I hereby certify that this report was prepared by myself.

Brian C. Hart
Colorado P.E. #34735

Table of Contents

I. General Location and Description

A. Site and Major Basin Location

Dinosaur Hill Estates (DHE) Subdivision of located south of the I-70 Frontage Road and directly east of Stone Mountain Subdivision. Vacant land exists to the southeast and northwest, and I-70 is located to the northeast of the property. Exhibit 1 shows the general location of the proposed project and Exhibit 2 shows the general topography of the site.

According to the City of Fruita Stormwater Management Master Plan (SWMMP), the basin in which the project is located is commonly known as the Murray Drain Basin. Please see the appendix for a delineation of the Murray Drain Basin that is shown in the SWMMP, Exhibit 3. The main channel borders the site to the east.

B. Site and Major Basin Description

The site contains approximately 6.54 acres and includes one existing residence. The property is currently being irrigated and has an agricultural past. The site is covered with relatively thick grass and weeds, with trees along the north boundary. Murray Drain is a tailwater and drainage ditch that defines the east boundary of the site. Exhibit 5 shows the proposed site layout.

The soils located on the site are described as Ravola fine sandy loam, 0-2% slopes (R_C), Ravola clay loam, 0-2% slopes (R_A) and Billings silty clay loam, 0-2% slopes (B_C). The Ravola soils are hydro-group 'B' and the Billings soil is hydro-group 'C'. The site is approximately 80% hydro-group 'B' and 20% hydro-group 'C'. The off-site basin is entirely Ravola soils, hydro-group 'B'. Exhibit 4 shows the soils map for the area.

The Murray Drain Basin is one of the primary drainage basins for the east part of Fruita. The basin is in various stages of development, with areas further from the center of Fruita being the least developed.

II. Existing Drainage Conditions

A. Major Basin

The general topography of the Murray Drain basin can be described as moderately sloping. In general, the basin drains to the southwest, crossing I-70 and passing through undeveloped areas. The main channel defines the eastern boundary of the site.

B. Site

The subject property generally drains south and west at less than 1%. Stormwater inflow from offsite enters the property from the northwest sides only. The site drains to the Murray Drain east side of the property. The inflow characteristics are as follows; sheet flow from the vacant property located to the northwest of the site.

The low point of the property is located at the southwest corner of the site. From this location the property drains to the Murray Drain through vacant property south of the site.

III. Proposed Drainage Conditions

A. Changes in Drainage Patterns

There will be one change to the historical drainage pattern with the development of this project. The project will be designed to drain directly to the Murray Drain rather than through the vacant property located south of the site, as mentioned in Section II-B of this report.

B. Maintenance Issues

The City of Fruita will maintain any storm sewer that is located within the public right-of-way or publicly owned property.

IV. Design Criteria & Approach

A. General Considerations

There has been one drainage study completed for a project near the subject property. The Stone Mountain Estates Subdivision is located directly to the west of the subject property. According to the study, the site drains to the west towards the Arcuby Drain,

which is located within the 17-½ Road right-of-way. Therefore, Stone Mountain Estates does not affect the proposed project.

Because this project is located near the southern extent of the Murray Drain and because of upstream capacity problems, the City of Fruita Engineer has required this project to directly discharge stormwater from the proposed project to the Murray Drain. This will allow stormwater from the project to completely discharge to the Colorado River before upstream flows cross I-70.

Constraints that would affect the drainage design would be the on-site and off-site flows, existing topography and the Murray Drain.

B. Hydrology

The Stormwater Management Manual (SWMM) for Mesa County has been used for the preparation of this Final Drainage Report. The design storms are defined in the SWMM as the 2-year and 100-year events. Grand Valley area precipitation information will be used which is outlined within the SWMM.

The rational method was used for the hydrological analysis. Rational 'C' values were determined from Table B-1 from the SWMM manual. Exhibit 6 shows the Rational 'C' values for each drainage basin.

There is one on-site historic drainage basin and one off-site drainage basin that contribute stormwater runoff to the site. Basin H is the historic drainage basin and basin OS is the off-site basin. Basin OS is located north of the subject property. Exhibits 7-10 show the calculations for basins H and OS. See Exhibit 2 for the location of basin OS.

There are four on-site developed basins, A-D. Each basin collects stormwater from the site towards storm sewer inlets. The storm sewer then conveys runoff to the Murray Drain. Exhibits 11-18 show the calculations for basins A-D.

C. Hydraulics

All hydraulic calculations for conveyance elements have been designed according the SWMM. The calculation and design of the hydraulic elements are based on the final construction plans.

The 2-year street capacities will not be exceed based on the anticipated street grades for the project and Figure G-5 from the

SWMM. The maximum half-street flow generated from any one developed basin will be 2.36 cfs for the 100-year event, is much less than the 2-year inundation limit of approximately 7 cfs for the minimum street grade. See Exhibit 19.

Single combination inlets will be planned to collect the on-site drainage. See Exhibit 20.

A new 18-inch storm sewer line will be installed in Kaley Street and Kyle Court to collect stormwater runoff from the project. Exhibits 21-23 show the schematic for the storm sewer line and the profile of the line with the hydraulic grade shown.

A storm drain line and swale combination will be installed along the north boundary of the site to drain the rear yards of Lots 1-8 of Block 1. Exhibits 24 and 25 show the calculations for the swale and drain.

V. Results and Conclusions

A. Results and Conclusions

Historic runoff rates for the 2 and 100 year storms:

Basin	*2-year*	*100-year*
H	*0.70 cfs*	*3.46 cfs*
OS	*0.36 cfs*	*1.88 cfs*
Total Historic Flow:	*1.06 cfs*	*5.34 cfs*

Developed runoff rates for the 2 and 100 year storms:

Basin	*2-year*	*100-year*
A	*0.65 cfs*	*3.29 cfs*
B	*0.26 cfs*	*1.30 cfs*
C	*0.17 cfs*	*0.88 cfs*
D	*0.54 cfs*	*2.74 cfs*
Total Developed Flow:	*1.62 cfs*	*8.21 cfs*

Detention Pond Volume:
No detention: *Direct discharge to Murray Drain required by City of Fruita*

B. Overall Compliance

This drainage study followed the Mesa County Stormwater Management Manual for drainage design, policy and criteria.

C. Report Limits

This report was prepared to analyze the developed conditions of the proposed site, the existing conditions of the limited off-site property and the design of the hydraulic elements on the site. Any changes or revisions to the project would necessitate a revised drainage study and design.

VI. References

1. Stormwater Management Manual, (SWMM), Mesa County, May 1996.

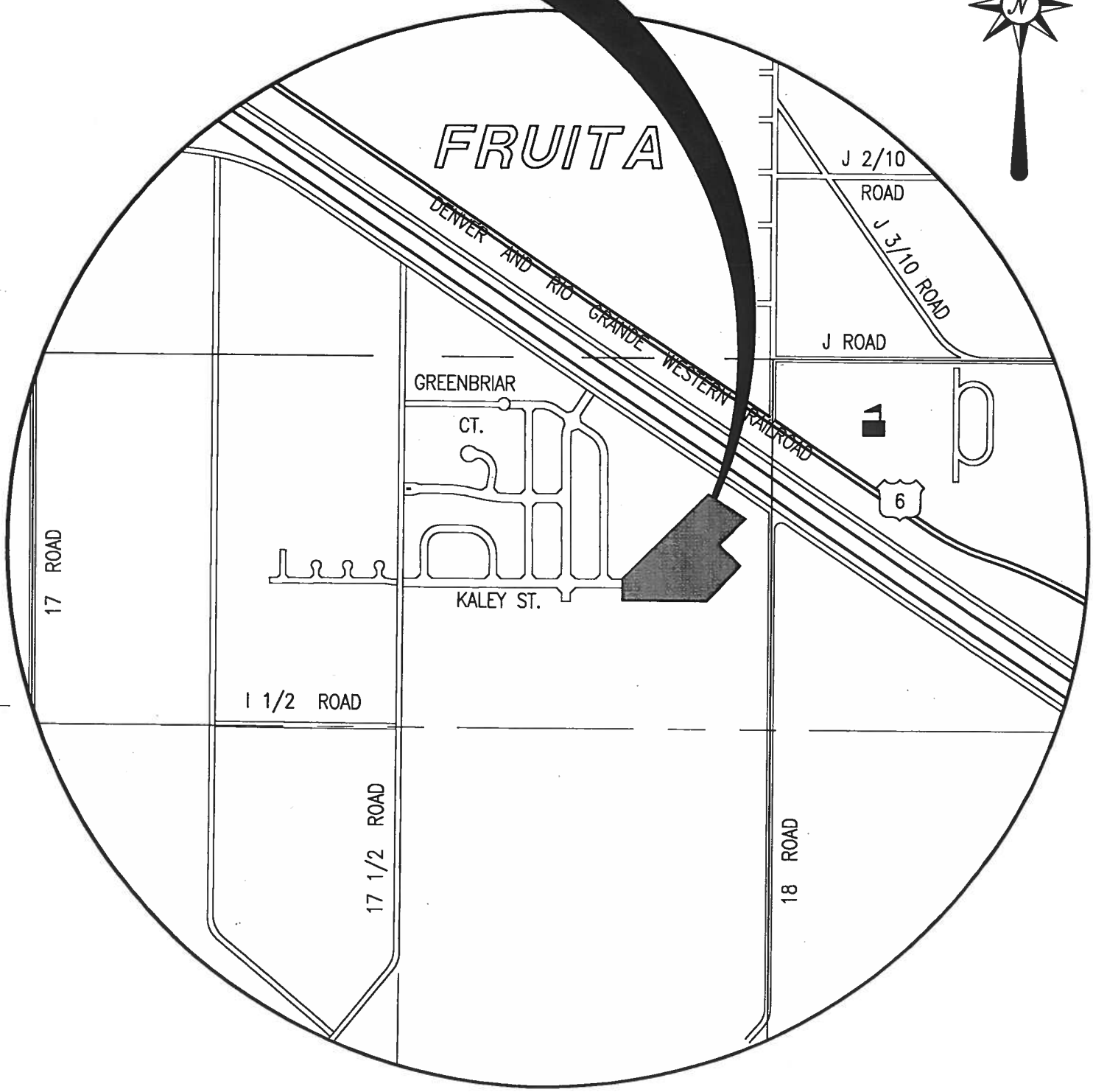
2. Flood Insurance Rate Map, Mesa County, Colorado, Prepared for the City of Grand Junction, Colorado and Mesa County by the Federal Emergency Management Agency, revised 1992.

