August 25, 1988

Department of Engineering
Seventh Floor-City Hall
455 North Main Street
Wichita, Kansas 67202

Attention: Ms. Vicky Hyang

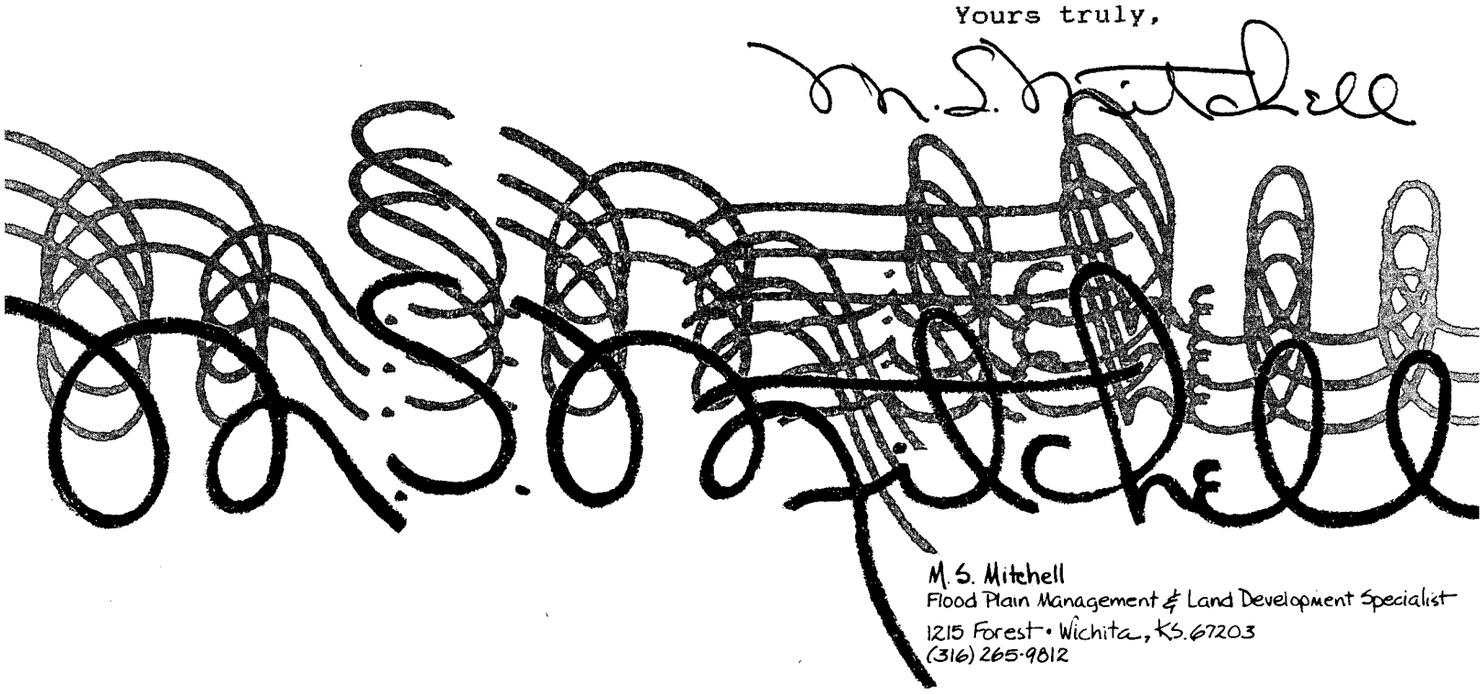
Dear Vicky:

At your suggestion, Mr. Don Moehring has calculated that his grading plan for lots along the western edge of Teal Brook Estates requires placing an estimated 28,000 cubic yards of fill in the flood plain as mapped on Panel 125 of the Flood Insurance Rate Map (FIRM) for Sedgwick County. Flood routing calculations for the two lakes proposed to be constructed in Teal Brook Estates show that over 30,000 cubic yard of flood water storage will be available for Cowskin Creek backwater in those two lakes between the permanent pool elevations and the Base Flood Elevation shown on the FIRM.

In addition to the Cowskin Creek flood storage, the two lakes are designed to reduce the peak rate of discharge for the 100-year storm on the combined drainage area of Cedar Downs Estates, Sunridge Addition and Teal Brook Estates from 223 cubic feet per second (cfs) to 152 cfs and to discharge the outflow from Lake Number 2 into the oxbow of Cowskin Creek where runoff from the field is discharged now.

We are still trying to arrange a meeting with Mr. Sam Eberly to hear his concerns about the changes in the flood plain, and hopefully to answer those concerns to his satisfaction.

Yours truly,



M. S. Mitchell
Flood Plain Management & Land Development Specialist
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DRAINAGE PLAN
AND
SUPPORTING CALCULATIONS

FOR

SUNRIDGE ADDITION
AND
TEAL BROOK ADDITION
WICHITA, SEDGWICK COUNTY, KANSAS

PREPARED BY

MOEHRING & ASSOCIATES
CONSULTING ENGINEERS

JULY 26, 1988

SUNRIDGE - TEAL BROOK ADD'N - SYSTEM 100
HYDROLOGY DATA COMPILATION - for DRAINAGE CONCEPT

A. Initial Data -

1. Drainage Areas -

Parcel a/ Sunridge Add'n = 23.01 Ac.

Parcel b/ Teal Brook Add'n = 36.28 Ac.

Parcel c/ Offsite - N. of 21st St. - Part of Cedar Downs Add'n = 55 Ac.

Parcel d/ Offsite - Proposed L.C. Site at S.W. Cor. of Intersection 21st & 119th = 2.51 Ac.

