

**MASTER DEVELOPMENT  
DRAINAGE PLAN  
FOR  
ASTROZON BUSINESS PARK**

Prepared For:  
Walter Schmidt  
10830 West 44th Avenue  
Wheat Ridge, CO 80033

Prepared By:  
Associated Design Professionals, Inc.  
1861 Austin Bluffs Parkway, Suite 101  
Colorado Springs, Colorado 80918  
(719) 266-5212

May 29, 1998  
#980402



**ENGINEERS STATEMENT:**

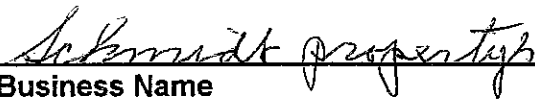
The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the City/County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.


  
\_\_\_\_\_  
Michael A. Bartusek, P.E., #23329



**DEVELOPER'S STATEMENT:**

I, the developer, have read and will comply with all of the requirements specified in this drainage report and plan.

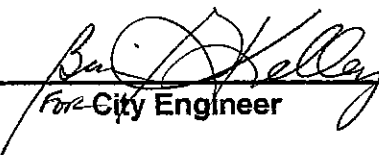
  
\_\_\_\_\_  
Business Name

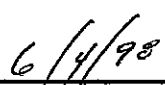
By:   
\_\_\_\_\_

Title:   
\_\_\_\_\_

Address: 10830 West 44<sup>th</sup> Avenue  
Wheat Ridge, CO 80033

Filed in accordance with Section 15-3-906 of the Code of the City of Colorado Springs, Colorado, 1980, as amended.

  
\_\_\_\_\_  
For City Engineer

  
\_\_\_\_\_  
Date

Conditions:

# **ASTROZON BUSINESS PARK MASTER DEVELOPMENT DRAINAGE PLAN**

## **GENERAL**

This is a drainage study for a 8.06 acre site described as a portion of the Northeast quarter of Section 34, Township 14 South, Range 66 West of the 6<sup>th</sup> PM. The site is further described as being adjacent to Astrozon Place. The site is located within the Sand Creek Basin in eastern Colorado Springs. The Master Development Drainage Plan (MDDP) will identify major drainage issues associated with the development. In order to assure conformity, previous drainage reports were considered. These include the "Drainage Report for Hancock Park, Second Filing" approved June 1973, by Cox Surveying Company, "Drainage Report for Hancock Park, Fourth Filing," approved September 1977, also by Cox Surveying Company, and Drainage Report for Hancock Park, 8<sup>th</sup> Filing, by Oliver & Watts, approved July, 1985.

No portion of the site is located within a designated FEMA 100-year floodplain as shown on Map No. 080059-0287E dated November 2, 1994. The site is adjacent to Sand Creek but flow is contained within the channel by a natural berm. According to the El Paso County Area Soil Survey, the soil on the site is an Ellicott loamy coarse sand. This soil can be described as having a rapid permeability, surface runoff is slow and high hazard of erosion. The soil classification is A.

## **METHOD OF COMPUTATIONS:**

The Methodology utilized for this report is in accordance with the City/County Drainage Criteria Manual. The Rational Method for computation of runoff was used.

$$Q = cia$$

Where Q = maximum rate of runoff in cubic feet per second  
c = runoff coefficient representing drainage area characteristics  
I = average rainfall intensity, in inches per hour, for the duration  
required for the runoff to become established  
a = drainage basin size in acres

**EXISTING DRAINAGE CHARACTERISTICS**

The site is currently covered with rangeland grasses. The site slopes vary between 0.5% and 4.0%. Lots 1 and 2 drain to Astrozon Place and to an existing asphalt swale within the adjacent property, Stor-N-Lock Self Storage. A portion of Lot 3 drains to Astrozon Place. Most of the remaining lots drain southwesterly toward San Creek. A small portion of Lot 6 drains directly into the Fountain Mutual Irrigation Ditch. The flows that reach the existing curb and gutter are carried into a standard 10' D10-R inlet at the end of Astrozon Court.

Based on the existing conditions of the site, the following storm flows will result (see Fig. 1):

| <u>Subbasin</u> | <u>5-Year Flow (CFS)</u> | <u>100-Year Flow (CFS)</u> |
|-----------------|--------------------------|----------------------------|
| EX A            | 21.8                     | 45.6                       |
| EX B            | 4.4                      | 9.7                        |

Total cumulative flow from the existing area at the Astrozon Place and Astrozon Court inlet is 21.8 CFS for a 5-year storm and 45.6 CFS for a 100-year storm. The inlet capacity is 23.7 CFS, while the maximum capacity of the storm sewer is 23.8 CFS. Once the capacity of the inlet is exceeded, flows will overtop the existing curb and flow westerly toward Sand Creek. It is recommended that a more defined shallow swale be constructed within the existing 14-foot drainage easement. A swale that is one foot deep with 4:1 side swipes and a 4 foot bottom would accommodate the 100-year flow and not interfere with adjacent uses.

**PROPOSED DRAINAGE CHARACTERISTICS**

The future development will not significantly change the drainage patterns in the area. Flow from each lot will be handled separately. The existing off-site flow patterns will remain the same. Flows from Lot 1 will travel southwesterly, where they are intercepted and carried in an existing swale to Astrozon Place. The flows from Lot 2 will travel through overland flow to the proposed curb and gutter that surrounds each parking area. The curb and gutter will carry

these flows to the existing curb and gutter along Astrozon Place. These cumulative flows will then travel in the curb and gutter along Astrozon Court to the existing inlet.

Lots 3, 4, and 5 will each drain directly into Sand Creek through a grate inlet connected to an 18" RCP storm sewer. Each lot will be drained independently to better control stormwater quality of each site. There will be a 18" landscape berm constructed along the easement line on the south side of Lot 6, to prevent any developed drainage from flowing into the Fountain Mutual Irrigation Ditch.

Based on the developed conditions of the site, the following storm flows will result:

| <u>Subbasin</u> | <u>5-Year Flow (CFS)</u> | <u>100-Year Flow (CFS)</u> |
|-----------------|--------------------------|----------------------------|
| A               | 5.3                      | 10.6                       |
| B               | 5.0                      | 10.0                       |
| C               | 2.9                      | 5.8                        |
| D               | 3.2                      | 6.4                        |
| E               | 3.2                      | 6.4                        |
| OS 1            | 1.9                      | 4.2                        |
| OS 2            | 3.3                      | 6.1                        |
| OS 3            | 9.3                      | 20.2                       |
| OS 4            | 16.7                     | 33.3                       |

The total cumulative flow at the end of Astrozon Place is 22.4 CFS for a 5-year storm and 46.3 CFS for a 100-year storm.

### **BASIN FEE DETERMINATION**

The entire 8.06-acre site is subject to the Sand Creek Basin drainage fees. The 1998 fees required are as follows:

Sand Creek Basin Fees: 8.06 Ac. X \$5,552 = \$44,749  
 Sand Creek Bridge Fees: 8.06 Ac. X \$356 = \$2,869  
 Sand Creek Pond Fees: 8.06 Ac. X (\$335 + \$1,331) = \$13,428

Total fees required: \$61,046

## **SUMMARY**

The Astrozon Business Park Subdivision will cause little or no impact to the surrounding properties and right-of-ways. Most of the drainage pattern is not being changed. The part that is being changed is being directed to a drainage system designed to accommodate those flows. All areas disturbed by construction will be reseeded and erosion control measures will be installed during construction of the proposed sites.

Based on discussions with the Stormwater Management Group, the platting of Lot 1 of this subdivision would not trigger the construction of the Sand Creek Improvements. However, the improvement of any of the lots adjacent to Sand Creek would cause the improvements to Sand Creek to occur. The drainage funds collected for Lot 1 will be held in escrow by the City for the construction of said Sand Creek Improvements. The redesign of the Sand Creek Improvements are currently underway, with construction expected during this calendar year.

