ft)=	4.76	L (ft)=	26.18
		60%L (ft)=	15.71

(Minimum required length from toe for protection, minimum Basin Length) = 16.7' — use 20'

Note: Calculations provided are for a 6' high drop structure. River Stations are arbitrary (do not match the drawing plan and profiles) and are relative to the drop crest.

- Froude No. at beginning of hydraulic jump
- Specific Force (cu ft) at beginning of hydraulic jump (at location where Specific Force (subcritical) > Specific Force (supercritical))
- Maximum Channel Depth (ft) at approximate downstream end of hydraulic jump

Tributary Four Drop Structures Below Research Parkway
Hydraulic Jump and Basin Length Calculations

Hydraulic jump locations were calculated using criteria from the Urban Storm Drainage Criteria Manual Vol. II, Hydraulic Structures section 2.3.4
Hydraulic jump lengths were calculated using criteria from the Urban Storm Drainage Criteria Manual Vol. II, Hydraulic Structures section 2.3.5 and from Open Channel Hydraulics by Ven Te Chow
HEC-RAS was used for the frontwater (supercirtical profile analysis) and for the backwater (subcritical profile analysis)

To determine the location of the hydraulic jump, a tailwater elevation has to be established by water surface profile analysis that starts from a downstream control point and works upstream to the drop basin. This backwater analysis is based upon entire cross sections for the downstream waterway. The hydraulic jump, in either the low-flow, trickle channel, or the main drop, will begin to form where the unit specific force of the downstream tailwater is greater than the specific force of the supercritical flow below the drop. Special consideration must be given to submerged hydraulic jumps because it is here that reverse rollers are most common. For submerged jumps, the resulting downstream hydraulics should be evaluated (Cotton 1995).

The determination of the jump location is usually accomplished through the comparison of specific force between supercritical inflow and the downstream subcritical flow (i.e., tailwater) conditions:

$$F = \left(\frac{q^2}{gy}\right) + \left(\frac{y^2}{2}\right) \qquad \text{(HS-6)}$$

in which:

F = specific force (ft^2)

q = unit discharge (determined at crest, for low-flow, trickle, and main channel zones) (cfs/ft)

y = depth at analysis point (ft)

g = acceleration of gravity = 32.2 ft/sec^2

The depth, y, for downstream specific energy determination is the tailwater water surface elevation minus the ground elevation at the point of interest, which is typically the main basin elevation or the trickle channel invert (if the jump is to occur in the basin). The depth, for the upstream specific energy (supercritical flow), is the supercritical flow depth at the point in question.

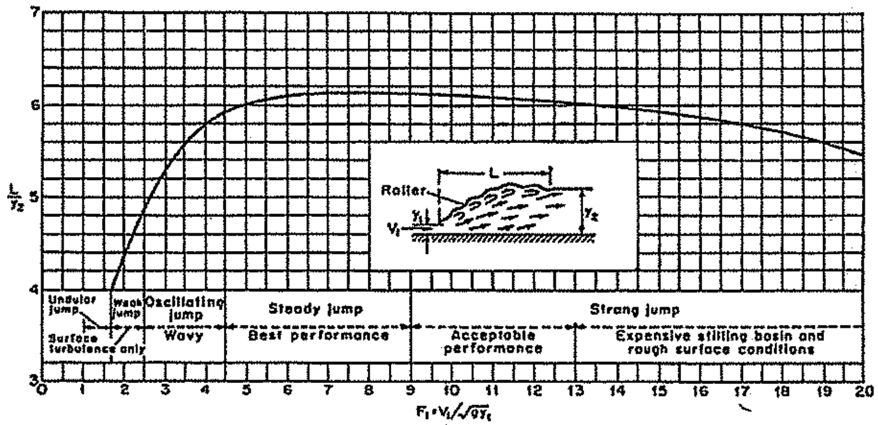


FIG. 15-4. Length in terms of sequent depth y_2 of jumps in horizontal channels. *(Based on data and recommendations of U.S. Bureau of Reclamation* [34].)

Figure 15-4 (Chow), Used to determine the length of the hydraulic jump

Tributary Four Improvements Below Research Parkway
Seepage Analysis and Cutoff Wall Calculations

Seepage Analysis (Lane's Weighted Creep Method Calculation)

Location	C_w	Weep Drain System	C_w	H_s	Drop Height	L_a	L_f	L_s	L_H	Required $L_{v\text{-calc}}$	$L_{V\text{-Struct}}$	L_v Difference $L_{v\text{-calc}}$ and $L_{v\text{-Struct}}$	Additional Calculated Cut off Wall Depth	Additional Cut off Wall Depth
Sta. 7+76.89	5.0	No	5.0	7.1 ft	5.5 ft	13.0ft	39.0ft	38.0ft	90.0 ft	5.5 ft	12.0 ft	0.0 ft	0.0 ft	0 ft
Sta. 11+15.79	5.0	No	5.0	5.6 ft	5.1 ft	13.0ft	30.6ft	33.2ft	76.8 ft	2.4 ft	12.0 ft	0.0 ft	0.0 ft	0 ft
Sta. 14+07.65	5.0	No	5.0	6.9 ft	5.0 ft	13.0ft	30.0ft	33.2ft	76.2 ft	9.1 ft	12.0 ft	0.0 ft	0.0 ft	0 ft
Sta. 16+61.34	5.0	No	5.0	7.9 ft	6.0 ft	13.0ft	36.0ft	33.2ft	82.2 ft	12.1 ft	12.0 ft	0.1 ft	0.0 ft	0 ft
* Sta. 19+51.22	5.0	No	5.0	6.8 ft	5.0 ft	13.0ft	30.0ft	33.2ft	76.2 ft	8.6 ft	12.0 ft	0.0 ft	0.0 ft	0 ft
Sta. 21+18.34	5.0	No	5.0	5.7 ft	3.9 ft	13.0ft	23.4ft	28.2ft	64.6 ft	7.0 ft	12.0 ft	0.0 ft	0.0 ft	0 ft
Sta. 24+53.34	5.0	No	5.0	6.3 ft	4.5 ft	13.0ft	27.0ft	33.2ft	73.2 ft	7.1 ft	12.0 ft	0.0 ft	0.0 ft	0 ft
Sta. 25+93.34	5.0	No	5.0	5.8 ft	4.0 ft	13.0ft	24.0ft	33.2ft	70.2 ft	5.6 ft	12.0 ft	0.0 ft	0.0 ft	0 ft
Sta. 28+36.02	5.0	No	5.0	7.9 ft	6.0 ft	13.0ft	36.0ft	33.2ft	82.2 ft	12.1 ft	12.0 ft	0.1 ft	0.0 ft	0 ft
Sta. 31+63.02	5.0	No	5.0	7.9 ft	6.0 ft	13.0ft	36.0ft	33.2ft	82.2 ft	12.1 ft	12.0 ft	0.1 ft	0.0 ft	0 ft
Sta. 34+18.36	5.0	No	5.0	5.7 ft	4.0 ft	13.0ft	24.0ft	33.2ft	70.2 ft	5.1 ft	12.0 ft	0.0 ft	0.0 ft	0 ft
Sta. 35+78.02	5.0	No	5.0	6.2 ft	4.4 ft	13.0ft	26.4ft	33.2ft	72.6 ft	6.8 ft	12.0 ft	0.0 ft	0.0 ft	0 ft

Equations:

$C_w = [(L_H/3)+L_v] / H_s$ (USDCM Eqn 9-5)

C_w = Lane's Weighted Creep Ratio

Table 9-3: Lane's Weighted Creep Recommended Ratios (USDCM)

- C_w = 8.5 Very fine sand or silt
- C_w = 7.0 Fine Sand
- C_w = 6.0 Medium Sand
- C_w = 5.0 Coarse Sand
- C_w = 4.0 Fine Gravel
- C_w = 3.0 Coarse gravel including cobbles or Soft Clay
- C_w = 2.0 Medium Clay

Weep Drain System: 10% Reduction is C_w if weep drain system is used

H_s = Head Differential between analysis points -- Taken from HEC-Ras

Drop Height = Difference between Crest and Sill

L_H = Sum of the Horizontal Creep Distances (Less than 45 degrees)

$L_H = L_a + L_f$

L_a = Approach Length

L_s = Length of stilling basin (Toe to Sill)

L_f = Drop Face Length (Crest to Toe)

L_v = Sum of the Vertical Creep Distances (Steeper than 45 degrees)

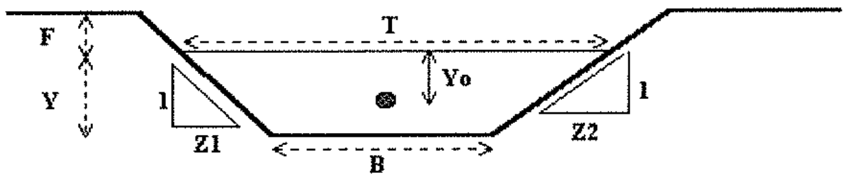
$L_{V\text{-Struct}}$ = Vertical creep distances of structure w/o cut off wall

Additional Calculated Cutoff Wall Depth = Half of L_v Difference if Sheet Pile

* USED FOR INFLOW DROP.

Normal Flow Analysis - Trapezoidal Channel

Project: Wolf Ranch
Channel ID: Upper Tributary Four

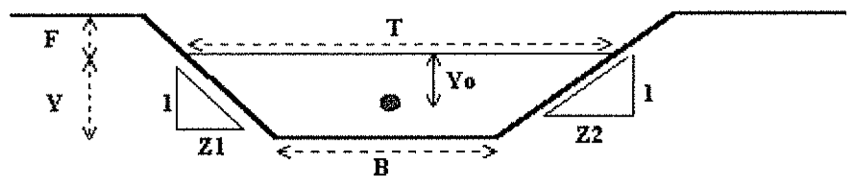


Design Information (Input)		
Channel Invert Slope	So =	0.0100 ft/ft
Manning's n	n =	0.040
Bottom Width	B =	8.00 ft
Left Side Slope	Z1 =	4.00 ft/ft
Right Side Slope	Z2 =	4.00 ft/ft
Freeboard Height	F =	1.00 ft
Design Water Depth	Y =	**2.69** ft

Normal Flow Condtion (Calculated)		
Discharge	**Q =**	**264.81** cfs
Froude Number	**Fr =**	**0.71**
Flow Velocity	**V =**	**5.25** fps
Flow Area	A =	50.46 sq ft
Top Width	T =	29.52 ft
Wetted Perimeter	P =	30.18 ft
Hydraulic Radius	R =	1.67 ft
Hydraulic Depth	D =	1.71 ft
Specific Energy	Es =	3.12 ft
Centroid of Flow Area	Yo =	1.08 ft
Specific Force	Fs =	6.11 kip

Critical Flow Analysis - Trapezoidal Channel

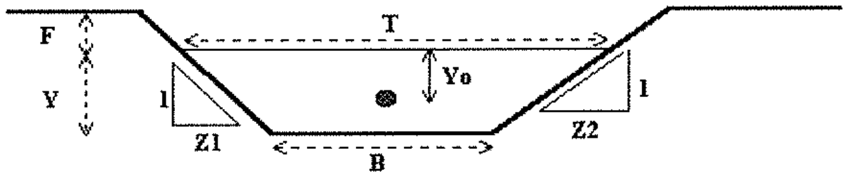
Project: Wolf Ranch
Channel ID: Upper Tributary Four



Design Information (Input)			
Bottom Width	B =	8.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Slope	Z2 =	4.00	ft/ft
Design Discharge	Q =	**264.00**	cfs
Critical Flow Condition (Calculated)			
Critical Flow Depth	**Y =**	**2.25**	ft
Critical Flow Area	A =	38.25	sq ft
Critical Top Width	T =	26.00	ft
Critical Hydraulic Depth	D =	1.47	ft
Critical Flow Velocity	V =	6.90	fps
Froude Number	**Fr =**	**1.00**	
Critical Wetted Perimeter	P =	26.55	ft
Critical Hydraulic Radius	R =	1.44	ft
Critical (min) Specific Energy	Esc =	2.99	ft
Centroid on the Critical Flow Area	Yoc =	0.73	ft
Critical (min) Specific Force	Fsc =	5.27	kip

Normal Flow Analysis - Trapezoidal Channel

Project: Wolf Ranch
Channel ID: Upper Tributary Four

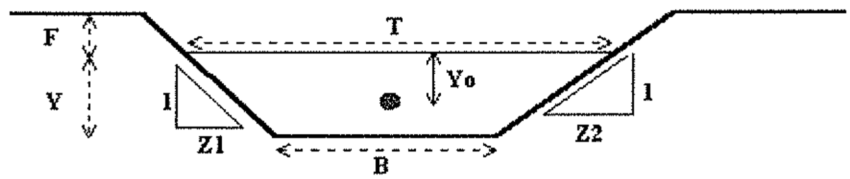


Design Information (Input)			
Channel Invert Slope	So =	0.0100	ft/ft
Manning's n	n =	0.035	
Bottom Width	B =	8.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Slope	Z2 =	4.00	ft/ft
Freeboard Height	F =	1.00	ft
Design Water Depth	Y =	**2.53**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**265.68**	cfs
Froude Number	**Fr =**	**0.80**	
Flow Velocity	**V =**	**5.80**	fps
Flow Area	A =	45.84	sq ft
Top Width	T =	28.24	ft
Wetted Perimeter	P =	28.86	ft
Hydraulic Radius	R =	1.59	ft
Hydraulic Depth	D =	1.62	ft
Specific Energy	Es =	3.05	ft
Centroid of Flow Area	Yo =	1.02	ft
Specific Force	Fs =	5.92	kip

Critical Flow Analysis - Trapezoidal Channel

Project: Wolf Ranch
Channel ID: Upper Tributary Four



Design Information (Input)			
Bottom Width	B =	8.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Slope	Z2 =	4.00	ft/ft
Design Discharge	Q =	**264.00**	cfs

Critical Flow Condition (Calculated)			
Critical Flow Depth	**Y =**	**2.25**	ft
Critical Flow Area	A =	38.25	sq ft
Critical Top Width	T =	26.00	ft
Critical Hydraulic Depth	D =	1.47	ft
Critical Flow Velocity	V =	6.90	fps
Froude Number	**Fr =**	**1.00**	
Critical Wetted Perimeter	P =	26.55	ft
Critical Hydraulic Radius	R =	1.44	ft
Critical (min) Specific Energy	Esc =	2.99	ft
Centroid on the Critical Flow Area	Yoc =	0.73	ft
Critical (min) Specific Force	Fsc =	5.27	kip

Upper Tributary Four Drop Structures
Wolf Lake to Detention Basin F28
Hydraulic Jump and Basin Length Calculations

6' High Drop Structure

Hec Ras Mixed Flow Analysis (100-year)				Supercritical Analysis						Subcritical Analysis					
	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	Vel Chnl	Froude # Chl	Max Chl Dpth	Specif Force	W.S. Elev	Crit W.S.	Vel Chnl	Froude # Chl	Max Chl Dpth	Specif Force
		(cfs)	(ft)	(ft)	(ft)	(ft/s)		(ft)	(cu ft)	(ft)	(ft)	(ft/s)		(ft)	(cu ft)
Drop Crest	930	264	95.80	98.03	98.04	6.99	1.02	2.23	92.04	98.04	98.04	6.93	1.01	2.24	92.03
	895	264	89.97	91.14	92.21	17.86	3.41	1.17	153.96	92.75	92.21	4.96	0.66	2.78	100.39
	894	264	89.80	90.96	92.04	18.00	3.44	1.16	155.01	92.79	92.04	4.42	0.57	2.99	107.68
	893	264	89.63	90.78	91.87	18.13	3.48	1.15	156.04	92.82	91.87	3.99	0.50	3.19	116.51
	892	264	89.47	90.62	91.71	18.25	3.51	1.15	156.94	92.84	91.71	3.65	0.45	3.37	126.11
	891	264	89.30	90.44	91.54	18.38	3.54	1.14	157.92	92.85	91.54	3.35	0.40	3.55	137.62
	890	264	89.13	90.27	91.37	18.51	3.57	1.14	158.88	92.86	91.37	3.09	0.35	3.73	150.48
Jump Begins	889	264	88.97	90.10	91.21	18.62	3.60	1.13	159.72	92.87	91.21	2.88	0.32	3.90	163.79
	887	264	88.63	89.75	90.87	18.86	3.66	1.12	161.53	92.89	90.87	2.52	0.26	4.26	195.96
Drop Toe	885	264	88.30	89.41	90.54	19.07	3.71	1.11	163.14	92.90	90.54	2.24	0.22	4.60	232.31
	884	264	88.30	89.43	90.54	18.73	3.63	1.13	160.57	92.90	90.54	2.24	0.22	4.60	232.29
	883	264	88.30	89.44	90.54	18.40	3.54	1.14	158.07	92.90	90.54	2.24	0.22	4.60	232.27
	882	264	88.30	89.46	90.54	18.08	3.46	1.16	155.63	92.90	90.54	2.24	0.22	4.60	232.24
	881	264	88.30	89.47	90.54	17.76	3.38	1.17	153.26	92.90	90.54	2.24	0.22	4.60	232.22
	880	264	88.30	89.49	90.54	17.45	3.31	1.19	150.94	92.90	90.54	2.24	0.22	4.60	232.19
	879	264	88.30	89.50	90.54	17.15	3.23	1.20	148.69	92.90	90.54	2.24	0.22	4.60	232.17
	873	264	88.30	89.60	90.54	15.45	2.82	1.30	136.28	92.90	90.54	2.24	0.22	4.60	232.02

Jump begins at Sta. 8+89 which is 4' upstream of the drop toe (Sta. 8+85) so start jump length at drop toe
Hydraulic Jump Length, Figure 15-4 (Chow)

F_1 = 3.60 L/Y_2 = 5.6
Y_2 (ft)= 4.60 L (ft)= 25.76
60%L (ft)= 15.46

(Minimum required length from toe for protection, minimum Basin Length) = **16'** **use 20'**

Note: Calculations provided are for a 6' high drop structure. River Stations and Minimum Channel Elevations are arbitrary (do not match the drawing plan and profiles) relative to the drop crest and used only for purposes of the analysis.

- Froude No. at beginning of hydraulic jump
- Specific Force (cu ft) at beginning of hydraulic jump (at location where Specific Force (subcritical) > Specific Force (supercritical))
- Maximum Channel Depth (ft) at approximate downstream end of hydraulic jump

Upper Tributary Four Drop Structures
Wolf Lake to Detention Basin F28
Hydraulic Jump and Basin Length Calculations

5' High Drop Structure
Hec Ras Mixed Flow Analysis (100-year)

	River Sta	Q Total	Min Ch El	Supercritical Analysis W.S. Elev	Crit W.S.	Vel Chnl	Froude # Chl	Max Chl Dpth	Specif Force	Subcritical Analysis W.S. Elev	Crit W.S.	Vel Chnl	Froude # Chl	Max Chl Dpth	Specif Force
		(cfs)	(ft)	(ft)	(ft)	(ft/s)		(ft)	(cu ft)	(ft)	(ft)	(ft/s)		(ft)	(cu ft)
Drop Crest	634	264	87.52	89.75	89.76	6.99	1.02	2.23	92.04	89.76	89.76	6.93	1.01	2.24	92.03
	606	264	82.85	84.07	85.09	16.81	3.15	1.22	146.22	85.42	85.09	5.61	0.77	2.57	95.20
	605	264	82.69	83.90	84.93	16.97	3.19	1.21	147.35	85.47	84.93	4.96	0.66	2.78	100.39
	604	264	82.52	83.72	84.76	17.13	3.23	1.20	148.55	85.51	84.76	4.42	0.57	2.99	107.68
	603	264	82.35	83.54	84.59	17.29	3.27	1.19	149.73	85.54	84.59	3.99	0.50	3.19	116.51
	602	264	82.19	83.38	84.43	17.43	3.30	1.19	150.77	85.56	84.43	3.65	0.45	3.37	126.11
	601	264	82.02	83.20	84.26	17.58	3.34	1.18	151.90	85.57	84.26	3.35	0.40	3.55	137.62
	600	264	81.85	83.02	84.09	17.73	3.38	1.17	153.00	85.58	84.09	3.09	0.35	3.73	150.48
Jump Begins	599	264	81.69	82.86	83.93	17.86	3.41	1.17	153.96	85.59	83.93	2.88	0.32	3.90	163.79
	597	264	81.35	82.50	83.59	18.13	3.48	1.15	156.04	85.61	83.59	2.52	0.26	4.26	195.96
Drop Toe	595	264	81.02	82.16	83.26	18.38	3.54	1.14	157.92	85.62	83.26	2.24	0.22	4.60	232.31
	594	264	81.02	82.18	83.26	18.06	3.46	1.16	155.49	85.62	83.26	2.24	0.22	4.60	232.29
	593	264	81.02	82.19	83.26	17.74	3.38	1.17	153.12	85.62	83.26	2.24	0.22	4.60	232.27
	592	264	81.02	82.21	83.26	17.43	3.30	1.19	150.81	85.62	83.26	2.24	0.22	4.60	232.24
	591	264	81.02	82.22	83.26	17.13	3.23	1.20	148.56	85.62	83.26	2.24	0.22	4.60	232.22
	590	264	81.02	82.24	83.26	16.83	3.16	1.22	146.36	85.62	83.26	2.24	0.22	4.60	232.19
	589	264	81.02	82.25	83.26	16.54	3.08	1.23	144.22	85.62	83.26	2.24	0.22	4.60	232.17
	583	264	81.02	82.35	83.26	14.90	2.69	1.33	132.41	85.62	83.26	2.24	0.22	4.60	232.02

Jump begins at Sta. 5+99 which is 4' upstream of the drop toe (Sta. 5+95) so start jump length at drop toe
Hydraulic Jump Length, Figure 15-4 (Chow)

F_1 = 3.41 L/Y_2 = 5.5
Y_2 (ft)= 4.60 L (ft)= 25.30
60%L (ft)= 15.18

(Minimum required length from toe for protection, minimum Basin Length) = **16'** use 20'

Note: Calculations provided are for a 5' high drop structure. River Stations and Minimum Channel Elevations are arbitrary (do not match the drawing plan and profiles) relative to the drop crest and used only for purposes of the analysis.

Froude No. at beginning of hydraulic jump
Specific Force (cu ft) at beginning of hydraulic jump (at location where Specific Force (subcritical) > Specific Force (supercritical))
Maximum Channel Depth (ft) at approximate downstream end of hydraulic jump

Upper Tributary Four Drop Structures
Wolf Lake to Detention Basin F28
Hydraulic Jump and Basin Length Calculations

4' High Drop Structure

Hec Ras Mixed Flow Analysis (100-year)

				Supercritical Analysis						Subcritical Analysis					
	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	Vel Chnl	Froude # Chl	Max Chl Dpth	Specif Force	W.S. Elev	Crit W.S.	Vel Chnl	Froude # Chl	Max Chl Dpth	Specif Force
		(cfs)	(ft)	(ft)	(ft)	(ft/s)		(ft)	(cu ft)	(ft)	(ft)	(ft/s)		(ft)	(cu ft)
Drop Crest	344	264	80.24	82.47	82.48	6.99	1.02	2.23	92.04	82.48	82.48	6.93	1.01	2.24	92.03
	323	264	76.74	78.03	78.98	15.49	2.83	1.29	136.58	79.06	78.98	6.60	0.95	2.32	92.16
	322	264	76.57	77.85	78.81	15.70	2.88	1.28	138.11	79.14	78.81	5.61	0.77	2.57	95.18
	321	264	76.41	77.68	78.65	15.89	2.93	1.27	139.46	79.19	78.65	4.96	0.66	2.78	100.36
	320	264	76.24	77.50	78.48	16.09	2.98	1.26	140.91	79.23	78.48	4.43	0.57	2.99	107.64
	319	264	76.07	77.32	78.31	16.28	3.02	1.25	142.31	79.26	78.31	3.99	0.50	3.19	116.46
	318	264	75.91	77.15	78.15	16.45	3.06	1.24	143.52	79.27	78.15	3.66	0.45	3.36	126.05
	317	264	75.74	76.97	77.98	16.64	3.11	1.23	144.96	79.29	77.98	3.35	0.40	3.55	137.56
Jump Begins	316	264	75.57	76.79	77.81	16.81	3.15	1.22	146.22	79.30	77.81	3.09	0.35	3.73	150.42
	314	264	75.24	76.44	77.48	17.13	3.23	1.20	148.55	79.32	77.48	2.69	0.29	4.08	179.14
Drop Toe	311	264	74.74	75.92	76.98	17.58	3.34	1.18	151.90	79.34	76.98	2.24	0.22	4.60	232.22
	310	264	74.74	75.94	76.98	17.27	3.26	1.20	149.62	79.34	76.98	2.24	0.22	4.60	232.19
	309	264	74.74	75.95	76.98	16.97	3.19	1.21	147.40	79.34	76.98	2.24	0.22	4.60	232.17
	308	264	74.74	75.97	76.98	16.68	3.12	1.23	145.24	79.34	76.98	2.24	0.22	4.60	232.15
	307	264	74.74	75.98	76.98	16.39	3.05	1.24	143.13	79.34	76.98	2.24	0.22	4.60	232.12
	306	264	74.74	76.00	76.98	16.11	2.98	1.26	141.06	79.34	76.98	2.24	0.22	4.60	232.10
	305	264	74.74	76.01	76.98	15.83	2.91	1.27	139.05	79.34	76.98	2.24	0.22	4.60	232.08
	303	264	74.74	76.05	76.98	15.29	2.79	1.31	135.16	79.34	76.98	2.24	0.22	4.60	232.03

Jump begins at Sta. 3+16 which is 5' upstream of the drop toe (Sta. 3+11) so start jump length at drop toe

Hydraulic Jump Length, Figure 15-4 (Chow)

F_1 =	3.15	L/Y_2 =	5.4
Y_2 (ft)=	4.60	L (ft)=	24.84
		60%L (ft)=	14.90

(Minimum required length from toe for protection, minimum Basin Length) = 15' | use 20'

Note: Calculations provided are for a 4' high drop structure. River Stations and Minimum Channel Elevations are arbitrary (do not match the drawing plan and profiles) relative to the drop crest and used only for purposes of the analysis.

- Froude No. at beginning of hydraulic jump
- Specific Force (cu ft) at beginning of hydraulic jump (at location where Specific Force (subcritical) > Specific Force (supercritical))
- Maximum Channel Depth (ft) at approximate downstream end of hydraulic jump

Upper Tributary Four Drop Structures
Wolf Lake to Detention Basin F28
Hydraulic Jump and Basin Length Calculations

- Hydraulic jump locations were calculated using criteria from the Urban Storm Drainage Criteria Manual Vol. II, Hydraulic Structures section 2.3.4

Hydraulic jump lengths were calculated using criteria from the Urban Storm Drainage Criteria Manual Vol. II, Hydraulic Structures section 2.3.5 and from Open Channel Hydraulics by Ven Te Chow

HEC-RAS was used for the frontwater (supercirtical profile analysis) and for the backwater (subcritical profile analysis)

To determine the location of the hydraulic jump, a tailwater elevation has to be established by water surface profile analysis that starts from a downstream control point and works upstream to the drop basin. This backwater analysis is based upon entire cross sections for the downstream waterway. The hydraulic jump, in either the low-flow, trickle channel, or the main drop, will begin to form where the unit specific force of the downstream tailwater is greater than the specific force of the supercritical flow below the drop. Special consideration must be given to submerged hydraulic jumps because it is here that reverse rollers are most common. For submerged jumps, the resulting downstream hydraulics should be evaluated (Cotton 1995).

The determination of the jump location is usually accomplished through the comparison of specific force between supercritical inflow and the downstream subcritical flow (i.e., tailwater) conditions:

$$F = \left(\frac{q^2}{gy}\right) + \left(\frac{y^2}{2}\right) \quad \text{(HS-6)}$$

In which:

F = specific force (ft^2)

q = unit discharge (determined at crest, for low-flow trickle, and main channel zones) (cfs/ft)

y = depth at analysis point (ft)

g = acceleration of gravity = 32.2 ft/sec^2

The depth, y, for downstream specific energy determination is the tailwater water surface elevation minus the ground elevation at the point of interest, which is typically the main basin elevation or the trickle channel invert (if the jump is to occur in the basin). The depth, for the upstream specific energy (supercritical flow), is the supercritical flow depth at the point in question.

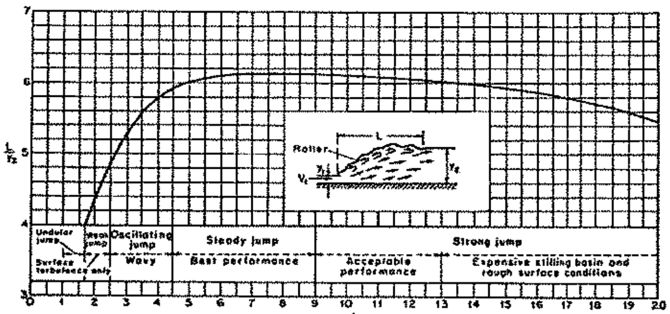


Fig. 15-4. Length in terms of sequent depth y_2 of jumps in horizontal channels. *(Based on data and recommendations of U.S. Bureau of Reclamation* [34].)

