MASTER DRAINAGE STUDY

FOR

WESTERN SUN DEVELOPMENT

COLORADO SPRINGS, COLORADO

MSM/SP Group
An International Professional
Services Organization

570 West 44th Avenue
Denver, Colorado 80216
(303) 455-7321

MASTER DRAINAGE STUDY

FOR

WESTERN SUN DEVELOPMENT

COLORADO SPRINGS, COLORADO

Job Number 5099607

AUGUST, 1982

PREPARED FOR

NORTH AMERICAN HOMES, INC.
P.O. Box 25069
Colorado Springs, Colorado 80936

PREPARED BY

MSM CONSULTANTS, INC.
570 West 44th Avenue
Denver, Colorado 80216
(303) 455-7321

HYDRAULIC REPORT

TABLE OF CONTENTS

MASTER DRAINAGE REPORT

FOR

WESTERN SUN DEVELOPMENT

JOB NO. 5099607
AUGUST, 1982

INTRODUCTION

The intent of the Master Drainage Study for the proposed Western Sun Development is to present the conceptual storm drainage system design. Offsite storm runoff evaluation, conceptual onsite initial and major storm drainage system design and the evaluation of downstream effects are within the scope of this study.

The proposed Western Sun Development is located in Section 22, Township 14 South, Range 66 West of the Sixth Principal Meridian, City of Colorado Springs, Colorado (See Vicinity Map - Figure 1). The Western Sun project site is located on 81.6 acres which is proposed for multi-family, park site and commercial development. The site is bordered on the north by the Spring Creek Channel and the Valley Hi Golf Course, on the west by Chelton Road and vacant land, on the south by Landmark Lane and Fountain Boulevard, and on the east by Academy Park Loop, Avenida Del Sol, Academy Boulevard, Academy Point Subdivision and Gateway Plaza.

The dedicated interior streets will have 60-foot rights-of-way with 40-foot flowline to flowline widths and 8" vertical curb and gutter. The interior private drives will be located within easements with 30-foot flowline to flowline widths and 6" vertical curb and gutter. Existing drainage facilities adjacent to the site include a 42" steel pipe culvert under Academy Boulevard. to drain Offsite Basin OS1 (See Figure 11), a temporary ditch to drain the culvert to Spring Creek, the Spring Creek channel and the four barrel box culvert (4 - 8' x 6') which conveys Spring Creek under Chelton Road. All these existing drainage facilities are located on the north side of the site.

The underlying soils identified on the site are of the Nelson and Midway complexes as shown on the SCS soil survey maps (Reference 2). See Figure 2 for a plot of the site on the soils map.

The recently completed Colorado Springs Flood Insurance Study (presently in draft form) calculated the 100-year, 500-year, and floodway elevations for Spring Creek adjacent to the site. Based on a review of this new flood insurance study the site is presently not subject to 100-year or 500-year flooding nor is any portion of the site located within a floodway. Previous drainage studies in the vicinity are: A) Final Drainage Study for Academy Point Subdivision (Reference 4); B) Drainage Study for Gateway Plaza (Reference 5); and C) Spring Creek Drainage Study (Reference 6).

CRITERIA

Storm drainage criteria published by the City of Colorado Springs (Reference 1) is the basis of this study. The initial storm evaluation is based on the 5-year event and the major storm evaluation is based on the 100-year event. The street curb and gutter, inlets, cross pans and storm sewer make up the initial storm drainage system. The major storm drainage system is made up of swales, street low points and other grading techniques in addition to the initial storm drainage system to safely convey major storm flows to the appropriate location.

The modified SCS method is the procedure used for the storm runoff determination of all subbasins. A review of the SCS soils maps shows that the project site is composed of 48% Midway soils and 52% Nelson soils by area (See Soils Map - Figure 2). Composite curve numbers and percent imperviousness for various types of land use are tabulated in Figure 3 and are based on data presented in Table 2 of the Colorado Springs storm drainage criteria(Reference 1). Ground cover in open space areas (parks) are assumed to be in good condition.

The values of percent impervious vs CN are plotted in Figure 4 for this site. The following table presents the various proposed Western Sun land uses with the associated curve numbers and total runoff.

			Runoff (inches)	
Land Use	% Impervious	Curve Number	5-year P= 2.1	100-year P=3.50
Villa Homes[1]	60%	89	1.11	2.36
Townhomes[1]	60%	89	1.11	2.36
Commercial	85%	94	1.49	2.84
Open Space	5%	74	0.40	1.24

[1] calculations shown in Figure 5. Storm runoff calculations (5-year event) for a range of basins (Figure 6) is used to construct the Drainage Area/5-year Discharge Chart (Figure 7).

A similar analysis is followed to determine the Drainage Area/ 100-year Discharge Chart (Figures 8 & 9). Street discharge capacities (5-year event) for the 40 foot residential streets are tabulated in Figure 10. These street capacities are from Table 5 of the Colorado Springs storm drainage criteria. Street and curb capacity calculations for the 30 foot private streets are located on Appendix Page 11. The maximum depth of flow at the gutter flowline was set at the top of curb (6 inches) for the 5-year event and 1.0 feet for the 100-year event. The Mannings "n" value was assumed to be .016 for the 5-year calculation (paved areas only) and .021 for the 100-year calculation. The streets are analyzed at critical locations to determine that major storm dischages are contained in the street rights-of-way (See Appendix Page 12). Inlets on grade were assumed to pick up approximately 40% of the street flow calculated to that point.

The preliminary evaluation of storm sewer, inlets, and street capacities are based on proposed street grades and will be revised with design grades in the final drainage study.

DISCUSSION:

The results of this Master Drainage Study are shown on the Drainage Plan enclosed in the back of this report as well as in the computation sheets in the Appendix.

Basin A

Basin A contains approximately 11.1 acres consisting of proposed townhomes and approximately 1 acre of existing single-family residences. Runoff from the basin will collect in the streets and be conveyed west to the low point of the basin (Design Point 1). The 5-year flows will be conveyed by storm sewer to Spring Creek and 100-year flows will be conveyed by a swale to Spring Creek. The peak runoff rates for the 5-year and 100-year frequency storms are 21 cfs and 58 cfs, respectively.

Basin B

Basin B consists of approximately 3.6 acres of proposed townhomes which will drain into "B" Street and be conveyed offsite into Chelton Road (Design Point 2). The flow will then be conveyed north in Chelton Road to Spring Creek. The peak runoff rates for the 5-year and 100-year frequency storms will be 7 cfs and 32 cfs, respectively.

Offsite Basin OC1

This basin consists of approximately 1.1 acres of a proposed residential land which will sheetflow into Basin C.

Basin C

Basin C consists of approximately 39.7 acres of proposed multi-family housing, commercial development, and a park/ greenbelt area with recreation facilities. Runoff from this basin will be conveyed in the streets, storm sewer, and swales to the north property line where the flow will outfall into Spring Creek (Design Point 3). The peak runoff rates leaving the basin will be 73 cfs and 330 cfs for the 5-year and 100-year frequency storms, respectively.

Basin D

Basin D consists of approximately 4.2 acres of proposed multi-family housing. Runoff will be conveyed to the north property line via storm sewer and swales where the 5-year flows will outfall into the proposed north side storm sewer. The 100-year flows will outfall into the golf course drainage way and be conveyed west to Spring Creek (Design Point 4). Peak flows from the basin will be 7 cfs and 34 cfs for the 5-year and 100-year frequency storms, respectively.

Offsite Basin OE1 and OE2

Offsite Basin OE1 consists of approximately 20.0 acres of the proposed Academy Point Subdivision which will drain onto the site. The subdivision proposes a storm sewer system across the Western Sun Development and outfall into the north side storm sewer system. This system will convey most of the 5-year frequency runoff from the site (64.5 cfs of the total 68 cfs). The remaining 3.5 cfs and the 100-year flow of 113.4 cfs will be conveyed in Avenida Del Sol onto the Western Sun Development. Runoff from the Western Sun Development will not enter the Academy Point storm sewer system.

Offsite Basin OE2 consists of approximately 1.9 acres of South Academy Boulevard which will flow onto the site via "A" Street.

Basin E

Basin E consists of approximately 12.6 acres, which along with Offsite Basins OE1 and OE2, will drain to a low point in "A" Street. Inlets and storm sewer will convey the 5-year frequency flow of 43.5 cfs to the north side storm sewer system (Design Point 5). The peak 100-year runoff of 277.4 cfs will top the curb and flow into the golf course drainage swale and be conveyed west to Spring Creek.

Basin F

Basin F consists of approximately 6.3 acres of proposed commercial development. Runoff from the basin will collect in "B" Street and be conveyed offsite into Fountain Boulevard (Design Point 6). The flow will then be conveyed west and north to Spring Creek via Fountain Boulevard and Chelton Road. Peak runoff rates will be 17 cfs and 50 cfs for the 5-year and 100-year frequency storms, respectively.

Basin G

Basin G consists of approximately 7.0 acres of proposed multi-family housing. Runoff will be collected in the streets and be conveyed offsite to the future Landmark Lane via two swales (Design Point 7). The flow will then be conveyed west to Chelton Road and north to Spring Creek. Peak runoff rates will be 13 cfs and 44 cfs for the 5-year and 100-year frequency storms, respectively.

Offsite Basin OS1

This basin is located just east of the Western Sun Development and consists of approximately 53.8 acres of proposed commercial and multi-family development in Gateway Plaza. The runoff from this development will be conveyed to an existing 42" steel pipe under South Academy Boulevard and into the proposed north side storm sewer (See "North Side Storm Sewer" Section). The peak 5-year runoff rate is based on a previous drainage study for Basin OS1 (Reference 5). The 100-year runoff rate is based on calculations presented on Page 18, Appendix. These flows are 117 cfs and 244 cfs for the 5-year storm and 100-year storms, respectively.

Downstream Effects

Runoff from this development will be conveyed to Spring Creek by the north side storm sewer and the golf course drainage swale.

