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CARMEL DRIVE OUTFALL STORM DRAIN ANALYSIS
FEBRUARY, 1997

Prepared for:

City of Colorado Springs Engineering Division

Prepared By:

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CARMEL DRIVE OUTFALL STORM DRAIN ANALYSIS
PRELIMINARY AND FINAL DRAINAGE REPORT
DRAINAGE PLAN STATEMENTS

ENGINEER'S 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.

Kent D. Rockwell, P.E.

Kent D. Rockwell, P.E.

COLORADO REGISTERED PROFESSIONAL ENGINEER KENT D. ROCKWELL 25086 KDR 3/25/97

DEVELOPER'S STATEMENT

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

BY: N/A DATE__________

TITLE:__________

ADDRESS:__________

____

CITY OF COLORADO SPRINGS

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

For City Engineer 3-31-97

CITY ENGINEER DATE

CARMEL DRIVE OUTFALL STORM DRAIN ANALYSIS
PRELIMINARY AND FINAL DRAINAGE REPORT
FEBRUARY, 1997

PURPOSE

The purpose of this report is to describe the drainage patterns and quantify the runoff quantities reaching the existing drainage facilities located on the north side of Hancock Expressway between Carmel Drive and Delta Drive and the natural channel just upstream of those facilities. The runoff quantities were then utilized to design a storm sewer pipe from Hancock Road to a point approximately 1500 feet to the north.

I. GENERAL DESCRIPTION

The area tributary to the proposed Carmel Drive storm drain pipe is located within the western half of Section 27 and the eastern half of Section 28, Township 14 South, Range 66 West of the 6th P.M., City of Colorado Springs, El Paso County Colorado (see Vicinity Map, Figure 1). The majority of the drainage basin area consists of residential subdivisions which were developed in the mid-1960's. Approximately 11 acres of commercial development and an additional 4 acres of undeveloped land are tributary to the proposed outfall at this time.

The majority of the residential lots consist of approximately 1/8 lots with slopes of 3 % to 6 %. There are also several native slopes within the contributing basins with grades of approximately 25 %.

II. HYDROLOGIC ANALYSIS

SOILS DESCRIPTION

The underlying soil types within the contributing basins are depicted on Figure 2. According to the Soil Survey of El Paso County, the underlying soils within the contributing basins consist of Bresser (Map No. 13), Nelson (Map No. 56) and Schanber (Map No. 82). The Bresser series is considered to be within the hydrological group B soils. The Nelson series consists of a Nelson part which is within the hydrological group B soils and a Tassel part which is a hydrological group D soil. The Scanber series also has two parts, the Schamber part and the Razor part. The Schamber part is a hydrological group A soil while the Razor part is a hydrological C soil (See Figure 2).

According to the Soil Survey, the permeability of the Nelson and Tassel soils is "moderately rapid," the permeability of the Schamber series is "rapid" and the permeability of the Razor series is "slow". Visual inspection of the site indicates that the majority of the underlying soils lays in the hydrological group A and B soils. Therefore, hydrological group A and B soils were utilized to select runoff coefficients.

DRAINAGE CRITERIA

The current City of Colorado Springs/El Paso County Drainage Criteria was utilized in the preparation of this study. Calculations were performed to determine the runoff quantities generated during the 5 year and 100 year frequency storm for the developed condition. The Rational Method was used according to criteria for basins less than 100 acres.

DRAINAGE PATTERNS

Exhibit A depicts the basins contributing runoff to the Carmel Drive and Hancock Road intersection. The contributory drainage basins consist of approximately 62 acres of fully developed residential land and open space, approximately 11 acres of commercial development, and 4 acres of undeveloped land. (An additional drainage basin (Basin VI) is located over the proposed storm sewer but will be directed to the southwest to a separate outfall.) Runoff rates were calculated to determine the flows reaching the Carmel Drive and Hancock Road intersection from the east (Design Point 1) and flow reaching the entrance of the proposed storm sewer pipe along Carmel Drive (Design Point 2).

Basin I, consisting of 3.6 acres east of the intersection of Carmel Drive and Hancock Road, consist of residential lots with approximately 2.7 acres of open space. Composite runoff coefficients of $C_5 = 0.41$ and $C_{100} = 0.50$ were utilized for this basin. The resulting 5 year and 100 year storm runoff rates were 5.9 cubic feet per second (cfs) and 13.1 cfs, respectively. The flows generated from this basin enter Hancock Expressway and continue westerly within Hancock as street flow.

Basin II is located northeast of the Carmel Drive and Hancock Road intersection. This basin also consist of residential development with a relatively large area of native open space. Runoff rates of $Q_5 = 25.0$ cfs and $Q_{100} = 58.5$ cfs generated from this basin also discharge to Hancock Expressway and reach the intersection of Hancock and Carmel.

Basin III is located along Carmel Drive and consists of approximately 9.8 acres. Runoff generated from this basin discharge to Carmel Drive and then continue southerly as street flow within Carmel eventually reaching Hancock Road. The total flows reaching the intersection of Carmel Drive and Hancock Road from Basins I, II and III are 46.2 cfs during the 5 year storm and 108.4 cfs during the 100 year storm (Design Point 1). Depths of flow within Hancock Expressway just west of Carmel Drive will be 0.3 feet during the 5 year storm and 0.5 feet during the 100 year storm. Based on as-built cross sections of Hancock Expressway, it does not appear that any runoff will cross the centerline of Hancock at Carmel.