Figure 15-4 (Chow), Used to determine the length of the hydraulic jump

Upper Tributary Four Improvements
Wolf Lake to Detention Basin F28
Seepage Analysis and Cutoff Wall Calculations

Seepage Analysis (Lane's Weighted Creep Method Calculation)

Drop No.	Location	C_w	Weep Drain System	C_w	H_s	Drop Height	L_a	L_f	L_s	L_H	Required $L_{v\text{-}calc}$	$L_{v\text{-}Struct}$	L_v Difference $L_{v\text{-}calc}$ and $L_{v\text{-}Struct}$	Additional Calculated Cut off Wall Depth	**Additional Cut off Wall Depth**
1	Sta. 52+25.00	5.0	No	**5.0**	**8.2 ft**	6.0 ft	13.0ft	45.0ft	33.7ft	**91.7 ft**	10.4 ft	**11.4 ft**	0.0 ft	0.0 ft	**0 ft**
2	Sta. 54+40.00	5.0	No	**5.0**	**8.2 ft**	6.0 ft	13.0ft	45.0ft	33.7ft	**91.7 ft**	10.4 ft	**11.4 ft**	0.0 ft	0.0 ft	**0 ft**
3	Sta. 57+80.00	5.0	No	**5.0**	**8.2 ft**	6.0 ft	13.0ft	45.0ft	33.7ft	**91.7 ft**	10.4 ft	**11.4 ft**	0.0 ft	0.0 ft	**0 ft**
4	Sta. 64+90.00	5.0	No	**5.0**	**8.2 ft**	6.0 ft	13.0ft	45.0ft	33.7ft	**91.7 ft**	10.4 ft	**11.4 ft**	0.0 ft	0.0 ft	**0 ft**
5	Sta. 67+67.19	5.0	No	**5.0**	**8.2 ft**	6.0 ft	13.0ft	45.0ft	33.7ft	**91.7 ft**	10.4 ft	**11.4 ft**	0.0 ft	0.0 ft	**0 ft**
6	Sta. 70+13.75	5.0	No	**5.0**	**5.7 ft**	4.0 ft	13.0ft	33.0ft	33.7ft	**79.7 ft**	1.9 ft	**11.4 ft**	0.0 ft	0.0 ft	**0 ft**
7	Sta. 72+57.02	5.0	No	**5.0**	**7.1 ft**	5.0 ft	13.0ft	39.0ft	33.7ft	**85.7 ft**	6.9 ft	**11.4 ft**	0.0 ft	0.0 ft	**0 ft**
8	Sta. 76+73.54	5.0	No	**5.0**	**8.2 ft**	6.0 ft	13.0ft	45.0ft	33.7ft	**91.7 ft**	10.4 ft	**10.9 ft**	0.0 ft	0.0 ft	**0 ft**
9	Sta. 81+41.67	5.0	No	**5.0**	**7.1 ft**	5.0 ft	13.0ft	39.0ft	33.7ft	**85.7 ft**	6.9 ft	**10.0 ft**	0.0 ft	0.0 ft	**0 ft**
10	Sta. 85+93.91	5.0	No	**5.0**	**8.0 ft**	5.6 ft	13.0ft	42.6ft	33.7ft	**89.3 ft**	10.2 ft	**11.4 ft**	0.0 ft	0.0 ft	**0 ft**
11	Sta. 89+95.60	5.0	No	**5.0**	**8.2 ft**	6.0 ft	13.0ft	45.0ft	33.7ft	**91.7 ft**	10.4 ft	**11.4 ft**	0.0 ft	0.0 ft	**0 ft**
12	Sta. 91+95.85	5.0	No	**5.0**	**8.2 ft**	6.0 ft	13.0ft	45.0ft	33.7ft	**91.7 ft**	10.4 ft	**11.4 ft**	0.0 ft	0.0 ft	**0 ft**
13	Sta. 95+06.94	5.0	No	**5.0**	**8.2 ft**	6.0 ft	13.0ft	45.0ft	33.7ft	**91.7 ft**	10.4 ft	**11.4 ft**	0.0 ft	0.0 ft	**0 ft**
14	Sta. 98+22.91	5.0	No	**5.0**	**7.0 ft**	4.4 ft	13.0ft	35.4ft	33.7ft	**82.1 ft**	7.6 ft	**11.4 ft**	0.0 ft	0.0 ft	**0 ft**
15	Sta. 100+98.92	5.0	No	**5.0**	**5.4 ft**	3.38 ft	13.0ft	29.3ft	33.7ft	**76.0 ft**	1.7 ft	**11.4 ft**	0.0 ft	0.0 ft	**0 ft**

Equations:

$C_w = [(L_H/3)+L_v] / H_s$ (USDCM Eqn 9-5)

C_w = Lane's Weighted Creep Ratio

Table 9-3: Lane's Weighted Creep Recommended Ratios (USDCM)

- C_w = 8.5 Very fine sand or silt
- C_w = 7.0 Fine Sand
- C_w = 6.0 Medium Sand
- C_w = 5.0 Coarse Sand
- C_w = 4.0 Fine Gravel
- C_w = 3.0 Coarse gravel including cobbles or Soft Clay
- C_w = 2.0 Medium Clay

Weep Drain System: 10% Reduction is C_w if weep drain system is used

H_s = Head Differential between analysis points -- Taken from HEC-Ras

Drop Height = Difference between Crest and Sill

L_H = Sum of the Horizontal Creep Distances (Less than 45 degrees)

$L_H = L_a + L_f$

- L_a = Approach Length
- L_s = Length of stilling basin (Toe to Sill)
- L_f = Drop Face Length (Crest to Toe)

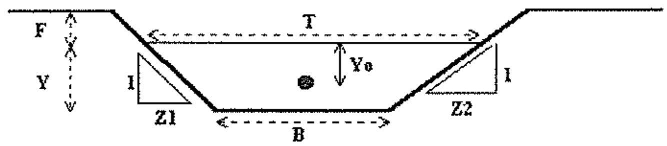
L_v = Sum of the Vertical Creep Distances (Steeper than 45 degrees)

$L_{v\text{-}Struct}$ = Vertical creep distances of structure w/o cut off wall

Additional Calculated Cutoff Wall Depth = Half of L_v Difference if Sheet Pile

Design of Riprap Channel Cross Section

Project: Wolf Ranch
Channel ID: Upper Tributary Four



Design Information (Input)			
Channel Invert Slope	So =	0.0100	ft/ft
Bottom Width	B =	8.0	ft
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Specific Gravity of Rock	Ss =	2.50	
Radius of Channel Centerline	Ccr =	60.0	ft
Design Disharge	**Q =**	**264.0**	**cfs**
Flow Condition (Calculated)			
Riprap Type (Straight Channel)	**Type =**	**VL**	
Intermediate Rock Diameter (Straight Channel)	**D50 =**	**6**	**inches**
Calculated Manning's n (Straight Channel)	**n =**	**0.0352**	
* **Riprap Type (Outside Bend of Curved Channel)**	**Type =**	**L**	
* **Intermediate Rock Dia. (O.B. of Curved Channel)**	**D50 =**	**9**	**inches**
* **Calculated Manning's N (Curved Channel)**	**n =**	**0.0377**	
Water Depth	Y =	2.54	ft
Top Width of Flow	T =	28.3	ft
Flow Area	A =	46.1	sq ft
Wetted Perimeter	P =	28.9	ft
Hydraulic Radius (A/P)	R =	1.6	ft
Average Flow Velocity (Q/A)	V =	5.8	fps
Hydraulic Depth (A/T)	D =	1.6	ft
Froude Number (max. = 0.8)	Fr =	0.80	
Channel Radius / Top Width	Ccr/T =	2.12	
** Riprap Design Velocity Factor For Curved Channel	Kv =	1.86	
Riprap Sizing Velocity For Curved Channel	V_{Kv} =	10.8	fps
Riprap Sizing Paramenter for Straight Channel	**K =**	**2.02**	
Riprap Sizing Paramenter for Outside Bend of Curve	**K_{curve} =**	**3.77**	
*** Superelevation (dh)	dh =	0.24	ft
Discharge (Check)	**Q =**	**266.5**	**cfs**

*** Outside bend and adjacent 1/4 of channel bottom. As an alternative to riprap lining the channel bottom, carry the bank liner at the bank slope to 5-ft. below the channel bottom.**

**** Increases the average channel velocity by a factor for sizing riprap on the outside bank when the channel curve has a radius <= 8 times top flow width. Minimum radius to top width ratio is 2.0. Carry the larger riprap for a distance of two times the top width (T) of the channel.**

***** Superelevation to be carried from the beginning of the channel bend to a distance of two times the top width (T) downstream of the channel bend.**

Check on Rock Size for Riprap

Range of K, K_{curve}	Riprap	D50
< 3.3	VL	6 inch
≥ 3.3 to < 4.0	L	9 inch
≥ 4.0 to < 4.6	M	12 inch
≥ 4.6 to < 5.6	H	18 inch
≥ 5.6 to 6.4	VH	24 inch

Upper Tributary Four Improvements
Wolf Lake to Detention Basin F28
Riprap Design Calculations

Station	Description	Riprap or Boulder	Straight or Curved Section	Flow Velocity	Channel Slope	For Curved Sections: rc	For Curved Sections: T	For Curved Sections: V_a	Velocity for Calc	Super-elevation dY	d_{50}	Calculated Riprap Type	Calculated Boulder Size	Riprap or Boulder Classification	Note
101+30	Outside Bend	Riprap	Curve	8.8ft/sec	0.24%	50ft	26ft	16.6ft/sec	16.6ft/sec	0.62ft	0.98	M	---	M	
99+68	Outside Bend	Riprap	Curve	7.5ft/sec	1.00%	50ft	26ft	14.2ft/sec	14.2ft/sec	0.46ft	1.17	H	---	H	
98+84	Outside Bend	Riprap	Curve	7.1ft/sec	1.00%	65ft	28ft	13.0ft/sec	13.0ft/sec	0.34ft	0.98	M	---	M	
96+85	Outside Bend	Riprap	Curve	7.7ft/sec	1.00%	65ft	25ft	13.8ft/sec	13.8ft/sec	0.36ft	1.10	H	---	H	
95+91	Straight Channel	Riprap	Straight	7.2ft/sec	1.00%				7.2ft/sec		0.30	VL	---	L	3
93+46	Outside Bend	Riprap	Curve	7.7ft/sec	1.00%	175ft	26ft	9.1ft/sec	9.1ft/sec	0.14ft	0.48	VL	---	L	3
92+16	Upstream of Drop Crest	Riprap	Straight	8.2ft/sec	1.00%				8.2ft/sec		0.39	VL	---	M	1
91+20	Downstream of Drop Sill	Riprap	Straight	7.7ft/sec	1.00%				7.7ft/sec		0.35	VL	---	M	2
86+36	Outside Bend	Riprap	Curve	6.0ft/sec	1.00%	35ft	40ft	12.4ft/sec	12.4ft/sec	0.77ft	0.89	M	---	M	
82+03	Outside Bend	Riprap	Curve	5.7ft/sec	1.00%	46ft	57ft	11.7ft/sec	11.7ft/sec	0.62ft	0.79	M	---	M	
77+20	Outside Bend	Riprap	Curve	5.7ft/sec	1.00%	37ft	50ft	11.8ft/sec	11.8ft/sec	0.68ft	0.80	M	---	M	
72+77	Outside Bend	Riprap	Curve	6.7ft/sec	1.00%	53ft	47ft	13.5ft/sec	13.5ft/sec	0.62ft	1.06	H	---	H	
71+07	Outside Bend	Riprap	Curve	6.5ft/sec	1.00%	60ft	33ft	12.4ft/sec	12.4ft/sec	0.36ft	0.89	M	---	M	
68+71	Outside Bend	Riprap	Curve	6.9ft/sec	1.00%	70ft	31ft	12.7ft/sec	12.7ft/sec	0.32ft	0.93	M	---	M	
65+90	Outside Bend	Riprap	Curve	6.5ft/sec	1.00%	65ft	32ft	12.2ft/sec	12.2ft/sec	0.32ft	0.86	M	---	M	
58+89	Outside Bend	Riprap	Curve	6.5ft/sec	1.00%	100ft	46ft	12.1ft/sec	12.1ft/sec	0.30ft	0.85	M	---	M	
55+80	Outside Bend	Riprap	Curve	6.7ft/sec	1.00%	90ft	32ft	11.8ft/sec	11.8ft/sec	0.25ft	0.81	M	---	M	
52+94	Outside Bend	Riprap	Curve	6.8ft/sec	1.00%	75ft	29ft	12.2ft/sec	12.2ft/sec	0.28ft	0.86	M	---	M	

Riprap Type	d_{50}
VL	0.50 ft
L	0.75 ft
M	1.0 ft
H	1.5 ft
VH	2.0 ft

Equations: Taken from *UDFCD USDCM, Volume 1*

$d_{50} \geq [VS^{0.17}/4.5(G_s-1)^{0.66}]^2$ (UDFCD Eqn 8-11)

d_{50} = Mean rock size (ft)

V = Mean channel velocity for riprap sizing (ft/sec)

S = Longitudinal channel slope (ft/ft)

G_s = Specific Gravity of stone (minimum G_s = 2.50)

G_s = 2.55 (UDFCD Recommended)

G_s = 2.55

V_a = (-0.147 r_c/T + 2.176)V (UDFCD Eqn 8-10)

V_a = Adjusted channel velocity for riprap sizing along outside of channel bends

r_c = channel centerline radius

T = Top width of water during the major design flood

Superelevation (dY) = $V^2T/2gr$, (UDFCD Eqn MD-9 from Vol. 1, 4/2008)

V = Mean channel flow velocity

T = Top Width of the channel under design flow conditions

g = Gravitational constant = 32.2 ft/sec^2

r_c = channel centerline radius

Notes:
1. Type M Riprap is minimum size recommended for areas immediately upstream of drop structures (water surface drawdown area).
2. Type M Riprap is minimum size recommended for areas immediately downstream of drop structures (hydraulic jump area).
3. Type L Riprap is minimum size recommended for bank lining/toe protection.

APPENDIX C

PLAN AND PROFILES

WOLF RANCH DEVELOPMENT
TRIBUTARY FOUR IMPROVEMENTS BELOW RESEARCH PARKWAY
CONSTRUCTION DRAWINGS
COLORADO SPRINGS, COLORADO

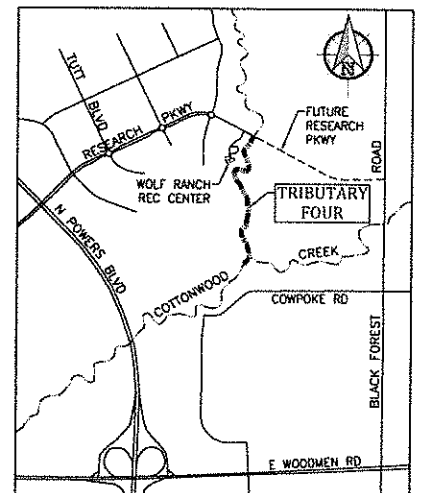
GENERAL NOTES

1. ALL MATERIALS AND WORKMANSHIP SHALL BE IN CONFORMANCE WITH THE CITY OF COLORADO SPRINGS SPECIFICATIONS (CURRENT EDITION) AND THE COLORADO DEPARTMENT OF TRANSPORTATION (CDOT) STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION (CURRENT EDITION).
2. THE CONTRACTOR SHALL HAVE IN HIS POSSESSION AT ALL TIMES ONE (1) SIGNED COPY OF THE PLANS AND SPECIFICATIONS WHICH HAVE BEEN APPROVED BY THE CITY OF COLORADO SPRINGS (CITY).
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING AS-BUILT INFORMATION ON A SET OF RECORD DRAWINGS.
4. THE CONTRACTOR SHALL NOTIFY THE OWNER AND ENGINEER OF ANY PROBLEM IN CONFORMING TO THE APPROVED PLANS FOR ANY ELEMENT OF THE PROPOSED IMPROVEMENTS PRIOR TO ITS CONSTRUCTION.
5. THE CONTRACTOR SHALL PROTECT ALL EXISTING FACILITIES IN THE GENERAL AREA OF CONSTRUCTION. THE CONTRACTOR SHALL REPAIR ANY DAMAGE CAUSED BY CONSTRUCTION OPERATIONS AT NO COST TO THE PROJECT.
6. UTILITY LINES AS SHOWN ON THESE DRAWINGS ARE PLOTTED FROM THE BEST AVAILABLE INFORMATION. THE CONTRACTOR SHALL CALL 811 FOR UTILITY LOCATIONS AT LEAST TWO WORKING DAYS PRIOR TO ANY DIGGING. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL UTILITIES PRIOR TO CONSTRUCTION AND SHALL PROTECT THEM FROM DAMAGE DURING CONSTRUCTION.
7. A CITY OF COLORADO SPRINGS UTILITIES INSPECTOR IS REQUIRED TO BE ONSITE DURING EXCAVATION AND CONSTRUCTION AROUND GAS AND ELECTRIC FACILITIES. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO COORDINATE WITH THE GAS AND ELECTRIC DEPARTMENT FORTY-EIGHT (48) HOURS PRIOR TO CONSTRUCTION.
8. ALL EARTHWORK, ROADWAY AND TRENCHING OPERATIONS SHALL BE IN CONFORMANCE WITH THE CITY STANDARD SPECIFICATIONS.
9. EXCAVATION REQUIRED FOR COMPACTION OF BASES OF CUTS AND FILLS WILL BE CONSIDERED AS SUBSIDIARY TO THAT OPERATION AND WILL NOT BE PAID FOR SEPARATELY.
10. THE TESTING OF COMPACTION FOR THIS PROJECT WILL BE PER AASHTO T 99.
11. ALL EXISTING MANHOLES TO BE MARKED WITH T-POSTS AND CAUTION TAPE PRIOR TO COMMENCING WITH THE CONSTRUCTION.
12. CONTRACTOR SHALL BE RESPONSIBLE FOR THE ESTABLISHMENT, MAINTENANCE AND DEMOBILIZATION OF CONSTRUCTION STAGING AREA(S) WITH THE CITY OF COLORADO SPRINGS.
13. WATER SHALL BE USED AS A DUST PALLIATIVE WHERE REQUIRED. WATER WILL NOT BE PAID FOR SEPARATELY, BUT WILL BE SUBSIDIARY TO THE EXCAVATION ITEM.
14. THE SOIL TO BE PLACED AS TOPSOIL MATERIAL SHALL BE FREE OF REFUSE, STUMPS, ROOTS, ROCKS, BRUSH, WEEDS, HARD CLODS, TOXIC SUBSTANCES OR OTHER MATERIAL WHICH WOULD BE DETRIMENTAL TO ITS USE ON THE PROJECT. IT SHALL HAVE A MINIMUM P.I. OF 5 BUT SHALL NOT BE SUCH HEAVY CLAY AS TO PRECLUDE PLACEMENT WITH A SHOULDER MACHINE.
15. SALVAGEABLE MATERIAL: MATERIAL THAT CAN BE SAVED OR SALVAGED. UNLESS OTHERWISE SPECIFIED IN THE CONTRACT, ALL SALVABLE MATERIAL SHALL BECOME THE PROPERTY OF THE CONTRACTOR.
16. TOPOGRAPHIC DATA INDICATED ON THESE DRAWINGS WAS COMPILED FROM AERIAL AND FIELD SURVEYS. CONTRACTOR MUST VERIFY EXTENT OF WORK WITHIN THESE AREAS. DIMENSIONS, ELEVATIONS, AND LOCATIONS OF EXISTING STRUCTURES, PIPELINES, AND UTILITIES ARE APPROXIMATE. WHERE SUCH DIMENSIONS OR LOCATIONS DETERMINE THE LIMITS OF THE WORK, SUCH DIMENSIONS OR LOCATIONS SHALL BE VERIFIED IN THE FIELD PRIOR TO CONSTRUCTION.
17. THE LOCATIONS OF EXISTING STRUCTURES, PIPELINES, UTILITIES, ETC., SHOWN ON THE DRAWINGS HAVE BEEN APPROXIMATED. THERE MAY BE OTHER STRUCTURES, PIPELINES, UTILITIES, ETC., NOT SHOWN ON THE DRAWINGS WHICH PRESENTLY EXIST IN THE AREA OF CONSTRUCTION. THE ENGINEER AND/OR OWNER ASSUMES NO RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS OF THE INFORMATION SHOWN. THE CONTRACTOR WILL BE RESPONSIBLE FOR LOCATING AND PROTECTING ALL IMPACTED EXISTING STRUCTURES, PIPELINES, UTILITIES, ETC., IN THE PROJECT SITE.
18. THE CONTRACTOR SHALL CAREFULLY PRESERVE ALL MONUMENTS, BENCHMARKS, PROPERTY MARKERS, REFERENCE POINTS, AND STAKES. IN CASE OF HIS DESTRUCTION OF THESE, THE CONTRACTOR WILL BE RESPONSIBLE FOR RESETTING SAME, AT NO COST TO THE OWNER, AND SHALL BE RESPONSIBLE FOR ANY LOSS OF TIME THAT MAY BE CAUSED.
19. THE CONTRACTOR SHALL NOTIFY THE ENGINEER WHERE UTILITIES CONFLICT WITH THE WORK IN CONFORMANCE WITH THE SPECIFICATIONS. WHERE FIELD VERIFICATION IS NOTED ON THE PLANS, THIS SHALL REQUIRE THE CONTRACTOR TO DETERMINE THE LOCATION OF THE FACILITY IN QUESTION PRIOR TO CONSTRUCTION. A DETERMINATION SHALL BE MADE BY THE CONTRACTOR IF THE CURRENT DESIGN WILL CONFLICT WITH THE EXISTING FACILITY AND NOTIFY THE ENGINEER IN WRITING.
20. ALL EXISTING AREAS DISTURBED OUTSIDE THE LIMITS OF CONSTRUCTION ACTIVITIES SHALL BE REVEGETATED IN CONFORMANCE WITH THE SPECIFICATIONS AT NO ADDITIONAL COST TO THE PROJECT.
21. ALL EXISTING ROADWAYS AND SIDEWALKS DAMAGED DURING CONSTRUCTION SHALL BE REPAIRED OR RECONSTRUCTED IN CONFORMANCE WITH THE SPECIFICATIONS.
22. SIGNAGE SHALL FOLLOW THE "MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES" LATEST EDITION AND THE CITY OF COLORADO SPRINGS TRAFFIC ENGINEERING SIGNAGE & PAVEMENT MARKING STANDARDS. CONTRACTOR SHALL SUBMIT TO THE CITY A TRAFFIC CONTROL PLAN PRIOR TO COMMENCING WITH THE WORK.
23. WHERE APPROPRIATE, NEATLY SAW CUT ALL EXISTING CONCRETE AND ASPHALT. THE PLACEMENT OF ADDITIONAL PAVING SHALL BE DONE TO A NEAT WORK LINE. SAW CUTTING A MINIMUM OF ONE (1) FOOT. SAW CUTTING WILL NOT BE PAID FOR SEPARATELY BUT WILL BE CONSIDERED INCIDENTAL TO THE WORK. REPAIR/REPLACE ALL DISTURBED EXISTING ITEMS WITH LIKE MATERIALS AND THICKNESSES. EXISTING CONCRETE PAVEMENT SHALL BE SCORED THEN BROKEN AT JOINT TO CREATE A ROUGH SURFACE FOR THE CONSTRUCTION JOINT.
24. CONTRACTOR SHALL PROTECT EXISTING BUILDINGS, STRUCTURES, ADJOINING PROPERTIES AND PUBLIC THOROUGHFARES FROM DAMAGE DURING CONSTRUCTION.
25. ALL DISCHARGES TO DRAINAGE COURSES AND STORM SEWER SYSTEMS MUST COMPLY WITH THE APPLICABLE PROVISIONS OF THE COLORADO WATER QUALITY CONTROL ACT AND THE COLORADO DISCHARGE PERMIT REGULATIONS, AND ARE SUBJECT TO INSPECTION BY THE CITY OF COLORADO SPRINGS, EL PASO COUNTY, CDOT AND CDPHE. EL PASO COUNTY AND COLORADO SPRINGS HAVE MS-4 PERMITS. CONTRACTOR SHALL DEVISE AND IMPLEMENT A PERMANENT PLAN FOR PERIODIC REMOVAL AND DISPOSAL OF SEDIMENT FROM EROSION CONTROL FACILITIES AND FOR MAINTENANCE OF EROSION CONTROL FACILITIES.
26. SURFACE AND GROUNDWATER AT THE SITE MAY CREATE A NEED FOR DEWATERING DURING CONSTRUCTION. CONTRACTOR SHALL BE RESPONSIBLE FOR THE MAINTENANCE OF TEMPORARY DEWATERING STRUCTURES, NECESSARY PERMITS AND PROVIDE FOR SAFE AND STABLE DISCHARGE OF WATER FROM THE CONSTRUCTION SITE. THE COST OF DEWATERING IS INCIDENTAL TO THE CONSTRUCTION AND WILL NOT BE PAID FOR UNDER A SPECIFIC ITEM IN THE BID DOCUMENTS.
27. NO PAVEMENT DROP-OFFS WILL BE ALLOWED TO REMAIN OVERNIGHT. DROP-OFFS TO BE TEMPORARILY FILLED WITH ASPHALT AT 3:1 MINIMUM SLOPE WITH DELINEATOR POLES MARKING THE UPPER EDGE OF DROP-OFF.
28. BASIS OF BEARINGS: WOLF RANCH SUBDIVISION PLATS AS PREPARED BY ROCKWELL CONSULTING, INC.
29. BENCHMARK: FIMS MONUMENT NO. 69 IS A 3-1/4" ALUMINUM CAP SET APPROXIMATELY 30' WEST OF THE BLACK FOREST ROAD CENTERLINE AND 1,200 FEET NORTH OF COWPOKE ROAD (300' SOUTH OF THE COTTONWOOD CREEK BRIDGE CROSSING). EL=6975.735 (NGVD 29 WITH 1960 SUPPLEMENTARY ADJUSTMENT) VERTICAL DATUM.
30. SURVEY CONTROL POINTS:

POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
301	8760.655	24665.115	6898.910	
304	9651.735	27491.475	6946.900	
305	9618.845	25287.535	6919.260	
308	11003.565	28531.705	6982.830	
2097	8725.54100	24865.26000	6894.161	MAG NAIL IN NORTH EDGE OF ASPHALT
2099	11511.90300	25736.30600	6974.357	#4 REBAR WITH RED CAP
9020	9941.82403	28549.82973	6975.735	3-1/4" ALUMINUM "FIMS 69" IN MONUMENT BOX "BENCHMARK"
9101	8782.27020	27431.69962	6967.954	#4 REBAR ON HILLTOP

GENERAL UTILITY NOTES:

1. ALL STORM WORK SHALL COMPLY WITH THE SPECIFICATIONS AND CITY STANDARDS AND SPECIFICATIONS (CURRENT EDITION) AND THE COLORADO DEPARTMENT OF TRANSPORTATION (CDOT) STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION (CURRENT EDITION).
2. THE CONTRACTOR AND SURVEY CREW SHALL VERIFY ELEVATIONS OF EXISTING SANITARY SEWER, STORM SEWER, WATER LINES AND MANHOLES TO BE TIED TO PRIOR TO CONSTRUCTION OR STAKING OF PIPE.
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR RECORDING AS-BUILT INFORMATION ON A SET OF RECORD DRAWINGS.
4. THE CONTRACTOR SHALL CONTACT ALL APPROPRIATE UTILITY COMPANIES, UTILITY DISTRICT AND THE CITY PRIOR TO THE BEGINNING OF ANY CONSTRUCTION. CONTRACTOR SHALL BE RESPONSIBLE FOR LOCATING ANY EXISTING UTILITY (INCLUDING DEPTHS) WHICH ARE WITHIN THE PROPOSED CONSTRUCTION AREA. ALL EXISTING UTILITIES SHALL BE PROTECTED FROM DAMAGE BY THE CONTRACTOR. DAMAGED UTILITIES SHALL BE REPAIRED BY THE CONTRACTOR AT HIS OWN EXPENSE.
5. THE LOCATIONS OF EXISTING UTILITIES ARE BASED UPON THE BEST AVAILABLE INFORMATION, ARE SHOWN IN AN APPROXIMATE WAY ONLY, AND HAVE NOT BEEN INDEPENDENTLY VERIFIED BY THE OWNER OR ITS REPRESENTATIVE. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK, AND AGREES TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE OCCASIONED BY THE CONTRACTOR'S FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UTILITIES.
6. PIPE BACKFILLING SHALL NOT OCCUR UNTIL PIPE HAS BEEN INSPECTED.
7. BEGIN LAYING PIPE AT THE LOWEST POINT, WITH THE BELLS POINTING UPHILL. LAY THE PIPE IN ACCORDANCE WITH THE MANUFACTURERS SPECIFICATIONS AND RECOMMENDATIONS. LAY PIPE TRUE TO LINE AND GRADE AS SHOWN ON THE DWGS.
8. ALL STORM SEWER PIPE LENGTHS AND SLOPES ARE FIGURED FROM CENTER OF MANHOLE AND THE INSIDE WALL OF INLETS. PIPE LENGTHS ARE GIVEN AS A HORIZONTAL LENGTH AND ARE APPROXIMATE. PIPE LENGTHS INCLUDE THE FLARED END SECTION.
9. ALL STORM SEWER PIPE BEDDING TO BE CLASS B BEDDING, UNLESS OTHERWISE NOTED. REFER TO CITY OF COLORADO SPRINGS STANDARD DRAWING D-30 FOR RCP, DWG D-31 FOR BOX CULVERT AND DWG D-32 FOR FLEXIBLE PIPE.
   9.1. REFER TO THE SPECIFICATIONS FOR GRANULAR BEDDING MATERIAL REQUIREMENTS FOR THE PIPE BEDDING.
10. RCP STORM SEWER PIPE SHALL BE CLASS III, UNLESS OTHERWISE NOTED.
11. ALL RCP SECTIONS SHALL BE JOINED IN SUCH A MANNER THAT THE ENDS ARE FULLY ENTERED AND THE INNER SURFACES ARE REASONABLY FLUSH. RUBBER GASKETS SHALL BE USED ON ALL PIPE JOINTS CONFORMING TO ASTM C-433. AVERAGE JOINT GAP THAT EXCEEDS 1/2 INCH SHALL BE FILLED WITH AN APPROVED FLEXIBLE PLASTIC SEALANT.
12. CONSTRUCTION AND MATERIALS USED IN ALL STORM MANHOLES SHALL BE PER CITY STANDARDS AND SPECIFICATIONS. ALL MANHOLES SHALL BE CONSTRUCTED IN ACCORDANCE WITH CITY STANDARD DETAILS D-20B AND D-20D FOR TYPE II STORM SEWER MANHOLES, AND SHALL HAVE SHAPED INVERTS.
13. MANHOLE RIM ELEVATIONS SHOWN ARE APPROXIMATE ONLY AND ARE NOT TO BE TAKEN AS FINAL ELEVATIONS. RING AND COVER TO BE SET IN CENTERED CONCRETE RINGS WITH RAM-NECK FOR ADJUSTMENT TO MATCH PROPOSED GRADE OR FINAL PAVEMENT ELEV.
14. WHERE APPROPRIATE, NEATLY SAW CUT ALL EXISTING CONCRETE AND ASPHALT. THE PLACEMENT OF ADDITIONAL PAVING SHALL BE DONE TO A NEAT WORK LINE. SAW CUTTING A MINIMUM OF ONE (1) FOOT. SAW CUTTING WILL NOT BE PAID FOR SEPARATELY BUT WILL BE CONSIDERED INCIDENTAL TO THE WORK. REPAIR/REPLACE ALL DISTURBED EXISTING ITEMS WITH LIKE MATERIALS AND THICKNESSES. ANY ASPHALT REMOVED IS TO BE REPLACED TO MEET THE SPECIFICATIONS OF THE COLORADO DEPT OF TRANSPORTATION. EXISTING CONCRETE PAVEMENT SHALL BE SCORED THEN BROKEN AT JOINT TO CREATE A ROUGH SURFACE FOR THE CONSTRUCTION JOINT.
15. ALL ASPHALT WORK REQUIRING PATCHING WILL BE PERFORMED TO A NEAT WORK LINE. THE EXISTING ASPHALT SHALL BE SAW CUT. ALL ASPHALT PATCH WORK SHALL BE AT LEAST 2' WIDE AFTER THE COMPLETION OF WORK. NEW CURB CAN BE PLACED FLUSH WITH THE EXISTING ASPHALT IF IT IS TO A NEAT WORK LINE.
16. WITH NOTIFICATION OF THE RESPECTIVE OWNER, ADJUST RIMS OF ALL MANHOLES WITHIN PAVEMENT TO 1/4 TO 1/2 INCH BELOW THE FINISHED GRADE AND CROSS SLOPE PRIOR TO FINAL LIFT PAVING AND ADJUST TO MATCH FINISH GRADE IN UNPAVED AREAS.



VICINITY MAP
SCALE: NTS

INDEX OF SHEETS

STATEMENTS AND APPROVALS

ENGINEER'S STATEMENT

"THIS PLAN FOR THE FINAL DRAINAGE DESIGN FOR NOR'WOOD WAS PREPARED BY ME (OR UNDER MY DIRECT SUPERVISION) IN ACCORDANCE WITH THE PROVISIONS OF THE CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL VOLUMES 1 AND 2 FOR THE OWNERS THEREOF. I UNDERSTAND THAT THE CITY OF COLORADO SPRINGS DOES NOT AND WILL NOT ASSUME LIABILITY FOR DRAINAGE FACILITIES DESIGNED BY OTHERS."

BY: ______________________ ____________

CHRISTOPHER J. CASTELLI, PE #38842
FOR & ON BEHALF OF KIOWA ENGINEERING CORP. DATE

DEVELOPER'S STATEMENT

"NOR'WOOD DEVELOPMENT HEREBY CERTIFIES THAT THE DRAINAGE FACILITIES FOR NOR'WOOD SHALL BE CONSTRUCTED ACCORDING TO THE DESIGN PRESENTED IN THIS REPORT. I UNDERSTAND THAT THE CITY OF COLORADO SPRINGS DOES NOT AND WILL NOT ASSUME LIABILITY FOR THE DRAINAGE FACILITIES DESIGNED AND/OR CERTIFIED BY MY ENGINEER AND THAT THE CITY OF COLORADO SPRINGS REVIEWS DRAINAGE PLANS PURSUANT TO COLORADO REVISED STATUTES, TITLE 30, ARTICLE 28; BUT CANNOT, ON BEHALF OF NOR'WOOD, GUARANTEE THAT FINAL DRAINAGE DESIGN REVIEW WILL ABSOLVE NOR'WOOD AND/OR THEIR SUCCESSORS AND/OR ASSIGNS OF FUTURE LIABILITY FOR IMPROPER DESIGN. I FURTHER UNDERSTAND THAT APPROVAL OF THE FINAL PLAT DOES NOT IMPLY APPROVAL OF MY ENGINEER'S DRAINAGE DESIGN."