According to the Spring Creek Drainage Study (Reference 6) the 100-year frequency runoff hydrograph for Spring Creek at Chelton Road peaks at 60 minutes. The runoff from the Western Sun Development will peak between 20 and 25 minutes and will not significantly effect the existing Spring Creek peak runoff. Therefore, the Western Sun Development will not adversely effect drainage facilities downstream of the site.

North Side Storm Sewer

Construction plans have been prepared for an outfall storm sewer system located in a 15-foot easement north of the

Western Sun Development in the Valley Hi Golf Course. The proposed storm sewer and the existing 42-inch pipe under Academy Boulevard will be connected at Manhole 1A. The 5-year design flow at this point will be 117 cfs. At Manhole #2 the design flow will be increased to 141 cfs with the addition of storm runoff from Basins E1 through E4 and OE1. At Manhole #4, 64.5 cfs from Academy Point Subdivision will be hydrologically added to increase the total design flow to 203 cfs. Basin D1 is added at Manhole #6 to increase the 5-year design discharge at Spring Creek to 211 cfs. Reference is made to the hydrologic calculations Appendix Pages 19 through 22. The storm sewer invert profile is located at a minimum of 3.5' below the overflow swale profile to allow for a 1.7% minimum slope on all gravel trench drains. Five gravel trench drains are to be field located by the soils consultant to alleviate golf course high ground water problems. Pipe slopes are also set to a grade that will allow the storm sewer to convey at a minimum 110% of the design flows to compensate for uncertainties in the final drainage patterns. The 5-foot diameter manholes will require an 18-inch thick base for stability due to the high ground water table (See Appendix Page 28). The existing temporary drainage ditch will be graded through and some grading is proposed at the outfall point to provide for the discharge of the 100-year storm runoff to Spring Creek. The 100-year discharge at Academy Boulevard is 244 cfs and will increase to 491 cfs at the outfall point at Spring Creek. The limits of 100-year flooding in the golf course area are shown on the construction plans. These limits are based on normal depth calculations (See Appendix Page 23). The 5-year depth of flow in Spring Creek is also based on a normal depth calculation. The 5-year discharge is estimated to be 350 cfs from the Frequency Discharge Curve (See Appendix Page 30). CDM supplied the 10-,50-, and 100-year discharges for their draft Colorado Springs Flood Insurance Study (Reference 7). The 5-year water surface elevation will be 5963.2. Since the outfall elevation is 5963.50 there will not be any backwater effects in the storm sewer at the outfall. All of the proposed storm sewer is designed for gravity drain and free outfall, therefore the hydraulic grade line will be below the pipe crown profile (i.e. no pressure flow).

Rip-rap erosion protection will be provided at the outfalls of all storm sewer systems. All swales will be designed in the Final Drainage Study to convey the 100-year flows.

This Master Drainage Study is submitted for review and approval.

Prepared by: Randy Kennedy
Randy Kennedy
Design Engineer

Checked by: David L. Mallory
David L. Mallory, P.E.
Project Engineer

Reviewed by: Edward G Beadenkopf
Edward G. Beadenkopf, P.E.
Department Manager, Hydrology

RK:ln

REFERENCES

1) City of Colorado Springs, "Determination of Storm Runoff Criteria", March 1977.

2) Soil Conservation Service, "Soil Survey of El Paso County Area, Colorado" June 1981.

3) Soil Conservation Service, "Procedures for Determining Peak Flows in Colorado", March 1980.

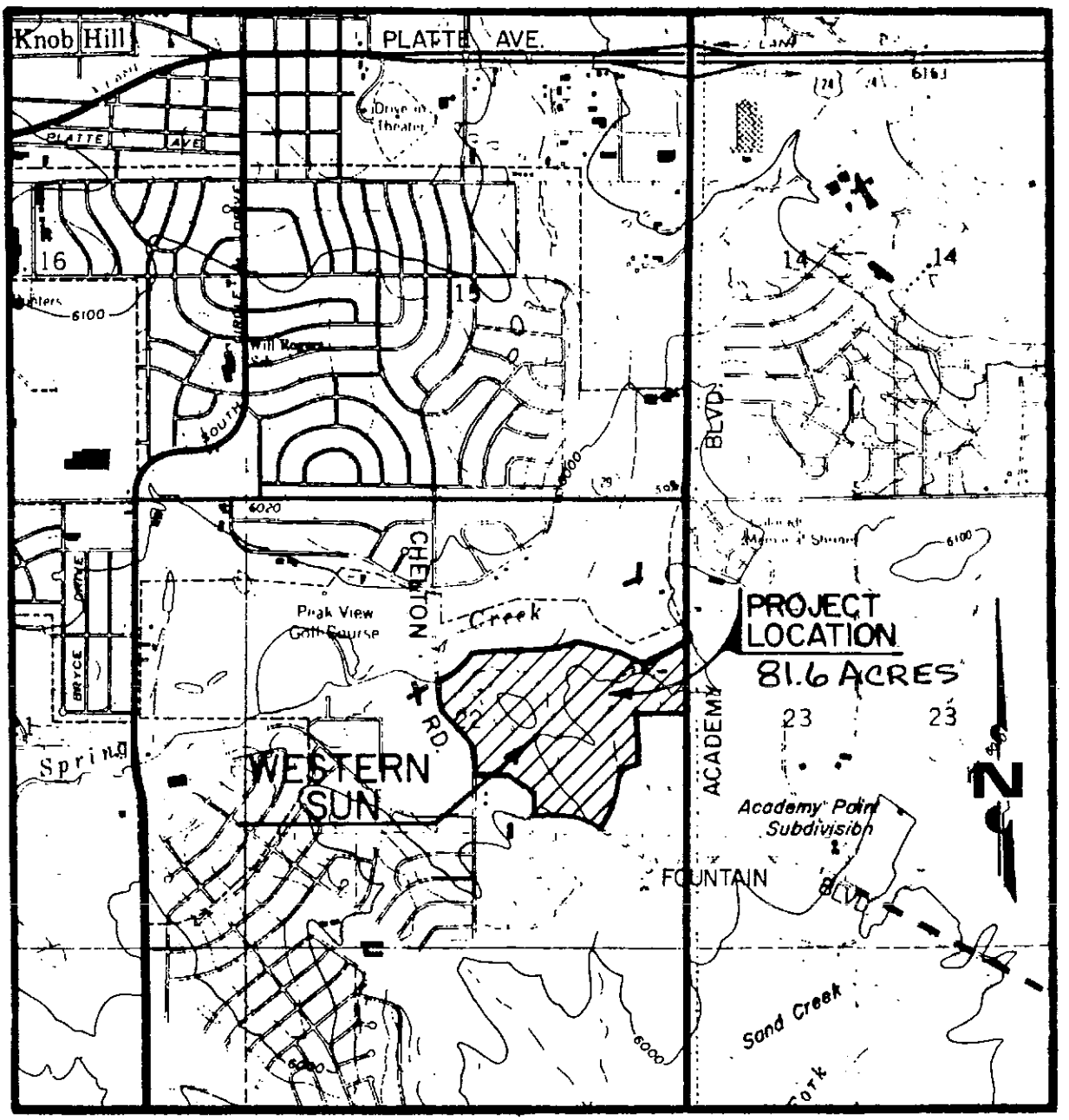
4) "Final Drainage Study for Academy Point Subdivision", prepared by EHMG Engineers-Consultants, June 1982.

5) "Drainage Study for Gateway Plaza Filing No. 1" prepared by Weiss Consulting Engineers, Inc., March 1981.

6) "Spring Creek Drainage Study" prepared by The Lincoln DeVore Testing Laboratory, March 1968.

7) "Draft Flood Insurance Study, Colorado Springs" prepared by CDM, 1982.

APPENDIX



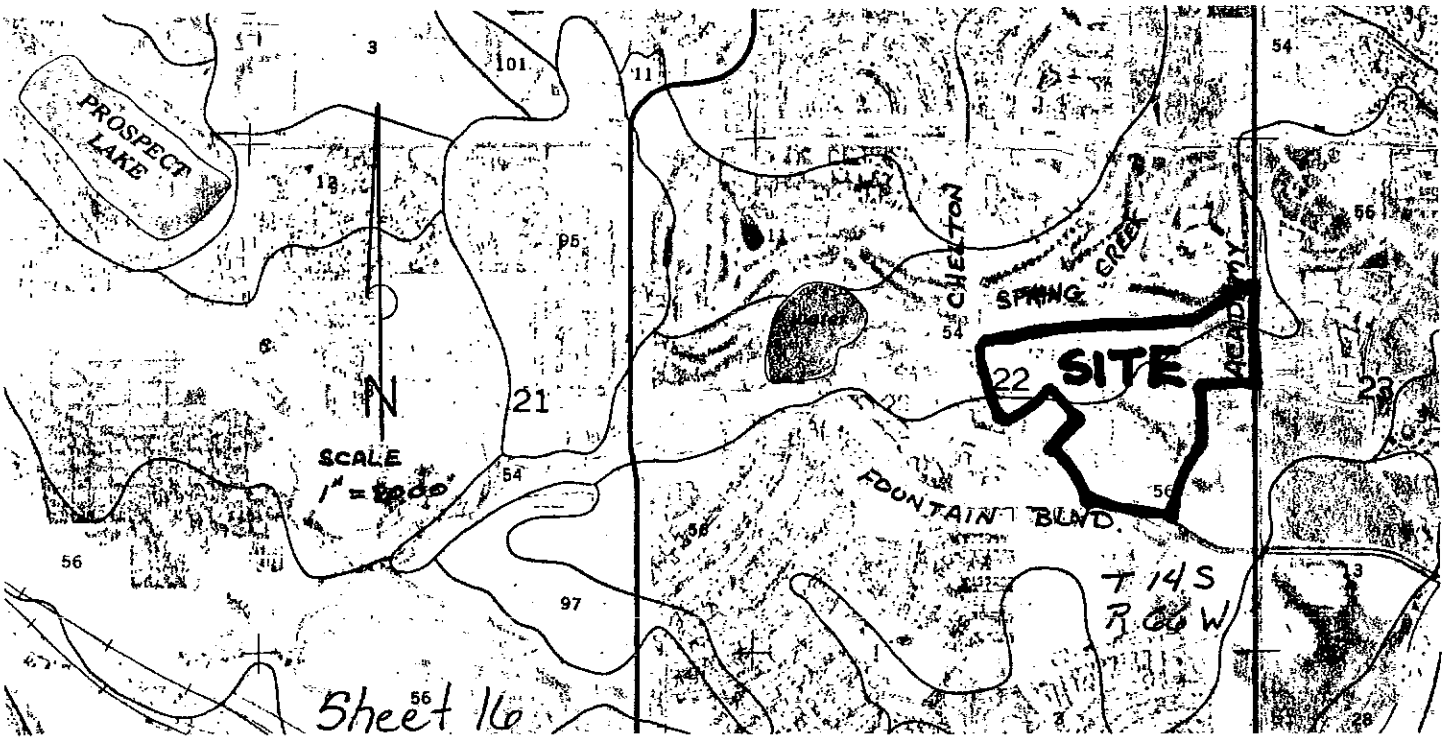
VICINITY MAP
SCALE 1" = 2000'

