Final
Drainage Report

For

Kokopelli Commercial Park

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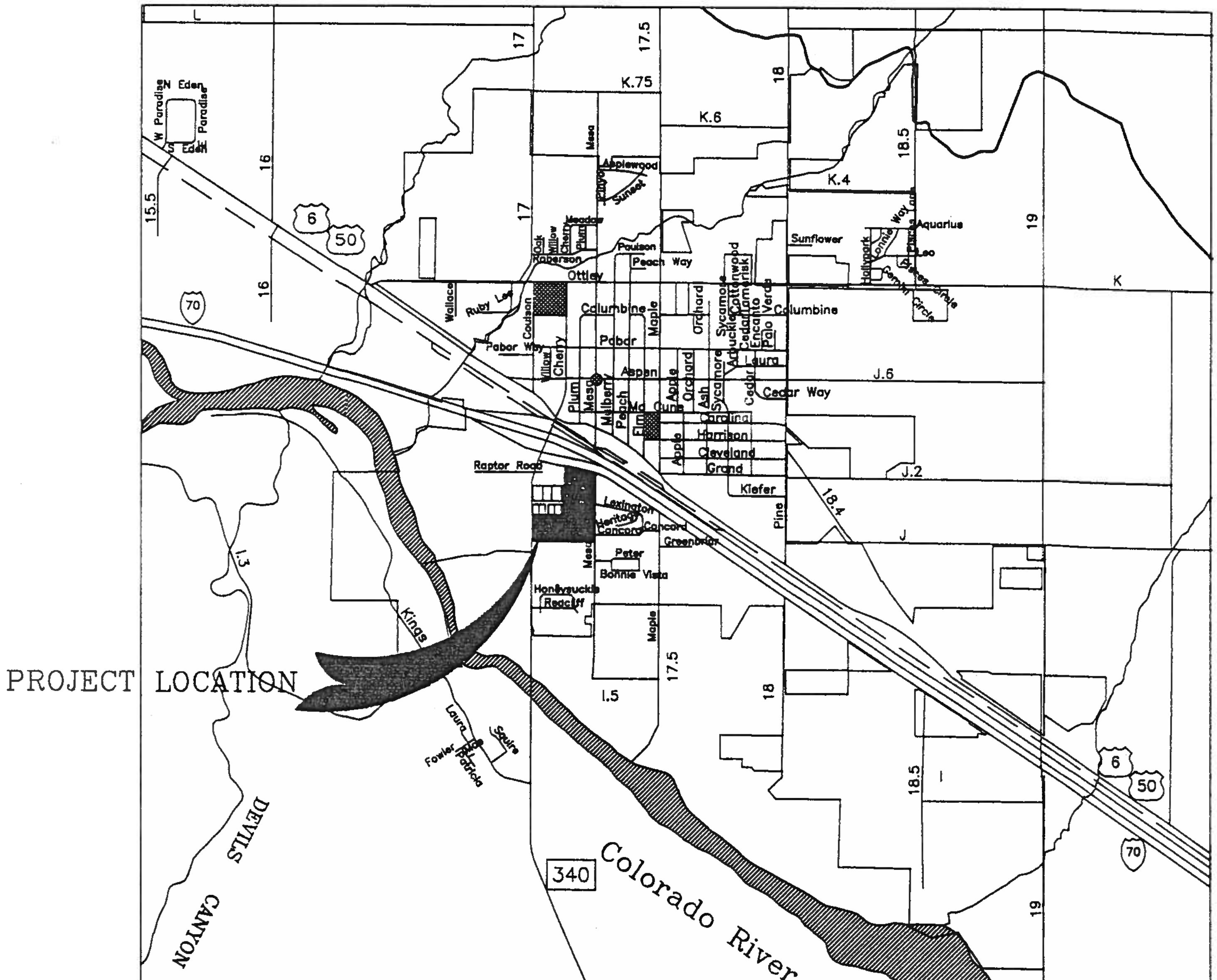
FRUITA



VICINITY MAP

I. General Location and Description

A. Site and Major Basin Location

The proposed Kokopelli Commercial Park is located within the Monument Park Subdivision near the southeast corner of the intersection of Interstate I-70 and Colorado State Highway 340. In more legal terms, the development is found within the Southwest ¼ of Section 17, Township 1 North, Range 2 West of the 6th Principal Meridian. The Mesa County Tax Identification Number is 2697-173-00-060.

B. Site and Major Basin Description

The commercial park development within the major basin accounts for approximately 85 percent of the total basin area. The remaining land areas are developed including commercial properties (the Jurassic Development) and the Colorado State Visitors Center. These areas include landscaping and impervious roofs and asphalt surfaces. The undeveloped areas within the site are covered with little to no vegetation.

According to the Soil Survey, Series 1940, No. 19, performed by the U.S. Department of Agriculture's Soil Conservation Service for the Grand Junction area (USDA), the soils present at the site are predominantly Ravola clay loams (R_A) and Billings silty clay loams (B_C). These materials occur on the broad flood plains and gently sloping coalescing alluvial fans north of the Colorado River. According to SCS TR-55, the hydrologic group for these soils is type B.

II. Existing Drainage Conditions

A. Major Basin

The watershed boundaries for the major basin were delineated from topographic information obtained from field explorations. The northern watershed boundary is formed by the northern edge of the I-70 Frontage Road, the western watershed boundary is formed by the centerline of Colorado Highway 340, the eastern watershed boundary is formed by curb and gutter along the western edge of 17 ¼ Road, and the southern watershed boundary is formed by an existing irrigation ditch traversing the project site from east to west along the southern property line. The entire basin is relatively flat, sloping gradually from the northeast corner to the southwest corner at about 0.5 percent.

Surface drainage within the Jurassic Development sheet flows from parking lot surfaces to curb and gutter in Jurassic Avenue and Cretaceous Avenue. There are a few detention structures for surface runoff but they are small and compared to the size of the overall basin their affect on peak flows are considered negligible. Storm water flow is conveyed by the street sections to storm drain inlets. The inlets in Jurassic Avenue are located approximately 190 feet east of the intersection of Jurassic Avenue and Highway 340. These inlets discharge into an 18 inch diameter storm drain line that slopes westerly in Jurassic Avenue to a junction with a 24 inch diameter pipe running north to south approximately 50 feet east of the centerline of Highway

340. This pipe runs southerly roughly 450 feet and discharges into a junction box. The inlet in Cretaceous Avenue is located at the southern end of the existing cul-de-sac and discharges into an 18" diameter line. From the inlet, the 18 inch diameter line flows southerly a distance of approximately 110 feet from where it turns and flows west into the previously described junction box next to Highway 340. The surface runoff from the Visitor's Center at the northern end of the basin flows overland across landscaped areas and asphalt surfaces to a low point in the far southwest corner of the center, where an existing pipe passes water beneath the Visitor Center's access road and into a 265-foot long ditch adjacent to Highway 340. This ditch conveys runoff southerly to a 70- foot long, 18" inch diameter pipe that combines it's flow with the flow from a detention basin in the Texaco parking lot. After another 60 feet these flows combine with the flow from the 18" diameter pipe in Jurassic Avenue and flow southerly to the junction box. The flows in the junction box are under a surcharged condition and when subjected to enough head flow up through the grate in the junction box and then flow overland to a set of five 21 inch diameter culverts in the southwest corner (or outlet point) of the major basin. Minor flows or surface runoff that is left in the system after a rainfall event are bled from the junction box by a 12-inch diameter line that flows to a manhole approximately 60 feet to the south of the junction box. A 6-inch diameter subsurface drainage line belonging to the Grand Junction Drainage District (GJDD) collects water from this manhole and continues flowing to the west.

B. Site

Storm water runoff from the undeveloped areas in the basin, i.e. the proposed area of the Kokopelli Commercial Park, flows overland from northeast to southwest to a low point in the far southwest corner of the basin where five 21-inch diameter pipes, recently constructed by the City of Fruita. convey this collected runoff to the south.

III. Proposed Drainage Conditions

A. Changes in Drainage Patterns

The applicant proposes to develop an area that can be described approximately as the northeast, southeast and southwest corners of the major drainage basin. A new commercial collector street section, Kokopelli Boulevard, is proposed for traffic flow into the new development. This street will run from west to east off of Highway 340 a distance of about 265 from the southern property line. After roughly 650 feet, the street turns and runs northward ultimately intersecting the I-70 Frontage Road along the northern boundary of the project site. The main drainage scheme in the northern portion of the project site is to utilize this new street section as principal conveyance for runoff off of developed parking lots to the east and west of Kokopelli Boulevard. Once the street section has reached it's maximum capacity, inlets will intercept curb and gutter flow and discharge collected runoff into an underground conduit system. These inlets will be located approximately at the end point of the horizontal curve for Kokopelli Blvd (PT) and discharge flow into a 24 inch diameter HDPE pipe sloped at roughly 0.5 percent. Past the PT, Kokopelli Blvd. begins to collect runoff again and conveys flow to a low point, located approximately at the beginning point of the horizontal curve. Again, several inlets intercept curb and gutter flows and discharge runoff into the storm drain line that now increases to a 30 inch diameter pipe, flowing westward. The storm drain line will continue west until it reaches the beginning of Kokopelli Blvd. where it collects some minor runoff and combines all collected flows with runoff from the existing developments in the northwest corner of the major drainage basin at a new junction box. This junction box will also be under a surcharged condition but will outlet flows into a newly constructed channel that conveys storm water flows to the existing 21-inch diameter pipes in the southwest corner of the basin. As with the existing junction box, the new junction box will also have a bleed off line that will connect to the existing manhole where the 6" diameter drainage line belonging to the GJDD collects water and flows west from the project site.

Runoff in the southern portion of land in the development will sheet flow from asphalt surfaces to curb and gutter and ultimately be directed to a ditch running from east to west about 20 feet from the southern property line. This ditch will be located north of the existing irrigation ditch and flows in both channels must be separated for the assumptions in this report to be valid.

B. Maintenance Issues

The applicant and future owners/tenants of parcels developed will maintain drainage features associated within private property while the City of Fruita will be responsible for drainage features within public right of way and outside the limits of the proposed development.

IV. Design Criteria & Approach

A. General Considerations

The Rational Method was chosen to be the best method suitable to estimate total runoff values and concentrated flow quantities for the project development. The 2-year and 100-year storm events were chosen as the design storm events. The analysis and design procedures as outlined in the Storm Water Management Manual for the City of Grand Junction and Mesa County (SWMM) were used to estimate the maximum precipitation values for the design storm intensities.

Four distinct design points were chosen within the entire drainage basin to calculate flow quantities for the design of drainage elements. The first point, design point 1 (DP1) is located at the lower southwest corner of the major drainage basin. The second point, design point 2 (DP2) is located on the southeast corner of the intersection of Kokopelli Blvd. and Highway 340 where flows from the northern portion of the proposed development confluence with flows from the existing developed areas in the major basin. The third design point (DP3) is located near the beginning point of the horizontal curve in Kokopelli Boulevard. The fourth and final design point (DP4) is located near the end point of the horizontal curve in Kokopelli Boulevard. A drainage map has been included in this report that displays the location of these points as well as the other pertinent information necessary for the drainage study of the proposed development.

The method of analysis was to calculate maximum flows at each of the design points from upstream tributary areas. Four sets of calculations were performed to determine these maximum flows using the Rational Method. These flows were then in turn utilized to evaluate the performance of the proposed storm drain system. For the underground storm drain line in Kokopelli Blvd., the program StormCad (StormCad) was used to calculate the resulting hydraulic grade lines using flows determined from the Rational Method equations.

B. Hydrology:

Stormwater runoff values for the 2-year and 100-year events were quantified using the Rational Method as detailed in Section VI "Hydrology" of the Joint City of Grand Junction, Mesa County, Stormwater Management Manual (SWMM) dated May 1996. The 2-year and the 100-year design storms were considered when sizing all proposed drainage features. For excess flow conveyed by street sections, the City of Fruita Design Standards (Fruita) were utilized to calculate allowable street flow capacities for the 2-year and 100-year storm events.

According to the Soil Conservation Service soil survey for the Grand Junction Area, the dominant soil types are Ravola clay loams (R_A) and Billings silty clay loams (B_C). Composite runoff coefficients used in the Rational equation were selected based on the hydrologic soil group and ground cover and calculations were tabulated on spreadsheets. These spreadsheets have been included in pages 2-5 of the appendix to this report titled, Composite Runoff Coefficients.

The times of concentration for various basins were calculated and compiled on spreadsheets containing formulas found in Appendix E of the SWMM. The maximum times of concentration used by the Rational Method to determine flow quantities for individual sub-basins at given concentration points are a cumulative result of overland, curb and gutter, asphalt sheeting and concrete swale or earthen ditch flow times. The summations for the travel times for each basin are shown along with the corresponding intensities for the storm events as taken from Appendix A of the SWMM. These spreadsheets are included in pages 6-15 of the appendix.

The total area for each drainage basin was used in the calculation of runoff. The breakdown of landscaped areas and impervious areas was derived from information supplied by the project architect. These areas were added to the area of sidewalks and asphalt paving to yield overall impervious surface area quantities. These breakdowns have been reproduced on page 1 of the appendix.

Stormwater runoff quantities for the 2-year and 100-year events were calculated and displayed on spreadsheets entitled "Runoff Rates". These spreadsheets have been included in pages 16-24 of the appendix.

C. Hydraulics:

In the upper, northern areas of the development, stormwater runoff from developed lots will sheet flow to concrete curb and gutter in parking lots and then into curb and gutter in Kokopelli Boulevard. The street section of the northern portion of Kokopelli Blvd. will convey concentrated runoff via curb and gutter to the storm drain line inlets located at design point 4 (DP4).

The maximum allowable ½ street flow quantities for a collector street section were taken from Section 04 of the City of Fruita Design Standards. For the 100-year storm event, these standards specify that allowable flow occurs when flow reaches the top back of curb. For the 2-year storm event, the center 24 feet of the street section must remain clear and free of water. Calculations to determine allowable flow rates were performed with the engineering software FlowMaster (FlowMaster) for the 100-year event and the modified Manning's equation for the 2-year event. The applicable street sections with allowable inundation limits are shown on pages 25 and 26 of the appendix and the hydraulic calculations are displayed on pages 26 thru 28 of the appendix.

The Inlet Grate Capacities design standards produced by the Neenah Foundry Company (Neenah) were utilized to determine the number of Type C, single grate inlets required to intercept curb and gutter flow from Kokopelli Boulevard at design points 3 and 4. For the 2-year storm event, a flow depth of 0.3 feet was used yielding an inlet capacity of 1.34 cfs for a single, Type C inlet. For the100-year storm event, a flow depth of 0.5 feet was used yielding an inlet capacity of 3.15 for a single, Type C inlet. Pages 29 and 30 of the appendix are copies of the pages used out of the Neenah design standards for the inlet capacity calculations.

The computer program FlowMaster was used to estimate the required pipe sizes for the storm drain line along Kokopelli Boulevard (pages 31 and 32 of the appendix). For the final analysis of the system, the program StormCad was utilized to calculate the resulting hydraulic grade line during the 100-year storm event. These calculations have been reproduced in pages 33 through 38 of the appendix.

The program FlowMaster was used to design the channel that conveys storm water flow from the outlet junction box at design point 2 to the existing 21 inch diameter pipes at design point 1. The culvert calculator in the AutoCAD program Land Development Desktop (LDD) was used to design the culvert passing water beneath the bike path adjacent to Highway 340. These calculations are reproduced on pages 39 and 40 of the appendix. Finally, the ditch that conveys storm water runoff from east to west along the southern boundary of the project was also designed with FlowMaster and these calculations are reproduced on page 41 of the appendix.

Pages 43 and 44 of the appendix display a summary of the storm drain line calculations from the upper inlets in Kokopelli Blvd. to the existing 21 inch diameter pipes in the lower southwest corner of the major basin.

D. <u>Floodplain Impacts:</u>

According to the Flood Insurance Rate Maps (FIRM) for the City of Fruita (Community Panel Numbers 080194 0001-0004) the proposed site for the Kokopelli Commercial Park is outside of the 100-year flood-plain limits.

V. CONCLUSIONS AND RECOMMENDATIONS

A. General Considerations and Overall Compliance

The criteria for the design of the drainage system for Kokopelli Commercial Park was based upon the anticipated 2-year and 100-year storm events within the Grand Valley. The Rational Method was used to calculate maximum flow rates for the design storms and land surface uses were assumed from current design information supplied by the project architect. All storm water features were designed to pass the 2-year and 100-year design storm runoff rates using both the City of Fruita and the City of Grand Junction design standards, whichever were deemed more conservative or applicable based upon sound engineering judgment.

B. Runoff Rates for the 2 and 100 Year Storm Events

The runoff rates for the 2-year and 100-year storm events at the outlet of the major basin, design point 1 (DP1) have been reproduced in Table I below.

Table I, 2-Year and 100-Year Runoff Rates for Design Point 1

Design Storm Event	Calculated Flow Rate (cfs)
2-Year	7.96
100-Year	43.45

The runoff rates used to design the storm drain system have been reproduced in Table II below.

Table II, 2-Year and 100-Year Runoff Rates for all Design Points

Design Storm Event	Design Point	Calculated Flow Rate (cfs)
2-Year	(Sub-Basin A)	1.45
	2	6.59
	3	4.27
	4	2.39
100-Year	(Sub-Basin A)	7.72
	2	36.46
	3	23.37
	4	13.17

C. Storm Drain System

Features of the overall storm drainage system were designed from flow rates calculated using the Rational Method. Pages 43 and 44 in the appendix reproduce the calculations used to design the storm drain system including; design point locations, design flow rates, street capacities, inlet capacities, inlet flows, bypass flows and cumulative street and storm drain line flows. This table demonstrates that at the outlet point for the entire major basin, design point 1 (DP1), the cumulative flow rate for the 100-year storm is 43.5 cfs. The five existing 21 inch diameter culverts at this location were analyzed for maximum capacity using the Manning's equation in FlowMaster (see page 45 of the appendix). At the project drawing specified slope of 0.258 % one of these pipes can carry a maximum flow of 9.38 cfs. This equates to a total flow of 46.9 cfs which is 3.4 cfs higher than the anticipated runoff rate for the 100-year storm event. Therefore these pipes have adequate capacity to carry the anticipated storm event.