All the runoff reaching Design Point 1 will be collected within a 30' inlet on the north side of Hancock approximately 100 feet west of Carmel Drive. This inlet was designed based on the localized accumulated flows of 108 cfs. The runoff collected within this inlet will be discharged to a future 60" RCP located just north of the proposed inlet via a 34" x 53" horizontal elliptical reinforced concrete pipe (hercp).

Basin IV consist of approximately 50 acres of residential and commercial developments. The total flows of $Q_5 = 89.2$ cfs and $Q_{100} = 182.4$ cfs ultimately reach an existing low point in Carmel Drive approximately 1500 feet north of Hancock Expressway. These flows will be collected within 2 - 30' sump inlets in Carmel Drive. The two inlets will be connected to a 42" RCP which will replace the existing v-shaped channel extending between Lots 5 and 6 of Pikes Peak Park Subdivision Filing No. 15. The 42" RCP will extend approximately 130 feet west of Carmel Drive and then extend south toward Hancock Expressway. A grass-lined swale will be constructed over the proposed 42" RCP extending west from Carmel to act as an overflow in the event of partial clogging of the inlets along Carmel Drive. The storm sewer system will extend south to Hancock Expressway and then east approximately 100 feet to an existing 60" RCP.

In addition to the flows reaching the proposed pipe from Basin IV, runoff generated from undeveloped Basin V (Q_5 = 2.7 cfs and Q_{100} = 7.1 cfs). Basin V consists of undeveloped land and the rear portion of 5 existing residential lots along the west side of Carmel Drive. These flows will discharge to the proposed pipe via a grated inlet at Station 16 + 05. Upon ultimate development of the Spring Creek Development, developed runoff generated from this basin will discharge to the west and will not enter the proposed Carmel Drive storm drain.

Basin VI consists of undeveloped land west of Carmel Drive and the rear half of developed lots along the west side of Carmel Drive. Runoff rates of Q_5 = 8.1 cfs and Q_{100} = 18.8 cfs generated from Basin VI will be directed to the southwest via a small earthen swale. A 24" diameter reinforced concrete pipe (RCP) will be stubbed out from an existing inlet at Design Point 3 to convey this flows to the existing storm sewer system within Hancock Expressway. A berm will also be constructed just north of Basin VI to direct flows to Delta Drive.

Currently, a large ravine extends from the a point just west of Lots 5 and 6 to Hancock Expressway. This ravine is parallel and to the west of the houses located along the west side of Carmel Drive. The ravine will be filled in slightly but will still operate as a wide drainageway for undeveloped flows generated from Basins V and VI.

PROPOSED FACILITIES

As stated above, the flows collected within the 2 -30 feet inlets along Carmel Drive will be conveyed to the existing system at the intersection of Carmel Drive and Hancock Expressway via 42", 48" and 60" diameter reinforced concrete pipes (RCP). These pipes are to be constructed just west of Lots 5 through 29 of Pikes Peak Park Subdivision Filing No. 15 as depicted on Exhibit A.

Two 30' inlets will be installed along Carmel Drive at Design Point No. 2 to collect the flows from Basin IV. These inlets will collect a total of 182.4 cfs. An additional 30' inlet will be constructed along the north side of Hancock Expressway just west of Carmel Drive. This inlet will collect approximately 108 cfs during the 100 year storm based on the localized flows. The outfall pipe from this inlet was designed to convey 88 cfs based on routed flows in the entire basin.

Due to the in-fill nature of this project, there is limited space to construct necessary drainage facilities. Therefore, the proposed facilities may not strictly adhere to the City of Colorado Springs 5 year storm and 100 year storm drainage criteria. The inlet along Hancock Expressway and the inlets along Carmel do not meet criteria due to limited cover on the existing outfall pipes.

The existing 60" RCP running parallel to Hancock Expressway has a normal flow capacity of approximately 485 cfs at 3.0% slope just downstream of the connection point to the existing system (Carmel Drive and Hancock Expressway). This appears to adequate to convey the combined 100 year frequency storm of 277 cfs from Design Points 1 and 2.

