HYDROLOGY

G11/D11

ONE PLAN

G 11- D 11

1 PLAN

Helmuth 836-3499

Villa de Paz

Town House

Doug Blot

Bruno said he under contract.

→ Bruno - As I recall

dr. study notes is supposed

to found in front of this

apts.

Can you contact him

with dr. report?

[illegible]

CAMPBELL-HICKS and ASSOCIATES, Inc.
Soils Testing Laboratory

232 Muriel Street, N.E. • Phone (505) 296-7139 • Albuquerque, New Mexico 87123

PRELIMINARY STORM DRAINAGE STUDY RELATIVE TO THE DEVELOPMENT OF VILLA DE PAZ

JULY 1972

DRAINAGE STUDY INDEX

DESCRIPTION	PAGE NO.
I. General	1
II. Location	1
III. Existing Drainage Conditions	1
A. General	
B. Topography	
C. Drainage Areas and Channels	
IV. Proposed Drainage Plans	2
A. General	
B. Drainage Areas	
C. Runoff Quantities	
D. Drainage Channels and Facilities	
V. Conclusions and Recommendations	4
Exhibits	
A. Location Map	6
B. Master Plan of Drainage	7
C. Summary of Runoff Computations	8
D. Summary of Street Carrying Capacities and Computer Output Sheets	19
E. Storm Sewer Pipe Carrying Capacities	22
Bibliography of References	25

PRELIMINARY STORM DRAINAGE STUDY
RELATIVE TO THE DEVELOPMENT OF
VILLA DE PAZ

I. GENERAL

This report has been prepared to present findings of a study of storm drainage conditions in an area proposed for development as Villa De Paz and to describe proposed methods for providing adequate storm drainage in the area.

II. LOCATION

The area considered in this report is bounded on the west by Atrisco Drive, N.W.; on the north by the North Boundary, Town of Atrisco Grant; on the east by Coors Road, N.W.; and on the south by Town of Atrisco Grant, Northeast Unit. It is situated in the Town of Atrisco Grant in the west one-half (W 1/2) of Section 2, Township 10 North (T10N), Range 3 East (R3E), New Mexico Principal Meridan.

III. EXISTING DRAINAGE CONDITIONS

A. General

The presently undeveloped area proposed for this development lies on the west mesa. It is marked by gentle to flat slopes with considerable areas of ponding.

B. Topography

The area of the proposed development is located between Atrisco Drive, N.W. and Coors Road, N.W., relatively flat with sparce vegetation just east of a major division line. This area has State Highway 448, portions of which were constructed as project S-1309 (200). This highway has been built with a borrow ditch on both sides with a low point 200 to 250' north of the south boundary of Villa De Paz at the point where a section was deleted during original construction. A silty sand appears on the surface which has a relatively low permeability after compaction.

The topography on the Master Plan of Drainage was obtained from field notes prepared under the direction of John R. Mendius and appears to be accurate and complete.

C. Drainage Areas and Channels

At the present time there are no drainage areas contributing runoff from the west. The main contribution is cut off by Atrisco Drive, N.W. borrow ditches which will probably be designed to carry all runoff from the west as well as carry the small additional runoff from the east after development.

IV. PROPOSED DRAINAGE PLANS

A. General

In order to provide an adequate system of storm drainage for the proposed development it was necessary to:

(1) Determine the drainage areas which can and will contribute storm runoff during a 100 year design storm.

(2) Determine the amount of runoff which could be expected after the entire area is developed.

(3) Determine the points where the storm runoff will concentrate.

(4) Prepare a table of street carrying capacities for use in sizing streets and overflow sections (section above high curb to property lines) and a table of concrete storm sewer pipe capacities for use in storm sewer design.

(5) Determine the ability of each of the drainage channels, streets plus overflow sections, and structures to handle the runoff that may concentrate on them.

(6) Determine and recommend the means by which the expected runoff can be safely carried across the subdivision in the same proportion as it now exists.

(7) Design additional channels and structures adequate to handle the runoff in the area to be developed.

B. Drainage Areas

A study of the photography, Exhibit "A", a photograph prepared by Koogle & Pouls Engineering, Inc., to determine the areas which could conceivably contribute runoff to the proposed development was made for which a copy of computations is contained in Exhibit "C" of this report. Finally, Exhibit "B", the Master Plan of Drainage, was

prepared showing the entire area with directions of flow as well as runoff quantities.

C. Runoff Quantities

The quantities of storm runoff to be expected from each drainage area were determined using the Rational Formula, Q=CIA, where Q=quantity of storm runoff in cubic feet per second; C=coefficient of runoff dependent upon the type of surface drained; I=intensity of rainfall in inches per hour for a duration equal to the total accumulation time in minutes; and A=area of contributing watershed in acres.

The area (A) of each separate contributing area was determined by outlining the watershed on a scale photograph or the contour map and measuring the area (by planimeter) in acres.

The intensity of rainfall (I) was determined by assuming a 100 year frequency rainfall and then utilizing Intensity Duration Frequency Curves (Chart I) for the Albuquerque Area, "Master Plan of Drainage - City of Albuquerque, New Mexico and Environs," 1963, prepared by Gordon Herkenhoff and Associates, consulting Engineers, together with expected accumulation of runoff from each of the areas. The total accumulation times are determined by a combination of Yarnell's Method and probable future streets and drainage channel alignments and grades, as shown; assuming overland flows to cross either poor grass, asphalt pavement or bare soil surfaces, depending upon the probable type of development in each area and estimating the probable type of grading to be done in each area; assuming future streets to be asphalt paved with concrete curbs and crowned with either full crown (4"), 1/2 crown (2") or no crown (0").

The coefficient of runoff (C) was determined by assuming the maximum possible development in the areas under consideration. A coefficient of 0.65 is used for areas where dense residential development was most probable.

