FINAL DRAINAGE REPORT

FOR

Miller's Run Subdivision

April 13, 2004

Prepared for:

Miller, Marais LLC
140 S. Peach Street
Fruita, CO 81521
(970) 858-3968

Prepared by:

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518 28 Road, Suite B-105, P.O. Box 2702
Grand Junction, Colorado 81502
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I hereby certify that this Preliminary Drainage Report was completed under my direct supervision.

Reviewed by: _____

Richard L. Atkins P.E.
State of Colorado, #12291

TABLE OF CONTENTS

I. General Location and Description

Site and Major Basin Location

Miller's Run Subdivision is located at 1084 18 Road, in the City of Fruita, State of Colorado, more particularly being part of Section 16, Township 1 North, Range 1 West of the Ute Meridian.

Existing streets within the area of the property include 18 Road to the west and Ottley Avenue to the north.

The property is bounded to the north by undeveloped agricultural land, to the east and south by Vista Valley PUD, and to the east by 18 Road. Land use in the vicinity of the project is best described as residential, with the exception of the land directly north which is agricultural.

Site and Major Basin Description

Miller's Run Subdivision contains approximately 1.3 acres and is planned for 8 single-family residential units. The site currently has an abandoned single-family structure and was used for agricultural purposes.

Topography of the site is considered relatively flat, draining from the northeast to the southeast at an average slope of 1% grade or less. Existing ground cover consists of native grasses and plants. The site soils are classified as (D) silty clay loam, 0 to 2 percent slopes. (Exhibit 1.0, Reference 3).

Irrigation water to serve each lot shall be provided by City of Fruita.

II. Existing Drainage Conditions

Major basin Drainage Description

The major basin areas surrounding Miller's Run Subdivision drain from northeast to the southwest being captured by a small swale that runs along the east side of 18 Road. Just south of Miller's Run Subdivision, the swale is collected in an existing 12-inch corrugated HDPE pipe installed as part of Vista Valley P.U.D. Vista Valley P.U.D. drainage is collect in an underground system and piped to the existing 18 Road storm sewer to the south. Miller's Run Subdivision is located at the most upstream end of the 18 Road Storm Sewer. These offsite areas are shown on the major basin drainage map (Exhibit 2.0).

The proposed project is defined as being in Zone X on the "Flood Insurance Rate Map, Mesa County, Colorado" (Exhibit 3.0, Reference 2).

Site Drainage Description

Historically the property drains in a sheet flow fashion from the northeast to the southwest at approximately 1% slope. This sheet flow drains to the swale along the west property edge that takes the runoff to the south of the property.

III. Proposed Drainage Conditions

Changes in Drainage Patterns

Based on the proposed land use plan, significant changes to the existing drainage patterns are not anticipated. The developed property will continue to drain from the northeast to the southwest, with runoff directed to the proposed subdivision street and the perimeter drainage swales. Runoff directed toward the street will be conveyed into 18 Road that will ultimately drain to the single inlet at the intersection of 18 Road and Monument Street in Vista Valley P.U.D. This watershed is located in the Little Salt Wash Drainage Basin based on the Mesa County drainage basin maps.

The drainage for the site will be accommodated through the use of the proposed perimeter swales, street flow, and the proposed 12-inch drain line along the east edge of 18 Road (Exhibit 4.0). Detention will not be incorporated into the design of the subdivision at the request of City Staff. Arrangements will be made between the developer and the City for any fees associated with the increased discharge resulting from this subdivision (See Exhibit 9.0 for summary of additional runoff).

Off-site flows are directed toward the site from the undeveloped land to the north. Ultimately this land is proposed to be developed commercially. The current roadway improvements to 18 Road as proposed in the Vista Valley P.U.D. Construction Documents, indicate there will be a high point located at the northern property line of Miller's Run Subdivision. Based on this design, the assumption is that all drainage from 18 Road to the north of the project would drain to the north and would not become a part of the Miller's Run Subdivision drainage system. However, the grades along the east side of 18 Road suggest a portion of the runoff would not be able to drain into the road without a substantial amount of fill material. A more appropriate grading approach would be to allow a portion of the runoff from the property to the north to become a part of the Miller's Run drainage system. We incorporated a 40-foot wide by 400-foot long area from that property in the drainage for Miller's Run. Based on the capacity of the existing 12-inch line and the runoff discharges, it was determined the line would be capable of accepting the additional developed 100-year storm frequency runoff. The design calculations are summarized in Exhibit 9.0.

Maintenance Issues

Access to the property will be via the proposed residential streets, built to city standards and maintained by the City of Fruita. The Miller's Run Subdivision HOA will dictate the maintenance of the landscaped areas within the subdivision.

IV. Design Criteria and Approach

General Considerations

We are not aware of any previous drainage studies performed in this area. The development of the proposed site will not impose any constraints to future development in this area.

Hydrology

The "City of Grand Junction Stormwater Management Manual" (Reference 1) was used as the basis for analysis.

As the project is a single-family residential development containing approximately 1.3 acres, the "Rational Method" was used to calculate historic and developed flow rates. The 2-year frequency rainfall event was considered the minor storm and the 100-year frequency rainfall event the major storm. All facilities were designed to accommodate the 100-year event.

This subdivision has 8 units on approximately 1.3 acres, which corresponds to 1/6.2 acres per unit. Therefore, the developed runoff coefficients were derived by utilizing C Values from Table "B-1" in the Stormwater Management Manual for Residential Areas, in soil type "D", with densities of 1/8 acre per unit. This method produces slightly conservative results. Calculations were performed to arrive at a 2-year Developed C-Value of 0.55 and a 100-year value of 0.64. For this particular site and proposed development, we think that these are reasonable values. These calculations can be found in Exhibit 9.0.

The Intensity Duration Frequency data (IDF) shown on Exhibit 6.0 was used for design and analysis.

Times of Concentration were calculated based on the Average Velocities for Overland Flow (Exhibit 7.0) and Manning's equation to calculate gutter flow velocities as shown on Exhibit 9.0.

Peak Discharge flow rates were computed for historic and developed values using the "rational method" as shown on Exhibit 9.0.

Hydraulics

The "City of Grand Junction Stormwater Management Manual" (Reference 1) shall be used as the basis for analysis.

Calculations were performed to analyze the historic and developed 2-year and 100-year storm event. Calculations were also performed to ensure that the proposed streets, existing and proposed catch basins, and existing and proposed storm drain pipes have the capacity to handle the 100-year event.

Historic drainage calculations were completed considering the site to be one large drainage area. These calculations produced a 2-year runoff of 0.56 cfs and a 100-year runoff of 2.62 cfs. These values are summarized in the table below and in Exhibit 9.0.

In order to calculate the developed runoff, the site was divided into several drainage basins. Developed runoff will be directed towards the street and the two catch basins proposed at the northwest and southwest corners of the property. Once the site was divided into several basins, calculations were performed to find the peak flow from each area. After the peak flows for each area were determined, calculations were completed to create a hydrograph for the peak discharge for the total site.