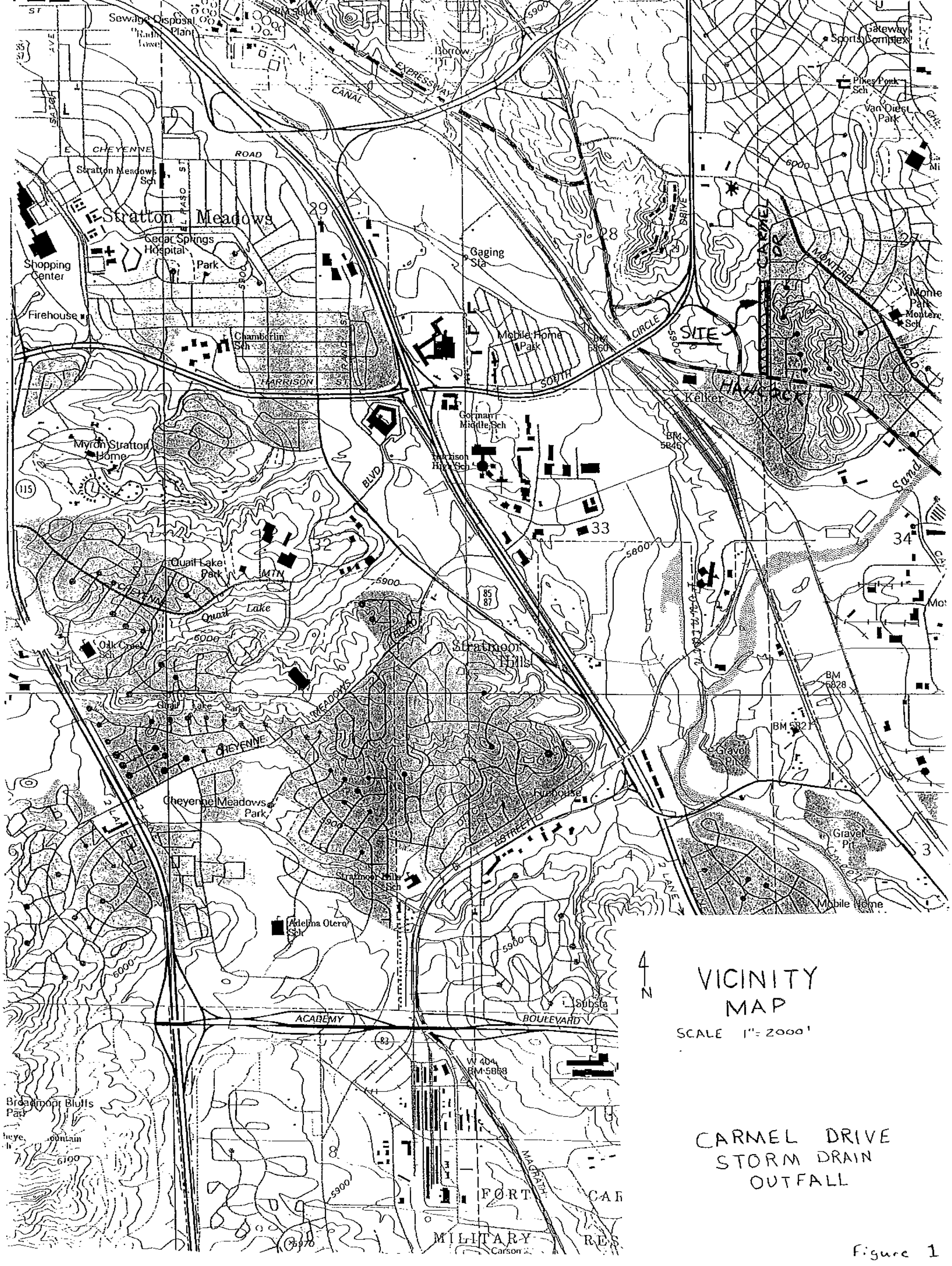
DRAINAGE FACILITY COSTS

Drainage facilities cost will be based on actual bids received through the City bid process. Therefore, these costs are not presented here. After the bids are received, a tabulation of the final bid costs will be added to this report as an addendum.

The cost of these facilities may be eligible for reimbursement due to the fact that they convey 100 year runoff rates. The Drainage Basin Study would have to be revised to make these reimbursable.

DRAINAGE BASIN FEES

Per the Drainage Report and Plan for Spring Creek Development Phase I Drainage Report, as prepared by URS/NES, dated January, 1985, a portion of the area between Pikes Peak Park Filings 15 and 16 and the Circle Drive off-ramp (Delta Drive) lies within the Sand Creek Basin. According to the URS report, these flows will be intercepted and directed out of the Sand Creek Basin and into the Spring Creek Basin. However, this area "will remain in Sand Creek for purposes of drainage fee calculations." (see attached map and excerpt from the URS study).