# **APPENDIX A**

## **DRAINAGE CALCULATIONS**

# LEGEND

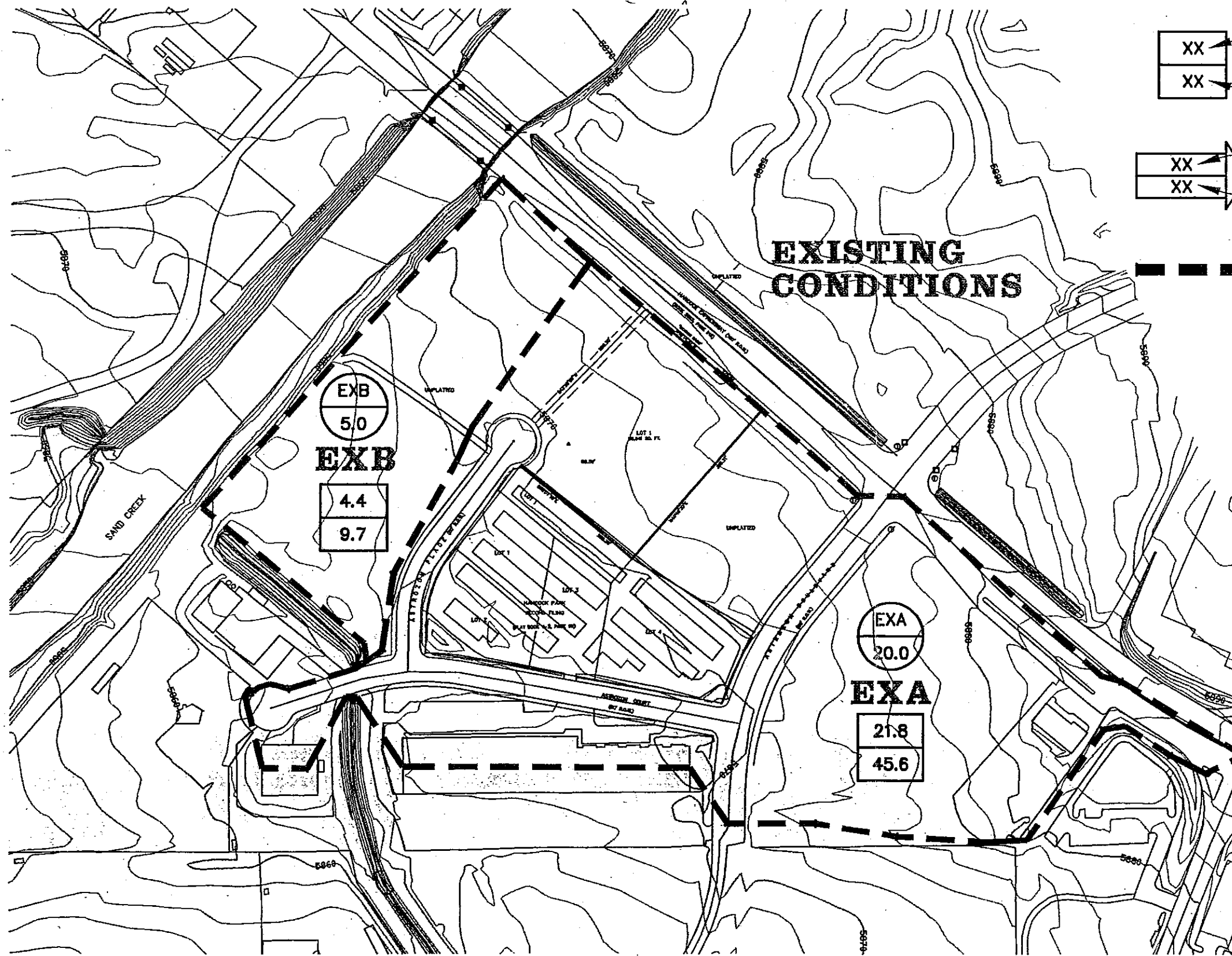
XX BASIN DESIGNATION  
 XX BASIN AREA, ACRES

XX 5 YEAR STORM, CFS  
 XX 100 YEAR STORM, CFS

XX 5 YEAR ACCUMULATED FLOW, CFS  
 XX 100 YEAR ACCUMULATED FLOW, CFS

--- BASIN BOUNDARY

**EXISTING  
 CONDITIONS**

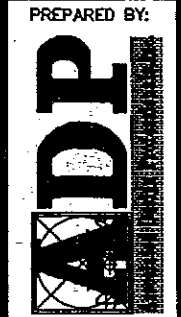


EXB  
 5.0  
**EXB**  
 4.4  
 9.7

EXA  
 20.0  
**EXA**  
 21.8  
 45.6

DESIGNED BY  
 JMM PROJECT ENGINEER  
 MAB PROJECT MANAGER  
 DATE: 4/9/98  
 JOB NO. 980402  
 CAD FILE NO. MAB  
 BASE.DWG  
 DRAWN BY JMM  
 HORZ. 200'  
 VERT. 100'

PREPARED BY:  
**ADP**



1881 South Meade Parkway  
 Suite 101  
 Colorado Springs, CO 80916  
 (719) 595-8222  
 Fax: (719) 595-8244

| NO. | DATE | REVISION | BY |
|-----|------|----------|----|
|     |      |          |    |
|     |      |          |    |
|     |      |          |    |

**ASTROZON BUSINESS PARK**  
**CITY OF COLORADO SPRINGS, COLORADO**  
**EXISTING DRAINAGE PLAN**



|                             |        |        |          |        |          |        |             |       |        |             |       |       |       |         |         |       |       |        |       |       |        |      |  |
|-----------------------------|--------|--------|----------|--------|----------|--------|-------------|-------|--------|-------------|-------|-------|-------|---------|---------|-------|-------|--------|-------|-------|--------|------|--|
| ASTROZON BUSINESS PARK MDDP |        |        |          |        |          |        |             |       |        |             |       |       |       |         |         |       |       |        |       |       |        |      |  |
| PROJ. #980402               |        |        |          |        |          |        |             |       |        |             |       |       |       |         |         |       |       |        |       |       |        |      |  |
| DRAINAGE CALCULATION SHEET  |        |        |          |        |          |        |             |       |        |             |       |       |       |         |         |       |       |        |       |       |        |      |  |
| SOIL TYPE A                 |        |        |          |        |          |        |             |       |        |             |       |       |       |         |         |       |       |        |       |       |        |      |  |
|                             |        |        |          |        |          |        |             |       |        |             |       |       |       |         |         |       |       |        |       |       |        |      |  |
|                             |        |        |          |        |          |        | Initial Tci |       |        | Travel Time |       |       |       |         |         |       |       |        |       |       | length | vel. |  |
| AREA                        | AREA   | C5     | C100     | C5 X A | C100 X A |        | Slope       | ti    |        | Slope       | V     | Tt    | TC    | I5      | I100    | Q5    | Q100  | L      | V     | ^t    |        |      |  |
| DESIG.                      | (acre) | (5 yr) | (100 yr) |        |          | L (ft) | (%)         | (min) | L (ft) | (%)         | (fps) | (min) | (min) | (in/hr) | (in/hr) | (cfs) | (cfs) | (feet) | (fps) | (min) |        |      |  |
| <b>EXISTING CONDITIONS</b>  |        |        |          |        |          |        |             |       |        |             |       |       |       |         |         |       |       |        |       |       |        |      |  |
| EXA                         | 20.00  | 0.50   | 0.60     | 9.98   | 11.98    | 300    | 2.00        | 15.49 | 1600   | 0.80        | 1.50  | 17.78 | 33.26 | 2.18    | 3.81    | 21.75 | 45.60 |        |       |       |        |      |  |
| EXB                         | 5.00   | 0.40   | 0.50     | 2.00   | 2.50     | 800    | 1.60        | 32.39 | 0      | 0.00        | 0.00  | 0.00  | 32.39 | 2.21    | 3.87    | 4.43  | 9.67  |        |       |       |        |      |  |
| <b>DEVELOPED CONDITIONS</b> |        |        |          |        |          |        |             |       |        |             |       |       |       |         |         |       |       |        |       |       |        |      |  |
| OS1                         | 1.90   | 0.40   | 0.50     | 0.76   | 0.95     | 300    | 1.00        | 22.67 | 250    | 0.50        | 1.40  | 2.98  | 25.65 | 2.54    | 4.44    | 1.93  | 4.21  | 240    | 1.4   | 2.86  |        |      |  |
| A                           | 2.30   | 0.70   | 0.80     | 1.61   | 1.84     | 300    | 1.00        | 12.96 | 240    | 0.50        | 1.40  | 2.86  | 15.81 | 3.29    | 5.74    | 6.29  | 10.56 |        |       |       |        |      |  |
| OS1+A                       |        |        |          | 2.37   | 2.79     |        |             |       |        |             |       |       | 28.51 | 2.39    | 4.17    | 5.66  | 11.65 |        |       |       |        |      |  |
| B                           | 1.80   | 0.70   | 0.80     | 1.26   | 1.44     | 180    | 1.66        | 8.49  | 170    | 0.50        | 1.40  | 2.02  | 10.51 | 3.97    | 6.93    | 5.00  | 9.97  |        |       |       |        |      |  |
| OS1+A+B                     |        |        |          | 2.02   | 2.39     |        |             |       |        |             |       |       | 28.51 | 2.39    | 4.17    | 4.83  | 9.98  | 400    | 1.4   | 4.76  |        |      |  |
| OS2                         | 0.70   | 0.90   | 0.95     | 0.63   | 0.67     | 25     | 2.00        | 1.49  | 400    | 1.00        | 2.00  | 3.33  | 4.82  | 5.25    | 9.16    | 3.30  | 6.09  |        |       |       |        |      |  |
| OS1-OS2                     |        |        |          | 2.65   | 3.06     |        |             |       |        |             |       |       | 33.27 | 2.18    | 3.81    | 5.77  | 11.63 | 320    | 1.5   | 3.56  |        |      |  |
| OS3                         | 8.50   | 0.40   | 0.50     | 3.40   | 4.25     | 300    | 2.00        | 18.04 | 500    | 0.80        | 1.80  | 4.63  | 22.67 | 2.72    | 4.76    | 9.26  | 20.21 | 900    | 1.5   | 10.00 |        |      |  |
| OS4                         | 5.90   | 0.70   | 0.80     | 4.13   | 4.72     | 180    | 1.66        | 8.49  | 170    | 0.50        | 1.80  | 1.67  | 10.06 | 4.04    | 7.06    | 16.68 | 33.30 | 460    | 1.4   | 5.48  |        |      |  |
| OS3+OS4                     |        |        |          | 7.53   | 8.97     |        |             |       |        |             |       |       | 32.67 | 2.20    | 3.85    | 16.59 | 34.52 |        |       |       |        |      |  |
| OS1-OS4                     |        |        |          | 10.18  | 12.03    |        |             |       |        |             |       |       | 32.67 | 2.20    | 3.85    | 22.43 | 46.28 |        |       |       |        |      |  |
| C                           | 1.00   | 0.70   | 0.80     | 0.70   | 0.80     | 100    | 1.00        | 7.48  | 250    | 1.00        | 2.00  | 2.08  | 9.56  | 4.13    | 7.21    | 2.89  | 5.76  |        |       |       |        |      |  |
| D                           | 1.20   | 0.70   | 0.80     | 0.84   | 0.96     | 160    | 1.00        | 9.46  | 260    | 1.00        | 2.00  | 2.17  | 11.63 | 3.80    | 6.63    | 3.19  | 6.37  |        |       |       |        |      |  |
| E                           | 1.30   | 0.70   | 0.80     | 0.91   | 1.04     | 130    | 1.00        | 8.53  | 320    | 1.00        | 1.00  | 5.33  | 13.86 | 3.50    | 6.12    | 3.19  | 6.36  |        |       |       |        |      |  |