The quantities of runoff are shown along with the areas after development on Exhibit "B", the Master Plan of Drainage for this subdivision.

D. Drainage Channels and Facilities.

All existing structure capacities, as well as any future proposed structures, were verified from computer output sheets which form a part of Exhibit "C" and are based on Manning's Equation, Q=AV, where $V=\frac{1.486}{n} R^{2/3} S^{1/2}$

when A=cross-sectional area of the channel or structure, R=hydraulic radius of channel or area divided by wetted perimeter, S=slope of channel or facility in feet per foot, and "n" values of 0.015 for concrete and asphalt surfaces, 0.015 for concrete pipes, and 0.0225 for dirt lined channels or a composite "n" value based on proportional wetted surfaces with different values.

V. CONCLUSIONS AND RECOMMENDATIONS

On the basis of this study and its calculations, it is concluded that the development of this area can be accomplished satisfactorily provided adequate storm drainage and the following recommendations are adhered to:

A. Construct both east-west streets with water blocks 120' to 130' east of Atrisco Drive, N.W. and maintain a minimum grade of 0.5% from Coors Road to a point at least 250' west of Coors Road, N.W. Also set temporary structures in existing borrow ditch along Atrisco Drive, N.W. until curbs and development further west proceeds.

B. Using anticipated total runoff quantities furnished in Exhibit "C", design streets using the street carrying capacities shown in Exhibit "D" using 0.2' overflow maximum for 40' R/W streets and 0.05' maximum overflow for 25' R/W streets.

C. After the entire surrounding area has been developed and prior to building curb and gutter on Coors Road, N.W., a storm sewer must be designed to drain the low spot near where platted Tucson Road intersects Coors. A suggested or proposed alignment is shown along Tucson Road, Alamogordo Drive, and Alamogordo Place leading east to the Rio Grande River. After the Albuquerque Metropolitan Arroyo Flood Control Authority completes planning the west mesa area, some other more suitable solution to the inevitable ponding in this area may be available.

D. As a temporary solution, construction of this area in such a manner as to deposit runoff in the present borrow ditch along the west side of State Road 448 (Coors Road, N.W.) is satisfactory since it is currently being distributed in this manner.

E. The plaza area about 450' west of Coors Road, N.W. and about 300' south of the North Boundary, Town of Atrisco Grant line was not considered as a retention structure or infiltration area, but it could readily be designed to temporarily retain about 10,000 cubic feet of runoff. However, due to the low rate of permeability of this material and the additional cost of construction and maintenance, it is not recommended. The small open area along the east edge should be designed as an infiltration area after curb and gutter is constructed on Coors Road.

This eventuality is reflected by a reduced coefficient of runoff being used in calculations in area no. 4.

F. A low point in Coors Road, N.W. near the intersection of the southerly forty foot right-of-way street will be a problem when development proceeds to the point where the present borrow ditch is filled and/or curb and gutter is constructed. At that time it will require a solution similar to the one suggested by recommendation C. Values of concrete storm sewer pipe are contained in Exhibit "E" for use in design. A double type C drop inlet will carry about 40 c.f.s. and the number may be increased to accomodate the expected runoff.

If all the above recommendations are complied with, this should provide a very satisfactory planned residential development.