Parcel e/ Offsite - Existing Residential tract on W. Side of 119th St. = 2.07 Acres

2. S.C.S. Hydrologic Soil Group & Runoff Coefficients

From S.C.S. Soil Survey Maps, for Sedgwick County, all soils within the above listed drainage areas, are identified as V_a, V_b & V_c; Vanoss soils, which are in the Hydrologic Soil Group "B"

Parcel/Area	Present CN	Future Ac./D.U.	Future CN	Future % Imperv.	"C_2" Future	C_{100}
a/ = 23.01	71	0.28	74	38%	0.44	0.61
b/ = 38.79	71	0.42	72	27%	0.37	0.55
c/ = 55.0	68	1.0	68	20%	0.33	0.51
d = 2.51	71	L.C.	92	90%	0.80	0.93
e = 2.07	68	0.33	72	30%	0.39	0.57

Note: The preceding "CN's" were determined from Table 2-2 of TR 55; and the Rational "C" values were taken from Attachment "D" of CofW Interim Drainage Policy

The "CN"s will be utilized in the development of Inflow Hydrograph for Flood Routing thru the Detention Pond(s).

The Rational "C" factors will be utilized with the Rational Method for determination of flow in streets to inlets and design of storm sewers

Future development of Parcel d/ (thu 2.51 Ac. Exception) will, as previously stated, be Light Commercial. As such, it will not be allowed to discharge storm runoff through the adjacent residential lots. Some "on site" detention might likely be developed in parking lots, etc., and discharged Thru a system of conduits into the South ditch of 21st Street, and flow approximately 1100 to 1200 feet West, joining the contribution from the 55 Acre offsite basin N. of 21st St. The time of concentration, and thus the storm runoff at that point, will be governed by the 55 Acre offsite drainage area.

Parcel e/ (2.07 Ac. Exception) is projected as future development into approx. 6 single family lots with a cul-de-sac as access to 119th St. West. As such, only the rear 1/2 of lots situated in the West 1/2 of Parcel e/ could be anticipated to discharge toward the Sunridge parcel, and that contributing area has been estimated as 0.69 Ac., and will be incorporated in peak discharge computations.

B - HYDROLOGY

Use Rational Method, $Q = CIA$

1. Determine "C" Factors for Sub-Basins, System 100

Node	Soil Type	Land Use	C_2	C_{100}
110	B	Res. - 1/4 Ac.	0.44	0.61
109	B	"	0.44	0.61
108	B	"	0.44	0.61
107	B	"	0.44	0.61
106	B	"	0.44	0.61
105	B	"	0.44	0.61
104	B	"	0.44	0.61
103	B	Res. - 2/5 Ac.	0.37	0.55
102	B	"	0.37	0.55
101	End of System			

2. - Determine T_c and I for Sub-basin contributing to each Node

Node	t_c	I_2	I_{100}
110	t_o = 21 min t_g = 0.9 min T_c = 21.9 min.	3.18	6.27
109	15	3.83	7.37
108	t_o = 21 min. t_g = 0.67 min. T_c = 21.67 min.	3.20	6.20
107	t_o = 7 min t_g = 6.37 min T_c = 13.37 min.	3.83	7.37
106	15	3.83	7.37
105	15	3.83	7.37
104	$t_o = T_c$ = 20	3.33	6.53
103	15	3.83	7.37
102	15	3.83	7.37
101	End of System	—	—

3. - Determine Area, "A", of Sub-Basins Contributing to each Node

Node	Area (Acres)		
110	2.94 + 0.06 + 0.15 + 0.35 + 0.04 + 0.12 + 0.41 + 0.43	=	4.50 Ac.
109	0.12 + 0.40 + 0.43 + 0.70 + 0.02	=	1.67 Ac
108	2.13 + 1.55 + 0.03	=	3.71 Ac.
107	1.60 + 0.43 + 0.32 + 1.41 + 0.01	=	3.77 Ac.
106	0.98 + 0.37 - 0.03 + 0.12	=	1.44 Ac
105	0.43 + 0.43 + 0.37 + 0.34 + 0.09 + 0.18 + 0.72 + 0.18 + 0.44 + 0.38	=	3.56 Ac.
104	0.06 + 0.04 + 0.10 + 0.13 + 0.84 + 0.15 + 1.02 + 0.57 + 0.15 + 0.09	=	3.15 Ac
103	0.68 + 0.60 + 0.67 + 0.58 + 0.64 + 0.79 + 0.25	=	4.23 Ac
102	1.0 + 0.34 + 0.36	=	1.70 Ac
101	End of System		

Summation of Contributing D.A.'s to Nodes

110 + 109 to 104 = 6.17 Ac

108 to 107 = 3.71 Ac.

108 + 107 to 106 = 7.48 Ac

108 + 107 + 106 to 105 = 8.92

108 + 107 + 106 + 105 to 104 = 12.48

To 104 = 12.48 + 6.17 = 18.65 Ac in Conduit
+ Overland to 104 = 3.15

Total to 104 = 21.80 Ac = 104 to 103

103 to 102 = 21.80 + 4.23 = 26.03 Ac.