References

(USDA) "Soil Survey, Grand Junction Area, Colorado"; Series 1940, No. 19
United States Department of Agriculture, November 1955

(StormCAD) StormCAD by Haestad Methods, Version 1.0

(Fruita) "City of Fruita Design Standards and Construction Specifications", City of Fruita

(FlowMaster) FlowMaster by Haestad Methods, Version 4.1c

(Neenah) "Inlet Grate Capacities for Gutter Flow and Ponded Water", Neenah Foundry Company, Neenah WI

(SWMM)"Storm Water Management Manual"; City of Grand Junction, June 1994

(FIRM) "Flood Insurance Rate Map"; Area 080115-0455B,
Federal Emergency Management Agency, July 1992

(LDD) AutoCAD Land Development Desktop, Version 1.02

Appendix

KOKOPELLI COMMERCIAL PARK

Land Use Areas

Lot #	Total Area	Landscape	Impervious
1	79828	13571	66257
2	52392	7859	44533
3	49259	12315	36944
4	33173	4976	28197
5	32983	4947	28036
6	59702	8955	50747
7	42701	6405	36296
8	55172	8276	46896
9	55324	8299	47025
10	228741	34311	194430
11	63726	12745	50980
12	55511	11102	44409
13	54483	10897	43586
14	54642	10928	43714
15	34565	5185	29380
16	47855	7178	40676
17	43563	6534	37028
	1043620	174483	869134
Basin K	706543	307024	399519

Basin	Lots	% Landscape	% Impervious	Area, A (Acres)	A Landscape	A Imp.
A	7,8,9,10	15.00%	85.00%	6.81	1.02	5.79
B	7,8	15.00%	85.00%	0.50	0.08	0.42
C	8,9	15.00%	85.00%	0.52	0.08	0.44
D	9,10	15.00%	85.00%	0.59	0.09	0.50
E	10,11	16.09%	83.91%	2.75	0.44	2.31
F	6	15.00%	85.00%	0.18	0.03	0.15
G	5	15.00%	85.00%	0.17	0.03	0.14
H	4,5	9.76%	90.24%	2.77	0.27	2.50
I	2,3	19.85%	80.15%	2.80	0.56	2.24
J	Street	0.00%	100.00%	0.58	0.00	0.58
K	Visitor Center +	43.45%	56.55%	16.22	7.05	9.17
L	12,13,14,15	19.13%	80.87%	5.33	1.02	4.31
M	1,16,17	15.93%	84.07%	3.58	0.57	3.01
N	Open space	100.00%	0.00%	0.46	0.46	0.00
O	Street+Swale	68.00%	32.00%	0.52	0.35	0.17
P	Street+Swale	68.00%	32.00%	0.44	0.30	0.14
				44.22		

COMPOSITE RUNOFF COEFICIENTS

For: KOKOPELLI COMMERCIAL PARK

USING

GRAND JUNCTION RECOMMENDED RUNOFF COEFICIENTS

Description Surface Area	Hydro. Soils Group	Slope <2% Runoff Coeff.'s	Sel. Coeff.		BASIN Hist. Unit Area	Wt'd Value	BASIN A Devel. Unit Area	Wt'd Value	BASIN B Devel. Unit Area	Wt'd Value	BASIN C Devel. Unit Area	Wt'd Value
Pavement and Roofs	B	0.93	0.93	2-Yr.	19.10	17.76	5.79	5.38	0.43	0.40	0.44	0.41
	B	0.95	0.95	100-Yr.	19.10	18.15	5.79	5.50	0.43	0.41	0.44	0.42
Green landscaping	B	0.14 to 0.22	0.18	2-Yr.	0.00	0.00	1.02	0.18	0.08	0.01	0.08	0.01
lawns and parks	B	0.20 to 0.28	0.24	100-Yr.	0.00	0.00	1.02	0.24	0.08	0.02	0.08	0.02
Meadows	B	0.14 to 0.22	0.16	2-Yr.	25.12	4.02						
		0.20 to 0.28	0.22	100-Yr.	25.12	5.53						
Total Basin Area:					44.22		6.81		0.51		0.52	
COMPOSITE "C" VALUE (2-year)						0.49		0.82		0.81		0.81
COMPOSITE "C" VALUE (100-year)						0.54		0.84		0.84		0.84

COMPOSITE RUNOFF COEFICIENTS

For: KOKOPELLI COMMERCIAL PARK

USING

GRAND JUNCTION RECOMMENDED RUNOFF COEFICIENTS

Description Surface Area	Hydro. Soils Group	Slope <2% Runoff Coeff.'s	Sel. Coeff.		BASIN D Devel. Unit Area	BASIN D Wt'd Value	BASIN E Devel. Unit Area	BASIN E Wt'd Value	BASIN F Devel. Unit Area	BASIN F Wt'd Value	BASIN G Devel. Unit Area	BASIN G Wt'd Value	BASIN H Devel. Unit Area	BASIN H Wt'd Value
Pavement and Roofs	B	0.93	0.93	2-Yr.	0.50	0.47	2.31	2.15	0.15	0.14	0.14	0.13	2.50	2.33
	B	0.95	0.95	100-Yr.	0.50	0.48	2.31	2.19	0.15	0.14	0.14	0.13	2.50	2.38
Green landscaping	B	0.14 to 0.22	0.18	2-Yr.	0.09	0.02	0.44	0.08	0.03	0.01	0.03	0.01	0.27	0.05
lawns and parks	B	0.20 to 0.28	0.24	100-Yr.	0.09	0.02	0.44	0.11	0.03	0.01	0.03	0.01	0.27	0.06
Meadows	B	0.14 to 0.22	0.16	2-Yr.										
		0.20 to 0.28	0.22	100-Yr.										
Total Basin Area:					0.59		2.75		0.18		0.17		2.77	
COMPOSITE "C" VALUE (2-year)						0.82		0.81		0.81		0.80		0.86
COMPOSITE "C" VALUE (100-year)						0.84		0.84		0.83		0.82		0.88

COMPOSITE RUNOFF COEFICIENTS

For: KOKOPELLI COMMERCIAL PARK

USING

GRAND JUNCTION RECOMMENDED RUNOFF COEFICIENTS

Description Surface Area	Hydro. Soils Group	Slope <2% Runoff Coeff.'s	Sel. Coeff.		BASIN I Devel. Unit Area	Wt'd Value	BASIN J Devel. Unit Area	Wt'd Value	BASIN K Devel. Unit Area	Wt'd Value	BASIN L Devel. Unit Area	Wt'd Value	BASIN M Devel. Unit Area	Wt'd Value
Pavement and Roofs	B	0.93	0.93	2-Yr.	2.24	2.08	0.58	0.54	9.17	8.53	4.31	4.01	3.01	2.80
	B	0.95	0.95	100-Yr.	2.24	2.13	0.58	0.55	9.17	8.71	4.31	4.09	3.01	2.86
Green landscaping	B	0.14 to 0.22	0.18	2-Yr.	0.56	0.10	0.00	0.00	7.05	1.27	1.02	0.18	0.57	0.10
lawns and parks	B	0.20 to 0.28	0.24	100-Yr.	0.56	0.13	0.00	0.00	7.05	1.69	1.02	0.24	0.57	0.14
Meadows	B	0.14 to 0.22	0.16	2-Yr.										
		0.20 to 0.28	0.22	100-Yr.										
Total Basin Area:					2.80		0.58		16.22		5.33		3.58	
COMPOSITE "C" VALUE (2-year)						0.78		0.93		0.60		0.79		0.81
COMPOSITE "C" VALUE (100-year)						0.81		0.95		0.64		0.81		0.84

4

COMPOSITE RUNOFF COEFICIENTS

For: KOKOPELLI COMMERCIAL PARK

USING

GRAND JUNCTION RECOMMENDED RUNOFF COEFICIENTS

Description Surface Area	Hydro. Soils Group	Slope <2% Runoff Coeff.'s	Sel. Coeff.		BASIN N Devel. Unit Area	Wt'd Value	BASIN O Devel. Unit Area	Wt'd Value	BASIN P Devel. Unit Area	Wt'd Value
Pavement and Roofs	B	0.93	0.93	2-Yr.	0.00	0.00	0.17	0.16	0.14	0.13
	B	0.95	0.95	100-Yr.	0.00	0.00	0.17	0.16	0.14	0.13
Green landscaping	B	0.14 to 0.22	0.18	2-Yr.	0.46	0.08	0.35	0.06	0.30	0.05
lawns and parks	B	0.20 to 0.28	0.24	100-Yr.	0.46	0.11	0.35	0.08	0.30	0.07
Meadows	B	0.14 to 0.22	0.16	2-Yr.						
		0.20 to 0.28	0.22	100-Yr.						
Total Basin Area:					0.46		0.52		0.44	
COMPOSITE "C" VALUE (2-year)						0.18		0.43		0.42
COMPOSITE "C" VALUE (100-year)						0.24		0.47		0.47

TIME OF CONCENTRATION and RAINFALL INTENSITIES
For: KOKOPELLI COMMERCIAL PARK
DESIGN POINT 1 (DP1)

Descrip. of Flow	L Length ft.	S Slope %	N or *N* * coef.	V** Vel. fps	Tt2 Travel Time min.	Tt100 Travel Time min.	Tc2 Time of Concentration min.	Tc100 min.	2-Year i Intensity Grd. Jctn. Curves	100-Year i Intensity Grd. Jctn. Curves
Full-Site" - H1										
Historic overland*	300	0.50%	0.150		87.84	51.84	113.4	77.4	0.20	1.09
Shallow Conc. Flow***	1075	0.50%	-	0.70	25.60	25.60				
Subbasin A										
Developed Landscape*	100	0.50%	0.300		63.51	37.48	84.7	58.7	0.26	1.35
Shallow Conc. Flow***	200	0.50%	-	1.00	3.33	3.33				
Conc C & G ***	164	0.50%	0.016	0.98	2.79	2.79				
Swale**	906	0.50%	0.035	1.00	15.10	15.10				
Subbasin B										
Developed Landscape*	50	0.50%	0.300		36.47	21.52	42.6	27.7	0.43	2.26
Conc C & G ***	290	0.50%	0.016	0.98	4.93	4.93				
Swale (from DP2 to DP1)	184	0.50%	0.035	2.50	1.23	1.23				
Subbasin C										
Developed Landscape*	50	0.50%	0.300		36.47	21.52	44.8	29.9	0.42	2.16
Conc C & G ***	298	0.50%	0.016	0.98	5.07	5.07				
Pipe (from DP3 to DP2)	620	0.50%	0.012	5.00	2.07	2.07				
Swale (from DP2 to DP1)	184	0.50%	0.035	2.50	1.23	1.23				
Subbasin D										
Developed Landscape*	50	0.50%	0.300		36.47	21.52	45.2	30.2	0.42	2.14
Conc C & G ***	318	0.50%	0.016	0.98	5.41	5.41				
Pipe (from DP3 to DP2)	620	0.50%	0.012	5.00	2.07	2.07				
Swale (from DP2 to DP1)	184	0.50%	0.035	2.50	1.23	1.23				

TIME OF CONCENTRATION and RAINFALL INTENSITIES
For: KOKOPELLI COMMERCIAL PARK
DESIGN POINT 1 (DP1)

Descrip. of Flow	L Length ft.	S Slope %	N or *N* * coef.	V** Vel. fps	Tt2 Travel Time min.	Tt100 Travel Time min.	Tc2 Time of Concentration min.	Tc100 min.	2-Year i Intensity Grd. Jctn. Curves	100-Year i Intensity Grd. Jctn. Curves
Subbasin E										
Developed Landscape*	100	0.50%	0.300		63.51	37.48	77.4	51.3	0.28	1.50
Shallow Conc. Flow***	235	0.50%	-	1.40	2.80	2.80				
Conc C & G ***	457	0.50%	0.016	0.98	7.77	7.77				
Pipe (from DP3 to DP2)	620	0.50%	0.012	5.00	2.07	2.07				
Swale (from DP2 to DP1)	184	0.50%	0.035	2.50	1.23	1.23				
Subbasin F										
Conc C & G ***	290	0.50%	0.016	0.98	4.93	4.93	6.2	6.2	1.06	4.21
Swale (from DP2 to DP1)	184	0.50%	0.035	2.50	1.23	1.23				
Subbasin G										
Conc C & G ***	308	0.50%	0.016	0.98	5.24	5.24	8.5	8.5	0.97	3.84
Pipe (from DP3 to DP2)	620	0.50%	0.012	5.00	2.07	2.07				
Swale (from DP2 to DP1)	184	0.50%	0.035	2.50	1.23	1.23				
Subbasin H										
Developed Landscape*	100	0.50%	0.300		63.51	37.48	75.8	49.7	0.28	1.53
Shallow Conc. Flow***	246	0.50%	-	1.40	2.93	2.93				
Conc C & G ***	356	0.50%	0.016	0.98	6.05	6.05				
Pipe (from DP3 to DP2)	620	0.50%	0.012	5.00	2.07	2.07				
Swale (from DP2 to DP1)	184	0.50%	0.035	2.50	1.23	1.23				
Subbasin I										
Developed Landscape*	100	0.50%	0.300		63.51	37.48	74.7	48.7	0.28	1.55
Shallow Conc. Flow***	305	0.50%	-	1.40	3.63	3.63				
Conc C & G ***	253	0.50%	0.016	0.98	4.30	4.30				
Pipe (from DP3 to DP2)	620	0.50%	0.012	5.00	2.07	2.07				
Swale (from DP2 to DP1)	184	0.50%	0.035	2.50	1.23	1.23				

TIME OF CONCENTRATION and RAINFALL INTENSITIES
For: KOKOPELLI COMMERCIAL PARK
DESIGN POINT 1 (DP1)

Descrip. of Flow	L Length ft.	S Slope %	N or *N* * coef.	V** Vel. fps	Tt2 Travel Time min.	Tt100 Travel Time min.	Tc2 Time of Concentration min.	Tc100 min.	2-Year i Intensity Grd. Jctn. Curves	100-Year i Intensity Grd. Jctn. Curves
Subbasin J										
Conc C & G ***	708	0.50%	0.016	0.98	12.03	12.03	13.3	13.3	0.83	3.27
Swale (from DP2 to DP1)	184	0.50%	0.035	2.50	1.23	1.23				
Subbasin K										
Developed Landscape*	300	0.50%	0.300		152.93	90.25	164.0	101.3	0.15	0.87
Shallow Conc. Flow***	155	0.50%	-	1.00	2.58	2.58				
Existing Channel ***	873	0.50%	0.035	2.00	7.28	7.28				
Swale (from DP2 to DP1)	184	0.50%	0.035	2.50	1.23	1.23				
Subbasin L										
Developed Landscape*	100	0.50%	0.300		63.51	37.48	90.2	64.1	0.24	1.27
Shallow Conc. Flow***	170	0.50%	-	1.40	2.02	2.02				
Conc C & G ***	1255	0.50%	0.016	0.98	21.33	21.33				
Pipe (from DP3 to DP2)	620	0.50%	0.012	5.00	2.07	2.07				
Swale (from DP2 to DP1)	184	0.50%	0.035	2.50	1.23	1.23				
Subbasin M										
Developed Landscape*	100	0.50%	0.300		63.51	37.48	89.4	63.4	0.25	1.28
Shallow Conc. Flow***	158	0.50%	-	1.40	1.88	1.88				
Conc C & G ***	1219	0.50%	0.016	0.98	20.72	20.72				
Pipe (from DP3 to DP2)	620	0.50%	0.012	5.00	2.07	2.07				
Swale (from DP2 to DP1)	184	0.50%	0.035	2.50	1.23	1.23				
Subbasin N										
Developed Landscape *	230	0.50%	0.300		123.65	72.97	138.1	87.4	0.17	0.99
Pipe ****	712	0.50%	0.012	2.00	5.93	5.93				
Existing Channel ***	873	0.50%	0.035	2.00	7.28	7.28				
Swale (from DP2 to DP1)	184	0.50%	0.035	2.50	1.23	1.23				

TIME OF CONCENTRATION and RAINFALL INTENSITIES
For: KOKOPELLI COMMERCIAL PARK
DESIGN POINT 1 (DP1)

Descrip. of Flow	L Length ft.	S Slope %	N or *N* * coef.	V** Vel. fps	Tt2 Travel Time min.	Tt100 Travel Time min.	Tc2 Time of Concentration min.	Tc100 min.	2-Year i Intensity Grd. Jctn. Curves	100-Year i Intensity Grd. Jctn. Curves
Subbasin O										
Developed Landscape *	100	0.50%	0.300		63.51	37.48	83.3	57.2	0.26	1.38
Grass Swale ***	320	0.50%	0.035	1.00	5.33	5.33				
Pipe ****	712	0.50%	0.012	2.00	5.93	5.93				
Existing Channel ***	873	0.50%	0.035	2.00	7.28	7.28				
Swale (from DP2 to DP1)	184	0.50%	0.035	2.50	1.23	1.23				
Subbasin P										
Developed Landscape *	100	0.50%	0.300		63.51	37.48	89.3	63.3	0.25	1.28
Grass Swale ***	684	0.50%	0.035	1.00	11.40	11.40				
Pipe ****	712	0.50%	0.012	2.00	5.93	5.93				
Existing Channel ***	873	0.50%	0.035	2.00	7.28	7.28				
Swale (from DP2 to DP1)	184	0.50%	0.035	2.50	1.23	1.23				

* N = Mannings n for Open Channel Flow calculations, *N* = Overland Flow Resistance Factor taken from Table "E-1" page E-5 of the SWMM.

**Mannings Equa. was used to determine gutter and natural swale velocities. Mannings n=0.016 was used for curb and gutter, and n=0.035 was used for natural swales.