Respectfully submitted,

Donald L. Campbell
P.E. & L.S. No. 3633

John R. Mendius
L.S. No. 3722

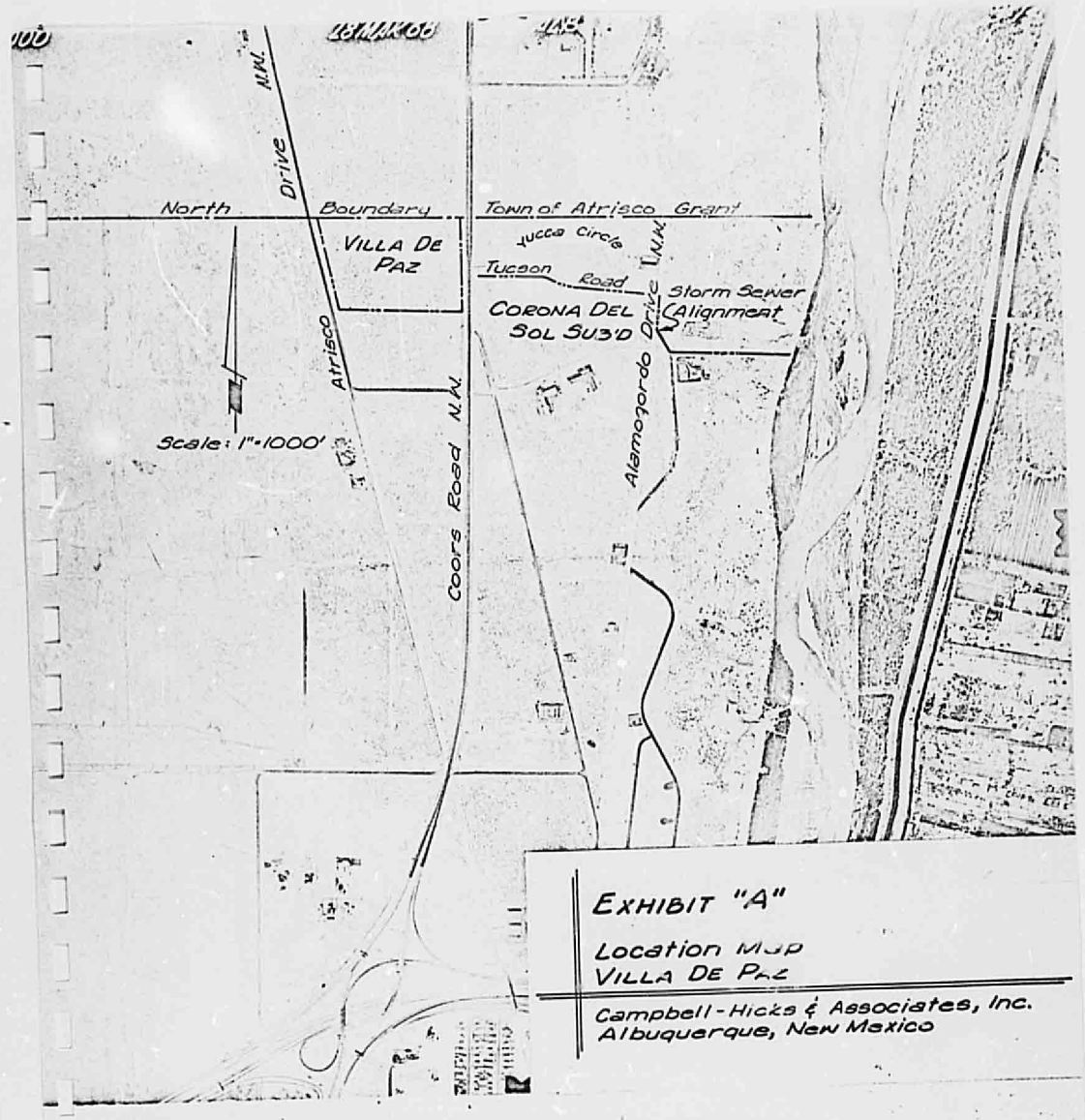

EXHIBIT "A"

Location Map
VILLA DE PAZ

Campbell-Hicks & Associates, Inc.
Albuquerque, New Mexico

EXHIBIT C

SUMMARY OF RUNOFF COMPUTATIONS

Sheet No.	Area No.	Area in Acres Individual	Area in Acres Total	Expected Runoff (in c.f.s.) Individual	Expected Runoff (in c.f.s.) Total
1	1	0.9	0.9	3	3
2	2	2.4	3.3	10	13
3	3	3.2	6.5	11	24
4	4	0.1	6.6	0	24
5	5	2.5	2.5	10	10
6	6	0.5	3.0	2	12
7	7	0.2	3.2	1	13
8	8	1.0	1.0	4	4
9	9	0.4	0.4	2	2
10	10	1.3	1.3	5	5

RUNOFF COMPUTATIONS

Sheet No. 1

Job No. VDP

Drainage Area No. 1

Area = 0.9 acres

Maximum Overland Flow: L = 112' S = 2.2%

Maximum Channel Flow:

Channel No. 1 L = 187' S = 0.5%

Channel No. 2 L = 210' S = 0.5%

Channel No. 3 L = 35' S = 2.9%

Accumulation Time

Overland Flow: 7.4 min.

Channel No. 1 Flow:

Velocity= 3.16 ft/sec; Time= $\frac{187}{3.16 \times 60}$ = 1.0 min.

Channel No. 2 Flow:

Velocity= 3.16 ft/sec; Time= $\frac{210}{3.16 \times 60}$ = 1.1 min.

Channel No. 3 Flow:

Velocity= 2.21 ft/sec; Time= $\frac{35}{2.21 \times 60}$ = 0.3 min.

Total Accumulation Time: T = 9.8 min.

$I = \frac{189}{T+25} = \frac{189}{9.8+25} = 5.42$

Q = CIA = (0.65)(5.42)(0.9) = 3 c.f.s.

Date: 7/11/72

Comp. by: [illegible]

Checked by: K.R.

RUNOFF COMPUTATIONS

Sheet No. 2

Job No. VDP

Drainage Area No. 2

Area = 2.4 acres

Maximum Overland Flow: L = 25' S = 5.2%

Maximum Channel Flow:

Channel No. 1 L = 230' S = 0.5%

Channel No. 2 L = 205' S = 1.25%

Channel No. 3 L = _____ S = _____

Accumulation Time

Overland Flow: 3.3 min.

Channel No. 1 Flow:

Velocity= 3.16 ft/sec; Time= $\frac{230}{3.16 \times 60}$ = 1.2 min.

Channel No. 2 Flow:

Velocity= 3.57 ft/sec; Time= $\frac{205}{3.57 \times 60}$ = 1.0 min.

Channel No. 3 Flow:

Velocity= _____ ft/sec; Time= $\frac{\quad}{\quad \times 60}$ = _____ min.

Total Accumulation Time: T = 5.5 min.

$i = \frac{189}{T+25} = \frac{189}{5.5+25} = 6.19$

Q = CIA = (.65)(6.19)(2.4) = 10 c.f.s.

Date: 7/11/72

Comp. by: [illegible]

Checked by: K. R.

Totals

AREA = 0.9 + 2.4 = 3.3 ACRES

Q = 3 + 10 = 13 c.f.s.

RUNOFF COMPUTATIONS

Sheet No. 3

Job No. VDP

Drainage Area No. 3

Area = 3.2 acres

Maximum Overland Flow: L = 166 S = 2.5%

Maximum Channel Flow:

Channel No. 1 L = 340 S = .5%

Channel No. 2 L = _____ S = _____

Channel No. 3 L = _____ S = _____

Accumulation Time

Overland Flow: 8.5 min.

Channel No. 1 Flow:

Velocity= 2.21 ft/sec; Time= $\frac{340}{2.21 \times 60}$ = 2.6 min.

Channel No. 2 Flow:

Velocity= _____ ft/sec; Time= $\frac{\quad}{\times 60}$ = _____ min.

Channel No. 3 Flow:

Velocity= _____ ft/sec; Time= $\frac{\quad}{\times 60}$ = _____ min.

Total Accumulation Time: T = 11.1 min.

$I = \frac{189}{T+25} = \frac{189}{11.1+25} = 5.23$

Q = CIA = (0.65)(5.23)(3.2) = 11 c.f.s.

Date: 7/11/77

Comp. by: [illegible]

Checked by: K.R.

Totals

AREA = 3.3 + 3.2 = 6.5 Acres

Q = 13 + 11 = 24 c.f.s.