Once developed 100-year event flows were calculated, they were compared with capacities of the street, proposed catch basins, and proposed storm drain pipes. The peak flow within the street will be 2.14 cfs. The minimum street slope is 0.5%, which will result in a carrying capacity of 5.0 cfs within the drive-over curb and gutter. Additionally the half street section for 18 Road has a capacity of 5.4 cfs which accommodates the peak flow in the street. These calculations can be found in Exhibit 9.0.

V. Results and Conclusion

Results

Following is a table showing historic and developed peak flows. Values for the developed peak runoff represent what will be discharged offsite during that particular event. Values include the offsite contribution to the north of the development. For the calculations performed to arrive at these values, please see Exhibit 9.0.

HISTORIC PEAK RUNOFF		DEVELOPED PEAK RUNOFF	
2-YEAR	0.56 CFS	2-YEAR	0.91 CFS
100-YEAR	2.62 CFS	100-YEAR	4.42 CFS

Conclusion

The proposed drainage plan includes swales along the north, east, and south borders of the project along with a 12-inch drainage line that runs the entire length of the west side of the property. The proposed facilities were designed to carry the 100-year frequency storm event.

This Preliminary Drainage Study has been prepared to address site-specific drainage concerns in accordance with the requirements of the City of Fruita, Colorado. The developed drainage facilities have been designed to accommodate the 100-year runoff. The Appendix of this report includes criteria, exhibits, tables, design nomographs, and calculations to support the proposed infrastructure.

VI. References

1. Mesa County Stormwater Management Manual (SWMM), City of Grand Junction and Mesa County, Colorado, May 1996.

2. Flood Insurance Rate Map, Mesa County, Colorado. (Unincorporated Areas), Community Panel Number 080115 0460 B, Federal Emergency Management Agency, Map Revised July 14, 1992.

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

VII. Appendix

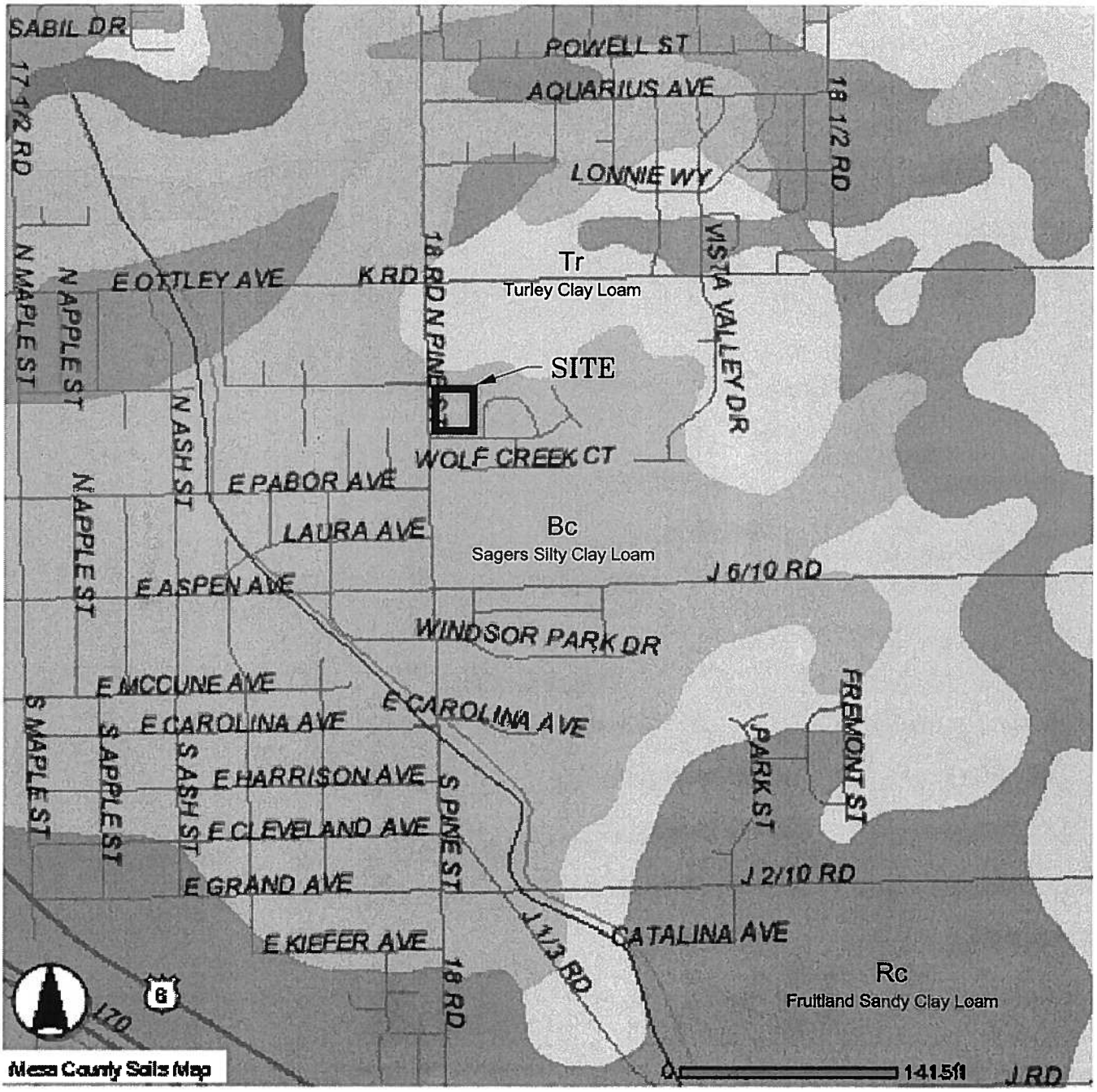


EXHIBIT 1A

SITE SOIL CLASSIFICATION

Grand Junction Area Soil Survey
U.S. Department of Agriculture, issued November 1955

Bc–Sagers silty clay loam, 0 to 2 percent slopes
Map Unit Setting
MLRA:
Elevation: 4,500 to 5,900 feet (1,372 to 1,798 meters)
Mean annual precipitation: 5 to 8 inches (127 to 203 millimeters)
Average annual air temperature: 50 to 54 degrees F. (10 to 12 degrees C.)
Frost–free period: 150 to 190 days
Map Unit Composition
Sagers and similar soils: 90 percent
Minor components: 10 percent
Component Descriptions
Sagers soils
Landform: Alluvial fan
Geomorphic position: Toeslope
Parent material: Alluvium derived from clayey shale
Slope: 0 to 2 percent
Surface fragments: Unspecified
Depth to restrictive feature: Unspecified
Drainage class: Well drained
Slowest permeability: About 0.20 in/hr (moderately slow)
Available water capacity: About 11.2 inches (high)
Shrink–swell potential: About 4.5 LEP (moderate)
Flooding hazard: None
Ponding hazard: Unspecified
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: Medium
Calcium carbonate maximum: About 15 percent
Gypsum maximum: About 5 percent
Salinity maximum: About 2 mmhos/cm (nonsaline)
Sodicity maximum: About 5 SAR (slightly sodic)
Ecological site: Unspecified
Potential native vegetation: Unspecified
Land capability (irrigated): 2e
Land capability (non irrigated): 7c