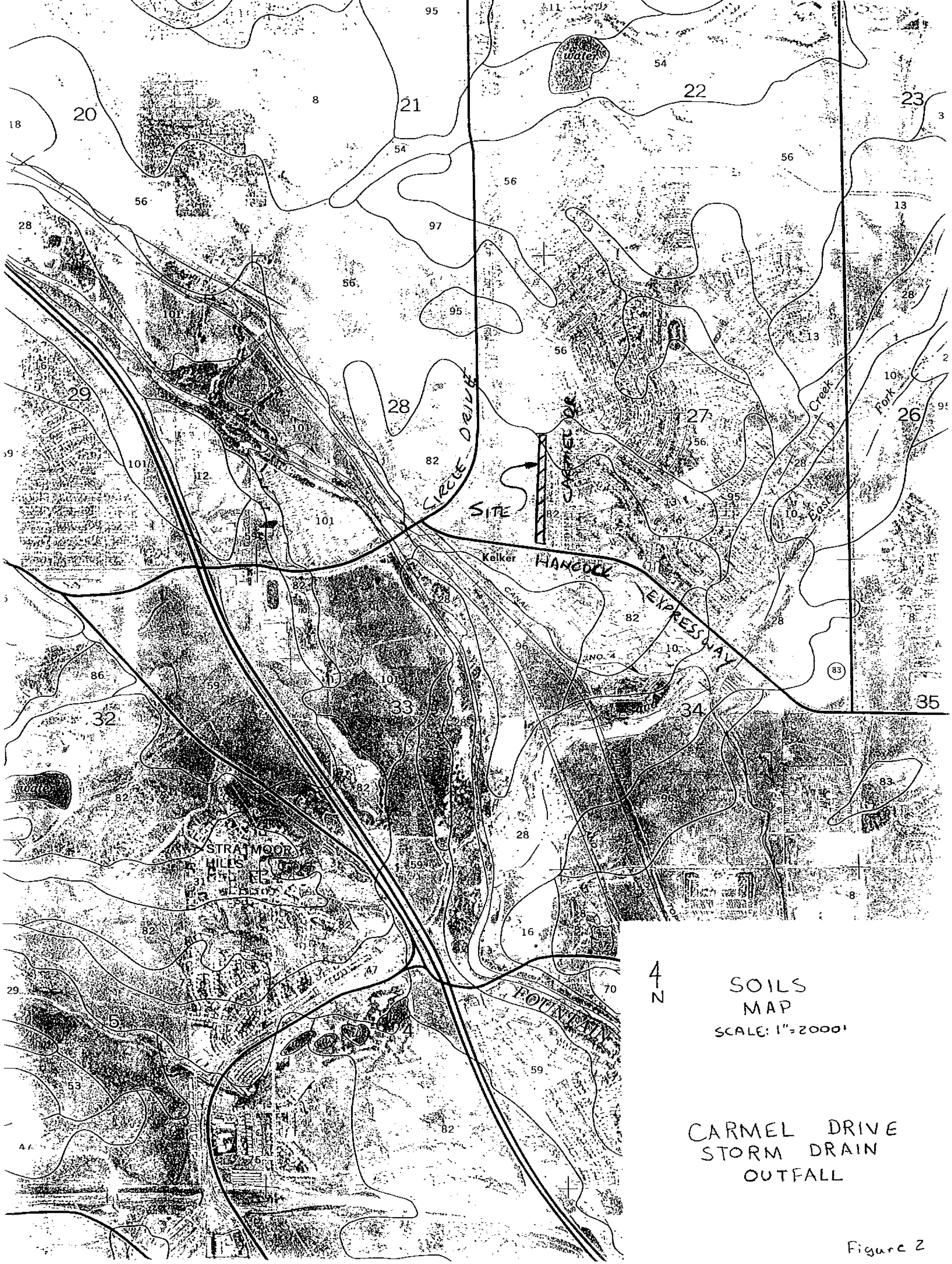


VICINITY MAP

SCALE 1"= 2000'

CARMEL DRIVE STORM DRAIN OUTFALL

Figure 1



SOILS MAP

SCALE: 1"=2000'

CARMEL DRIVE STORM DRAIN OUTFALL

Figure 2

TAKEN FROM: DRAINAGE REPORT AND PLAN FOR: Spring Creek Development, Phase I

BY: URS/NES, 911 South 8th Street, Ste # 1, Colorado Springs, CO 80906

January 1985

The western portion of the site lies within a small unstudied drainage basin which drains directly into Fountain Creek. This basin is bounded by the Spring Creek Basin on the North, and Sand Creek Basin on the East. For calculation of drainage fees, this basin will be classisfied as Miscellaneous. The Eastern portion of the site (subbasins 11,12,14,15, 16, and 19) lies within the Sand Creek drainage. While flows will be intercepted and directed into the outfall of the unstudied basin, these subbasins will remain in Sand Creek for purposes of drainage fee calculation. The location of the site with respect to the boundaries of the basins are shown on the Drainage Basin Map (Figure 3).

Numerous drainage obstructions and constraints to future drainage construction exist between the site and Fountain Creek. In the Hancock Expressway, a 20" diameter gas line and 16 and 20 inch water mains at shallow depth will restrict future drainage outfall, and deep storm sewers under these utilities will be required.

The existing Fountain Mutual Canal No. 4 will create a further constraint to drainage. This canal is adjacent to the site for the entire length of the Southwest boundary. The canal has a normal flow capacity of about 100 cfs, according to a drainage report for Pikes Peak Park 15 and 16, dated March 15, 1966. Study of available drainage reports for surrounding sites and on-site inspection of drainage facilities on these sites indicates that drainage from Pikes Peak Park 15 and 16 and Sproul Rail Industrial Park Filings 1 and 5 are discharged into the ditch, in addition to irrigation flows and present undeveloped flows from the Spring Creek Development. Clearly, the majority of developed flows from Spring Creek, Phase I, must be carried past the canal before discharge, and water entering the canal from Spring Creek Developent Phase I must be kept at or below historic levels.