RUNOFF COMPUTATIONS

Sheet No. 4

Job No. VDP

Drainage Area No. 4

Area = 0.1 acres

Maximum Overland Flow: L = 25' S = 4.0%

Maximum Channel Flow:

Channel No. 1 L = 220' S = 0.5%

Channel No. 2 L = 42' S = 0.5%

Channel No. 3 L = _____ S = _____

Accumulation Time

Overland Flow: 3.6 min.

Channel No. 1 Flow:

Velocity= 3.16 ft/sec; Time= $\frac{220}{3.16 \times 60}$ = 1.2 min.

Channel No. 2 Flow:

Velocity= 3.54 ft/sec; Time= $\frac{42}{3.54 \times 60}$ = 0.2 min.

Channel No. 3 Flow:

Velocity= _____ ft/sec; Time= $\frac{\quad}{\times 60}$ = _____ min.

Total Accumulation Time: T = 5.0 min.

$$I = \frac{189}{T+25} = \frac{189}{5.0+25} = 6.30$$

$$Q = CIA = (.50)(6.30)(0.1) = \cancel{0.30}\ 0 \text{ c.f.s.}$$

Date: 7/11/72

Comp. by: DPC

Checked by: R.R.

Totals

AREA = 6.5 + 0.1 = 6.6 ACRES

Q = 24 + 0 = 24.0 c.f.s.

RUNOFF COMPUTATIONS

Sheet No. 5

Job No. VDP

Drainage Area No. 5

Area = 2.5 acres

Maximum Overland Flow: L = 25' S = 5.0%

Maximum Channel Flow:

Channel No. 1 L = 110' S = 0.8%

Channel No. 2 L = 363' S = 3.0%

Channel No. 3 L = 260' S = 0.5%

Accumulation Time

Overland Flow: 3.2 min.

Channel No. 1 Flow:

Velocity= 2.76 ft/sec; Time= $\frac{110}{2.76 \times 60}$ = 0.7 min.

Channel No. 2 Flow:

Velocity= 5.42 ft/sec; Time= $\frac{363}{5.42 \times 60}$ = 1.1 min.

Channel No. 3 Flow:

Velocity= 3.16 ft/sec; Time= $\frac{260}{3.16 \times 60}$ = 1.4 min.

Total Accumulation Time: T = 6.4 min.

$I = \frac{189}{T+25} = \frac{189}{6.4+25} = 6.01$

Q = CIA = (.65)(6.01)(2.5) = 10 c.f.s.

Date: 7/11/22

Comp. by: [illegible]

Checked by: K.R.

RUNOFF COMPUTATIONS

Sheet No. 6

Job No. VDP

Drainage Area No. 6

Area = 0.5 acres

Maximum Overland Flow: L = 25' S = 4.0%

Maximum Channel Flow:

Channel No. 1 L = 221 S = 0.5%

Channel No. 2 L = 113 S = 0.8%

Channel No. 3 L = 80 S = 0.8%

Accumulation Time

Overland Flow: 3.3 min.

Channel No. 1 Flow:

Velocity= 2.21 ft/sec; Time= $\frac{221}{2.21 \times 60}$ = 1.7 min.

Channel No. 2 Flow:

Velocity= 2.76 ft/sec; Time= $\frac{113}{2.76 \times 60}$ = 0.7 min.

Channel No. 3 Flow:

Velocity= 4.37 ft/sec; Time= $\frac{80}{4.37 \times 60}$ = 0.3 min.

Total Accumulation Time: T = 6.0 min.

$I = \frac{189}{T+25} = \frac{189}{6+25} = 6.09$

$Q = CIA = (0.65)(6.09)(0.5) = 2$ c.f.s.

Date: 7/11/22

Comp. by: [illegible]

Checked by: K.R.

Totals

Area = 2.5 + 0.5 = 3.0 Acres

Q = 10 + 2 = 12 c.f.s.

RUNOFF COMPUTATIONS

Sheet No. 7

Job No. VDP

Drainage Area No. 7

Area = 0.2 acres

Maximum Overland Flow: L = 35' S = 5.0%

Maximum Channel Flow:

Channel No. 1 L = 114 S = 0.5%

Channel No. 2 L = _____ S = _____

Channel No. 3 L = _____ S = _____

Accumulation Time

Overland Flow: 3.6 min.

Channel No. 1 Flow:

Velocity= 2.21 ft/sec; Time= $\frac{114}{2.21 \times 60}$ = 0.9 min.

Channel No. 2 Flow:

Velocity=_____ft/sec; Time= $\frac{\quad}{\times 60}$ = _____min.

Channel No. 3 Flow:

Velocity=_____ft/sec; Time= $\frac{\quad}{\times 60}$ = _____min.

Total Accumulation Time: T = 4.5 min.

$I = \frac{189}{T+25} = \frac{189}{4.5+25} = 6.40$

$Q = CIA = (0.65)(6.40)(0.2) = 1$ c.f.s.

Date: 7/11/22

Comp. by: DRC

Checked by: K. R.

Totals

Area = 3.0 + 0.2 = 3.2 Acres

Q = 12 + 1 = 13 c.f.s.

RUNOFF COMPUTATIONS

Sheet No. 8

Job No. VDP

Drainage Area No. 8

Area = 1.0 acres

Maximum Overland Flow: L = 25' S = 1.0%

Maximum Channel Flow:

Channel No. 1 L = 147' S = 1.8%

Channel No. 2 L = 175' S = 1.7%

Channel No. 3 L = _____ S = _____

Accumulation Time

Overland Flow: 4.6 min.

Channel No. 1 Flow:

Velocity= 5.98 ft/sec; Time= $\frac{147}{5.98 \times 60}$ = 0.4 min.

Channel No. 2 Flow:

Velocity= 5.81 ft/sec; Time= $\frac{175}{5.81 \times 60}$ = 0.5 min.