*** Figure "E-3" on page E-9 of the SWMM was used for shallow concentrated flow velocities

**** Pipes were assumed to be flowing half full for the Mannings Equa., n = 0.012

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TIME OF CONCENTRATION and RAINFALL INTENSITIES
For: KOKOPELLI COMMERCIAL PARK
DESIGN POINT 2 (DP2)

Descrip. of Flow	L Length ft.	S Slope %	N or *N* * coef.	V** Vel. fps	Tt2 Travel Time min.	Tt100 Travel Time min.	Tc2 Time of Concentration min.	Tc100 min.	2-Year i Intensity Grd. Jctn. Curves	100-Year i Intensity Grd. Jctn. Curves
Subbasin B										
Developed Landscape*	50	0.50%	0.300		36.47	21.52	41.4	26.5	0.44	2.32
Conc C & G ***	290	0.50%	0.016	0.98	4.93	4.93				
Subbasin C										
Developed Landscape*	50	0.50%	0.300		36.47	21.52	43.6	28.7	0.43	2.21
Conc C & G ***	298	0.50%	0.016	0.98	5.07	5.07				
Pipe (from DP3 to DP2)	620	0.50%	0.012	5.00	2.07	2.07				
Subbasin D										
Developed Landscape*	50	0.50%	0.300		36.47	21.52	43.9	29.0	0.42	2.20
Conc C & G ***	318	0.50%	0.016	0.98	5.41	5.41				
Pipe (from DP3 to DP2)	620	0.50%	0.012	5.00	2.07	2.07				
Subbasin E										
Developed Landscape*	100	0.50%	0.300		63.51	37.48	77.3	51.2	0.28	1.50
Shallow Conc. Flow***	235	0.50%	-	1.00	3.92	3.92				
Conc C & G ***	457	0.50%	0.016	0.98	7.77	7.77				
Pipe (from DP3 to DP2)	620	0.50%	0.012	5.00	2.07	2.07				
Subbasin F										
Conc C & G ***	290	0.50%	0.016	0.98	4.93	4.93	4.9	4.9	1.12	4.42

TIME OF CONCENTRATION and RAINFALL INTENSITIES
For: KOKOPELLI COMMERCIAL PARK
DESIGN POINT 2 (DP2)

Descrip. of Flow	L Length ft.	S Slope %	N or *N* * coef.	V** Vel. fps	Tt2 Travel Time min.	Tt100 Travel Time min.	Tc2 Time of Concentration min.	Tc100 min.	2-Year i Intensity Grd. Jctn. Curves	100-Year i Intensity Grd. Jctn. Curves
Subbasin G										
Conc C & G ***	308	0.50%	0.016	0.98	5.24	5.24	7.3	7.3	1.02	4.02
Pipe (from DP3 to DP2)	620	0.50%	0.012	5.00	2.07	2.07				
Subbasin H										
Developed Landscape*	100	0.50%	0.300		63.51	37.48	75.7	49.7	0.28	1.53
Shallow Conc. Flow***	246	0.50%	-	1.00	4.10	4.10				
Conc C & G ***	356	0.50%	0.016	0.98	6.05	6.05				
Pipe (from DP3 to DP2)	620	0.50%	0.012	5.00	2.07	2.07				
Subbasin I										
Developed Landscape*	100	0.50%	0.300		63.51	37.48	75.0	48.9	0.28	1.55
Shallow Conc. Flow***	305	0.50%	-	1.00	5.08	5.08				
Conc C & G ***	253	0.50%	0.016	0.98	4.30	4.30				
Pipe (from DP3 to DP2)	620	0.50%	0.012	5.00	2.07	2.07				
Subbasin J										
Conc C & G ***	708	0.50%	0.016	0.98	12.03	12.03	12.0	12.0	0.86	3.40
Subbasin K										
Developed Landscape*	300	0.50%	0.300		152.93	90.25	158.4	95.7	0.15	0.92
Shallow Conc. Flow***	155	0.50%	-	1.00	2.58	2.58				
Existing Channel ***	873	0.50%	0.035	5.00	2.91	2.91				
Subbasin L										
Developed Landscape*	100	0.50%	0.300		63.51	37.48	89.7	63.7	0.25	1.27
Shallow Conc. Flow***	170	0.50%	-	1.00	2.83	2.83				
Conc C & G ***	1255	0.50%	0.016	0.98	21.33	21.33				
Pipe (from DP3 to DP2)	620	0.50%	0.012	5.00	2.07	2.07				

TIME OF CONCENTRATION and RAINFALL INTENSITIES
For: KOKOPELLI COMMERCIAL PARK
DESIGN POINT 2 (DP2)

Descrip. of Flow	L Length ft.	S Slope %	N or *N* * coef.	V** Vel. fps	Tt2 Travel Time min.	Tt100 Travel Time min.	Tc2 Time of Concentration min.	Tc100 min.	2-Year i Intensity Grd. Jctn. Curves	100-Year i Intensity Grd. Jctn. Curves
Subbasin M										
Developed Landscape*	100	0.50%	0.300		63.51	37.48	88.9	62.9	0.25	1.28
Shallow Conc. Flow***	158	0.50%	-	1.00	2.63	2.63				
Conc C & G ***	1219	0.50%	0.016	0.98	20.72	20.72				
Pipe (from DP3 to DP2)	620	0.50%	0.012	5.00	2.07	2.07				
Subbasin N										
Developed Landscape *	230	0.50%	0.300		123.65	72.97	136.9	86.2	0.17	1.00
Pipe ****	712	0.50%	0.012	2.00	5.93	5.93				
Existing Channel ***	873	0.50%	0.035	2.00	7.28	7.28				
Subbasin O										
Developed Landscape *	100	0.50%	0.300		63.51	37.48	82.0	56.0	0.26	1.40
Grass Swale ***	320	0.50%	0.035	1.00	5.33	5.33				
Pipe ****	712	0.50%	0.012	2.00	5.93	5.93				
Existing Channel ***	873	0.50%	0.035	2.00	7.28	7.28				
Subbasin P										
Developed Landscape *	100	0.50%	0.300		63.51	37.48	88.1	62.1	0.25	1.30
Grass Swale ***	684	0.50%	0.035	1.00	11.40	11.40				
Pipe ****	712	0.50%	0.012	2.00	5.93	5.93				
Existing Channel ***	873	0.50%	0.035	2.00	7.28	7.28				

* N = Mannings n for Open Channel Flow calculations, *N* = Overland Flow Resistance Factor taken from Table "E-1" page E-5 of the SWMM.
**Mannings Equa. was used to determine gutter and natural swale velocities.
Mannings n=0.016 was used for curb and gutter, and n=0.035 was used for natural swales.
*** Figure "E-3" on page E-9 of the SWMM was used for shallow concentrated flow velocities
**** Pipes were assumed to be flowing half full for the Mannings Equa., n = 0.012

TIME OF CONCENTRATION and RAINFALL INTENSITIES
For: KOKOPELLI COMMERCIAL PARK
DESIGN POINT 3 (DP3)

Descrip. of Flow	L Length ft.	S Slope %	N or *N* * coef.	V** Vel. fps	Tt2 Travel Time min.	Tt100 Travel Time min.	Tc2 Time of Concentration min.	Tc100 min.	2-Year i Intensity Grd. Jctn. Curves	100-Year i Intensity Grd. Jctn. Curves
Subbasin C										
Developed Landscape*	50	0.50%	0.300		36.47	21.52	41.5	26.6	0.44	2.31
Conc C & G ***	298	0.50%	0.016	0.98	5.07	5.07				
Subbasin D										
Developed Landscape*	50	0.50%	0.300		36.47	21.52	41.9	26.9	0.44	2.29
Conc C & G ***	318	0.50%	0.016	0.98	5.41	5.41				
Subbasin E										
Developed Landscape*	100	0.50%	0.300		63.51	37.48	75.2	49.2	0.28	1.54
Shallow Conc. Flow***	235	0.50%	-	1.00	3.92	3.92				
Conc C & G ***	457	0.50%	0.016	0.98	7.77	7.77				
Subbasin G										
Conc C & G ***	308	0.50%	0.016	0.98	5.24	5.24	5.2	5.2	1.10	4.37

TIME OF CONCENTRATION and RAINFALL INTENSITIES
For: KOKOPELLI COMMERCIAL PARK
DESIGN POINT 3 (DP3)

Descrip. of Flow	L Length ft.	S Slope %	N or *N* * coef.	V** Vel. fps	Tt2 Travel Time min.	Tt100 Travel Time min.	Tc2 Time of Concentration min.	Tc100 min.	2-Year i Intensity Grd. Jctn. Curves	100-Year i Intensity Grd. Jctn. Curves
Subbasin H										
Developed Landscape*	100	0.50%	0.300		63.51	37.48	73.7	47.6	0.29	1.58
Shallow Conc. Flow***	246	0.50%	-	1.00	4.10	4.10				
Conc C & G ***	356	0.50%	0.016	0.98	6.05	6.05				
Subbasin I										
Developed Landscape*	100	0.50%	0.300		63.51	37.48	72.9	46.9	0.29	1.60
Shallow Conc. Flow***	305	0.50%	-	1.00	5.08	5.08				
Conc C & G ***	253	0.50%	0.016	0.98	4.30	4.30				
Subbasin L										
Developed Landscape*	100	0.50%	0.300		63.51	37.48	87.7	61.6	0.25	1.30
Shallow Conc. Flow***	170	0.50%	-	1.00	2.83	2.83				
Conc C & G ***	1255	0.50%	0.016	0.98	21.33	21.33				
Subbasin M										
Developed Landscape*	100	0.50%	0.300		63.51	37.48	86.9	60.8	0.25	1.32
Shallow Conc. Flow***	158	0.50%	-	1.00	2.63	2.63				
Conc C & G ***	1219	0.50%	0.016	0.98	20.72	20.72				

* N = Mannings n for Open Channel Flow calculations, *N* = Overland Flow Resistance Factor taken from Table "E-1" page E-5 of the SWMM.
**Mannings Equa. was used to determine gutter and natural swale velocities. Mannings n=0.016 was used for curb and gutter, and n=0.035 was used for natural swales.
*** Figure "E-3" on page E-9 of the SWMM was used for shallow concentrated flow velocities
**** Pipes were assumed to be flowing half full for the Mannings Equa., n = 0.012

TIME OF CONCENTRATION and RAINFALL INTENSITIES
For: KOKOPELLI COMMERCIAL PARK
DESIGN POINT 4 (DP4)

Descrip. of Flow	L Length ft.	S Slope %	N or *N* * coef.	V** Vel. fps	Tt2 Travel Time min.	Tt100 Travel Time min.	Tc2 Time of Concentration min.	Tc100 min.	2-Year i Intensity Grd. Jctn. Curves	100-Year i Intensity Grd. Jctn. Curves
Subbasin E'										
Developed Landscape*	50	0.50%	0.300		36.47	21.52	41.3	26.4	0.44	2.32
Shallow Conc. Flow***	175	0.50%	-	1.00	2.92	2.92				
Conc C & G ***	113	0.50%	0.016	0.98	1.92	1.92				
	338									
Subbasin I'										
Developed Landscape*	50	0.50%	0.300		36.47	21.52	39.2	24.3	0.46	2.44
Shallow Conc. Flow***	100	0.50%	-	1.00	1.67	1.67				
Conc C & G ***	65	0.50%	0.016	0.98	1.10	1.10				
	215									
Subbasin L										
Developed Landscape*	100	0.50%	0.300		63.51	37.48	79.9	53.9	0.27	1.44
Shallow Conc. Flow***	170	0.50%	-	1.00	2.83	2.83				
Conc C & G ***	800	0.50%	0.016	0.98	13.60	13.60				
Subbasin M										
Developed Landscape*	100	0.50%	0.300		63.51	37.48	80.1	54.0	0.27	1.44
Shallow Conc. Flow***	158	0.50%	-	1.00	2.63	2.63				
Conc C & G ***	820	0.50%	0.016	0.98	13.94	13.94				

* N = Mannings n for Open Channel Flow calculations, *N* = Overland Flow Resistance Factor taken from Table "E-1" page E-5 of the SWMM.

**Mannings Equa. was used to determine gutter and natural swale velocities. Mannings n=0.016 was used for curb and gutter, and n=0.035 was used for natural swales.

*** Figure "E-3" on page E-9 of the SWMM was used for shallow concentrated flow velocities

**** Pipes were assumed to be flowing half full for the Mannings Equa., n = 0.012

RUNOFF RATES (Q)

For: KOKOPELLI COMMERCIAL PARK

DESIGN POINT 1 (DP1)

RATIONAL METHOD Q=CxCfxIxA

BASIN	Q Volume cfs	C Composite Coefficient n/a	Cf Antecedent Precip. Fac. n/a	I* Rainfall Intensity in/hr	A Basin Area acres
HISTORIC					
Full Site (2-Yr)	4.33	0.49	1	0.20	44.22
Full Site (100-Yr)	26.03	0.54	1	1.09	44.22
DEVELOPED					
Basin A (2-Yr)	1.45	0.82	1	0.26	6.81
Basin A (100-Yr)	7.72	0.84	1	1.35	6.81
Basin B (2-Yr)	0.18	0.81	1	0.43	0.51
Basin B (100-Yr)	0.97	0.84	1	2.26	0.51
Basin C (2-Yr)	0.18	0.81	1	0.42	0.52
Basin C (100-Yr)	0.94	0.84	1	2.16	0.52
Basin D (2-Yr)	0.20	0.82	1	0.42	0.59
Basin D (100-Yr)	1.06	0.84	1	2.14	0.59
Basin E (2-Yr)	0.62	0.81	1	0.28	2.75
Basin E (100-Yr)	3.47	0.84	1	1.50	2.75
Basin F (2-Yr)	0.15	0.81	1	1.06	0.18
Basin F (100-Yr)	0.63	0.83	1	4.21	0.18

RUNOFF RATES (Q)

For: KOKOPELLI COMMERCIAL PARK

DESIGN POINT 1 (DP1)

RATIONAL METHOD Q=CxCfxIxA

BASIN	Q Volume cfs	C Composite Coefficient n/a	Cf Antecedent Precip. Fac. n/a	I* Rainfall Intensity in/hr	A Basin Area acres
Basin G (2-Yr)	0.13	0.80	1	0.97	0.17
Basin G (100-Yr)	0.54	0.82	1	3.84	0.17
Basin H (2-Yr)	0.67	0.86	1	0.28	2.77
Basin H (100-Yr)	3.73	0.88	1	1.53	2.77
Basin I (2-Yr)	0.61	0.78	1	0.28	2.80
Basin I (100-Yr)	3.52	0.81	1	1.55	2.80
Basin J (2-Yr)	0.45	0.93	1	0.83	0.58
Basin J (100-Yr)	1.80	0.95	1	3.27	0.58
Basin K (2-Yr)	1.46	0.60	1	0.15	16.22
Basin K (100-Yr)	9.03	0.64	1	0.87	16.22
Basin L (2-Yr)	1.01	0.79	1	0.24	5.33
Basin L (100-Yr)	5.48	0.81	1	1.27	5.33
Basin M (2-Yr)	0.72	0.81	1	0.25	3.58
Basin M (100-Yr)	3.85	0.84	1	1.28	3.58
Basin N (2-Yr)	0.01	0.18	1	0.17	0.46
Basin N (100-Yr)	0.11	0.24	1	0.99	0.46

RUNOFF RATES (Q)

For: KOKOPELLI COMMERCIAL PARK

DESIGN POINT 1 (DP1)

RATIONAL METHOD Q=CxCfxIxA

BASIN	Q Volume cfs	C Composite Coefficient n/a	Cf Antecedent Precip. Fac. n/a	I* Rainfall Intensity in/hr	A Basin Area acres
Basin O (2-Yr)	0.06	0.43	1	0.26	0.52
Basin O (100-Yr)	0.34	0.47	1	1.38	0.52
Basin P (2-Yr)	0.05	0.42	1	0.25	0.44
Basin P (100-Yr)	0.26	0.47	1	1.28	0.44
TOTAL FLOWS:					
DESIGN POINT 1 (2-Yr)	7.96				
DESIGN POINT 1 (100-Yr)	43.45				

*Rainfall intensity was picked from Table A-1, the Intensity/Duration curves for the City of Grand Junction, based on Time of Concentration

RUNOFF RATES (Q)

For: KOKOPELLI COMMERCIAL PARK

DESIGN POINT 2 (DP2)

RATIONAL METHOD Q=CxCfxIxA

BASIN	Q Volume cfs	C Composite Coefficient n/a	Cf Antecedent Precip. Fac. n/a	I* Rainfall Intensity in/hr	A Basin Area acres
DEVELOPED					
Basin B (2-Yr)	**0.18**	0.81	1	0.44	0.51
Basin B (100-Yr)	**0.99**	0.84	1	2.32	0.51
Basin C (2-Yr)	**0.18**	0.81	1	0.43	0.52
Basin C (100-Yr)	**0.97**	0.84	1	2.21	0.52
Basin D (2-Yr)	**0.20**	0.82	1	0.42	0.59
Basin D (100-Yr)	**1.09**	0.84	1	2.20	0.59
Basin E (2-Yr)	**0.62**	0.81	1	0.28	2.75
Basin E (100-Yr)	**3.47**	0.84	1	1.50	2.75
Basin F (2-Yr)	**0.16**	0.81	1	1.12	0.18
Basin F (100-Yr)	**0.66**	0.83	1	4.42	0.18
Basin G (2-Yr)	**0.14**	0.80	1	1.02	0.17
Basin G (100-Yr)	**0.56**	0.82	1	4.02	0.17

RUNOFF RATES (Q)

For: KOKOPELLI COMMERCIAL PARK

DESIGN POINT 2 (DP2)

RATIONAL METHOD Q=CxCfxIxA

BASIN	Q Volume cfs	C Composite Coefficient n/a	Cf Antecedent Precip. Fac. n/a	I* Rainfall Intensity in/hr	A Basin Area acres
Basin H (2-Yr)	0.67	0.86	1	0.28	2.77
Basin H (100-Yr)	3.73	0.88	1	1.53	2.77
Basin I (2-Yr)	0.61	0.78	1	0.28	2.80
Basin I (100-Yr)	3.52	0.81	1	1.55	2.80
Basin J (2-Yr)	0.46	0.93	1	0.86	0.58
Basin J (100-Yr)	1.87	0.95	1	3.40	0.58
Basin K (2-Yr)	1.46	0.60	1	0.15	16.22
Basin K (100-Yr)	9.55	0.64	1	0.92	16.22
Basin L (2-Yr)	1.05	0.79	1	0.25	5.33
Basin L (100-Yr)	5.48	0.81	1	1.27	5.33
Basin M (2-Yr)	0.72	0.81	1	0.25	3.58
Basin M (100-Yr)	3.85	0.84	1	1.28	3.58
Basin N (2-Yr)	0.01	0.18	1	0.17	0.46
Basin N (100-Yr)	0.11	0.24	1	1.00	0.46

RUNOFF RATES (Q)

For: KOKOPELLI COMMERCIAL PARK

DESIGN POINT 2 (DP2)