MSM CONSULTANTS, INC. **FIGURE 1**

MSM CONSULTANTS, INC. **DENVER, COLORADO**

By RC Date 7/7/82 PROJECT Western Sun Sheet No. ___ of ___

Checked By DM Date 7/8/82 SCS Soils Group Determination Job No. 5099607



Area composed of 48% Midway (#54)
52% Nelson (#56)

Nelson soil:

45% Nelson (Group B)
30% Tassel (Group D)
} Soil Survey of El Paso County Pg. 37

$$\frac{.45(CN_B) + .30(CN_D)}{.75} = .60(CN_B) + .40(CN_D)$$

Midway Soil:

Group D

Determine Composite CN:

$$CN = .48[CN_D] + .52[.60(CN_B) + .40(CN_D)]$$

$$= .31(CN_B) + .69(CN_D)$$

Figure 2

MSM CONSULTANTS, INC. DENVER, COLORADO

By RC Date 7/7/82 PROJECT Western Sun Sheet No. ___ of ___

Checked By DM Date 7/8/82 Determine Composite CN Job No. 5099607

Land Use	% Impervious	CN Values Group B	Group D	Composite *
Open Space	≈ 5	61	80	74
Residential	20	68	84	79
	25	70	85	80
	30	72	86	82
	38	75	87	83
	47	78	89	85
	65	85	92	90
Industrial	72	88	93	91
Commercial & Business	85	92	95	94
Paved Areas	98	98	98	98

* Composite $CN = .31(CN_B) + .69(CN_D)$

Figure 3

MSM CONSULTANTS, INC. DENVER, COLORADO

By RC Date 7/7/82 PROJECT Western Sun Sheet No. ___ of ___

Checked By DM Date 7/7/82 % Impervious vs. CN Job No. 5099607

for Composite Soil

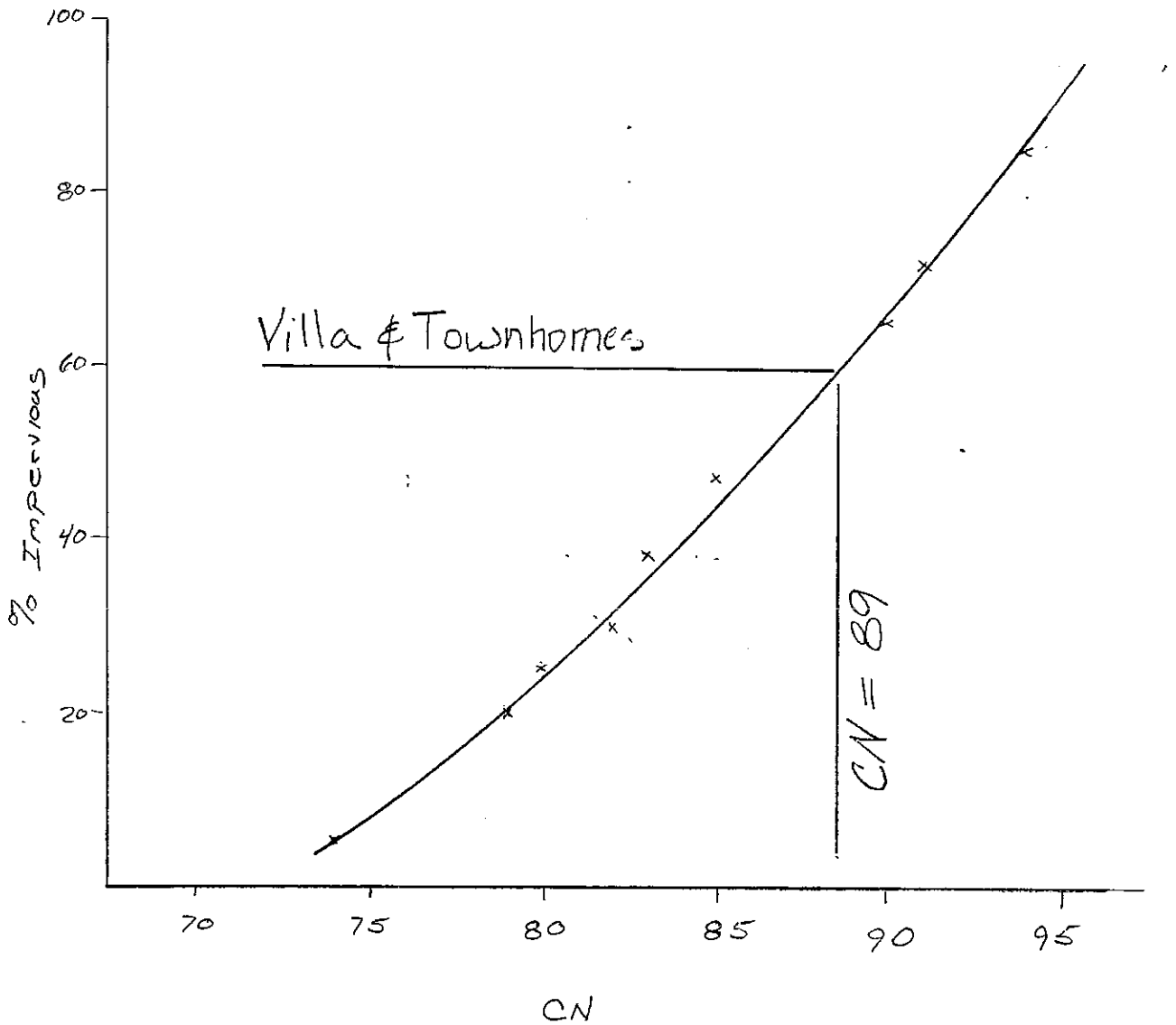


Figure 4

MSM CONSULTANTS, INC. **DENVER, COLORADO**

By RC Date 7/7/82 PROJECT Western Sun Sheet No. ___ of ___

Checked By DM Date 7/8/82 Determine % Impervious Job No. 5099607

for Residential Areas

Villa Homes

Use 60% Impervious for Villa & Townhomes

Impervious Areas:

Private Parking & Street	33' × 3150'	= 103,950
Private Street	24' × 2100'	= 50,400
Collector Street	25' × 2350'	58,750
Units 100, 200, 300	4300 SF × 28	= 120,400
Unit 400	5250 SF × 11	= 57,750
	Total Impervious	= 391,250
	Total Area	= 710,000
	% Impervious	= 55%

Townhomes

Units	1450 × 107	= 155,150
Private Streets	24 × 2600	= 62,400
Collector Street	26 × 1500	= 39,000
	Total Impervious	= 256,550
	Total Area	= 450,000
	% Impervious	= 57%

Figure 5

MSM CONSULTANTS, INC. DENVER, COLORADO

By RC Date 7/7/82 PROJECT Western Sun Sheet No. ___ of ___

Checked By DM Date 7/8/82 Determine CFS/acre Job No. 5099607

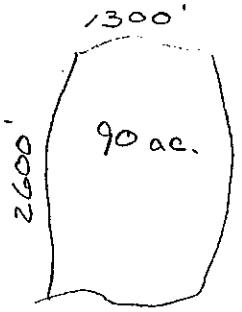
5-YEAR STORM

	Land Use	Open Space	Townhomes	Commercial & Business
	CN	74	89	94
Area (acres)	CSM/in \ P(in)	0.40	1.11	1.49
90	1010	57	158	212
60	1040	39	108	145
30	1100	21	57	77
10	1110	7	19	26

From Fig. 1 Colo. Springs Criteria

* The time of concentration used in determining CSM/in. was calculated by using basins of an assumed shape which were twice as long as they were wide. The basin travel time was calculated using an assumed value of 10.0 fps and this was added to an initial time of concentration of 10.0 minutes.