102 to 101 = 26.03 + 1.70 = 27.73 Ac. = Disch. to Pond #1

4.- Determine Surface Contributions (Q_2), to each Node (6)

Node	C_2	I_2	A	Q_2
110	0.44	3.18	4.50	6.30 cfs
109	0.44	3.83	1.67	2.81 cfs
108	0.44	3.20	3.71	5.22 cfs
107	0.44	3.83	3.77	6.35 cfs
106	0.44	3.83	1.44	2.43 cfs
105	0.44	3.83	3.56	6.00 cfs
104	0.44	3.33	3.15	4.62 cfs
103	0.37	3.83	4.23	5.99 cfs
102	0.37	3.83	1.70	2.41 cfs
101	(End System)			

5. Determine Surface Contribution (Q_{100}) to each Node

Node	C_{100}	I_{100}	A	Q_{100}	
110	0.61	6.27	4.50	17.21	cfs
109	0.61	7.37	1.67	7.51	"
108	0.61	6.30	3.71	14.26	"
107	0.61	7.37	3.77	16.95	"
106	0.61	7.37	1.44	6.47	"
105	0.61	7.37	3.56	16.00	"
104	0.61	6.53	3.15	12.55	"
103	0.55	7.37	4.23	17.15	"
102	0.55	7.37	1.70	6.89	"
101	(END OF SYSTEM)				

$S = 0.0135$ $\quad h_f = S \times L = 0.0135 \times 215 = 2.9'$

$6.07 \times 0.60 \times 27.73$

6. - Flood Routing / Inlet Sizing - 2yr design storm

Node	Inlet Condition	Inlet Length	Q_2 * Approach	Q_2 # Intercept	Q_2 By Pass	By Pas To Nod
110	Sump	5	6.30	6.30	0	—
109	Sump	5	2.81	2.81	0	—
108	Sump	5	5.22	5.22	0	—
107	Sump	5	6.35	6.35	0	—
106	Sump	5	2.43	2.43	0	—
105	Sump	5	6.00	6.00	0	—
104	Sump	Area Inlet	4.62	4.62	0	—
103	Sump	5	5.99	5.99	0	—
102	Sump	5	2.41	2.41	0	—
101	(end of System)					

* Q approach = Q_2 + Q by Pass from upstream Node

\# Q intercept = Q_{input} into pipe system

Configuration of Sunridge Add'n, and the site topography create 2 principal sump areas. The discharge of surface runoff for the 2yr storm, is conveyed thru storm sewers, located in drainage easements, to a point of discharge into detention pond #1. To prevent the necessity of overland channels, investigate the capability of storm sewer system 100, to convey the 100yr runoff.

Therefore, a flood routing / Inlet sizing evaluation will be made, as well as the evaluation of 100 yr. containment within the street R/W's.

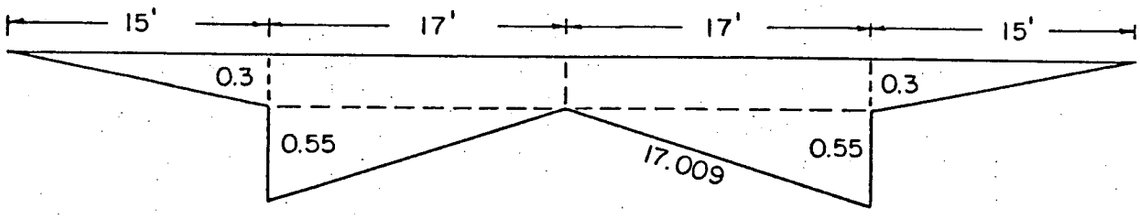
Subsequently, an evaluation of system Hydrology, including Conduit Data will be made for the 100 yr Storm Frequency, thru System 100.

FLOOD ROUTING / Inlet Sizing — 100yr design storm

Node	Inlet Condition	Inlet Length	Q_{100}* Approach	Q_{100} Intercept	Q_{100} By-Pass across Street	By-Pass to Node
110	Sump	5	17.21	9.5	7.71	109
109	Sump	10	7.71+7.51 = 15.22	15.22	0	—
108	Sump	5	14.26	9.5	4.76	106
107	Sump	10	16.95	16.95	0	—
106	Sump	5	6.47+4.76 = 11.23	10.10	1.13	105
105	Sump	10	16.0+1.13 = 17.13	17.13	0	—
104	Sump	Area Inlet	12.55	12.55	0	—
103	Sump	10	17.15	17.15	0	—
102	Sump	5	6.89	6.89	0	—
102	(End of System)					

7.- Street Flow Depths - 2yr Design Storm

Node	Q_2 Approach	Flow Distribution	Street Slope (%)	Flow Depth	Allowable Depth	Comment
110	6.30	80% (N.) = 5.04	0.35	0.39	0.55	OK
		20% (E) = 1.26	1.00	0.19	0.55	OK
109	2.81	55% (N) = 1.55	0.35	0.25	0.55	OK
		45% (E) = 1.26	1.00	0.19	0.55	OK
108	5.22	58% (N) = 3.03	0.34	0.31	0.55	OK
		42% (E) = 2.19	0.70	0.25	0.55	OK
107	6.35	10% (N) = 5.71	0.34	0.44	0.55	OK
		90% (E.) = 0.64	0.70	0.16	0.55	OK
106	2.43	4% (S) = 0.10	1.00	0.09	0.55	OK
		96% (E) = 2.33	0.73	0.25	0.55	OK
105	6.00	2% (S) = 0.12	0.66	0.09	0.55	OK
		98% (E) = 5.88	0.73	0.38	0.55	OK
103	5.99	54% (S) = 3.24	0.40	0.30	0.30	
		46% (N) = 2.75	0.40	0.29	0.30	OK
102	2.41	46% (N) = 1.11	0.40	0.09	0.30	OK
		54% (S) = 1.30	0.40	0.09	0.30	OK
101	(End of System)					



"N" = 0.030 Grass
"N" = 0.013 Conc. C & G
"N" = 0.016 Asph. Pvm't

64' R/W
0.3' Min. Walk Gr.
34' Fc. to Fc. Pvm't

$$Q = \frac{1.486}{N} AR^{2/3} S^{1/2}$$

Weighted "N" = 2(14.5 x 0.030) + 2(2.5 x 0.013) + 2(2.5 x 0.016)/65.12

$\Longrightarrow$ "N" = 1.415/65.12 = 0.0217

Wetted Perimeter = P = 65.12

Area, "A" = $[\frac{0.3 \times 15}{2} + \frac{0.55 \times 17}{2} + (0.3 \times 17)] \times 2 = (2.25 + 4.675 + 5.10) \times 2$

$\Longrightarrow$ Area = 24.05 sq.ft.