3. Soil Survey, Grand Junction Area, Colorado, Series 1940, No. 19, U.S. Department of Agriculture, issues November 1955.

4. Flowmaster Version 6.0, Haestad Methods Inc., 1998.

5. StormCAD Version 1.0, Haestad Methods Inc., 1995.

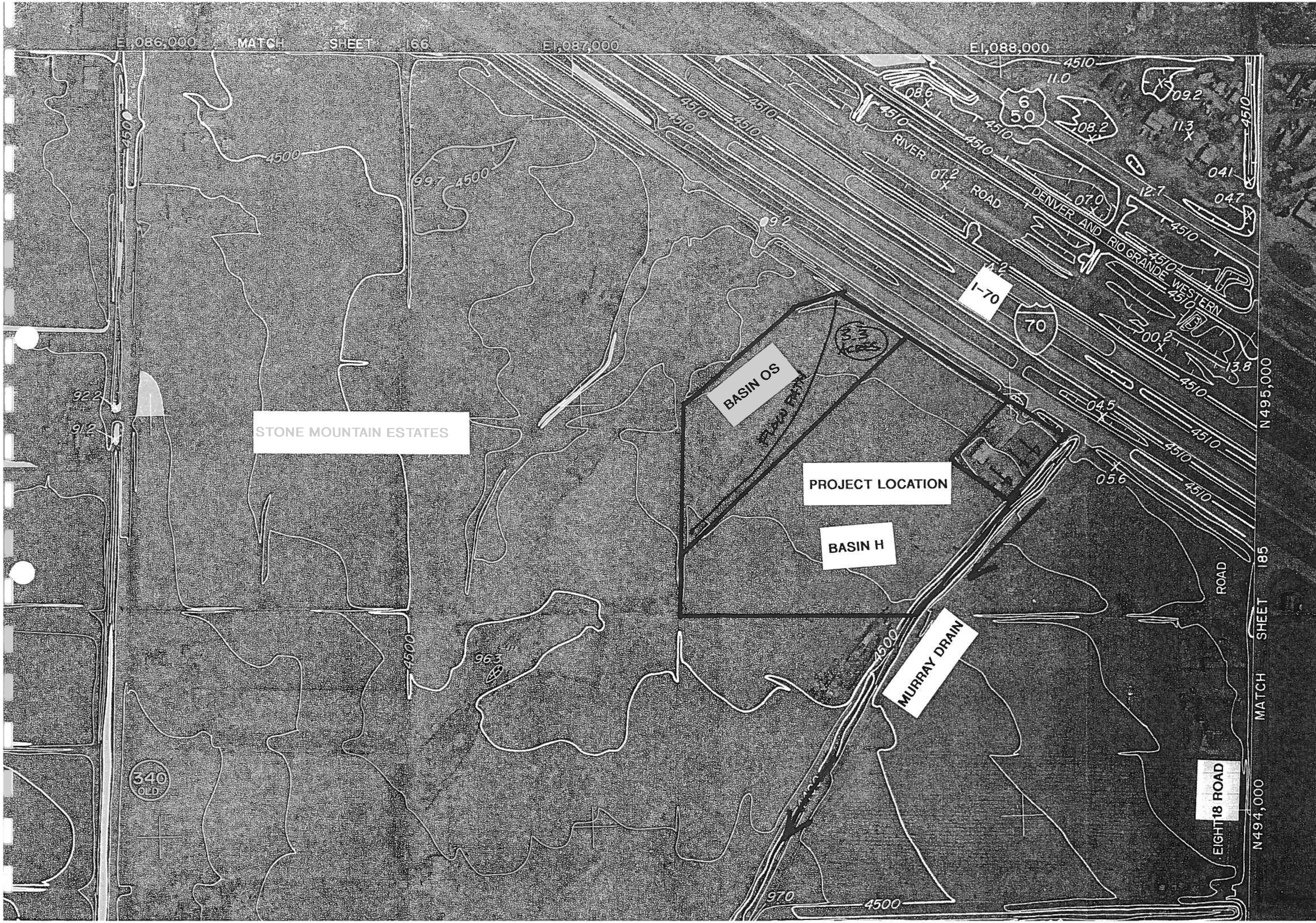
PROJECT LOCATION



VICINITY MAP

NTS

EXHIBIT 1



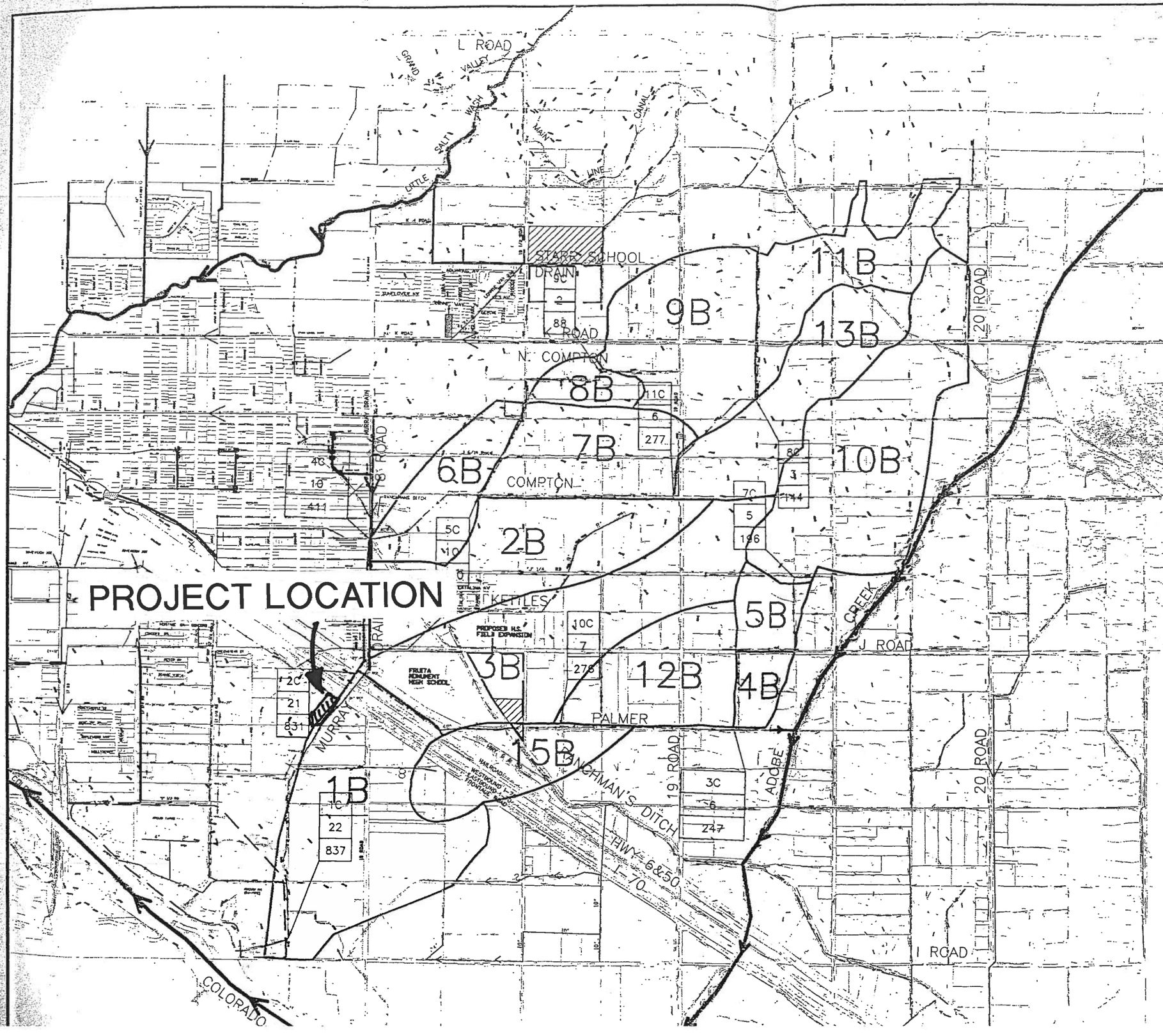
E1,086,000
MATCH SHEET 166
E1,087,000
E1,088,000
STONE MOUNTAIN ESTATES
BASIN OS
PROJECT LOCATION
BASIN H
MURRAY DRAIN
I-70
RIVER ROAD
DENVER AND RIO GRANDE WESTERN
4510
4500
N495,000
N494,000
MATCH SHEET 185
ROAD
EIGHT 18 ROAD
340 OLD