RATIONAL METHOD Q=CxCfxIxA

BASIN	Q Volume cfs	C Composite Coefficient n/a	Cf Antecedent Precip. Fac. n/a	I* Rainfall Intensity in/hr	A Basin Area acres
Basin O (2-Yr)	0.06	0.43	1	0.26	0.52
Basin O (100-Yr)	0.34	0.47	1	1.40	0.52
Basin P (2-Yr)	0.05	0.42	1	0.25	0.44
Basin P (100-Yr)	0.27	0.47	1	1.30	0.44

TOTAL FLOWS:

DESIGN POINT 2 (2-Yr)	6.59
DESIGN POINT 2 (100-Yr)	36.46

*Rainfall intensity was picked from Table A-1, the Intensity/Duration curves for the City of Grand Junction, based on Time of Concentration

RUNOFF RATES (Q)

For: KOKOPELLI COMMERCIAL PARK

DESIGN POINT 3 (DP3)

RATIONAL METHOD Q=CxCfxIxA

BASIN	Q Volume cfs	C Composite Coefficient n/a	Cf Antecedent Precip. Fac. n/a	I* Rainfall Intensity in/hr	A Basin Area acres
DEVELOPED					
Basin C (2-Yr)	0.19	0.81	1	0.44	0.52
Basin C (100-Yr)	1.01	0.84	1	2.31	0.52
Basin D (2-Yr)	0.21	0.82	1	0.44	0.59
Basin D (100-Yr)	1.13	0.84	1	2.29	0.59
Basin E (2-Yr)	0.62	0.81	1	0.28	2.75
Basin E (100-Yr)	3.56	0.84	1	1.54	2.75
Basin G (2-Yr)	0.15	0.80	1	1.10	0.17
Basin G (100-Yr)	0.61	0.82	1	4.37	0.17

RUNOFF RATES (Q)

For: KOKOPELLI COMMERCIAL PARK

DESIGN POINT 3 (DP3)

RATIONAL METHOD Q=CxCfxIxA

BASIN	Q Volume cfs	C Composite Coefficient n/a	Cf Antecedent Precip. Fac. n/a	I* Rainfall Intensity in/hr	A Basin Area acres
Basin H (2-Yr)	0.69	0.86	1	0.29	2.77
Basin H (100-Yr)	3.85	0.88	1	1.58	2.77
Basin I (2-Yr)	0.63	0.78	1	0.29	2.80
Basin I (100-Yr)	3.63	0.81	1	1.60	2.80
Basin L (2-Yr)	1.05	0.79	1	0.25	5.33
Basin L (100-Yr)	5.61	0.81	1	1.30	5.33
Basin M (2-Yr)	0.72	0.81	1	0.25	3.58
Basin M (100-Yr)	3.97	0.84	1	1.32	3.58

TOTAL FLOWS:

SOUTH/EAST SIDE OF THE STREET	
DESIGN POINT 3 (2-Yr)	2.07
DESIGN POINT 3 (100-Yr)	11.31

NORTH/WEST SIDE OF THE STREET	
DESIGN POINT 3 (2-Yr)	2.20
DESIGN POINT 3 (100-Yr)	12.06

RUNOFF RATES (Q)

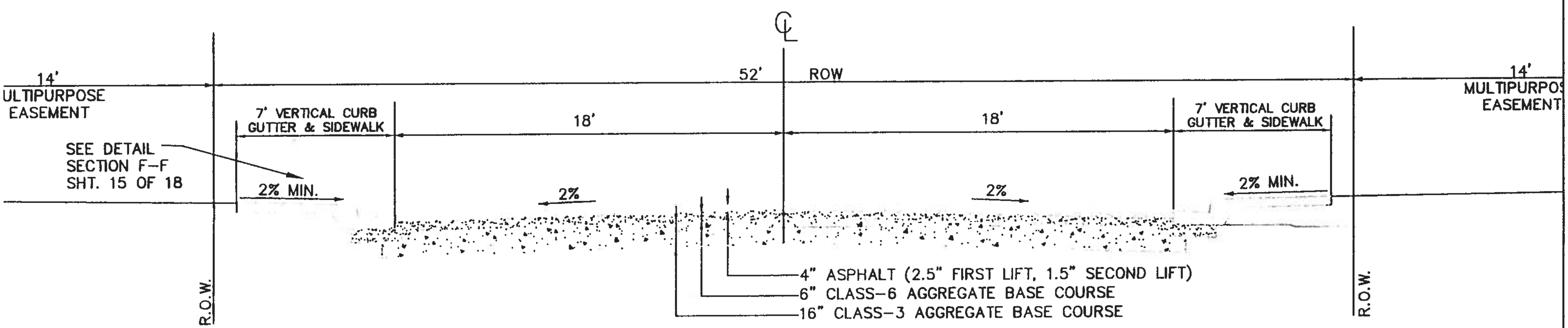
For: KOKOPELLI COMMERCIAL PARK

DESIGN POINT 4 (DP4)

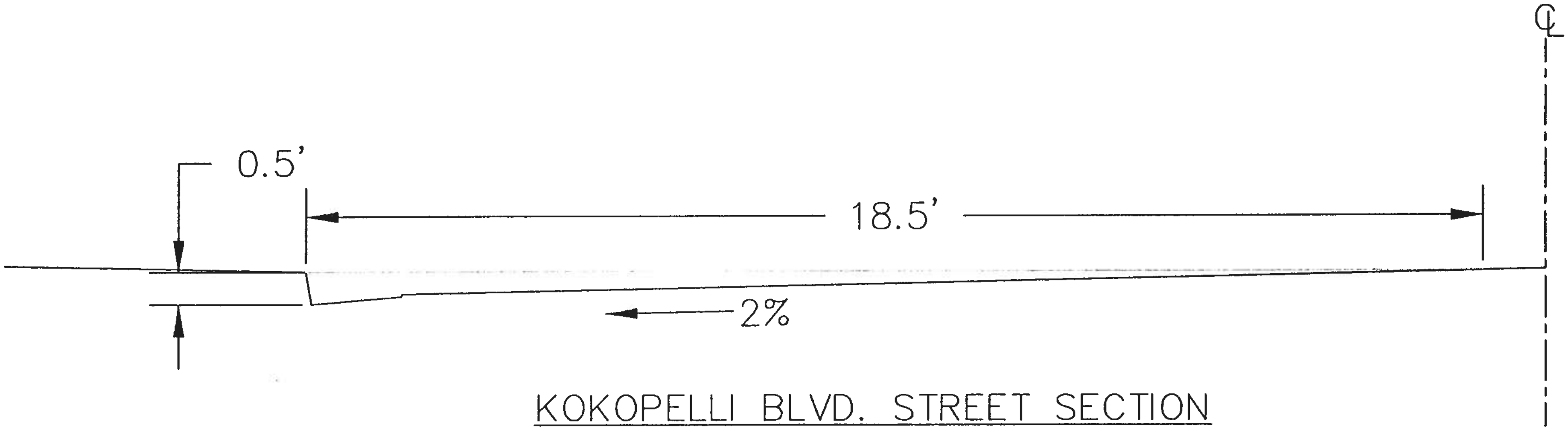
RATIONAL METHOD Q=CxCfxIxA

BASIN	Q Volume cfs	C Composite Coefficient n/a	Cf Antecedent Precip. Fac. n/a	I* Rainfall Intensity in/hr	A Basin Area acres
DEVELOPED					
Basin E' (2-Yr)	0.33	0.81	1	0.44	0.92
Basin E' (100-Yr)	1.79	0.84	1	2.32	0.92
Basin I' (2-Yr)	0.15	0.78	1	0.46	0.42
Basin I' (100-Yr)	0.83	0.81	1	2.44	0.42
Basin L (2-Yr)	1.14	0.79	1	0.27	5.33
Basin L (100-Yr)	6.22	0.81	1	1.44	5.33
Basin M (2-Yr)	0.78	0.81	1	0.27	3.58
Basin M (100-Yr)	4.33	0.84	1	1.44	3.58
EAST SIDE OF THE STREET					
DESIGN POINT 4 (2-Yr)	1.46				
DESIGN POINT 4 (100-Yr)	8.01				
WEST SIDE OF THE STREET					
DESIGN POINT 4 (2-Yr)	0.93				
DESIGN POINT 4 (100-Yr)	5.16				

*Rainfall intensity was picked from Table A-1, the Intensity/Duration curves for the City of Grand Junction, based on Time of Concentration

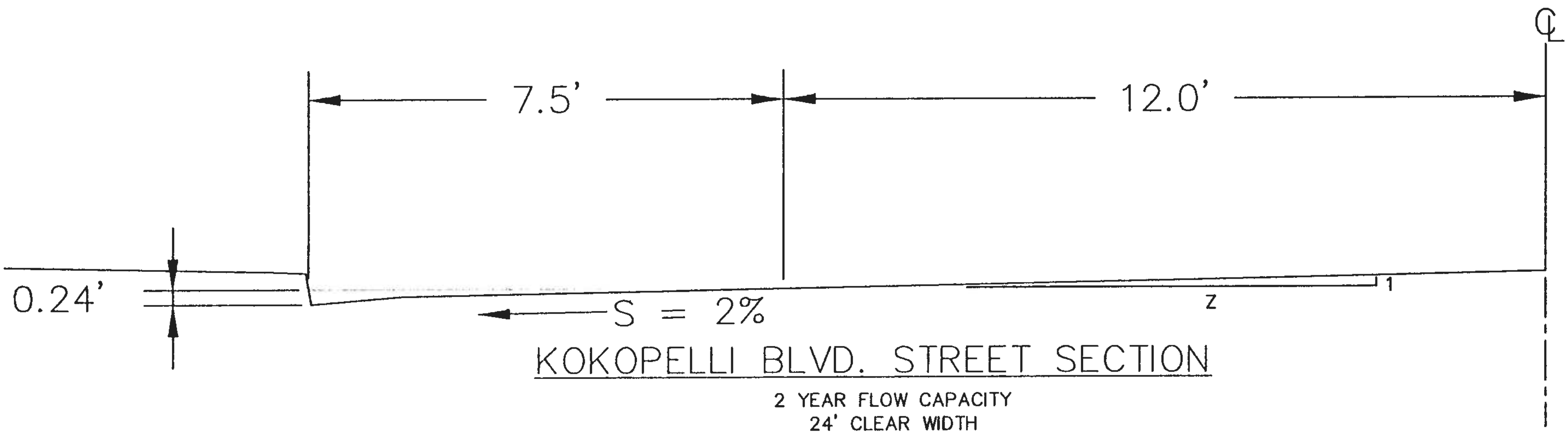


14'
ULTIPURPOSE
EASEMENT
SEE DETAIL
SECTION F-F
SHT. 15 OF 18
R.O.W.
7' VERTICAL CURB
GUTTER & SIDEWALK
2% MIN.
18'
2%
52'
ROW
18'
2%
7' VERTICAL CURB
GUTTER & SIDEWALK
2% MIN.
R.O.W.
14'
MULTIPURPOS
EASEMENT
4" ASPHALT (2.5" FIRST LIFT, 1.5" SECOND LIFT)
6" CLASS-6 AGGREGATE BASE COURSE
16" CLASS-3 AGGREGATE BASE COURSE



KOKOPELLI BLVD. STREET SECTION

100 YEAR FLOW CAPACITY
FLOW TO TOP BACK OF CURB
FOR CAPACITY: SEE FLOWMASTER CALCS



KOKOPELLI BLVD. STREET SECTION

2 YEAR FLOW CAPACITY
24' CLEAR WIDTH
FOR CAPACITY:
MODIFIED MANNING'S EQUATION

$$Q = \frac{0.56}{N} Z D^{8/3} S^{1/2}$$

Z = 50
D = 0.24
S = 0.005
N = 0.016
Q = 2.75

Kokopelli Blvd. 100 Yr Street Capacity
Worksheet for Irregular Channel

Project Description	
Project File	c:\fmw-old\koko.fm2
Worksheet	1/2 Street Flows II
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data

Channel Slope	0.005300	ft/ft
Water Surface Elevation	100.52	ft

Elevation range: 100.00 ft to 100.52 ft.

Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
5.50	100.52	5.50	7.51	0.016
6.00	100.50	7.51	25.51	0.018
6.08	100.00			
7.50	100.12			
7.51	100.16			
25.51	100.52			

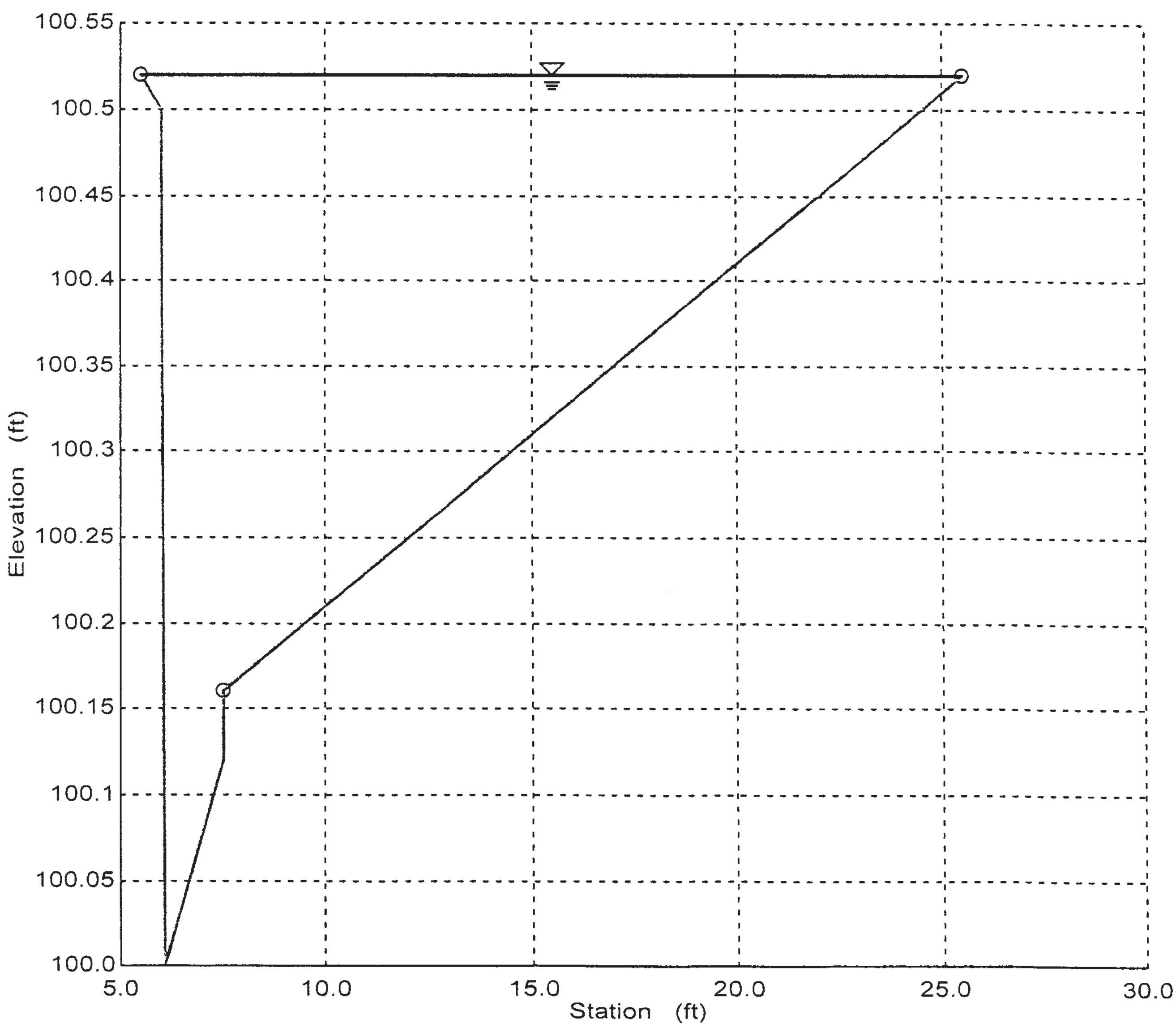
Results		
Wtd. Mannings Coefficient	0.017	
Discharge	8.17	ft³/s
Flow Area	3.92	ft²
Wetted Perimeter	20.48	ft
Top Width	20.01	ft
Depth	0.52	ft
Critical Water Elev.	100.49	ft
Critical Slope	0.007440	ft/ft
Velocity	2.08	ft/s
Velocity Head	0.07	ft
Specific Energy	100.59	ft
Froude Number	0.83	
Full Flow Capacity	8.17	ft³/s

Flow is subcritical.

Kokopelli Blvd. 100 Yr Street Capacity
Cross Section for Irregular Channel

Project Description	
Project File	c:\fmw-old\koko.fm2
Worksheet	1/2 Street Flows II
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data		
Wtd. Mannings Coefficient	0.017	
Channel Slope	0.005300	ft/ft
Water Surface Elevation	100.52	ft
Discharge	8.17	ft^3/s



THEORY:

The velocity of water in a natural or man-made channel is governed principally by the slope along the axis of the channel, the shape of the channel cross-section, and the roughness of the surface in contact with the water, also known as the wetted perimeter.

The most generally used formula or equation is one developed by an early hydraulic investigator by the name of Manning. This expression is familiar to all hydraulic designers and is shown in the following form:

$$V = \frac{1.486}{n} R^{2/3} S^{1/2} \text{ where}$$

V = Velocity of flow in ft./second

n = Roughness coefficient

R = Hydraulic radius—defined as the area/wetted perimeter

S = Slope of the longitudinal axis of channel in ft./ft.

Where the width of the channel cross-section is relatively great in respect to the depth of flow, the depth can be used as the value of R. The depth is considered to be the depth at the curb.

The discharge, Q in cubic feet per second, is obtained by multiplying the area which, for rectangular channels, is width x depth, x the velocity of flow. Thus the equation of discharge becomes Q = AV = WDV where:

$$V = \frac{1.486}{n} D^{2/3} S^{1/2} \text{ then}$$

$$Q = \frac{1.486}{n} WD^{5/3} S^{1/2}$$

When the flow in the gutter takes the shape of a triangular channel the Manning equation has been modified by Izzard[2] to include the transverse slope and has the following form:

$$Q = \frac{.56Z}{n} D^{8/3} S^{1/2}$$ where Z is the reciprocal of the cross-slope and D is the depth or head (h) in feet.

The 8/3 power of the depth arises from the flow area being a function of D^2. This form of the equation describes the flow in a triangular section very accurately and computations of discharge for the test flows in the approach channel agree very closely with the actual values.