EXAMPLE:



$$t_c = 10.0 \text{ min} + \frac{2600 \text{ ft}}{(10 \text{ fps})(60 \text{ sec/min})}$$

$$= 14 \text{ min}$$

BASIN AREA ACRES	BASIN AREA SQ. MI.	TIME MIN	TIME HRS
90	0.14	14	0.23
60	0.09	13	0.22
30	0.05	11	0.18
10	0.02	10	0.17

Figure 6

MSM CONSULTANTS, INC. DENVER, COLORADO

By RC Date 7/7/82 PROJECT Western Sun Sheet No. ___ of ___

Checked By DM Date 7/8/82 D.A./Discharge - 5 yr. Job No. 5099607

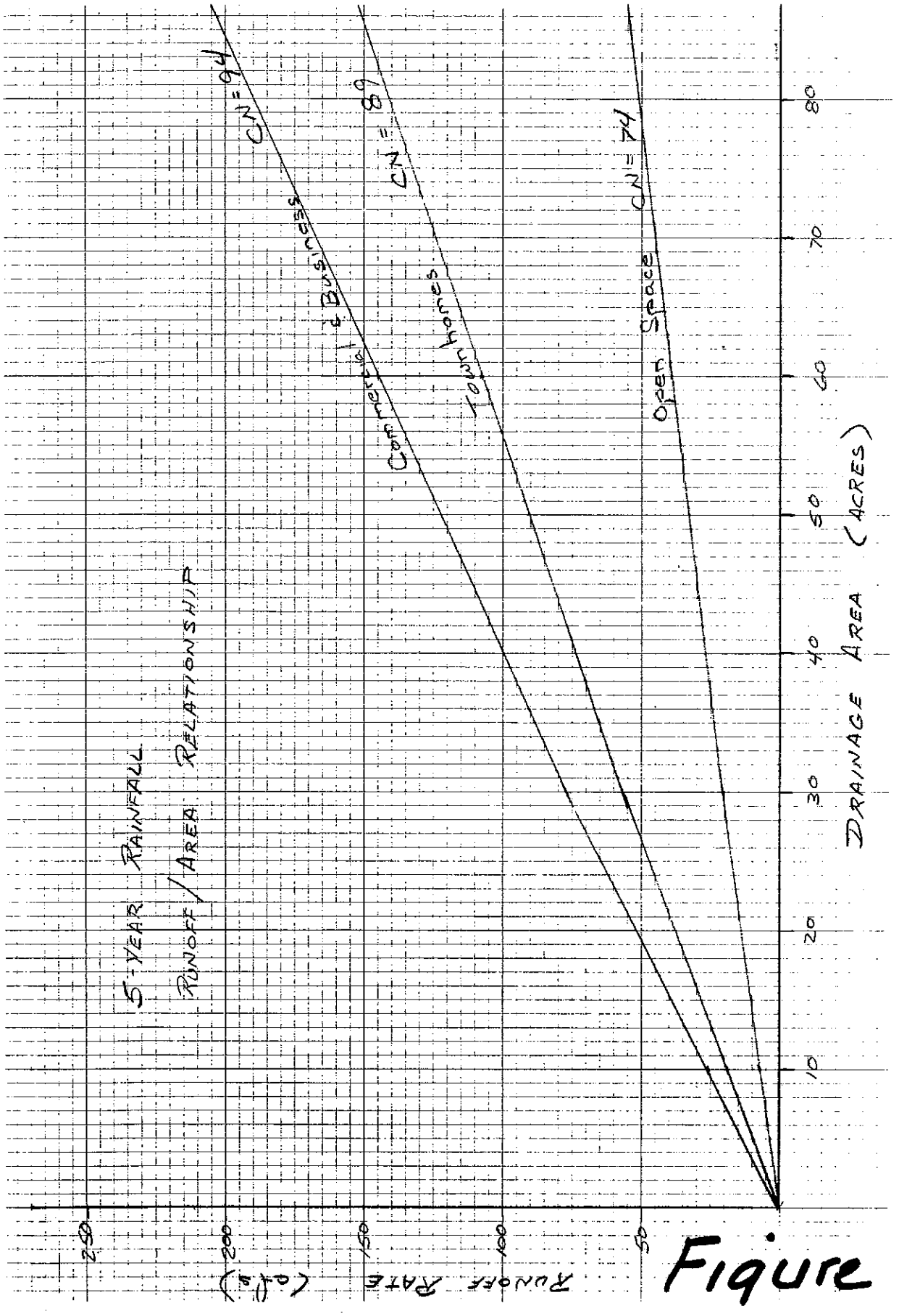


Figure 7

MSM CONSULTANTS, INC. DENVER, COLORADO

By RPK Date 8/1/82 PROJECT Western Sun Sheet No. ___ of ___

Checked By DLM Date 8/6/82 Determine CFS/Acre Job No. 5099607

100-yr. storm.

	Land Use	Open Space	Townhomes	Commercial & Business
	CN	74	89	94
Area (acres)	CSM/in ↓ \ P (in) →	1.24	2.36	2.84
90	1040	181	344	414
60	1070	124	237	285
30	1110	65	123	148
10	1160	22	42	51

From Fig. 1 Colo. Springs Criteria.

Note: Time of concentration used to determine CSM/inch based upon 5 year t_c minus one minute.

Basin Area (acres)	t_c min.	t_c hr.
90	13	0.22
60	12	0.2
30	10	0.17
10	9	0.15

Figure 8

MSM CONSULTANTS, INC. DENVER, COLORADO

By RPK Date 8/4/82 PROJECT Western Sun Sheet No. ___ of ___

Checked By DLM Date 8/6/82 D.A. / Discharge - 100yr Job No. 5097607

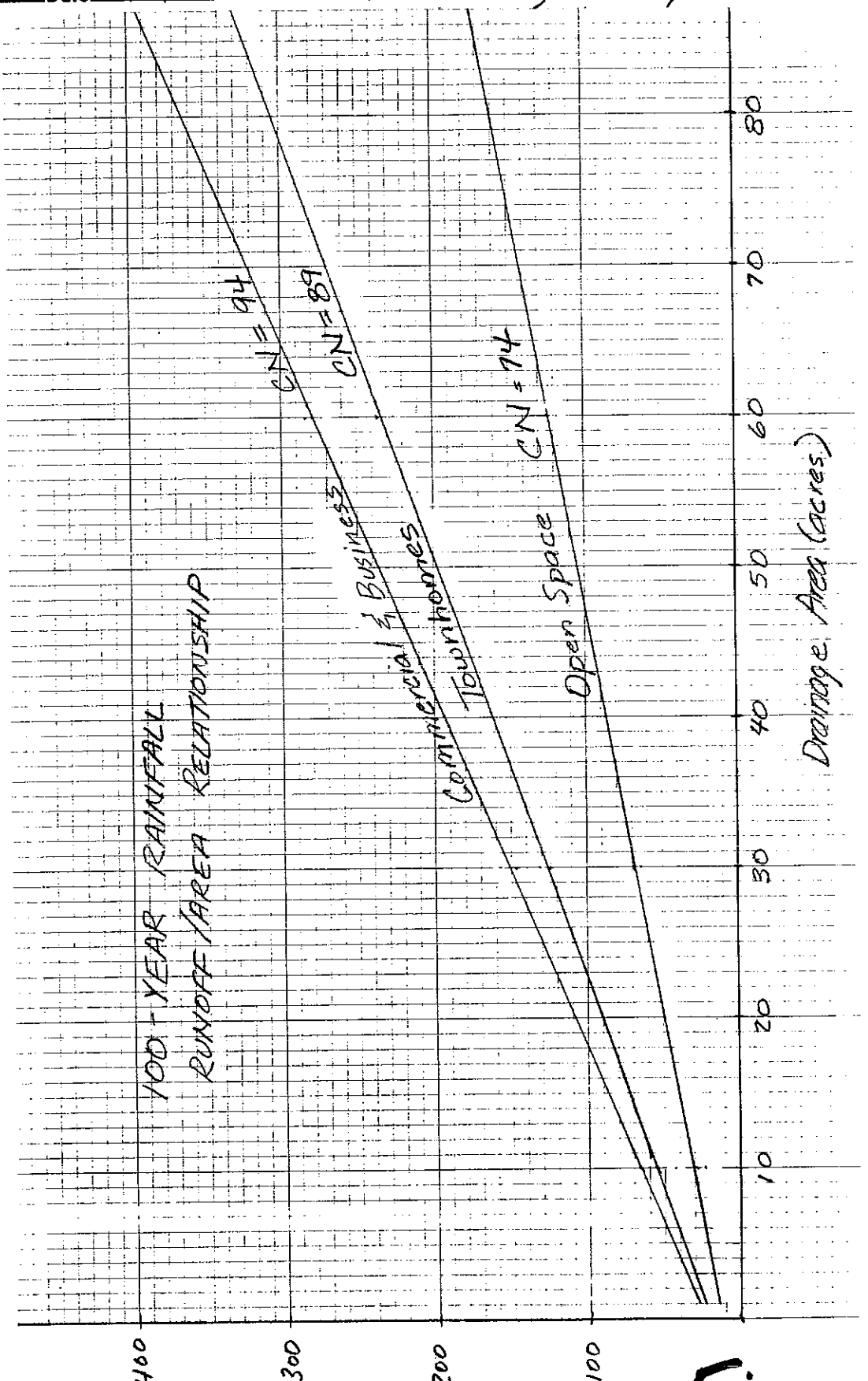


Figure 9

MSM CONSULTANTS, INC. DENVER, COLORADO

By RC Date 7/7/82 PROJECT Western Sun Sheet No. ___ of ___

Checked By DM Date 7/8/82 Street Capacities Job No. 5099607

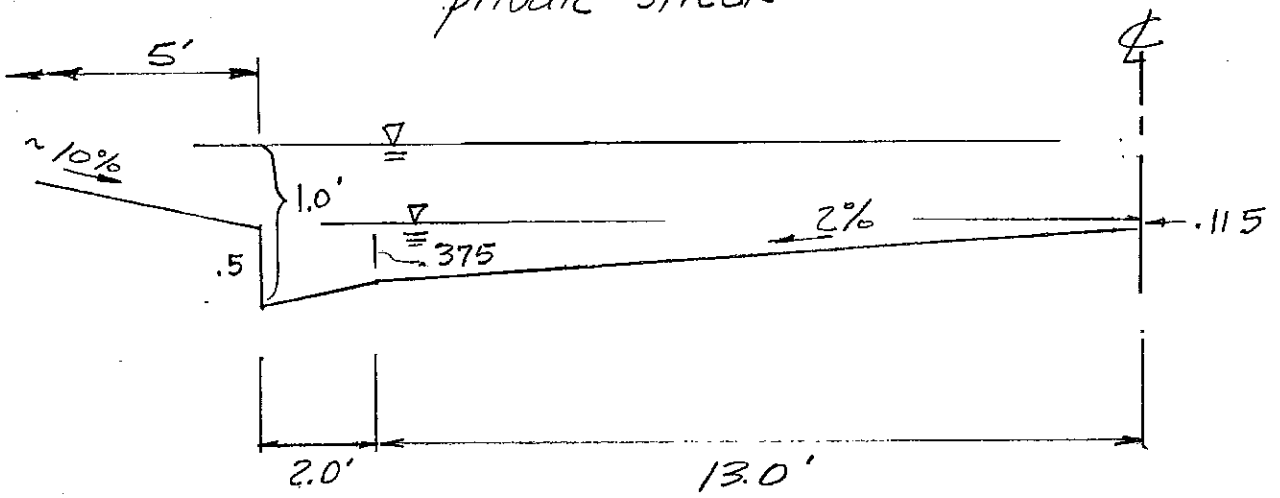
SLOPE %	40' RESIDENTIAL ① FPS	CFS
0.5	3.90	30.1
1.0	5.51	42.6
1.5	6.75	52.2
2.0	7.79	60.2
2.5	8.71	67.4
3.0	9.54	73.8
3.5	10.31	79.7
4.0	11.02	85.2
4.5	11.69	90.4
5.0	12.32	95.3
5.5	12.92	99.9
6.0	13.49	104.3