EXHIBIT 2

EXHIBIT "10A"

GJDD MURRAY DRAIN

2 & 100 Year Storm Condition



LEGEND

FACILITY	EXISTING	PROPOSED	REMOVE & REPLACE
CONTOURS	(BOR 1975)		
GJDD DRAIN CHANNEL			
GJDD DRAIN PIPE			
IRRIGATION CANAL/ DITCH			
IRRIGATION PIPE			
STORM DETENTION FACILITY			
STORM DRAIN CHANNEL			
STORM DRAIN PIPE			
STORM PEAK RUNOFF VALUES AT CONCENTRATION POINT	POINT ID / 2 YR. / 100 YR.		
STREAM, CREEK, RIVER, OR WASH			
WATERSHED SUBBASIN BOUNDARY			
WATERSHED SUBBASIN IDENTIFIER	1A	1A	

HYDROLOGICAL DATA

I.D.	AREA (AC)	EX Q2 (CFS)	PO Q2 (CFS)	EX Q100 (CFS)	PO Q100 (CFS)
1B	218	5		211	
2B	160	3		131	
3B	262	4		174	
4B	26	1		27	
5B	38	1		42	
6B	64	2		70	
7B	115	3		118	
8B	32	1		36	
9B	102	2		88	
10B	243	5		196	
11B	128	3		144	
12B	102	2		110	
13B	134	3		125	
14B	6	0		8	
15B	70	2		71	
	1700				

GENERAL RECOMMENDATIONS

1. THE GJDD DRAIN CULVERTS AND OUTFALL ACROSS THE HIGHWAYS AND RAILROAD ARE NOT ADEQUATE TO CONVEY RUNOFF FROM DESIGN STORM EVENTS. DEVELOPMENT IN THE MURRAY DRAIN SYSTEM AREA CANNOT INCREASE RUNOFF DUE TO DEVELOPMENT.
2. DRAINAGE IMPACT FEES SHOULD BE USED TO FUND CONSTRUCTION OF A REGIONAL PARK/DETENTION FACILITY ON THE MURRAY DRAIN SYSTEM JUST NORTH OF THE HIGHWAY. A FACILITY IN CONJUNCTIO WITH THE HIGH SCHOOL OR SEPARATELY WOULD BE ACCEPTABLE.
3. ADOBE CREEK IS A LONG NARROW WATERSHED, AND THE LOCALIZED RUNOFF COULD BE PASSED THROUGH IN ADVANCE OF THE FULL BASIN CONTRIBUTING. THEREFORE IT WOULD BE ADVISABLE TO DIRECT AS MUCH FLOW FROM THE MURRAY DRAIN AS POSSIBLE TO ADOBE CREEK.
4. MORE SPECIFIC RECOMMENDATIONS CANNOT BE GIVEN WITHOUT A MORE DETAILED ANALYSIS FOR THIS AREA.