Typical Profile:
Ap–0 to 12 inches; silty clay loam
Cy–12 to 60 inches; silty clay loam

EXHIBIT 1B

SITE SOIL
CLASSIFICATION

Grand Junction Area Soil Survey
U.S. Department of Agriculture, issued November 1955

Minor Components
Sagers, Wet and similar soils
Composition: About 5 percent
Landform: Terrace
Geomorphic Position: Unspecified
Slope: Unspecified
Depth to restrictive feature: Unspecified
Drainage class: Unspecified
Ecological site: Unspecified

Other Soils and similar soils
Composition: About 5 percent
Landform: Unspecified
Geomorphic Position: Unspecified
Slope: Unspecified
Depth to restrictive feature: Unspecified
Drainage class: Unspecified
Ecological site: Unspecified

Major uses: Irrigated cropland, urban development
Major management limitations: Irrigated Cropland
Soil related factors: Salinity, piping hazard in some areas, slow permeability, moderate shrink–swell potential
Management considerations:
Suitable irrigation systems are furrow, sprinkler, and drip
If irrigation water is to be applied and removed efficiently, leveling is needed in sloping areas
All crops but legumes respond to nitrogen. Legumes respond to phosphorus
Urban Development
Soil related factors: Piping hazard in some areas, moderate shrink–swell potential, soft shale bedrock within 60 inches in some areas
Management considerations:
Heavy equipment is needed for excavation.
Because of the high content of gypsum, the soil may subside as the gypsum is dissolved and leached.
Some areas of this unit may be subject to salt heave because of the expansion of sodium sulfate salts. This action is likely to crack concrete slab floors, driveways, and sidewalks.
The deep cuts needed to level the road surface can expose soft bedrock; however, it can be easily excavated.
Cut slopes generally are stable, but slumping can occur where the bedrock is highly fractured or where rock layers are parallel to the slope.
The quality of roadbeds and road surfaces can be adversely affected by shrinking and swelling, frost action, and limited soil strength.
Local roads and streets may require a special base to prevent frost heave damage.
Septic tank absorption fields may function poorly because of limited permeability, which restricts the movement and filtration of the effluent.
Untreated effluent can move along the surface of the restrictive layer and seep in downslope areas, creating a health hazard.
Onsite investigation is needed to determine whether the area considered for a septic tank absorption field is underlain by unsuitable material. If such material is present, consider placing absorption lines beneath it.