When the test data are plotted logarithmically for given longitudinal and transverse slopes a relationship between Q and D is observed which closely follows the manning equation.

If the term $\frac{1.486}{n} WS^{1/2}$ is combined to become K′ this relation simplifies to $Q = K'D^{5/3}$. Further consideration of the interception process indicates that the quantity that can be removed is limited to the water flowing in that portion of the gutter equal to the grate width. Minor additions to the grate flow will occur due to inflow from the side of the grate. No attempt was made to include a factor measuring side flow since this would unnecessarily complicate the equation.

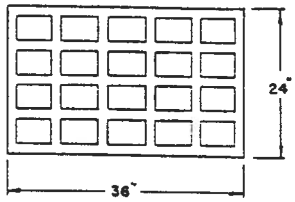
The discharge through the gutter section equal to the grate width similarly has a discharge-depth relation which can be expressed by $Q = KD^{5/3}$ where K is unique to the geometry of each grate. Analysis of the test data revealed that the discharge did not follow the slope term ($S^{1/2}$) closely, therefore a general equation for each transverse slope could not be used. Consequently K values for each tested combination of longitudinal and transverse slope for a specific grate installation were evaluated.

The geometry of the inlet grate also governs the capacity of the system. Long narrow bars parallel to the direction of flow are, with one exception, the most efficient arrangement. As cross-bars are added to reduce size of openings or for strength reasons the potential capacity of the grate is reduced. Cross-bars form barriers to the smooth flow of water through the grate and will often deflect the jet upward, further interfering with flow through the grate. For a theoretical analysis of this action see Guillou[1], Fig. 3, page 17. Thick wide bars permit a portion of the flow to reach the far end of the grate. A grate made up entirely of cross-bars whose shape is patterned after an air foil and positioned to turn the flow at an angle with the vertical is the most efficient geometry available.

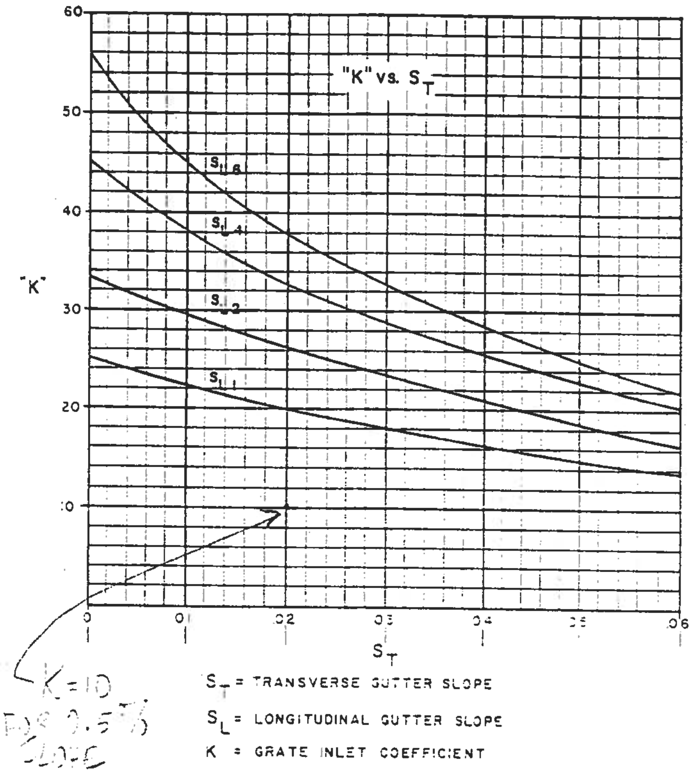
Tests were run on all grates using a standard procedure. Six rates of gutter flow were run for each of four longitudinal and four different cross-slopes with a total of 96 separate test points for each complete grate test. Values of the grate constant "K" were obtained for each combination of longitudinal and cross-slope. Each test point was computed and compared with the observed value. Comparison of these values indicates that an average accuracy of individual points is about 5% with the maximum deviation being about ±10%. Considering the number of variables involved and the accuracy with which each could be observed, the correlation is quite acceptable.

CAT. NO.- R-3246-A
DESCRIPTION- TYPE C
COMP. CODE - 3246-0002

FLOW →



✱ DESIGN



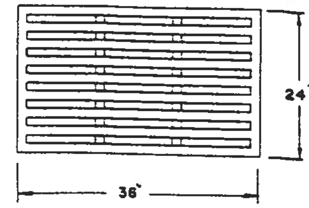
S_T = TRANSVERSE GUTTER SLOPE

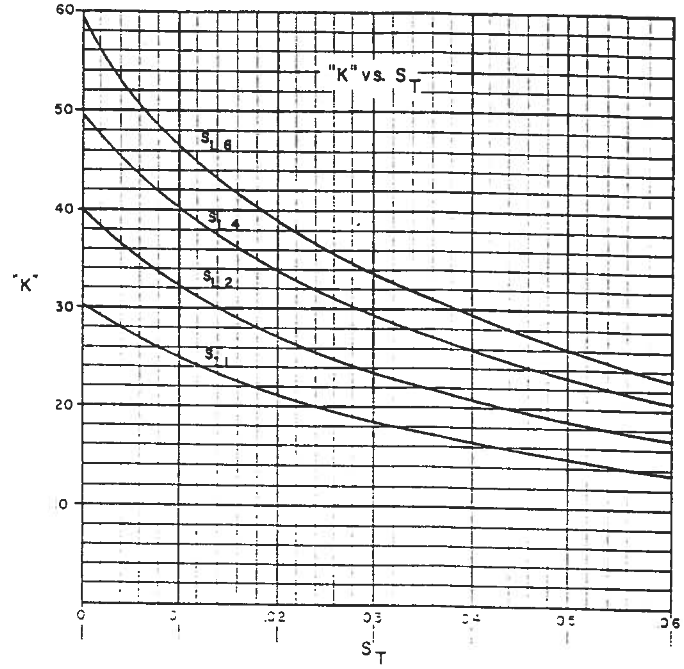
S_L = LONGITUDINAL GUTTER SLOPE

K = GRATE INLET COEFFICIENT

CAT. NO.- R-3246-A
DESCRIPTION- TYPE 'D' WITH TWO DEPRESSED BARS 2" BELOW TOP OF GRATE
COMP. CODE - 3246-0003

FLOW →





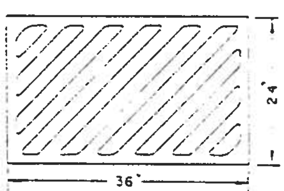
S_T = TRANSVERSE GUTTER SLOPE

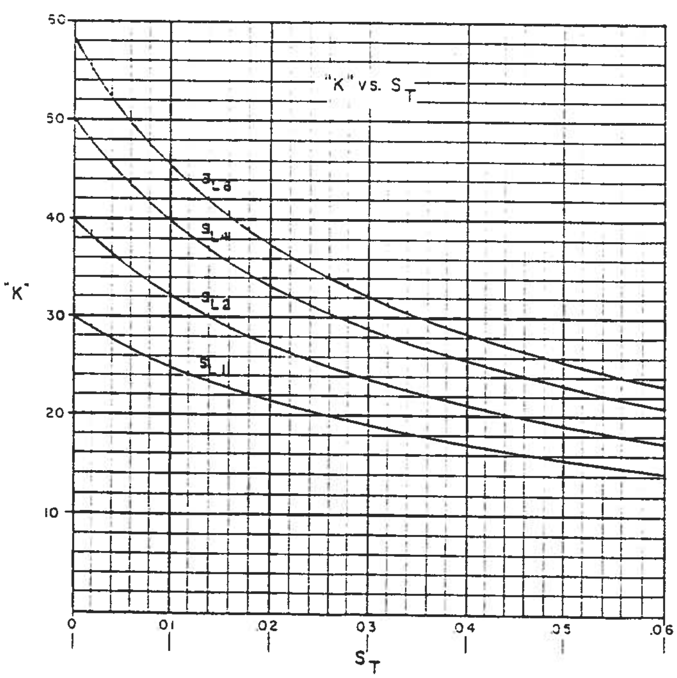
S_L = LONGITUDINAL GUTTER SLOPE

K = GRATE INLET COEFFICIENT

CAT. NO.- R-3246-A
DESCRIPTION- DIAGONAL REVERSIBLE
COMP. CODE - 3246-0027

FLOW →



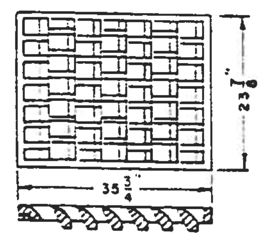


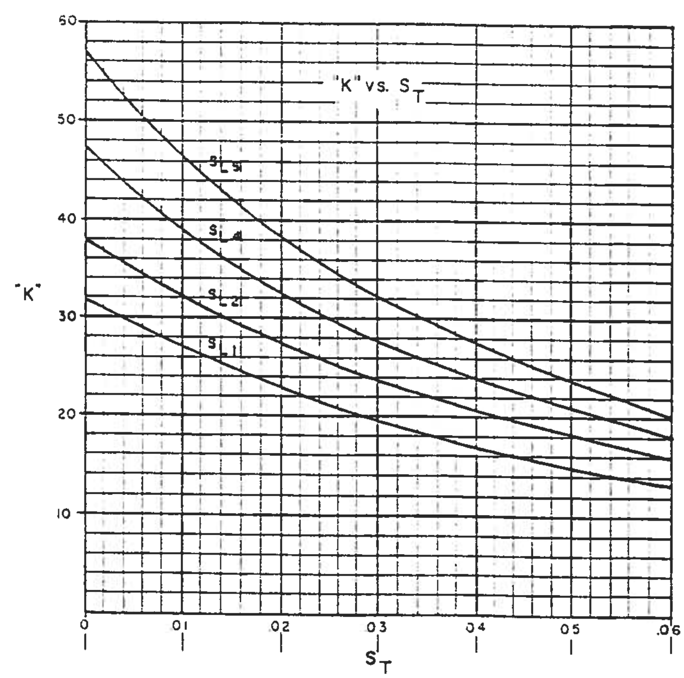
S_T = TRANSVERSE GUTTER SLOPE

S_L = LONGITUDINAL GUTTER SLOPE

CAT. NO.- R-3246-AL
DESCRIPTION- TYPE L
COMP. CODE - 3246-0034 FLOW LEFT
3246-0035 FLOW RIGHT

FLOW →





S_T = TRANSVERSE GUTTER SLOPE

S_L = LONGITUDINAL GUTTER SLOPE

24" Diam. Pipe from DP4 to DP3
Worksheet for Circular Channel

Project Description	
Project File	c:\fmw-old\koko.fm2
Worksheet	Storm Drain Pipe from DP4 to DP3
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Mannings Coefficient	0.012	
Channel Slope	0.005000	ft/ft
Depth	2.00	ft
Diameter	2.00	ft

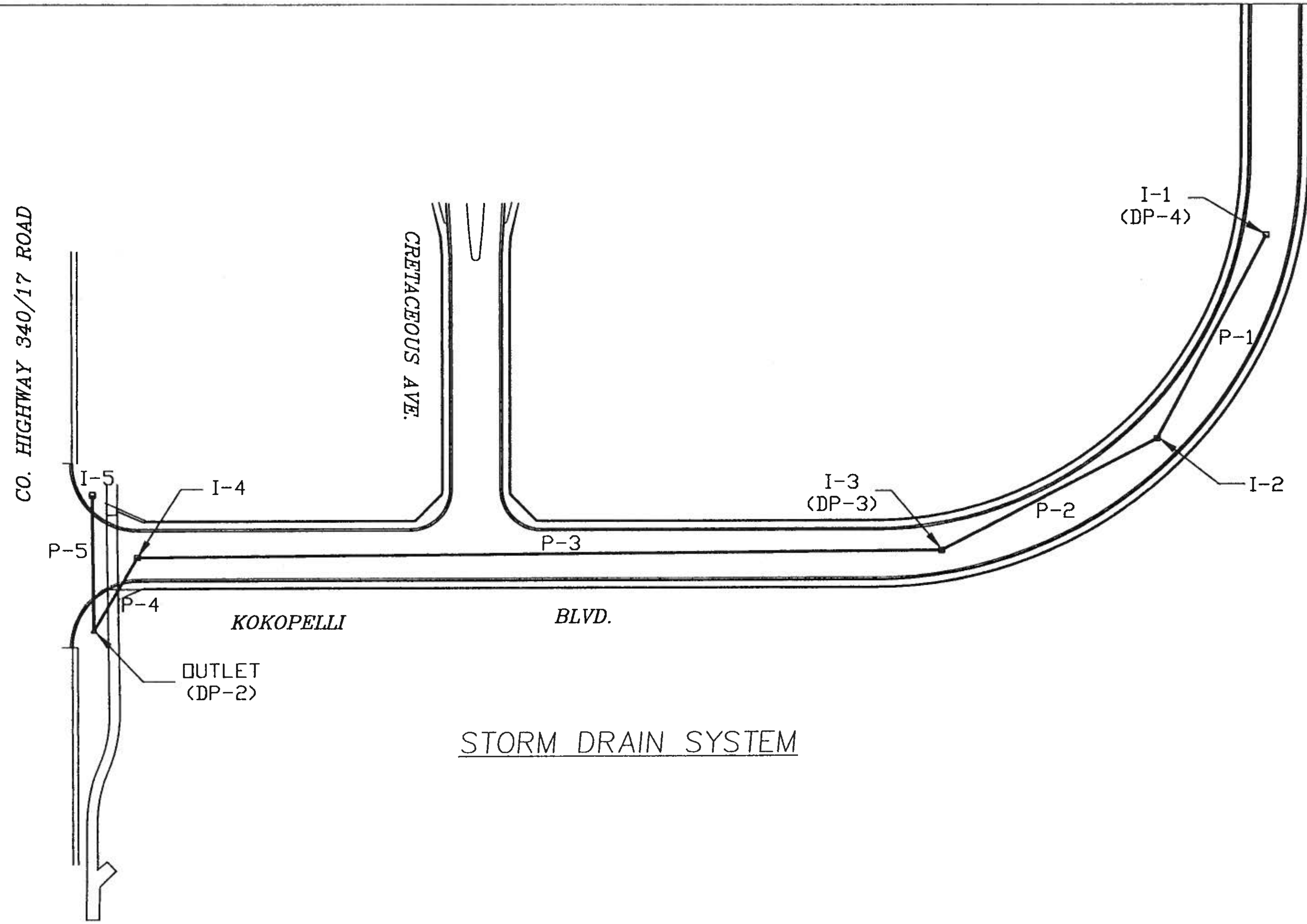
Results		
Discharge	17.33	ft^3/s
Flow Area	3.14	ft^2
Wetted Perimeter	6.28	ft
Top Width	0.00	ft
Critical Depth	1.50	ft
Percent Full	100.00	%
Critical Slope	0.006009	ft/ft
Velocity	5.52	ft/s
Velocity Head	0.47	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	18.64	ft^3/s
Full Flow Capacity	17.33	ft^3/s
Full Flow Slope	0.005000	ft/ft

30" Diameter HDPE Pipe from DP3 to DP2
Worksheet for Circular Channel

Project Description	
Project File	c:\fmw-old\koko.fm2
Worksheet	Storm Drain Pipe from DP3 to DP2
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Mannings Coefficient	0.012	
Channel Slope	0.005000	ft/ft
Depth	2.50	ft
Diameter	2.50	ft

Results		
Discharge	31.42	ft^3/s
Flow Area	4.91	ft^2
Wetted Perimeter	7.85	ft
Top Width	0.00	ft
Critical Depth	1.91	ft
Percent Full	100.00	%
Critical Slope	0.005766	ft/ft
Velocity	6.40	ft/s
Velocity Head	0.64	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	33.80	ft^3/s
Full Flow Capacity	31.42	ft^3/s
Full Flow Slope	0.005000	ft/ft



STORM DRAIN SYSTEM

Combined Pipe/Node Report

Pipe	Upstream Node	Downstream Node	Length (ft)	Inlet Discharge (cfs)	Section Size	Capacity (cfs)	Average Velocity (ft/s)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Constructed Slope (ft/ft)	Description
P-5	I-5	Outlet	103.00	0.00	24 inch	12.55	3.27	4,483.75	4,483.27	0.004660	
P-1	I-1	I-2	174.00	0.00	24 inch	17.43	4.19	4,486.05	4,485.17	0.005057	
P-2	I-2	I-3	183.00	0.00	24 inch	17.47	4.19	4,485.17	4,484.24	0.005082	
P-3	I-3	I-4	605.00	0.00	30 inch	31.44	4.76	4,483.74	4,480.71	0.005008	
P-4	I-4	Outlet	65.00	0.00	30 inch	30.19	5.10	4,480.71	4,480.41	0.004615	

Node Report

Node	Known Flow (cfs)	Ground Elevation (ft)	Rim Elevation (ft)	HGL In (ft)	HGL Out (ft)
I-5	10.27	4,489.35	4,489.35	4,488.07	4,488.07
I-1	13.17	4,491.98	4,491.98	4,491.28	4,491.28
I-2	13.17	4,491.04	4,491.04	4,490.78	4,490.61
I-3	23.37	4,490.19	4,490.19	4,490.08	4,489.87
I-4	25.02	4,490.43	4,490.43	4,488.20	4,487.96
Outlet	N/A	4,487.75	4,487.75	4,487.75	4,487.75