EXHIBIT 3

WILLIAMS ENGINEERING
1231 19 ROAD, FRUITA, COLORADO 81521-9689
(970) 858-1014 PHONE (970) 858-1007 FAX

GRAPHIC SCALE (METRIC) 0 100 200	JOB: FR-SWMMP	DATE: 05/27/9
	FILE: MURRAYHY	

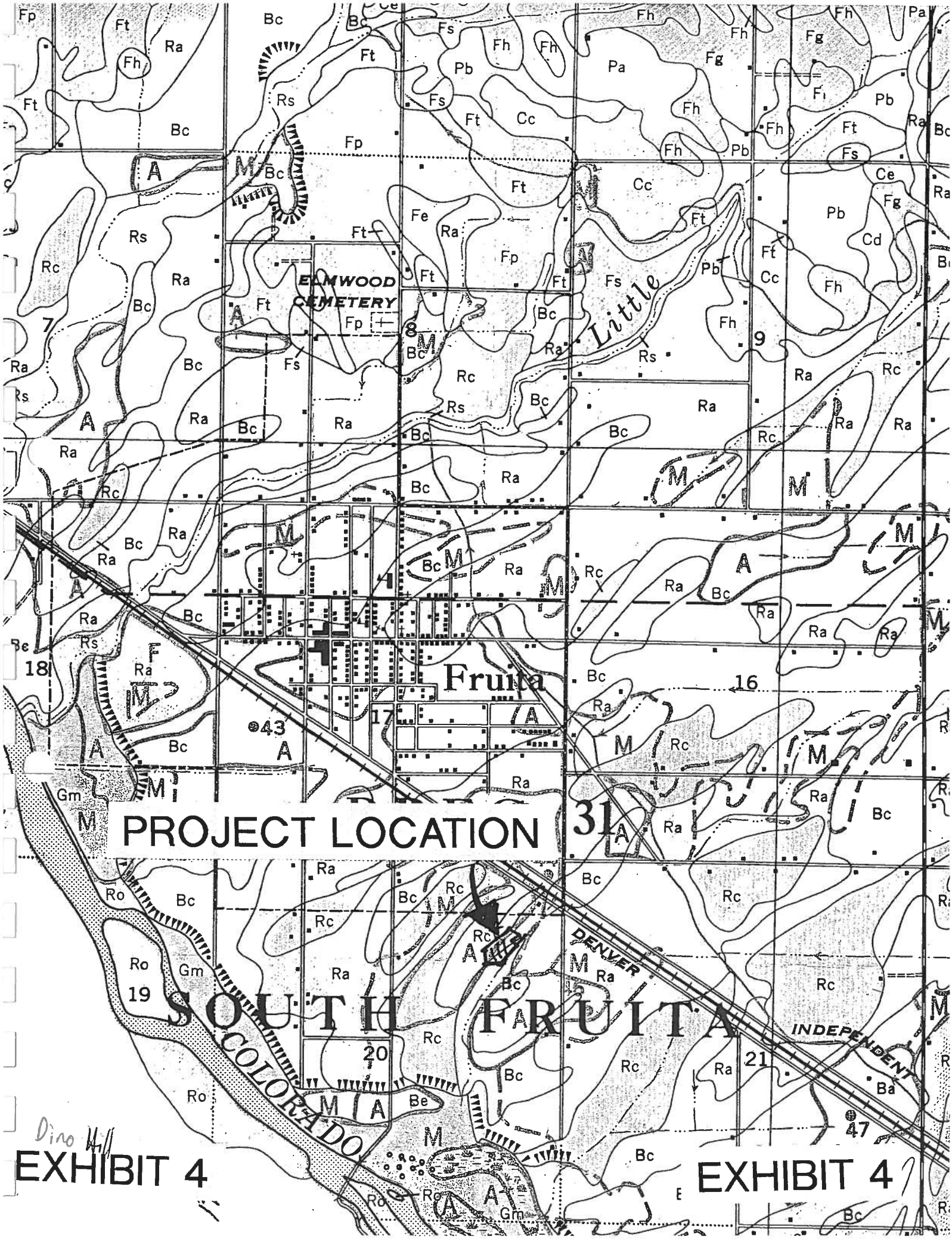

PROJECT LOCATION
Fruita
SOUTH FRUITA
ELMWOOD CEMETERY
Little
COLORADO
DENVER
INDEPENDENT
EXHIBIT 4
EXHIBIT 4

EXHIBIT 5

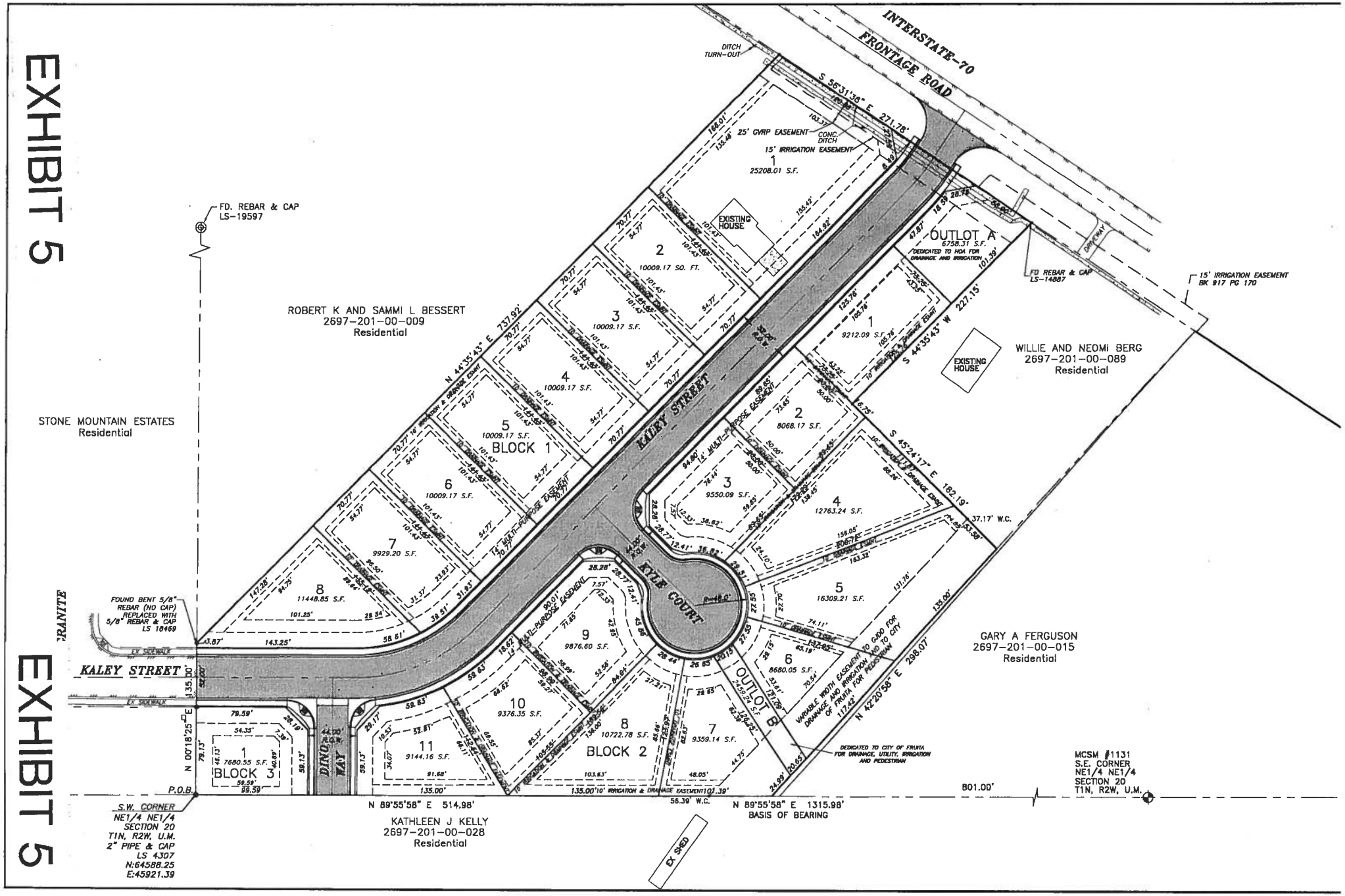


EXHIBIT 5

COMPOSITE RUNOFF COEFFICIENTS WORKSHEET

JOB NAME: **Dinosaur Hill Estates Subdivision**
JOB NUMBER: 203062.40
DATE: 10/22/2003

SUBBASIN I.D.	LAND USE /SURFACE DESCRIPTION	STORM FREQUENCY	SCS HYDROLOGIC SOIL GROUP AND NAME (eg - B:RAVOLA)								COMPOSITE C VALUE
			A:		B:		C:		D:		
			% OF SUBBASIN	"C" VALUE	% OF SUBBASIN	"C" VALUE	% OF SUBBASIN	"C" VALUE	% OF SUBBASIN	"C" VALUE	
Historic Conditions (Basin H1)											
2-Year	Pasture	2			80.00	0.22	20.00	0.28			**0.23**
100-Year	Pasture	100			80.00	0.27	20.00	0.34			**0.28**
Historic Conditions (Basin OS)											
2-Year	Bare Ground	2					100.00	0.20			**0.20**
100-Year	Bare Ground	100					100.00	0.26			**0.26**
Developed Conditions (Basin D1, D2 and D3)											
2-Year	3 units/acre	2			80.00	0.29	20.00	0.32			**0.31**
100-Year	3 units/acre	100			80.00	0.37	20.00	0.40			**0.39**

EXHIBIT 6

TIME OF CONCENTRATION CALCULATION WORKSHEET

JOB NAME: **Dinosaur Hill Estates Subdivision**
JOB NUMBER: 203062.40
DATE: 8/1/2003

BASIN DESIGNATION: H - Historic on-site

Flowing to: South Boundary

OVERLAND FLOW:	2-Year	100-Year
Surface Description:	Pasture	Pasture
Rational Coefficient: c<2>:	0.23	0.28
Flow Length, L (total < 300 ft.)	200 ft.	200 ft.
Land Slope, S	0.0075 ft/ft	0.0075 ft/ft
To<2> (Figure E-2):	**24.38** min.	
To<100> (Figure E-2):		**22.97** min.

SHALLOW CONCENTRATED FLOW		
Surface Description:	Pasture	Pasture
Flow Length, L	300 ft.	300 ft.
Flow Slope, S	0.005 ft/ft	0.005 ft/ft
Flow Velocity: (Figure E-3)	0.5 ft/sec	0.5 ft/sec
Travel Time = L/(60V)	**10.00** min.	**10.00** min.

CHANNEL FLOW	
Cross-Sectional Flow Area, a	1.00 ft^2
Wetted Perimeter, Pw	3.00 ft.
Hydraulic Radius, r = a/Pw	0.33 ft.
Channel Slope, S	0.005 ft./ft.
Manning's Coefficient, n	0.035
Velocity, V=1.49r^.67s^.5/n	1.45 ft./sec.
Flow Length, L	320.00 ft.
Travel Time = L/(60V)	**3.69** min.

TIME OF CONCENTRATION

Tc<2>	**38.06** min.
Tc<100>	**36.66** min.

EXHIBIT 7

EXHIBIT 7

RUNOFF CALCULATION WORKSHEET
RATIONAL METHOD

JOB NAME: **Dinosaur Hill Estates Subdivision**
JOB NUMBER: 203062.40
DATE: 8/1/2003

BASIN DESIGNATION: H - Historic on-Site
FLOWING TO: South Boundary

1. Basin Area — 6.54 acres

2. Time of Concentration
   - 2-Year — 38.06 min.
   - 100-Year — 36.66 min.

3. Storm Intensity (for use in the Grand Valley) per Table "A-1a"
   - 2-year $\frac{26.71}{Tc + 19.01}$ — 0.47 in/hr
   - 100-Year $\frac{104.94}{Tc + 18.8}$ — 1.89 in/hr

4. Composite Runoff Coefficients
   - 2-Year — 0.23
   - 100-Year — 0.28

5. Q = CIA

Q(2)=	0.23 x	0.47	x	6.540	=	**0.70 cfs**
Q(100)=	0.28 x	1.89	x	6.540	=	**3.46 cfs**

EXHIBIT 8

EXHIBIT 8

TIME OF CONCENTRATION CALCULATION WORKSHEET

JOB NAME: **Dinosaur Hill Estates Subdivision**
JOB NUMBER: 203062.40
DATE: 8/1/2003

BASIN DESIGNATION: OS - Historic off-site

Flowing to: South Boundary

OVERLAND FLOW:		2-Year	100-Year
Surface Description:		Bare Ground	Bare Ground
Rational Coefficient:	c<2>:	0.20	0.26
Flow Length, L (total < 300 ft.)		200 ft.	200 ft.
Land Slope, S		0.01 ft/ft	0.01 ft/ft
To<2> (Figure E-2):		**22.91** min.	
To<100> (Figure E-2):			**21.38** min.

SHALLOW CONCENTRATED FLOW		
Surface Description:	Bare Ground	Bare Ground
Flow Length, L	200 ft.	200 ft.
Flow Slope, S	0.005 ft/ft	0.005 ft/ft
Flow Velocity: (Figure E-3)	0.65 ft/sec	0.65 ft/sec
Travel Time = L/(60V)	**5.13** min.	**5.13** min.

CHANNEL FLOW	
Cross-Sectional Flow Area, a	1.00 ft^2
Wetted Perimeter, Pw	3.00 ft.
Hydraulic Radius, r = a/Pw	0.33 ft.
Channel Slope, S	0.005 ft./ft.
Manning's Coefficient, n	0.030
Velocity, V=1.49r^.67s^.5/n	1.69 ft./sec.
Flow Length, L	250.00 ft.
Travel Time = L/(60V)	**2.47** min.

TIME OF CONCENTRATION

Tc<2>	**30.51** min.
Tc<100>	**28.98** min.

EXHIBIT 9

RUNOFF CALCULATION WORKSHEET
RATIONAL METHOD

JOB NAME: **Dinosaur Hill Estates Subdivision**
JOB NUMBER: 203062.40
DATE: 8/1/2003

BASIN DESIGNATION: OS - Historic off-site
FLOWING TO: South Boundary

1. Basin Area — 3.30 acres

2. Time of Concentration

2-Year	30.51	min.
100-Year	28.98	min.