BUSINESS NAME: NOR'WOOD DEVELOPMENT

BY: ______________________ ____________

AUTHORIZED SIGNATURE TITLE

ADDRESS: 111 S. TEJON ST., SUITE 222
COLORADO SPRINGS, COLORADO 80903

CITY OF COLORADO SPRINGS:

FILED IN ACCORDANCE WITH SECTION 7.7.906 OF THE CODE OF THE CITY OF COLORADO SPRINGS, 2001, AS AMENDED.

______________________ ____________

FOR THE CITY ENGINEER DATE

CONDITIONS:

PRE-EXCAVATION CHECKLIST

- ☐ GAS AND OTHER UTILITY LINES OF RECORD SHOWN ON PLANS.
- ☐ UTILITIES CENTRAL LOCATING CALLED AT LEAST 2 BUSINESS DAYS AHEAD.
- ☐ UTILITIES LOCATED AND MARKED.
- ☐ EMPLOYEES BRIEFED ON MARKING AND COLOR CODES.*
- ☐ EMPLOYEES TRAINED ON EXCAVATION AND SAFETY PROCEDURES FOR NATURAL GAS LINES.
- ☐ WHEN EXCAVATION APPROACHES GAS LINES, EMPLOYEES EXPOSE LINES BY CAREFUL PROBING AND HAND DIGGING.

*A.G.A./A.P.W.A. STANDARD UTILITY MARKING COLOR CODE

NATURAL GAS	YELLOW	WATER	BLUE
ELECTRIC	RED	WASTEWATER	GREEN

811
Know what's below.
Call before you dig.

ABBREVIATIONS

BNDY	= BOUNDARY	MIN	= MINIMUM
BOP	= BOTTOM OF PIPE	NTS	= NOT TO SCALE
C&G	= CURB & GUTTER	OD	= OUTSIDE DIAMETER
CL	= CENTERLINE	PC	= POINT OF HORIZONTAL CURVATURE
COORDS	= COORDINATES	PP	= PROPOSED
DIA	= DIAMETER	PRC	= POINT OF REVERSE CURVE
DIP	= DUCTILE IRON PIPE	PROP	= PROPERTY
DTL	= DETAIL	PRT	= PRIVATE
EL,ELEV	= ELEVATION	PT	= POINT OF HORIZONTAL TANGENCY
EOA	= EDGE OF ASPHALT	PVC	= POLY VINYL CHLORIDE PIPE
ESMT	= EASEMENT	PVC	= POINT OF VERTICAL CURVATURE
EX	= EXISTING	PVI	= POINT OF VERTICAL INTERSECTION
FC	= FACE OF CURB	PVT	= POINT OF VERTICAL TANGENCY
FES	= FLARED END SECTION	R	= RADIUS
FL	= FLOWLINE	R	= RIGHT
GB	= GRADE BREAK	RCP	= REINFORCED CONCRETE PIPE
GP	= GRADING PLAN	ROW	= RIGHT OF WAY
HP	= HIGH POINT	RT	= RIGHT
HORIZ	= HORIZONTAL	SHT	= SHEET
HW	= HEADWALL	SS	= SANITARY SEWER
ID	= INSIDE DIAMETER	STA	= STATION
INV	= INVERT	STD	= STANDARD
L	= LEFT	TC	= TOP OF CURB
LT	= LEFT	THK	= THICK
LF	= LINEAR FEET	TOC	= TOP OF CONCRETE
LP	= LOW POINT	TOP	= TOP OF PIPE
MAX	= MAXIMUM	T.O.R.	= TOP OF ROCK
MH	= MANHOLE	TYP	= TYPICAL

LEGEND

- EXISTING CONTROL POINT
- EXISTING FIRE HYDRANT
- EXISTING WATER VALVE
- EXISTING GAS VALVE
- EXISTING SANITARY SEWER MANHOLE
- EXISTING STORM SEWER MANHOLE
- EXISTING WATER MANHOLE
- EXISTING TELEPHONE MANHOLE
- EXISTING TELEPHONE PEDESTAL
- EXISTING CABLE TV PEDESTAL
- EXISTING LIGHT POLE
- EXISTING ELECTRIC BOX OR TRANSFORMER
- EXISTING ELECTRIC MANHOLE
- POTHOLE LOCATION
- CURB & GUTTER
- APPROXIMATE LIMIT OF DISTURBANCE
- EXISTING OR PROPOSED PROPERTY LINE
- EXISTING EASEMENT
- EXISTING WATER LINE
- EXISTING SANITARY SEWER
- EXISTING STORM SEWER
- EXISTING UNDERGROUND ELECTRIC LINE
- EXISTING UNDERGROUND TELEPHONE LINE
- EXISTING GAS LINE
- FUTURE WATER LINE
- PROPOSED STORM SEWER PIPE AND MANHOLE
- EXISTING BARBED WIRE FENCE
- EXISTING WOOD FENCE
- (6020) EXISTING CONTOURS
- 6020 PROPOSED CONTOURS
- (14.79) EXISTING SPOT ELEVATION
- (14.8±) APPROXIMATE EXISTING SPOT ELEVATION. ELEVATION TO BE FIELD VERIFIED PRIOR TO CONSTRUCTION.
- 15.41 PROPOSED SPOT ELEVATION
- (2.3%) EXISTING FLOW DIRECTION AND SLOPE
- 2.3% PROPOSED FLOW DIRECTION AND SLOPE

15D12 Base.dwg/Apr 20, 2016

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

WOLF RANCH DEVELOPMENT
TRIBUTARY FOUR IMPROVEMENTS BELOW RESEARCH PKWY
COVER SHEET
COLORADO SPRINGS, COLORADO

Project No.:	15D12
Date:	April 7, 2016
Design:	CJC
Drawn:	CJC
Check:	RNW
Revisions:	

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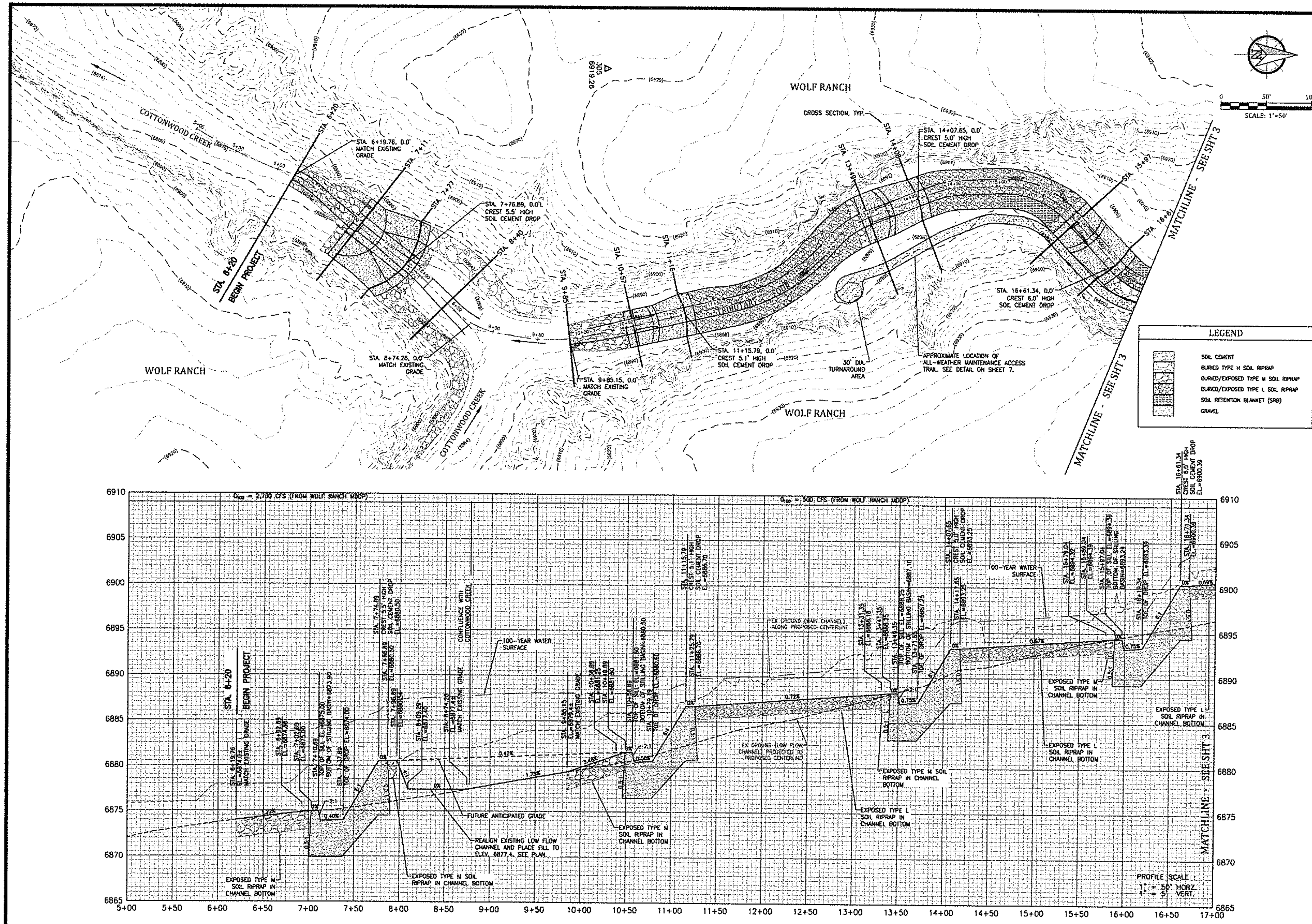
OF 22 SHEETS



Kiowa Engineering Corporation
1604 South 21st Street
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(719) 630-7342

WOLF RANCH DEVELOPMENT

TRIBUTARY FOUR IMPROVEMENTS BELOW RESEARCH PKWY

PLAN AND PROFILE STA. 5+00 TO STA. 17+00

COLORADO SPRINGS, COLORADO

Project No.:	15012
Date:	April 7, 2016
Design:	CJC
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Revisions:	

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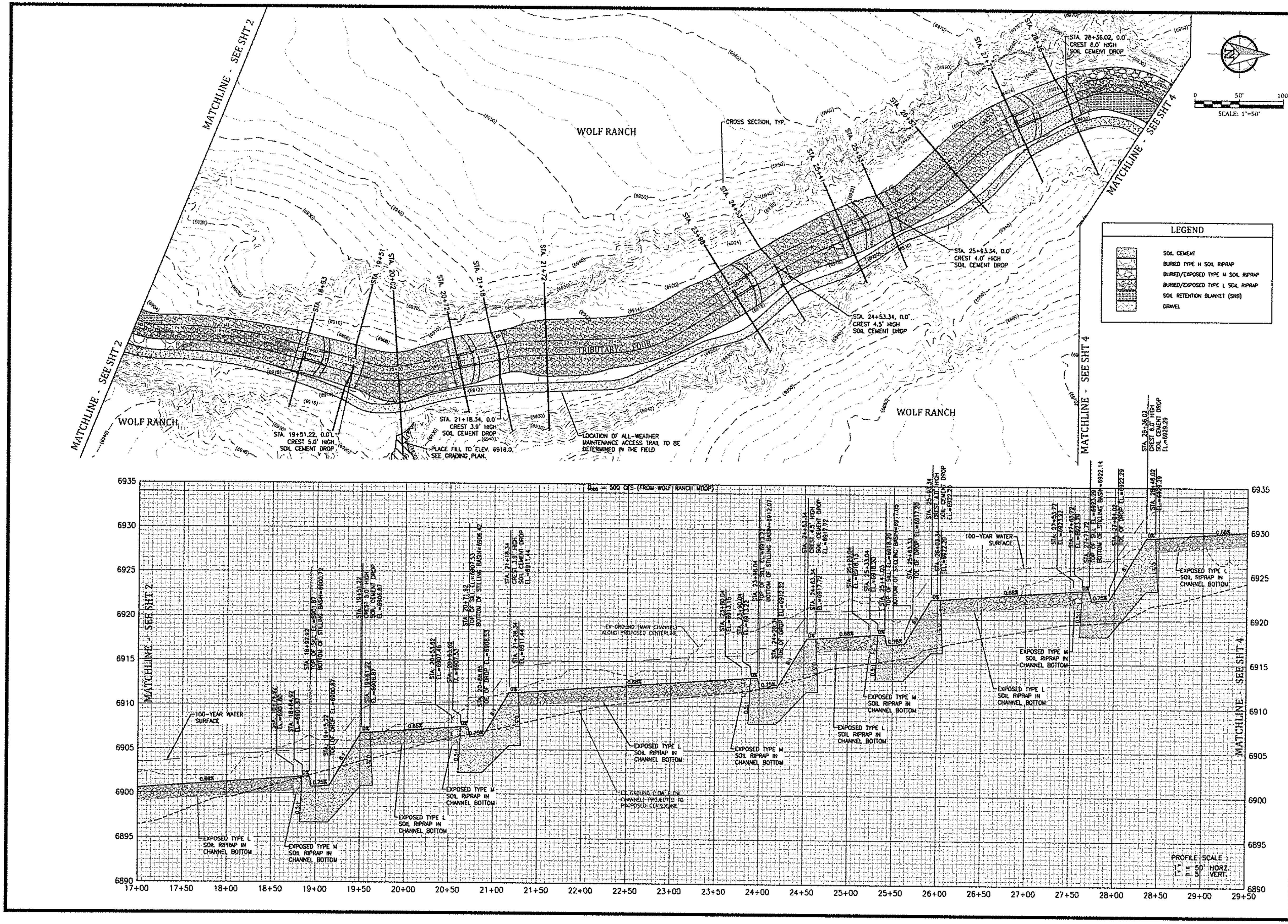
OF 22 SHEETS



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WOLF RANCH DEVELOPMENT
TRIBUTARY FOUR IMPROVEMENTS BELOW RESEARCH PKWY
PLAN AND PROFILE STA. 17+00 TO STA. 29+50
COLORADO SPRINGS, COLORADO

Project No.:	15012
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Design:	CJC
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Revisions:	

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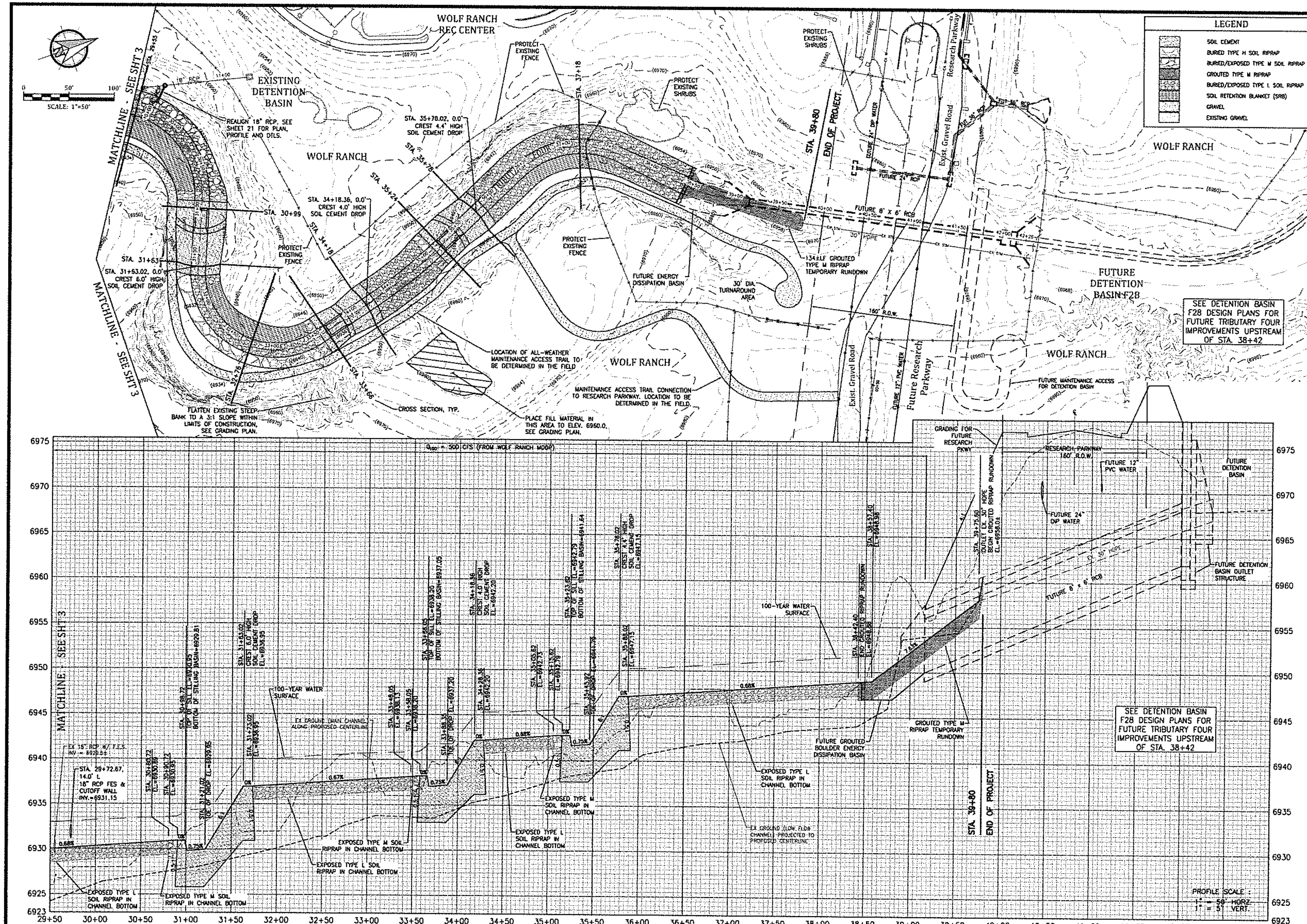
OF 22 SHEETS



WOLF RANCH DEVELOPMENT

TRIBUTARY FOUR IMPROVEMENTS BELOW RESEARCH PKWY

PLAN AND PROFILE STA. 29+50 TO STA. 40+00

COLORADO SPRINGS, COLORADO

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

Project No.	15012
Date:	April 7, 2016
Design:	CJC
Drawn:	CJC
Check:	RNW
Revisions:	

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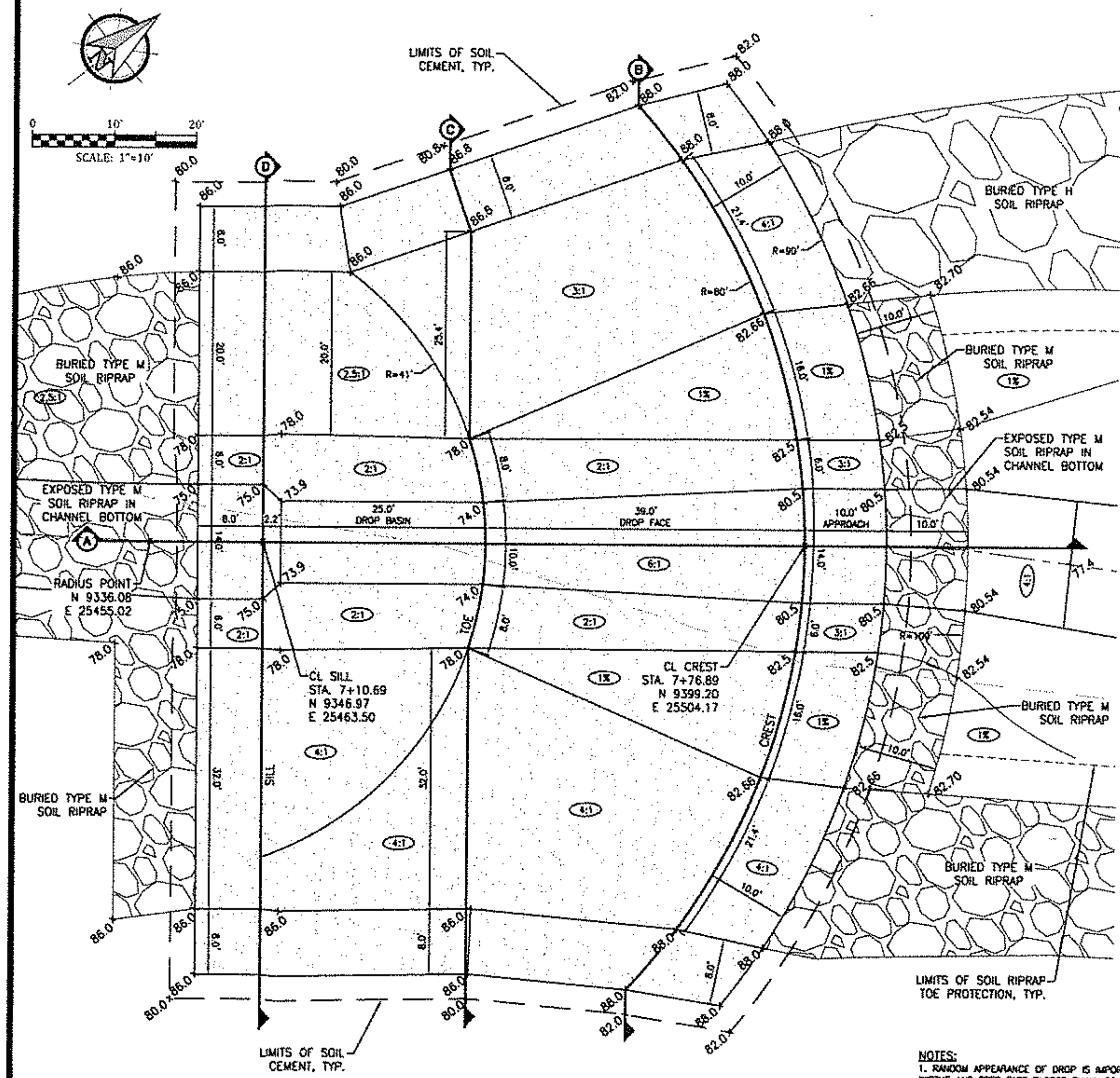
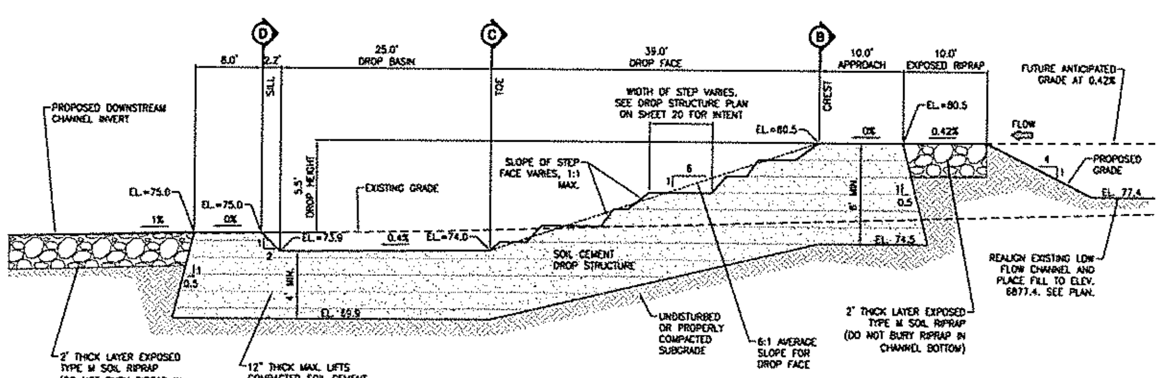
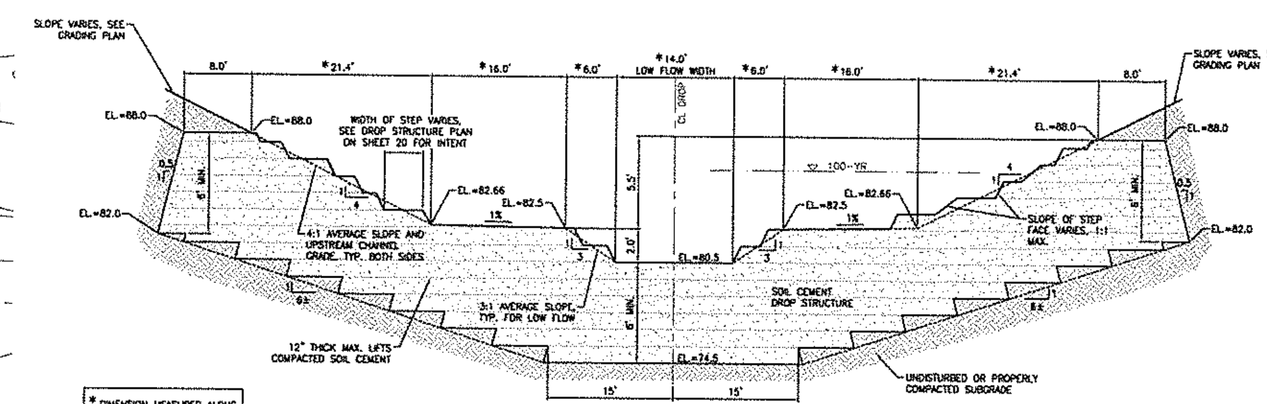


DROP PLAN
SCALE: 1"=10'

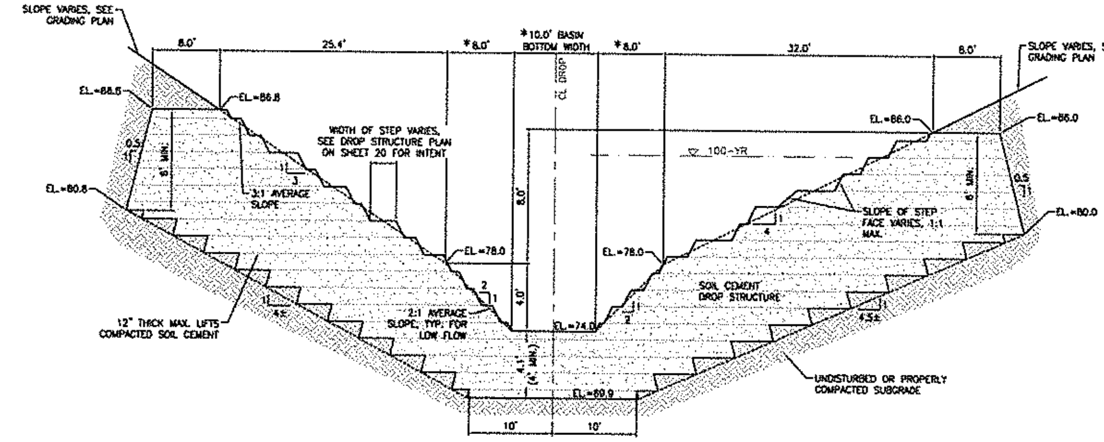
NOTES:
1. RANDOM APPEARANCE OF DROP IS IMPORTANT, VARYING STEP WIDTHS AND STEP FACE SLOPES SHALL BE COORDINATED AND ESTABLISHED IN FIELD. SEE DROP STRUCTURE PLAN ON SHEET 20 FOR INTENT.
2. SEE SPECIFICATIONS FOR SOIL CEMENT PROPORTIONING AND PLACEMENT REQUIREMENTS.
3. IF BEDROCK IS ENCOUNTERED, KEY SIDES AND BOTTOM OF SOIL CEMENT 12" MIN. INTO NATIVE ROCK LAYER.



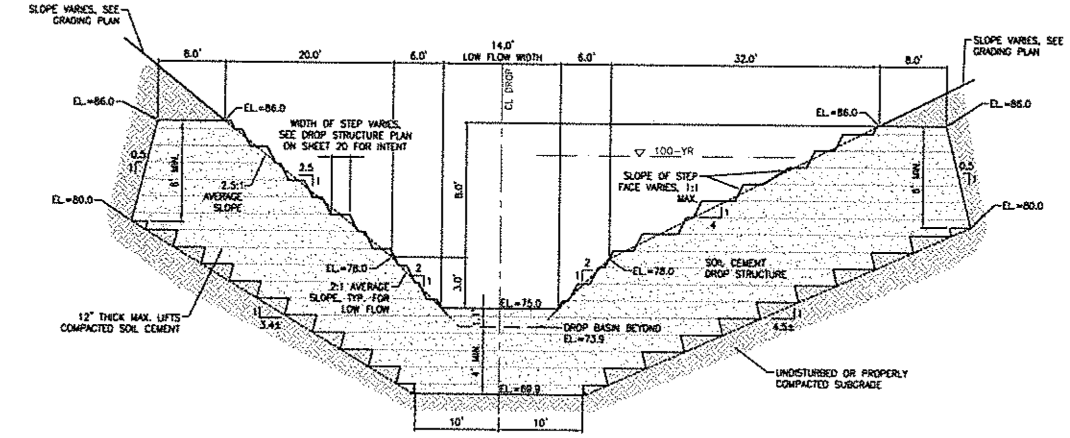
A/19 DROP PROFILE
SCALE: 1"=10' HORIZ/1"=5' VERT



B/19 DROP CREST SECTION
SCALE: 1"=10' HORIZ/1"=5' VERT



C/19 DROP TOE SECTION
SCALE: 1"=10' HORIZ/1"=5' VERT



D/19 DROP SILL SECTION
SCALE: 1"=10' HORIZ/1"=5' VERT

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WOLF RANCH DEVELOPMENT
TRIBUTARY FOUR IMPROVEMENTS BELOW RESEARCH PKWY
COTTONWOOD CREEK DROP STRUCTURE PLAN AND SECTIONS
COLORADO SPRINGS, COLORADO

Project No.:	15012
Date:	April 7, 2016
Design:	CJC
Drawn:	ELS, CJC
Check:	RNW
Revisions:	