|                             |             |           |         |      |    |       |       |
|-----------------------------|-------------|-----------|---------|------|----|-------|-------|
| ASTROZON BUSINESS PARK MDDP |             |           |         |      |    |       |       |
| INLET CAPACITY              |             |           |         |      |    |       |       |
| PROPOSED CONDITIONS         |             |           |         |      |    |       |       |
| #980402                     |             |           |         |      |    |       |       |
| DESIGN PT                   | INLET TYPE  | DESIGN YR | Q(area) | Qi/Q | Li | Qi    | Qby   |
| ASTROZON                    | WINDOW SUMP | 5         | 23.70   | 1.00 | 10 | 27.65 | -3.95 |
| COURT                       | WINDOW SUMP | 100       | 48.50   | 1.00 | 10 | 34.53 | 13.97 |
|                             |             |           |         |      |    |       |       |
|                             |             |           |         |      |    |       |       |

Circular Channel Analysis & Design  
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: ASTROZON MDDP

Comment: STORM SEWER CAPACITY

Solve For Full Flow Capacity

Given Input Data:

|                  |              |
|------------------|--------------|
| Diameter.....    | 2.00 ft      |
| Slope.....       | 0.0097 ft/ft |
| Manning's n..... | 0.013        |
| Discharge.....   | 22.28 cfs    |

Computed Results:

|                         |              |
|-------------------------|--------------|
| Full Flow Capacity..... | 22.28 cfs    |
| Full Flow Depth.....    | 2.00 ft      |
| Velocity.....           | 7.09 fps     |
| Flow Area.....          | 3.14 sf      |
| Critical Depth....      | 1.68 ft      |
| Critical Slope....      | 0.0093 ft/ft |
| Percent Full.....       | 100.00 %     |
| Full Capacity.....      | 22.28 cfs    |
| QMAX @.94D.....         | 23.97 cfs    |
| Froude Number.....      | FULL         |

Circular Channel Analysis & Design  
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: ASTROZON MDDP

Comment: STORM SEWER CAPACITY

Solve For Full Flow Capacity

Given Input Data:

|                  |              |
|------------------|--------------|
| Diameter.....    | 1.50 ft      |
| Slope.....       | 0.0200 ft/ft |
| Manning's n..... | 0.013        |
| Discharge.....   | 14.86 cfs    |

Computed Results:

|                         |              |
|-------------------------|--------------|
| Full Flow Capacity..... | 14.86 cfs    |
| Full Flow Depth.....    | 1.50 ft      |
| Velocity.....           | 8.41 fps     |
| Flow Area.....          | 1.77 sf      |
| Critical Depth....      | 1.40 ft      |
| Critical Slope....      | 0.0173 ft/ft |
| Percent Full.....       | 100.00 %     |
| Full Capacity.....      | 14.86 cfs    |
| QMAX @.94D.....         | 15.98 cfs    |
| Froude Number.....      | FULL         |

Trapezoidal Channel Analysis & Design  
Open Channel - Uniform flow

Worksheet Name: ASTROZON BUS. PARK

Comment: OVERFLOW SWALE CAPACITY

Solve For Depth

Given Input Data:

|                   |              |
|-------------------|--------------|
| Bottom Width..... | 4.00 ft      |
| Left Side Slope.. | 4.00:1 (H:V) |
| Right Side Slope. | 4.00:1 (H:V) |
| Manning's n.....  | 0.035        |
| Channel Slope.... | 0.0100 ft/ft |
| Discharge.....    | 24.00 cfs    |

Computed Results:

|                   |                            |
|-------------------|----------------------------|
| Depth.....        | 0.97 ft                    |
| Velocity.....     | 3.14 fps                   |
| Flow Area.....    | 7.64 sf                    |
| Flow Top Width... | 11.76 ft                   |
| Wetted Perimeter. | 11.99 ft                   |
| Critical Depth... | 0.79 ft                    |
| Critical Slope... | 0.0223 ft/ft               |
| Froude Number.... | 0.69 (flow is Subcritical) |