3. Storm Intensity (for use in the Grand Valley) per Table "A-1a"

2-year $\frac{26.71}{Tc + 19.01}$ — 0.54 in/hr

100-Year $\frac{104.94}{Tc + 18.8}$ — 2.20 in/hr

4. Composite Runoff Coefficients

2-Year	0.20
100-Year	0.26

5. Q = CIA

Q(2)=	0.20 x	0.54	x	3.300	=	**0.36 cfs**
Q(100)=	0.26 x	2.20	x	3.300	=	**1.88 cfs**

EXHIBIT 10

TIME OF CONCENTRATION CALCULATION WORKSHEET

JOB NAME: **Dinosaur Hill Estates Subdivision**
JOB NUMBER: 203062.40
DATE: 8/1/2003

BASIN DESIGNATION: A - Developed Conditions

Flowing to: Murray Drain

OVERLAND FLOW:	2-Year	100-Year
Surface Description:	Lawn	Lawn
Rational Coefficient:	0.23	0.28
Flow Length, L (total < 300 ft.)	80 ft.	80 ft.
Land Slope, S	0.01 ft/ft	0.01 ft/ft
To<2> (Figure E-2):	**14.01** min.	
To<100> (Figure E-2):		**13.20** min.

SHALLOW CONCENTRATED FLOW		
Surface Description:	n/a	n/a
Flow Length, L	0 ft.	0 ft.
Flow Slope, S	0 ft/ft	0 ft/ft
Flow Velocity: (Figure E-3)	0.000 ft/sec	0.000 ft/sec
Travel Time = L/(60V)	**0.00** min.	**0.00** min.

CHANNEL FLOW	
Cross-Sectional Flow Area, a	4.00 ft^2
Wetted Perimeter, Pw	16.00 ft.
Hydraulic Radius, r = a/Pw	0.25 ft.
Channel Slope, S	0.011 ft./ft.
Manning's Coefficient, n	0.016
Velocity, V=1.49r^.67s^.5/n	3.87 ft./sec.
Flow Length, L	430.00 ft.
Travel Time = L/(60V)	**1.85** min.

TIME OF CONCENTRATION

Tc<2>	**15.86** min.
Tc<100>	**15.05** min.

EXHIBIT 11

RUNOFF CALCULATION WORKSHEET
RATIONAL METHOD

JOB NAME: **Dinosaur Hill Estates Subdivision**
JOB NUMBER: 203062.40
DATE: 8/1/2003

BASIN DESIGNATION: A - Developed Conditions
FLOWING TO: Murray Drain

1. Basin Area — 2.720 acres

2. Time of Concentration
   - 2-Year — 15.86 min.
   - 100-Year — 15.05 min.

3. Storm Intensity (for use in the Grand Valley) per Table "A-1a"
   - 2-year $\frac{26.71}{Tc + 19.01}$ — 0.77 in/hr
   - 100-Year $\frac{104.94}{Tc + 18.8}$ — 3.10 in/hr

4. Composite Runoff Coefficients
   - 2-Year — 0.31
   - 100-Year — 0.39

5. Q = CIA

Q(2)=	0.31 x	0.77	x	2.720	=	**0.65 cfs**
Q(100)=	0.39 x	3.10	x	2.720	=	**3.29 cfs**

EXHIBIT 12

TIME OF CONCENTRATION CALCULATION WORKSHEET

JOB NAME: **Dinosaur Hill Estates Subdivision**
JOB NUMBER: 203062.40
DATE: 8/1/2003

BASIN DESIGNATION: B - Developed Conditions

Flowing to: Murray Drain

OVERLAND FLOW:	2-Year	100-Year
Surface Description:	Lawn	Lawn
Rational Coefficient:	0.23	0.28
Flow Length, L (total < 300 ft.)	80 ft.	80 ft.
Land Slope, S	0.01 ft/ft	0.01 ft/ft
To<2> (Figure E-2):	**14.01** min.	
To<100> (Figure E-2):		**13.20** min.

SHALLOW CONCENTRATED FLOW		
Surface Description:	n/a	n/a
Flow Length, L	0 ft.	0 ft.
Flow Slope, S	0 ft/ft	0 ft/ft
Flow Velocity: (Figure E-3)	0.000 ft/sec	0.000 ft/sec
Travel Time = L/(60V)	**0.00** min.	**0.00** min.

CHANNEL FLOW	
Cross-Sectional Flow Area, a	4.00 ft^2
Wetted Perimeter, Pw	16.00 ft.
Hydraulic Radius, r = a/Pw	0.25 ft.
Channel Slope, S	0.006 ft./ft.
Manning's Coefficient, n	0.016
Velocity, V=1.49r^.67s^.5/n	2.86 ft./sec.
Flow Length, L	215.00 ft.
Travel Time = L/(60V)	**1.25** min.

TIME OF CONCENTRATION

Tc<2>	**15.26** min.
Tc<100>	**14.45** min.

EXHIBIT 13

RUNOFF CALCULATION WORKSHEET
RATIONAL METHOD

JOB NAME: **Dinosaur Hill Estates Subdivision**
JOB NUMBER: 203062.40
DATE: 8/1/2003

BASIN DESIGNATION: B - Developed Conditions
FLOWING TO: Murray Drain

1. Basin Area — 1.060 acres

2. Time of Concentration
   - 2-Year — 15.26 min.
   - 100-Year — 14.45 min.

3. Storm Intensity (for use in the Grand Valley) per Table "A-1a"
   - 2-year $\frac{26.71}{Tc + 19.01}$ — 0.78 in/hr
   - 100-Year $\frac{104.94}{Tc + 18.8}$ — 3.16 in/hr

4. Composite Runoff Coefficients
   - 2-Year — 0.31
   - 100-Year — 0.39

5. Q = CIA

Q(2)=	0.31 x	0.78	x	1.060	=	**0.26 cfs**
Q(100)=	0.39 x	3.16	x	1.060	=	**1.30 cfs**

EXHIBIT 14

TIME OF CONCENTRATION CALCULATION WORKSHEET

JOB NAME: **Dinosaur Hill Estates Subdivision**
JOB NUMBER: 203062.40
DATE: 8/1/2003

BASIN DESIGNATION: C - Developed Conditions

Flowing to: Murray Drain

OVERLAND FLOW:	2-Year	100-Year
Surface Description:	Lawn	Lawn
Rational Coefficient:	0.23	0.28
Flow Length, L (total < 300 ft.)	90 ft.	90 ft.
Land Slope, S	0.01 ft/ft	0.01 ft/ft
To<2> (Figure E-2):	**14.86** min.	
To<100> (Figure E-2):		**14.00** min.

SHALLOW CONCENTRATED FLOW		
Surface Description:	n/a	n/a
Flow Length, L	0 ft.	0 ft.
Flow Slope, S	0 ft/ft	0 ft/ft
Flow Velocity: (Figure E-3)	0.000 ft/sec	0.000 ft/sec
Travel Time = L/(60V)	**0.00** min.	**0.00** min.

CHANNEL FLOW	
Cross-Sectional Flow Area, a	4.00 ft^2
Wetted Perimeter, Pw	16.00 ft.
Hydraulic Radius, r = a/Pw	0.25 ft.
Channel Slope, S	0.005 ft./ft.
Manning's Coefficient, n	0.016
Velocity, V=1.49r^.67s^.5/n	2.61 ft./sec.
Flow Length, L	55.00 ft.
Travel Time = L/(60V)	**0.35** min.

TIME OF CONCENTRATION

Tc<2>	**15.21** min.
Tc<100>	**14.35** min.

EXHIBIT 15

RUNOFF CALCULATION WORKSHEET
RATIONAL METHOD

JOB NAME: **Dinosaur Hill Estates Subdivision**
JOB NUMBER: 203062.40
DATE: 8/1/2003

BASIN DESIGNATION: C - Developed Conditions
FLOWING TO: Murray Drain

1. Basin Area — 0.710 acres

2. Time of Concentration
   - 2-Year — 15.21 min.
   - 100-Year — 14.35 min.

3. Storm Intensity (for use in the Grand Valley) per Table "A-1a"
   - 2-year $\frac{26.71}{Tc + 19.01}$ — 0.78 in/hr
   - 100-Year $\frac{104.94}{Tc + 18.8}$ — 3.17 in/hr

4. Composite Runoff Coefficients
   - 2-Year — 0.31
   - 100-Year — 0.39

5. Q = CIA

Q(2)=	0.31 x	0.78	x	0.710	=	**0.17 cfs**
Q(100)=	0.39 x	3.17	x	0.710	=	**0.88 cfs**

EXHIBIT 16

TIME OF CONCENTRATION CALCULATION WORKSHEET

JOB NAME: **Dinosaur Hill Estates Subdivision**
JOB NUMBER: 203062.40
DATE: 8/1/2003

BASIN DESIGNATION: D - Developed Conditions

Flowing to: Murray Drain

OVERLAND FLOW:	2-Year	100-Year
Surface Description:	Lawn	Lawn
Rational Coefficient:	0.23	0.28
Flow Length, L (total < 300 ft.)	55 ft.	55 ft.
Land Slope, S	0.01 ft/ft	0.01 ft/ft
To<2> (Figure E-2):	**11.61** min.	
To<100> (Figure E-2):		**10.95** min.

SHALLOW CONCENTRATED FLOW		
Surface Description:	n/a	n/a
Flow Length, L	0 ft.	0 ft.
Flow Slope, S	0 ft/ft	0 ft/ft
Flow Velocity: (Figure E-3)	0.000 ft/sec	0.000 ft/sec
Travel Time = L/(60V)	**0.00** min.	**0.00** min.