$\Longrightarrow$ R_h = A/P = 24.05/65.12 = 0.3693; $R^{2/3}$ = 0.5147

$\therefore Q = \frac{1.486}{0.0217} \times 24.05 \times 0.5147 \times S^{1/2}$

$\Longrightarrow Q = 847.67\ (S^{1/2})$

Then, Q = 49.42 @ 0.34%

Q = 50.86 @ 0.36% $\Longleftarrow$ w/minimum slopes

Q = 52.25 @ 0.38%

SUNRIDGE - TEAL BROOK HYDROLOGY - SYSTEM 100 - 24yr Frequency

SURFACE TRIBUTARY AREA						HYDROLOGY SUMMATION				CONDUIT DATA				
Node to Node	"C"	Area Ac.	T_c min.	I_2	Q_2 cfs	T_c Min.	I_2	Q_2 cfs	ΣQ_2	Size	Vel. fps	Length	T.T.	T.T. + T_c
110-109	.44	4.50	21.9	3.18	6.30	21.9	3.18	6.30	6.30	18"	3.57	40	0.19	22.09
109-104	.44	1.67	15	3.83	2.81	22.09	3.16	2.32	8.62	24"	2.74	215	1.31	23.40
108-107	.44	3.71	21.67	3.20	5.22	21.67	3.20	5.22	5.22	18"	2.95	40	0.23	21.90
107-106	.44	3.77	15	3.83	6.35	21.90	3.18	5.28	10.50	24"	3.34	215	1.07	22.97
106-105	.44	1.44	15	3.83	2.43	22.97	3.10	1.96	12.46	30"	2.54	40	0.26	23.23
105-104	.44	3.56	15	3.83	6.00	23.23	3.08	4.82	17.28	30"	3.52	225	1.06	24.29
104-103	.44	3.15	20	3.33	4.62	24.29	3.01	4.17	30.07	42"	3.13	160	0.85	25.14
103-102	.37	4.23	15	3.83	5.99	25.14	2.95	4.62	34.69	48"	2.76	40	0.24	25.38
102-101	.37	1.70	15	3.83	2.41	25.38	2.94	1.85	36.54	48"	2.91	180	1.03	26.41

101 - Outlet into Detention Pond

C of W Min. Constr. Slopes
to produce V=2 fps @ flow
depth = 0.2 x diam.

18" = 0.30%
24" = 0.20%
30" = 0.15%
36" = 0.12%
42" = 0.10%
48" = 0.08%

HYDROLOGY - SYSTEM 100 - 100 yr Frequency

SUNRIDGE-TEAL BROOK

Surface Tributary Area						Hydrology Summation				Inlet Size & Capacity				Conduit Data				
Node-to Node	"C"	Area Ac.	Tc Min.	I_{100}	Q_{100} cfs	Tc Min.	I_{100}	Q_{100} cfs	ΣQ_{100} to Inlet	Inlet Length	Q_{100} Intercept	Q_{100} By-Pass	ΣQ_{100} Pipe	Pipe size	Velocity fps	Length	T.T.	T.T. + T.C.
10-109	.61	4.50	21.9	6.27	17.21	21.9	6.27	17.21	17.21	5	9.5	7.71 To 109	9.51	18"	5.38	40	0.12	22.02
09-104	.61	1.67	15	7.37	7.51	22.02	6.26	6.38	14.09	10	14.09	0	23.60	24"	7.51	215	0.48	22.50
08-107	0.61	3.71	21.67	6.30	14.26	21.67	6.30	14.26	14.26	5	9.5	4.76 To 106	9.5	18"	5.38	40	0.12	21.79
07-106	0.61	3.77	15	7.37	16.94	21.79	6.28	14.49	14.44	10	14.44	0	23.94	24"	7.62	215	0.47	22.26
106-105	0.61	1.44	15	7.37	6.47	22.26	6.23	5.47	10.23	5	9.5	0.73 To 105	33.44	30"	6.81	40	0.10	22.36
05-104	0.61	3.56	15	7.37	16.00	22.36	6.21	13.49	14.22	10	14.22	0	47.66	30"	9.70	215	0.37	22.73
04-103	0.61	3.15	20	6.53	12.55	22.73	6.17	11.86	11.86	Area Inlet	11.86	0	83.12	42"	8.64	160	0.31	23.04
03-102	0.55	4.23	15	7.37	17.15	23.04	6.13	14.26	14.26	10	14.26	0	97.38	48"	7.75	40	0.09	23.13
02-101	0.55	1.70	15	7.37	6.89	23.13	6.11	5.71	5.71	5	5.71	0	103.09	48"	8.20	180	0.37	23.50

SUNRIDGE - TEALBROOK ADD'NS - SYSTEM 90

A HYDROLOGY DATA COMPILATION - DRAINAGE PLAN

Use Rational Method - $Q = CIA$

1. - DETERMINE "C" FACTORS for Sub-Basins

Node	Soil Type	Land Use	C_2	C_{100}
97	B	Res., 2/5 Acre	0.37	0.55
96	B	"	0.37	0.55
95	B	"	0.37	0.55
94	B	"	0.37	0.55
93	B	"	0.37	0.55
92	B	"	0.37	0.55
91	B	"	0.37	0.55
90	(Outlet to Detention Pond #1)			