Channel No. 3 Flow:

Velocity= _____ ft/sec; Time= $\frac{\quad}{\quad \times 60}$ = _____ min.

Total Accumulation Time: T = 5.5 min.

$$I = \frac{189}{T + 25} = \frac{189}{5.5 + 25} = 6.19$$

$$Q = CIA = (0.65)(6.19)(1.0) = 4 \text{ c.f.s.}$$

Date: 7/11/72

Comp. by: [illegible]

Checked by: K. R.

RUNOFF COMPUTATIONS

Sheet No. 9

Job No. VDP

Drainage Area No. 9

Area = 0.4 acres

Maximum Overland Flow: L = 35' S = 5.0%

Maximum Channel Flow:

Channel No. 1 L = 182' S = 1.4%

Channel No. 2 L = _____ S = _____

Channel No. 3 L = _____ S = _____

Accumulation Time

Overland Flow: 3.6 min.

Channel No. 1 Flow:

Velocity= 5.27 ft/sec; Time= $\frac{182}{5.27 \times 60}$ = 0.6 min.

Channel No. 2 Flow:

Velocity= _____ ft/sec; Time= $\frac{\quad}{\times 60}$ = _____ min.

Channel No. 3 Flow:

Velocity= _____ ft/sec; Time= $\frac{\quad}{\times 60}$ = _____ min.

Total Accumulation Time: T = 4.2 min.

$$I = \frac{189}{T+25} = \frac{189}{4.2+25} = 6.47$$

$$Q = CIA = (0.65)(6.47)(0.4) = 2 \text{ c.f.s.}$$

Date: 7/11/72

Comp. by: [illegible]

Checked by: R. R.

RUNOFF COMPUTATIONS

Sheet No. 10

Job No. VDP

Drainage Area No. 10

Area = 1.3 acres

Maximum Overland Flow: L = 25' S = 2.8%

Maximum Channel Flow:

Channel No. 1 L = 170' S = 0.5%

Channel No. 2 L = 175' S = 0.5%

Channel No. 3 L = _____ S = _____

Accumulation Time

Overland Flow: 3.6 min.

Channel No. 1 Flow:

Velocity= 3.16 ft/sec; Time= $\frac{170}{3.16 \times 60}$ = 0.9 min.

Channel No. 2 Flow:

Velocity= 3.16 ft/sec; Time= $\frac{175}{3.16 \times 60}$ = 0.9 min.

Channel No. 3 Flow:

Velocity= _____ ft/sec; Time= $\frac{\quad}{\times 60}$ = _____ min.

Total Accumulation Time: T = 5.4 min.

$$I = \frac{189}{T+25} = \frac{189}{5.4+25} = 6.22$$

$$Q = CIA = (0.65)(6.22)(1.3) = 5 \text{ c.f.s.}$$

Date: 7/11/72

Comp. by: [illegible]

Checked by: K. R.

EXHIBIT D

STREET CARRYING CAPACITIES AT VARIOUS GRADES IN CFS

n(conc)=.015 Curb Height=4"

R/W	ST WD	TYPE CROWN	HI CURB DEPTH	.0050	.0100	.0150	.0200	.0250	.0300	.0350	.0400
25'	20'	0"	.05'	25	35	43	49	55	60	65	70
		2"	.05'	14	20	24	28	31	34	37	40
		4"	.05'	6	9	10	12	13	15	16	17
40'	32'	2"	.10'	31	44	54	62	70	76	82	88
		4"	.10'	16	23	28	32	36	39	42	45
		2"	.20	52	74	91	105	117	128	139	148
		4"	.20	33	47	57	66	74	81	88	94

25' R.O.W. 20' FACE-FACE 4" CURB 0" CROWN .05' OVERFLOW

N	A	P	S	S1/2	R	R2/3	V	Q
.0150	7.7865	25.6708	.0050	.0707	.3033	.4514	3.1621	24.6217
.0150	7.7865	25.6708	.0100	.1000	.3033	.4514	4.4719	34.8203
.0150	7.7865	25.6708	.0150	.1225	.3033	.4514	5.4769	42.6460
.0150	7.7865	25.6708	.0200	.1414	.3033	.4514	6.3242	49.2433
.0150	7.7865	25.6708	.0250	.1581	.3033	.4514	7.0707	55.0557
.0150	7.7865	25.6708	.0300	.1732	.3033	.4514	7.7456	60.3105
.0150	7.7865	25.6708	.03[illegible]	.1871	.3033	.4514	8.3662	65.1428
.0150	7.7865	25.6708	.0400	.2000	.3033	.4514	8.9438	69.6406

25' R.O.W. 20' FACE-FACE 4" CURB 2" CROWN .05' OVERFLOW

N	A	P	S	S1/2	R	R2/3	V	Q
.0150	5.5642	25.6745	.0050	.0707	.2167	.3608	2.5272	14.0621
.0150	5.5642	25.6745	.0100	.1000	.2167	.3608	3.5741	19.8869
.0150	5.5642	25.6745	.0150	.1225	.2167	.3608	4.3773	24.3563
.0150	5.5642	25.6745	.0200	.1414	.2167	.3608	5.0545	28.1243
.0150	5.5642	25.6745	.0250	.1581	.2167	.3608	5.6511	31.4439
.0150	5.5642	25.6745	.0300	.1732	.2167	.3608	6.1904	34.4451
.0150	5.5642	25.6745	.0350	.1871	.2167	.3608	6.6864	37.2049
.0150	5.5642	25.6745	.0400	.2000	.2167	.3608	7.1481	39.7737