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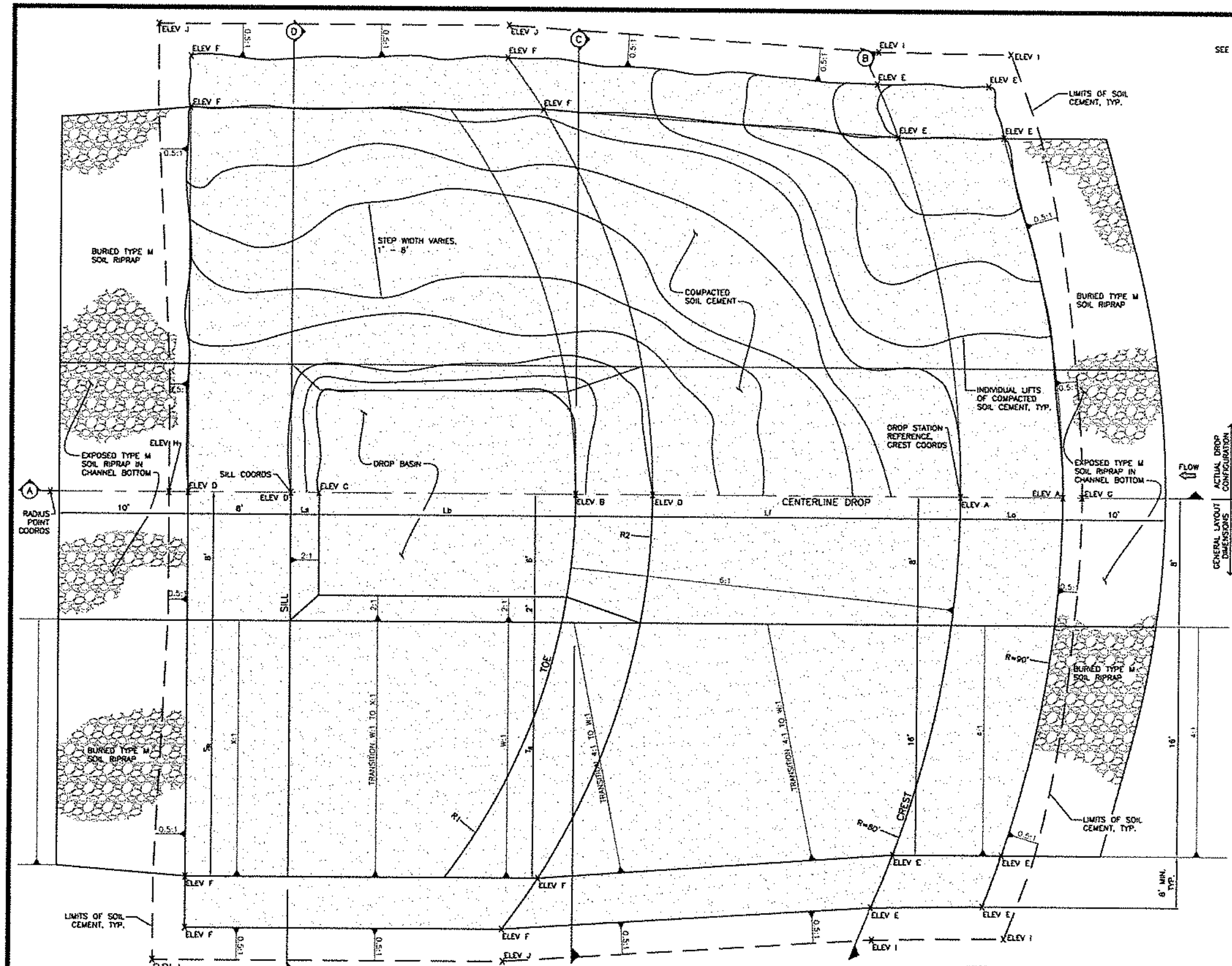
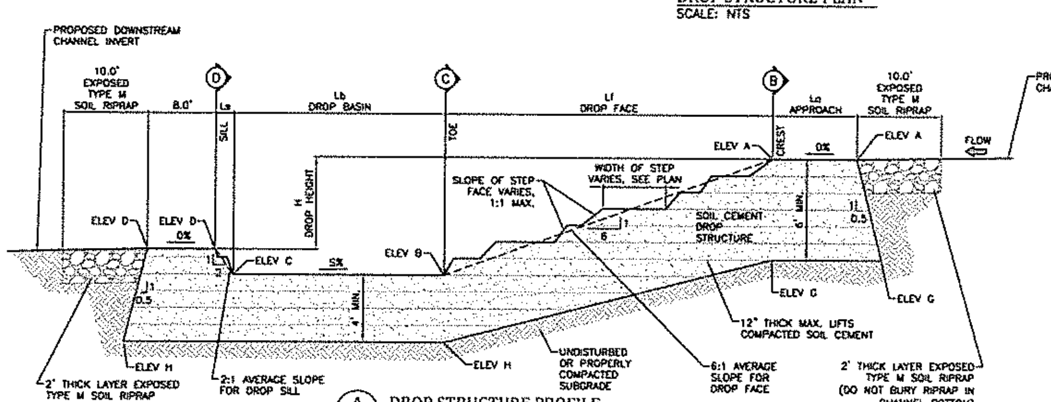
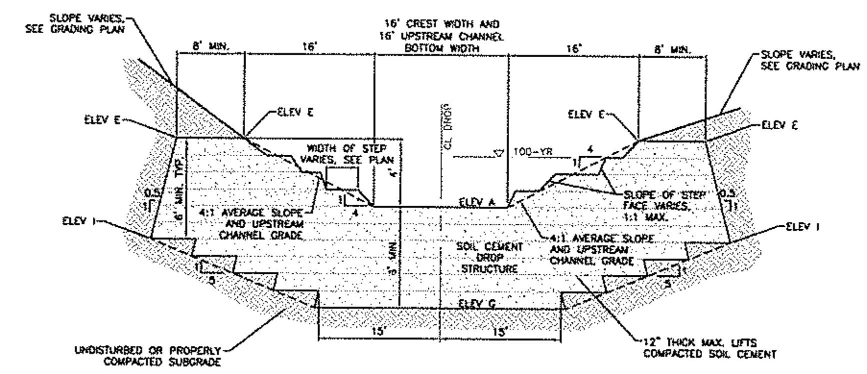


DROP STRUCTURE PLAN
SCALE: NTS

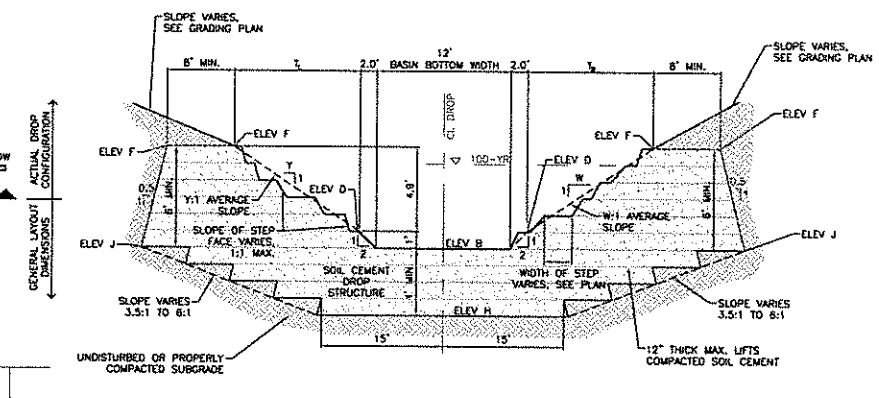
NOTES:
1. RANDOM APPEARANCE OF DROP IS IMPORTANT. VARYING STEP WIDTHS AND STEP FACE SLOPES SHALL BE COORDINATED AND ESTABLISHED IN FIELD.
2. SEE SPECIFICATIONS FOR SOIL CEMENT PROPORTIONING AND PLACEMENT REQUIREMENTS.
3. IF BEDROCK IS ENCOUNTERED, KEY SIDES AND BOTTOM OF SOIL CEMENT 12" MIN. INTO NATIVE ROCK LAYER.



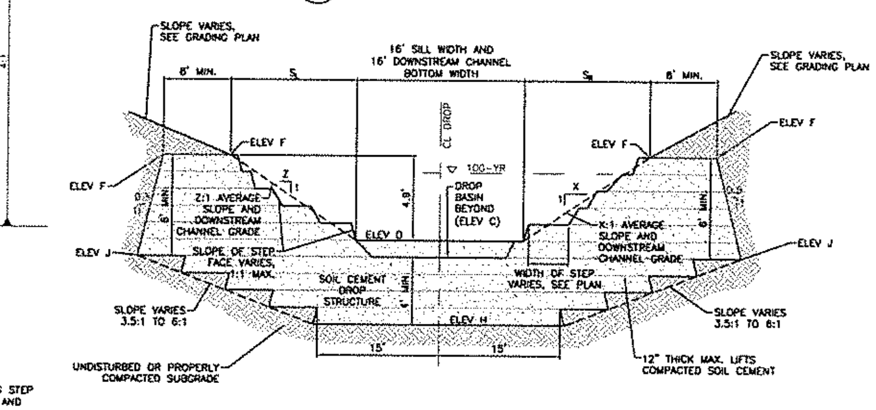
DROP STRUCTURE PROFILE
SCALE: NTS



TYPICAL CREST SECTION
SCALE: NTS



TYPICAL DROP TOE SECTION
SCALE: NTS



TYPICAL SILL SECTION
SCALE: NTS

SOIL CEMENT DROP STRUCTURE SCHEDULE

STATION	CREST COORDINATES	SILL COORDINATES	RADIUS PT. COORDINATES	DROP HT(H)	La	Lf	Lb	Ls	R1	R2	S_L	S_R	T_L	T_R	W	X	Y	Z	ELEV A	ELEV B	ELEV C	ELEV D	ELEV E	ELEV F	ELEV G	ELEV H	ELEV I	ELEV J
11+15.79	N 9707.48 E 25558.01	N 9650.09 E 25571.00	N 9629.45 E 25575.66	5.1'	10'	30.6'	20'	2.2'	43.4'	49.4'	9.8'	14.7'	9.8'	14.7'	3	3	2	2	86.7	80.6	80.5	81.6	90.7	86.5	80.7	76.5	84.7	80.5
14+07.65	N 9982.74 E 25428.76	N 9908.41 E 25449.89	N 9888.18 E 25457.76	5.0'	10'	30'	20'	2.2'	44.0'	50.0'	19.6'	19.6'	19.6'	19.6'	4	4	4	4	93.25	87.25	87.1	88.25	97.25	93.15	87.25	83.1	91.25	87.15
16+61.34	N 10181.69 E 25500.06	N 10138.23 E 25452.68	N 10127.61 E 25441.10	6.0'	10'	36'	20'	2.2'	38.0'	44.0'	14.7'	19.6'	14.7'	19.6'	4	4	3	3	00.39	93.39	93.24	94.39	04.39	99.29	94.39	89.24	98.39	93.29
19+51.22	N 10459.62 E 25565.00	N 10403.31 E 25549.87	N 10382.36 E 25544.24	5.0'	10'	30'	20'	2.2'	44.0'	50.0'	14.7'	14.7'	14.7'	14.7'	3	3	3	3	06.87	00.87	00.72	01.87	10.87	06.77	00.87	96.72	04.87	00.77
21+18.34	N 10623.18 E 25548.67	N 10577.53 E 25558.94	N 10545.13 E 25566.27	3.9'	10'	23.4'	15'	2.2'	50.5'	56.5'	19.6'	19.6'	19.6'	19.6'	4	4	4	4	11.44	06.53	06.43	07.53	15.44	12.43	05.44	02.43	09.44	06.43
24+53.34	N 10933.30 E 25448.16	N 10886.61 E 25477.80	N 10865.76 E 25491.04	4.5'	10'	27'	20'	2.2'	47.0'	53.0'	19.6'	19.6'	19.6'	19.6'	4	4	4	4	17.72	12.22	12.08	13.22	21.72	18.12	11.72	8.08	15.72	12.12
25+93.34	N 11059.88 E 25388.67	N 11012.05 E 25409.87	N 10986.72 E 25421.09	4.0'	10'	24'	20'	2.2'	50.0'	56.0'	19.6'	19.6'	19.6'	19.6'	4	4	4	4	22.2	17.2	17.06	18.2	26.2	23.1	16.2	13.06	20.2	17.1
28+36.02	N 11261.33 E 25258.80	N 11203.21 E 25284.30	N 11189.02 E 25291.02	6.0'	10'	36'	20'	2.2'	38.0'	44.0'	19.6'	19.6'	19.6'	19.6'	4	4	4	4	29.29	22.29	22.15	23.29	33.29	28.19	23.29	18.15	27.29	22.19
31+63.02	N 11379.31 E 25447.93	N 11404.33 E 25388.70	N 11410.44 E 25374.24	6.0'	10'	36'	20'	2.2'	38.0'	44.0'	19.6'	19.6'	19.6'	19.6'	4	4	4	4	36.95	29.95	29.81	30.95	40.95	35.85	30.95	25.81	34.95	29.85
34+18.36	N 11539.35 E 25550.12	N 11488.68 E 25563.09	N 11461.85 E 25569.96	4.0'	10'	24'	20'	2.2'	50.0'	56.0'	14.7'	14.7'	12.25'	12.25'	2.5	3	2.5	3	42.2	37.2	37.06	38.2	46.2	43.1	36.2	33.06	40.2	37.1
35+78.02	N 11688.57 E 25494.24	N 11638.90 E 25516.43	N 11615.53 E 25526.87	4.4'	10'	26.4'	20'	2.2'	47.9'	53.9'	19.6'	12.25'	19.6'	12.25'	2.5	2.5	4	4	47.15	41.79	41.65	42.79	51.15	47.69	41.15	37.65	45.15	41.69

Kiowa
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WOLF RANCH DEVELOPMENT
TRIBUTARY FOUR IMPROVEMENTS BELOW RESEARCH PKWY
TRIBUTARY FOUR DROP STRUCTURE DETAILS
COLORADO SPRINGS, COLORADO

Project No.:	15012
Date:	April 7, 2016
Design:	CJC
Drawn:	CJC
Check:	RNW
Revisions:	

WOLF RANCH DEVELOPMENT
UPPER TRIBUTARY FOUR IMPROVEMENTS
WOLF LAKE TO DETENTION BASIN F28
CONSTRUCTION DRAWINGS
COLORADO SPRINGS, COLORADO

INDEX OF SHEETS

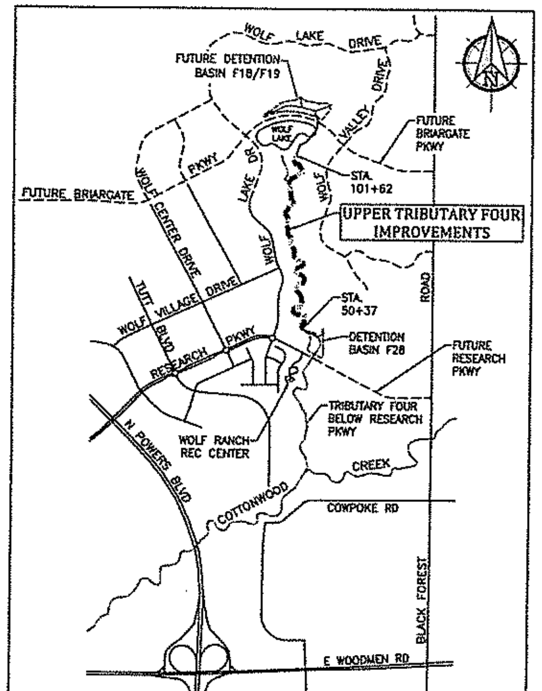
GENERAL NOTES

1. ALL MATERIALS AND WORKMANSHIP SHALL BE IN CONFORMANCE WITH THE CITY OF COLORADO SPRINGS SPECIFICATIONS (CURRENT EDITION) AND THE COLORADO DEPARTMENT OF TRANSPORTATION (CDOT) STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION (CURRENT EDITION).
2. THE CONTRACTOR SHALL HAVE IN HIS POSSESSION AT ALL TIMES ONE (1) SIGNED COPY OF THE PLANS AND SPECIFICATIONS WHICH HAVE BEEN APPROVED BY THE CITY OF COLORADO SPRINGS (CITY).
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING AS-BUILT INFORMATION ON A SET OF RECORD DRAWINGS.
4. THE CONTRACTOR SHALL NOTIFY THE OWNER AND ENGINEER OF ANY PROBLEM IN CONFORMING TO THE APPROVED PLANS FOR ANY ELEMENT OF THE PROPOSED IMPROVEMENTS PRIOR TO ITS CONSTRUCTION.
5. THE CONTRACTOR SHALL PROTECT ALL EXISTING FACILITIES IN THE GENERAL AREA OF CONSTRUCTION. THE CONTRACTOR SHALL REPAIR ANY DAMAGE CAUSED BY CONSTRUCTION OPERATIONS AT NO COST TO THE PROJECT.
6. UTILITY LINES AS SHOWN ON THESE DRAWINGS ARE PLOTTED FROM THE BEST AVAILABLE INFORMATION. THE CONTRACTOR SHALL CALL 811 FOR UTILITY LOCATIONS AT LEAST TWO WORKING DAYS PRIOR TO ANY DIGGING. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL UTILITIES PRIOR TO CONSTRUCTION AND SHALL PROTECT THEM FROM DAMAGE DURING CONSTRUCTION.
7. A CITY OF COLORADO SPRINGS UTILITIES INSPECTOR IS REQUIRED TO BE ONSITE DURING EXCAVATION AND CONSTRUCTION AROUND GAS AND ELECTRIC FACILITIES. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO COORDINATE WITH THE GAS AND ELECTRIC DEPARTMENT FORTY-EIGHT (48) HOURS PRIOR TO CONSTRUCTION.
8. ALL EARTHWORK, ROADWAY AND TRENCHING OPERATIONS SHALL BE IN CONFORMANCE WITH THE CITY STANDARD SPECIFICATIONS.
9. EXCAVATION REQUIRED FOR COMPACTION OF BASES OF CUTS AND FILLS WILL BE CONSIDERED AS SUBSIDIARY TO THAT OPERATION AND WILL NOT BE PAID FOR SEPARATELY.
10. THE TESTING OF COMPACTION FOR THIS PROJECT WILL BE PER AASHTO T 99.
11. ALL EXISTING MANHOLES TO BE MARKED WITH T-POSTS AND CAUTION TAPE PRIOR TO COMMENCING WITH THE CONSTRUCTION.
12. CONTRACTOR SHALL BE RESPONSIBLE FOR THE ESTABLISHMENT, MAINTENANCE AND DEMOBILIZATION OF CONSTRUCTION STAGING AREA(S) WITH THE CITY OF COLORADO SPRINGS.
13. WATER SHALL BE USED AS A DUST PALLIATIVE WHERE REQUIRED. WATER WILL NOT BE PAID FOR SEPARATELY, BUT WILL BE SUBSIDIARY TO THE EXCAVATION ITEM.
14. THE SOIL TO BE PLACED AS TOPSOIL MATERIAL SHALL BE FREE OF REFUSE, STUMPS, ROOTS, ROCKS, BRUSH, WEEDS, HARD CLODS, TOXIC SUBSTANCES OR OTHER MATERIAL WHICH WOULD BE DETRIMENTAL TO ITS USE ON THE PROJECT. IT SHALL HAVE A MINIMUM P.I. OF 5 BUT SHALL NOT BE SUCH HEAVY CLAY AS TO PRECLUDE PLACEMENT WITH A SHOULDER MACHINE.
15. SALVAGEABLE MATERIAL: MATERIAL THAT CAN BE SAVED OR SALVAGED. UNLESS OTHERWISE SPECIFIED IN THE CONTRACT, ALL SALVABLE MATERIAL SHALL BECOME THE PROPERTY OF THE CONTRACTOR.
16. TOPOGRAPHIC DATA INDICATED ON THESE DRAWINGS WAS COMPILED FROM AERIAL AND FIELD SURVEYS. CONTRACTOR MUST VERIFY EXTENT OF WORK WITHIN THESE AREAS. DIMENSIONS, ELEVATIONS, AND LOCATIONS OF EXISTING STRUCTURES, PIPELINES, AND UTILITIES ARE APPROXIMATE. WHERE SUCH DIMENSIONS OR LOCATIONS DETERMINE THE LIMITS OF THE WORK, SUCH DIMENSIONS OR LOCATIONS SHALL BE VERIFIED IN THE FIELD PRIOR TO CONSTRUCTION.
17. THE LOCATIONS OF EXISTING STRUCTURES, PIPELINES, UTILITIES, ETC., SHOWN ON THE DRAWINGS HAVE BEEN APPROXIMATED. THERE MAY BE OTHER STRUCTURES, PIPELINES, UTILITIES, ETC., NOT SHOWN ON THE DRAWINGS WHICH PRESENTLY EXIST IN THE AREA OF CONSTRUCTION. THE ENGINEER AND/OR OWNER ASSUMES NO RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS OF THE INFORMATION SHOWN. THE CONTRACTOR WILL BE RESPONSIBLE FOR LOCATING AND PROTECTING ALL IMPACTED EXISTING STRUCTURES, PIPELINES, UTILITIES, ETC., IN THE PROJECT SITE.
18. THE CONTRACTOR SHALL CAREFULLY PRESERVE ALL MONUMENTS, BENCHMARKS, PROPERTY MARKERS, REFERENCE POINTS, AND STAKES. IN CASE OF HIS DESTRUCTION OF THESE, THE CONTRACTOR WILL BE RESPONSIBLE FOR RESETTING SAME, AT NO COST TO THE OWNER, AND SHALL BE RESPONSIBLE FOR ANY LOSS OF TIME THAT MAY BE CAUSED.
19. THE CONTRACTOR SHALL NOTIFY THE ENGINEER WHERE UTILITIES CONFLICT WITH THE WORK IN CONFORMANCE WITH THE SPECIFICATIONS. WHERE FIELD VERIFICATION IS NOTED ON THE PLANS, THIS SHALL REQUIRE THE CONTRACTOR TO DETERMINE THE LOCATION OF THE FACILITY IN QUESTION PRIOR TO CONSTRUCTION. A DETERMINATION SHALL BE MADE BY THE CONTRACTOR IF THE CURRENT DESIGN WILL CONFLICT WITH THE EXISTING FACILITY AND NOTIFY THE ENGINEER IN WRITING.
20. ALL EXISTING AREAS DISTURBED OUTSIDE THE LIMITS OF CONSTRUCTION ACTIVITIES SHALL BE REVEGETATED IN CONFORMANCE WITH THE SPECIFICATIONS AT NO ADDITIONAL COST TO THE PROJECT.
21. ALL EXISTING ROADWAYS AND SIDEWALKS DAMAGED DURING CONSTRUCTION SHALL BE REPAIRED OR RECONSTRUCTED IN CONFORMANCE WITH THE SPECIFICATIONS.
22. SIGNAGE SHALL FOLLOW THE "MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES" LATEST EDITION AND THE CITY OF COLORADO SPRINGS TRAFFIC ENGINEERING SIGNAGE & PAVEMENT MARKING STANDARDS. CONTRACTOR SHALL SUBMIT TO THE CITY A TRAFFIC CONTROL PLAN PRIOR TO COMMENCING WITH THE WORK.
23. WHERE APPROPRIATE, NEATLY SAW CUT ALL EXISTING CONCRETE AND ASPHALT. THE PLACEMENT OF ADDITIONAL PAVING SHALL BE DONE TO A NEAT WORK LINE, SAW CUTTING A MINIMUM OF ONE (1) FOOT. SAW CUTTING WILL NOT BE PAID FOR SEPARATELY BUT WILL BE CONSIDERED INCIDENTAL TO THE WORK. REPAIR/REPLACE ALL DISTURBED EXISTING ITEMS WITH LIKE MATERIALS AND THICKNESSES. EXISTING CONCRETE PAVEMENT SHALL BE SCORED THEN BROKEN AT JOINT TO CREATE A ROUGH SURFACE FOR THE CONSTRUCTION JOINT.
24. CONTRACTOR SHALL PROTECT EXISTING BUILDINGS, STRUCTURES, ADJOINING PROPERTIES AND PUBLIC THOROUGHFARES FROM DAMAGE DURING CONSTRUCTION.
25. ALL DISCHARGES TO DRAINAGE COURSES AND STORM SEWER SYSTEMS MUST COMPLY WITH THE APPLICABLE PROVISIONS OF THE COLORADO WATER QUALITY CONTROL ACT AND THE COLORADO DISCHARGE PERMIT REGULATIONS, AND ARE SUBJECT TO INSPECTION BY THE CITY OF COLORADO SPRINGS, EL PASO COUNTY, CDOT AND CDPHE. EL PASO COUNTY AND COLORADO SPRINGS HAVE MS-4 PERMITS. CONTRACTOR SHALL DEVISE AND IMPLEMENT A PERMANENT PLAN FOR PERIODIC REMOVAL AND DISPOSAL OF SEDIMENT FROM EROSION CONTROL FACILITIES AND FOR MAINTENANCE OF EROSION CONTROL FACILITIES.
26. SURFACE AND GROUNDWATER AT THE SITE MAY CREATE A NEED FOR DEWATERING DURING CONSTRUCTION. CONTRACTOR SHALL BE RESPONSIBLE FOR THE MAINTENANCE OF TEMPORARY DEWATERING STRUCTURES, NECESSARY PERMITS AND PROVIDE FOR SAFE AND STABLE DISCHARGE OF WATER FROM THE CONSTRUCTION SITE. THE COST OF DEWATERING IS INCIDENTAL TO THE CONSTRUCTION AND WILL NOT BE PAID FOR UNDER A SPECIFIC ITEM IN THE BID DOCUMENTS.
27. NO PAVEMENT DROP-OFFS WILL BE ALLOWED TO REMAIN OVERNIGHT. DROP-OFFS TO BE TEMPORARILY FILLED WITH ASPHALT AT 3:1 MINIMUM SLOPE WITH DELINEATOR POLES MARKING THE UPPER EDGE OF DROP-OFF.
28. BASIS OF BEARINGS: WOLF RANCH SUBDIVISION PLATS AS PREPARED BY ROCKWELL CONSULTING, INC.
29. BENCHMARK: FIMS MONUMENT NO. 69 IS A 3-1/4" ALUMINUM CAP SET APPROXIMATELY 30' WEST OF THE BLACK FOREST ROAD CENTERLINE AND 1,200 FEET NORTH OF COWPOKE ROAD (300' SOUTH OF THE COTTONWOOD CREEK BRIDGE CROSSING). EL=6975.735 (NGVD 29 WITH 1960 SUPPLEMENTARY ADJUSTMENT) VERTICAL DATUM.
30. SURVEY CONTROL POINTS:

POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
311	13436.975	25242.405	7006.790	
316	15975.785	25158.045	7078.850	
319	17274.185	25213.735	7117.940	
1065	12843.045	25481.175	6982.850	
2097	8725.54100	24865.26000	6894.161	MAG NAIL IN NORTH EDGE OF ASPHALT
2099	11511.90300	25736.30600	6974.357	#4 REBAR WITH RED CAP
9020	9941.82403	28549.82973	6975.735	3-1/4" ALUMINUM "FIMS 69" IN MONUMENT BOX "BENCHMARK"
9101	8782.27020	27431.69962	6967.954	#4 REBAR ON HILLTOP

GENERAL UTILITY NOTES:

1. ALL STORM WORK SHALL COMPLY WITH THE SPECIFICATIONS AND CITY STANDARDS AND SPECIFICATIONS (CURRENT EDITION) AND THE COLORADO DEPARTMENT OF TRANSPORTATION (CDOT) STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION (CURRENT EDITION).
2. THE CONTRACTOR AND SURVEY CREW SHALL VERIFY ELEVATIONS OF EXISTING SANITARY SEWER, STORM SEWER, WATER LINES AND MANHOLES TO BE TIED TO PRIOR TO CONSTRUCTION OR STAKING OF PIPE.
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR RECORDING AS-BUILT INFORMATION ON A SET OF RECORD DRAWINGS.
4. THE CONTRACTOR SHALL CONTACT ALL APPROPRIATE UTILITY COMPANIES, UTILITY DISTRICT AND THE CITY PRIOR TO THE BEGINNING OF ANY CONSTRUCTION. CONTRACTOR SHALL BE RESPONSIBLE FOR LOCATING ANY EXISTING UTILITY (INCLUDING DEPTHS) WHICH ARE WITHIN THE PROPOSED CONSTRUCTION AREA. ALL EXISTING UTILITIES SHALL BE PROTECTED FROM DAMAGE BY THE CONTRACTOR. DAMAGED UTILITIES SHALL BE REPAIRED BY THE CONTRACTOR AT HIS OWN EXPENSE.
5. THE LOCATIONS OF EXISTING UTILITIES ARE BASED UPON THE BEST AVAILABLE INFORMATION, ARE SHOWN IN AN APPROXIMATE WAY ONLY, AND HAVE NOT BEEN INDEPENDENTLY VERIFIED BY THE OWNER OR ITS REPRESENTATIVE. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK, AND AGREES TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE OCCASIONED BY THE CONTRACTOR'S FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UTILITIES.
6. PIPE BACKFILLING SHALL NOT OCCUR UNTIL PIPE HAS BEEN INSPECTED.
7. BEGIN LAYING PIPE AT THE LOWEST POINT, WITH THE BELLS POINTING UPHILL. LAY THE PIPE IN ACCORDANCE WITH THE MANUFACTURERS SPECIFICATIONS AND RECOMMENDATIONS. LAY PIPE TRUE TO LINE AND GRADE AS SHOWN ON THE DWGS.
8. ALL STORM SEWER PIPE LENGTHS AND SLOPES ARE FIGURED FROM CENTER OF MANHOLE AND THE INSIDE WALL OF INLETS. PIPE LENGTHS ARE GIVEN AS A HORIZONTAL LENGTH AND ARE APPROXIMATE. PIPE LENGTHS INCLUDE THE FLARED END SECTION.
9. ALL STORM SEWER PIPE BEDDING TO BE CLASS B BEDDING, UNLESS OTHERWISE NOTED. REFER TO CITY OF COLORADO SPRINGS STANDARD DRAWING D-30 FOR RCP, DWG D-31 FOR BOX CULVERT AND DWG D-32 FOR FLEXIBLE PIPE.
   9.1. REFER TO THE SPECIFICATIONS FOR GRANULAR BEDDING MATERIAL REQUIREMENTS FOR THE PIPE BEDDING.
10. RCP STORM SEWER PIPE SHALL BE CLASS III, UNLESS OTHERWISE NOTED.
11. ALL RCP SECTIONS SHALL BE JOINED IN SUCH A MANNER THAT THE ENDS ARE FULLY ENTERED AND THE INNER SURFACES ARE REASONABLY FLUSH. RUBBER GASKETS SHALL BE USED ON ALL PIPE JOINTS CONFORMING TO ASTM C-433. AVERAGE JOINT GAP THAT EXCEEDS 1/2 INCH SHALL BE FILLED WITH AN APPROVED FLEXIBLE PLASTIC SEALANT.
12. CONSTRUCTION AND MATERIALS USED IN ALL STORM MANHOLES SHALL BE PER CITY STANDARDS AND SPECIFICATIONS. ALL MANHOLES SHALL BE CONSTRUCTED IN ACCORDANCE WITH CITY STANDARD DETAILS D-20B AND D-20D FOR TYPE II STORM SEWER MANHOLES, AND SHALL HAVE SHAPED INVERTS.
13. MANHOLE RIM ELEVATIONS SHOWN ARE APPROXIMATE ONLY AND ARE NOT TO BE TAKEN AS FINAL ELEVATIONS. RING AND COVER TO BE SET IN CENTERED CONCRETE RINGS WITH RAM-NECK FOR ADJUSTMENT TO MATCH PROPOSED GRADE OR FINAL PAVEMENT ELEV.
14. WHERE APPROPRIATE, NEATLY SAW CUT ALL EXISTING CONCRETE AND ASPHALT. THE PLACEMENT OF ADDITIONAL PAVING SHALL BE DONE TO A NEAT WORK LINE, SAW CUTTING A MINIMUM OF ONE (1) FOOT. SAW CUTTING WILL NOT BE PAID FOR SEPARATELY BUT WILL BE CONSIDERED INCIDENTAL TO THE WORK. REPAIR/REPLACE ALL DISTURBED EXISTING ITEMS WITH LIKE MATERIALS AND THICKNESSES. ANY ASPHALT REMOVED IS TO BE REPLACED TO MEET THE SPECIFICATIONS OF THE COLORADO DEPT OF TRANSPORTATION. EXISTING CONCRETE PAVEMENT SHALL BE SCORED THEN BROKEN AT JOINT TO CREATE A ROUGH SURFACE FOR THE CONSTRUCTION JOINT.
15. ALL ASPHALT WORK REQUIRING PATCHING WILL BE PERFORMED TO A NEAT WORK LINE. THE EXISTING ASPHALT SHALL BE SAW CUT. ALL ASPHALT PATCH WORK SHALL BE AT LEAST 2' WIDE AFTER THE COMPLETION OF WORK. NEW CURB CAN BE PLACED FLUSH WITH THE EXISTING ASPHALT IF IT IS TO A NEAT WORK LINE.
16. WITH NOTIFICATION OF THE RESPECTIVE OWNER, ADJUST RIMS OF ALL MANHOLES WITHIN PAVEMENT TO 1/4 TO 1/2 INCH BELOW THE FINISHED GRADE AND CROSS SLOPE PRIOR TO FINAL LIFT PAVING AND ADJUST TO MATCH FINISH GRADE IN UNPAVED AREAS.



VICINITY MAP
SCALE: NTS

PRE-EXCAVATION CHECKLIST

- ☐ GAS AND OTHER UTILITY LINES OF RECORD SHOWN ON PLANS.
- ☐ UTILITIES CENTRAL LOCATING CALLED AT LEAST 2 BUSINESS DAYS AHEAD.
- ☐ UTILITIES LOCATED AND MARKED.
- ☐ EMPLOYEES BRIEFED ON MARKING AND COLOR CODES.*
- ☐ EMPLOYEES TRAINED ON EXCAVATION AND SAFETY PROCEDURES FOR NATURAL GAS LINES.
- ☐ WHEN EXCAVATION APPROACHES GAS LINES, EMPLOYEES EXPOSE LINES BY CAREFUL PROBING AND HAND DIGGING.

*A.G.A./A.P.W.A. STANDARD UTILITY MARKING COLOR CODE

NATURAL GAS	YELLOW	WATER	BLUE
ELECTRIC	RED	WASTEWATER	GREEN

811
Know what's below.
Call before you dig.

STATEMENTS AND APPROVALS

ENGINEER'S STATEMENT

"THIS PLAN FOR THE FINAL DRAINAGE DESIGN FOR NOR'WOOD WAS PREPARED BY ME (OR UNDER MY DIRECT SUPERVISION) IN ACCORDANCE WITH THE PROVISIONS OF THE CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL VOLUMES 1 AND 2 FOR THE OWNERS THEREOF. I UNDERSTAND THAT THE CITY OF COLORADO SPRINGS DOES NOT AND WILL NOT ASSUME LIABILITY FOR DRAINAGE FACILITIES DESIGNED BY OTHERS."