## **APPENDIX B**

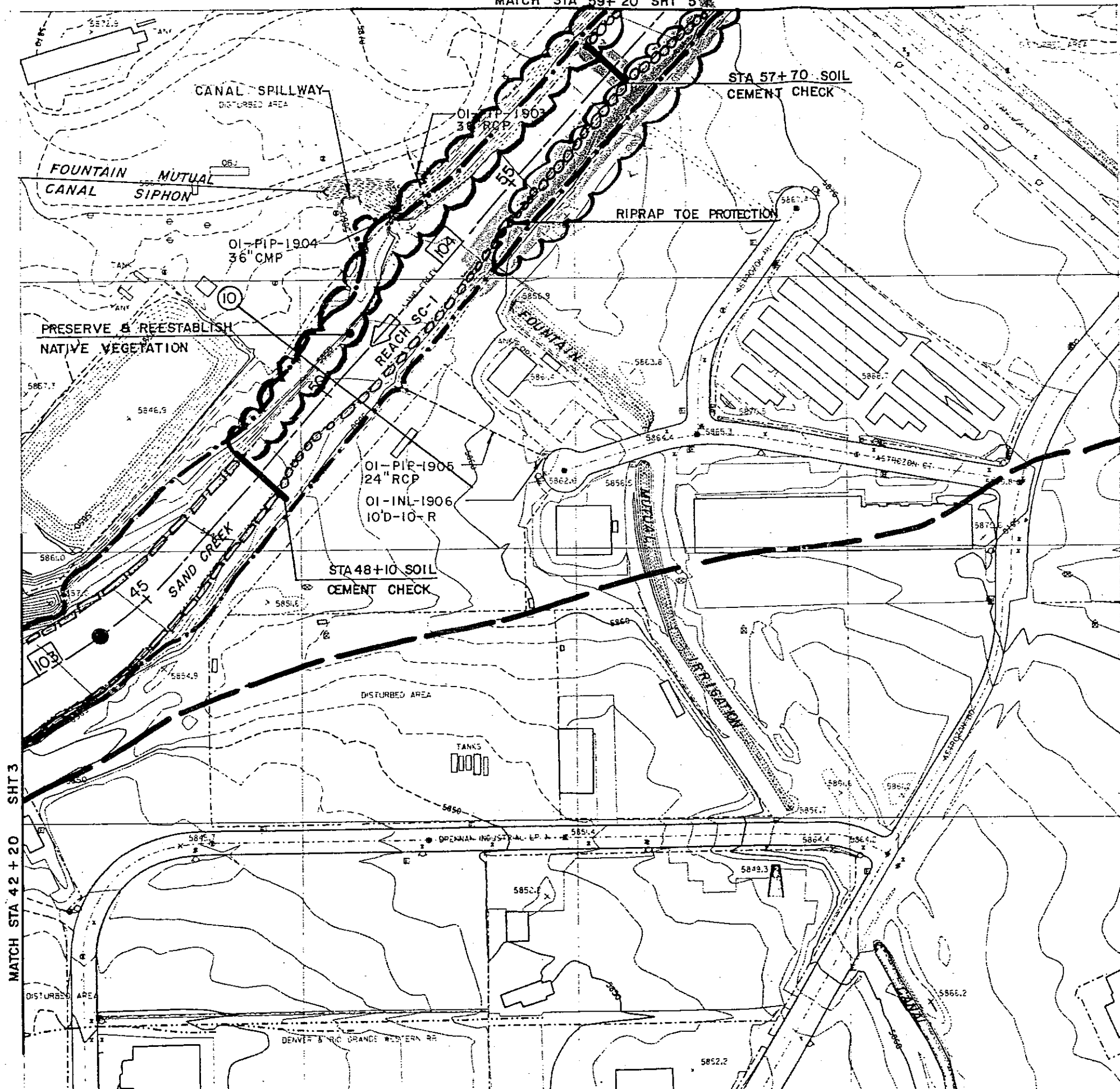
### **SAND CREEK RECOMMENDATION**

TABLE VIII-2: SAND CREEK DRAINAGE BASIN PLANNING STUDY  
DRAINAGEWAY CONVEYANCE COST ESTIMATE  
WITH SELECTED DETENTION ALTERNATIVES

| SEGMENT NUMBER   | REACH NUMBER | SEGMENT LENGTH (FT) | IMPROVEMENT TYPE                      | IMP. LENGTH (FT) | UNIT COST (\$/LF) | NUMBER OF GRADE CONTROLS | GRADE CONTROL LENGTH (FT) | TOTAL REIMBURSABL COSTS | TOTAL COST             |
|------------------|--------------|---------------------|---------------------------------------|------------------|-------------------|--------------------------|---------------------------|-------------------------|------------------------|
| LOWER SAND CREEK |              |                     |                                       |                  |                   |                          |                           |                         |                        |
| 101              | SC-1         | 1400                | 10-YR RIPRAP                          | 1400             | 268               | 4                        | 250                       | \$413,950               | \$413,950              |
| 102              | "            | 1970                | "                                     | 1470             | 268               | 4                        | 500                       | \$471,460               | \$471,460              |
| 103              | "            | 1030                | "                                     | 1030             | 268               | 1                        | 230                       | \$0                     | \$311,690              |
| 104              | "            | 1800                | 10-YR RIPRAP<br>TOE PROTECTION        | 420<br>1750      | 268<br>130        | 2<br>0                   | 260<br>0                  | \$0<br>\$0              | \$152,860<br>\$227,500 |
| 112              | "            | 3530                | 10-YR RIPRAP<br>10-YR RIPRAP (1 SIDE) | 1300<br>2130     | 268<br>130        | 9                        | 1580                      | \$0<br>\$0              | \$593,300<br>\$276,900 |
| 115              | "            | 3680                | 10-YEAR RIPRAP<br>100-YEAR RIPRAP     | 2950<br>600      | 268<br>360        | 9<br>0                   | 800<br>0                  | \$0<br>\$0              | \$914,600<br>\$216,000 |
| 136              | "            | 1440                | "                                     | 0                | 0                 | 1                        | 170                       | \$0                     | \$26,350               |
| 119              | SC-2         | 2150                | 100-YEAR RIPRAP                       | 480              | 331               | 6                        | 1020                      | \$316,980               | \$316,980              |
| 121              | "            | 2250                | "                                     | 2250             | 331               | 9                        | 1350                      | \$1,217,250             | \$1,217,250            |
| 125-1            | "            | 2900                | "                                     | 2780             | 331               | 7                        | 1110                      | \$1,308,680             | \$1,308,680            |
| 125-2            | "            | 1950                | 10-YEAR RIPRAP                        | 1950             | 238               | 4                        | 620                       | \$681,100               | \$681,100              |

MATCH STA 59+20 SHT 5

THIS DRAWING IS A MASTER PLANNING SHEET REPRESENTING PRELIMINARY AND CONCEPTUAL ENGINEERING. IT SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES.



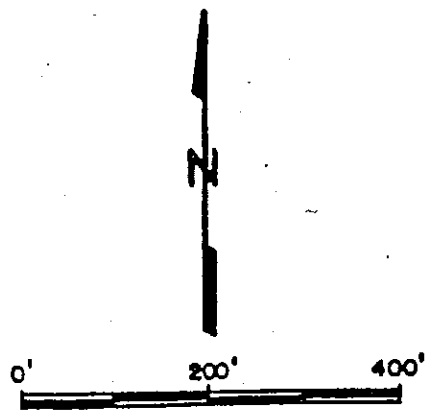
| CHANNEL IMPROVEMENTS |                   |                                   |
|----------------------|-------------------|-----------------------------------|
| SEGMENT NO.          | BOTTOM WIDTH (FT) | CHANNEL TYPE                      |
| 103                  | 155               | 10-YEAR RIPRAP LININGS<br>6' HIGH |
| 104                  | 155               |                                   |

FOR PROFILE SEE SHEET P-1

Kiowa Engineering Corporation  
 419 W. Bijou Street  
 Colorado Springs, Colorado  
 80905-1308

SAND CREEK DRAINAGE  
 BASIN PLANNING STUDY  
 PRELIMINARY DESIGN PLANS

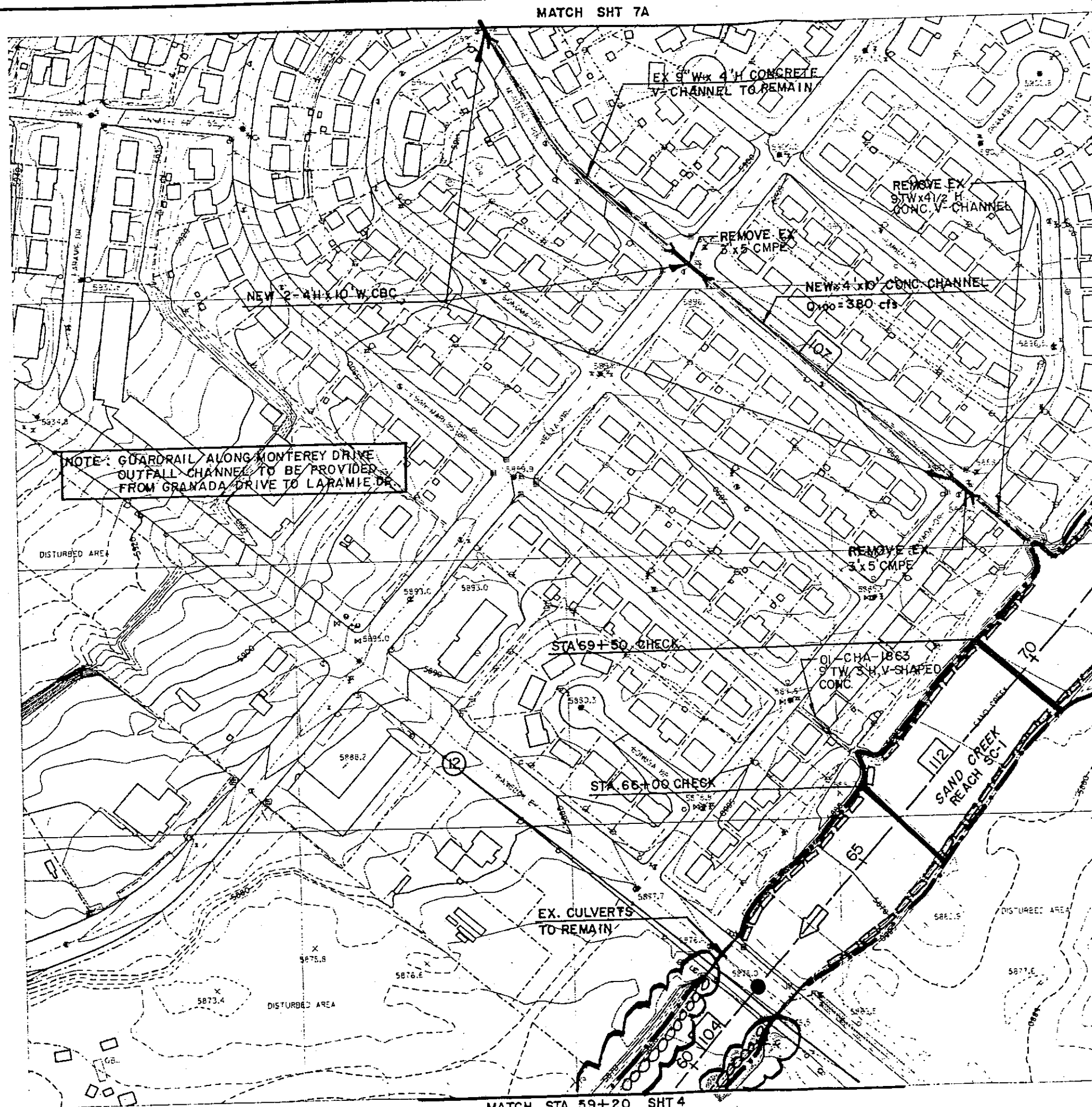
Project No 90-04-09  
 Date: 9-92  
 Design: RNW  
 Drawn: EAK  
 Check: RNW  
 Revisions:



MATCH STA 42+20 SHT 3



THIS DRAWING IS A MASTER PLANNING SHEET REPRESENTING PRELIMINARY AND CONCEPTUAL ENGINEERING. IT SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES.