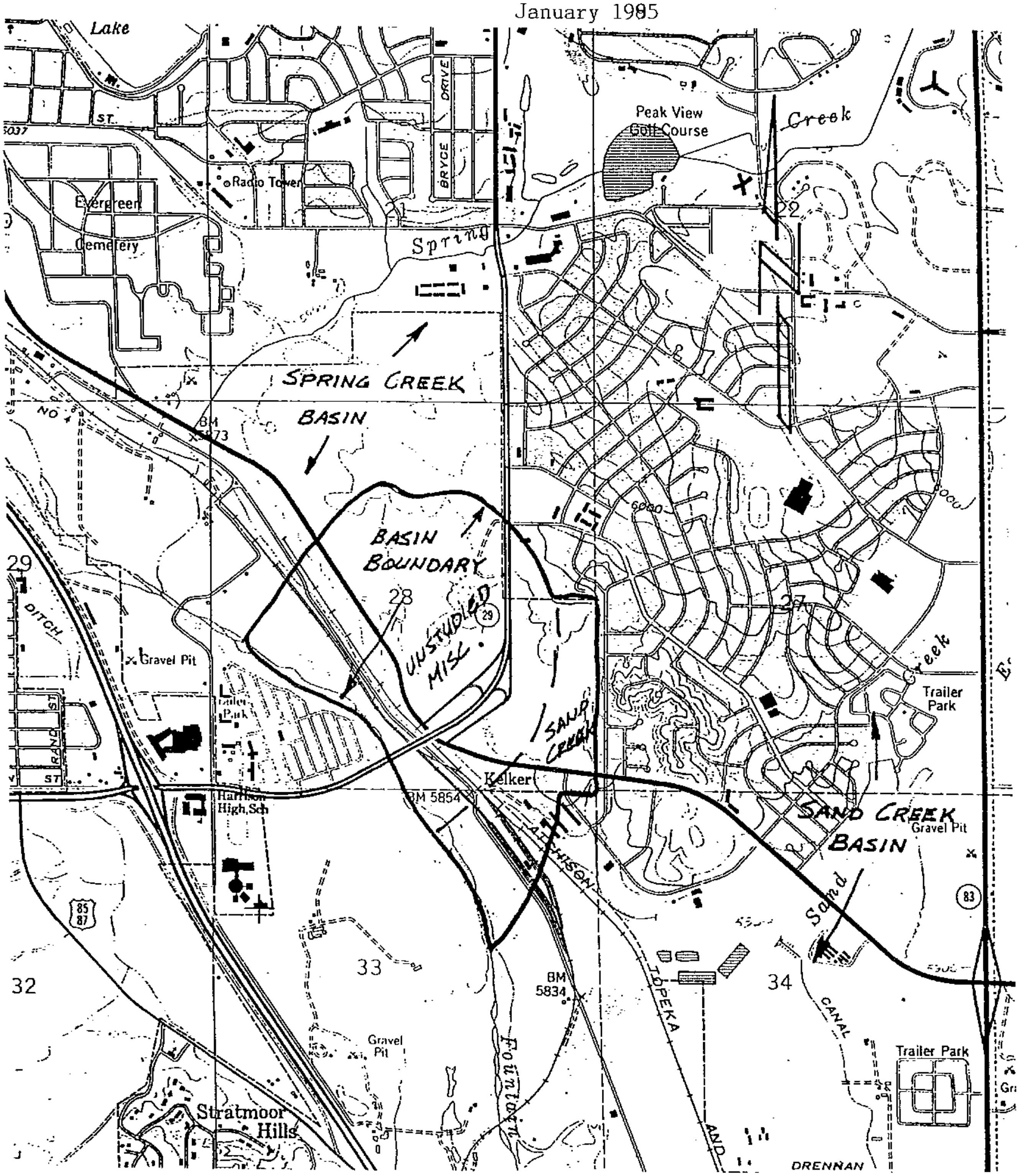
The existing Denver and Rio Grande Railroad allignment is an additional constraint to drainage. Large diameter boring or jacking will be required to conduct water beneath the railroad. Other constraints include a 30 inch diameter sewage force main and a proposed sludge piping system located within the Las Vegas Street Right-of-Way. The above described constraints will influence drainage design to a great degree and will add to the expense of constructing adequate drainage outfalls.

The entire Spring Creek Phase I site is above the 100-year and 500-year flood plains for Fountain Creek.

AKEN FROM: DRAINAGE REPORT AND PLAN FOR : Spring Creek Development, Phase I
BY: URS/NES 911 South 8th Street
Suite # 100, Colorado Springs, CO

80906

January 1985



SCALE: 1" = 2000'

FIGURE 3
DRAINAGE BASIN MAP

BASIN I

AREA = 3.6 ACRES

SOIL 82 A & C
USE A FOR DEVELOPED CONDITION

LAND USE

		C_5	C_{100}
IMPERVIOUS	0.9 ACRE	0.90	0.95
OPEN SPACE	2.7 ACRES	0.25	0.35
	3.6		

$\text{Comp } C_5 = \frac{(0.9)(0.9) + 2.7(0.25)}{3.6} = 0.41$ $\quad \text{Comp } C_{100} = \frac{(0.9)(0.95) + 2.7(0.35)}{3.6} = 0.50$