BY: ______________________ ______________
CHRISTOPHER J. CASTELLI, PE #38842 — DATE
FOR & ON BEHALF OF KIOWA ENGINEERING CORP.

DEVELOPER'S STATEMENT

"NOR'WOOD DEVELOPMENT HEREBY CERTIFIES THAT THE DRAINAGE FACILITIES FOR NOR'WOOD SHALL BE CONSTRUCTED ACCORDING TO THE DESIGN PRESENTED IN THIS REPORT. I UNDERSTAND THAT THE CITY OF COLORADO SPRINGS DOES NOT AND WILL NOT ASSUME LIABILITY FOR THE DRAINAGE FACILITIES DESIGNED AND/OR CERTIFIED BY MY ENGINEER AND THAT THE CITY OF COLORADO SPRINGS REVIEWS DRAINAGE PLANS PURSUANT TO COLORADO REVISED STATUTES, TITLE 30, ARTICLE 28; BUT CANNOT, ON BEHALF OF NOR'WOOD, GUARANTEE THAT FINAL DRAINAGE DESIGN REVIEW WILL ABSOLVE NOR'WOOD AND/OR THEIR SUCCESSORS AND/OR ASSIGNS OF FUTURE LIABILITY FOR IMPROPER DESIGN. I FURTHER UNDERSTAND THAT APPROVAL OF THE FINAL PLAT DOES NOT IMPLY APPROVAL OF MY ENGINEER'S DRAINAGE DESIGN."

BUSINESS NAME: NOR'WOOD DEVELOPMENT

BY: ______________________ ______________
AUTHORIZED SIGNATURE — TITLE

ADDRESS: 111 S. TEJON ST., SUITE 222
COLORADO SPRINGS, COLORADO 80903

CITY OF COLORADO SPRINGS:

FILED IN ACCORDANCE WITH SECTION 7.7.906 OF THE CODE OF THE CITY OF COLORADO SPRINGS, 2001, AS AMENDED.

______________________ ______________
FOR THE CITY ENGINEER — DATE

CONDITIONS:

ABBREVIATIONS

BNDY	= BOUNDARY	MIN	= MINIMUM
BOP	= BOTTOM OF PIPE	NTS	= NOT TO SCALE
C&G	= CURB & GUTTER	OD	= OUTSIDE DIAMETER
CL	= CENTERLINE	PC	= POINT OF HORIZONTAL CURVATURE
COORDS	= COORDINATES	PP	= PROPOSED
DIA	= DIAMETER	PRC	= POINT OF REVERSE CURVE
DIP	= DUCTILE IRON PIPE	PROP	= PROPERTY
DTL	= DETAIL	PRT	= PRIVATE
EL,ELEV	= ELEVATION	PT	= POINT OF HORIZONTAL TANGENCY
EOA	= EDGE OF ASPHALT	PVC	= POLY VINYL CHLORIDE PIPE
ESMT	= EASEMENT	PVC	= POINT OF VERTICAL CURVATURE
EX	= EXISTING	PVI	= POINT OF VERTICAL INTERSECTION
FC	= FACE OF CURB	PVT	= POINT OF VERTICAL TANGENCY
FES	= FLARED END SECTION	R	= RADIUS
FL	= FLOWLINE	R	= RIGHT
GB	= GRADE BREAK	RCP	= REINFORCED CONCRETE PIPE
GP	= GRADING PLAN	ROW	= RIGHT OF WAY
HP	= HIGH POINT	RT	= RIGHT
HORIZ	= HORIZONTAL	SHT	= SHEET
HW	= HEADWALL	SS	= SANITARY SEWER
ID	= INSIDE DIAMETER	STA	= STATION
INV	= INVERT	STD	= STANDARD
L	= LEFT	TC	= TOP OF CURB
LT	= LEFT	THK	= THICK
LF	= LINEAR FEET	TOC	= TOP OF CONCRETE
LP	= LOW POINT	TOP	= TOP OF PIPE
MAX	= MAXIMUM	T.O.R.	= TOP OF ROCK
MH	= MANHOLE	TYP	= TYPICAL

LEGEND

- EXISTING CONTROL POINT
- EXISTING FIRE HYDRANT
- EXISTING WATER VALVE
- EXISTING GAS VALVE
- EXISTING SANITARY SEWER MANHOLE
- EXISTING STORM SEWER MANHOLE
- EXISTING WATER MANHOLE
- EXISTING TELEPHONE MANHOLE
- EXISTING TELEPHONE PEDESTAL
- EXISTING CABLE TV PEDESTAL
- EXISTING LIGHT POLE
- EXISTING ELECTRIC BOX OR TRANSFORMER
- EXISTING ELECTRIC MANHOLE
- POTHOLE LOCATION
- CURB & GUTTER
- APPROXIMATE LIMIT OF DISTURBANCE
- EXISTING RIGHT-OF-WAY LINE
- FUTURE RIGHT-OF-WAY LINE
- FUTURE LOT LINE
- EXISTING EASEMENT
- EXISTING WATER LINE
- EXISTING SANITARY SEWER
- EXISTING STORM SEWER
- EXISTING UNDERGROUND ELECTRIC LINE
- EXISTING UNDERGROUND TELEPHONE LINE
- EXISTING GAS LINE
- FUTURE WATER LINE
- PROPOSED STORM SEWER PIPE AND MANHOLE
- EXISTING BARBED WIRE FENCE
- EXISTING WOOD FENCE
- (6020) EXISTING CONTOURS
- 6020 PROPOSED CONTOURS
- (14.79) EXISTING SPOT ELEVATION
- (14.8±) APPROXIMATE EXISTING SPOT ELEVATION. ELEVATION TO BE FIELD VERIFIED PRIOR TO CONSTRUCTION.
- 15.41 PROPOSED SPOT ELEVATION
- (2.3%) EXISTING FLOW DIRECTION AND SLOPE
- 2.3% PROPOSED FLOW DIRECTION AND SLOPE

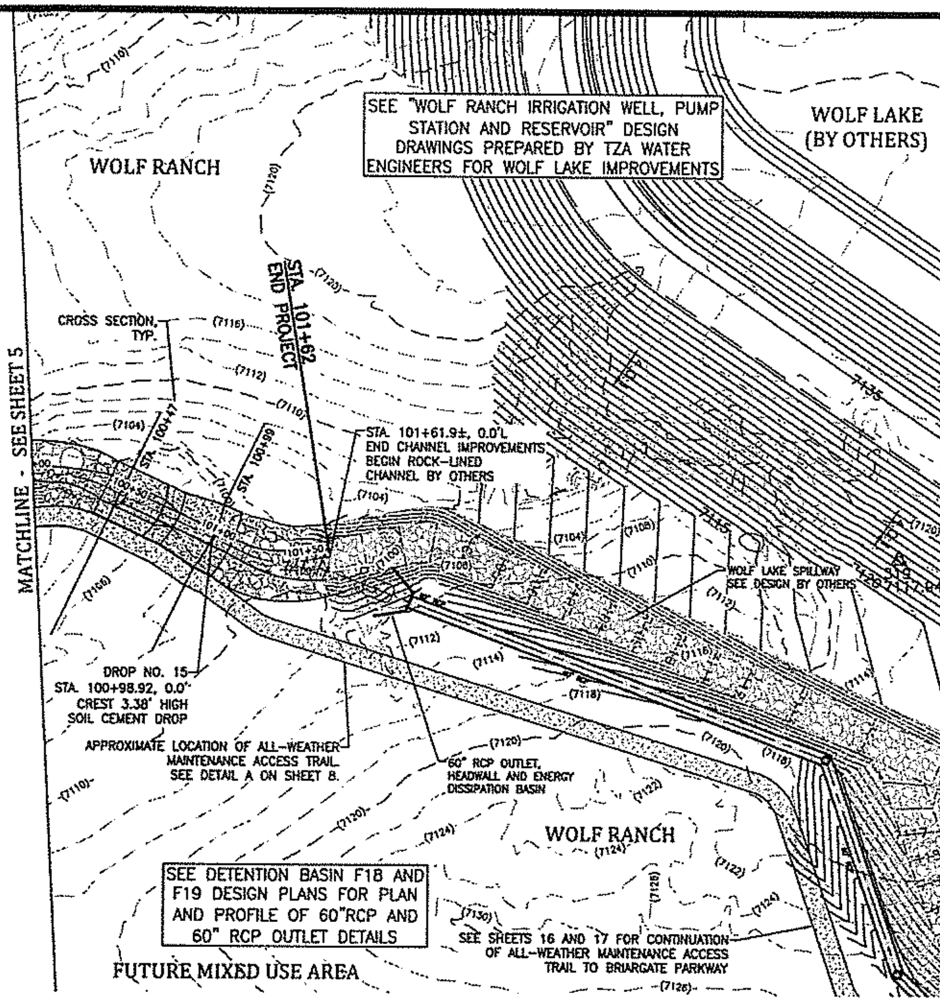
Kiowa Engineering Corporation
Celebrating 30 years
1604 South 21st Street
Colorado Springs, Colorado 80904
(719) 630-7342

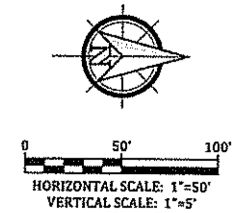
WOLF RANCH DEVELOPMENT
UPPER TRIBUTARY FOUR IMPROVEMENTS
COVER SHEET
COLORADO SPRINGS, COLORADO

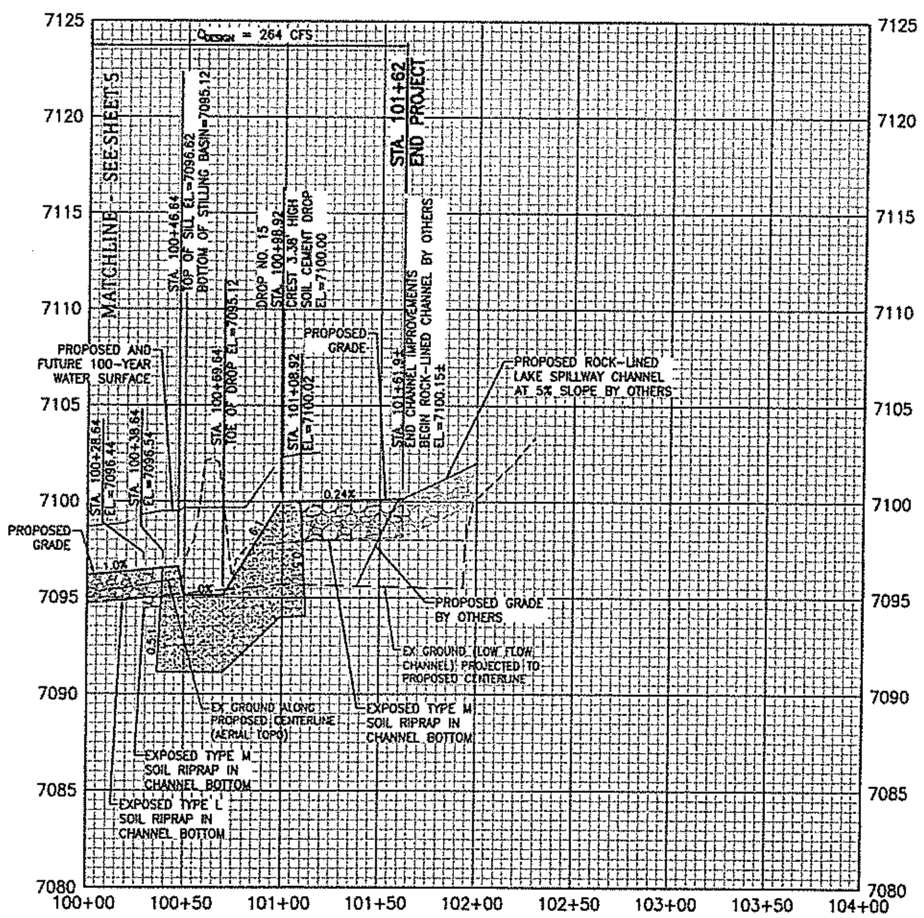
Project No.:	17004
Date:	October 18, 2017
Design:	CJC
Drawn:	CJC
Check:	RNW
Revisions:	

SHEET 1 OF 27 SHEETS

17004 Base.dwg/Oct 18, 2017







LEGEND

— — —	EXISTING RIGHT-OF-WAY LINE
— — —	FUTURE RIGHT-OF-WAY LINE
— — —	FUTURE LOT LINE
—x—x—	EXISTING FENCE
—EX STM—	EXISTING STORM SEWER
—EX W—	EXISTING WATER LINE
—EX G—	EXISTING GAS LINE
	SOIL CEMENT
	BURIED TYPE H SOIL RIPRAP
	BURIED/EXPOSED TYPE M SOIL RIPRAP
	BURIED/EXPOSED TYPE L SOIL RIPRAP
	SOIL RETENTION BLANKET (SRB)
	GRAVEL
	EXISTING RIPRAP

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Colorado Springs, Colorado 80904
(719) 630-7342

WOLF RANCH DEVELOPMENT
UPPER TRIBUTARY FOUR IMPROVEMENTS
PLAN AND PROFILE STA. 100+00 TO STA. 101+62
COLORADO SPRINGS, COLORADO

Project No.:	17004
Date:	October 18, 2017
Design:	CJC
Drawn:	CJC
Check:	RNW
Revisions:	

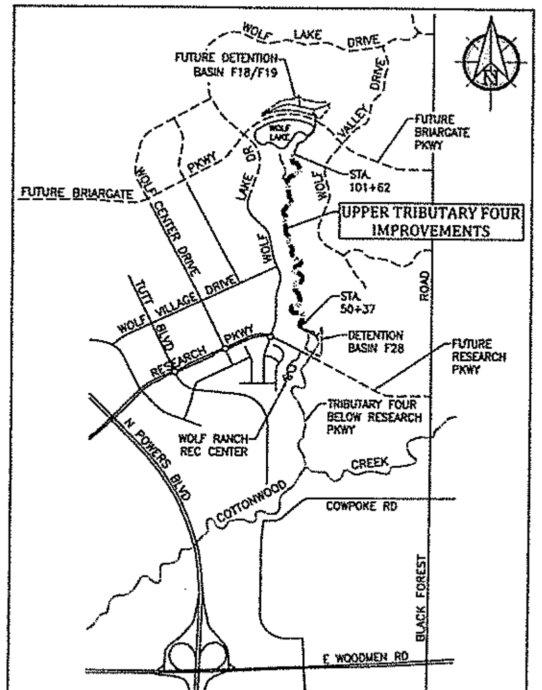
SHEET
6
OF 27 SHEETS

WOLF RANCH DEVELOPMENT
UPPER TRIBUTARY FOUR IMPROVEMENTS
WOLF LAKE TO DETENTION BASIN F28
CONSTRUCTION DRAWINGS
COLORADO SPRINGS, COLORADO

GENERAL NOTES
1. ALL MATERIALS AND WORKMANSHIP SHALL BE IN CONFORMANCE WITH THE CITY OF COLORADO SPRINGS SPECIFICATIONS (CURRENT EDITION) AND THE COLORADO DEPARTMENT OF TRANSPORTATION (CDOT) STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION (CURRENT EDITION).
2. THE CONTRACTOR SHALL HAVE IN HIS POSSESSION AT ALL TIMES ONE (1) SIGNED COPY OF THE PLANS AND SPECIFICATIONS WHICH HAVE BEEN APPROVED BY THE CITY OF COLORADO SPRINGS (CITY).
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING AS-BUILT INFORMATION ON A SET OF RECORD DRAWINGS.
4. THE CONTRACTOR SHALL NOTIFY THE OWNER AND ENGINEER OF ANY PROBLEM IN CONFORMING TO THE APPROVED PLANS FOR ANY ELEMENT OF THE PROPOSED IMPROVEMENTS PRIOR TO ITS CONSTRUCTION.
5. THE CONTRACTOR SHALL PROTECT ALL EXISTING FACILITIES IN THE GENERAL AREA OF CONSTRUCTION. THE CONTRACTOR SHALL REPAIR ANY DAMAGE CAUSED BY CONSTRUCTION OPERATIONS AT NO COST TO THE PROJECT.
6. UTILITY LINES AS SHOWN ON THESE DRAWINGS ARE PLOTTED FROM THE BEST AVAILABLE INFORMATION. THE CONTRACTOR SHALL CALL 811 FOR UTILITY LOCATIONS AT LEAST TWO WORKING DAYS PRIOR TO ANY DIGGING. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL UTILITIES PRIOR TO CONSTRUCTION AND SHALL PROTECT THEM FROM DAMAGE DURING CONSTRUCTION.
7. A CITY OF COLORADO SPRINGS UTILITIES INSPECTOR IS REQUIRED TO BE ONSITE DURING EXCAVATION AND CONSTRUCTION AROUND GAS AND ELECTRIC FACILITIES. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO COORDINATE WITH THE GAS AND ELECTRIC DEPARTMENT FORTY-EIGHT (48) HOURS PRIOR TO CONSTRUCTION.
8. ALL EARTHWORK, ROADWAY AND TRENCHING OPERATIONS SHALL BE IN CONFORMANCE WITH THE CITY STANDARD SPECIFICATIONS.
9. EXCAVATION REQUIRED FOR COMPACTION OF BASES OF CUTS AND FILLS WILL BE CONSIDERED AS SUBSIDIARY TO THAT OPERATION AND WILL NOT BE PAID FOR SEPARATELY.
10. THE TESTING OF COMPACTION FOR THIS PROJECT WILL BE PER AASHTO T 99.
11. ALL EXISTING MANHOLES TO BE MARKED WITH T-POSTS AND CAUTION TAPE PRIOR TO COMMENCING WITH THE CONSTRUCTION.
12. CONTRACTOR SHALL BE RESPONSIBLE FOR THE ESTABLISHMENT, MAINTENANCE AND DEMOBILIZATION OF CONSTRUCTION STAGING AREA(S) WITH THE CITY OF COLORADO SPRINGS.
13. WATER SHALL BE USED AS A DUST PALLIATIVE WHERE REQUIRED. WATER WILL NOT BE PAID FOR SEPARATELY, BUT WILL BE SUBSIDIARY TO THE EXCAVATION ITEM.
14. THE SOIL TO BE PLACED AS TOPSOIL MATERIAL SHALL BE FREE OF REFUSE, STUMPS, ROOTS, ROCKS, BRUSH, WEEDS, HARD CLODS, TOXIC SUBSTANCES OR OTHER MATERIAL WHICH WOULD BE DETRIMENTAL TO ITS USE ON THE PROJECT. IT SHALL HAVE A MINIMUM P.I. OF 5 BUT SHALL NOT BE SUCH HEAVY CLAY AS TO PRECLUDE PLACEMENT WITH A SHOULDER MACHINE.
15. SALVAGEABLE MATERIAL: MATERIAL THAT CAN BE SAVED OR SALVAGED. UNLESS OTHERWISE SPECIFIED IN THE CONTRACT, ALL SALVABLE MATERIAL SHALL BECOME THE PROPERTY OF THE CONTRACTOR.
16. TOPOGRAPHIC DATA INDICATED ON THESE DRAWINGS WAS COMPILED FROM AERIAL AND FIELD SURVEYS. CONTRACTOR MUST VERIFY EXTENT OF WORK WITHIN THESE AREAS. DIMENSIONS, ELEVATIONS, AND LOCATIONS OF EXISTING STRUCTURES, PIPELINES, AND UTILITIES ARE APPROXIMATE. WHERE SUCH DIMENSIONS OR LOCATIONS DETERMINE THE LIMITS OF THE WORK, SUCH DIMENSIONS OR LOCATIONS SHALL BE VERIFIED IN THE FIELD PRIOR TO CONSTRUCTION.
17. THE LOCATIONS OF EXISTING STRUCTURES, PIPELINES, UTILITIES, ETC., SHOWN ON THE DRAWINGS HAVE BEEN APPROXIMATED. THERE MAY BE OTHER STRUCTURES, PIPELINES, UTILITIES, ETC., NOT SHOWN ON THE DRAWINGS WHICH PRESENTLY EXIST IN THE AREA OF CONSTRUCTION. THE ENGINEER AND/OR OWNER ASSUMES NO RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS OF THE INFORMATION SHOWN. THE CONTRACTOR WILL BE RESPONSIBLE FOR LOCATING AND PROTECTING ALL IMPACTED EXISTING STRUCTURES, PIPELINES, UTILITIES, ETC., IN THE PROJECT SITE.
18. THE CONTRACTOR SHALL CAREFULLY PRESERVE ALL MONUMENTS, BENCHMARKS, PROPERTY MARKERS, REFERENCE POINTS, AND STAKES. IN CASE OF HIS DESTRUCTION OF THESE, THE CONTRACTOR WILL BE RESPONSIBLE FOR RESETTING SAME, AT NO COST TO THE OWNER, AND SHALL BE RESPONSIBLE FOR ANY LOSS OF TIME THAT MAY BE CAUSED.
19. THE CONTRACTOR SHALL NOTIFY THE ENGINEER WHERE UTILITIES CONFLICT WITH THE WORK IN CONFORMANCE WITH THE SPECIFICATIONS. WHERE FIELD VERIFICATION IS NOTED ON THE PLANS, THIS SHALL REQUIRE THE CONTRACTOR TO DETERMINE THE LOCATION OF THE FACILITY IN QUESTION PRIOR TO CONSTRUCTION. A DETERMINATION SHALL BE MADE BY THE CONTRACTOR IF THE CURRENT DESIGN WILL CONFLICT WITH THE EXISTING FACILITY AND NOTIFY THE ENGINEER IN WRITING.
20. ALL EXISTING AREAS DISTURBED OUTSIDE THE LIMITS OF CONSTRUCTION ACTIVITIES SHALL BE REVEGETATED IN CONFORMANCE WITH THE SPECIFICATIONS AT NO ADDITIONAL COST TO THE PROJECT.
21. ALL EXISTING ROADWAYS AND SIDEWALKS DAMAGED DURING CONSTRUCTION SHALL BE REPAIRED OR RECONSTRUCTED IN CONFORMANCE WITH THE SPECIFICATIONS.
22. SIGNAGE SHALL FOLLOW THE "MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES" LATEST EDITION AND THE CITY OF COLORADO SPRINGS TRAFFIC ENGINEERING SIGNAGE & PAVEMENT MARKING STANDARDS. CONTRACTOR SHALL SUBMIT TO THE CITY A TRAFFIC CONTROL PLAN PRIOR TO COMMENCING WITH THE WORK.
23. WHERE APPROPRIATE, NEATLY SAW CUT ALL EXISTING CONCRETE AND ASPHALT. THE PLACEMENT OF ADDITIONAL PAVING SHALL BE DONE TO A NEAT WORK LINE, SAW CUTTING A MINIMUM OF ONE (1) FOOT. SAW CUTTING WILL NOT BE PAID FOR SEPARATELY BUT WILL BE CONSIDERED INCIDENTAL TO THE WORK. REPAIR/REPLACE ALL DISTURBED EXISTING ITEMS WITH LIKE MATERIALS AND THICKNESSES. EXISTING CONCRETE PAVEMENT SHALL BE SCORED THEN BROKEN AT JOINT TO CREATE A ROUGH SURFACE FOR THE CONSTRUCTION JOINT.
24. CONTRACTOR SHALL PROTECT EXISTING BUILDINGS, STRUCTURES, ADJOINING PROPERTIES AND PUBLIC THOROUGHFARES FROM DAMAGE DURING CONSTRUCTION.
25. ALL DISCHARGES TO DRAINAGE COURSES AND STORM SEWER SYSTEMS MUST COMPLY WITH THE APPLICABLE PROVISIONS OF THE COLORADO WATER QUALITY CONTROL ACT AND THE COLORADO DISCHARGE PERMIT REGULATIONS, AND ARE SUBJECT TO INSPECTION BY THE CITY OF COLORADO SPRINGS, EL PASO COUNTY, CDOT AND COPHE. EL PASO COUNTY AND COLORADO SPRINGS HAVE MS-4 PERMITS. CONTRACTOR SHALL DEVISE AND IMPLEMENT A PERMANENT PLAN FOR PERIODIC REMOVAL AND DISPOSAL OF SEDIMENT FROM EROSION CONTROL FACILITIES AND FOR MAINTENANCE OF EROSION CONTROL FACILITIES.
26. SURFACE AND GROUNDWATER AT THE SITE MAY CREATE A NEED FOR DEWATERING DURING CONSTRUCTION. CONTRACTOR SHALL BE RESPONSIBLE FOR THE MAINTENANCE OF TEMPORARY DEWATERING STRUCTURES, NECESSARY PERMITS AND PROVIDE FOR SAFE AND STABLE DISCHARGE OF WATER FROM THE CONSTRUCTION SITE. THE COST OF DEWATERING IS INCIDENTAL TO THE CONSTRUCTION AND WILL NOT BE PAID FOR UNDER A SPECIFIC ITEM IN THE BID DOCUMENTS.
27. NO PAVEMENT DROP-OFFS WILL BE ALLOWED TO REMAIN OVERNIGHT. DROP-OFFS TO BE TEMPORARILY FILLED WITH ASPHALT AT 3:1 MINIMUM SLOPE WITH DELINEATOR POLES MARKING THE UPPER EDGE OF DROP-OFF.
28. BASIS OF BEARINGS: WOLF RANCH SUBDIVISION PLATS AS PREPARED BY ROCKWELL CONSULTING, INC.
29. BENCHMARK: FIMS MONUMENT NO. 69 IS A 3-1/4" ALUMINUM CAP SET APPROXIMATELY 30' WEST OF THE BLACK FOREST ROAD CENTERLINE AND 1,200 FEET NORTH OF COWPOKE ROAD (300' SOUTH OF THE COTTONWOOD CREEK BRIDGE CROSSING). EL=6975.735 (NGVD 29 WITH 1960 SUPPLEMENTARY ADJUSTMENT) VERTICAL DATUM.
30. SURVEY CONTROL POINTS:

POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
311	13436.975	25242.405	7006.790	
316	15975.785	25158.045	7078.850	
319	17274.185	25213.735	7117.940	
1065	12843.045	25481.175	6982.850	
2097	8725.54100	24865.26000	6894.161	MAG NAIL IN NORTH EDGE OF ASPHALT
2099	11511.90300	25736.30600	6974.357	#4 REBAR WITH RED CAP
9020	9941.82403	28549.82973	6975.735	3-1/4" ALUMINUM "FIMS 69" IN MONUMENT BOX "BENCHMARK"
9101	8782.27020	27431.69962	6967.954	#4 REBAR ON HILLTOP

GENERAL UTILITY NOTES:
1. ALL STORM WORK SHALL COMPLY WITH THE SPECIFICATIONS AND CITY STANDARDS AND SPECIFICATIONS (CURRENT EDITION) AND THE COLORADO DEPARTMENT OF TRANSPORTATION (CDOT) STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION (CURRENT EDITION).
2. THE CONTRACTOR AND SURVEY CREW SHALL VERIFY ELEVATIONS OF EXISTING SANITARY SEWER, STORM SEWER, WATER LINES AND MANHOLES TO BE TIED TO PRIOR TO CONSTRUCTION OR STAKING OF PIPE.
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR RECORDING AS-BUILT INFORMATION ON A SET OF RECORD DRAWINGS.
4. THE CONTRACTOR SHALL CONTACT ALL APPROPRIATE UTILITY COMPANIES, UTILITY DISTRICT AND THE CITY PRIOR TO THE BEGINNING OF ANY CONSTRUCTION. CONTRACTOR SHALL BE RESPONSIBLE FOR LOCATING ANY EXISTING UTILITY (INCLUDING DEPTHS) WHICH ARE WITHIN THE PROPOSED CONSTRUCTION AREA. ALL EXISTING UTILITIES SHALL BE PROTECTED FROM DAMAGE BY THE CONTRACTOR. DAMAGED UTILITIES SHALL BE REPAIRED BY THE CONTRACTOR AT HIS OWN EXPENSE.
5. THE LOCATIONS OF EXISTING UTILITIES ARE BASED UPON THE BEST AVAILABLE INFORMATION, ARE SHOWN IN AN APPROXIMATE WAY ONLY, AND HAVE NOT BEEN INDEPENDENTLY VERIFIED BY THE OWNER OR ITS REPRESENTATIVE. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK, AND AGREES TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE OCCASIONED BY THE CONTRACTOR'S FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UTILITIES.
6. PIPE BACKFILLING SHALL NOT OCCUR UNTIL PIPE HAS BEEN INSPECTED.
7. BEGIN LAYING PIPE AT THE LOWEST POINT, WITH THE BELLS POINTING UPHILL. LAY THE PIPE IN ACCORDANCE WITH THE MANUFACTURERS SPECIFICATIONS AND RECOMMENDATIONS. LAY PIPE TRUE TO LINE AND GRADE AS SHOWN ON THE DWGS.
8. ALL STORM SEWER PIPE LENGTHS AND SLOPES ARE FIGURED FROM CENTER OF MANHOLE AND THE INSIDE WALL OF INLETS. PIPE LENGTHS ARE GIVEN AS A HORIZONTAL LENGTH AND ARE APPROXIMATE. PIPE LENGTHS INCLUDE THE FLARED END SECTION.
9. ALL STORM SEWER PIPE BEDDING TO BE CLASS B BEDDING, UNLESS OTHERWISE NOTED. REFER TO CITY OF COLORADO SPRINGS STANDARD DRAWING D-30 FOR RCP, DWG D-31 FOR BOX CULVERT AND DWG D-32 FOR FLEXIBLE PIPE.
   9.1. REFER TO THE SPECIFICATIONS FOR GRANULAR BEDDING MATERIAL REQUIREMENTS FOR THE PIPE BEDDING.
10. RCP STORM SEWER PIPE SHALL BE CLASS III, UNLESS OTHERWISE NOTED.
11. ALL RCP SECTIONS SHALL BE JOINED IN SUCH A MANNER THAT THE ENDS ARE FULLY ENTERED AND THE INNER SURFACES ARE REASONABLY FLUSH. RUBBER GASKETS SHALL BE USED ON ALL PIPE JOINTS CONFORMING TO ASTM C-433. AVERAGE JOINT GAP THAT EXCEEDS 1/2 INCH SHALL BE FILLED WITH AN APPROVED FLEXIBLE PLASTIC SEALANT.
12. CONSTRUCTION AND MATERIALS USED IN ALL STORM MANHOLES SHALL BE PER CITY STANDARDS AND SPECIFICATIONS. ALL MANHOLES SHALL BE CONSTRUCTED IN ACCORDANCE WITH CITY STANDARD DETAILS D-20B AND D-20D FOR TYPE II STORM SEWER MANHOLES, AND SHALL HAVE SHAPED INVERTS.
13. MANHOLE RIM ELEVATIONS SHOWN ARE APPROXIMATE ONLY AND ARE NOT TO BE TAKEN AS FINAL ELEVATIONS. RING AND COVER TO BE SET IN CENTERED CONCRETE RINGS WITH RAM-NECK FOR ADJUSTMENT TO MATCH PROPOSED GRADE OR FINAL PAVEMENT ELEV.
14. WHERE APPROPRIATE, NEATLY SAW CUT ALL EXISTING CONCRETE AND ASPHALT. THE PLACEMENT OF ADDITIONAL PAVING SHALL BE DONE TO A NEAT WORK LINE, SAW CUTTING A MINIMUM OF ONE (1) FOOT. SAW CUTTING WILL NOT BE PAID FOR SEPARATELY BUT WILL BE CONSIDERED INCIDENTAL TO THE WORK. REPAIR/REPLACE ALL DISTURBED EXISTING ITEMS WITH LIKE MATERIALS AND THICKNESSES. ANY ASPHALT REMOVED IS TO BE REPLACED TO MEET THE SPECIFICATIONS OF THE COLORADO DEPT OF TRANSPORTATION. EXISTING CONCRETE PAVEMENT SHALL BE SCORED THEN BROKEN AT JOINT TO CREATE A ROUGH SURFACE FOR THE CONSTRUCTION JOINT.
15. ALL ASPHALT WORK REQUIRING PATCHING WILL BE PERFORMED TO A NEAT WORK LINE. THE EXISTING ASPHALT SHALL BE SAW CUT. ALL ASPHALT PATCH WORK SHALL BE AT LEAST 2' WIDE AFTER THE COMPLETION OF WORK. NEW CURB CAN BE PLACED FLUSH WITH THE EXISTING ASPHALT IF IT IS TO A NEAT WORK LINE.
16. WITH NOTIFICATION OF THE RESPECTIVE OWNER, ADJUST RIMS OF ALL MANHOLES WITHIN PAVEMENT TO 1/4 TO 1/2 INCH BELOW THE FINISHED GRADE AND CROSS SLOPE PRIOR TO FINAL LIFT PAVING AND ADJUST TO MATCH FINISH GRADE IN UNPAVED AREAS.