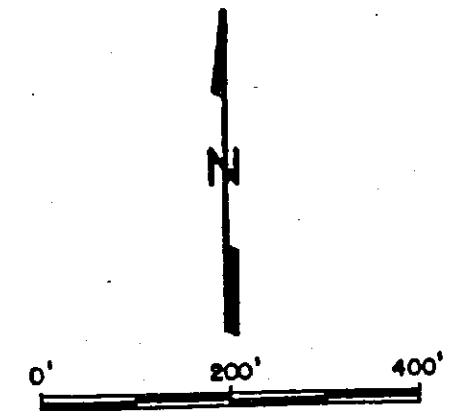
| CHANNEL IMPROVEMENTS |                   |                                   |
|----------------------|-------------------|-----------------------------------|
| SEGMENT NO.          | BOTTOM WIDTH (FT) | CHANNEL TYPE                      |
| 104                  | 155               | 10-YEAR RIPRAP LININGS<br>5' HIGH |
| 112                  | 140               |                                   |

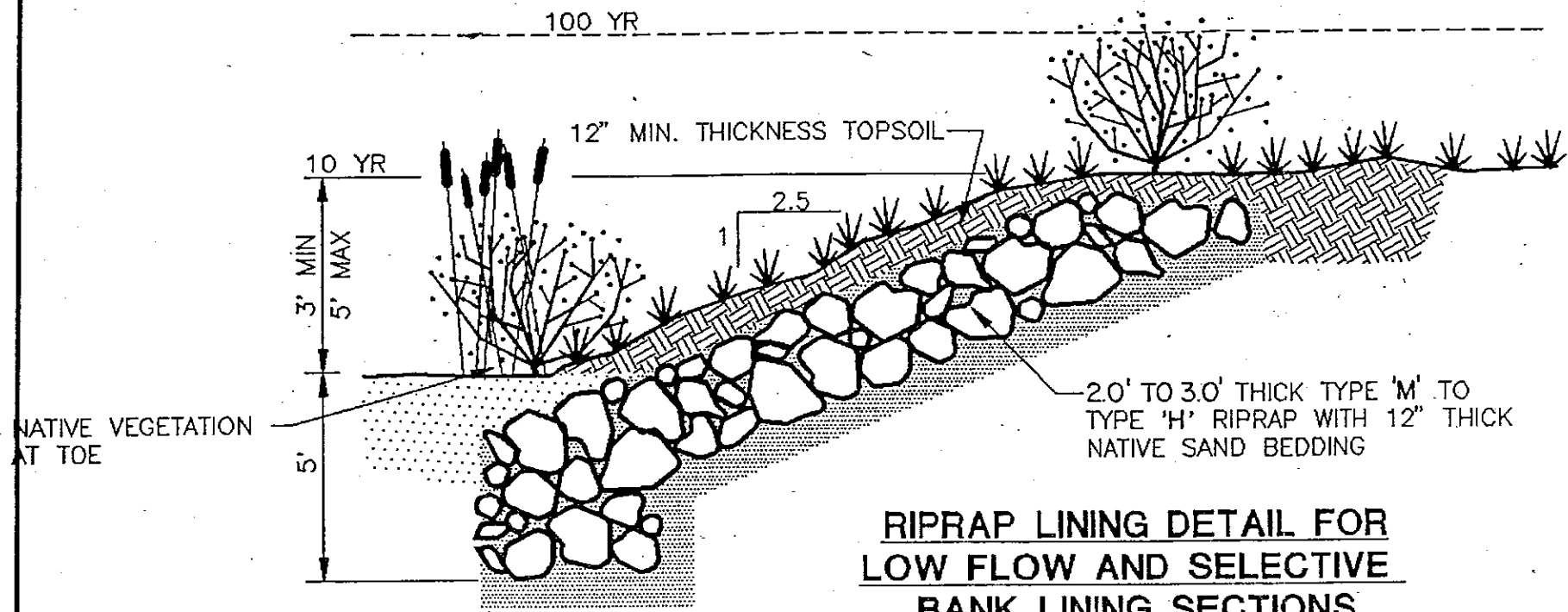
FOR PROFILE SEE SHEET P-2

Kiowa Engineering Corporation  
 419 W. Bijou Street  
 Colorado Springs, Colorado  
 80905-1308

SAND CREEK DRAINAGE  
 BASIN PLANNING STUDY  
 PRELIMINARY DESIGN PLANS

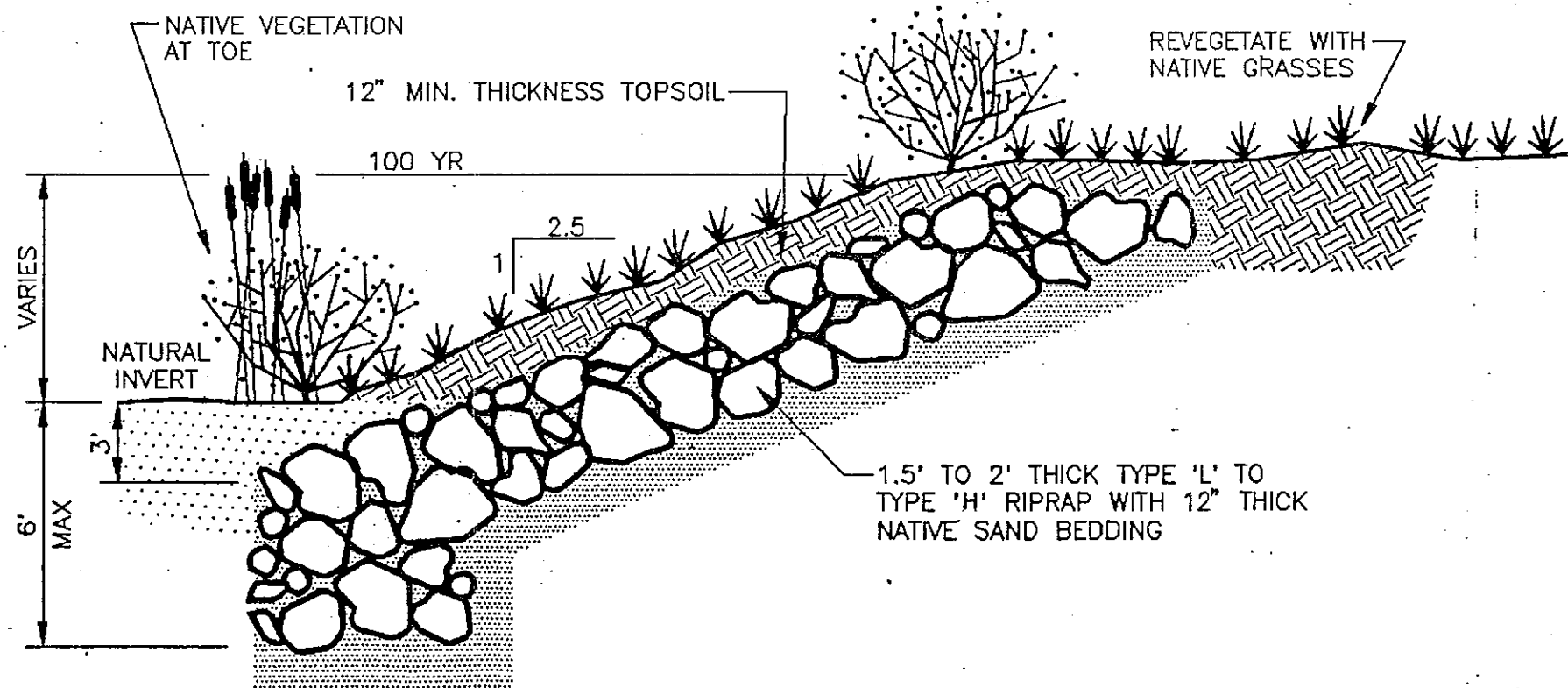
|            |          |
|------------|----------|
| Project No | 90-04-09 |
| Date       | 9-92     |
| Design     | RNW      |
| Drawn      | EAK      |
| Check      | RNW      |
| Revisions  |          |