Pipe Report

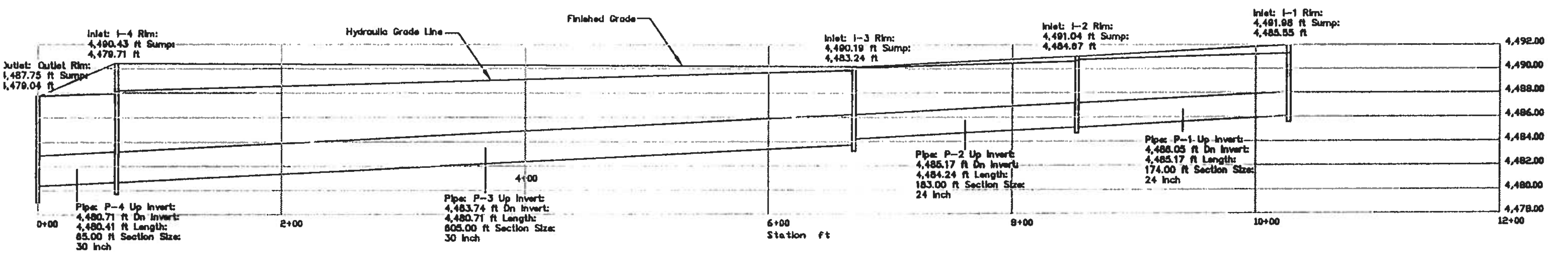
Pipe	Discharge (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Roughness	Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream HGL (ft)	Downstream HGL (ft)
P-5	10.27	103.00	0.004660	24 inch	0.016	12.55	4,483.75	4,483.27	4,489.35	4,487.75	4,488.07	4,487.75
P-1	13.17	174.00	0.005057	24 inch	0.012	17.43	4,486.05	4,485.17	4,491.98	4,491.04	4,491.28	4,490.78
P-2	13.17	183.00	0.005082	24 inch	0.012	17.47	4,485.17	4,484.24	4,491.04	4,490.19	4,490.61	4,490.08
P-3	23.37	605.00	0.005008	30 inch	0.012	31.44	4,483.74	4,480.71	4,490.19	4,490.43	4,489.87	4,488.20
P-4	25.02	65.00	0.004615	30 inch	0.012	30.19	4,480.71	4,480.41	4,490.43	4,487.75	4,487.96	4,487.75

```
------------------ Beginning Calculation Cycle ------------------
Discharge: 13.17 cfs  at node I-1
Discharge: 13.17 cfs  at node I-2
Discharge: 23.37 cfs  at node I-3
Discharge: 25.02 cfs  at node I-4
Discharge: 10.27 cfs  at node I-5
Discharge: 35.29 cfs  at node Outlet
Beginning iteration 1
Discharge: 13.17 cfs  at node I-1
Discharge: 13.17 cfs  at node I-2
Discharge: 23.37 cfs  at node I-3
Discharge: 25.02 cfs  at node I-4
Discharge: 10.27 cfs  at node I-5
Discharge: 35.29 cfs  at node Outlet
Discharge Convergence Achieved in 1 iterations: relative error:  0.0
** Warning: Design constraints not met.
Warning: No Duration data exists in IDF Table
Information: Outlet Known flow propogated from upstream junctions.
Information: P-4 Surcharged condition
Violation: P-4 does not meet minimum slope constraint.
Information: P-5 Surcharged condition
Violation: P-5 does not meet minimum cover constraint at downstream end.
Information: P-3 Surcharged condition
Violation: P-3 does not meet minimum cover constraint at upstream end.
Information: P-2 Surcharged condition
Violation: P-2 does not meet minimum cover constraint at downstream end.
Information: P-1 Surcharged condition
Violation: P-1 does not meet minimum cover constraint at downstream end.
-------------------- Calculations Complete ---------------------

** Analysis Options **
Friction method:  Manning's Formula
HGL Convergence Test:  0.001000
Maximum Network Traversals:  5
Number of Pipe Profile Steps:  5
Discharge Convergence Test:  0.001000
Maximum Design Passes:  3


 ---------------- Network Quick View  -----------------------
```

Label	Length	Size	Discharge	Hydraulic Grade Upstream	Hydraulic Grade Downstream
P-1	174.00	24 inch	13.17	4,491.28	4,490.78
P-2	183.00	24 inch	13.17	4,490.61	4,490.08
P-3	605.00	30 inch	23.37	4,489.87	4,488.20
P-4	65.00	30 inch	25.02	4,487.96	4,487.75
P-5	103.00	24 inch	10.27	4,488.07	4,487.75

Label	Discharge	Elevations Ground	Elevations Upstream HGL	Elevations Downstream HGL
I-1	13.17	4,491.98	4,491.28	4,491.28
I-2	13.17	4,491.04	4,490.78	4,490.61
I-3	23.37	4,490.19	4,490.08	4,489.87
I-4	25.02	4,490.43	4,488.20	4,487.96
Outlet	10.27	4,487.75	4,487.75	4,487.75
I-5	10.27	4,489.35	4,488.07	4,488.07

Elapsed: 0 minute(s) 1 second(s)



STORM SEWER SYSTEM PROFILE

New Channel from DP 2 to DP1
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\fmw-old\koko.fm2
Worksheet	New Channel from DP2 to DP1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.005000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	2.50	ft
Discharge	36.50	ft^3/s

Results		
Depth	1.56	ft
Flow Area	11.15	ft^2
Wetted Perimeter	12.34	ft
Top Width	11.83	ft
Critical Depth	1.21	ft
Critical Slope	0.015157	ft/ft
Velocity	3.27	ft/s
Velocity Head	0.17	ft
Specific Energy	1.72	ft
Froude Number	0.59	
Flow is subcritical.		

Culvert Calculator

Entered Data:

Shape	Circular
Number of Barrels	2
Solving for	Headwater
Chart Number	1
Scale Number	3
Chart Description	CONCRETE PIPE CULVERT; NO BEVELED RING ENTRANCE
Scale Decsription	GROOVE END ENTRANCE, PIPE PROJECTING FROM FILL
Flowrate	36.5000 cfs
Manning's n	0.0150
Roadway Elevation	4490.9500 ft
Inlet Elevation	4486.9500 ft
Outlet Elevation	4486.7500 ft
Diameter	36.0000 in
Length	40.0000 ft
Entrance Loss	0.0000
Tailwater	1.1314 ft

Computed Results:

Headwater	4488.7000 ft From Outlet
Slope	0.0050 ft/ft
Velocity	5.8136 fps

DIS-CHARGE Flow cfs	HEAD-WATER ELEV. ft	INLET CONTROL DEPTH ft	OUTLET CONTROL DEPTH ft	FLOW TYPE	NORMAL DEPTH in	CRITICAL DEPTH in	OUTLET VEL. fps	OUTLET DEPTH ft	TAILWATER VEL. fps	TAILWATER DEPTH ft
0.00	4490.10	0.41	3.15	NA	0.00	0.00	0.00	0.00	0.00	0.00
1.00	4490.12	0.58	3.17	M2	3.88	17.22	2.60	0.32	1.21	0.25
2.00	4490.15	0.72	3.20	M2	5.42	17.22	3.12	0.45	1.49	0.37
3.00	4490.18	0.84	3.23	M2	6.60	17.22	3.47	0.55	1.67	0.46
4.00	4490.21	0.94	3.26	M2	7.60	17.22	3.75	0.63	1.82	0.54
5.00	4490.23	1.04	3.28	M2	8.50	17.22	3.99	0.71	1.93	0.60
6.00	4490.25	1.13	3.30	M2	9.32	17.22	4.19	0.78	2.03	0.66
7.00	4490.28	1.21	3.33	M2	10.08	17.22	4.38	0.84	2.12	0.71
8.00	4490.30	1.29	3.35	M2	10.79	17.22	4.54	0.90	2.20	0.76
9.00	4490.32	1.37	3.37	M2	11.47	17.22	4.70	0.96	2.27	0.81
10.00	4490.34	1.44	3.39	M2	12.12	17.22	4.85	1.01	2.34	0.85
11.00	4490.36	1.51	3.41	M2	12.75	17.22	4.98	1.06	2.40	0.89
12.00	4490.39	1.58	3.44	M2	13.36	17.22	5.11	1.11	2.45	0.93
13.00	4490.41	1.65	3.46	M2	13.95	17.22	5.23	1.16	2.50	0.96
14.00	4490.43	1.71	3.48	M2	14.52	17.22	5.35	1.21	2.55	1.00
15.00	4488.75	1.78	1.80	M2	15.09	17.22	5.47	1.26	2.60	1.03
16.00	4490.47	1.84	3.52	M2	15.64	17.22	5.58	1.30	2.64	1.06
17.00	4490.49	1.90	3.54	M2	16.18	17.22	5.68	1.35	2.69	1.09
18.00	4490.51	1.96	3.56	M2	16.71	17.22	5.79	1.39	2.73	1.12
19.00	4489.01	2.02	2.06	M2	17.24	17.22	5.89	1.44	2.77	1.15

Drainage Swale at South Property Line
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\fmw-old\koko.fm2
Worksheet	Drainage Swale at South Property Line
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.005000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	1.50	ft
Discharge	14.13	ft^3/s

Results		
Depth	1.12	ft
Flow Area	5.46	ft^2
Wetted Perimeter	8.60	ft
Top Width	8.23	ft
Critical Depth	0.85	ft
Critical Slope	0.017202	ft/ft
Velocity	2.59	ft/s
Velocity Head	0.10	ft
Specific Energy	1.23	ft
Froude Number	0.56	
Flow is subcritical.		

Existing 24" Diameter Pipe along 340
Worksheet for Circular Channel

Project Description	
Project File	c:\fmw-old\koko.fm2
Worksheet	Existing 24" Diameter Pipe Along 340
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Mannings Coefficient	0.016	
Channel Slope	0.005000	ft/ft
Depth	2.00	ft
Diameter	2.00	ft

Results		
Discharge	13.00	ft^3/s
Flow Area	3.14	ft^2
Wetted Perimeter	6.28	ft
Top Width	0.00	ft
Critical Depth	1.30	ft
Percent Full	100.00	%
Critical Slope	0.008794	ft/ft
Velocity	4.14	ft/s
Velocity Head	0.27	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	13.98	ft^3/s
Full Flow Capacity	13.00	ft^3/s
Full Flow Slope	0.005000	ft/ft

STORM SEWER FLOWS
KOKPELLI COMMERCIAL PARK

2-YEAR STORM EVENT:

A Design Point	B Location	C Flow Rate from Rational Formula	D Net Flow Tributary to Design Point	Remarks
4	East Side Street	1.46	1.46	
4	West Side Street	0.93	0.93	
3	South/East Side Street	2.07	0.61	Q_{net} = D-C
3	North/West Side Street	2.20	1.27	Q_{net} = D-C
2	Junction of Pipes	6.59	6.59	
1	Inlet to Culverts	7.96	7.96	

Design Point	Location	Flow Rate from Rational Formula	Street Capacity	Inlet Capacity	Inlet Flow	Bypass Flow	$Q_{cummulative\ pipe}$	$Q_{cummulative\ street}$
4	East Side Street	1.46	2.5	4.03	2.5	0	-	-
4	West Side Street	0.93	2.5	4.03	0.93	0	3.43	0
3	South/East Side Street	0.61	2.5	2.69	0.61	0	-	-
3	North/West Side Street	1.27	2.5	4.03	1.27	0	5.31	0
2	Junction of Pipes	6.59	-		-	-	6.59	-
1	Inlet to Culverts	7.96	-		-	-	7.96	-

Inlet capacity is based upon a depth flow of 0.3 ft

$Q = K'Q^{5/3}$

Where K' = 10

STORM SEWER FLOWS
KOKPELLI COMMERCIAL PARK
100-YEAR STORM EVENT:

A Design Point	B Location	C Flow Rate from Rational Formula	D Net Flow Tributary to Design Point	Remarks
4	East Side Street	8.01	8.01	
4	West Side Street	5.16	5.16	
3	South/East Side Street	11.31	3.30	Q_{net} = D-C
3	North/West Side Street	12.06	6.90	Q_{net} = D-C
2	Junction of Pipes	36.46	36.46	
1	Inlet to Culverts	43.45	43.45	

Design Point	Location	Flow Rate from Rational Formula	Street Capacity	Inlet Capacity*	Inlet	Bypass Flow	$Q_{cummulative\ pipe}$	$Q_{cummulative\ street}$
4	East Side Street	8.01	8.2	9.45	8.01	0	-	-
4	West Side Street	5.16	8.2	9.45	5.16	0	13.17	0
3	South/East Side Street	3.30	8.2	6.3	3.30	0	-	-
3	North/West Side Street	6.90	8.2	9.45	6.90	0	23.37	0
2	Junction of Pipes	36.46	-	-	-	-	36.46	-
1	Inlet to Culverts	43.45	-	-	-	-	43.45	-

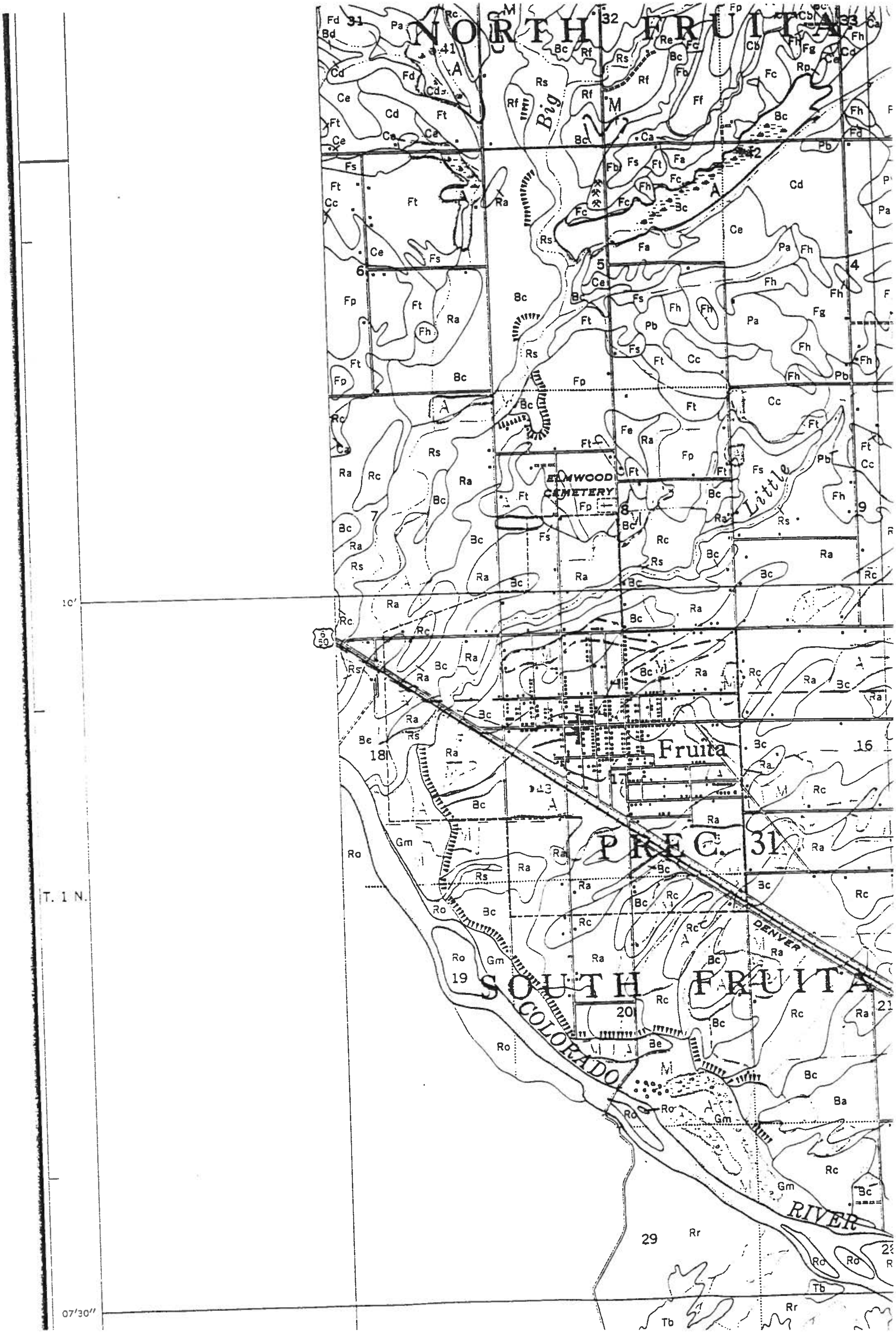
Inlet capacity is based upon a depth flow of 0.5 ft
$Q = K'Q^{5/3}$
Where K' = 10

One Existing 21 Inch Diameter Pipe
Worksheet for Circular Channel

Project Description	
Project File	c:\fmw-old\koko.fm2
Worksheet	1- 21 inch diameter pipe at 0.258%
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Mannings Coefficient	0.012	
Channel Slope	0.002580	ft/ft
Depth	1.75	ft
Diameter	1.75	ft

Results		
Discharge	8.72	ft^3/s
Flow Area	2.41	ft^2
Wetted Perimeter	5.50	ft
Top Width	0.00	ft
Critical Depth	1.10	ft
Percent Full	100.00	%
Critical Slope	0.005008	ft/ft
Velocity	3.62	ft/s
Velocity Head	0.20	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	9.38	ft^3/s
Full Flow Capacity	8.72	ft^3/s
Full Flow Slope	0.002580	ft/ft


NORTH FRUITA
Big
ELMWOOD CEMETERY
Little
10'
Fruita
PREC. 31
T. 1 N.
DENVER
SOUTH FRUITA
COLORADO
RIVER
07'30"

United States
Department of
Agriculture

Soil
Conservation
Service

Engineering
Division

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Soil Conservation Service
In cooperation with the
COLORADO AGRICULTURAL EXPERIMENT STATION