CHANNEL FLOW	
Cross-Sectional Flow Area, a	4.00 ft^2
Wetted Perimeter, Pw	16.00 ft.
Hydraulic Radius, r = a/Pw	0.25 ft.
Channel Slope, S	0.090 ft./ft.
Manning's Coefficient, n	0.016
Velocity, V=1.49r^.67s^.5/n	11.08 ft./sec.
Flow Length, L	570.00 ft.
Travel Time = L/(60V)	**0.86** min.

TIME OF CONCENTRATION

Tc<2>	**12.47** min.
Tc<100>	**11.80** min.

EXHIBIT 17

RUNOFF CALCULATION WORKSHEET
RATIONAL METHOD

JOB NAME: **Dinosaur Hill Estates Subdivision**
JOB NUMBER: 203062.40
DATE: 8/1/2003

BASIN DESIGNATION: D - Developed Conditions
FLOWING TO: Murray Drain

1. Basin Area — 2.050 acres

2. Time of Concentration
   - 2-Year — 12.47 min.
   - 100-Year — 11.80 min.

3. Storm Intensity (for use in the Grand Valley) per Table "A-1a"
   - 2-year $\frac{26.71}{Tc + 19.01}$ — 0.85 in/hr
   - 100-Year $\frac{104.94}{Tc + 18.8}$ — 3.43 in/hr

4. Composite Runoff Coefficients
   - 2-Year — 0.31
   - 100-Year — 0.39

5. Q = CIA

Q(2)=	0.31	x	0.85	x	2.050	=	**0.54 cfs**
Q(100)=	0.39	x	3.43	x	2.050	=	**2.74 cfs**

EXHIBIT 18

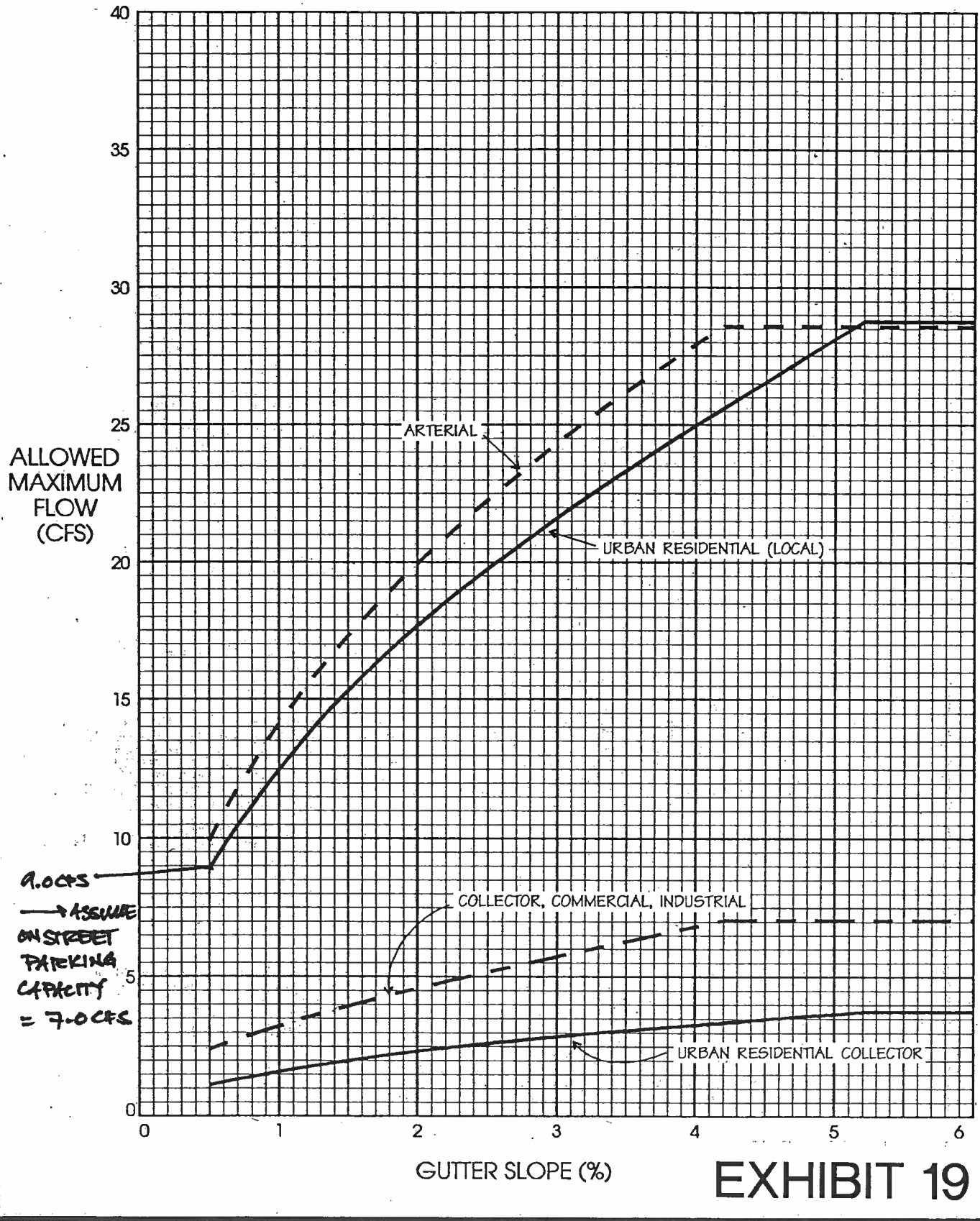


EXHIBIT 19

MAXIMUM HALF STREET FLOWS (Sx=2%, n=0.016)
(Based upon Figures G-3 and G-4)

FIGURE "G-5"

ROAD TYPE	COMBINATION INLET CAPACITY (CFS)					
	SINGLE		DOUBLE		TRIPLE	
	2-YR	100-YR	2-YR	100-YR	2-YR	100-YR
Urban Residential (local)	6.4	13	9.5	22	12.7	31
Residential Collector, Commercial and Industrial Streets	3.2	13	4.9	22	6.5	31
Collector Streets (3000 - 8000 ADT)	2.7	13	4.0	22	5.3	31
Principal and Minor Arterials	6.0	13	9.0	22	12.0	31

Inlet capacities shown above are based upon: 1) use of non-curved vane grates (similar to HEC-12 P-1 7/8-4 grates; 2) HEC-12 procedures; 3) clogging factors per Section VI; and 4) City/County standard inlets with 2-inch radius on curb face and type C grates. Capacities shown for 2-year storms are based upon depths allowed by maximum street inundation per Figure "G-3". The 100-year capacities are based upon a ponded depth of 1.0 foot. Note that only combination inlets are allowed in sag or sump conditions.