Source: City of Colorado Springs Criteria Ref. 1

① 8" Vertical Curbs - Full Storm Water Capacity (with level curbs)

Figure 10

Calculations for private streets



Capacity Curb to Curb: $n = 0.016$ ✓

$$\text{Area} = 2\left[\frac{.375+.5}{2}(2) + \frac{.375+.115}{2}(13.0)\right] = 8.12 \text{ ft}^2$$

$$\text{W.P.} = 2[.5+2+13.0] = 31 \text{ ft}$$

$$R^{2/3} = \left(\frac{8.12}{31}\right)^{.667} = 0.409$$

$$Q = \frac{1.49}{.016}(8.12)(.409)(s)^{1/2} = 309.3\,(s)^{1/2}$$

@ $S = 0.005$ $Q = 21.9$ cfs ✓ $K = 309.43$

Capacity @ 1.0' above flowline: $n = 0.021$

for 100 yr. storm.

$$\text{Area} = 8.12 + 2\left(\frac{15+20}{2}(.5)\right) = 25.6 \text{ ft}^2$$

$$\text{W.P.} = 31 + 2(5.02) = 41.04$$ ✓

$$R^{2/3} = \left(\frac{25.6}{41.04}\right)^{.667} = 0.730$$

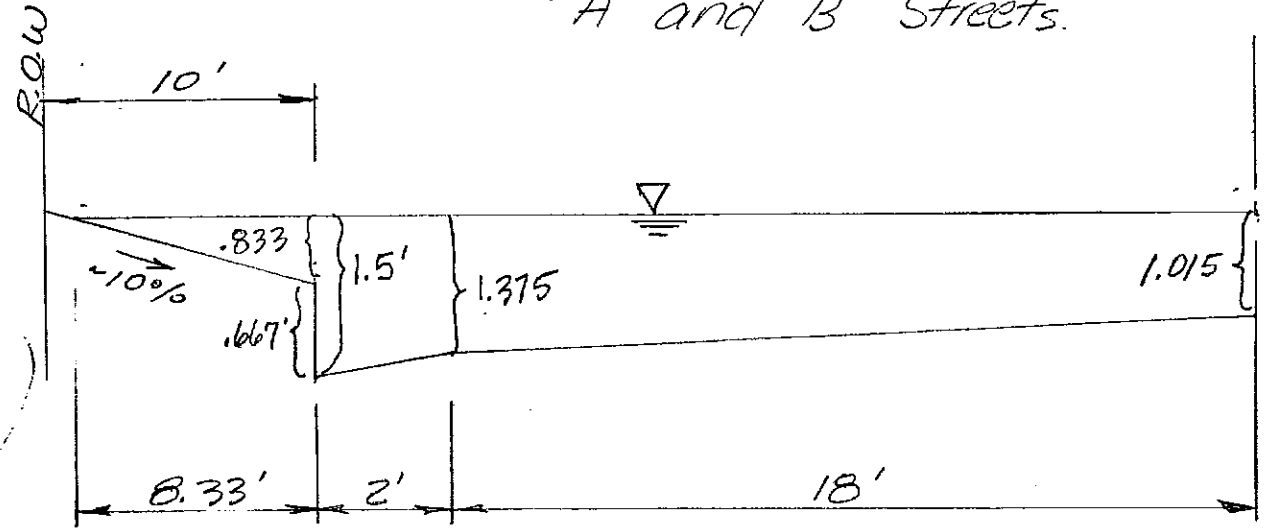
$$Q = \frac{1.49}{.021}(25.6)(0.730)(S)^{1/2} = 1325.8\,(S)^{1/2}$$

@ 0.5% slope

$Q = 93.8$ cfs @ 3.7 fps.

Major Storm

"A" and "B" Streets.



Typical Section

Use $n=0.025$ to account for area from flowline to right-of-way.

$$A = 2\left[\frac{.833 \times 8.33}{2} + \frac{1.5+1.375}{2}(2) + \frac{1.375+1.015}{2}(18)\right] = 55.71 \text{ ft}^2$$

$$W.P. = 2\left[8.37 + .667 + 2 + 18\right] = 58.08 \text{ ft}$$

$$R^{2/3} = \left(\frac{55.71}{58.08}\right)^{0.667} = 0.973$$

$$Q = \frac{1.49}{.025}(55.71)(0.973)(S)^{1/2} = 3230.7\,(S)^{1/2}$$

Critical Street Sections

In "B" Street - Sub-basin C5 - $Q_{100} = 256$ cfs.

$S_{min} = 1.27\%$ $\therefore Q_{CAP} = 3230.7(.0127)^{1/2} = 364$ cfs ✓

In "A" Street - Sub-basin E4 - $Q_{100} = 277.4$ cfs

$S_{min} = 0.87\%$ $Q_{CAP} = 3230.7(.0087)^{1/2} = 301$ cfs ✓

MSM CONSULTANTS, INC. DENVER, COLORADO

By RPK Date 7/30/82 PROJECT Western Sun Sheet No. ___ of ___

Checked By DLL Date 8/5/82 Runoff Computations Job No. 5099607

Basin(s)	Area (acres)	ΣArea	Discharge (cfs) 5-Year / 100-Year	Street Slope (%)	Curb Capacity (cfs)	Remarks
A1	11.1		21 / 58	0.5 est. min.	21.9	Sump Inlet @ Outfall Pt. Design Ft. 1
B1	3.6		7 / 32	1.27		Flows into Chelton Rd. Design Ft. 2
C1	9.3		24 / 64	3.5	79.7	
+C2	4.4	13.7	+8/34 = 32/98	2.1	61.5	
C3	8.6		17 / 60	0.5 est. min.	21.9	Sump Inlet @ Outfall Pt. Zero Bypass
C4	1.7		3 / 26			
C1→C4		24.0	52 / 184	2.1	61.5	Inlet - Assume 20cfs Bypass
+C5	0.9	24.9	+3/24 = 55/208	2.1	61.5	

MSM CONSULTANTS, INC. DENVER, COLORADO

By RPK Date 7/30/82 PROJECT Western Sun Sheet No. ___ of ___

Checked By DLL Date 8/3/82 Runoff Computations Job No. 5099607

Basin(s)	Area (acres)	Σ Area	Discharge (cfs) 5-Year / 100-Year	Street Slope (%)	Curb Capacity (cfs)	Remarks
OC1	1.1		3 / 22			Residential
C6	7.1		5 / 26			Park Sump Inlets Zero Bypass
C1→C6 +OC1		33.1	6.0 / 256	2.1	61.5	
C7	1.3		3 / 24			Sump Inlet Zero Bypass
C8	3.9		8 / 34			Sump Inlet Zero Bypass
C1→C8 +OC1		38.3	71 cfs total flow in storm sewer			
C9	2.5		2 / 16			
C1→C9 +OC1		40.8	2 / 330 +71 cfs in storm sewer			Outfalls into Spring Creek Design Pt. 3

MSM CONSULTANTS, INC. DENVER, COLORADO

By RPK Date 7/30/82 PROJECT Western Sun Sheet No. ___ of ___

Checked By DLH Date 8/5/82 Runoff Computations Job No. 5099607

Basin(s)	Area (acres)	ΣArea	Discharge (cfs) 5-Year / 100-Year	Street Slope (%)	Curb Capacity (cfs)	Remarks
D1	4.2		7 / 34	0.5 est min	21.9	Design Pt. 4 Sump Inlets at low point = Zero Bypass
OE1	20.0		68 / 113.4			Flows from Academy Point Drainage Study 64.5 cfs is in storm sewer 3.5 cfs Bypass
+E1	2.5	22.5	+5/28 = 8.5/141.4	0.87	20 ½ street	
+E2	0.7	23.2	+3/20 = 11.5/161.4			
OE2	1.9		6/32			
E3+ E1→E2 +OE1→OE2	8.3	33.4	+22/58 = 39.5/251.4			
+E4	1.1	34.5	+4/26 = 43.5/277.4	0.87	40	Sump Inlets Required Zero Bypass Design Pt. 5

MSM CONSULTANTS, INC. DENVER, COLORADO

By RPK Date 7/30/82 PROJECT Western Sun Sheet No. ___ of ___

Checked By DLM Date 8/5/82 Runoff Computations Job No. 5099607

Basin(s)	Area (acres)	ΣArea	Discharge (cfs) 5-Year / 100-Year	Street Slope (%)	Curb Capacity (cfs)	Remarks
F1	6.3		17 / 50	1.11 "B" St.	42.6	Design Pt 6 Flows South into Fountain Boulevard
G1	7.0		13 / 44			Flows into Landmark Lane. Design Pt. 7