25' R.O.W. 20' FACE-FACE 4" CURB 4" CROWN .05' OVERFLOW

N	A	P	S	S1/2	R	R2/3	V	Q
.0150	3.3420	25.6856	.0050	.0707	.1301	.2568	1.7986	6.0108
.0150	3.3420	25.6856	.0100	.1000	.1301	.2568	2.5435	8.5005
.0150	3.3420	25.6856	.0150	.1225	.1301	.2568	3.1152	10.4110
.0150	3.3420	25.6856	.0200	.1414	.1301	.2568	3.5971	12.0216
.0150	3.3420	25.6856	.0250	.1581	.1301	.2568	4.0217	13.4405
.0150	3.3420	25.6856	.0300	.1732	.1301	.2568	4.4055	14.7233
.0150	3.3420	25.6856	.0350	.1871	.1301	.2568	4.7585	15.9030
.0150	3.3420	25.6856	.0400	.2000	.1301	.2568	5.0871	17.0011

40' R.O.W. 32' FACE-FACE 4" CURB 2" CROWN .10' OVERFLOW

N	A	P	S	S1/2	R	R2/3	V	Q
.0150	10.7778	40.7023	.0050	.0707	.2648	.4124	2.8874	31.1198
.0150	10.7778	40.7023	.0100	.1000	.2648	.4124	4.0834	44.0101
.0150	10.7778	40.7023	.0150	.1225	.2648	.4124	5.0011	53.9011
.0150	10.7778	40.7023	.0200	.1414	.2648	.4124	5.7748	62.2397
.0150	10.7778	40.7023	.0250	.1581	.2648	.4124	6.4564	69.5861
.0150	10.7778	40.7023	.0300	.1732	.2648	.4124	7.0727	76.2277
.0150	10.7778	40.7023	.0350	.1871	.2648	.4124	7.6394	82.3354
.0150	10.7778	40.7023	.0400	.2000	.2648	.4124	8.1668	88.0202

40' R.O.W. 32' FACE-FACE 4" CURB 4" CROWN .10' OVERFLOW

N	A	P	S	S1/2	R	R2/3	V	Q
.0150	7.2222	40.7093	.0050	.0707	.1774	.3157	2.2108	15.9670
.0150	7.2222	40.7093	.0100	.1000	.1774	.3157	3.1266	22.5808
.0150	7.2222	40.7093	.0150	.1225	.1774	.3157	3.8293	27.6557
.0150	7.2222	40.7093	.0200	.1414	.1774	.3157	4.4216	31.9341
.0150	7.2222	40.7093	.0250	.1581	.1774	.3157	4.9435	35.7034
.0150	7.2222	40.7093	.0300	.1732	.1774	.3157	5.4154	39.1111
.0150	7.2222	40.7093	.0350	.1871	.1774	.3157	5.8493	42.2448
.0150	7.2222	40.7093	.0400	.2000	.1774	.3157	6.2531	45.1616

40' R.O.W. 32' FACE-FACE 4" CURB 2" CROWN .20' OVERFLOW

N	A	P	S	S1/2	R	R2/3	V	Q
.0150	14.7778	40.9023	.0050	.0707	.3613	.5073	3.5434	52.3631
.0150	14.7778	40.9023	.0100	.1000	.3613	.5073	5.0111	74.0526
.0150	14.7778	40.9023	.0150	.1225	.3613	.5073	6.1373	90.6956
.0150	14.7778	40.9023	.0200	.1414	.3613	.5073	7.0867	104.7262
.0150	14.7778	40.9023	.0250	.1581	.3613	.5073	7.9232	117.0875
.0150	14.7778	40.9023	.0300	.1732	.3613	.5073	8.6794	128.2629
.0150	14.7778	40.9023	.0350	.1871	.3613	.5073	9.3749	138.5398
.0150	14.7778	40.9023	.0400	.2000	.3613	.5073	10.0222	148.1053

40' R.O.W. 32' FACE-FACE 4" CURB 4" CROWN .20' OVERFLOW

N	A	P	S	S1/2	R	R2/3	V	Q
.0150	11.2222	40.9093	.0050	.0707	.2743	.4222	2.9490	33.0948
.0150	11.2222	40.9093	.0100	.1000	.2743	.4222	4.1706	46.8031
.0150	11.2222	40.9093	.0150	.1225	.2743	.4222	5.1079	57.3218
.0150	11.2222	40.9093	.0200	.1414	.2743	.4222	5.8981	66.1896
.0150	11.2222	40.9093	.0250	.1581	.2743	.4222	6.5943	74.0022
.0150	11.2222	40.9093	.0300	.1732	.2743	.4222	7.2236	81.0653
.0150	11.2222	40.9093	.0350	.1871	.2743	.4222	7.8024	87.5606
.0150	11.2222	40.9093	.0400	.2000	.2743	.4222	8.3411	93.6062

EXHIBIT E
CONCRETE STORM SEWER CARRYING CAPACITIES

CONCRETE STORM SEWER PIPE.....DIAMETER = 18"

N	A	P	S	S1/2	R	R2/3	V	Q
.0150	1.7671	4.7124	.0050	.0707	.3750	.5200	3.6428	6.4373
.0150	1.7671	4.7124	.0100	.1000	.3750	.5200	5.1517	9.1038
.0150	1.7671	4.7124	.0150	.1225	.3750	.5200	6.3095	11.1498
.0150	1.7671	4.7124	.0200	.1414	.3750	.5200	7.2856	12.8747
.0150	1.7671	4.7124	.0250	.1581	.3750	.5200	8.1455	14.3943
.0150	1.7671	4.7124	.0300	.1732	.3750	.5200	8.9230	15.7682
.0150	1.7671	4.7124	.0350	.1871	.3750	.5200	9.6379	17.0316
.0150	1.7671	4.7124	.0400	.2000	.3750	.5200	10.3033	18.2075
.0150	1.7671	4.7124	.0450	.2121	.3750	.5200	10.9284	19.3120
.0150	1.7671	4.7124	.0500	.2236	.3750	.5200	11.5195	20.3566
.0150	1.7671	4.7124	.0550	.2345	.3750	.5200	12.0817	21.3502
.0150	1.7671	4.7124	.0600	.2449	.3750	.5200	12.6190	22.2996
.0150	1.7671	4.7124	.0650	.2550	.3750	.5200	13.1342	23.2101
.0150	1.7671	4.7124	.0700	.2646	.3750	.5200	13.6300	24.0863
.0150	1.7671	4.7124	.0750	.2739	.3750	.5200	14.1084	24.9317
.0150	1.7671	4.7124	.0800	.2828	.3750	.5200	14.5711	25.7493
.0150	1.7671	4.7124	.0850	.2915	.3750	.5200	15.0196	26.5418
.0150	1.7671	4.7124	.0900	.3000	.3750	.5200	15.4550	27.3113
.0150	1.7671	4.7124	.0950	.3082	.3750	.5200	15.8785	28.0597
.0150	1.7671	4.7124	.1000	.3162	.3750	.5200	16.2910	28.7886