Exhibit A-1, continued: Hydrologic soil groups for United States soils

Soil	Group
BELMONT	B
BELMORE	B
BELPRE	C
BELSAC	B
BELTED	D
BELTON	C
BELTRAMI	B
BELTSVILLE	C
BELUGA	D
BELUGA, DRAINED, SLOPING	C
BELVOIR	C
BELZAR	C
BEMIDJI	A
BEN LOMOND	B
BENCHLEY	C
BENCLARE	C
BENCO	B
BENDER	B
BENDIRE	C
BENEVOLA	C
BENEWAH	D
BENFIELD	C
BENGAL	C
BENGE	B
BENHAM	B
BENIN	D
BENITO	D
BENJAMIN	D
BENKLIN	C
BENMAN	C
BENNDALE	B
BENNINGTON	C
BENRIDGE	B
BENSLEY	B
BENSON	D
BENTEEN	C
BENWY	B
BENZ	D
BEOR	D
BEOSKA	B
BEOTIA	B
BEOWAWE	B
BEQUINN	B
BERCUMB	B
BERDA	B
BEREA	C
BERENICETON	B
BERGHOLZ	C
BERGLAND	D
BERGQUIST	B
BERGSTROM	B
BERGSVIK	D
BERINO	B
BERIT	D
BERKS	C
BERKSHIRE	B
BERLAKE	B
BERLIN	C
BERMESA	C
BERMUDIAN	B
BERNAL	D
BERNALDO	B
BERNARD	D
BERNARDINO	C
BERNARDSTON	C
BERNHILL	B
BERNICE	A
BERNING	C
BERNOW	B
BERRYLAND	B/D
BERRYMAN	C
BERSON	B
BERTAG	C
BERTELSON	B
BERTHOUD	B
BERTIE	B
BERTO	D
BERTOLOTTI	B
BERTRAM	B
BERTRAND	B
BERVILLE	B/D
BERWOLF	B
BERYL	B
BERZATIC	D
BESEMAN	A/D
BESHERM	C
BESNER	B
BESSEMER	C
BESSIE	D
BESTROM	C
BETHANY	C
BETHEL	B
BETHERA	D
BETHESDA	C
BETHLEHEM	B
BETIS	A
BETONNIE	B
BETRA	C
BETTERAVIA	C
BETTS	B
BEULAH	B
BEVENT	A
BEVERIDGE	D
BEVERLY	B
BEVERLY, GRAVELLY	A
BEW	C
BEWLEYVILLE	B
BEXAR	D
BEZO	D
BEZZANT	B
BIBB	C
BIBLESPRINGS	B
BICE	B
BICKERDYKE	D
BICKETT	D
BICKLETON	B
BICKMORE	C
BICONDOA	D
BICONDOA, DRAINED	C
BIDDEFORD	D
BIDDLEMAN	B
BIDMAN	C
BIDWELL	B
BIEBER	D
BIEDELL	D
BIEDSAW	C
BIENVILLE	A
BIG BLUE	D
BIG HORN	B
BIG TIMBER	D
BIGARM	B
BIGBEE	A
BIGBEND	B
BIGBROWN	C
BIGELOW	B
BIGETTY	B
BIGFLAT	D
BIGFOOT	C
BIGFORK	C
BIGHAMS	B
BIGHILL	B
BIGLAKE	A
BIGMEADOW	C
BIGNELL	C
BIGRIVER	B
BIGSHEEP	B
BIGSPRING	D
BIGWIN	C
BIGWINDER	D
BIJORJA	C
BIJOU	B
BILBO	C
BILGER	D
BILLETT	B
BILLINGS	C
BILLINGS, MODERATELY SLOW PERM	B
BILLYCREEK	C
BILLYHAW	D
BILTMORE	A
BIMMER	D
BINCO	D
BINDLE	B
BINFORD	B
BINGER	B
BINGHAM	B
BINGHAMPTON	B
BINGHAMVILLE	D
BINNA	B
BINNSVILLE	D
BINS	B
BINTON	C
BINTON, RECLAIMED	B
BIOYA	B
BIPPUS	B
BIRCHBAY	C
BIRCHFIELD	D
BIRCHWOOD	C
BIRDOW	B
BIRDS	C/D
BIRDSALL	D
BIRDSBORO	B
BIRDSLEY	D
BIRDSVIEW	A
BIRKBECK	B
BIRMINGHAM	B
BIRNEY	B
BIROME	C
BISBEE	A
BISCARO	D
BISCAY	B/D
BISGANI, MODERATELY WET	B
BISGANI, FLOODED	C
BISHOP	D
BISMARCK	D
BISODDI	D
BISPING	B
BISSELL	B
BISSONNET	C
BIT	C
BITTER	B
BITTER SPRING	B
BITTERROOT	C
BITTERWATER	B
BITTON	B
BIVANS	D
BIXBY	B
BIXLER	C
BJORK	C
BLACHLY	B
BLACK BUTTE	B
BLACK CANYON	D
BLACK CANYON, DRAINED	C
BLACK RIDGE	D
BLACKA	C
BLACKBURN	B
BLACKDRAW	D
BLACKETT	B
BLACKFOOT	C
BLACKFOOT, DRAINED	B
BLACKHALL	D
BLACKHALL, WARM	C
BLACKHAMMER	B
BLACKHAWK	D
BLACKHOOF	D
BLACKHORSE	C
BLACKLEED	B
BLACKLEG	C
BLACKLOCK	D
BLACKMAN	C
BLACKMOUNT	B
BLACKNOLL	C
BLACKOAR	B/D
BLACKPIPE	C
BLACKPRINCE	B
BLACKROCK	B
BLACKSAN	B
BLACKSPAR	D
BLACKSPOT	D
BLACKSTON	B
BLACKTHORN	B
BLACKTOP	D
BLACKWATER	D
BLACKWELL	D
BLADEN	D
BLAG	D
BLAGO	D
BLAINE	C
BLAIR	C
BLAIRTON	C
BLAKABIN	C
BLAKE	B
BLAKELAND	A
BLAKENEY	C
BLAKEWELL	C
BLALOCK	D
BLAMER	C
BLANCA	B
BLANCHARD	A
BLANCHE	B
BLANCHESTER	B/D
BLANCOT	B
BLAND	C
BLANDING	B
BLANEY	B
BLANKET	C
BLANTON	A
BLANTON, MODERATELY WET	B
BLANYON	C
BLAPPERT	D
BLAQUIERE	C
BLASDELL	A
BLASE	C
BLASINGAME	C
BLAYDEN	C
BLAZBIRD	D
BLAZON	D
BLEAKWOOD	C
BLEDSOE	C
BLEIBLERVILLE	D
BLENCOE	D
BLEND	D
BLENDON	B
BLETHEN	B
BLEVINS	B
BLEVINTON	B
BLEWETT	D
BLICHTON	D
BLICKENSTAFF	B
BLIMO	B
BLINSTER	C
BLINN	C
BLISS	C
BLITZEN	C
BLOCKHOUSE	D
BLOMFORD	B/D
BLOOM	D
BLOOMFIELD	A
BLOOMING	B
BLOOMSDALE	B
BLOOR	C
BLOOR, GRAVELLY SUBSTRATUM	D
BLOUNT	C
BLOWERS	B
BLUCHER	C
BLUE EARTH	B/D
BLUE EARTH, SLOPING	D
BLUE LAKE	A
BLUE STAR	B
BLUEBELL	C
BLUECHIEF	C
BLUECREEK	D
BLUEDOME	C
BLUEFLAT	C
BLUEGROVE	C
BLUEGULCH	B
BLUEHILL	C
BLUEMON	C
BLUEJOINT	B
BLUENOSE	B
BLUEPOINT	A
BLUERIM	C
BLUESLIDE	D
BLUESPRIN	C
BLUESTONE	D
BLUEWING	A
BLUFF	D
BLUFFDALE	C
BLUFFTON	C/D
BLUFORD	C
BLUM	C
BLY	B
BLYBURG	B
BLYTHE	D
BOARDMAN	D
BOARDTREE	C
BOASH	D
BOAZ	C
BOBBITT	C
BOBILLO	A
BOBNBOB	C
BOBS	D
BOBTAIL	C
BOBTOWN	B
BOCA	B/D
BOCA, DEPRESSIONAL	D
BOCA, TIDAL	D
BOCK	B
BOCKER	D
BOCKSTON	B
BODE	B
BODECKER	A
BODELL	D
BODEN	C
BODENBURG	B
BODINE	B
BODORUMPE	C
BODOT	C
BOEL	A
BOEL, OVERWASH	C
BOELUS	A
BOERNE	B
BOESEL	C
BOESEL, PROTECTED	B
BOETTCHER	C
BOGAN	C
BOGART	B
BOGGS	C
BOGGY	C
BOGRAP	B
BOGUE	D
BOGUS	C
BOHANNON	C
BOHEMIAN	B
BOHICKET	D
BOHNA	B
BOHNLY	D
BOHNSACK	B
BOISTFORT	B
BOJAC	B
BOJO	D
BOLAN	B
BOLAR	C
BOLD	B
BOLENT	A
BOLES	C

NOTES: TWO HYDROLOGIC SOIL GROUPS SUCH AS B/C INDICATES THE DRAINED/UNDRAINED SITUATION.
MODIFIERS SHOWN, E.G., BEDROCK SUBSTRATUM, REFER TO A SPECIFIC SOIL SERIES PHASE FOUND IN SOIL MAP LEGEND.

Exhibit A-1, continued: Hydrologic soil groups for United States soils

Soil	Group
POQUONOCK	C
PORFIRIO	C
PORRETT	D
PORRONE	B
PORT	B
PORT BYRON	B
PORTAGE	D
PORTAGEVILLE	D
PORTALES	B
PORTALTO	B
PORTERFIELD	C
PORTERS	B
PORTERVILLE	D
PORTHILL	D
PORTIA	C
PORTINO	C
PORTLAND	D
PORTMOUNT	B
PORTNEUF	B
PORTOLA	B
PORTSMOUTH	B/D
PORUM	D
POSANT	D
POSEN	B
POSEY	B
POSEYVILLE	C
POSITAS	D
POSKIN	C
POSO	B
POSOS	C
POST	D
POTAMUS	B
POTCHUB	C
POTEET	C
POTELL	B
POTH	C
POTLATCH	C
POTOMAC	A
POTOSI	A
POTRATZ	C
POTSDAM	C
POTTER	C
POTTINGER	B
POTTS	B
POTTSBURG	B/D
POUDRE	D
POUJADE	D
POULSBO	D
POUNCEY	D
POVERTY	D
POVEY	B
POWDER	B
POWDERHORN	C
POWDERWASH	C
POWEEN	C
POWELL	C
POWER	B
POWERLINE	C
POWLEY	D
POWMENT	C
POWWAHKEE	B
POWWATKA	C
POY	D
POYGAN	D
POYNOR	B
POZO	C
POZO BLANCO	B
PRAG	C
PRAIRIEVILLE	B
PRAMISS	C
PRATHER	C
PRATLEY	C
PRATT	A
PREACHER	B
PREAKNESS	B/D
PREATORSON	B
PREBISH	C/D
PREBLE	D
PRELO	B

Soil	Group
PREMIER	B
PRENTISS	C
PRESA	B
PRESHER	B
PRESTO	B
PRESTON	A
PREWITT	B
PREY	C
PRICE	B
PRIDA	C
PRIDHAM	D
PRIESTLAKE	B
PRIETA	D
PRIM	D
PRIMEAUX	C
PRIMEN	D
PRIMGHAR	B
PRINCETON	B
PRINEVILLE	C
PRING	B
PRINGLE	D
PRITCHARD	C
PRITCHETT	C
PROCHASKA	A/D
PROCTOR	B
PROGRESSO	C
PROMISE	D
PROMO	D
PRONG	C
PROPHETSTOWN	B/D
PROSPECT	B
PROSPER	B
PROSSER	C
PROTIVIN	C
PROUT	C
PROUTY	C
PROVIDENCE	C
PROVIG	C
PROVO	D
PROVO BAY	D
PROW	D
PRUDY	B
PRUE	B
PRUITTON	B
PRUNIE	D
PRYOR	C
PSUGA	B
PTARMIGAN	C
PUAPUA	D
PUAULU	A
PUCHYAN	B
PUDDLE	B
PUERCO	D
PUERTA	D
PUERTECITO	D
PUETT	D
PUFFER	D
PUGET	D
PUGET, PROTECTED	C
PUGSLEY	C
PUHI	B
PUHIMAU	D
PUICE	C
PULA	C
PULANTAT	C
PULASKI	B
PULCAN	C
PULEHU	B
PULEXAS	B
PULLMAN	D
PULPIT	C
PULS	D
PULSIPHER	D
PULTNEY	C
PUMEL	D
PUMEL, NONGRAVELLY	C
PUMPER	B
PUNA	A
PUNALUU	D

Soil	Group
PUNCHBOWL	D
PUNG	C
PUNGO	D
PUNOHU	A
PUNSIT	C
PUNTA	B/D
PUNTILLA	B
PURCELLA	B
PURCHES	C
PURDAM	C
PURDY	D
PURETT	B
PURGATORY	C
PURNER	D
PUROB	D
PURSLEY	B
PURVES	D
PUSHMATAHA	C
PUSTOI	B
PUTNAM	D
PUTNEY	B
PUTT	C
PUTTSTER	C
PUU OO	A
PUU OPAE	B
PUU PA	A
PUU PA, NONSTONY	B
PUUKALA	D
PUUONE	C
PUYALLUP	B
PYBURN	D
PYLE	B
PYLON	D
PYOTE	A
PYRAMID	D
PYRMONT	D
PYRMONT, BEDROCK SUBSTRATUM	C
PYWELL	D
QUAFENO	C
QUAKER	C
QUAKERTOWN	C
QUAM	B/D
QUAMON	A
QUANAH	B
QUANDER	B
QUANTICO	B
QUARLES	D
QUARTZBURG	C
QUARTZVILLE	B
QUARZ	C
QUATAMA	C
QUAY	B
QUAZO	D
QUEALMAN	C
QUEALY	D
QUEBRADA	C
QUEENY	D
QUEETS	B
QUEMADO	C
QUENZER	D
QUERC	C
QUERENCIA	B
QUETICO	D
QUICKSELL	C
QUICKSILVER	D
QUICKVERT	C
QUIDEN	B
QUIENSABE	C
QUIETUS	C
QUIGLEY	B
QUIHI	C
QUILCENE	C
QUILLAYUTE	B
QUILOTOSA	D
QUILT	D
QUIMA	B
QUINCY	A
QUINLAN	C

Soil	Group
QUINLIVEN	C
QUINN	B/D
QUINNEY	C
QUINTANA	B
QUINTO	D
QUINTON	C
QUITERIA	B
QUITMAN	C
QUIVERA	C
QUONSET	A
QUOPANT	D
QUOSATANA	D
RABBITEX	B
RABER	C
RABIDEUX	B
RABUN	B
RACE	B
RACINE	B
RACKER	A
RACOMBES	B
RACOON	C/D
RAD	B
RAD, LACUSTRINE SUBSTRATUM	C
RAD, FLOODED	C
RADDLE	B
RADER	D
RADERSBURG	B
RADFORD	B
RADLEY	B
RADNOR	C
RAFAEL	D
RAFTON	D
RAFTRIVER	C
RAGLAN	B
RAGNAR	B
RAGNEL	B
RAGO	C
RAGPIE	D
RAGSDALE	B/D
RAGSDALE, OVERWASH	B
RAGTOWN	C
RAHAL	C
RAHM	C
RAMWORTH	B
RAIL	D
RAILCITY	A
RAINBOW	C
RAINEY	C
RAINIER	C
RAINO	D
RAINS	B/D
RAINS, FLOODED	D
RAINSBORO	C
RAINSVILLE	B
RAIRDENT	B
RAISIO	C
RAKANE	C
RAKE	D
RAKIED	C
RALEIGH	D
RALLOD	D
RALLS	B
RALPH	B
RALPHSTON	B
RALSEN	D
RAMADERO	B
RAMBLA	C
RAMBOUILLET	B
RAMELLI	D
RAMIRES	C
RAMMEL	C
RAMO	C
RAMONA	B
RAMONA, HARD SUBSTRATUM	C
RAMPART	B
RAMPARTER	B
RAMPS	B

Soil	Group
RAMROD	C
RAMSDELL	D
RAMSDELL, DRAINED	C
RAMSEY	D
RAMSHORN	B
RANA	D
RANCE	C
RANCHOSECO	D
RANDADO	C
RANDALL	D
RANDCORE	D
RANDMAN	D
RANDOLPH	C
RANDS	C
RANDSBURG	D
RANGEE	D
RANGER	C
RANPUFF	D
RANSLO	D
RANSOM	B
RANSTEIN	B
RANTOUL	D
RAPATEE	D
RAPELJE	B
RAPH	B
RAPHO	B
RAPIDAN	B
RAPLEE	C
RAPPAHANNOCK	D
RAPSON	B
RARDEN	C
RARICK	C
RARITAN	C
RASBAND	B
RASILLE	B
RASSER	B
RASSET	B
RASTUS	C
RATAKE	D
RATHBUN	C
RATHDRUM	B
RATLAKE	D
RATLEFLAT	B
RATLIFF	B
RATON	D
RATSOW	C
RATTLER	D
RATTO	C
RATTO, STONY	D
RAUB	C
RAUGHT	B
RAUVILLE	D
RAUZI	B
RAVALLI	D
RAVALLI, BEDROCK SUBSTRATUM	B
RAVEN	A
RAVENDALE	D
RAVENELL	D
RAVENNA	C
RAVENSWOOD	C
RAVIA	C
RAVOLA	B
RAWAH	C
RAWE	C
RAWLES	B
RAWLINS	B
RAWSON	B
RAWSONVILLE	C
RAYBURN	D
RAYEX	D
RAYFORD	C
RAYLAKE	D
RAYMONDVILLE	D
RAYNE	B
RAYNESFORD	B
RAYNHAM	C
RAYNOLDSON	B
RAYOHILL	C

NOTES: TWO HYDROLOGIC SOIL GROUPS SUCH AS B/C INDICATES THE DRAINED/UNDRAINED SITUATION.
MODIFIERS SHOWN, E.G., BEDROCK SUBSTRATUM, REFER TO A SPECIFIC SOIL SERIES PHASE FOUND IN SOIL MAP LEGEND.

Billings silty clay loam, 0 to 2 percent slopes (Bc). This soil, locally called adobe, is one of the most important and extensive in the Grand Valley. It covers nearly one-fifth of the Grand Junction Area. The areas occur on the broad flood plains and very gently sloping coalescing alluvial fans along streams. Many large areas are north of the Colorado River.

The soil is derived from deep alluvial deposits that came mainly from Mancos shale but in a few places from fine-grained sandstone materials. The deposits ordinarily range from 4 to 40 feet deep but in places exceed 40 feet. The deposits have been built up from thin sediments brought in by the streams that have formed the coalescing alluvial fans or have been dropped by the broad washes that have no drainage channel. The thickest deposit, near Grand Junction, was built up by Indian Wash.

The color and texture of the soil profile vary from place to place. The 8- to 10-inch surface soil normally consists of gray, light-gray, light olive-gray, or light brownish-gray silty clay loam. This layer grades into material of similar color and texture that extends to depths of 3 or 4 feet. Below this depth the successive depositional layers show more variation. Although the dominant texture is silty clay loam, the profile may have a loam, clay loam, fine sandy loam, or a very fine sandy loam texture.

Where there are fairly uniform beds of Mancos shale and where the soil is not influenced by materials deposited by adjoining drainage courses, the profile varies only slightly within the upper 3 or 4 feet. In areas bordering drainage courses, however, the soil varies more in texture and color from the surface downward.