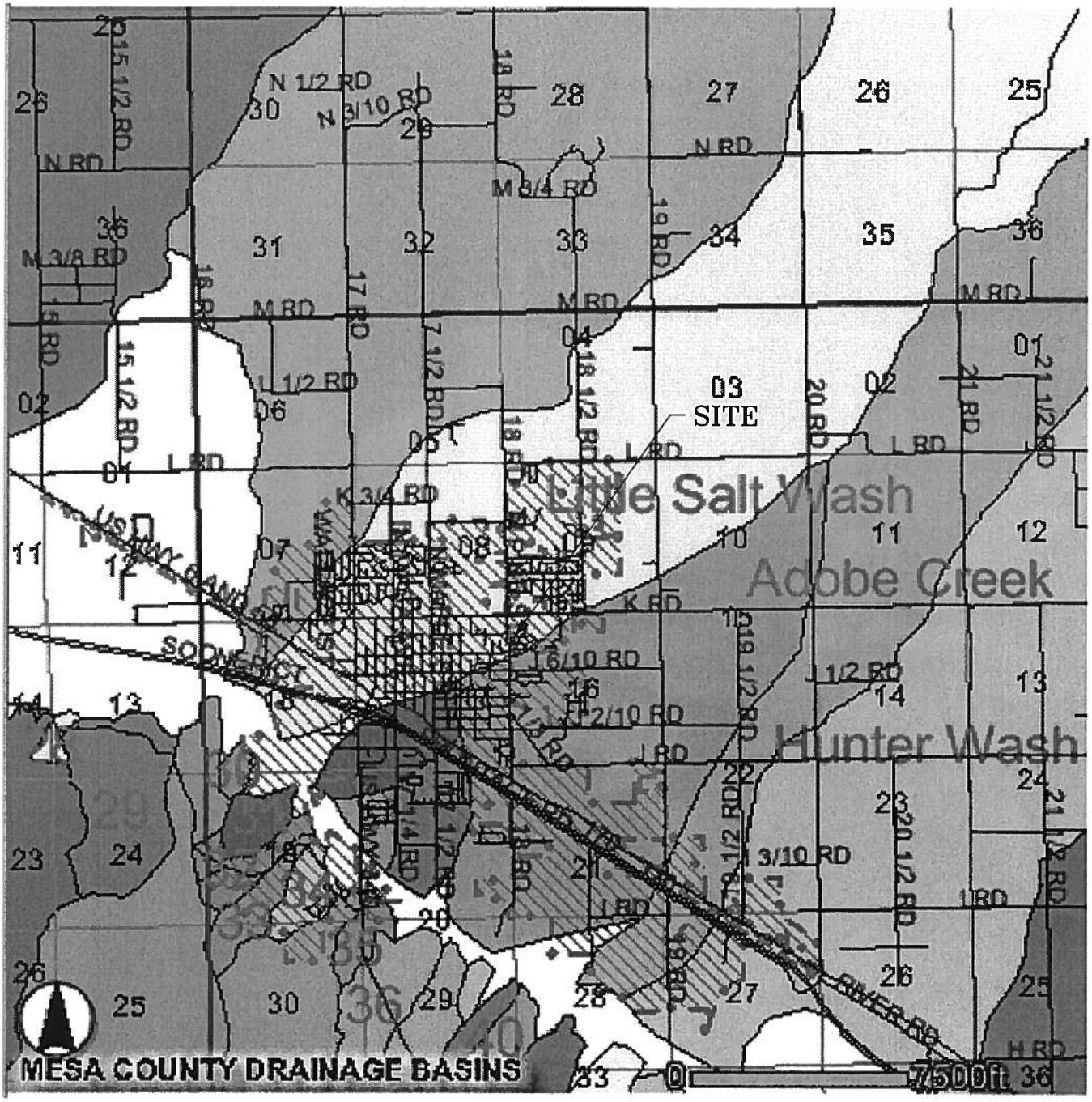


EXHIBIT 2

MAJOR BASIN
DRAINAGE MAP

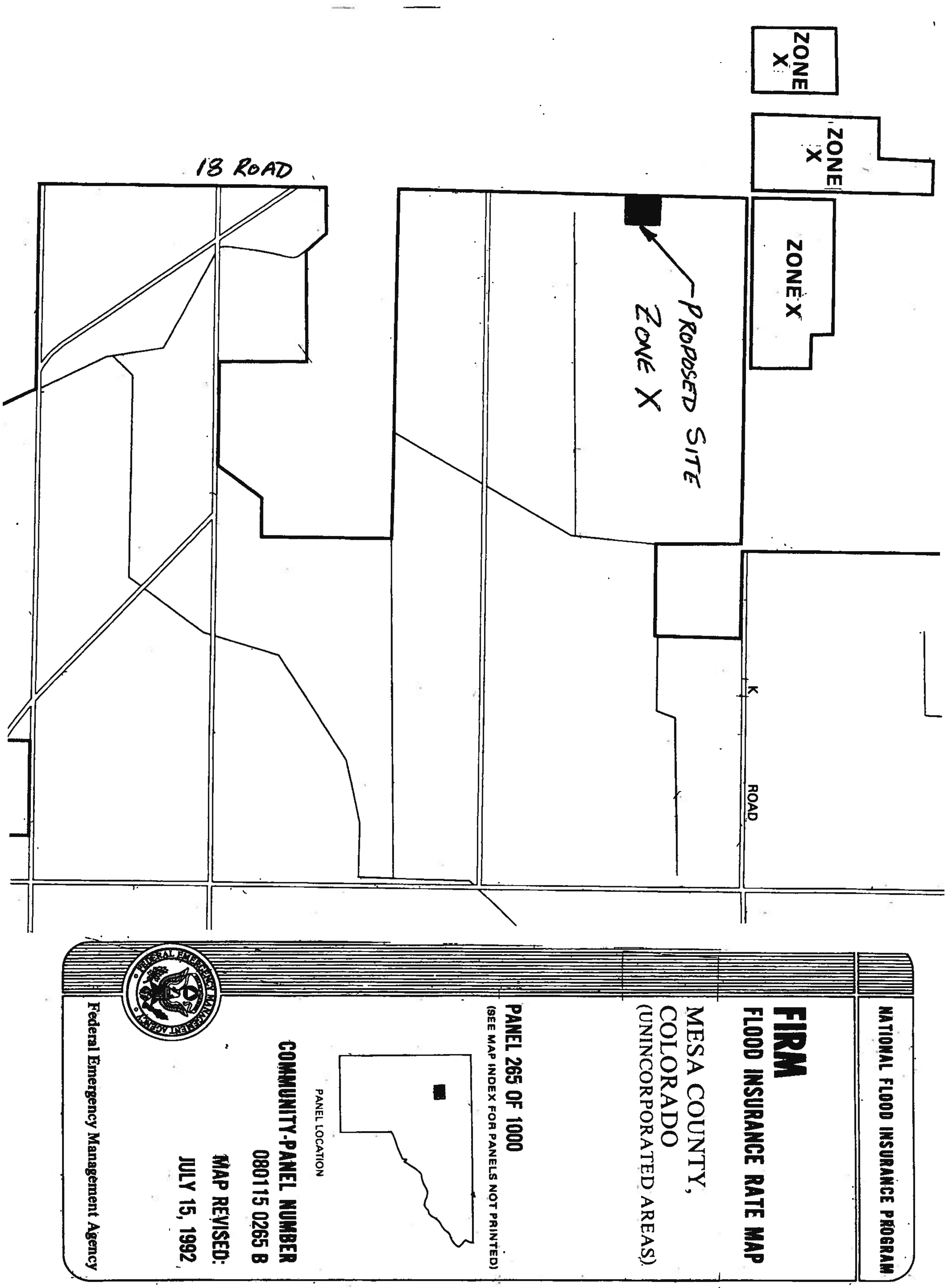


EXHIBIT 3

FLOOD INSURANCE RATE MAP

Miller's Run Storm Drainage Computations

UNDEVELOPED CONDITIONS

Location	Area (sf)	Area (acres)	Overland Flow Length (ft)	Ground Slope %	Runoff Coeficient 100-year	Runoff Coeficient 2-year	Time of Concentration 100-year (min)	Time of Concentration 2-year (min)	Rainfall Intesity 100-year (in/hr)	Rainfall Intesity 2-year (in/hr)	Discharge 100-year (cfs)	Discharge 2-year (cfs)
Runoff to Exist. 12" Storm Drain												
Offsite-A1	16000	0.367	400	0.93%	0.41	0.34	26.55	29.24	2.31	0.55	0.35	0.07
A2	56070	1.287	340	1.00%	0.43	0.37	23.09	25.38	2.51	0.60	1.40	0.28
										Total Basin A (12" Line)	1.75	0.35
Runoff to Street												
Offsite-B1	8010	0.184	267	0.50%	0.95	0.93	5.82	6.59	4.26	1.04	0.74	0.18
										Total Basin B (To Street)	0.74	0.18
										Total Undeveloped Discharge from Basins A & B	2.49	0.53

DEVELOPED CONDITIONS

Location	Area (sf)	Area (acres)	Overland Flow Length (ft)	Ground Slope %	Runoff Coeficient 100-year	Runoff Coeficient 2-year	Time of Concentration 100-year (min)	Time of Concentration 2-year (min)	Rainfall Intesity 100-year (in/hr)	Rainfall Intesity 2-year (in/hr)	Discharge 100-year (cfs)	Discharge 2-year (cfs)
Runoff to Exist. 12" Storm Drain												
Offsite-A1	16000	0.367	400	1.77%	0.80	0.70	9.32	12.42	3.73	0.85	1.10	0.22
A2	9625	0.221	210	1.16%	0.64	0.55	11.92	14.25	3.42	0.80	0.48	0.10
A3	19001	0.436	477	0.55%	0.64	0.55	23.06	27.57	2.51	0.57	0.70	0.14
										Total Basin A (12" Line)	2.28	0.45
Runoff to Street												
Offsite-B1	8010	0.184	267	0.50%	0.95	0.93	5.82	6.59	4.26	1.04	0.74	0.18
B2	27444	0.630	179	1.00%	0.64	0.55	11.56	13.82	3.46	0.81	1.39	0.28
										Total Basin B (To Street)	2.14	0.46
										Total Developed Discharge from Basins A & B	4.42	0.91

18 Road Surface Storm Drainage Capacity

Equation: $Qt=(0.56/n)(Sx^{1.67})(S^{0.5})(T^{2.67})$

Where:
- Qt = Total Half-Roadway Discharge Capacity for Width 'T'
- n = 0.016 Mannings n for Pavement
- Sx = 0.02 Pavement Cross Slope
- S = 0.005 Gutter Slope Along Road
- T = 15.5 Width of street Flow

$Qt = (0.56/0.016)(0.02^{1.67})(0.005^{0.5})(15.5^{2.67})$

Qt = 5.43 cfs (Provides for 8-ft clear lane)

2.14 cfs required (100 Year Frequency)