**RIPRAP LINING DETAIL FOR  
LOW FLOW AND SELECTIVE  
BANK LINING SECTIONS**

NTS



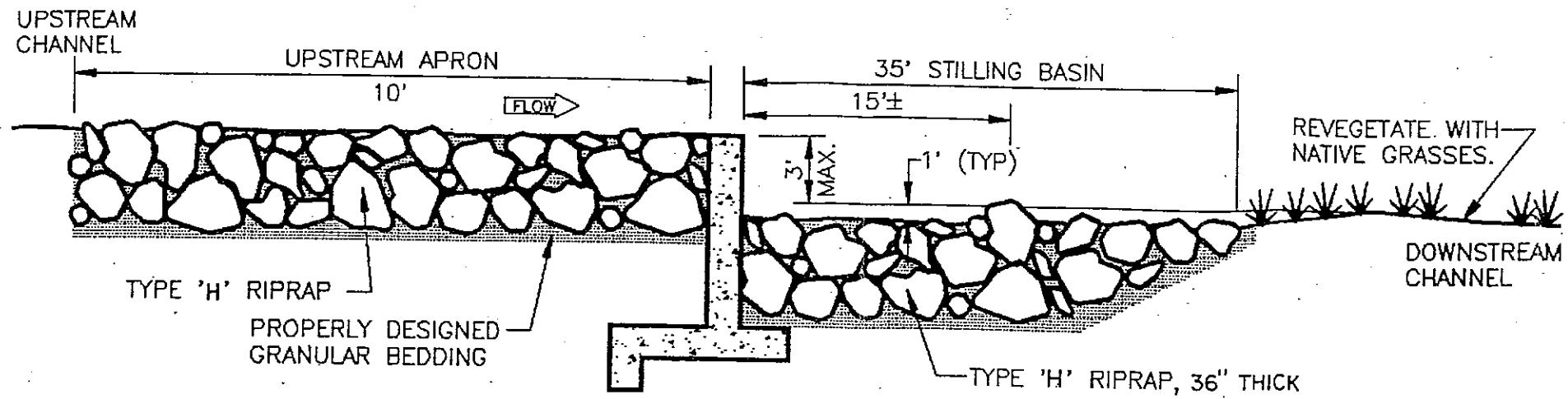
**RIPRAP LINING DETAIL FOR  
100 YR CHANNEL SECTIONS**

NTS

Kiowa Engineering Corporation  
419 W. Bijou Street  
Colorado Springs, Colorado  
80905-1308

SAND CREEK DRAINAGE  
BASIN PLANNING STUDY

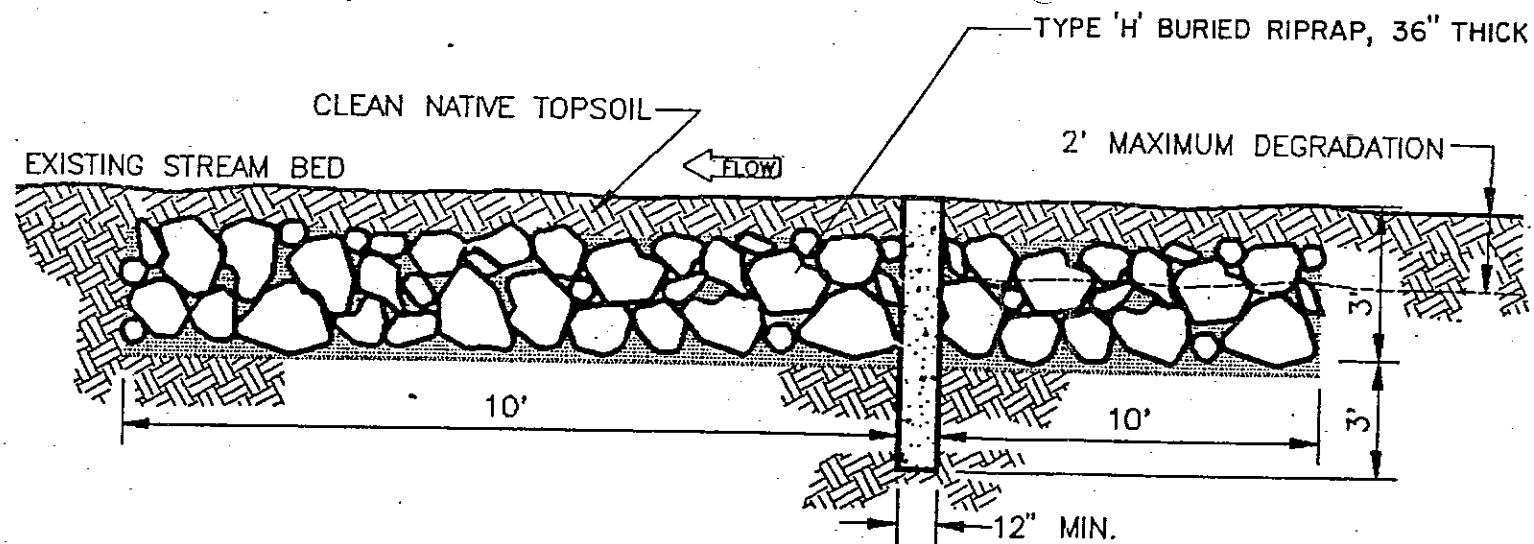
Project No:  
Date:  
Design:  
Drawn:  
Check:  
Revisions:



**TYPICAL DROP STRUCTURE  
GENERALIZED PROFILE**

NTS

NOTE: DIMENSIONS OF APRON, STILLING BASIN, RIPRAP, AND CHECK STRUCTURE IS TO BE DETERMINED DURING FINAL DESIGN.



**TYPICAL EROSION CONTROL  
CHECK PROFILE**

NTS

Kiowa Engineering Corporation  
419 W. Bijou Street  
Colorado Springs, Colorado  
80905-1308

SAND CREEK DRAINAGE  
BASIN PLANNING STUDY

|            |
|------------|
| Project No |
| Date:      |
| Design:    |
| Drawn:     |
| Check:     |
| Revisions: |