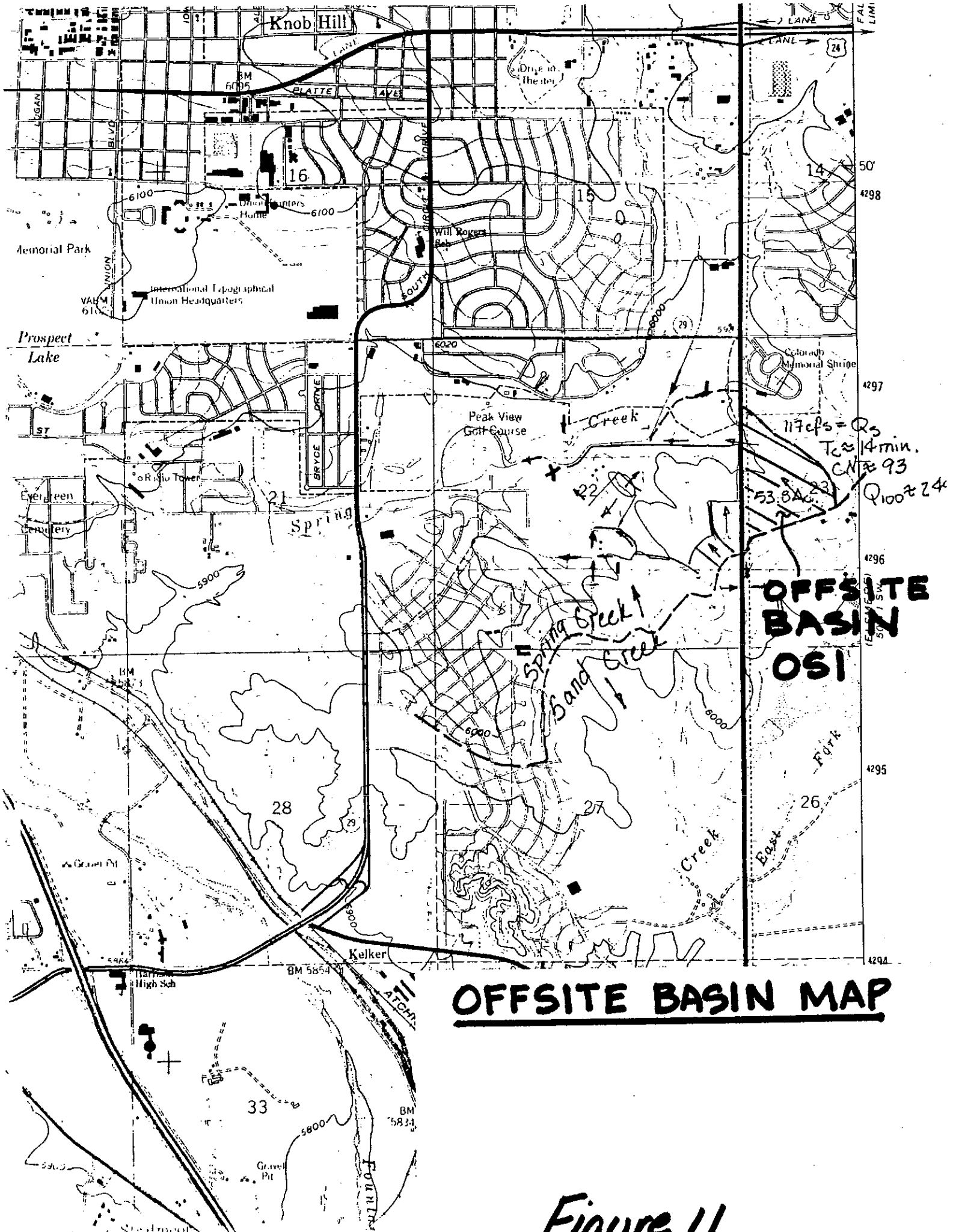

Knob Hill
PLATTE AVE
Drive-in Theater
Memorial Park
International Typographical Union Headquarters
Prospect Lake
Peak View Golf Course
Will Rogers Sch.
Colorado Memorial Shrine
Evergreen Cemetery
Spring Creek
Sand Creek
East Fork
Creek
Kelker
Harrison High Sch
Gravel Pit
117cfs = Q5
Tc ≈ 14 min.
CN ≈ 93
Q100 ≈ 24
53.8Ac.
OFFSITE BASIN OS1
OFFSITE BASIN MAP

Figure 11

MSM CONSULTANTS, INC. DENVER, COLORADO

By RPK Date 8/2/82 PROJECT Western Sun Sheet No. ___ of ___

Checked By DLM Date 8/5/82 Offsite Basin OS1 Job No. 5099607

Runoff Calculations

From Drainage Study for Gateway Plaza - Filing #1
by Weiss Consulting Engineers, March 1981

$Q_5 = 117$ cfs Area = 53.8 Ac. = 0.084 mi.²

$T_c \approx 14$ min. ∴ CSM = 1010

- From SCS method:

$Q = 117 = P \times 1010 \times 0.084$

$P = 1.38$

Using Table 1 from Colo. Springs Criteria.

$CN \approx 93$

To calculate Q_{100} using CN = 93

$P = 2.74$ Use $T_c = 12$ min ∴ CSM = 1060

$Q_{100} = 2.74 \times .084 \times 1060 = 244$ cfs ✓

Type II A 6 hr 5yr. Storm

OS1 At Academy Blvd

Area = 53.8 Ac. / .084 mi²

CN ~ 93 , Q = 1.38 in.

Unit Flow = 1010 CSM/in.

T_c = 14 min

Q = 117 cfs ← From Gateway Plaza Study

Add E1, E2, E3, E4, OE2 (MH #2)

OS	53.8	93	5003
E1	2.5	89	223
E2	0.7	94	66
E3	8.3	94	780
E4	1.1	94	103
OE2	1.9	94	179
COMPOSITE	68.3	93	6354

T_c = 15 min. - 1 min added for 400 feet storm sewer

Q = 1.41 (68.3/640) 1000 CSM/in.

Q = 150 cfs.

Add Academy Point Flows (Manhole #4)

Area = 20.0 Ac. ①

Discharge = 64.5 cfs (Storm Sewer) ①

3.5 cfs (street) ①

T_c = 15 min. (Basin D) ① + 3 min (Pipe time)

= 18 min. / 0.30 hr.

CSM = 920 CSM / in.

$$Q = [1.41\ (68.3/640.)\ 920] + 64.5$$

$$Q = 203 \text{ cfs.}$$

① From Final Drainage Study Academy Point Sub., EHMG 6/82 Ref. 4

Add D1 (MH # 6) T_c = 18 min.

OS → E3	68.3	93	6352
D1	4.2	89	374
	72.5	93	6726

$$Q = [1.41\ (72.5/640)\ 920] + 64.5$$

$$Q = 211 \text{ cfs.}$$

Type II A 6hr. 100 yr. Storm

OS1 (Academy Blvd.)

Area = 53.8 Ac.
T_c = 12 min. / .20 hrs.
CN = 93

$$Q = 2.74 \text{ in} \times 1060 \frac{CSM}{in} \times \frac{53.8}{640} \text{ sq. mi.}$$

$$Q = 244 \text{ cfs.}$$

Add E1 → E4 + OE2 (MH #2)

Area = 68.3 / 0.107 sq mi.
T_c = 13 min. / 0.22 hrs.
CN = 93

$$Q = 2.74 \text{ in} \times 1030 \text{ CSM/in} \times 0.107$$

$$Q = 302 \text{ cfs.}$$

Add Academy Point Flows, D1 & Northerly Offsite Area

Area =	68.3	OS1+E1 → E4+OE2	(93)
	20.0	Acad. Pt.	(92)
	4.2	D1	(89)
	23.0	Northerly Area	(94)
	115.5	Ac. / 0.18 sq. mi.	

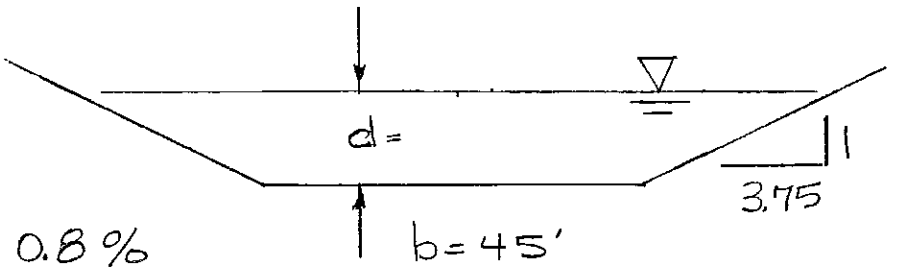
CN = 94

T_c = 16 min / 0.27 hrs.

Q = 2.84 in x 900 CSM/in x 0.18 sq.mi

Q = 491 cfs.

Section A



min. slope = 0.8 %

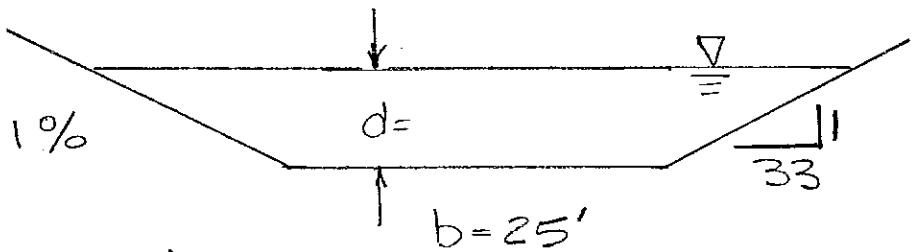
n = 0.03

Q = 491 cfs (100yr.)