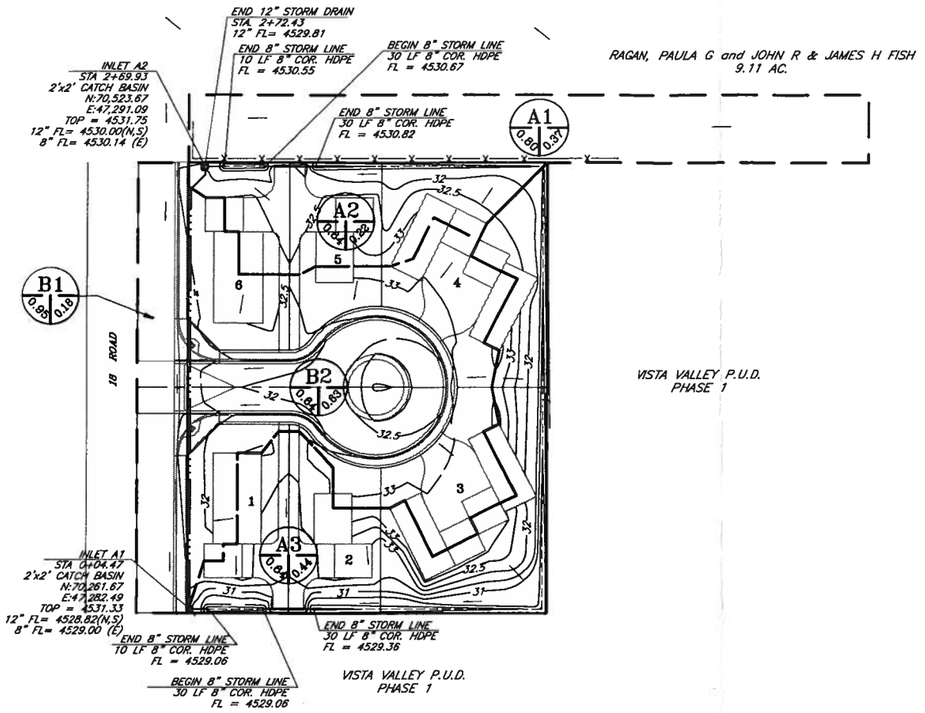
On-Site Increase in Runoff for Developed Conditions

	Discharge 100-year (cfs)	Discharge 2-year (cfs)
Total On-Site Developed Discharge	2.58	0.52
Total On-Site Undeveloped Discharge	1.40	0.28
OnSite Runoff Increase	1.18	0.23

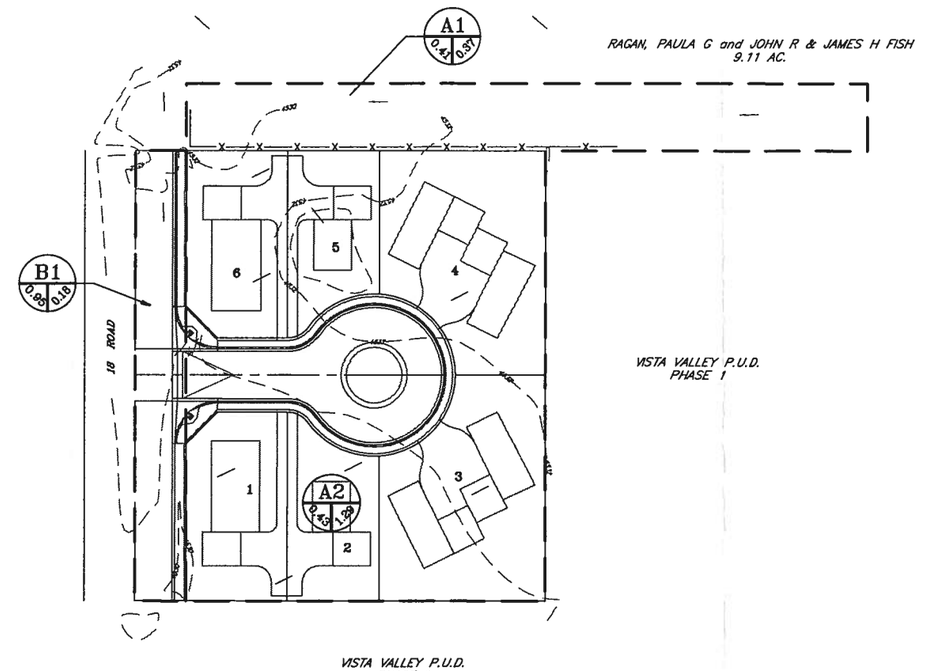
On-Site Conduit Capacities

	Pipe size (in)	Area (sf)	P (ft)	A/P	Length (ft)	Outlet Elevation (ft)	Inlet Elev (ft)	Surcharge (ft)	Head (ft)	Hyd Slope (ft/ft)	n	Discharge Capacity (cfs)
12" Capacity	12	0.785	3.142	0.25	265.48	4528.82	4530.00	0	1.18	0.445%	0.013	2.38
8" Capacity*	8	0.349	2.094	0.17	30	4530.00	4530.15	0	0.15	0.500%	0.013	0.85

* Both 8-inch lines are on the same grade and the same length.



DEVELOPED CONDITIONS
SCALE: 1"= 20'



UNDEVELOPED CONDITIONS
SCALE: 1"= 20'

EXHIBIT 4.0

LEGEND

- = DIRECTION OF FLOW
- = EXISTING CONTOURS
- = SUB-BASIN BOUNDARY

A1 (0.54 / 0.45) — SUB-BASIN I.D. | 100 YR RUNOFF COEFFICIENT | SUB-BASIN AREA IN ACRES

0' 40' 80' 120'

SCALE: 1" = 20'
HORIZ: -
VERT: -

DRAWN BY: SLA
CHECKED BY: RLA
DATE: 10/11/03
PROJECT NO.: -

PRELIMINARY DRAINAGE PLAN

MILLER'S RUN SUBDIVISION

ATKINS AND ASSOCIATES, INC.
P. O. BOX 2702, 518 28 ROAD, SUITE B-105
GRAND JUNCTION, COLORADO 81502
970-245-6630 FAX 970-245-2355

SHEET 1 OF 1

ACAD Rel 16.0 User: SATKINS
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EXHIBIT 5