VICINITY MAP
SCALE: NTS

INDEX OF SHEETS

STATEMENTS AND APPROVALS

ENGINEER'S STATEMENT

"THIS PLAN FOR THE FINAL DRAINAGE DESIGN FOR NOR'WOOD WAS PREPARED BY ME (OR UNDER MY DIRECT SUPERVISION) IN ACCORDANCE WITH THE PROVISIONS OF THE CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL VOLUMES 1 AND 2 FOR THE OWNERS THEREOF. I UNDERSTAND THAT THE CITY OF COLORADO SPRINGS DOES NOT AND WILL NOT ASSUME LIABILITY FOR DRAINAGE FACILITIES DESIGNED BY OTHERS."

BY: ______________________ ______________

CHRISTOPHER J. CASTELLI, PE #38842 DATE
FOR & ON BEHALF OF KIOWA ENGINEERING CORP.

DEVELOPER'S STATEMENT

"NOR'WOOD DEVELOPMENT HEREBY CERTIFIES THAT THE DRAINAGE FACILITIES FOR NOR'WOOD SHALL BE CONSTRUCTED ACCORDING TO THE DESIGN PRESENTED IN THIS REPORT. I UNDERSTAND THAT THE CITY OF COLORADO SPRINGS DOES NOT AND WILL NOT ASSUME LIABILITY FOR THE DRAINAGE FACILITIES DESIGNED AND/OR CERTIFIED BY MY ENGINEER AND THAT THE CITY OF COLORADO SPRINGS REVIEWS DRAINAGE PLANS PURSUANT TO COLORADO REVISED STATUTES, TITLE 30, ARTICLE 28; BUT CANNOT, ON BEHALF OF NOR'WOOD, GUARANTEE THAT FINAL DRAINAGE DESIGN REVIEW WILL ABSOLVE NOR'WOOD AND/OR THEIR SUCCESSORS AND/OR ASSIGNS OF FUTURE LIABILITY FOR IMPROPER DESIGN. I FURTHER UNDERSTAND THAT APPROVAL OF THE FINAL PLAT DOES NOT IMPLY APPROVAL OF MY ENGINEER'S DRAINAGE DESIGN."

BUSINESS NAME: NOR'WOOD DEVELOPMENT

BY: ______________________ ______________

AUTHORIZED SIGNATURE TITLE

ADDRESS: 111 S. TEJON ST., SUITE 222
COLORADO SPRINGS, COLORADO 80903

CITY OF COLORADO SPRINGS:

FILED IN ACCORDANCE WITH SECTION 7.7.906 OF THE CODE OF THE CITY OF COLORADO SPRINGS, 2001, AS AMENDED.

______________________ ______________

FOR THE CITY ENGINEER DATE

CONDITIONS:

PRE-EXCAVATION CHECKLIST

- ☐ GAS AND OTHER UTILITY LINES OF RECORD SHOWN ON PLANS.
- ☐ UTILITIES CENTRAL LOCATING CALLED AT LEAST 2 BUSINESS DAYS AHEAD.
- ☐ UTILITIES LOCATED AND MARKED.
- ☐ EMPLOYEES BRIEFED ON MARKING AND COLOR CODES.*
- ☐ EMPLOYEES TRAINED ON EXCAVATION AND SAFETY PROCEDURES FOR NATURAL GAS LINES.
- ☐ WHEN EXCAVATION APPROACHES GAS LINES, EMPLOYEES EXPOSE LINES BY CAREFUL PROBING AND HAND DIGGING.

*A.G.A./A.P.W.A. STANDARD UTILITY MARKING COLOR CODE

NATURAL GAS	YELLOW	WATER	BLUE
ELECTRIC	RED	WASTEWATER	GREEN

811
Know what's below.
Call before you dig.

ABBREVIATIONS

BNDY	= BOUNDARY	MIN	= MINIMUM
BOP	= BOTTOM OF PIPE	NTS	= NOT TO SCALE
C&G	= CURB & GUTTER	OD	= OUTSIDE DIAMETER
CL	= CENTERLINE	PC	= POINT OF HORIZONTAL CURVATURE
COORDS	= COORDINATES	PP	= PROPOSED
DIA	= DIAMETER	PRC	= POINT OF REVERSE CURVE
DIP	= DUCTILE IRON PIPE	PROP	= PROPERTY
DTL	= DETAIL	PRT	= PRIVATE
EL,ELEV	= ELEVATION	PT	= POINT OF HORIZONTAL TANGENCY
EOA	= EDGE OF ASPHALT	PVC	= POLY VINYL CHLORIDE PIPE
ESMT	= EASEMENT	PVC	= POINT OF VERTICAL CURVATURE
EX	= EXISTING	PVI	= POINT OF VERTICAL INTERSECTION
FC	= FACE OF CURB	PVT	= POINT OF VERTICAL TANGENCY
FES	= FLARED END SECTION	R	= RADIUS
FL	= FLOWLINE	R	= RIGHT
GB	= GRADE BREAK	RCP	= REINFORCED CONCRETE PIPE
GP	= GRADING PLAN	ROW	= RIGHT OF WAY
HP	= HIGH POINT	RT	= RIGHT
HORIZ	= HORIZONTAL	SHT	= SHEET
HW	= HEADWALL	SS	= SANITARY SEWER
ID	= INSIDE DIAMETER	STA	= STATION
INV	= INVERT	STD	= STANDARD
L	= LEFT	TC	= TOP OF CURB
LT	= LEFT	THK	= THICK
LF	= LINEAR FEET	TOC	= TOP OF CONCRETE
LP	= LOW POINT	TOP	= TOP OF PIPE
MAX	= MAXIMUM	T.O.R.	= TOP OF ROCK
MH	= MANHOLE	TYP	= TYPICAL

LEGEND

- EXISTING CONTROL POINT
- EXISTING FIRE HYDRANT
- EXISTING WATER VALVE
- EXISTING GAS VALVE
- EXISTING SANITARY SEWER MANHOLE
- EXISTING STORM SEWER MANHOLE
- EXISTING WATER MANHOLE
- EXISTING TELEPHONE MANHOLE
- EXISTING TELEPHONE PEDESTAL
- EXISTING CABLE TV PEDESTAL
- EXISTING LIGHT POLE
- EXISTING ELECTRIC BOX OR TRANSFORMER
- EXISTING ELECTRIC MANHOLE
- POTHOLE LOCATION
- CURB & GUTTER
- APPROXIMATE LIMIT OF DISTURBANCE
- EXISTING RIGHT-OF-WAY LINE
- FUTURE RIGHT-OF-WAY LINE
- FUTURE LOT LINE
- EXISTING EASEMENT
- EX W — EXISTING WATER LINE
- EX SS — EXISTING SANITARY SEWER
- EX STM — EXISTING STORM SEWER
- EX UGE — EXISTING UNDERGROUND ELECTRIC LINE
- EX T — EXISTING UNDERGROUND TELEPHONE LINE
- EX G — EXISTING GAS LINE
- W — FUTURE WATER LINE
- PROPOSED STORM SEWER PIPE AND MANHOLE
- EXISTING BARBED WIRE FENCE
- EXISTING WOOD FENCE
- (6020) — EXISTING CONTOURS
- 6020 — PROPOSED CONTOURS
- (14.79) — EXISTING SPOT ELEVATION
- (14.8±) — APPROXIMATE EXISTING SPOT ELEVATION. ELEVATION TO BE FIELD VERIFIED PRIOR TO CONSTRUCTION.
- 15.41 — PROPOSED SPOT ELEVATION
- (2.3%) — EXISTING FLOW DIRECTION AND SLOPE
- 2.3% — PROPOSED FLOW DIRECTION AND SLOPE

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

WOLF RANCH DEVELOPMENT
UPPER TRIBUTARY FOUR IMPROVEMENTS
COVER SHEET
COLORADO SPRINGS, COLORADO

Project No.:	17004
Date:	October 18, 2017
Design:	CJC
Drawn:	CJC
Check:	RNW
Revisions:	

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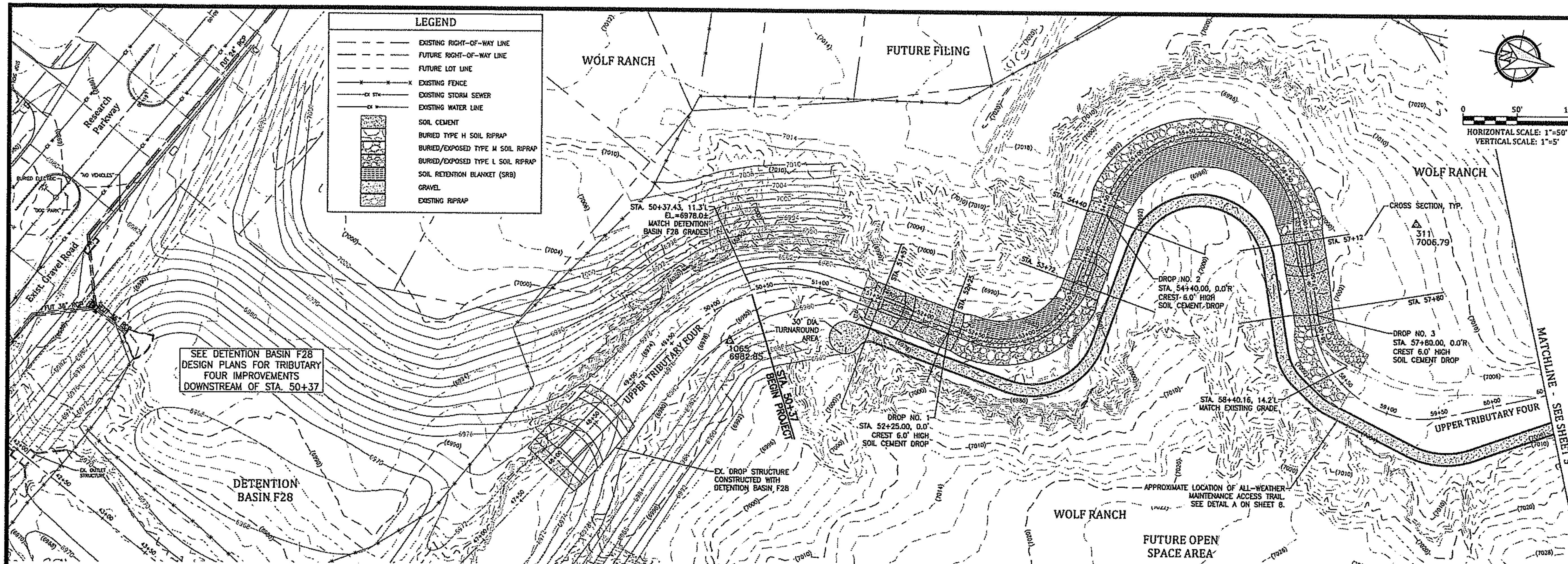
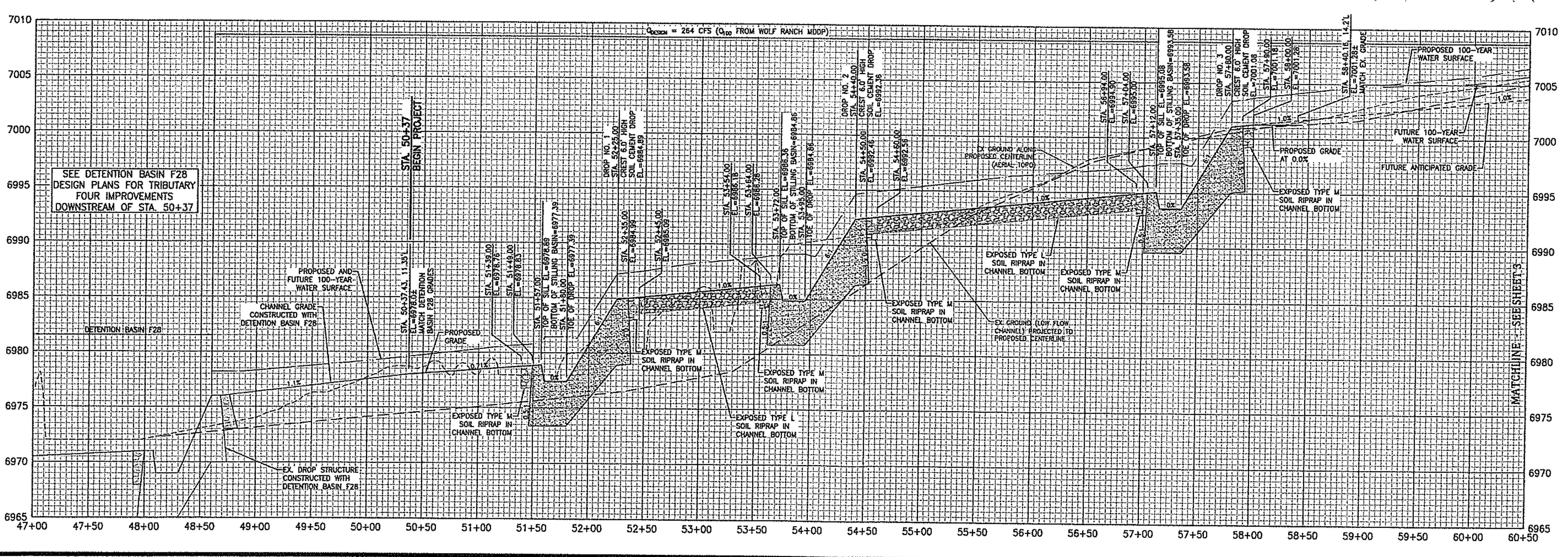
17004 Base.dwg/Oct 18, 2017





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WOLF RANCH DEVELOPMENT
UPPER TRIBUTARY FOUR IMPROVEMENTS
PLAN AND PROFILE STA. 47+00 TO STA. 60+50
COLORADO SPRINGS, COLORADO

Project No.:	17004
Date:	October 18, 2017
Design:	CJC
Drawn:	CJC
Check:	RNW
Revisions:	

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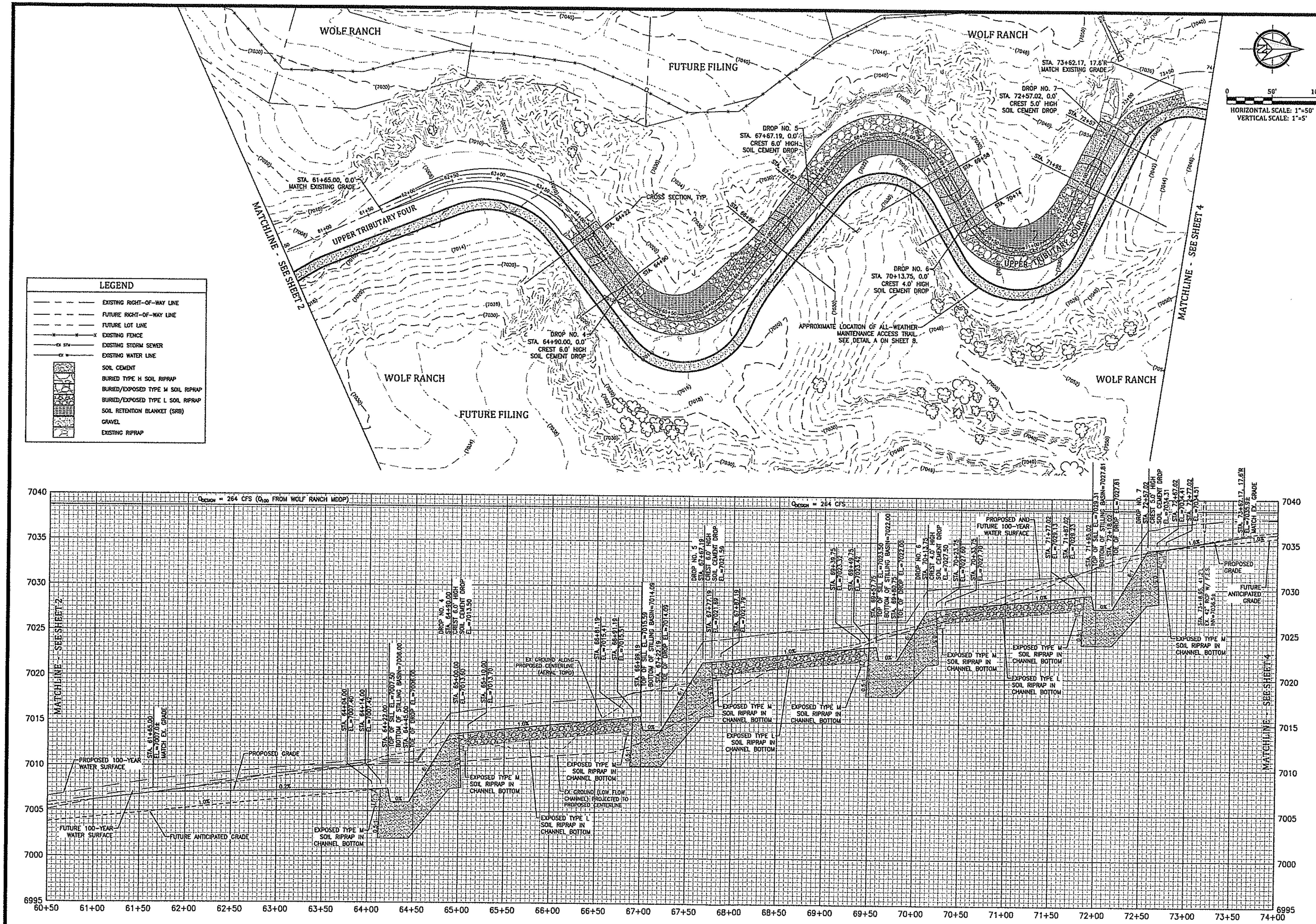

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WOLF RANCH DEVELOPMENT
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PLAN AND PROFILE STA. 60+50 TO STA. 74+00
COLORADO SPRINGS, COLORADO

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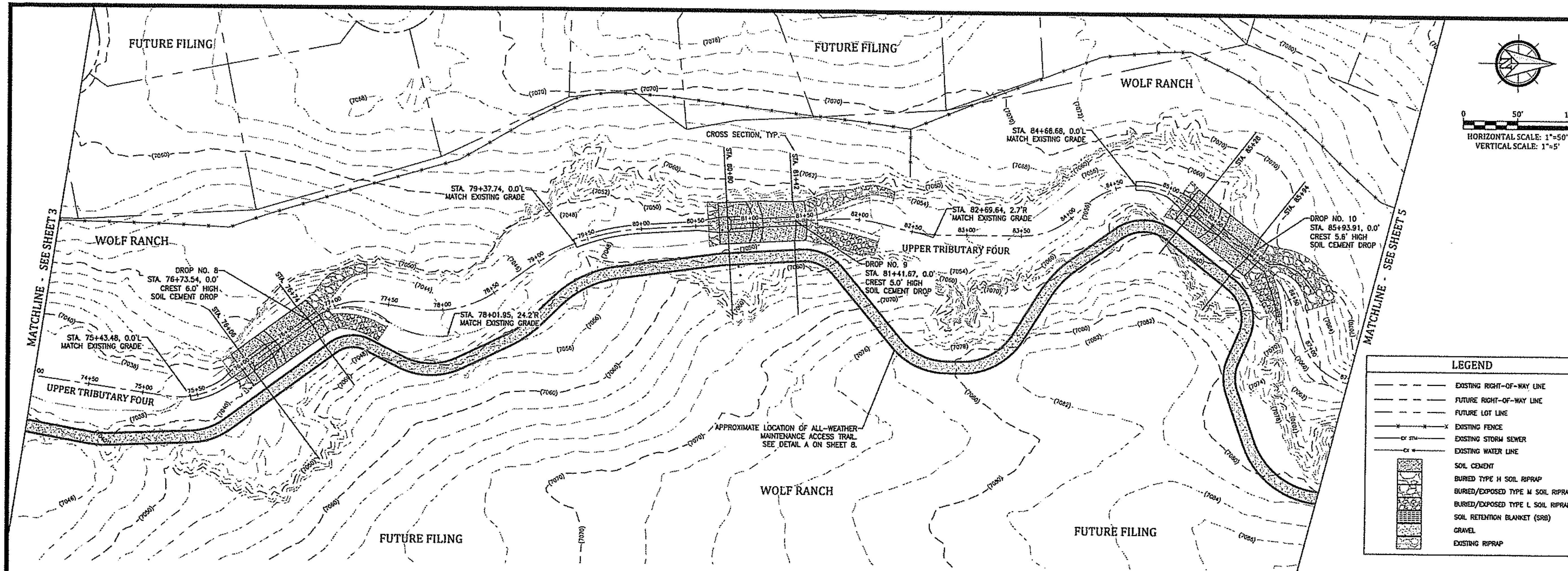

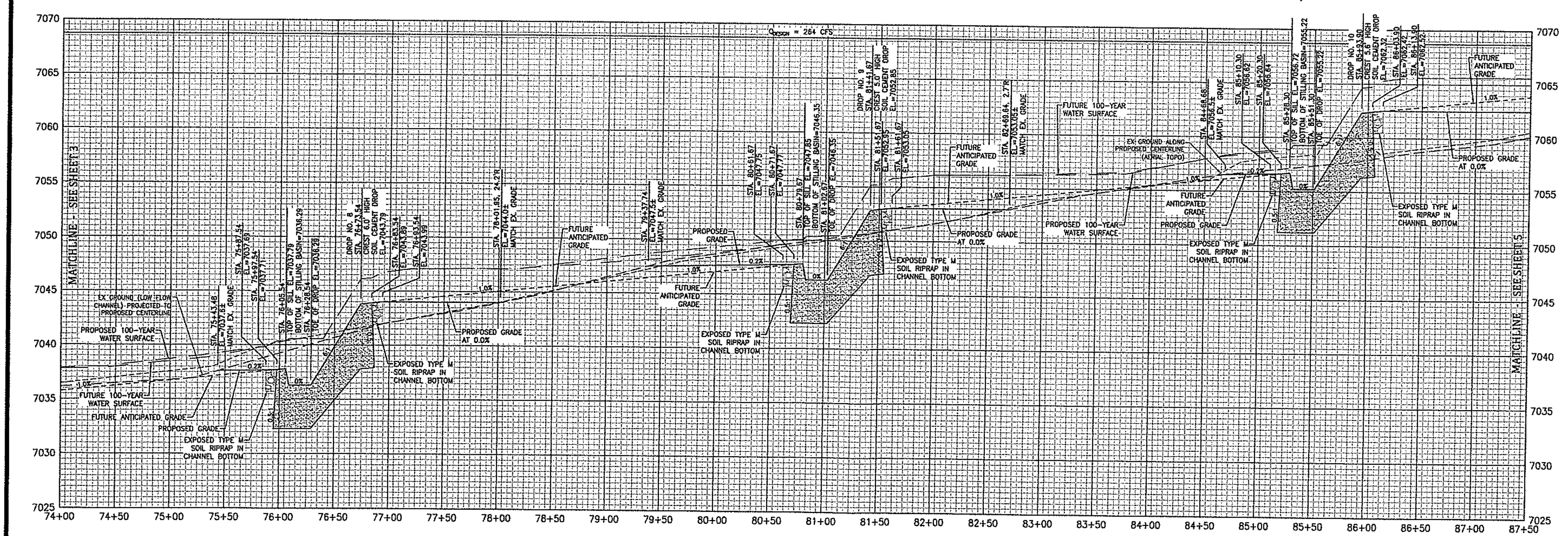

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WOLF RANCH DEVELOPMENT
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PLAN AND PROFILE STA. 74+00 TO STA. 87+50
COLORADO SPRINGS, COLORADO

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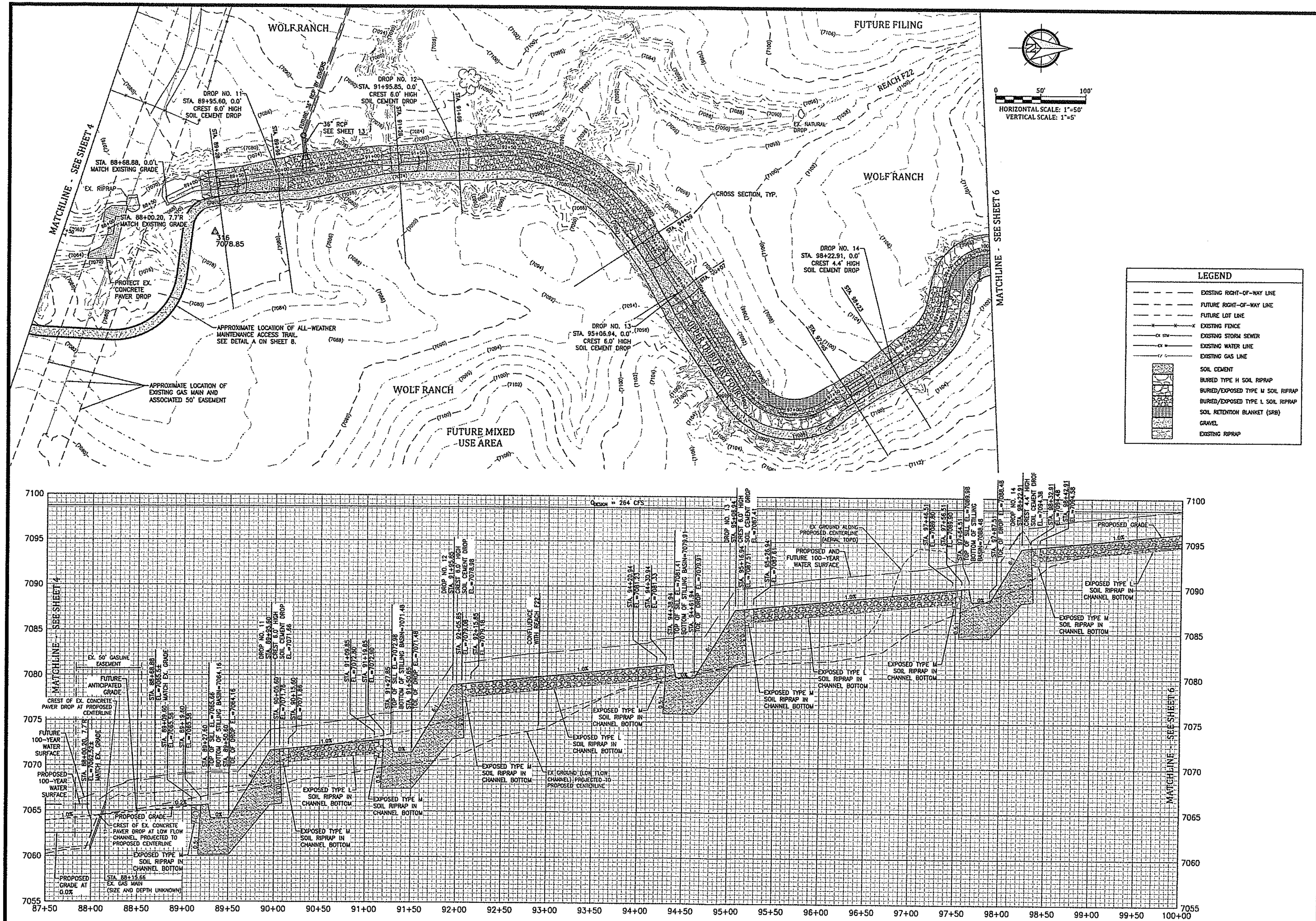

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PLAN AND PROFILE STA. 87+50 TO STA. 100+00
COLORADO SPRINGS, COLORADO

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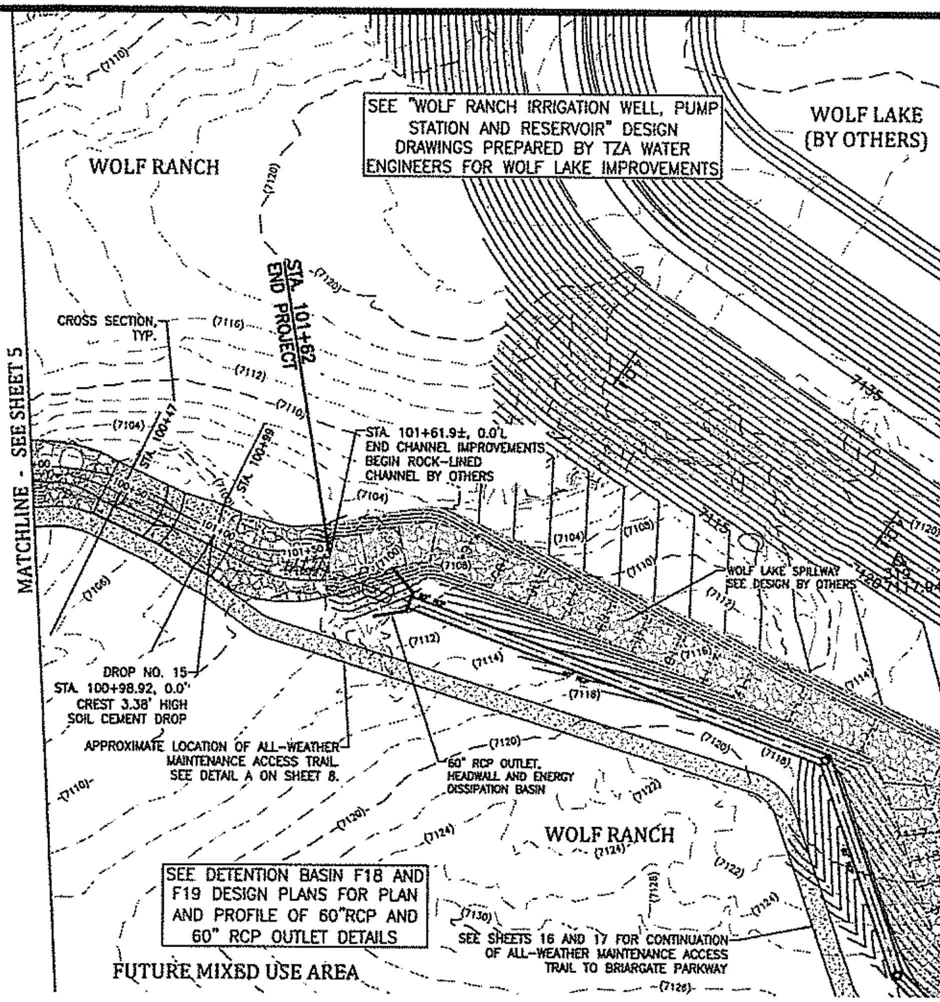