2. DETERMINE Tc & I for EACH SUB-BASIN

Node	t_c	I_2	I_{100}
97	$t_o = 8.33$ $t_g = 4.42$ $t_c = 12.75$ - Use 15	3.83	7.37
96	15	3.83	7.37
95	15	3.83	7.37
94	$t_o = 12.5$ $t_g = 2.2$ $t_c = 14.7$ - Use 15	3.83	7.37
93	$t_o = 13.33$ $t_g = 2.33$ $t_c = 15.66$	3.76	7.24
92	15	3.83	7.37
91	15	3.83	7.37
90	(Outlet to Detention Pond #1)		

3. - Determine Area, "A", of Sub-Basins Contributing To Each Node

Node	Area (Acres)		
97	(N) 1.92 + 1.73 (E)	=	3.65
96	(N) 0.70 + 1.13 (E)	=	1.83
95	(E) 0.65 + 0.79 (W) 1.65	=	1.44
94	(E) 1.84 + 1.95 (W)	=	3.79
93	(N & W) 2.80	=	3.33
92	(E) 0.58 + 0.73 (N)	=	1.31
91	(W & N) 0.99	=	0.99
90	(Outlet to Detention Pond #1)		

4. - Determine Surface Contribution (Q_2) to Each Node

Node	C_2	I_2	A	Q_2
97	0.37	3.83	3.65	5.17
96	0.37	3.83	1.83	2.59
95	0.37	3.83	1.44	2.04
94	0.37	3.83	3.79	5.37
93	0.37	3.76	3.33	4.63
92	0.37	3.83	1.31	1.86
91	0.37	3.83	0.99	1.40
90	(outlet)			

5. DETERMINE SURFACE CONTRIBUTION (Q_{100}) TO EACH NODE

Node	C_{100}	I_{100}	A	Q_{100}
97	0.55	7.37	3.65	14.80
96	0.55	7.37	1.83	7.42
95	0.55	7.37	1.44	5.84
94	0.55	7.37	3.79	15.36
93	0.55	7.24	3.33	13.26
92	0.55	7.37	1.31	5.31
91	0.55	7.37	0.99	4.01
90	(outlet to Detention Pond #1)			

6. - FLOOD ROUTING / INLET SIZING - 2yr design storm

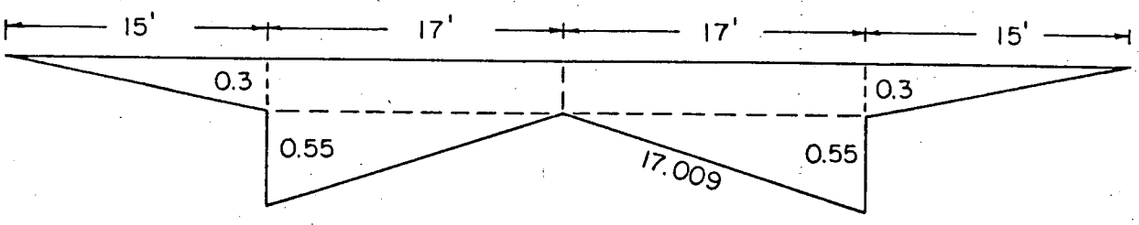
Node	Inlet Condition	Inlet Length	Q_2 Approach	Q_2 Intercept	Q_2 By-Pass	By-Pass To Node
97	Sump	5	5.17	5.17	0	—
96	Sump	5	2.59	2.59	0	—
95	Sump	5	1.44	1.44	0	—
94	Sump	5	5.37	5.37	0	—
93	Sump	5	4.63	4.63	0	—
92	Sump	5	1.86	1.86	0	—
91	Sump	5	1.40	1.40	0	—
90	(Outlet to Detention Pond #1)					

7.- FLOOD ROUTING / INLET SIZING — 100 yr design storm

Node	Inlet Condition	Inlet Length	Q_{100} Approach	Q_{100} Intercept	Q_{100} By-Pass	By-Pass To Node
97	Sump	5	14.80	9.5	5.30	Pond #2
96	Sump	5	7.42	7.42	—	—
95	Sump	5	5.84	5.84	—	—
94	Sump	5	15.36	9.5	5.86	95 & Pond #1
93	Sump	5	13.26	9.5	3.76	92
92	Grade	5	3.76 5.31 9.07	9.07	0	—
91	Sump	5	4.01	4.01	0	—
90	(Outlet to Detention Pond #1)					

8.– Street Flow Depths – 2yr Design Storm

Node	Q_2 Approach	Flow Distribution	Street Slope	Flow Depth	Allowable Depth	Comment
97	5.17	53% (N.W) = 2.74	0.39 9.4	0.30	0.30	OK
		47% (E) = 2.43	0.87 8.1	0.25	0.30	OK
96	2.59	38% (N) = 0.98	0.39 6.9	0.20	0.30	OK
		62% (E) = 1.16	0.87 5.8	0.18	0.30	OK
95	1.44	45% (E) = 0.65	0.90 4.8	0.15	0.30	OK
		55% (W) = 0.79	0.36 6.1	0.19	0.30	OK
94	5.37	49% (E) = 2.63	0.90 7.9	0.25	0.30	OK
		51% (W) = 2.74	0.36 9.7	0.30	0.30	OK
93	4.63	100% (N) = 4.63	0.60 10.1	0.32	0.30	0.02 OVE OK
92	1.86	44% (E) = 0.82	0.77 5.3	0.14	0.30	OK
		56% (N) = 1.04	0.60 6.0	0.19	0.30	OK
91	1.40	100% = 1.40	0.50 7.1	0.22	0.30	OK
90	(Outlet to Detention Pond #1)					



"N" = 0.030 Grass
"N" = 0.013 Conc. C & G
"N" = 0.016 Asph. Pvm't

64' R/W
0.3' Min. Walk Gr.
34' Fc. to Fc. Pvm't

$$Q = \frac{1.486}{N} AR^{2/3} S^{1/2}$$

Weighted "N" = 2(14.5 x 0.030) + 2(2.5 x 0.013) + 2(2.5 x 0.016)/65.12

$\Longrightarrow$ "N" = 1.415/65.12 = 0.0217

Wetted Perimeter = P = 65.12

Area, "A" = $[\frac{0.3 \times 15}{2} + \frac{0.55 \times 17}{2} + (0.3 \times 17)] \times 2 = (2.25 + 4.675 + 5.10) \times 2$

$\Longrightarrow$ Area = 24.05 sq.ft.