TIME OF CONCENTRATION

OVERLAND $L = 200'$ $H = 6006 - 5950 = 56'$

$S = \frac{56}{200} = 28\%$

$T_c = 1.87(1.1 - C)(L)^{0.5}(S)^{-0.33}$

5 yr $T_c = 1.87(1.1 - 0.25)(200)^{0.5}(28)^{-0.33}$
$= 7.5$ min

100 yr $T_c = 1.87(1.1 - 0.35)(200)^{0.5}(28)^{-0.33}$
$= 6.6$ min

STREET $L = 750'$ $H = 29'$ $S = 3.89\%$ $V_5 = 4.7$

5 yr $T_c = \frac{750}{(4.7)(60)} = 2.7$

$V_{100} = 5.8$

100 yr $T_c = \frac{750}{(60)(5.8)} = 2.2$

TOTAL 5 yr $T_c = 7.5 + 2.7 = 10.2$

100 yr $T_c = 6.6 + 2.2 = 8.8$

$I_5 = 4.0$ $\quad I_{100} = 7.3$

$Q_5 = CIA$
$= (0.41)(4.0)(3.6)$
$= 5.9$

$Q_{100} = (0.50)(7.3)(3.6)$
$= 13.1$

BASIN II

AREA = 19.40 ACRES

SOILS 82 A & C
USE A FOR DEV. CONDITION

LAND USE

			C_5	C_{100}
IMPERVIOUS	5.4	ACRES	0.90	0.95
OPEN SPACE	14.0	ACRES	0.25	0.35
	19.4			

$$\text{Comp } C_5 = \frac{(5.4)(0.90) + (14.0)(0.25)}{19.4} = 0.43$$

$$\text{Comp } C_{100} = \frac{5.4(0.95) + (14.0)(0.35)}{19.4} = 0.52$$

TIME OF CONCENTRATION

OVERLAND $L = 400$ $H = 6004 - 5964 = 40$ $S = 10\%$

5 YR $T_c = 1.87(1.1 - 0.25)(400)^{0.5}(10)^{-0.33}$
$= 14.9$

100 YR $T_c = 1.87(1.1 - 0.35)(400)^{0.5}(10)^{-0.33}$
$= 13.1$

STREET $L = 1200$ $H = 5960 - 5910 = 50$ $V_5 = 5.5$
$S = \frac{50}{1200} = 4.167\%$ $V_{100} = 7.8$

5 YR $T_c = \frac{1200}{(5.5)(60)} = 3.6$

100 YR $T_c = \frac{1200}{(7.8)(60)} = 2.6$

TOTAL 5 YR $T_c = 14.9 + 3.6 = 18.5$
100 YR $T_c = 13.1 + 2.6 = 15.7$

$I_5 = 3.0$ $I_{100} = 5.8$

$Q_5 = (0.43)(19.40)(3.0)$
$= 25.0$

$Q_{100} = (0.52)(19.40)(5.8)$
$= 58.5$

BASIN III

AREA = 9.84 ACRES

SOILS 82 A & C
USE A FOR DEV

LAND USE

		C_5	C_{100}
IMPERVIOUS	5.0	0.90	0.95
OPEN SPACE	4.8	0.25	0.35
	9.8		

$$\text{Comp } C_5 = \frac{(5.0)(0.90) + (4.8)(0.25)}{9.8} = 0.58$$

$$\text{Comp } C_{100} = \frac{(5.0)(0.95) + (4.8)(0.35)}{9.8} = 0.68$$

TIME OF CONCENTRATION

OVERLAND L = 200 H = 6010 - 5960 = 50 $S = \frac{50}{200} = 25\%$

5 yr $T_c = 1.87(1.1 - 0.25)(200)^{0.5}(25)^{-0.33}$
$= 7.8$ min

100 yr $T_c = 1.87(1.1 - 0.35)(200)^{0.5}(25)^{-0.33}$
$= 6.9$ min

STREET L = 1150 H = 5960 - 5910 = 50 $S = \frac{50}{1150} = 4.3\%$

5 yr $T_c = \frac{1150}{(5.2)(60)} = 3.8$ $V_5 = 5.2$

100 yr $T_c = \frac{1150}{(7.5)(60)} = 2.6$ $V_{100} = 7.5$

TOTAL 5 yr $T_c = 7.8 + 3.8 = 11.6$

TOTAL 100 yr $T_c = 6.9 + 2.6 = 9.5$

$I_5 = 3.8$ $I_{100} = 7.1$

$Q_5 = (3.8)(0.58)(9.8)$
$= 21.6$

$Q_{100} = (7.1)(0.68)(9.8)$
$= 47.3$

BASIN IV

AREA = 49.3 ACRE

SOILS
82 - A & C
13 - B
56 - B & D

LAND USE

USE A SOILS

	AREA	C_5	C_{100}
1/8 ACRE RES	38.3	0.60	0.70
COMMERCIAL	11.0	0.90	0.90
	49.3		

$$\text{Comp } C_5 = \frac{(38.3)(0.60) + (11.0)(0.90)}{49.3} = 0.67$$

$$\text{Comp } C_{100} = \frac{38.3(0.70) + (11.0)(0.90)}{49.3} = 0.74$$

TIME OF CONCENTRATION

OVERLAND L = 150' H = 10 S = 6%

$$5 \text{ yr } T_c = 1.87(1.1 - 0.25)(150)^{0.5}(6)^{-0.33}$$
$$= 10.8$$

$$100 \text{ yr } T_c = 1.87(1.1 - 0.35)(150)^{0.5}(6)^{-0.33}$$
$$= 9.5$$

STREET L = 1200 H = 6000 - 5988 = 12 $S = \frac{12}{1200} = 1\%$

$V_{100} = 2.5$ $V_5 = 2$ fps

PLUS

L = 750 H = 5988 - 5965 = 23 $S = \frac{23}{750} = 3.0\%$

$V_5 = 3.5$

$V_{100} = 4.0$

$$5 \text{ yr } T_c = \frac{1200}{(60)(2)} + \frac{750}{(60)(3.5)} = 13.6$$

$$100 \text{ yr } T_c = \frac{1200}{60(2.5)} + \frac{750}{(60)(4.0)} = 11.1$$

TOTAL 5 yr T_c = 10.8 + 13.6 = 24.4

TOTAL 100 yr T_c = 9.5 + 11.1 = 20.6

$I_5 = 2.7$ $I_{100} = 5.0$

BASIN IV (CONTINUED)