@ d = 1.67 ft Q = 492 cfs V = 5.7 fps

@ d = 1.55 ft Q = 433 cfs V = 5.5 fps

Section B



min slope = 1.1 %

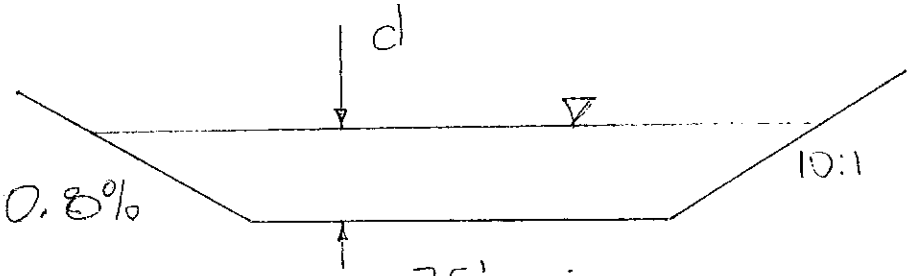
n = 0.03

Q = 491 cfs (100yr)

@ d = 1.44 ft Q = 494 cfs V = 4.7 fps

@ d = 1.36 ft Q = 435 cfs V = 4.6 fps

Section C



min slope = 0.8%

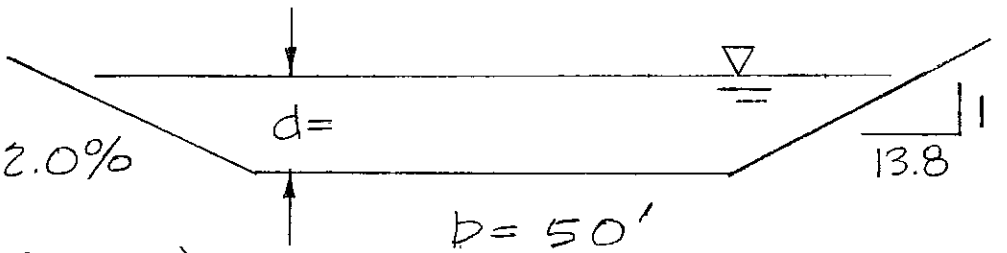
n = .030

Q = 491 cfs (100 yr.) Swale Section

d = 1.22 ft. Q = 493 cfs V = 4.6 fps

d = 1.13 ft. Q = 431 cfs V = 4.4 fps

Section D



min. slope = 2.0%

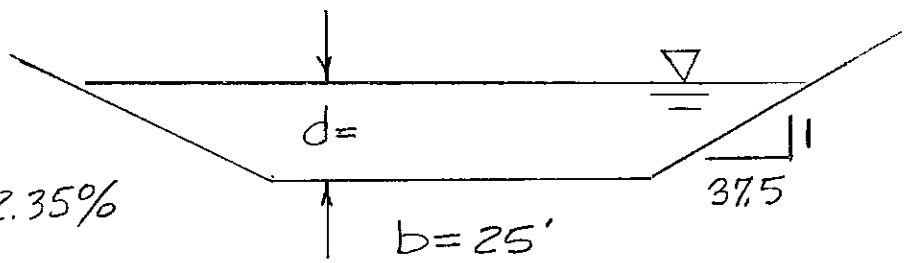
n = 0.03

Q = 302 cfs (100 yr.)

@ d = 0.9 ft Q = 325 cfs V = 5.8 fps.

@ d = 0.8 ft. Q = 263 cfs V = 5.4 fps

Section E



min. slope = 2.35%

$n = 0.030$

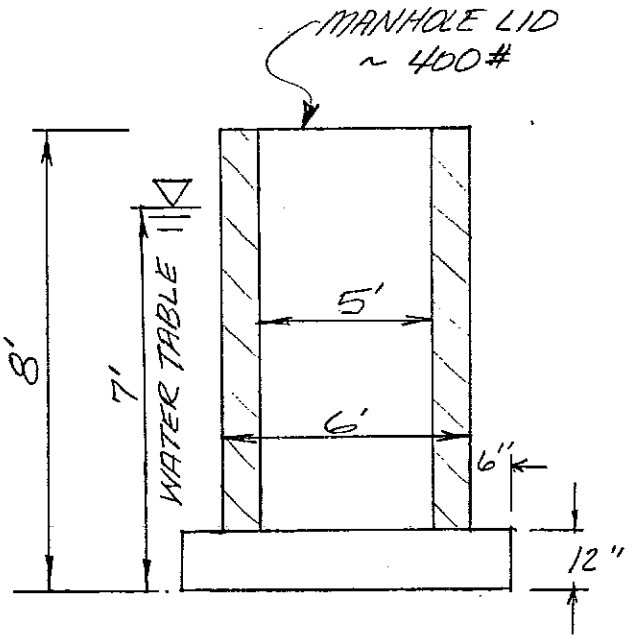
$Q = 244$ cf (100 yr.)

90% = 220 cfs

@ $d = 0.85$ ft $Q = 245$ cfs $V = 5.1$ fps

@ $d = 0.81$ $Q = 221$ cfs $V = 4.9$ fps

Bouyancy Calculation for Manhole



Manhole Weight:

Concrete:

Cylinder Volume - 60.5 ft³

Base Volume - 38.5 ft³ (12" base)

Total 99 ft³

× 150 #/ft³ Concrete

14850 # + 400 = 15250 #

w/18" base — Total volume = 118.3 ft³

weight = 17.745 # + 400#

= 18,145 #

Bouyancy Calc. Cont'd.

Water Bouyancy Force:

Volume displaced by manhole -

Cylinder - 169.6 ft^3

Base - 38.5 ft^3

Total 208.1 ft^3

Bouyancy = 62.4 #/ft^3 x 208.1 ft^3

= 12,985 #

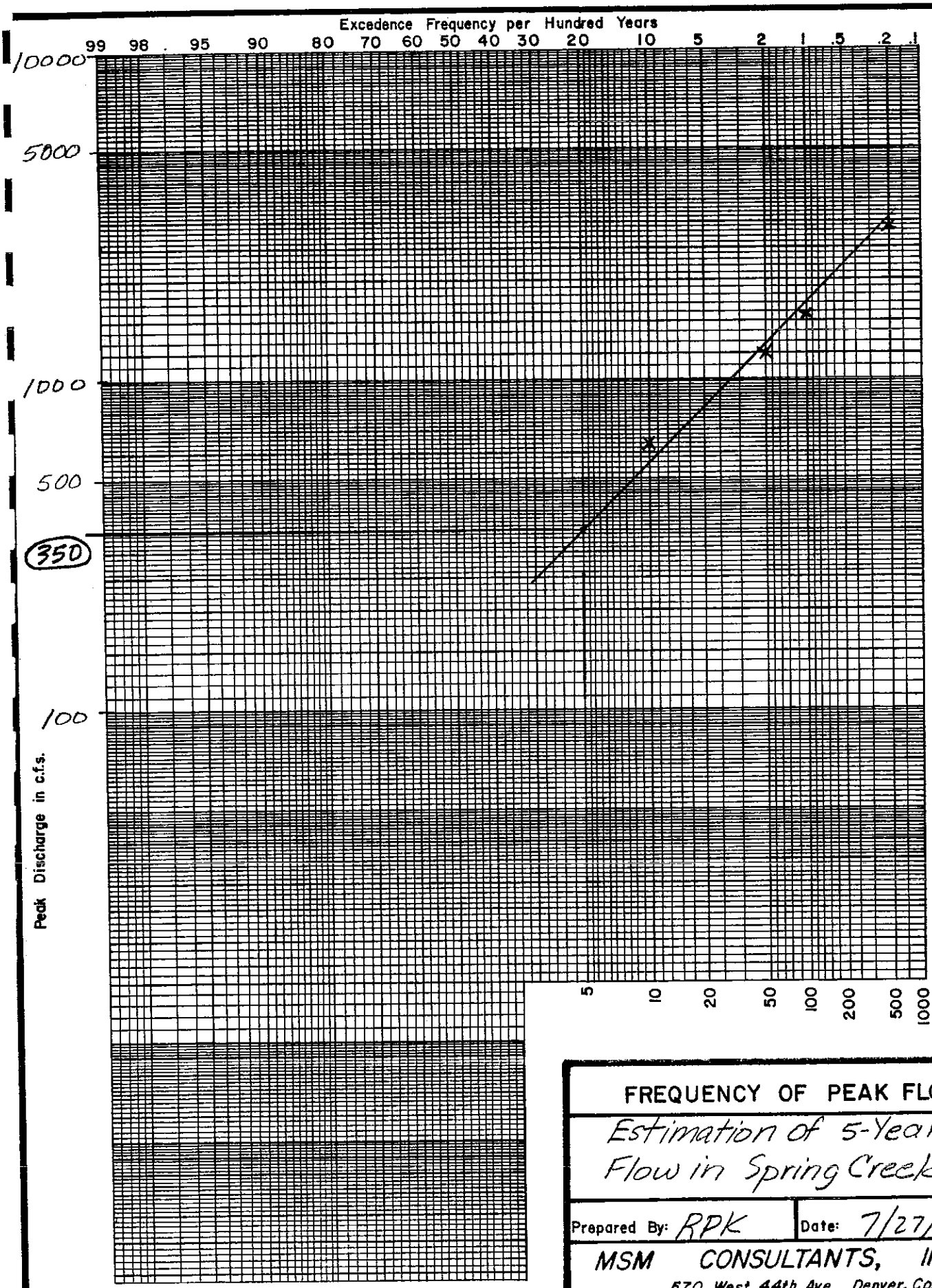
15,250 lbs. (manhole wt.) > 12,985 lbs (water bouyancy)