$\Longrightarrow$ R_h = A/P = 24.05/65.12 = 0.3693; $R^{2/3}$ = 0.5147

$\therefore Q = \frac{1.486}{0.0217} \times 24.05 \times 0.5147 \times S^{1/2}$

$\Longrightarrow Q = 847.67\ (S^{1/2})$

Then, Q = 49.42 @ 0.34%

Q = 50.86 @ 0.36% $\Longleftarrow$ w/minimum slopes

Q = 52.25 @ 0.38%

SUNRIDGE – TEALBROOK HYDROLOGY – SYSTEM 90 – 24yr Frequency (6)

SURFACE TRIBUTARY AREA				HYDROLOGY SUMMATION					CONDUIT DATA				
Node to Node	"C" C_2	Area (Ac.)	T_c (Min.)	I_2	Q_2 (cfs)	T_c (Min.)	I_2	Q_2 (cfs)	$\leq Q_2$	Size	Vel. (fps)	Length	T.T	T.T. + T.C.
97	0.37	3.65	15	3.83	5.17	15	3.83	5.17	5.17	No Pipe - Direct Discharge to Pond #2				
96	0.37	1.83	15	3.83	2.59	15	3.83	2.59	2.59	No Pipe - Direct Discharge to R.C.B.C.				
95	0.37	1.44	15	3.83	2.04	15	3.83	2.04	2.04	No Pipe - Direct Discharge to Pond #1				
94	0.37	3.79	15	3.83	5.37	15	3.83	5.37	5.37	No Pipe - Direct Discharge to R.C.B.C.				
93-92	0.37	3.33	15.66	3.76	4.63	15.66	3.76	4.63	4.63	18"	2.62	60	0.38	16.04
92-91	0.37	1.31	15	3.83	1.86	16.04	3.72	1.80	6.43	24"	2.05	225	1.83	17.87
91-90	0.37	0.99	15	3.83	1.40	17.87	3.52	1.29	7.72	24"	2.46	180	1.22	19.09
90 (Outlet to Detention Pond #1)														

SUNRIDGE - TEALBROOK HYDROLOGY - SYSTEM 90 - 100yr Frequency ①

SURFACE TRIBUTARY AREA				HYDROLOGY SUMMATION					CONDUIT DATA				
Node to Node	"C" $_{100}$	Area (Acres)	T_c (Min.)	I_{100}	Q_{100} (cfs)	T_c (Min.)	I_{100}	Q_{100} (cfs)	ΣQ_{100}	Size	Vel. (fps)	Length	T.T.	T.T. + T.C.
97	0.55	3.65	15	7.37	14.80	15	7.37	14.80	14.80	— Direct Discharge to Pond # 2				
96	0.55	1.83	15	7.37	7.42	15	7.37	7.42	7.42	— Direct Discharge to R.C.B.C.				
95	0.55	1.44	15	7.37	5.84	15	7.37	5.84	5.84	— Direct Discharge to Pond # 1				
94	0.55	3.79	15	7.37	15.36	15	7.37	15.36	15.36	— Direct Discharge to R.C.B.C.				
93-92	0.55	3.33	15.66	7.24	13.26	15.66	7.24	13.26	13.26	18"	7.50	60	0.13	15.79
92-91	0.55	1.31	15	7.37	5.31	15.79	7.22	5.20	18.46	24"	5.88	225	0.64	16.43
91-90	0.55	0.99	15	7.37	4.01	16.43	7.11	3.87	22.33	24"	7.11	180	0.42	16.85
90 (Outlet to Detention Pond # 1)														

2 290 000 FEET
390 000 FEET
T. 27 S.
(Joins sheet 33)
Dry Creek
Teal Brook
Sunridge
Int
Vc
Bb
Vb
Ba
Ea
Va
Wb
Ta
Mb
Na
Eb
Vd
Mc
1
2
11
12
13
14