RATIONAL METHOD RUNOFF COEFFICIENTS

LAND USE OR SURFACE CHARACTERISTICS	SCS HYDROLOGIC SOIL GROUP (SEE APPENDIX "C" FOR DESCRIPTIONS)											
	A			B			C			D		
	0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+
UNDEVELOPED AREAS Bare ground	.10 - .20 .14 - .24	.16 - .26 .22 - .32	.25 - .35 .30 - .40	.14 - .22 .20 - .28	.22 - .30 .28 - .36	.30 - .38 .37 - .45	.20 - .28 .26 - .34	.28 - .36 .35 - .43	.36 - .44 .40 - .48	.24 - .32 .30 - .38	.30 - .38 .40 - .48	.40 - .48 .50 - .58
Cultivated/Agricultural	.08 - .18 .14 - .24	.13 - .23 .18 - .28	.16 - .26 .22 - .32	.11 - .19 .16 - .24	.15 - .23 .21 - .29	.21 - .29 .28 - .36	.14 - .22 .20 - .28	.19 - .27 .25 - .33	.26 - .34 .34 - .42	.18 - .26 .24 - .32	.23 - .31 .29 - .37	.31 - .39 .41 - .49
Pasture	.12 - .22 .15 - .25	.20 - .30 .25 - .35	.30 - .40 .37 - .47	.18 - .26 .23 - .31	.28 - .36 .34 - .42	.37 - .45 .45 - .53	.24 - .32 .30 - .38	.34 - .42 .42 - .50	.44 - .52 .52 - .60	.30 - .38 .37 - .45	.40 - .48 .50 - .58	.50 - .58 .62 - .70
Meadow	.10 - .20 .14 - .24	.16 - .26 .22 - .32	.25 - .35 .30 - .40	.14 - .22 .20 - .28	.22 - .30 .28 - .36	.30 - .38 .37 - .45	.20 - .28 .26 - .34	.28 - .36 .35 - .43	.36 - .44 .44 - .52	.24 - .32 .30 - .38	.30 - .38 .40 - .48	.40 - .48 .50 - .58
Forest	.05 - .15 .08 - .18	.08 - .18 .11 - .21	.11 - .21 .14 - .24	.08 - .16 .10 - .18	.11 - .19 .14 - .22	.14 - .22 .18 - .26	.10 - .18 .12 - .20	.13 - .21 .16 - .24	.16 - .24 .20 - .28	.12 - .20 .15 - .23	.16 - .24 .20 - .28	.20 - .28 .25 - .33
RESIDENTIAL AREAS 1/8 acre per unit	.40 - .50 .48 - .58	.43 - .53 .52 - .62	.46 - .56 .55 - .65	.42 - .50 .50 - .58	.45 - .53 .54 - .62	.50 - .58 .59 - .67	.45 - .53 .53 - .61	.48 - .56 .57 - .65	.53 - .61 .64 - .72	.48 - .56 .56 - .64	.51 - .59 .60 - .68	.57 - .65 .69 - .77
1/4 acre per unit	.27 - .37 .35 - .45	.31 - .41 .39 - .49	.34 - .44 .42 - .52	.29 - .37 .38 - .46	.34 - .42 .42 - .50	.38 - .46 .47 - .55	.32 - .40 .41 - .49	.36 - .44 .45 - .53	.41 - .49 .52 - .60	.35 - .43 .43 - .51	.39 - .47 .47 - .55	.45 - .53 .57 - .65
1/3 acre per unit	.22 - .32 .31 - .41	.26 - .36 .35 - .45	.29 - .39 .38 - .48	.25 - .33 .33 - .41	.29 - .37 .38 - .46	.33 - .41 .42 - .50	.28 - .36 .36 - .44	.32 - .40 .41 - .49	.37 - .45 .48 - .56	.31 - .39 .39 - .47	.35 - .43 .43 - .51	.42 - .50 .53 - .61
1/2 acre per unit	.16 - .26 .25 - .35	.20 - .30 .29 - .39	.24 - .34 .32 - .42	.19 - .27 .28 - .36	.23 - .31 .32 - .40	.28 - .36 .36 - .44	.22 - .30 .31 - .39	.27 - .35 .35 - .43	.32 - .40 .42 - .50	.26 - .34 .34 - .42	.30 - .38 .38 - .46	.37 - .45 .48 - .56
1 acre per unit	.14 - .24 .22 - .32	.19 - .29 .26 - .36	.22 - .32 .29 - .39	.17 - .25 .24 - .32	.21 - .29 .28 - .36	.26 - .34 .34 - .42	.20 - .28 .28 - .36	.25 - .33 .32 - .40	.31 - .39 .40 - .48	.24 - .32 .31 - .39	.29 - .37 .35 - .43	.35 - .43 .46 - .54
MISC. SURFACES Pavement and roofs	.93 .95	.94 .96	.95 .97	.93 .95	.94 .96	.95 .97	.93 .95	.94 .96	.95 .97	.93 .95	.94 .96	.95 .97
Traffic areas (soil and gravel)	.55 - .65 .65 - .70	.60 - .70 .70 - .75	.64 - .74 .74 - .79	.60 - .68 .68 - .76	.64 - .72 .72 - .80	.67 - .75 .75 - .83	.64 - .72 .72 - .80	.67 - .75 .75 - .83	.69 - .77 .77 - .85	.72 - .80 .79 - .87	.75 - .83 .82 - .90	.77 - .85 .84 - .92
Green landscaping (lawns, parks)	.10 - .20 .14 - .24	.16 - .26 .22 - .32	.25 - .35 .30 - .40	.14 - .22 .20 - .28	.22 - .30 .28 - .36	.30 - .38 .37 - .45	.20 - .28 .26 - .34	.28 - .36 .35 - .43	.36 - .44 .42 - .52	.24 - .32 .30 - .38	.30 - .38 .40 - .48	.40 - .48 .50 - .58
Non-green and gravel landscaping	.30 - .40 .34 - .44	.36 - .46 .42 - .52	.45 - .55 .50 - .60	.45 - .55 .50 - .60	.42 - .50 .48 - .56	.50 - .58 .57 - .65	.40 - .48 .46 - .54	.48 - .56 .55 - .63	.56 - .64 .64 - .72	.44 - .52 .50 - .58	.50 - .58 .60 - .68	.60 - .68 .70 - .78
Cemeteries, playgrounds	.20 - .30 .24 - .34	.26 - .36 .32 - .42	.35 - .45 .40 - .50	.35 - .45 .40 - .50	.32 - .40 .38 - .46	.40 - .48 .47 - .55	.30 - .38 .36 - .44	.38 - .44 .45 - .53	.46 - .54 .54 - .62	.34 - .42 .40 - .48	.40 - .48 .50 - .58	.50 - .58 .60 - .68

NOTES:
1. Values above and below pertain to the 2-year and 100-year storms, respectively.
2. The range of values provided allows for engineering judgement of site conditions such as basic shape, homogeneity of surface type, surface depression storage, and storm duration. In general, during shorter duration storms (Tc ≤ 10 minutes), infiltration capacity is higher, allowing use of a "C" value in the low range. Conversely, for longer duration storms (Tc) 30 minutes), use a ""C value in the higher range.
3. For residential development at less than 1/8 acre per unit or greater than 1 acre per unit, and also for commercial and industrial areas, use values under MISC SURFACES to estimate "C" value ranges for use.