F.S. = 1.17

∴ Use 18" manhole base

18,145 lbs (manhole wt. 18" base) > 12,985 lbs

Manhole placement will be stable with an 18" base. FS = 1.41



FREQUENCY OF PEAK FLOWS

Estimation of 5-Year Flow in Spring Creek

Prepared By: RPK | Date: 7/27/82

MSM CONSULTANTS, INC.
570 West 44th Ave. Denver, Co.
(303) 455-7321

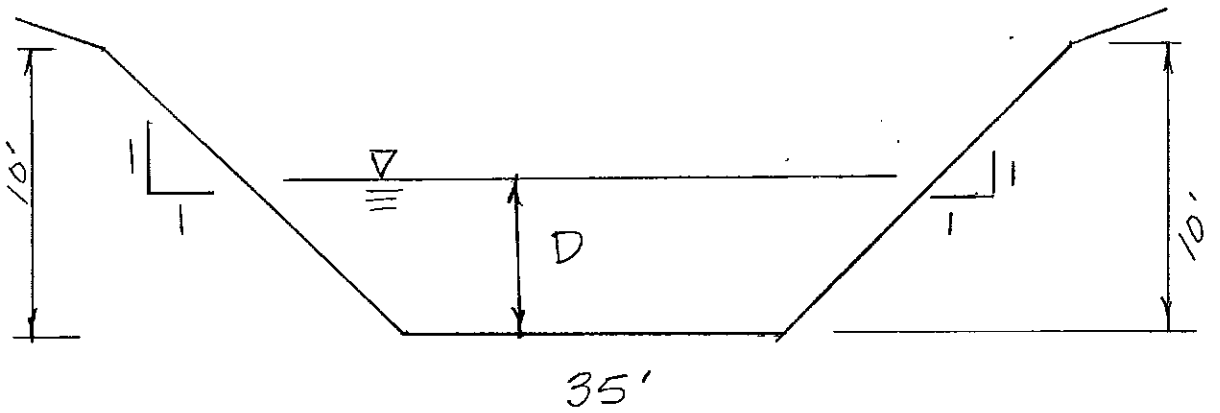
MSM CONSULTANTS, INC. DENVER, COLORADO

By RPK Date 7/27/82 PROJECT Western Sun Sheet No. ___ of ___

Checked By W.A Date 8/6/82 Normal Depth in Job No. 5099609

Spring Creek for 5 yr. Flow.

Typical Section
Downstream of Proposed Storm Sewer Outfall.



– Check Cross-section using 100-yr. data of Flood Insurance Study – Cross-section "W"

@ $D_{100} = 3.7$ $n = 0.02$ $S = .0043$

$A = 143$ $WP = 45.5$

$R^{2/3} = \left(\frac{143}{45.5}\right)^{2/3} = 2.15$

$Q_{100} = \frac{1.49}{.02}(143)(2.15)(.0043)^{1/2} = 1502$ cfs

from F.I.S. $Q_{100} = 1570$ cfs

$\%\ \text{error} = \frac{1570-1502}{1570}(100) = 4.3\%$

Cross-section is good

MSM CONSULTANTS, INC. DENVER, COLORADO

By RPK Date 7/27/82 PROJECT Western Sun Sheet No. ___ of ___

Checked By DLM Date 8/6/82 Normal depth in Job No. 5099609

Spring Creek for 5 yr. Flow

$Q_5 = 350$ cfs

Using typical section Mannings equation:

$n = .02 \quad S = .0043$

Try $D = 1.5'$ $A = 54.75$ $WP = 39.2$

$$Q = \frac{1.49}{.02}(54.75)\left(\frac{54.75}{39.2}\right)^{2/3}(.0043)^{1/2} = 334 \text{ cfs}$$

@ $D = 1.6$ $A = 58.56$ $WP = 39.53$

$$Q = \frac{1.49}{.02}(58.56)\left(\frac{58.56}{39.53}\right)^{2/3}(.0043)^{1/2} = 372$$

Use $D_{5yr.} = 1.55$ ft

Channel Invert = 5961.6'

WSEL (5-yr.) = 5963.2'

FOUR SQUARE
ENGINEERING & SURVEYING, INC.
1120 N. Circle Drive, Suite 1
(Circle U Center)
Colorado Springs, Colorado 80909
Telephone (303) 635-7393

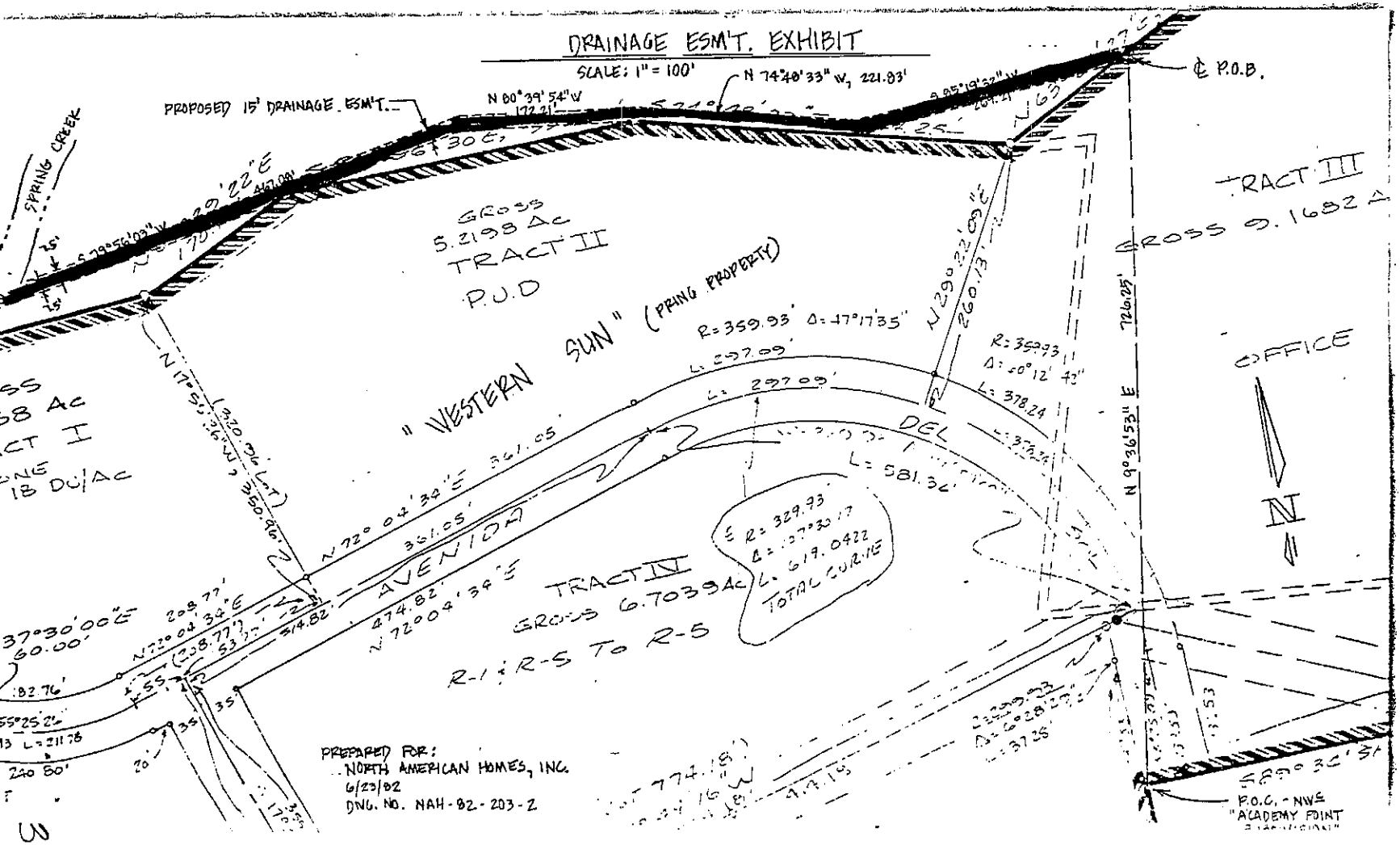
June 23, 1982

PROPOSED 15' DRAINAGE EASEMENT LEGAL DESCRIPTION

A fifteen (15') foot drainage easement lying in a portion of the PRING property (part of the Northeast One-Quarter of Section 22, Township 14 South, Range 66 West of the 6th P.M., situate in the city of Colorado Springs, El Paso County, Colorado), being 7.50 feet each side of the following described centerline:

Commencing at the Northwest corner of ACADEMY POINT SUBDIVISION (Plat Book N-3, Page 77) (all bearings in this description are relative to those platted in said SUBDIVISION); thence N 9°36'53" E, 726.25 feet to a point on the Northerly boundary line of the PRING property, said point also being the point of beginning of the centerline herein described; thence S 85°19'32" W, 269.21 feet; thence N 74°48'33" W 221.83 feet; thence N 80°39'54" W, 172.21 feet; thence S 79°56'03" W, 467.08 feet to intercept the existing channel of Spring Creek and the terminus point of this description.

Prepared for: NORTH AMERICAN HOMES, INC.


DRAINAGE ESM'T. EXHIBIT
SCALE: 1" = 100'
PROPOSED 15' DRAINAGE ESM'T.
N 80°39'54"W
172.21'
N 74°40'33" W, 221.83'
℄ P.O.B.
SPRING CREEK
GROSS
5.2198 AC
TRACT II
P.U.D
"WESTERN SUN" (PRING PROPERTY)
R=359.93' Δ=47°17'35"
L=297.09'
N29°22'09"E
260.13'
TRACT III
GROSS 0.1682 AC
OFFICE
N 9°36'53" E
726.25'
N
TRACT IV
GROSS 6.7039 AC
R-1 & R-5 To R-5
AVENIDA
N 72°04'34" E
361.05'
474.82'
N 17°55'26" W
320.96' (M)
350.46' (R)
R=329.93'
Δ=107°30'17"
L=619.0422
TOTAL CURVE
L=581.32'
PREPARED FOR:
NORTH AMERICAN HOMES, INC.
6/23/02
DWG. NO. NAH-02-203-2
P.O.C. - NW℄
"ACADEMY POINT"