EXHIBIT NO. 1

SOIL LEGEND

SYMBOL	HYDROLOGIC GROUP	NAME
Aa	B	Albion-Shellabarger sandy loams, 1 to 4 percent slopes
Ab	B	Albion and Shellabarger sandy loans, 7 to 15 percent slopes
Ba	C	Blanket silt loam, 0 to 1 percent slopes
Bb	C	Blanket silt loan, 1 to 3 percent slopes
Ca	B	Canadian fine sandy loan
Cb	B	Canadian-Waldeck fine sandy loams
Cc	D	Carwile fine sandy loam
Cd	B	Clark-Ost clay loams, 1 to 4 percent slopes
Ce	C	Clime silty clay, 3 to 6 percent slopes
Ea	B	Elandco silt loam
Eb	B	Elandco silt loam, occasionally flooded
Ec	B	Elandco silt loam, frequently flooded
Fa	B	Farnum loam, 0 to 1 percent slopes
Fb	B	Farnum loam, 1 to 3 percent slopes
Fc	B	Farnum loam, sandy substratum, 0 to 1 percent slopes
Ga	D	Goessel silty clay, 0 to 1 percent slopes
Gb	D	Goessel silty clay, 1 to 2 percent slopes
Ia	D	Irwin silty clay loam, 1 to 3 percent slopes
Ib	D	Irwin silty clay loam, 3 to 6 percent slopes
Ic	D	Irwin silty clay loam, 2 to 6 percent slopes, eroded
La	C	Lesho loam
Lb	A	Lincoln soils
Ma	B	Milan loam, 1 to 3 percent slopes
Mb	B	Milan form, 3 to 6 percent slopes
Mc	B	Milan clay loam, 2 to 6 percent slopes, eroded
Na	B	Naron fine sandy loam
Oc	D	Owens clay loam, 1 to 3 percent slopes
Od	D	Owens-Rock outcrop complex, 3 to 10 percent slopes
Pa		Pits
Pb	D	Plevna fine sandy loam
Pc	A	Pratt loamy fine sand, undulating
Pd	A	Pratt-Tivoli complex, rolling
Ra	D	Renfrow silty clay loam, 1 to 3 percent slopes
Rb	D	Renfrow silty clay loam, 3 to 6 percent slopes
Rc	D	Renfrow-Owens clay loams, 1 to 4 percent slopes
Rd	D	Rosehill silty clay, 1 to 3 percent slopes
Sa	B	Shellabarger sandy loam, 1 to 3 percent slopes
Sb	B	Shellabarger sandy loam, 3 to 6 percent slopes
Sc	B	Shellabarger sandy loam, 3 to 6 percent slopes, eroded
Ta	D	Tabler silty clay loam
Tb	D	Tabler-Drummond complex
Ua	B	Urban land-Canadian complex
Ub	B	Urban land-Elandco complex
Uc	B	Urban land-Farnum complex, 0 to 3 percent slopes
Ud	D	Urban land-Irwin complex, 1 to 3 percent slopes
Ue	D	Urban land-Tabler complex
Va	B	Vanoss silt loam, 0 to 1 percent slopes
Vb	B	Vanoss silt loam, 1 to 3 percent slopes
Vc	B	Vanoss silt loam, 3 to 6 percent slopes
Vd	B	Vanoss silt loam, 3 to 6 percent slopes, eroded
Ve	D	Vernon sandy loam, 1 to 3 percent slopes
Vf	D	Vernon sandy loam, 3 to 6 percent slopes
Wa	C	Waldeck sandy loam
Wb	D	Waurika silt loam

ATTACHMENT D

DRAINAGE CRITERIA

CITY OF WICHITA, KANSAS

RECOMMENDED RUNOFF COEFFICIENTS FOR RATIONAL METHOD
AND PERCENT IMPERVIOUS FOR UNIT HYDROGRAPH METHOD

Land Use or Surface Characteristics	Percent Impervious	Frequency 2	5	10	100
1. Business:					
Downtown Areas	95	0.84	0.85	0.87	0.91
Neighborhood Areas	70	0.68	0.69	0.73	0.80
2. Residential:					
Single Family (Soil Group D)					
1/8 Acre	50	0.57	0.61	0.66	0.79
1/4 Acre	38	0.50	0.54	0.62	0.76
1/3 Acre	30	0.46	0.50	0.59	0.73
1/2 Acre	25	0.42	0.48	0.56	0.72
3/4 Acre	22	0.42	0.46	0.55	0.71
1 Acre	20	0.41	0.45	0.54	0.71
Multi-Family (Soil Group D)					
Multi-Unit (detached)	60	0.62	0.66	0.72	0.82
Multi-Unit (attached)	65	0.64	0.68	0.73	0.83
Apartments	75	0.70	0.73	0.79	0.86
Single Family (Soil Group C)					
1/8 Acre	50	0.55	0.58	0.64	0.73
1/4 Acre	38	0.48	0.51	0.57	0.68
1/3 Acre	30	0.43	0.46	0.53	0.65
1/2 Acre	25	0.40	0.43	0.50	0.63
3/4 Acre	22	0.39	0.42	0.49	0.62
1 Acre	20	0.37	0.40	0.48	0.61
Multi-Family (Soil Group C)					
Multi-Unit (detached)	60	0.60	0.63	0.69	0.77
Multi-Unit (attached)	65	0.63	0.66	0.71	0.79
Apartments	75	0.68	0.72	0.77	0.83
Single-Family (Soil Group B)					
1/8 Acre	50	0.52	0.54	0.59	0.67
1/4 Acre	38	0.44	0.46	0.52	0.61
1/3 Acre	30	0.39	0.41	0.47	0.57
1/2 Acre	25	0.36	0.38	0.44	0.54
3/4 Acre	22	0.34	0.36	0.42	0.52
1 Acre	20	0.33	0.35	0.40	0.51
Multi-Family (Soil Group B)					
Multi-Unit (detached)	60	0.58	0.60	0.65	0.72
Multi-Unit (attached)	65	0.61	0.64	0.68	0.75
Apartments	75	0.67	0.70	0.74	0.80