RATIONAL METHOD RUNOFF COEFFICIENTS
(Modified from Table 4, UC-Davis, which appears to be a modification of work done by Rawls)

TABLE "B-1"

TABLE "A-1a"
IDF DATA FOR USE IN THE GRAND VALLEY

Time (min)	2-Year Intensity (in/hr)	100-Year Intensity (in/hr)	Time (min)	2-Year Intensity (in/hr)	100-Year Intensity (in/hr)
5	1.11	4.41	33	0.51	2.03
6	1.07	4.23	34	0.50	1.99
7	1.03	4.07	35	0.49	1.95
8	0.99	3.92	36	0.49	1.91
9	0.95	3.78	37	0.48	1.88
10	0.92	3.64	38	0.47	1.85
11	0.89	3.52	39	0.46	1.82
12	0.86	3.41	40	0.45	1.79
13	0.83	3.30	41	0.45	1.76
14	0.81	3.20	42	0.44	1.73
15	0.79	3.11	43	0.43	1.70
16	0.76	3.02	44	0.42	1.67
17	0.74	2.93	45	0.42	1.64
18	0.72	2.85	46	0.41	1.61
19	0.70	2.77	47	0.40	1.59
20	0.68	2.70	48	0.40	1.57
21	0.67	2.63	49	0.39	1.55
22	0.65	2.57	50	0.39	1.53
23	0.64	2.51	51	0.38	1.50
24	0.62	2.45	52	0.38	1.48
25	0.61	2.39	53	0.37	1.46
26	0.59	2.34	54	0.37	1.44
27	0.58	2.29	55	0.36	1.42
28	0.57	2.24	56	0.36	1.40
29	0.56	2.19	57	0.35	1.38
30	0.54	2.15	58	0.35	1.37
31	0.53	2.11	59	0.34	1.35
32	0.52	2.07	60	0.34	1.33

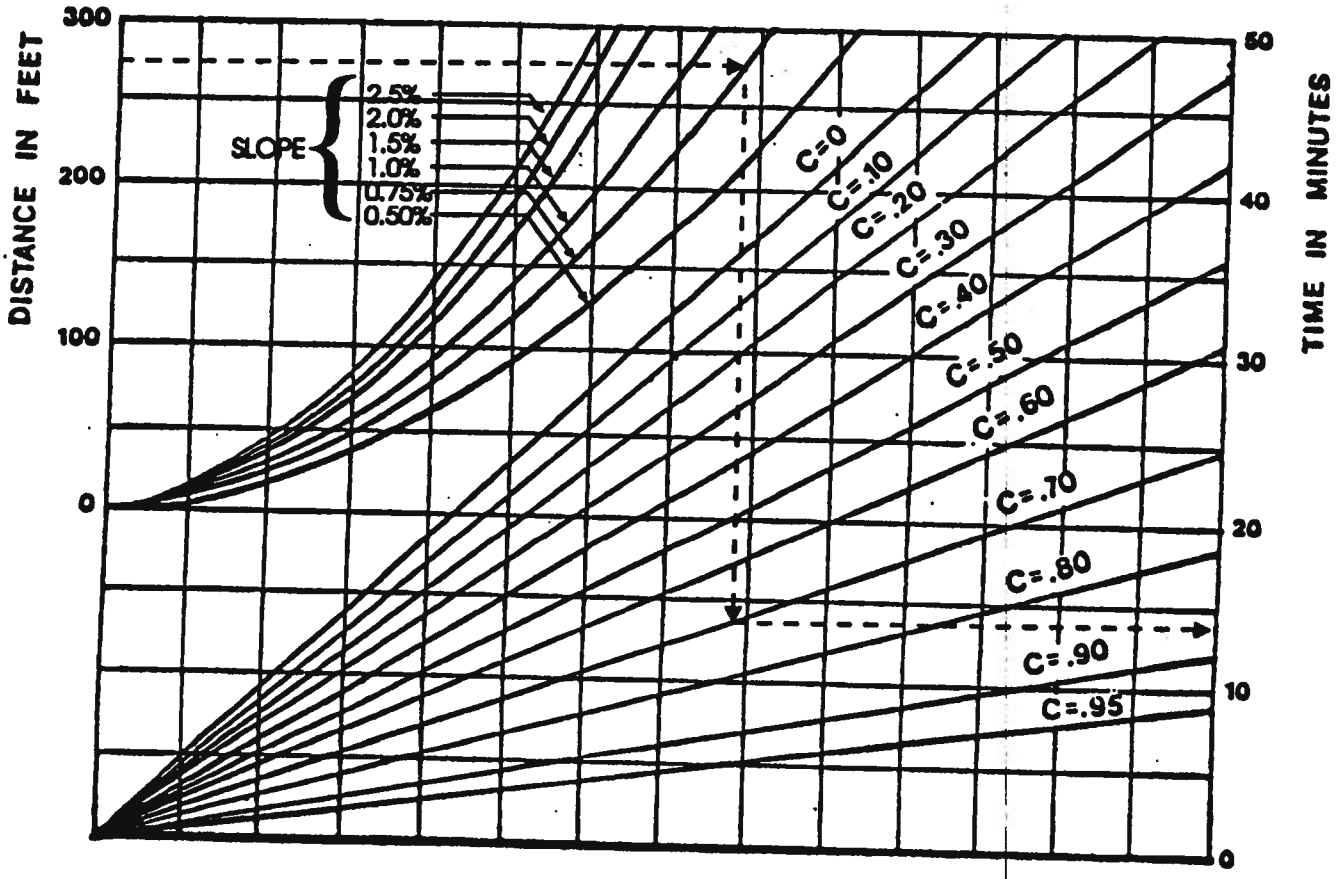
Source: Mesa County 1992 (Modified)