CONCRETE STORM SEWER PIPE.....DIAMETER = 24"

N	A	P	S	S1/2	R	R2/3	V	Q
.0150	3.1416	6.2832	.0050	.0707	.5000	.6300	4.4129	13.8636
.0150	3.1416	6.2832	.0100	.1000	.5000	.6300	6.2408	19.6061
.0150	3.1416	6.2832	.0150	.1225	.5000	.6300	7.6434	24.0124
.0150	3.1416	6.2832	.0200	.1414	.5000	.6300	8.8258	27.7272
.0150	3.1416	6.2832	.0250	.1581	.5000	.6300	9.8676	30.9999
.0150	3.1416	6.2832	.0300	.1732	.5000	.6300	10.8094	33.9587
.0150	3.1416	6.2832	.0350	.1871	.5000	.6300	11.6755	36.6796
.0150	3.1416	6.2832	.0400	.2000	.5000	.6300	12.4816	39.2122
.0150	3.1416	6.2832	.0450	.2121	.5000	.6300	13.2388	41.5908
.0150	3.1416	6.2832	.0500	.2236	.5000	.6300	13.9549	43.8405
.0150	3.1416	6.2832	.0550	.2345	.5000	.6300	14.6360	45.9803
.0150	3.1416	6.2832	.0600	.2449	.5000	.6300	15.2868	48.0249
.0150	3.1416	6.2832	.0650	.2550	.5000	.6300	15.9110	49.9859
.0150	3.1416	6.2832	.0700	.2646	.5000	.6300	16.5116	51.8728
.0150	3.1416	6.2832	.0750	.2739	.5000	.6300	17.0912	53.6935
.0150	3.1416	6.2832	.0800	.2828	.5000	.6300	17.6517	55.4544
.0150	3.1416	6.2832	.0850	.2915	.5000	.6300	18.1949	57.1611
.0150	3.1416	6.2832	.0900	.3000	.5000	.6300	18.7224	58.8182
.0150	3.1416	6.2832	.0950	.3082	.5000	.6300	19.2355	60.4300
.0150	3.1416	6.2832	.1000	.3162	.5000	.6300	19.7352	61.9999

CONCRETE STORM SEWER PIPE.....DIAMETER = 30"

N	A	P	S	S1/2	R	R2/3	V	Q
.0150	4.9087	7.8540	.0050	.0707	.6250	.7310	5.1207	25.1364
.0150	4.9087	7.8540	.0100	.1000	.6250	.7310	7.2418	35.5482
.0150	4.9087	7.8540	.0150	.1225	.6250	.7310	8.8694	43.5375
.0150	4.9087	7.8540	.0200	.1414	.6250	.7310	10.2415	50.2727
.0150	4.9087	7.8540	.0250	.1581	.6250	.7310	11.4503	56.2066
.0150	4.9087	7.8540	.0300	.1732	.6250	.7310	12.5432	61.5713
.0150	4.9087	7.8540	.0350	.1871	.6250	.7310	13.5482	66.5046
.0150	4.9087	7.8540	.0400	.2000	.6250	.7310	14.4836	71.0964
.0150	4.9087	7.8540	.0450	.2121	.6250	.7310	15.3622	75.4091
.0150	4.9087	7.8540	.0500	.2236	.6250	.7310	16.1932	79.4882
.0150	4.9087	7.8540	.0550	.2345	.6250	.7310	16.9836	83.3679
.0150	4.9087	7.8540	.0600	.2449	.6250	.7310	17.7388	87.0749
.0150	4.9087	7.8540	.0650	.2550	.6250	.7310	18.4631	90.6305
.0150	4.9087	7.8540	.0700	.2646	.6250	.7310	19.1600	94.0517
.0150	4.9087	7.8540	.0750	.2739	.6250	.7310	19.8325	97.3527
.0150	4.9087	7.8540	.0800	.2828	.6250	.7310	20.4830	100.5455
.0150	4.9087	7.8540	.0850	.2915	.6250	.7310	21.1133	103.6399
.0150	4.9087	7.8540	.0900	.3000	.6250	.7310	21.7255	106.6446
.0150	4.9087	7.8540	.0950	.3082	.6250	.7310	22.3208	109.5669
.0150	4.9087	7.8540	.1000	.3162	.6250	.7310	22.9006	112.4132

CONCRETE STORM SEWER PIPE.....DIAMETER = 36"