MAXIMUM INLET CAPACITIES: SUMP OR SAG CONDITION — **TABLE "G-1"**

EXHIBIT 20

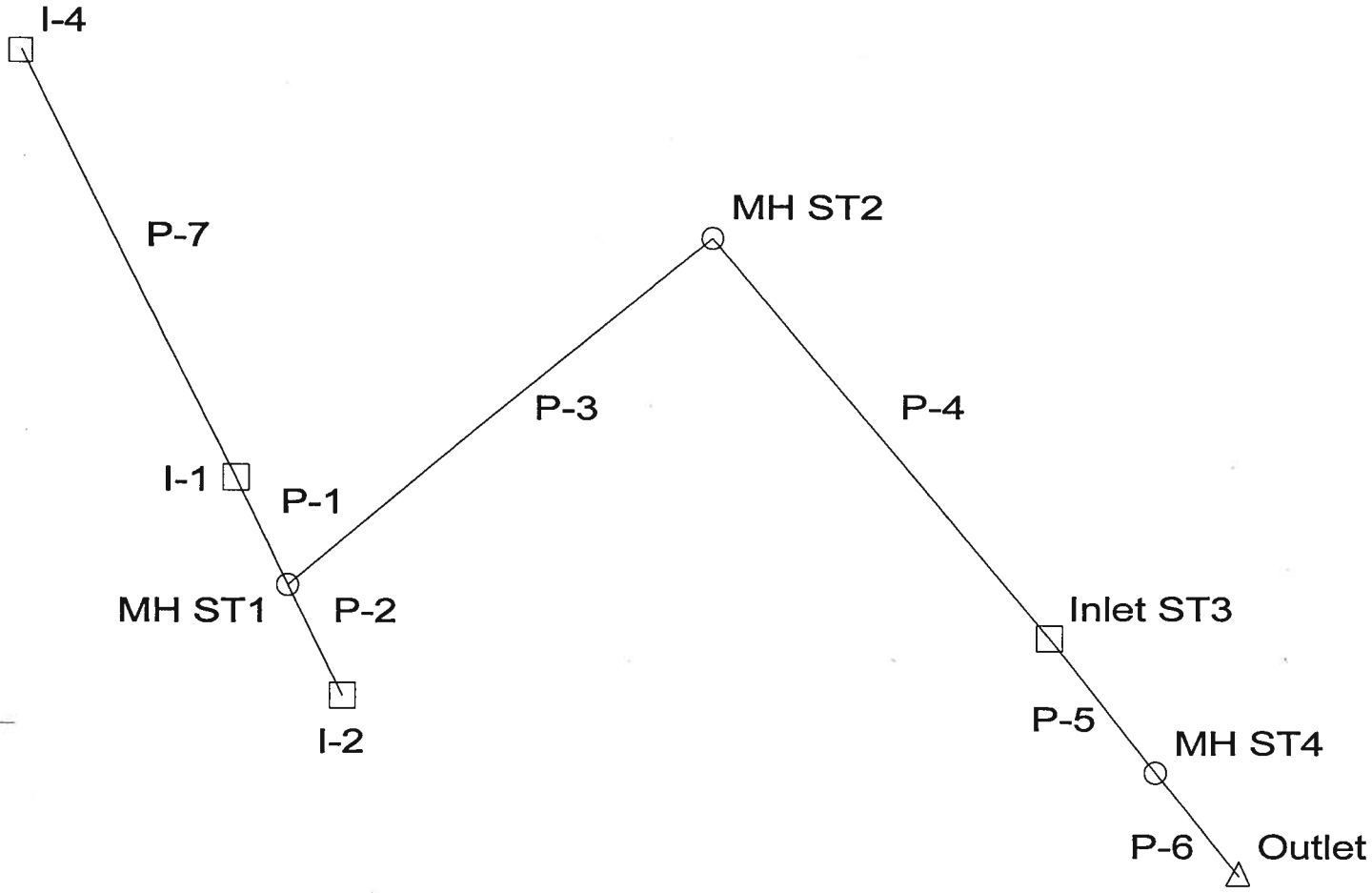


EXHIBIT 21

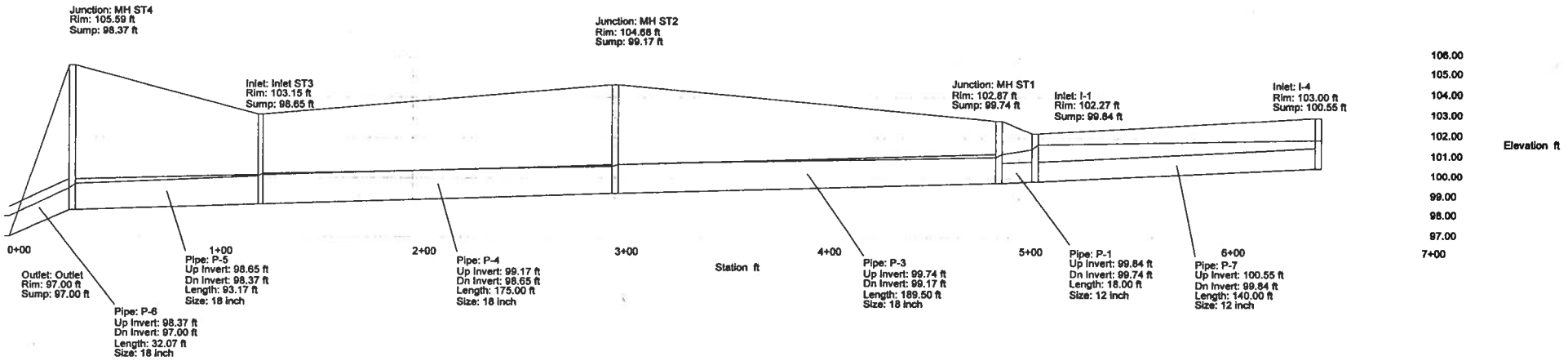

Junction: MH ST4
Rim: 105.59 ft
Sump: 98.37 ft
Junction: MH ST2
Rim: 104.68 ft
Sump: 99.17 ft
Inlet: Inlet ST3
Rim: 103.15 ft
Sump: 98.65 ft
Junction: MH ST1
Rim: 102.87 ft
Sump: 99.74 ft
Inlet: I-1
Rim: 102.27 ft
Sump: 99.84 ft
Inlet: I-4
Rim: 103.00 ft
Sump: 100.55 ft
106.00
105.00
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
Elevation ft
0+00
1+00
2+00
3+00
4+00
5+00
6+00
7+00
Station ft
Outlet: Outlet
Rim: 97.00 ft
Sump: 97.00 ft
Pipe: P-6
Up Invert: 98.37 ft
Dn Invert: 97.00 ft
Length: 32.07 ft
Size: 18 inch
Pipe: P-5
Up Invert: 98.65 ft
Dn Invert: 98.37 ft
Length: 93.17 ft
Size: 18 inch
Pipe: P-4
Up Invert: 99.17 ft
Dn Invert: 98.65 ft
Length: 175.00 ft
Size: 18 inch
Pipe: P-3
Up Invert: 99.74 ft
Dn Invert: 99.17 ft
Length: 189.50 ft
Size: 18 inch
Pipe: P-1
Up Invert: 99.84 ft
Dn Invert: 99.74 ft
Length: 18.00 ft
Size: 12 inch
Pipe: P-7
Up Invert: 100.55 ft
Dn Invert: 99.84 ft
Length: 140.00 ft
Size: 12 inch

EXHIBIT 22

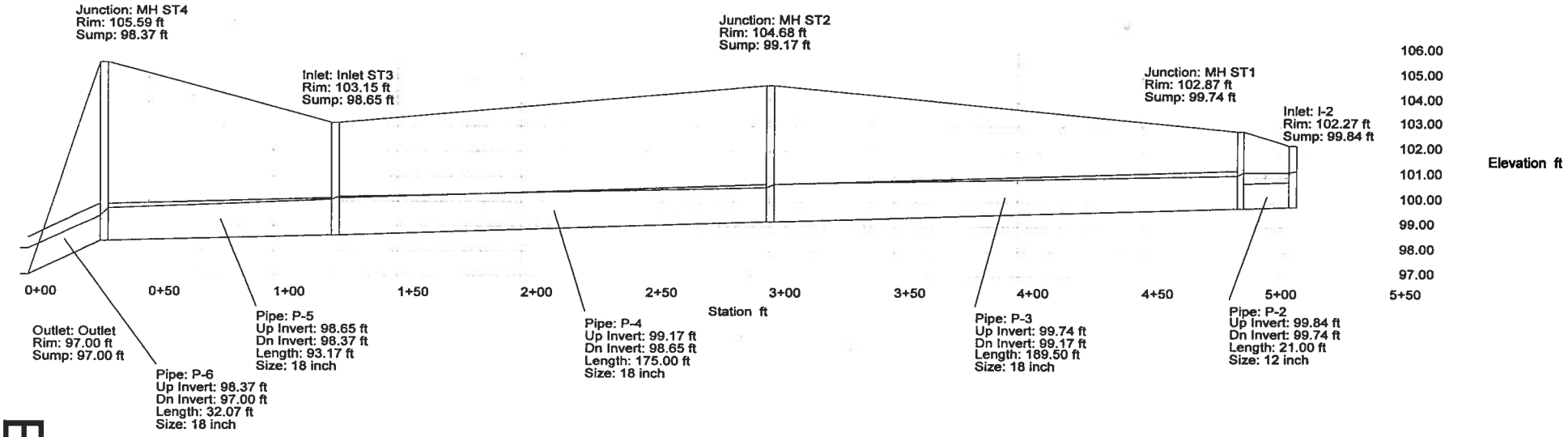


EXHIBIT 23

Project Title: Dinosaur Hill Estates
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Landesign
 37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666

Project Engineer: Brian Hart
StormCAD v1.0

Rear Yard Drain
Worksheet for Circular Channel

Project Description	
Worksheet	Rear Yard Drain
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Mannings Coefficient	0.010	
Slope	0.012500	ft/ft
Depth	0.83	ft
Diameter	10	in

Results		
Discharge	3.27	cfs
Flow Area	0.5	ft²
Wetted Perimeter	2.51	ft
Top Width	0.11	ft
Critical Depth	0.77	ft
Percent Full	99.6	%
Critical Slope	0.011424	ft/ft
Velocity	6.00	ft/s
Velocity Head	0.56	ft
Specific Energy	1.39	ft
Froude Number	0.46	
Maximum Discharg	3.43	cfs
Discharge Full	3.18	cfs
Slope Full	0.013186	ft/ft
Flow Type	Subcritical	