$$I_2 = \frac{26.71}{Tc + 19.01} \qquad I_{100} = \frac{104.94}{Tc + 18.80}$$

EXHIBIT 6

RAINFALL INTESITY
DURATION FREQUENCY DATA

MODIFIED FROM FIGURE 403, MESA COUNTY



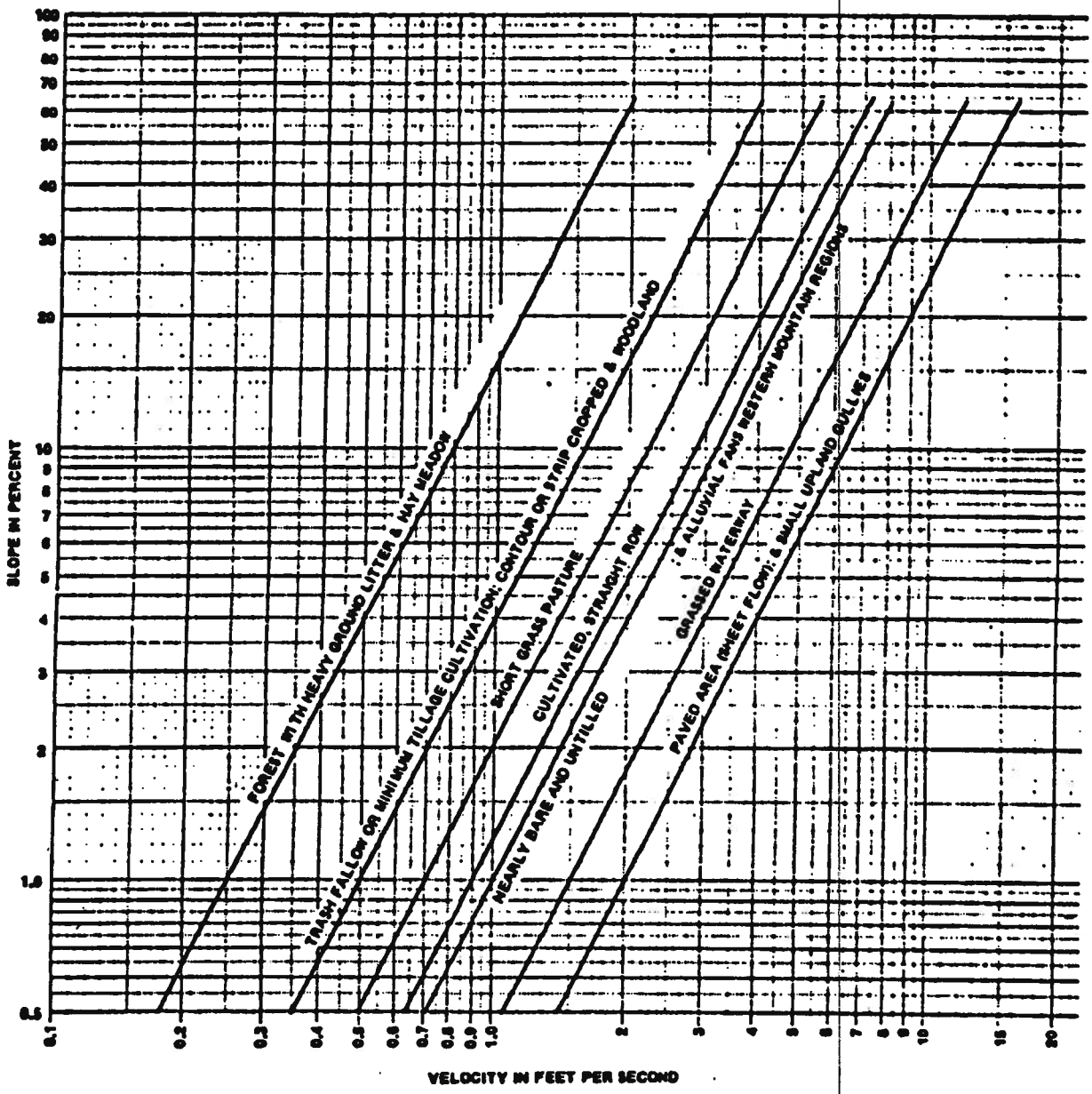
THE ABOVE CURVES ARE A SOLUTION OF THE FOLLOWING EQUATION:

$$To = \frac{1.8\ (1.1 - C)\sqrt{L}}{\sqrt[3]{S}}$$

WHERE: To = OVERLAND FLOW TIME (MIN.)
S = SLOPE OF BASIN (%)
C = RUNOFF COEFFICIENT (SEE TABLE "B-1" IN APPENDIX "B")
L = LENGTH OF BASIN (ft)

GRAPHICAL DETERMINATION OF "To" FAA METHOD | EXHIBIT 7

REPRODUCED FROM FIGURE 15.2, SCS 1972



DIRECT DETERMINATION OF "T_L"

EXHIBIT 8

Miller's Run Storm Drainage Computations

UNDEVELOPED CONDITIONS

Location	Area (sf)	Area (acres)	Overland Flow Length (ft)	Ground Slope %	Runoff Coeficient 100-year	Runoff Coeficient 2-year	Time of Concentration 100-year (min)	Time of Concentration 2-year (min)	Rainfall Intesity 100-year (in/hr)	Rainfall Intesity 2-year (in/hr)	Discharge 100-year (cfs)	Discharge 2-year (cfs)
Runoff to Exist. 12" Storm Drain												
Offsite-A1	16000	0.367	400	0.93%	0.41	0.34	26.55	29.24	2.31	0.55	0.35	0.07
A2	56070	1.287	340	1.00%	0.43	0.37	23.09	25.38	2.51	0.60	1.40	0.28
										Total Basin A (12" Line)	**1.75**	**0.35**
Runoff to Street												
Offsite-B1	8010	0.184	267	0.50%	0.95	0.93	5.82	6.59	4.26	1.04	0.74	0.18
										Total Basin B (To Street)	**0.74**	**0.18**
									Total Undeveloped Discharge from Basins A & B		**2.49**	**0.53**

DEVELOPED CONDITIONS

Location	Area (sf)	Area (acres)	Overland Flow Length (ft)	Ground Slope %	Runoff Coeficient 100-year	Runoff Coeficient 2-year	Time of Concentration 100-year (min)	Time of Concentration 2-year (min)	Rainfall Intesity 100-year (in/hr)	Rainfall Intesity 2-year (in/hr)	Discharge 100-year (cfs)	Discharge 2-year (cfs)
Runoff to Exist. 12" Storm Drain												
Offsite-A1	16000	0.367	400	1.77%	0.80	0.70	9.32	12.42	3.73	0.85	1.10	0.22
A2	9625	0.221	210	1.16%	0.64	0.55	11.92	14.25	3.42	0.80	0.48	0.10
A3	19001	0.436	477	0.55%	0.64	0.55	23.06	27.57	2.51	0.57	0.70	0.14
										Total Basin A (12" Line)	**2.28**	**0.45**
Runoff to Street												
Offsite-B1	8010	0.184	267	0.50%	0.95	0.93	5.82	6.59	4.26	1.04	0.74	0.18
B2	27444	0.630	179	1.00%	0.64	0.55	11.56	13.82	3.46	0.81	1.39	0.28
										Total Basin B (To Street)	**2.14**	**0.46**
									Total Developed Discharge from Basins A & B		**4.42**	**0.91**

18 Road Surface Storm Drainage Capacity

Equation:Qt=(0.56/n)(Sx^1.67)(S^0.5)(T^2.67)

Where: Qt = Total Half-Roadway Discharge Capacity for Width 'T'
n = 0.016 Mannings n for Pavement
Sx = 0.02 Pavement Cross Slope
S = 0.005 Gutter Slope Along Road
T = 15.5 Width of street Flow

Qt = (0.56/0.016)(0.02^1.67)(0.005^0.5)(15.5^2.67)
Qt = 5.43 cfs (Provides for 8-ft clear lane)
2.14 cfs required (100 Year Frequency)

On-Site Increase in Runoff for Developed Conditions

	Discharge 100-year (cfs)	Discharge 2-year (cfs)
Total On-Site Developed Discharge	2.58	0.52
Total On-Site Undeveloped Discharge	1.40	0.28
OnSite Runoff Increase	**1.18**	**0.23**

On-Site Conduit Capacities

	Pipe size (in)	Area (sf)	P (ft)	A/P	Length (ft)	Outlet Elevation (ft)	Inlet Elev (ft)	Surcharge (ft)	Head (ft)	Hyd Slope (ft/ft)	n	Discharge Capacity (cfs)
12" Capacity	12	0.785	3.142	0.25	265.46	4528.82	4530.00	0	1.18	0.445%	0.013	**2.38**
8" Capacity*	8	0.349	2.094	0.17	30	4530.00	4530.15	0	0.15	0.500%	0.013	**0.85**

* Both 8-inch lines are on the same grade and the same length.

EXHIBIT 9