N	A	P	S	S1/2	R	R2/3	V	Q
.0150	7.0686	9.4248	.0050	.0707	.7500	.8255	5.7826	40.8745
.0150	7.0686	9.4248	.0100	.1000	.7500	.8255	8.1778	57.8053
.0150	7.0686	9.4248	.0150	.1225	.7500	.8255	10.0157	70.7967
.0150	7.0686	9.4248	.0200	.1414	.7500	.8255	11.5651	81.7490
.0150	7.0686	9.4248	.0250	.1581	.7500	.8255	12.9302	91.3982
.0150	7.0686	9.4248	.0300	.1732	.7500	.8255	14.1643	100.1217
.0150	7.0686	9.4248	.0350	.1871	.7500	.8255	15.2992	108.1438
.0150	7.0686	9.4248	.0400	.2000	.7500	.8255	16.3555	115.6105
.0150	7.0686	9.4248	.0450	.2121	.7500	.8255	17.3477	122.6235
.0150	7.0686	9.4248	.0500	.2236	.7500	.8255	18.2861	129.2565
.0150	7.0686	9.4248	.0550	.2345	.7500	.8255	19.1786	135.5654
.0150	7.0686	9.4248	.0600	.2449	.7500	.8255	20.0314	141.5934
.0150	7.0686	9.4248	.0650	.2550	.7500	.8255	20.8493	147.3751
.0150	7.0686	9.4248	.0700	.2646	.7500	.8255	21.6364	152.9384
.0150	7.0686	9.4248	.0750	.2739	.7500	.8255	22.3958	158.3063
.0150	7.0686	9.4248	.0800	.2828	.7500	.8255	23.1302	163.4980
.0150	7.0686	9.4248	.0850	.2915	.7500	.8255	23.8421	168.5299
.0150	7.0686	9.4248	.0900	.3000	.7500	.8255	24.5333	173.4158
.0150	7.0686	9.4248	.0950	.3082	.7500	.8255	25.2056	178.1678
.0150	7.0686	9.4248	.1000	.3162	.7500	.8255	25.8604	182.7963

CONCRETE STORM SEWER PIPE.....DIAMETER = 42"

N	A	P	S	S1/2	R	R2/3	V	Q
.0150	9.6211	10.9956	.0050	.0707	.8750	.9148	6.4084	61.6563
.0150	9.6211	10.9956	.0100	.1000	.8750	.9148	9.0629	87.1951
.0150	9.6211	10.9956	.0150	.1225	.8750	.9148	11.0997	106.7918
.0150	9.6211	10.9956	.0200	.1414	.8750	.9148	12.8168	123.3125
.0150	9.6211	10.9956	.0250	.1581	.8750	.9148	14.3297	137.8676
.0150	9.6211	10.9956	.0300	.1732	.8750	.9148	15.6974	151.0264
.0150	9.6211	10.9956	.0350	.1871	.8750	.9148	16.9551	163.1271
.0150	9.6211	10.9956	.0400	.2000	.8750	.9148	18.1258	174.3903
.0150	9.6211	10.9956	.0450	.2121	.8750	.9148	19.2253	184.9688
.0150	9.6211	10.9956	.0500	.2236	.8750	.9148	20.2652	194.9742
.0150	9.6211	10.9956	.0550	.2345	.8750	.9148	21.2543	204.4907
.0150	9.6211	10.9956	.0600	.2449	.8750	.9148	22.1994	213.5836
.0150	9.6211	10.9956	.0650	.2550	.8750	.9148	23.1059	222.3048
.0150	9.6211	10.9956	.0700	.2646	.8750	.9148	23.9781	230.6966
.0150	9.6211	10.9956	.0750	.2739	.8750	.9148	24.8197	238.7937
.0150	9.6211	10.9956	.0800	.2828	.8750	.9148	25.6337	246.6251
.0150	9.6211	10.9956	.0850	.2915	.8750	.9148	26.4226	254.2153
.0150	9.6211	10.9956	.0900	.3000	.8750	.9148	27.1886	261.5854
.0150	9.6211	10.9956	.0950	.3082	.8750	.9148	27.9337	268.7534
.0150	9.6211	10.9956	.1000	.3162	.8750	.9148	28.6593	275.7352

CONCRETE STORM SEWER PIPE.....DIAMETER = 48"

N	A	P	S	S1/2	R	R2/3	V	Q
.0150	12.5664	12.5664	.0050	.0707	1.0000	1.0000	7.0051	88.0283
.0150	12.5664	12.5664	.0100	.1000	1.0000	1.0000	9.9067	124.4908
.0150	12.5664	12.5664	.0150	.1225	1.0000	1.0000	12.1331	152.4695
.0150	12.5664	12.5664	.0200	.1414	1.0000	1.0000	14.0101	176.0566
.0150	12.5664	12.5664	.0250	.1581	1.0000	1.0000	15.6638	196.8373
.0150	12.5664	12.5664	.0300	.1732	1.0000	1.0000	17.1589	215.6245
.0150	12.5664	12.5664	.0350	.1871	1.0000	1.0000	18.5337	232.9010
.0150	12.5664	12.5664	.0400	.2000	1.0000	1.0000	19.8133	248.9817
.0150	12.5664	12.5664	.0450	.2121	1.0000	1.0000	21.0152	264.0850
.0150	12.5664	12.5664	.0500	.2236	1.0000	1.0000	22.1520	278.3700
.0150	12.5664	12.5664	.0550	.2345	1.0000	1.0000	23.2332	291.9569
.0150	12.5664	12.5664	.0600	.2449	1.0000	1.0000	24.2663	304.9390
.0150	12.5664	12.5664	.0650	.2550	1.0000	1.0000	25.2571	317.3906
.0150	12.5664	12.5664	.0700	.2646	1.0000	1.0000	26.2106	329.3718
.0150	12.5664	12.5664	.0750	.2739	1.0000	1.0000	27.1305	340.9322
.0150	12.5664	12.5664	.0800	.2828	1.0000	1.0000	28.0203	352.1133
.0150	12.5664	12.5664	.0850	.2915	1.0000	1.0000	28.8826	362.9501
.0150	12.5664	12.5664	.0900	.3000	1.0000	1.0000	29.7200	373.4725
.0150	12.5664	12.5664	.0950	.3082	1.0000	1.0000	30.5344	383.7066
.0150	12.5664	12.5664	.1000	.3162	1.0000	1.0000	31.3276	393.6746

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