**APPENDIX C**

**DESIGN CHARTS**

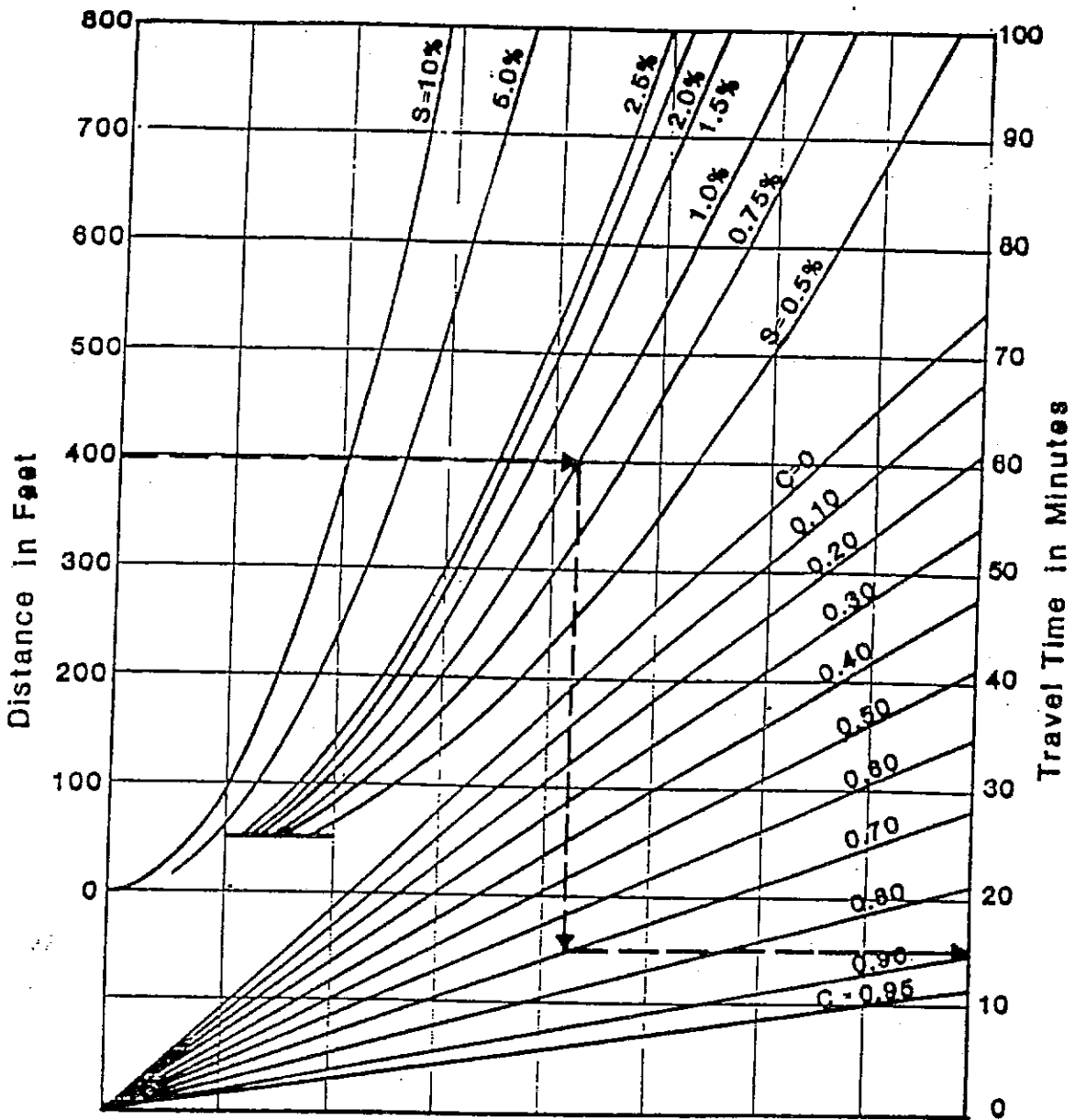
TABLE 5-1

## RECOMMENDED AVERAGE RUNOFF COEFFICIENTS AND PERCENT IMPERVIOUS

| LAND USE OR<br>SURFACE CHARACTERISTICS                                | PERCENT<br>IMPERVIOUS | "C"<br>FREQUENCY |      |      |      |
|---|-----------------------|------------------|------|------|------|
|   |                       | 10               |      | 100  |      |
|   |                       | A&B*             | C&D* | A&B* | C&D* |
| Business  |                       |                  |      |      |      |
| Commercial Areas  | 95                    | 0.90             | 0.90 | 0.90 | 0.90 |
| Neighborhood Areas  | 70                    | 0.75             | 0.75 | 0.80 | 0.80 |
| Residential   |                       |                  |      |      |      |
| 1/8 Acre or less  | 65                    | 0.60             | 0.70 | 0.70 | 0.80 |
| 1/4 Acre  | 40                    | 0.50             | 0.60 | 0.60 | 0.70 |
| 1/3 Acre  | 30                    | 0.40             | 0.50 | 0.55 | 0.60 |
| 1/2 Acre  | 25                    | 0.35             | 0.45 | 0.45 | 0.55 |
| 1 Acre  | 20                    | 0.30             | 0.40 | 0.40 | 0.50 |
| Industrial  |                       |                  |      |      |      |
| Light Areas   | 80                    | 0.70             | 0.70 | 0.80 | 0.80 |
| Heavy Areas   | 90                    | 0.80             | 0.80 | 0.90 | 0.90 |
| Parks and Cemeteries  | 7                     | 0.30             | 0.35 | 0.55 | 0.60 |
| Playgrounds   | 13                    | 0.30             | 0.35 | 0.60 | 0.65 |
| Railroad Yard Areas   | 40                    | 0.50             | 0.55 | 0.60 | 0.65 |
| Undeveloped Areas   |                       |                  |      |      |      |
| Historic Flow Analysis-<br>Greenbelts, Agricultural<br>Pasture/Meadow | 0                     | 0.25             | 0.30 | 0.35 | 0.45 |
| Forest  | 0                     | 0.10             | 0.15 | 0.15 | 0.20 |
| Exposed Rock  | 100                   | 0.90             | 0.90 | 0.95 | 0.95 |
| Offsite Flow Analysis<br>(when land use not defined)                  | 45                    | 0.55             | 0.60 | 0.65 | 0.70 |
| Streets   |                       |                  |      |      |      |
| Paved   | 100                   | 0.90             | 0.90 | 0.95 | 0.95 |
| Gravel  | 80                    | 0.80             | 0.80 | 0.85 | 0.85 |
| Drive and Walks   | 100                   | 0.90             | 0.90 | 0.95 | 0.95 |
| Roofs   | 90                    | 0.90             | 0.90 | 0.95 | 0.95 |
| Lawns   | 0                     | 0.25             | 0.30 | 0.35 | 0.45 |

\* Hydrologic Soil Group

9/30/90



REFERENCE : Wright - McLaughlin Engineers, Urban Storm Drainage Criteria Manual, Vol. 1,  
 Denver Regional Council of Governments, Denver, Co, 1977



HDR Infrastructure, Inc.  
 A Centerra Company

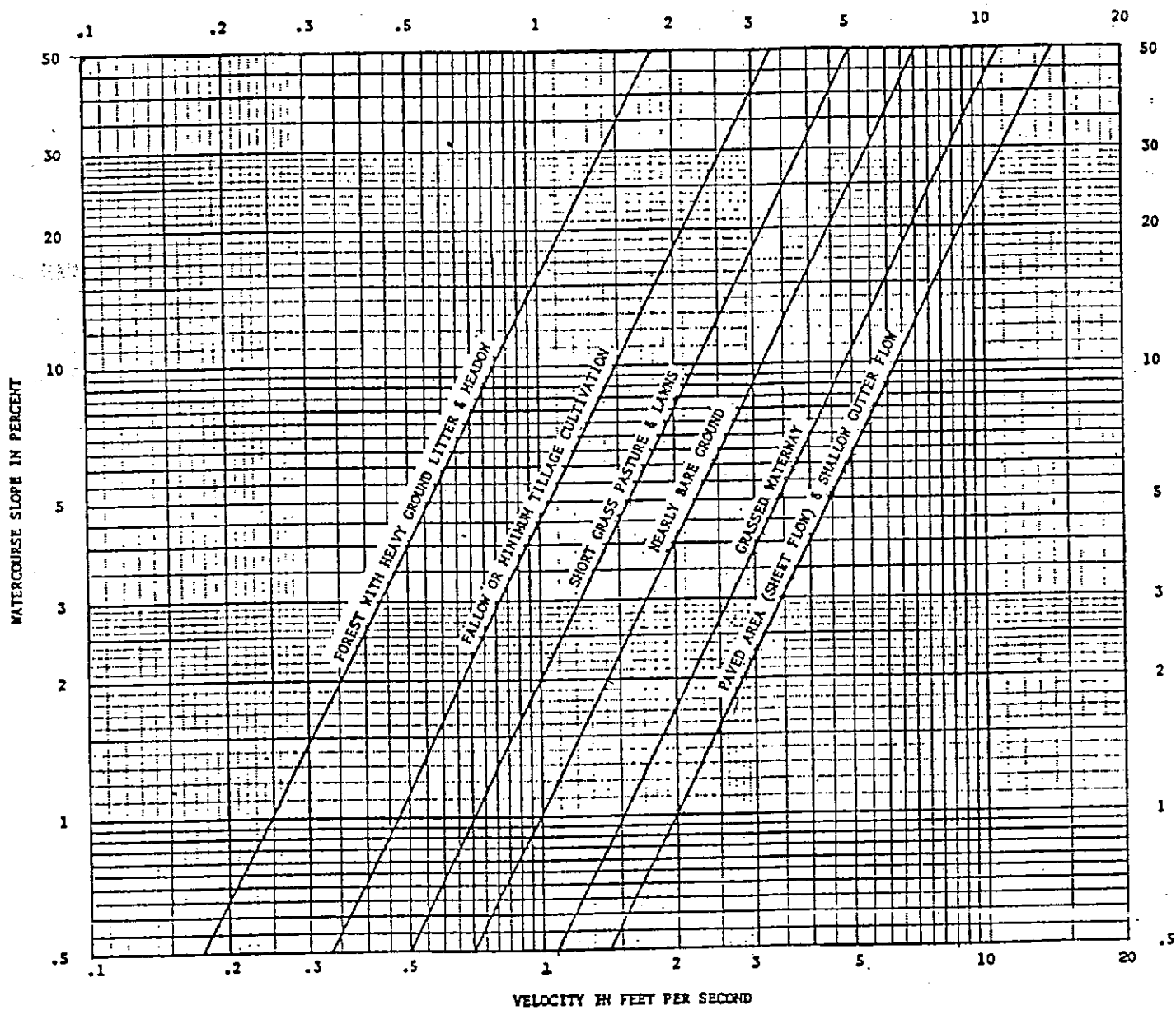
The City of Colorado Springs / El Paso County  
 Drainage Criteria Manual