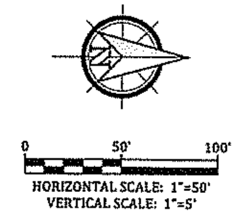

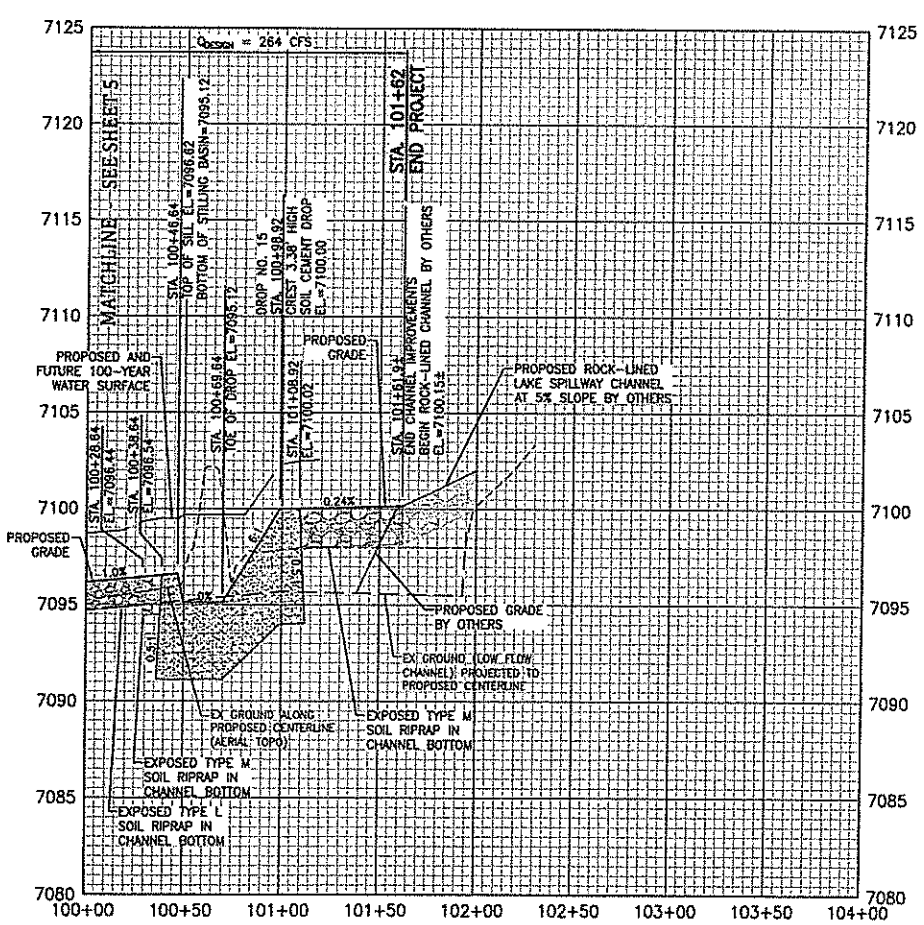

LEGEND

- EXISTING RIGHT-OF-WAY LINE
- FUTURE RIGHT-OF-WAY LINE
- FUTURE LOT LINE
- EXISTING FENCE
- EXISTING STORM SEWER
- EXISTING WATER LINE
- EXISTING GAS LINE
- SOIL CEMENT
- BURIED TYPE H SOIL RIPRAP
- BURIED/EXPOSED TYPE M SOIL RIPRAP
- BURIED/EXPOSED TYPE L SOIL RIPRAP
- SOIL RETENTION BLANKET (SRB)
- GRAVEL
- EXISTING RIPRAP

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WOLF RANCH DEVELOPMENT
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PLAN AND PROFILE STA. 100+00 TO STA. 101+62
COLORADO SPRINGS, COLORADO

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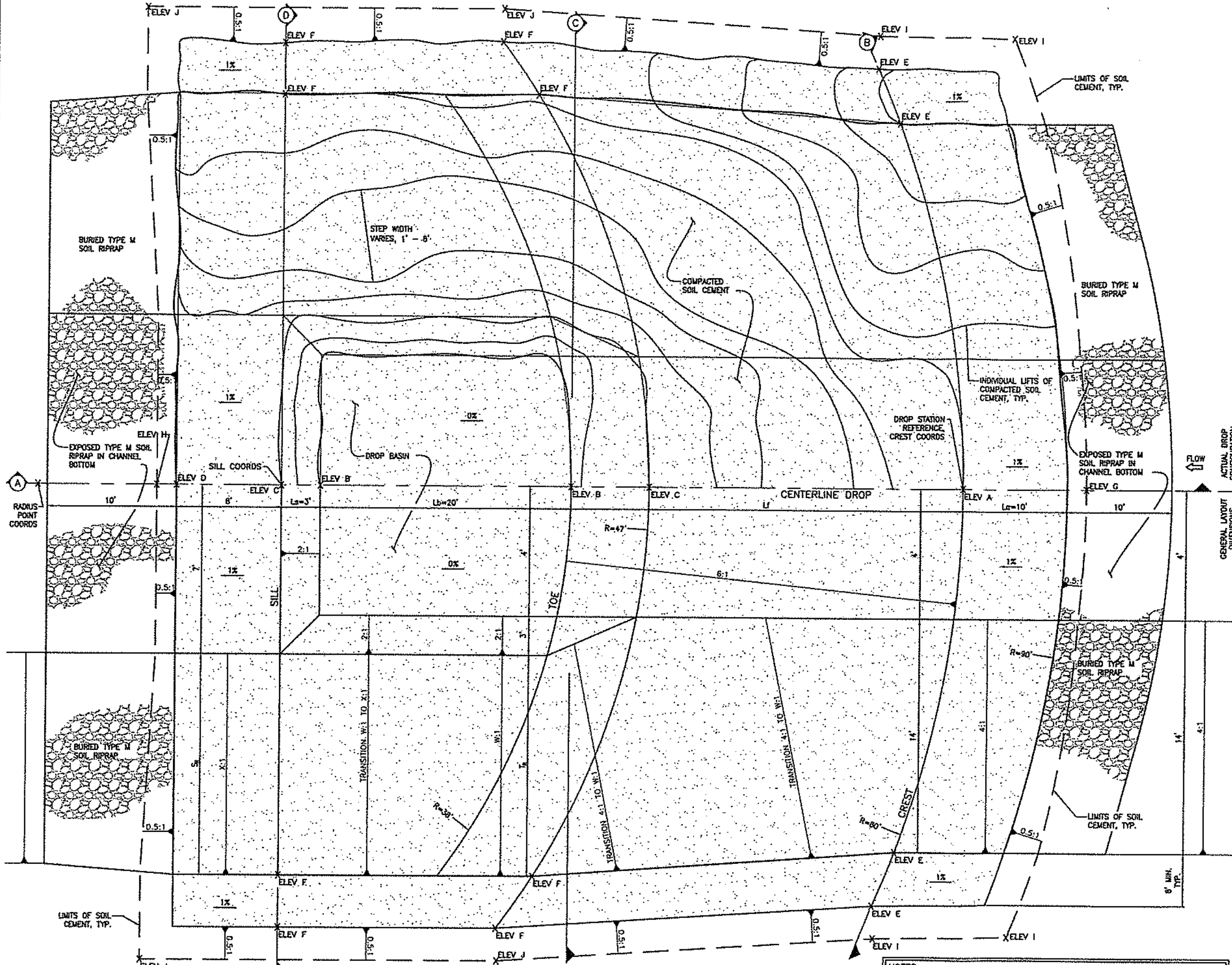
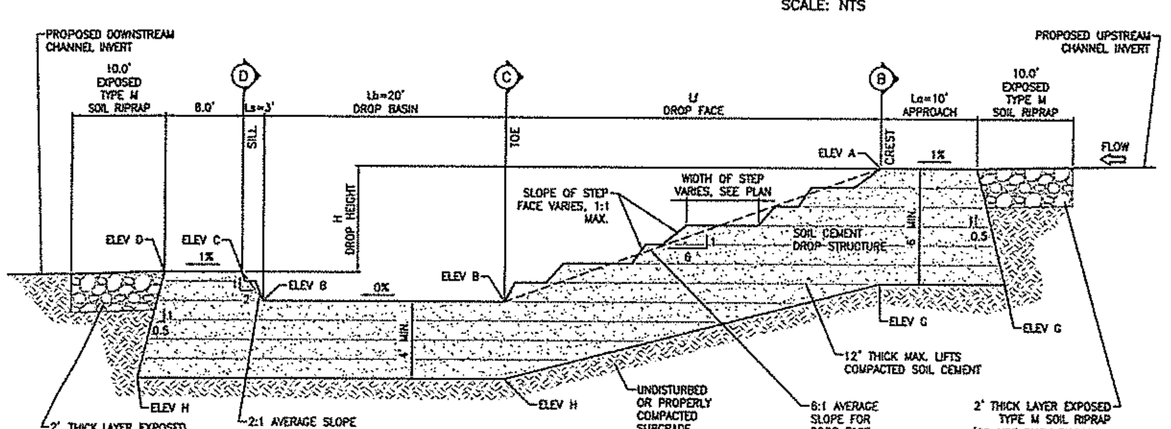
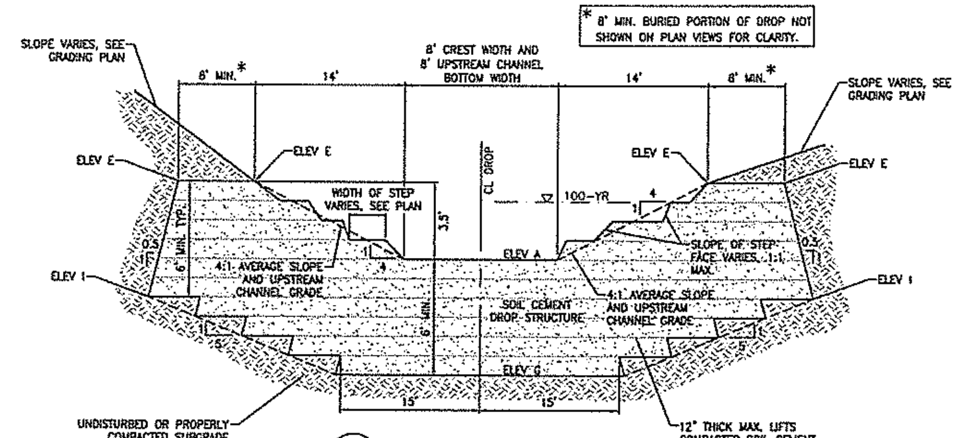


DROP STRUCTURE PLAN
SCALE: NTS

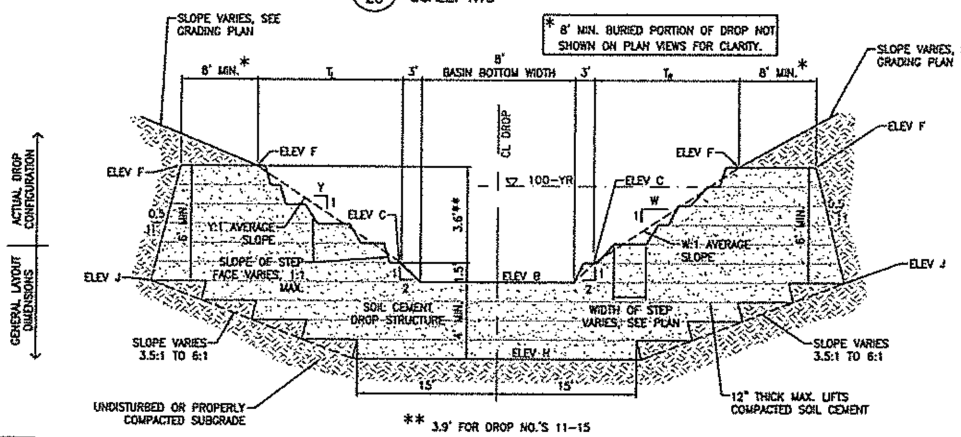
NOTES:
1. RANDOM APPEARANCE OF DROP IS IMPORTANT. VARYING STEP WIDTHS AND STEP FACE SLOPES SHALL BE COORDINATED AND ESTABLISHED IN FIELD.
2. SEE SPECIFICATIONS FOR SOIL CEMENT PROPORTIONING AND PLACEMENT REQUIREMENTS.
3. IF BEDROCK IS ENCOUNTERED, KEY SIDES AND BOTTOM OF SOIL CEMENT 12" MIN. INTO NATIVE ROCK LAYER.



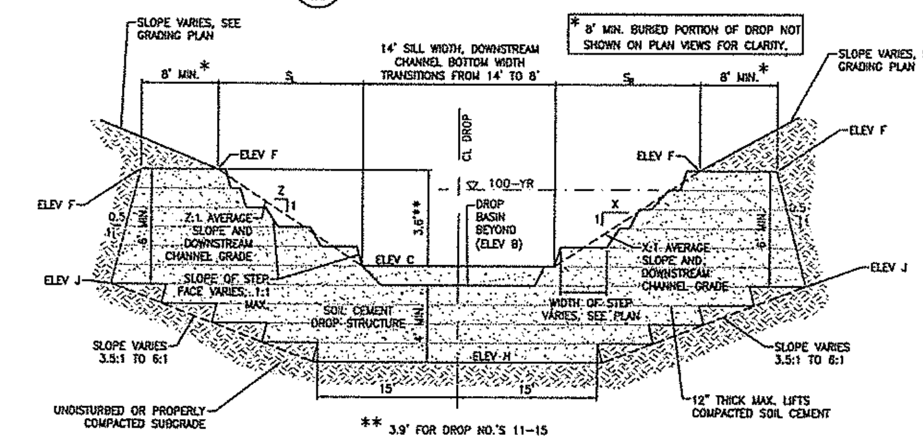
A/26 DROP STRUCTURE PROFILE
SCALE: NTS



B/26 TYPICAL CREST SECTION
SCALE: NTS



C/26 TYPICAL DROP TOE SECTION
SCALE: NTS



D/26 TYPICAL SILL SECTION
SCALE: NTS

SOIL CEMENT DROP STRUCTURE SCHEDULE

DROP NO.	STATION	CREST COORDINATES	SILL COORDINATES	RADIUS PT. COORDINATES	DROP HT(H)	Lf	S_L	S_R	T_L	T_R	W	X	Y	Z	ELEV A	ELEV B	ELEV C	ELEV D	ELEV E	ELEV F	ELEV G	ELEV H	ELEV I	ELEV J
1	52+25.00	N 13037.07 E 25427.82	N 12969.76 E 25418.18	N 12957.89 E 25416.39	6.0'	45.0'	10.8'	10.8'	10.8'	10.8'	3	3	3	3	84.89	77.39	78.89	78.83	88.39	82.49	78.89	73.39	82.39	76.49
2	54+40.00	N 133155.67 E 25295.10	N 13146.40 E 25362.47	N 13144.69 E 25374.34	6.0'	45.0'	9.3'	12.4'	9.3'	12.4'	4	4	3	3	92.36	84.86	86.36	86.28	95.86	89.46	86.36	80.86	89.86	83.46
3	57+80.00	N 13362.28 E 25343.04	N 13338.60 E 25279.52	N 13333.79 E 25268.29	6.0'	45.0'	12.4'	12.4'	12.4'	12.4'	4	4	4	4	01.08	93.58	95.08	95.00	04.58	98.18	95.08	89.58	98.58	92.18
4	64+90.00	N 13963.34 E 25404.74	N 13921.94 E 25350.79	N 13914.71 E 25341.22	6.0'	45.0'	9.3'	12.4'	9.3'	12.4'	4	4	3	3	13.50	06.00	07.50	07.42	17.00	10.60	07.50	02.00	11.00	04.60
5	67+67.19	N 14163.80 E 25300.71	N 14121.86 E 25354.24	N 14114.40 E 25363.64	6.0'	45.0'	9.3'	9.3'	9.3'	9.3'	3	3	3	3	21.59	14.09	15.59	15.51	25.09	18.69	15.59	10.09	19.09	12.69
6	70+13.75	N 14339.85 E 25329.04	N 14311.73 E 25280.62	N 14299.75 E 25259.82	4.0'	33.0'	12.4'	9.3'	12.4'	9.3'	3	3	4	4	27.50	22.00	23.50	23.42	31.00	26.60	21.50	18.00	25.00	20.60
7	72+57.02	N 14496.56 E 25235.21	N 14468.97 E 25290.76	N 14460.95 E 25306.84	5.0'	39.0'	12.4'	9.3'	12.4'	9.3'	3	3	4	4	34.31	27.81	29.31	29.23	37.81	32.41	28.31	23.81	31.81	26.41
8	76+73.54	N 14858.98 E 25114.18	N 14804.47 E 25154.84	N 14794.80 E 25161.95	6.0'	45.0'	10.8'	10.8'	10.8'	10.8'	3	3	3	3	43.79	36.29	37.79	37.71	47.29	41.39	37.79	32.29	41.29	35.39
9	81+41.67	N 15303.03 E 25017.78	N 15241.15 E 25021.60	N 15223.18 E 25022.62	5.0'	39.0'	13.3'	10.8'	13.3'	10.8'	3	3	3.7	3.7	52.85	46.35	47.85	47.77	56.35	51.45	46.85	42.35	50.35	45.45
10	85+93.91	N 15720.84 E 25044.48	N 15689.20 E 25004.03	N 15657.92 E 24995.06	5.6'	42.6'	10.8'	10.8'	10.8'	10.8'	3	3	3	3	62.32	55.22	56.72	56.64	65.82	60.32	56.32	51.22	59.82	54.32
11	89+95.60	N 16044.94 E 25094.47	N 15977.56 E 25103.66	N 15965.66 E 25105.20	6.0'	45.0'	7.8'	7.8'	7.8'	7.8'	2	2	2	2	71.66	64.16	65.66	65.58	75.16	69.56	65.66	60.16	69.16	63.56
12	91+95.85	N 16243.82 E 25070.67	N 16175.82 E 25075.93	N 16163.85 E 25076.78	6.0'	45.0'	7.8'	7.8'	7.8'	7.8'	2	2	2	2	78.98	71.48	72.98	72.90	82.48	76.88	72.98	67.48	76.48	70.88
13	95+06.94	N 16468.18 E 25219.62	N 16450.71 E 25162.88	N 16444.17 E 25152.82	6.0'	45.0'	7.8'	7.8'	7.8'	7.8'	2	2	2	2	87.41	79.91	81.41	81.33	90.91	85.31	81.41	75.91	84.91	79.31
14	98+22.91	N 16721.13 E 25297.42	N 16672.05 E 25329.07	N 16653.86 E 25340.71	4.4'	35.4'	7.8'	7.8'	7.8'	7.8'	2	2	2	2	94.38	88.48	89.98	89.90	97.88	93.88	88.38	84.48	91.88	87.88
15	100+98.92	N 16920.14 E 25204.61	N 16872.93 E 25182.14	N 16847.93 E 25170.16	3.38'	29.3'	7.8'	7.8'	7.8'	7.8'	2	2	2	2	100.00	95.12	96.62	96.54	103.50	100.52	94.00	91.12	97.50	94.52

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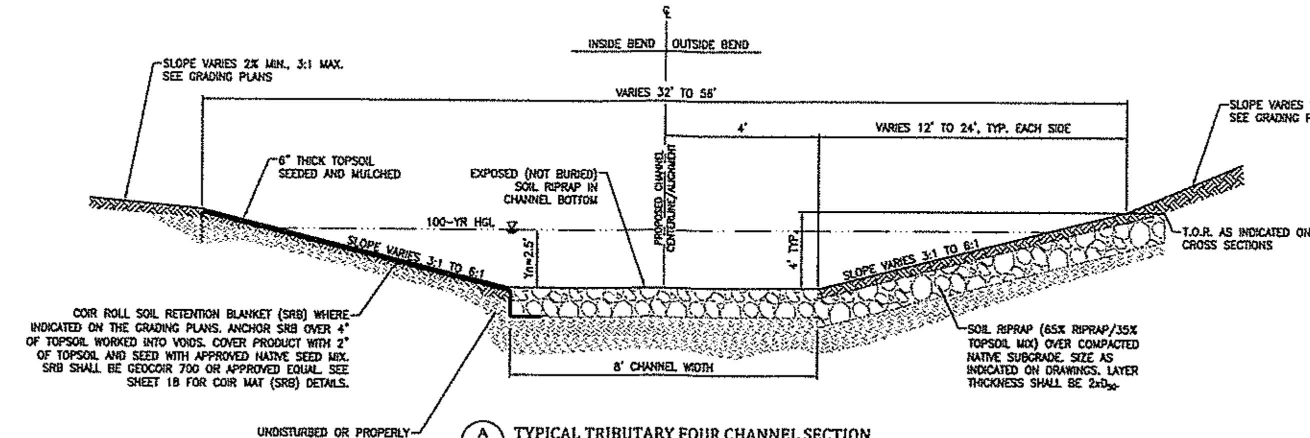
WOLF RANCH DEVELOPMENT
UPPER TRIBUTARY FOUR IMPROVEMENTS
DROP STRUCTURE DETAILS
COLORADO SPRINGS, COLORADO

Project No.: 17004
Date: October 18, 2017
Design: CJC
Drawn: CJC
Check: RNW
Revisions:

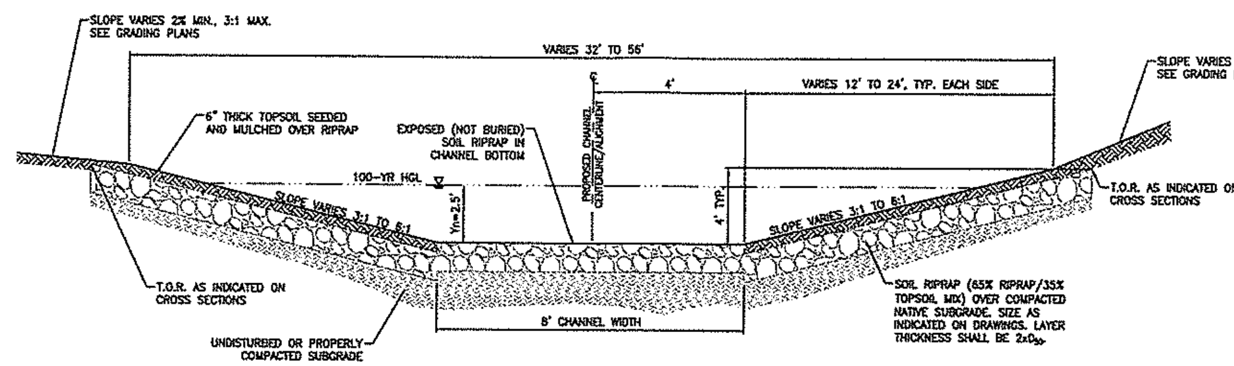
SHEET
26
OF 27 SHEETS



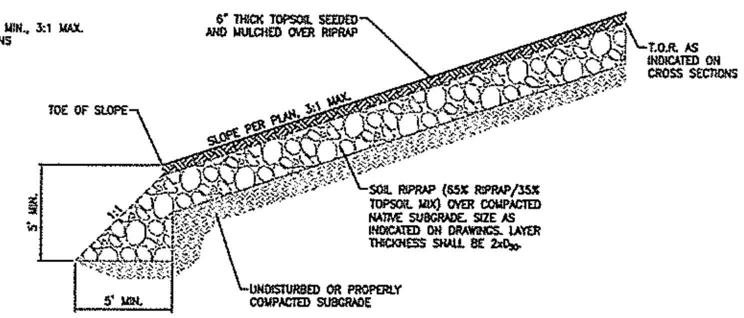
A/27 **TYPICAL TRIBUTARY FOUR CHANNEL SECTION LINED ON OUTSIDE BEND AND CHANNEL BOTTOM**
SCALE: NTS

CLASSIFICATION AND GRADATION OF RIPRAP			
RIPRAP DESIGNATION	% SMALLER THAN GIVEN SIZE BY WEIGHT	INTERMEDIATE ROCK DIMENSION (INCHES)	d50* (INCHES)
TYPE VL	70-100	12	
	50-70	9	
	35-50	6	6**
	2-10	2	
TYPE L	70-100	15	
	50-70	12	
	35-50	9	9**
	2-10	3	
TYPE M	70-100	21	
	50-70	18	
	35-50	12	12**
	2-10	4	
TYPE H	100	21	
	50-70	24	
	35-50	18	18
	2-10	6	
TYPE VH	100	42	
	50-70	33	
	35-50	24	24
	2-10	9	

* d50=MEAN PARTICLE SIZE (INTERMEDIATE DIMENSION) BY WEIGHT.
** MIX VL, L AND M RIPRAP WITH 35% TOPSOIL (BY VOLUME) AND BURY WITH 4-6 INCHES OF TOPSOIL, ALL VIBRATION COMPACTED & REVEGETATE.
(TABLE MD-7: CLASSIFICATION AND GRADATION OF ORDINARY RIPRAP. UDFCD, DRAINAGE CRITERIA MANUAL, VOL. 1)



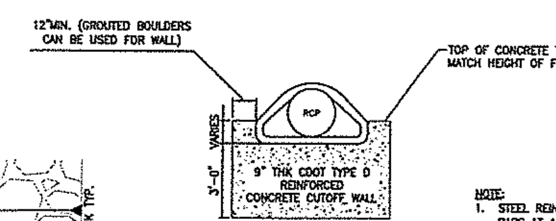
B/27 **TYPICAL TRIBUTARY FOUR CHANNEL SECTION BOTH BANKS AND CHANNEL FULLY-LINED**
SCALE: NTS



C/27 **SOIL RIPRAP TOE PROTECTION**
SCALE: NTS

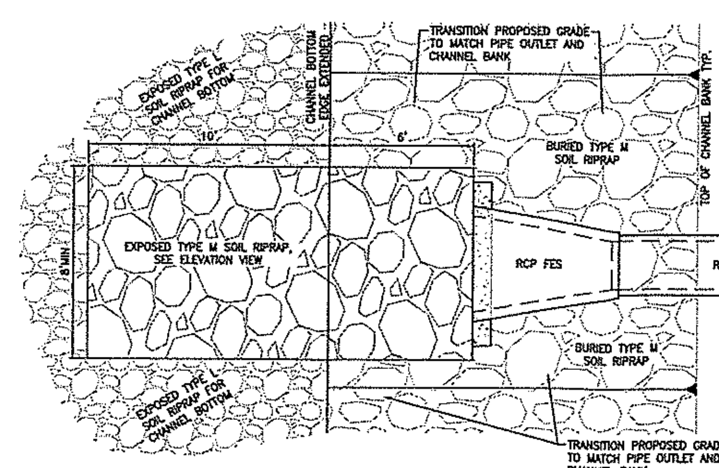
RIPRAP NOTES:
1. CONTRACTOR TO CONTACT ENGINEER TO REVIEW REPRESENTATIVE RIPRAP FOR APPROVAL PRIOR TO DELIVERY TO SITE.
2. ENGINEER SHALL BE CONTACTED TO INSPECT SUBGRADE PRIOR TO PLACEMENT OF RIPRAP.
3. ALTHOUGH THE OWNER OR ENGINEER SHALL PROVIDE FIELD INSPECTION, CONTRACTOR HAS FULL RESPONSIBILITY OF CONFORMING WITH THE PROJECT DRAWINGS AND SPECIFICATIONS. ANY REWORK COST SHALL BE BORNE BY THE CONTRACTOR.
4. SOIL RIPRAP: BEFORE PLACEMENT, MIX RIPRAP WITH STABILIZATION SOIL (NATIVE MATERIAL OR TOPSOIL CONSISTING OF GRAVELLY, CLAYEY, ORGANIC SOIL) AT APPROXIMATE RATIO OF 65% RIPRAP : 35% STABILIZATION SOIL. PLACE IN TWO LIFTS (MINIMUM) WITH LARGER ROCK ON TOP. ROCK VOIDS TO BE COMPLETELY FILLED FORMING A HOMOGENEOUS MASS FOR THE FORMATION OF A ROOT MAT INTERTWINED WITH THE RIPRAP. STABILIZATION SOIL IS TO FILL RIPRAP VOIDS, NOT DISPLACE RIPRAP. STABILIZATION SOIL IS NOT TO BE PERCHED. FILL ALL VOIDS FROM FINISHED SURFACE TO NATIVE SUBGRADE.
5. GENERAL PLACEMENT TECHNIQUES SHOULD RESULT IN LARGER ROCK AT THE SURFACE WITH ROCK SECURELY INTERLOCKED AT THE DESIGN THICKNESS AND GRADE. COMPACTION AND LEVELING SHOULD RESULT IN MINIMAL VOIDS AND PROJECTIONS ABOVE GRADE. TYPICAL FOR BOTH BURIED AND EXPOSED SOIL RIPRAP.
6. FOR BURIED SOIL RIPRAP: FINAL SOIL RIPRAP TO BE COMPACTED BY FULL LOADING OF BACKHOE BUCKET AS APPROVED. ANY SOFT, YIELDING OR POCKETS OF SMALL ROCK WILL BE REWORKED. PLACE TOPSOIL SO NO MORE THAN 6 INCHES THICK OVER SOIL RIPRAP.

NOTE:
1. PIPE OUTLET TO BE RECESSED INTO THE CHANNEL BANK TO MINIMIZE THE PIPE PROTRUDING INTO THE TYPICAL CHANNEL SECTION.

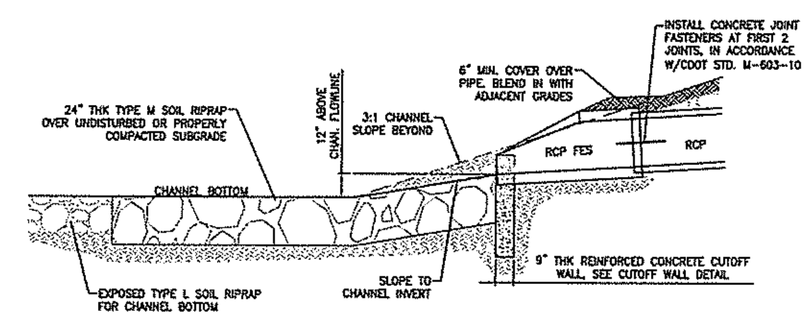


CUTOFF WALL DETAIL

NOTE:
1. STEEL REINFORCEMENT FOR CUTOFF WALL SHALL BE #4 BARS AT 12" O.C. EACH WAY. STEEL REINFORCEMENT CLEARANCES SHALL BE 2" TO FORMED SURFACES AND FES, AND 3" TO SOIL.