$Q_5 = (2.7)(49.3)(0.67)$

$= 89.2$

$Q_{100} = (5.0)(49.3)(0.74)$

$Q_{100} = 182.4$

500 SHEETS, FILLER 5 SQUARE 13-782
50 SHEETS EYE-EASE® 5 SQUARE 42-381
100 SHEETS EYE-EASE® 5 SQUARE 42-382
200 SHEETS EYE-EASE® 5 SQUARE 42-389
100 RECYCLED WHITE 5 SQUARE 42-392
200 RECYCLED WHITE 5 SQUARE 42-399
Made in U.S.A.
National® Brand

BASIN V EXISTING w/ EXISTING RESIDENTIAL LOTS

	A	C_5	C_{100}
OPEN SPACE	3.48	0.25	0.35
1/8 ACRE LOTS	0.31	0.90	0.90
	3.79		

Comp C_5 = 0.30
Comp C_{100} = 0.39

TIME OF CONCENTRATION

OVERLAND $L = 1000'$ $H = 50'$ $S = \frac{50}{1000} = 5\%$

5 yr $T_c = 1.87(1.1-0.25)(1000)^{0.5}(5.0)^{-0.33}$
$= 29.6$

100 yr $T_c = 1.87(1.1-0.35)(1000)^{0.5}(5.0)^{-0.33}$
$= 26.1$

$I_5 = 2.4$ $I_{100} = 4.8$

$Q_5 = (2.4)(0.30)(3.79)$
$= 2.7$

$Q_{100} = (0.39)(4.8)(3.79)$
$= 7.1$

BASIN VI EXISTING

AREA = 11.2

	A	C_5	C_{100}
OPEN SPACE	10.37	0.25	0.35
1/8 ACRE LOTS	0.83	0.90	0.90
	11.2		

COMP C_5 = 0.30
COMP C_{100} = 0.39

TIME OF CONCENTRATION

OVERLAND L = 1000 H = 40 S = 4%

5 YR $T_c = 1.87(1.1 - 0.25)(1000)^{0.5}(4.0)^{-0.33}$
$= 31.8$

100 YR $T_c = 1.87(1.1 - 0.35)(1000)^{0.5}(4.0)^{-0.33}$
$= 28.1$

$I_5 = 2.4$ $I_{100} = 4.3$

$Q_5 = 2.4(0.30)(11.2)$
$= 8.1$

$Q_{100} = (4.3)(0.39)(11.2)$
$= 18.8$

DESIGN PT 1

	AREA	C_5	C_{100}
BASIN I	3.6	0.41	0.50
BASIN II	19.40	0.43	0.52
BASIN III	9.84	0.58	0.68
	32.8		

$$\text{COMP } C_5 = \frac{(3.6)(0.41) + (19.40)(0.43) + 9.84(0.68)}{32.8} = 0.47$$

$$C_{100} = \frac{(3.6)(0.50) + (19.40)(0.52) + (9.84)(0.68)}{32.8} = 0.57$$

TIME OF CONCENTRATION

USE T_c OF BASIN II

5 yr = 18.5 $I_5 = 3.0$

100 yr = 15.7 $I_{100} = 5.8$

$Q_5 = (32.8)(3.0)(0.47)$
$= 46.2$

$Q_{100} = (32.8)(5.8)(0.57)$
$= 108.4$

SIZE INLET TO CULVERT $Q_{100} = 108.4$

SUMP INLET $Q_5 = 46.2$

5 yr $Q_i = 1.7\left[L_i + 1.8(w)\right] d^{1.85}$ USE 30'

$46.2 = 1.7\left[30 + 1.8(3)\right] d^{1.85}$

$0.77 = d^{1.85}$

$0.87 = d$

100 yr $d = 0.94$

$\therefore Q = 3.60 (L_i)(d - 0.08)^{0.5}$

$108.4 = 3.60 (30)(d - 0.08)^{0.5}$

$1.0037 = (d - 0.08)^{0.5}$

$1.087 = d$ $\therefore$ OK

INLETS ON CARMEL

$Q_5 = 89.2$ $Q_{100} = 182.4$

FLOW WILL BE SPLIT EQUALLY ON BOTH SIDE OF CARMEL

$Q_5 = \frac{89.2}{2} = 44.6$ cfs / SIDE $Q_{100} = \frac{182.4}{2} = 91.2$ / SIDE