One small area about 1½ miles southeast of Loma consists of light grayish-brown or pale-brown heavy silty clay loam that shows only slight variation in texture to depths of 4 to 6 feet. The underlying soil material is more variable. Below depths of 6 to 10 feet the layers generally are somewhat thicker and have a higher percentage of coarse soil material.

Also included with this soil are several small areas totaling about 3 square miles that are dominantly pale yellow. These are located 2½ to 3½ miles northeast of Fruita, 5 miles north of Fruita, 2½ miles northeast of Loma, 3 to 5 miles north of Loma, 1½ miles northwest of Loma, and 4 miles northwest of Mack. In these areas the 8- or 10-inch surface soil is pale-yellow silty clay loam, and the subsoil is a relatively uniform pale-yellow silty clay loam to depths of 4 to 8 feet. The accumulated alluvial layers are difficult to distinguish, but in a few places transitional to Fruita soils there are small areas having a pale-brown to light-yellowish brown color. These transitional areas are included with Billings silty clay loam because they have a finer textured subsoil than is characteristic of the Ravola soils.

Although moderately fine textured, this Billings soil permits successful growth of deep-rooted crops such as alfalfa and tree fruits. Its permeability is normally not so favorable as that of the Mesa, Fruita, and Ravola soils. Its tilth and workability are fair, but it puddles so quickly when wet and bakes so hard when dry that good tilth can be maintained only by proper irrigation and special cultural practices. Runoff is slow and internal drainage is very slow.

Like all other soils in the area, this one has a low organic-matter content. Under natural conditions it contains a moderate concentration of salts derived from the parent rock (Mancos shale). In places, however, it contains so much salt that good yields cannot be obtained. Some large areas are so strongly saline they cannot be used for crops. Generally, this soil is without visible lime, but it is calcareous. In many places small white flecks or indistinct light-colored streaks or seams indicate that lime, gypsum, or salts are present.

Use and management.—About 80 percent of this soil is cultivated. The chief irrigated crops are alfalfa, corn, dry beans, sugar beets, small grains, and tomatoes and other truck crops. Where the soil is located so as to avoid frost damage, tree fruits are grown.

Most of the field crops are grown in the central and western parts of the valley, or from Grand Junction westward. The entire acreage in tree fruits—approximately 3 square miles—lies between Grand Junction and Palisade. Because the climate is more favorable near Palisade, the acreage in orchard fruits is greater there. A few small orchards are located northeast of Grand Junction in the direction of Clifton. The main fruit acreage is between Clifton and Palisade. Peach orchards predominate, but a considerable acreage is in pears, especially near Clifton. Yields depend on the age of the trees and other factors, including management, but the estimated potential yield is somewhat less on this soil than on Mesa soils. This takes into account the slower internal drainage of this soil and its susceptibility to salinity if overirrigated. Yields of other crops vary according to the length of time the land has been irrigated, internal drainage or subdrainage, salt content of the soil, management practices, and local climate.

The uncultivated areas of this soil are mostly inaccessible places adjoining the larger washes, which occur mainly in the western part of the area, and those places that cannot be cropped profitably because they have inadequate drainage and a harmful concentration of salts. The uncultivated land supports a sparse growth of greasewood, saltbush, shadscale, rabbitbrush, ryegrass, peppergrass, and saltgrass. From 70 to 90 acres are required to pasture one animal during a season.

A number of places shown on the map by small marsh symbols are low and seepy. They could be ditched, but their acreage is likely too small to justify the expense. Left as they are, their salt content makes them worthless for any use except pasture.

Sizeable acreages of this soil apparently were overirrigated in the past. Irrigation water applied at higher levels to the north seeps upward in this soil where it occurs in low areas toward the river. Even now, new saline areas are appearing, and existing areas are getting larger. The total acreage affected by salts has remained more or less the same for the last two decades, but affected areas will continue to change in size and shape because of seepage.

Most fields are ditched where necessary. Some uncultivated areas require both leveling and ditching. In places subdrainage is inadequate because irregularities in the underlying shale tend to create pockets and prevent underground water from flowing into the drainage ditches. Also, in some areas where the alluvial mantle is 30 to 40 feet thick, the ditches are not always deep enough to drain the soil. Some areas are seepy because there are no ditches running in an east-west direction to intercept lateral flow of ground water from the overcomparatively sharp rises or undulations having slopes of more than 5 percent that extend 4 to 6 feet above the prevailing level or in small irregularly shaped bodies on relatively smooth topography. Wherever the areas of Chipeta soil occur, they are too small and too intricately associated with the Persayo soil to be mapped separately.

Use and management.—About 25 percent of this complex is cultivated, but practically all of it could be. The Chipeta soil is not difficult to level, but the expense of leveling and the isolated location of the areas have not favored development for irrigation and cropping. The kinds of crops grown, the management practiced, and the yields produced are approximately the same as for Persayo-Chipeta silty clay loams, 0 to 2 percent slopes.

Ravola clay loam, 0 to 2 percent slopes (RA).—This soil, the second most extensive in the area, has developed in material that consists largely of reworked Mancos shale but includes an appreciable amount of sandy alluvium from the higher Mesaverde formation. The surface of these deposits is relatively level, but the depth of the deposits ranges from 5 to 30 feet. The soil is associated with the Billings silty clay loams and the Ravola fine sandy loams. The most important areas are east, northeast, and southeast of Fruita, north and northwest of Palisade, and north and northwest of Clifton.

The soil is much like the Billings silty clay loams but more porous because it contains more fine sand, especially in the subsoil. Ordinarily, the 10- or 12-inch surface layer consists of light brownish-gray to very pale-brown light clay loam. The underlying layers vary from place to place in thickness and texture and become more sandy below depths of 4 to 5 feet. The range in the subsoil is from fine sandy loam to clay loam.

Small fragments of shale and sandstone are common from the surface downward and are especially noticeable in areas nearest the source of the soil material. The entire profile is calcareous and friable, so internal drainage is medium and development of plant roots is not restricted. The surface is smooth. Most areas are at slightly higher levels than the associated areas of Billings silty clay loams and therefore have better drainage and a lower content of salts. The soil, however, is slightly saline under native cover, and in places it has strongly saline spots and a high water table.

Use and management.—About 95 percent of this soil is cultivated. The chief crops are alfalfa, corn, pinto beans, small grains, and, where climate is favorable, orchard fruits. Practically all the acreage used for tree fruits is near Clifton and Palisade. The acreage used for field crops varies from year to year, but by rough estimate about 30 percent is cropped to corn, 25 percent to alfalfa, 15 percent to pinto beans, 13 percent to orchard fruits, 10 percent to small grains, and the rest to sugar beets, tame hay, tomatoes, and various vegetable crops.

In general, the tilth and workability of this soil are favorable. The content of organic matter is generally less than 1 percent, but many farmers are improving the supply by growing more alfalfa and by using other improved management.

Ravola clay loam, 2 to 5 percent slopes (RB).—This soil differs from Ravola clay loam, 0 to 2 percent slopes, mainly in having greater slopes. Although the combined areas total only seven-tenths of a square mile, this soil is important because the largest single area—approximately 300 acres—is located southeast of Palisade in the Vinelands and is used for peach growing. The remaining areas, widely scattered over the valley, total about 150 acres and are of minor importance.

The large area occupies a position intermediate between the Green River soils and the higher Mesa soils. Its underlying gravel and stone strata consist not only of sandstone but also of granite, schist, basalt, and lava. Much of the lava was deposited by drainage from the southeast. This large area was included with the soil unit largely because its color was similar to that of the other soil areas. Not many years ago subdrainage became inadequate for existing tree fruits and it was not until a number of tile drains were laid, as deep as 7 to 8 feet in places, that subdrainage was corrected in parts of this particular area.

Use and management.—All of the large soil area is in peaches. On it peach yields average as high as in any section of the valley, primarily because the danger of frost damage is negligible. Some of the orchards are now more than 50 years old but have produced steadily and still yield more than 400 bushels an acre according to reports from local growers. About half of the small scattered areas are cultivated. They are used largely for field crops because climatic conditions are not so favorable for peach growing. In building up the organic matter content, the growing of legumes, application of manure in large amounts, and use of commercial fertilizer generally are practiced.

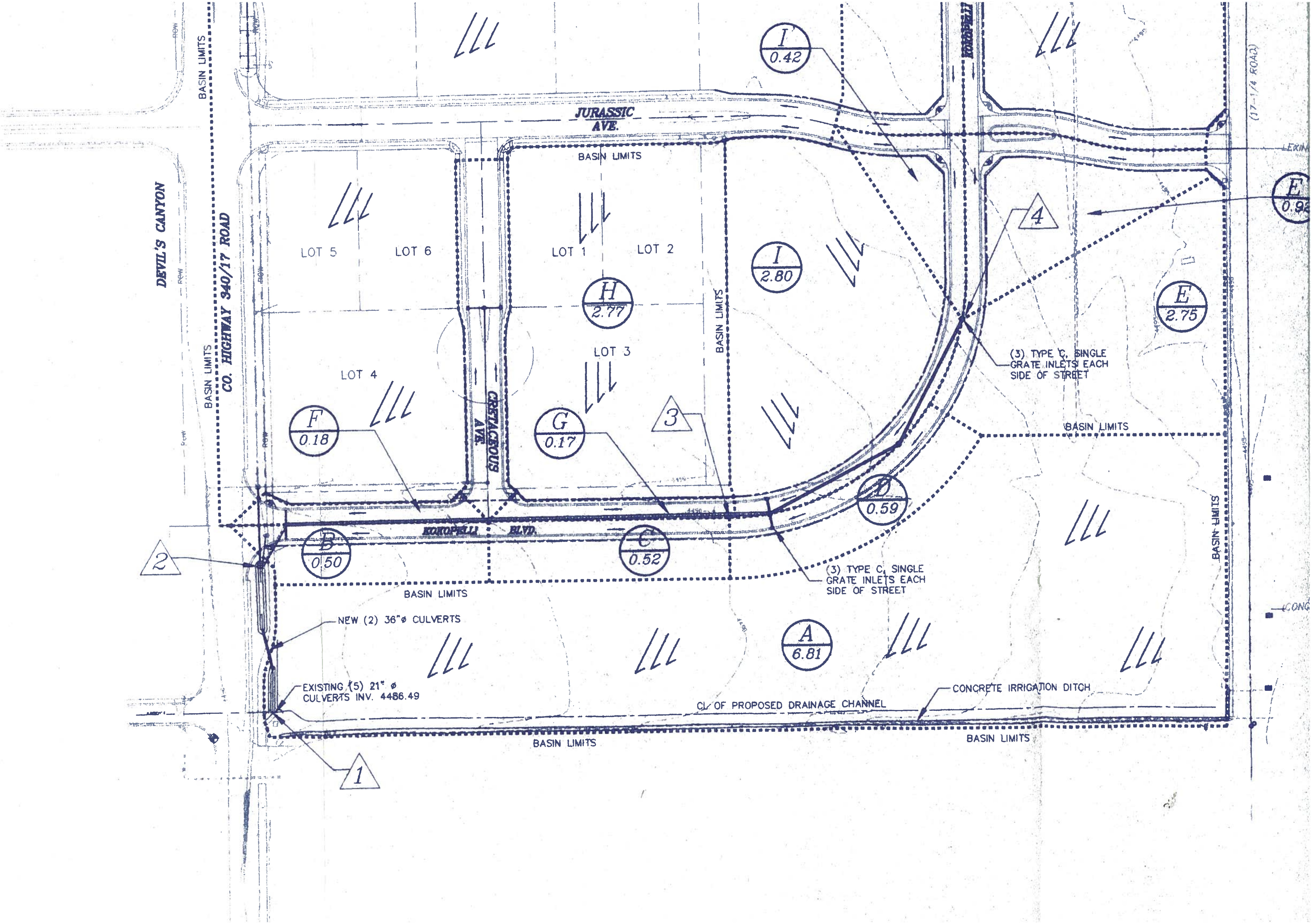
Ravola very fine sandy loam, 0 to 2 percent slopes (RF).—This extensive and important soil occurs either along washes or arroyos extending from the north or on broad coalescing alluvial fans. The alluvial material from which the soil has developed was derived from sandstone and shale and ranges from 4 to 20 feet deep. The principal areas of the soil are north and northwest of Grand Junction and north, northwest, and southwest of Fruita.

This soil is much like Ravola fine sandy loam, 0 to 2 percent slopes, but is generally more uniformly level. The texture is prevailingly very fine sandy loam, but the percentage of silt is noticeably higher in some places. A few small areas that have a loam texture are included.

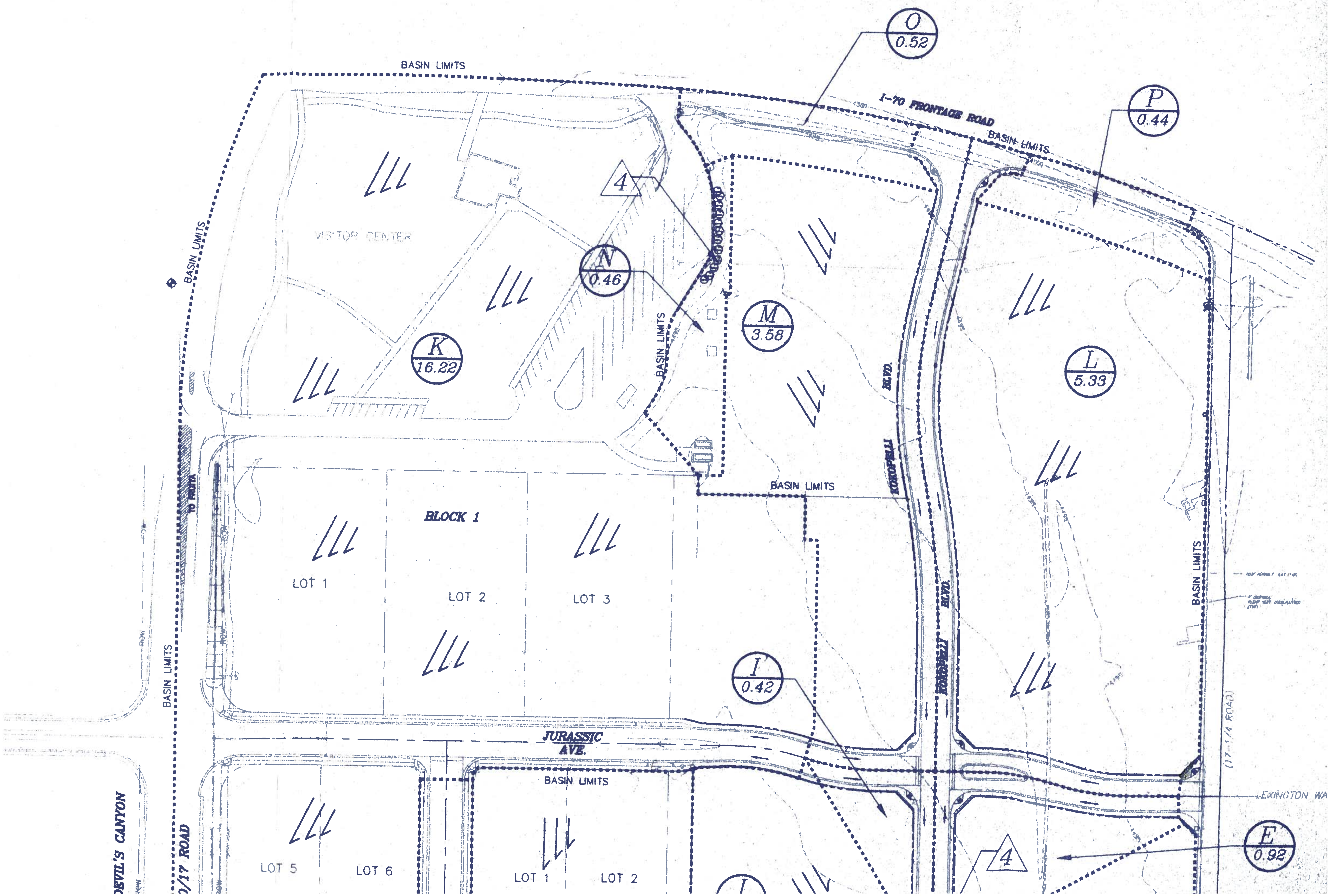
The 10- or 12-inch surface layer consists of light brownish-gray to very pale-brown very fine sandy loam. In some places the underlying thin depositional layers vary only slightly in color or texture. In other places, especially near drainage courses, the layers are more variable and may grade to loam, silt loam, or fine sandy loam. Nevertheless, layers of very fine sandy loam are more numerous. Below depths of 4 to 5 feet, the texture is sandier, and at depths of 8 to 12 feet strata of loamy fine sand, gravel, and scattered sandstone rock are common.

Disseminated lime occurs from the surface downward. Owing to the friable consistence of the successive layers, the tilth, internal drainage, available supply of moisture for plants, permeability to plant roots, and other physical properties are favorable and assure a wide suitability range for crops. The organic-matter content, however, is low. The soil is slightly saline under native cover and has a few strongly saline spots. Occasionally the water table is high.

Use and management.—More than 99 percent of this soil is cultivated. The chief crops are alfalfa, corn, pinto beans, small grains,



JURASSIC AVE.
KOKOPELLI BLVD.
CRETACEOUS AVE.
DEVIL'S CANYON
CO. HIGHWAY 340/17 ROAD
(17-1/4 ROAD)
BASIN LIMITS
LOT 1
LOT 2
LOT 3
LOT 4
LOT 5
LOT 6
A 6.81
B 0.50
C 0.52
D 0.59
E 2.75
F 0.18
G 0.17
H 2.77
I 2.80
I 0.42
1
2
3
4
(3) TYPE C, SINGLE GRATE INLETS EACH SIDE OF STREET
NEW (2) 36"ø CULVERTS
EXISTING (5) 21" ø CULVERTS INV. 4486.49
CL OF PROPOSED DRAINAGE CHANNEL
CONCRETE IRRIGATION DITCH
ROW


BASIN LIMITS
I-70 FRONTAGE ROAD
O 0.52
P 0.44
N 0.46
K 16.22
M 3.58
L 5.33
I 0.42
E 0.92
4
VISITOR CENTER
BLOCK 1
LOT 1
LOT 2
LOT 3
LOT 5
LOT 6
KOKOPELLI BLVD.
JURASSIC AVE.
(17-1/4 ROAD)
LEXINGTON WA
TO FRUITA
DEVIL'S CANYON
ROW