Overland Flow Curves

5-10

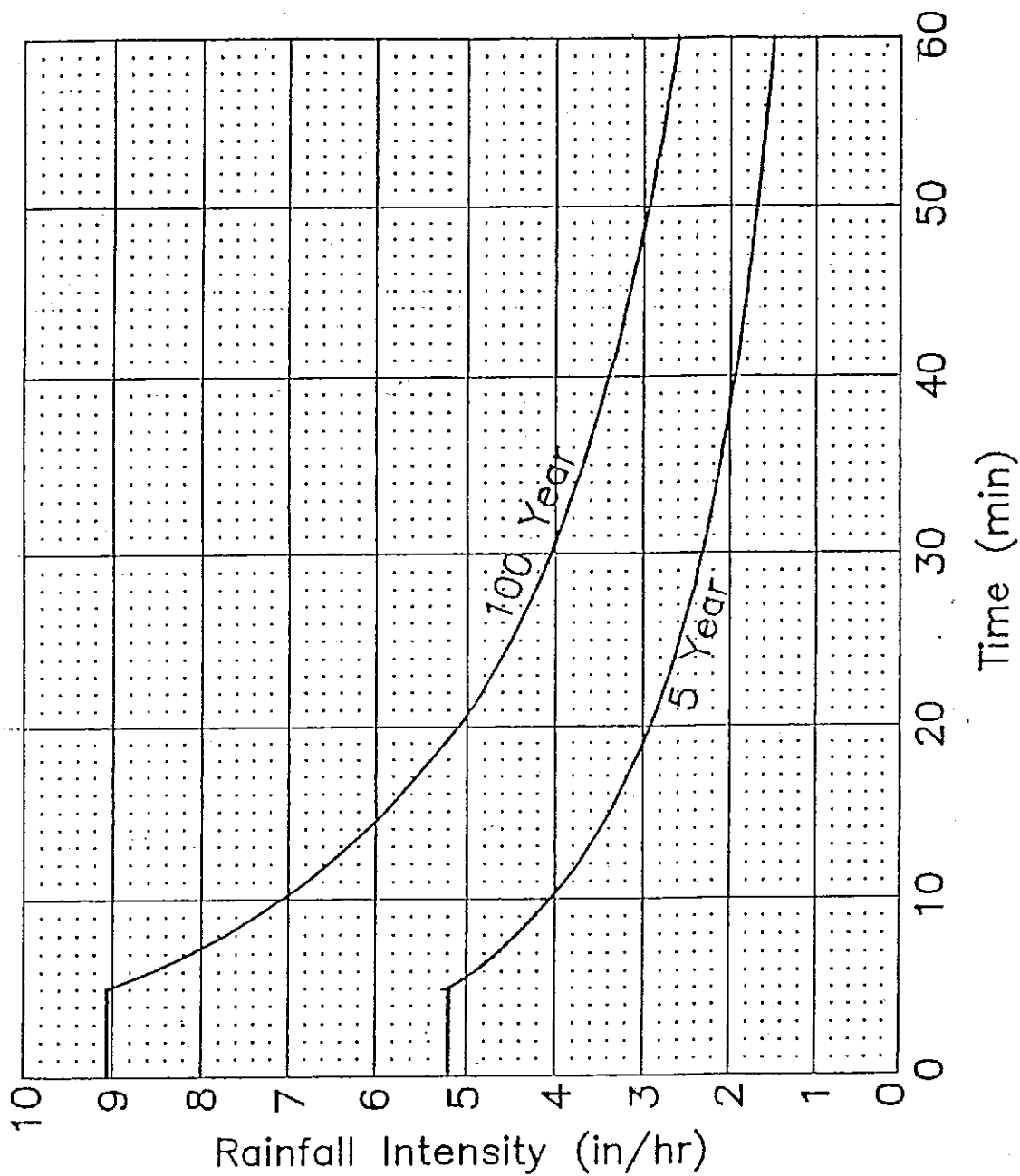
Date  
 OCT. 1987

Figure  
 5-2



--Average velocities for estimating travel time for overland flow.

FIGURE 4



$$I_t = \frac{36.4 * I_{60}}{t^{0.63} + 6.72}$$

5 Year:  $I_{60} = 1.50$   
 100 Year:  $I_{60} = 2.62$

RE: Based upon Pikes Peak Area Council of Governments  
 Areawide Urban Runoff Control Manual.

The City of Colorado Springs / El Paso County  
 Drainage Criteria Manual

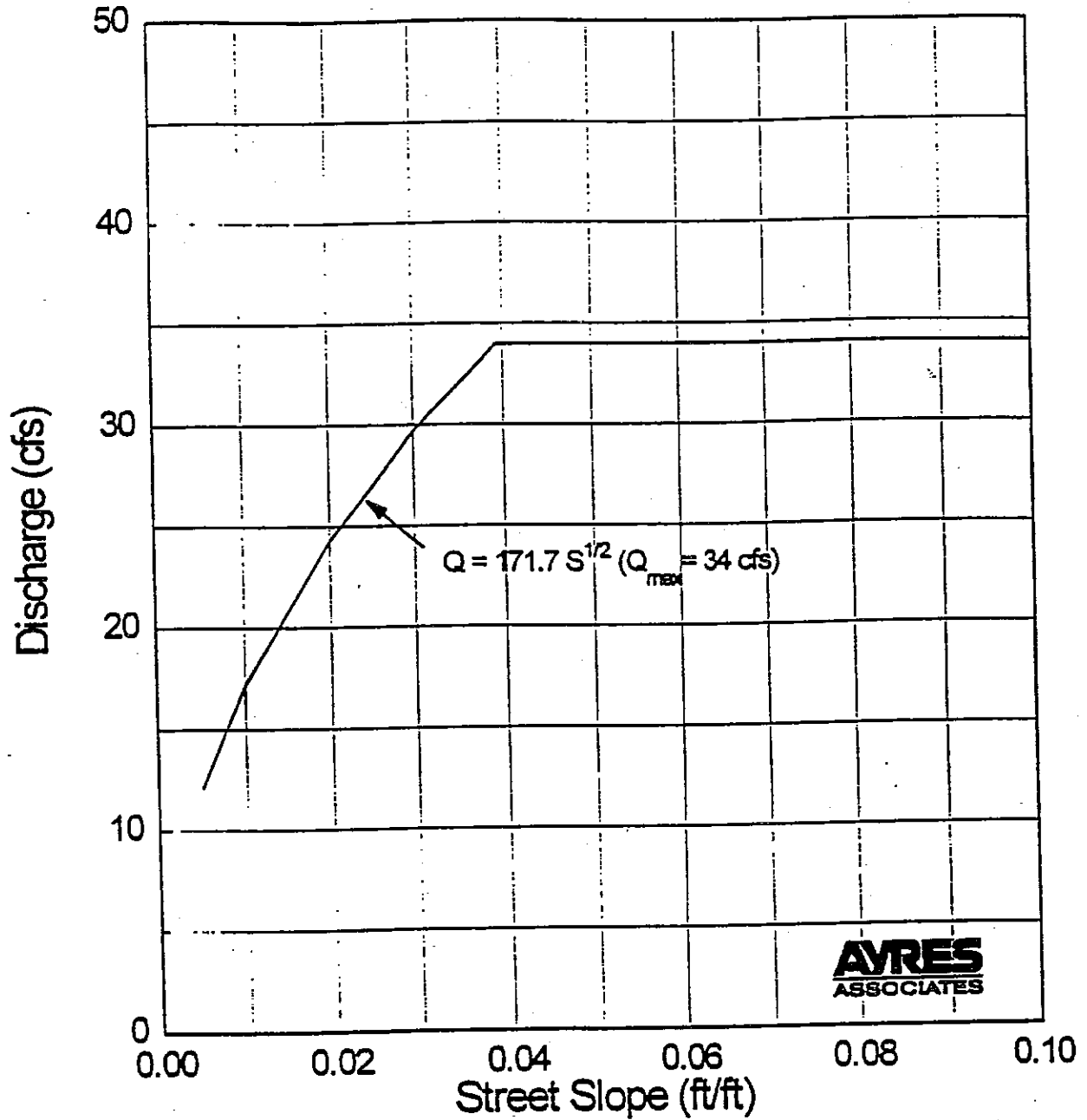
Storm Rainfall  
 Time Intensity - Frequency Curves

Date:  
 MAR. 1995

Figure:  
 5 - 1



### COLLECTOR STREETS (Major and Minor)



Interim Release October 12, 1994  
City of Colorado Springs

Use this graph to determine the allowable street capacity per side, initial storm, for the typical street section using a 2% crown. No flow may cross the crown.