TRY $L = 30'$

$44.6 = 1.7 [(30 + (1.8)(3)] d^{1.85}$

$0.85 = d$ ∴ OK

$Q_{100} = 91.2$ $d \geq 0.94$

$Q_i = 3.60 (30)(0.94 - 0.08)^{0.5}$

$= 100.1$ ∴ OK

DESIGN PT # 2

BASIN	AREA	C_5	C_{100}
V	3.79	0.30	0.39
IV	49.30	0.67	0.74
	53.09		

COMP C_5 = 0.64

COMP C_{100} = 0.72

TIME OF CONCENTRATION

USE Tc FROM IV PLUS PIPE FLOW

5 yr $T_c = 24.4 + \frac{1500}{(60)(19)} = 25.7$ V = 19 fps

100 yr $T_c = 20.6 + \frac{1500}{(60)(21)} = 21.7$ V = 21

$I_5 = 3.3$ $I_{100} = 4.9$

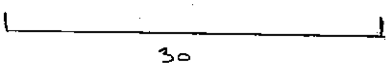
$Q_5 = (3.3)(53.09)(0.64)$
$= 112.1$

$Q_{100} = (4.9)(53.09)(0.72)$
$= 187.3$

STREET CAPACITY OF HANCOCK EXPRESSWAY
JUST WEST OF CARMEL DRIVE

SECTION @ CARMEL HAS $S_x = 0\%$

$S =$



$A = (30)(0.5) = 15^{\square}$

$P = 31$

$$Q = \frac{1.486}{0.016}\left(\frac{15}{31}\right)^{0.67}(15)(0.016)^{0.5}$$

$Q_{CAP} = 108$ cfs $\qquad Q_{100} = 108.4 \doteq$ OK

DEPTH OF WATER DURING 100 YR STORM = 0.5'

$Q_5 = 46.2$ ASSUME DEPTH OF WATER = 0.30

$A = 9.0$
$P = 30.6$

$$Q = \frac{1.486}{0.016}\left(\frac{9.0}{30.6}\right)^{0.67}(9.0)(0.016)^{0.5}$$

$= 46.5$

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name:

Comment:

Solve For Depth

Given Input Data:

Bottom Width.....	6.00 ft
Left Side Slope..	5.00:1 (H:V)
Right Side Slope.	5.00:1 (H:V)
Manning's n......	0.030
Channel Slope....	0.0200 ft/ft
Discharge........	8.00 cfs

Computed Results:

Depth............	0.35 ft
Velocity.........	3.00 fps
Flow Area........	2.67 sf
Flow Top Width...	9.45 ft
Wetted Perimeter.	9.52 ft
Critical Depth...	0.34 ft
Critical Slope...	0.0202 ft/ft
Froude Number....	0.99 (flow is Subcritical)

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name:

Comment:

Solve For Depth

Given Input Data:

Bottom Width.....	6.00 ft
Left Side Slope..	5.00:1 (H:V)
Right Side Slope.	5.00:1 (H:V)
Manning's n......	0.030
Channel Slope....	0.0200 ft/ft
Discharge........	8.00 cfs

Computed Results:

Depth............	0.35 ft
Velocity.........	3.00 fps
Flow Area........	2.67 sf
Flow Top Width...	9.45 ft
Wetted Perimeter.	9.52 ft
Critical Depth...	0.34 ft
Critical Slope...	0.0202 ft/ft
Froude Number....	0.99 (flow is Subcritical)

Circular Channel Analysis & Design
Solved with Manning's Equation

60" @ 1%

Open Channel - Uniform flow

Worksheet Name:

Comment:

Solve For Actual Depth

Given Input Data:

Diameter..........	5.00 ft
Slope.............	0.0100 ft/ft
Manning's n.......	0.013
Discharge.........	280.00 cfs

Computed Results:

Depth.............	4.65 ft
Velocity..........	14.72 fps
Flow Area.........	19.02 sf
Critical Depth....	4.59 ft
Critical Slope....	0.0100 ft/ft
Percent Full......	92.92 %
Full Capacity.....	260.44 cfs
QMAX @.94D........	280.16 cfs
Froude Number.....	0.95 (flow is Subcritical)

60" @ 3.8%

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name:

Comment:

Solve For Actual Depth

Given Input Data:

Diameter..........	5.00 ft
Slope.............	0.0380 ft/ft
Manning's n.......	0.013
Discharge.........	280.00 cfs

Computed Results:

Depth.............	2.65 ft
Velocity..........	26.49 fps
Flow Area.........	10.57 sf
Critical Depth....	4.59 ft
Critical Slope....	0.0100 ft/ft
Percent Full......	53.01 %
Full Capacity.....	507.70 cfs
QMAX @.94D........	546.13 cfs
Froude Number.....	3.21 (flow is Supercritical)

Hydrology

Location: COMBINE OP #1 & OP #2
Area: 85.89 Ac.
Soil or Land Use: ______

Runoff Coefficient, C:

Area Zone	A	C5	C100	%Area
OP #1	32.8	0.47	0.57	
OP #2	53.09	0.64	0.72	

Composite: C5 0.58 C100 0.66 100%

Time of Concentration: T_c in minutes:

Travel Type	L(ft)	s%	v(fps)	T_c

T_{c5}: 25.7
T_c Total: 21.7 (100)

Intensity, I (inches/hr) from Fig 5-1

I5: 3.3 in/hr I100 4.9 in/hr

Peak Flow: Q = CIA in cfs

Q5 164.4 cfs Q100: 277.8 cfs

Hydrology

Location: ______
Area: ______ Ac.
Soil or Land Use: ______

Runoff Coefficient, C:

Area Zone	C5	C100	%Area

Composite: C5 ______ C100 ______ 100%

Time of Concentration: T_c in minutes:

Travel Type	L(ft)	s%	v(fps)	T_c

T_c Total: ______

Intensity, I (inches/hr) from Fig 5-1

I5: ______ in/hr I100 ______ in/hr

Peak Flow: Q = CIA in cfs

Q5 ______ cfs Q100: ______ cfs