EXHIBIT 24

Landesign
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666

Rear Yard Swale
Worksheet for Triangular Channel

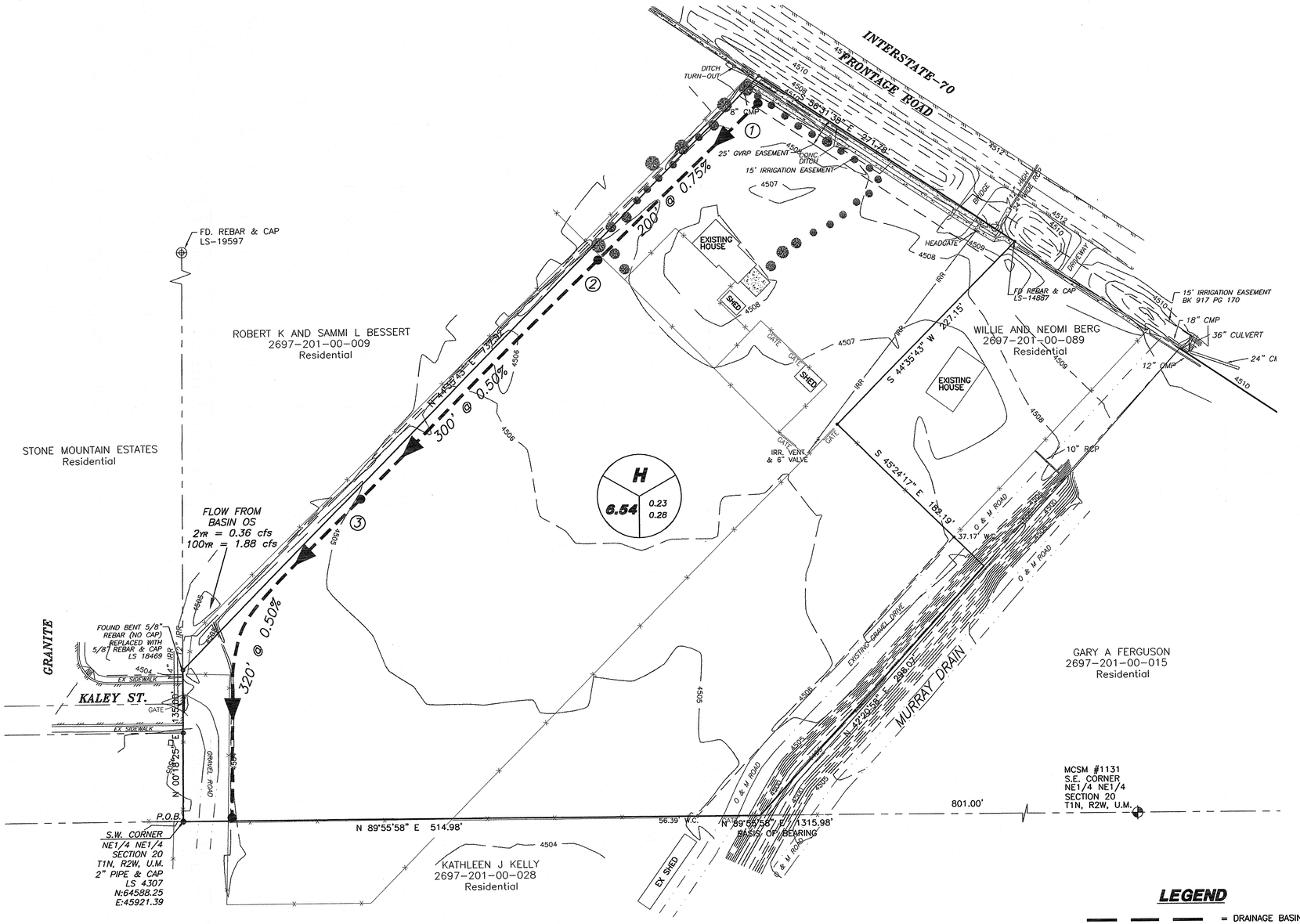
Project Description	
Worksheet	Rear Yard Swale
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Mannings Coefficient	0.030	
Slope	0.012500	ft/ft
Depth	1.00	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V

Results		
Discharge	10.10	cfs
Flow Area	3.0	ft²
Wetted Perimeter	6.32	ft
Top Width	6.00	ft
Critical Depth	0.93	ft
Critical Slope	0.018143	ft/ft
Velocity	3.37	ft/s
Velocity Head	0.18	ft
Specific Energy	1.18	ft
Froude Number	0.84	
Flow Type	Subcritical	

EXHIBIT 25

Landesign
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666



LEGEND

= DRAINAGE BASIN BOUNDARY

H1 — BASIN DESIGNATION
11.07 — BASIN ACREAGE
.36 — 2 YEAR "C" VALUE
.43 — 100 YEAR "C" VALUE

BENCHMARK
MCSM #1131
S.E. CORNER
NE1/4 NE1/4
SECTION 20
T1N, R2W, U.M.
ELEV=4612.08
N:64589.80
E:47237.37

NO.	REVISION:	BY:	DATE:

HISTORIC DRAINAGE MAP

DINOSAUR HILL ESTATES

LANDesign
ENGINEERS • SURVEYORS • PLANNERS
244 NORTH 7th STREET
GRAND JUNCTION, COLORADO 81501 (970) 245-4099

DRAWN: CJM
CHK'D: BCH
DATE: 07/31/03
PROJECT NO.: 203062
FILE NAME: 203062-hist-drainage

SHEET 1 OF 1

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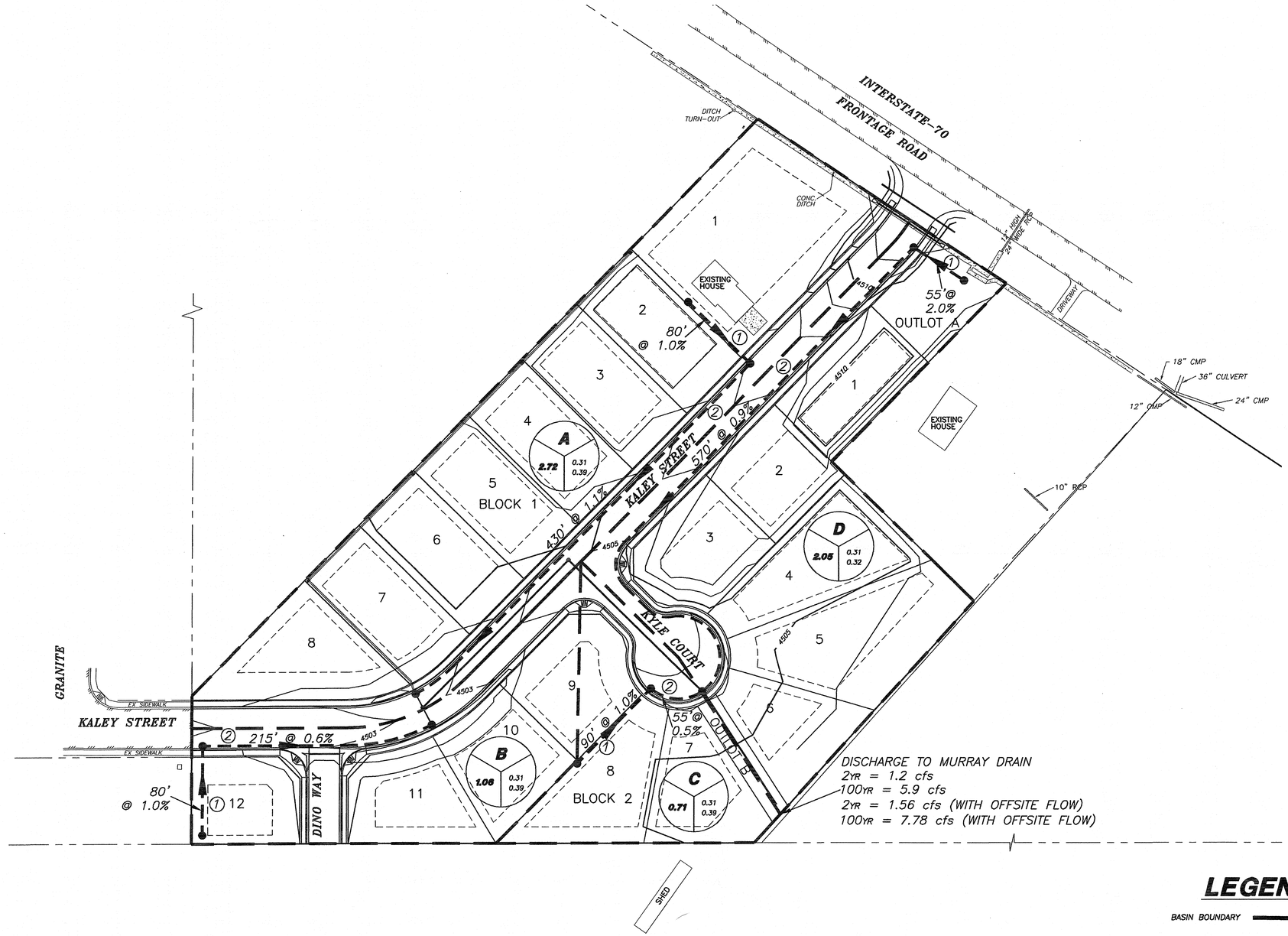

LEGEND

BASIN BOUNDARY

FLOW PATH

(1) = OVERLAND FLOW

(2) = CHANNEL FLOW

BASIN DESIGNATION
A
32.51 BASIN ACRES
0.26 2-YR C VALUE
0.32 100-YR C VALUE

BENCHMARK
MCSM #1131
S.E. CORNER
NE1/4 NE1/4
SECTION 20
T1N, R2W, U.M.
ELEV=4612.08
N:64589.80
E:47237.37

DATE:	NO:	REVISION:	BY:

DEVELOPED DRAINAGE MAP

DINOSAUR HILL ESTATES

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244 NORTH 7th STREET
GRAND JUNCTION, COLORADO 81501 (970) 245-4099

DRAWN: CJM | CHK'D: BCH | DATE: 07/31/03 | PROJECT NO.: 203062 | FILE NAME: 203062-dev-drainage

SHEET 1 OF 1

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