PLAN VIEW: ALONG TRIBUTARY FOUR CHANNEL



ELEVATION VIEW: ALONG TRIBUTARY FOUR CHANNEL

D/27 **RCP FES PIPE OUTLET w/CONCRETE CUTOFF WALL AND JOINT RESTRAINTS**
SCALE: NTS

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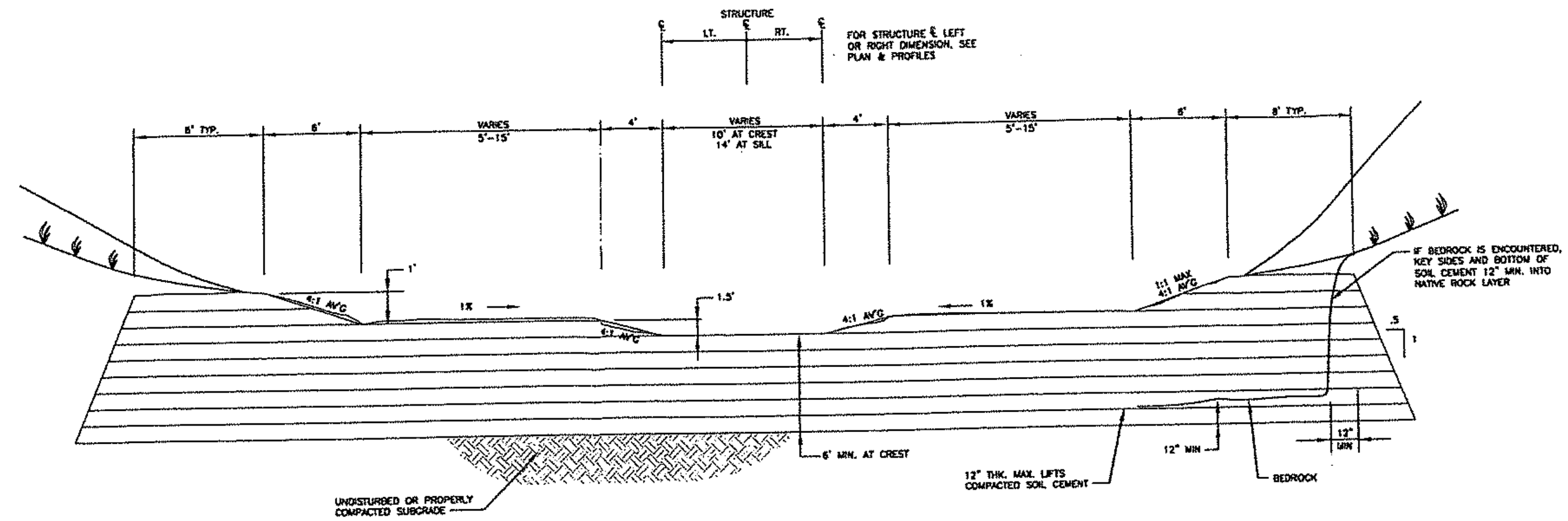
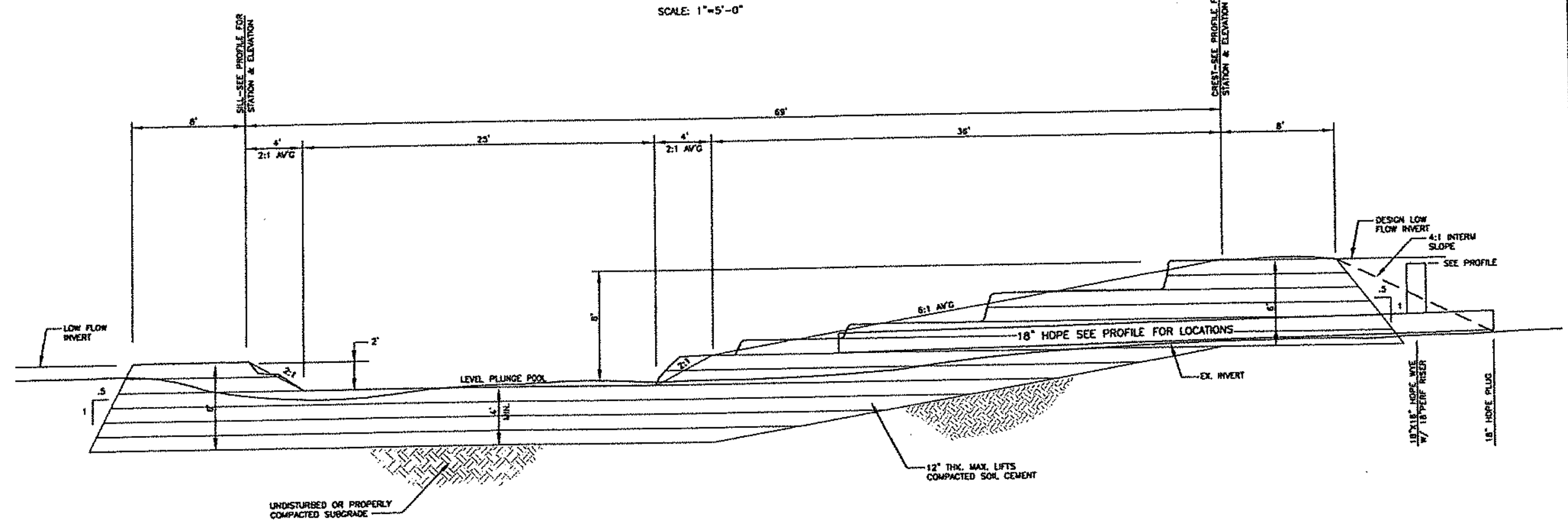
WOLF RANCH DEVELOPMENT
UPPER TRIBUTARY FOUR IMPROVEMENTS
CHANNEL DETAILS
COLORADO SPRINGS, COLORADO

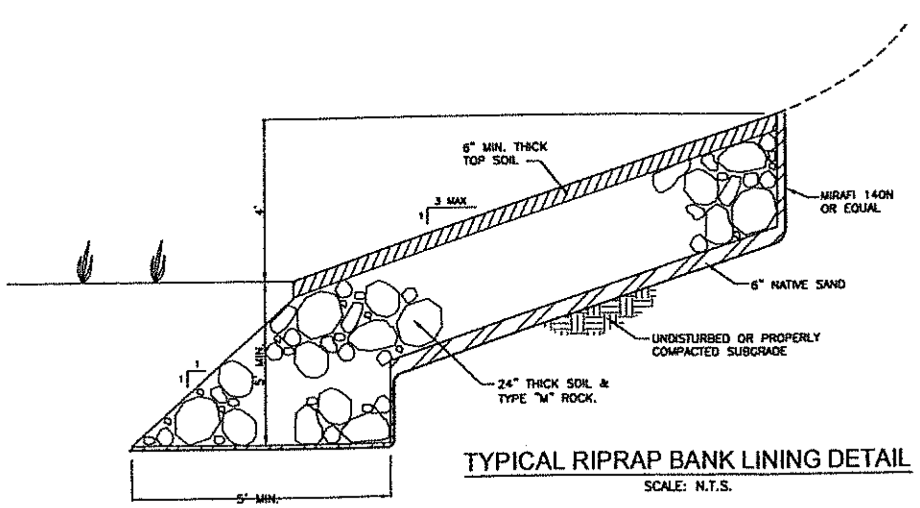
Project No.:	17004
Date:	October 18, 2017
Design:	CJC
Drawn:	CJC
Check:	RNW
Revisions:	



TYPICAL SOIL CEMENT SLOPING
DROP SECTION AT CREST & SILL
SCALE: 1"=5'-0"



TYPICAL SOIL CEMENT SLOPING
DROP LONGITUDINAL SECTION
SCALE: 1"=5'-0"



TYPICAL RIPRAP BANK LINING DETAIL
SCALE: N.T.S.

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WOLF RANCH
MASTER DEVELOPMENT DRAINAGE PLAN UPDATE
TYPICAL DRAINAGEWAY DETAILS
COLORADO SPRINGS, COLORADO

Project No.:	12055
Date:	03/2013
Design:	RNW
Drawn:	JLN
Check:	RNW
Revisions:	

PP7

SUB-BASIN DISCHARGES SUMMARY			
SUB-BASIN	AREA	Q_5 (cfs)	Q_{100} (cfs)
A−1	0.1819	7	85
A−2	0.1098	5	59
A−3	0.1318	12	142
B−1	0.1505	5	55
C−1	0.1300	5	58
C−2	0.0990	4	41
D−1	0.1503	5	60
D−2	0.1660	7	75
D−3	0.0450	4	36
E−1	0.1640	6	66
E−2	0.1520	6	61
F−1 (1)	0.1659	8	94
F−2 (1)	0.0424	2	24
F−3 (1)	0.0942	4	52
F−4 (1)	0.2681	12	147
F−5 (1)	0.1073	5	57
F−6 (1)	0.0310	1	18
F−7 (1)	0.0782	4	46

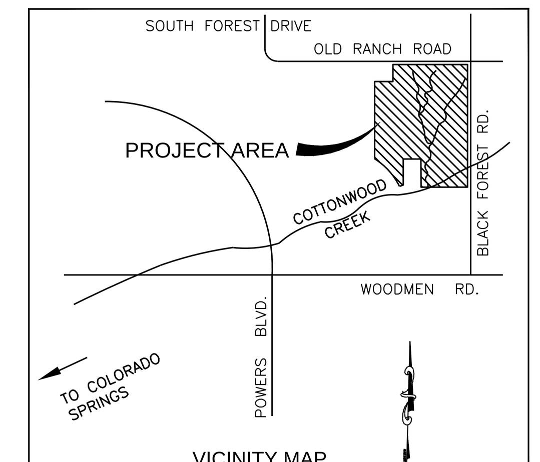
(1) UPDATED HYDROLOGY FOR BASINS F, G, AND H DETERMINED USING CITY OF COLORADO SPRINGS DCM 2014.

SUB-BASIN DISCHARGES SUMMARY (Con't)			
SUB-BASIN	AREA	Q_5 (cfs)	Q_{100} (cfs)
F−8 (1)	0.1499	8	101
F−9 (1)	0.1953	9	111
F−10(1)	0.0883	3	42
F−11(1)	0.1136	7	80
F−12(1)	0.2471	44	527
F−13(1)	0.1169	4	54
F−14(1)	0.1493	7	85
F−15(1)	0.0321	2	23
F−16(1)	0.0570	4	45
F−17(1)	0.0520	2	26
G−1 (1)	0.0808	1	18
G−2 (1)	0.1710	3	33
G−3 (1)	0.0680	1	12
H−1 (1)	0.0370	1	11
H−2 (1)	0.0930	1	12
J−1 (1)	0.0250	1	9
J−2 (1)	0.0530	4	42

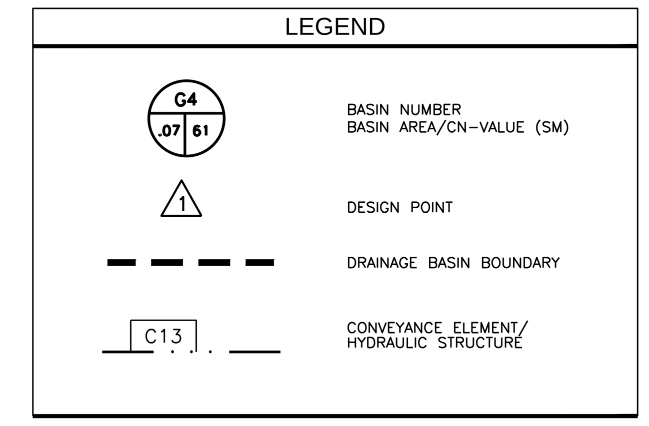
(1) UPDATED HYDROLOGY FOR BASINS F, G, H, AND J DETERMINED USING CITY OF COLORADO SPRINGS DCM 2014.

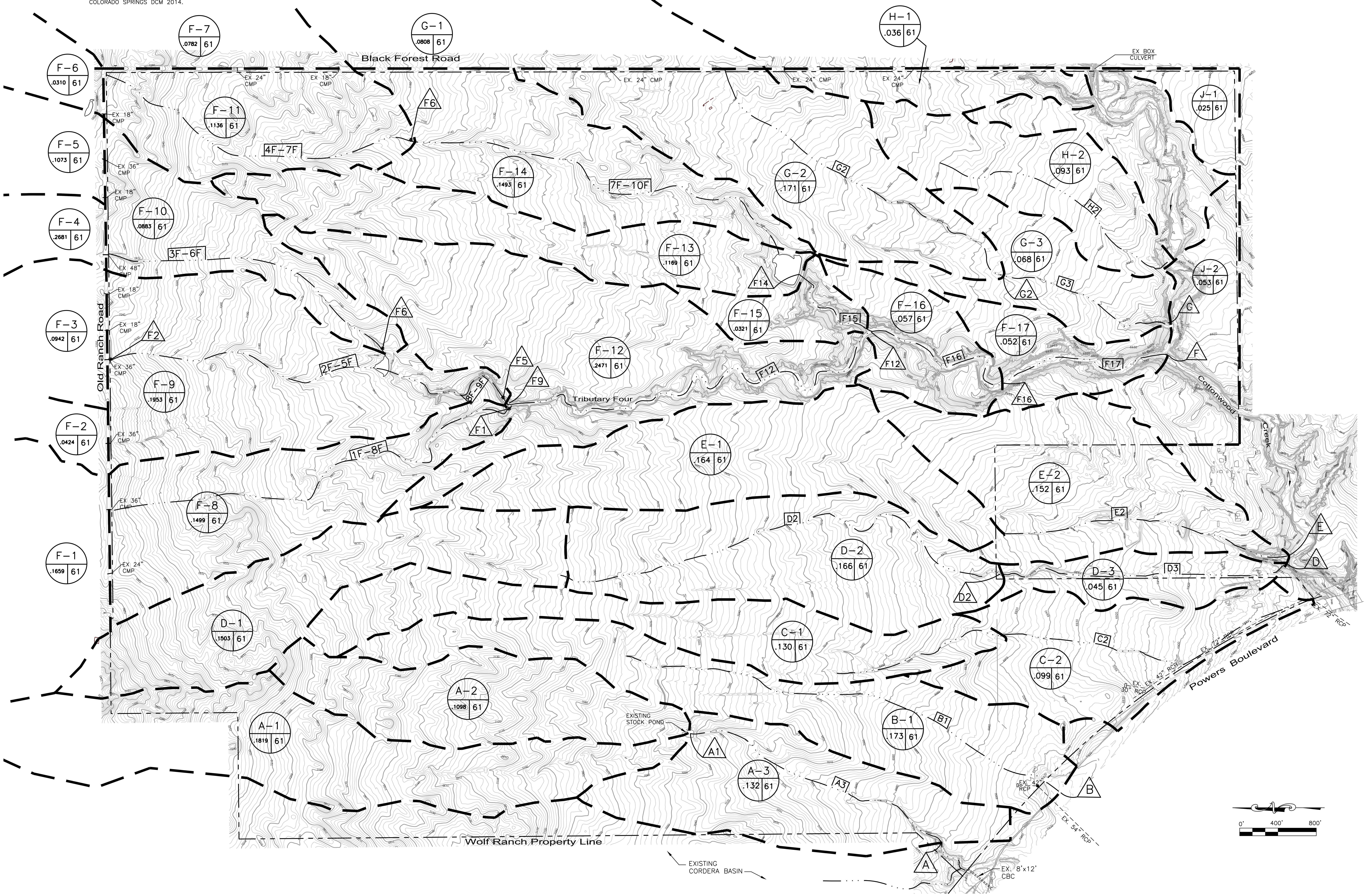
DESIGN POINT DISCHARGES SUMMARY			
BASIN	AREA	Q_5 (cfs)	Q_{100} (cfs)
A	0.4235	11	157
A1 INFLOW	0.2917	12	142
A1 OUTFLOW	0.2917	8	116
B	0.1505	5	55
C	0.2510	8	94
D	0.3610	10	107
D2	0.3216	10	103
E	0.3200	11	124
F (1)	1.9900	48	599
F9 (1)	1.1100	46	536
F12 (1)	1.8800	44	527
F14 (1)	0.4900	18	219
F15 (1)	0.5200	2	33
F16 (1)	1.9400	45	587
G (1)	0.3200	4	60
G2 (1)	0.2500	3	49

(1) UPDATED HYDROLOGY FOR BASINS F, G, AND H DETERMINED USING CITY OF COLORADO SPRINGS DCM 2014.



VICINITY MAP
NOT TO SCALE





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WOLF RANCH
MASTER DEVELOPMENT DRAINAGE PLAN UPDATE
EXISTING CONDITION HYDROLOGIC SUB-BASIN MAP
COLORADO SPRINGS, COLORADO

Project No.: 17049
Date: 2/28/2018
Design: RNW
Drawn: EAK
Check: RNW
Revisions:

Fig. 4

17049 Fig4.dwg/Aug 05, 2019

SUB-BASIN DISCHARGES SUMMARY

SUB-BASIN	AREA(sm)	Q_5 (cfs)	Q_{100} (cfs)
A−1	0.060	3	32
A−3	0.150	49	194
A−4	0.086	39	133
A−5	0.111	27	126
A−6	0.037	29	84
A−7	0.050	18	69
A−8	0.080	57	152
A−9	0.067	24	81
A−10	0.009	5	15
A−11	0.081	41	134
A−12	0.048	27	84
B−1	0.040	60	122
C−1	0.046	30	86
C−2	0.110	84	240
C−3	0.055	33	100
D−1	0.062	35	108
D−2	0.036	15	57
D−3	0.024	1	11
E−1	0.040	26	77
E−2	0.052	22	79
E−3	0.100	0	4

(1) UPDATED HYDROLOGY FOR BASINS F, G, AND H DETERMINED USING CITY OF COLORADO SPRINGS DCM 2014.

SUB-BASIN DISCHARGES SUMMARY

SUB-BASIN	AREA(sm)	Q_5 (cfs)	Q_{100} (cfs)
E−4	0.042	18	63
E−5	0.040	28	82
E−6	0.052	29	87
F−1 (1)	0.166	8	94
F−2 (1)	0.042	2	25
F−3 (1)	0.094	4	52
F−4 (1)	0.268	11	128
F−5 (1)	0.107	4	46
F−6 (1)	0.031	2	7
F−7 (1)	0.078	4	46
F−8 (1)	0.063	16	64
F−9 (1)	0.043	11	48
F−10 (1)	0.018	3	18
F−11 (1)	0.046	9	46
F−12 (1)	0.058	12	57
F−13 (1)	0.014	1	10
F−14 (1)	0.129	37	138
F−15 (1)	0.021	5	22

(1) UPDATED HYDROLOGY FOR BASINS F, G, AND H DETERMINED USING CITY OF COLORADO SPRINGS DCM 2014.

SUB-BASIN DISCHARGES SUMMARY

SUB-BASIN	AREA(sm)	Q_5 (cfs)	Q_{100} (cfs)
F−16 (1)	0.027	8	30
F−17 (1)	0.039	1	20
F−18 (1)	0.098	29	111
F−19 (1)	0.166	32	123
F−22 (1)	0.064	6	44
F−23 (1)	0.031	10	38
F−24 (1)	0.089	39	117
F−25 (1)	0.089	25	92
F−27 (1)	0.201	67	222
F−28 (1)	0.038	7	35
F−29 (1)	0.025	6	24
F−30 (1)	0.022	11	33
F−31 (1)	0.094	12	66
G−1 (1)	0.081	1	18
G−2 (1)	0.035	4	25

(1) UPDATED HYDROLOGY FOR BASINS F, G, AND H DETERMINED USING CITY OF COLORADO SPRINGS DCM 2014.

SUB-BASIN DISCHARGES SUMMARY

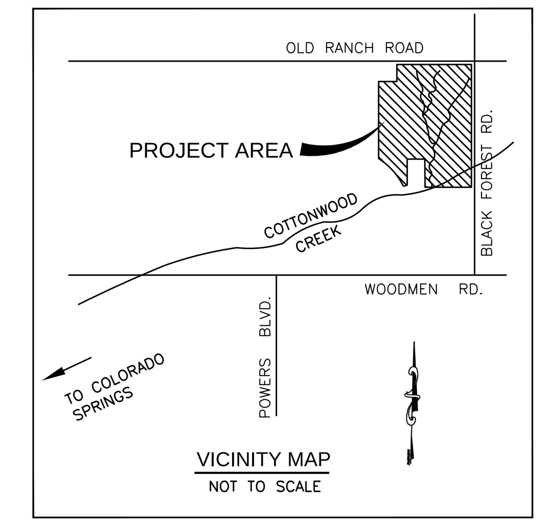
SUB-BASIN	AREA(sm)	Q_5 (cfs)	Q_{100} (cfs)
G−3 (1)	0.177	18	108
G−5 (1)	0.153	40	157
H−1 (1)	0.037	6	38
H−2 (1)	0.096	8	53
J−1 (1)	0.025	10	20
J−2 (1)	0.053	14	65

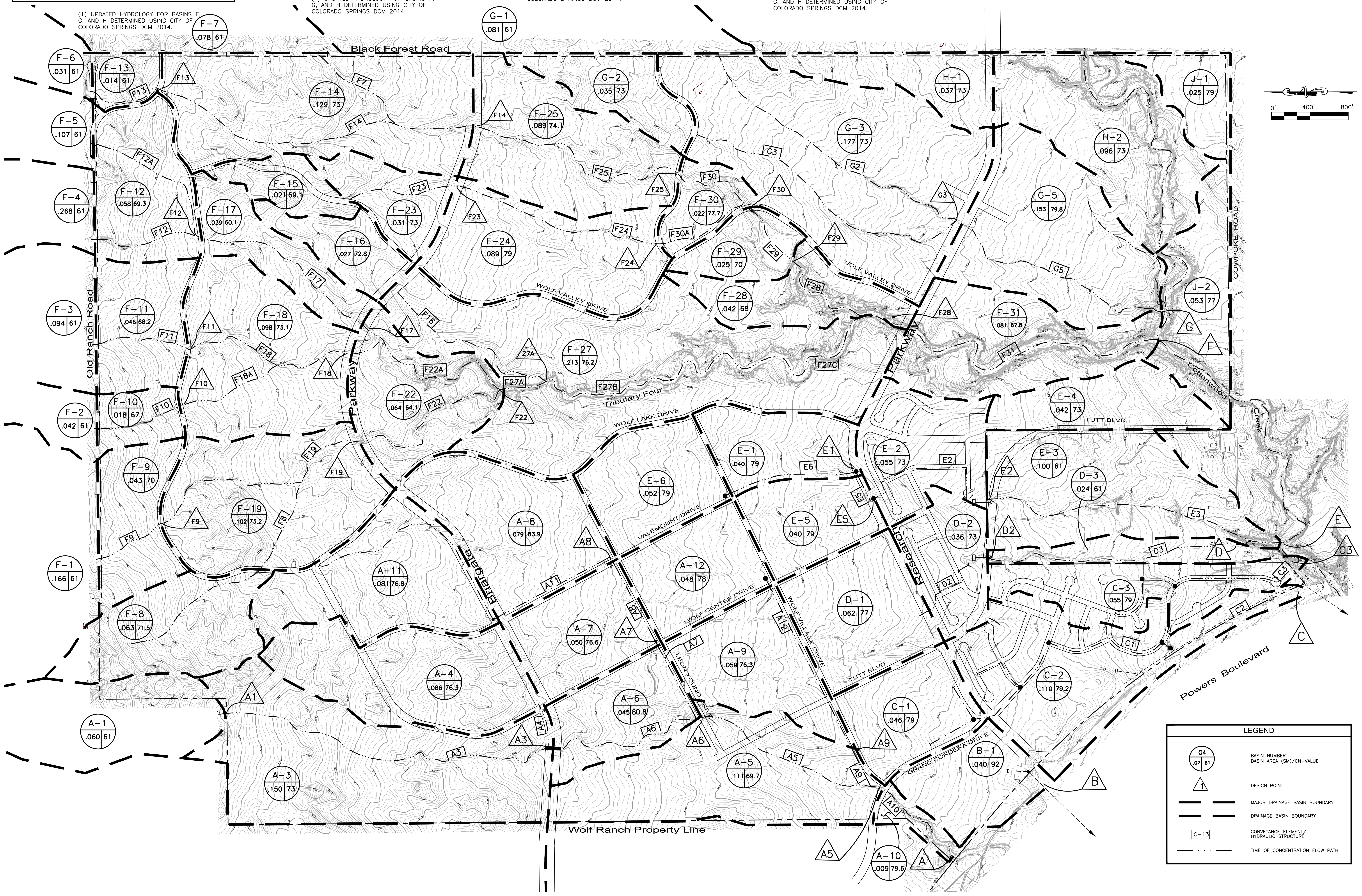
(1) UPDATED HYDROLOGY FOR BASINS F, G, AND H DETERMINED USING CITY OF COLORADO SPRINGS DCM 2014.

DESIGN POINT DISCHARGES SUMMARY

BASIN	AREA(sm)	Q_5 (cfs)	Q_{100} (cfs)
A	0.780	279	995
A3	0.380	87	326
A5	0.770	281	983
A6	0.540	222	722
A9	0.120	49	161
B	0.040	60	122
C	0.160	104	314
D	0.120	47	162
E	0.190	94	304
F22(1)	1.210	108	749
F28(1)	2.020	270	1408
F (1)	2.100	265	1453
G (1)	0.4500	55	271

(1) UPDATED HYDROLOGY FOR BASINS F, G, AND H DETERMINED USING CITY OF COLORADO SPRINGS DCM 2014.





LEGEND

G4 / .07 / 61	BASIN NUMBER BASIN AREA (SM)/CN−VALUE
1 (triangle)	DESIGN POINT
	MAJOR DRAINAGE BASIN BOUNDARY
	DRAINAGE BASIN BOUNDARY
C−13	CONVEYANCE ELEMENT/ HYDRAULIC STRUCTURE
	TIME OF CONCENTRATION FLOW PATH

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WOLF RANCH
MASTER DEVELOPMENT DRAINAGE PLAN UPDATE
PROPOSED CONDITION HYDROLOGIC SUB-BASIN MAP
COLORADO SPRINGS, COLORADO

Project No.: 17049
Date: 2/28/2018
Design: RNW
Drawn: EAK
Check: RNW
Revisions:

Fig. 5

17049 Fig5.dwg/Aug 05, 2019

DESIGN POINT	AREA(sm)	Q_5 (cfs)	Q_{100} (cfs)
A1	0.06	3	32
A3	0.21	49	194
A4 (IN)	030	87	334
A4 (OUT)	0.30	8	87
A5 (IN)	0.74	193	663
A5 (OUT)	0.74	27	114
A6	0.52	118	391
A7	0.18	90	292
A	1.02	154	236
A9	0.11	49	161
B	0.04	60	122
C3	0.05	33	100
C	0.16	104	314
E5	0.13	85	241
E2 (IN)	0.18	114	335
D2 (IN)	0.10	49	160
DBDE (OUT)	0.18	13	157

DESIGN POINT DISCHARGE SUMMARY w/DETENTION

DESIGN POINT		AREA(sm)	Q_5 (cfs)	Q_{100} (cfs)
F9	(1)	0.21	16	134
F10	(1)	0.06	4	40
F11	(1)	0.14	11	90
F12	(1)	0.43	20	211
F13	(1)	0.05	2	25
F14	(1)	0.25	37	138
F18 / F19 (IN)	(1)	1.14	113	750
F18 / F19 (OUT)	(1)	1.14	12	215
F22	(1)	1.22	15	230
F23	(1)	0.05	14	59
F24	(1)	0.14	53	124
F25	(1)	0.34	62	113
F30	(1)	0.50	121	478
F28 (IN)	(1)	2.05	196	770
F28 (OUT)	(1)	2.05	26	536
F	(1)	2.12	26	559

(1) UPDATED HYDROLOGY FOR BASINS F, G, AND H DETERMINED USING CITY OF COLORADO SPRINGS DCM 2014.

DESIGN POINT DISCHARGE SUMMARY w/DETENTION

DESIGN POINT	AREA(sm)	Q_5 (cfs)	Q_{100} (cfs)
G3	0.29	16	102
G3 (OUT)	0.29	1	23
G-4	.043	8	37

(1) UPDATED HYDROLOGY FOR BASINS F, G, AND H DETERMINED USING CITY OF COLORADO SPRINGS DCM 2014.

DETENTION BASIN E/D DATA (2)

Q_5 IN = 163 cfs — Q_{100} IN = 495 cfs
Q_5 OUT = 13 cfs — Q_{100} OUT = 157 cfs (1)
VOL_5 = 5.9 AC-FT
VOL_{100} = 14.8 AC-FT
WS_5 = 55.2
WS_{100} = 57.8

(1) TOTAL OUTFLOW. OUTFLOW TO BE CONTROLLED TO EXISTING LEVELS AT DP E2 & DP D2
(2) DETENTION BASIN IN AS-BUILT CONDITION

DETENTION BASIN DB F18/F19 DATA (1)

Q_5 IN = 113 cfs — Q_{100} IN = 750 cfs
Q_5 OUT = 12 cfs — Q_{100} OUT = 215 cfs
VOL_5 = 9.8 AC-FT
VOL_{100} = 27.7 AC-FT

(1) NOAA ATLAS 14 RAINFALL .30% DESIGN STORM DISTRIBUTION.

DETENTION BASIN DB F28 DATA(1)

Q_5 IN = 196 cfs — Q_{100} IN = 770 cfs
Q_5 OUT = 26 cfs — Q_{100} OUT = 536 cfs
VOL_5 = 16.7 AC-FT
VOL_{100} = 24.8 AC-FT

(1) NOAA ATLAS 14 RAINFALL .30% DESIGN STORM DISTRIBUTION.

DETENTION BASIN A DATA (1)

Q_5 IN = 193 cfs — Q_{100} IN = 663 cfs
Q_5 OUT = 27 cfs — Q_{100} OUT = 114 cfs
VOL_5 = 6.9 AC-FT
VOL_{100} = 28.2 AC-FT

(1) DETENTION BASIN MODELED ITS AS-BUILT CONDITION

DETENTION BASIN A4 DATA

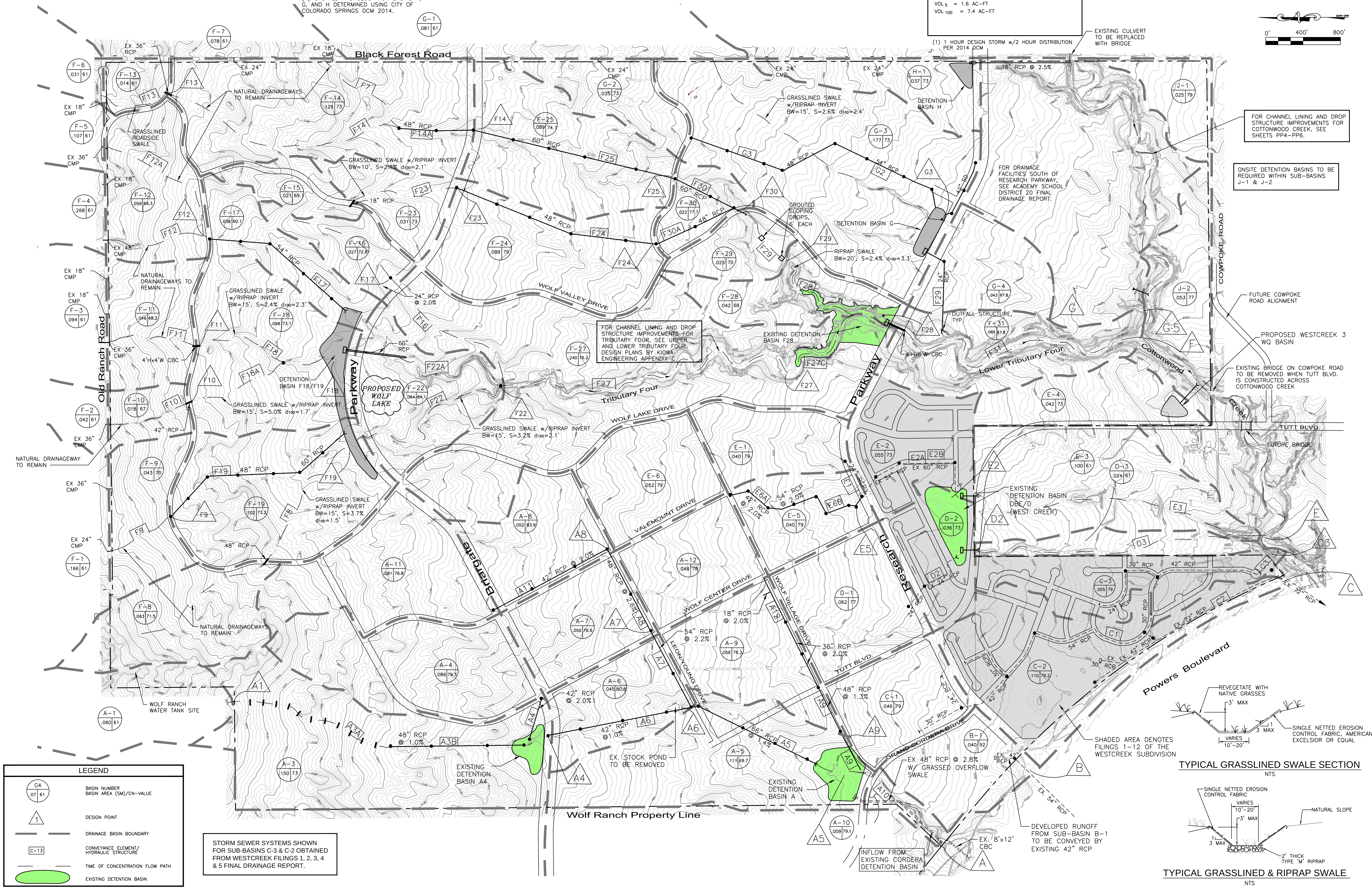
Q_5 IN = 87 cfs — Q_{100} IN = 334 cfs
Q_5 OUT = 8 cfs — Q_{100} OUT = 87 cfs
VOL_5 = 4.6 AC-FT
VOL_{100} = 10.9 AC-FT

(1) DETENTION BASIN MODELED AS A FSD

DETENTION BASIN G DATA

Q_5 IN = 16 cfs — Q_{100} IN = 102 cfs
Q_5 OUT = 1 cfs — Q_{100} OUT = 23 cfs
VOL_5 = 1.6 AC-FT
VOL_{100} = 7.4 AC-FT

(1) 1 HOUR DESIGN STORM w/2 HOUR DISTRIBUTION PER 2014 DCM



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WOLF RANCH
MASTER DEVELOPMENT DRAINAGE PLAN UPDATE
PROPOSED FACILITIES
COLORADO SPRINGS, COLORADO

Project No.: 17049
Date: 6/8/2018
Design: RNW
Drawn: JLN
Check: RNW
Revisions:

Fig. 6

17049 Fig6.dwg/Aug 05, 2019