Land Use or Surface Characteristics	Percent Impervious	Frequency 2	5	10	100
Single Family (Soil Group A)					
1/8 Acre	50	0.47	0.50	0.54	0.60
1/4 Acre	38	0.39	0.41	0.45	0.52
1/3 Acre	30	0.33	0.35	0.39	0.47
1/2 Acre	25	0.30	0.31	0.35	0.44
3/4 Acre	22	0.28	0.29	0.33	0.42
1 Acre	20	0.26	0.28	0.32	0.40
Multi-Family (Soil Group A)					
Multi-Unit (detached)	60	0.55	0.57	0.61	0.67
Multi-Unit (attached)	65	0.58	0.60	0.64	0.70
Apartments	75	0.65	0.68	0.72	0.77
3. Industrial:					
Light Areas	70	0.68	0.69	0.73	0.80
Heavy Areas	80	0.74	0.76	0.79	0.84
4. Playgrounds:	15	0.33	0.35	0.42	0.55
5. Schools:	40	0.49	0.51	0.56	0.66
6. Railroad Yard Areas:	30	0.43	0.45	0.50	0.62
7. Undeveloped Urban Areas: Offsite Flow Analysis (when land use not defined)	45	0.52	0.54	0.59	0.68
8. Streets:					
Paved	99	0.87	0.88	0.90	0.93
Gravel	00	0.24	0.26	0.33	0.48
9. Drive, Parking Lots and Walks:	96	0.87	0.87	0.88	0.89
10. Roofs:	90	0.80	0.85	0.90	0.93
11. Urban Lawn Areas (See Note No. 1 below):					
Soil Group A					
Slope less than 1%	00	0.08	0.09	0.13	0.23
Slope 1% to 4%	00	0.12	0.13	0.17	0.27
Slope more than 4%	00	0.16	0.17	0.21	0.31
Soil Group B					
Slope less than 1%	00	0.16	0.18	0.24	0.37
Slope 1% to 4%	00	0.20	0.22	0.28	0.41
Slope more than 4%	00	0.24	0.26	0.32	0.45
Soil Group C					
Slope less than 1%	00	0.24	0.27	0.35	0.51
Slope 1% to 4%	00	0.26	0.29	0.37	0.53
Slope more than 4%	00	0.28	0.31	0.39	0.55

Land Use or Surface Characteristics	Percent Impervious	Frequency 2	5	10	100
Soil Group D					
Slope less than 1%	00	0.28	0.33	0.43	0.63
Slope 1% to 4%	00	0.30	0.35	0.45	0.65
Slope more than 4%	00	0.32	0.37	0.47	0.67

Note No. 1: Coefficients shown in the above table are for pervious open space areas with thick turf which includes pervious areas in parks and cemeteries. Coefficients shown above must be increased 0.02 for use with agricultural pasture areas. Coefficients shown above must be reduced by 0.04 for use with agricultural cultivated areas. Group A soils are well-drained, coarse textured sands with high infiltration rates. Group B soils are moderately well-drained, moderately coarse textured soils with moderate infiltration rates. Group C soils are moderately poor-drained, moderately fine textured soils with slow infiltration rates. Group D soils are poor-drained, fine textured soils with very slow infiltration rates.

GENERAL NOTE: These Rational Formula Coefficients may not be valid for basins 320 acres or larger.

ATTACHMENT A
DRAINAGE CRITERIA MANUAL

CITY OF WICHITA, KANSAS

RAINFALL INTENSITY TABLE FOR SEDGWICK COUNTY, KANSAS

The following tabulation contains rainfall intensity in inches per hour as derived from ESSA Weather Bureau Technical Paper 40 Modified to NWS Hydro-35, 1977 During First Hour

DURATION IN MINUTES	RETURN PERIODS OF 1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
5	4.18	5.57	6.53	7.41	8.52	9.48	10.32
6	3.99	5.32	6.25	7.09	8.16	9.09	9.89
7	3.81	5.09	5.99	6.81	7.84	8.74	9.50
8	3.66	4.89	5.75	6.55	7.55	8.42	9.15
9	3.52	4.70	5.54	6.31	7.28	8.13	8.83
10	3.39	4.52	5.34	6.09	7.04	7.86	8.54
11	3.27	4.36	5.16	5.89	6.81	7.61	8.27
12	3.18	4.21	4.99	5.71	6.60	7.38	8.02
13	3.05	4.08	4.84	5.53	6.41	7.17	7.79
14	2.96	3.95	4.69	5.37	6.23	6.97	7.57
15	2.87	3.83	4.56	5.22	6.06	6.78	7.37
16	2.78	3.72	4.43	5.08	5.90	6.60	7.18
17	2.71	3.61	4.31	4.95	5.75	6.44	7.00
18	2.63	3.51	4.20	4.83	5.61	6.29	6.84
19	2.56	3.42	4.10	4.71	5.47	6.14	6.68
20	2.50	3.33	4.00	4.60	5.35	6.00	6.53
21	2.44	3.25	3.90	4.50	5.23	5.87	6.39
22	2.38	3.17	3.81	4.40	5.12	5.75	6.26
23	2.32	3.10	3.73	4.31	5.01	5.63	6.13
24	2.27	3.03	3.65	4.22	4.91	5.52	6.01
25	2.22	2.96	3.57	4.13	4.81	5.41	5.90
26	2.20	2.90	3.50	4.05	4.72	5.31	5.79
27	2.16	2.84	3.43	3.98	4.63	5.21	5.69
28	2.14	2.78	3.37	3.90	4.55	5.12	5.59
29	2.11	2.72	3.30	3.83	4.47	5.03	5.49
30	2.08	2.67	3.24	3.76	4.39	4.94	5.40
31	2.05	2.62	3.19	3.70	4.32	4.86	5.32
32	2.02	2.57	3.10	3.63	4.25	4.79	5.22
33	1.99	2.52	3.05	3.57	4.18	4.71	5.14
34	1.96	2.48	3.01	3.51	4.11	4.63	5.07
35	1.93	2.44	2.98	3.46	4.05	4.56	5.00
36	1.91	2.39	2.93	3.41	3.99	4.50	4.93
37	1.89	2.35	2.88	3.36	3.93	4.43	4.86
38	1.87	2.32	2.84	3.31	3.87	4.37	4.79
39	1.85	2.28	2.80	3.26	3.82	4.31	4.73
40	1.83	2.24	2.76	3.22	3.76	4.25	4.66
41	1.81	2.21	2.72	3.17	3.71	4.19	4.60
42	1.79	2.18	2.68	3.13	3.66	4.13	4.54
43	1.77	2.14	2.64	3.09	3.61	4.08	4.49
44	1.75	2.11	2.61	3.05	3.57	4.03	4.43
45	1.73	2.08	2.57	3.01	3.52	3.98	4.38

ATTACHMENT E

DRAINAGE CRITERIA

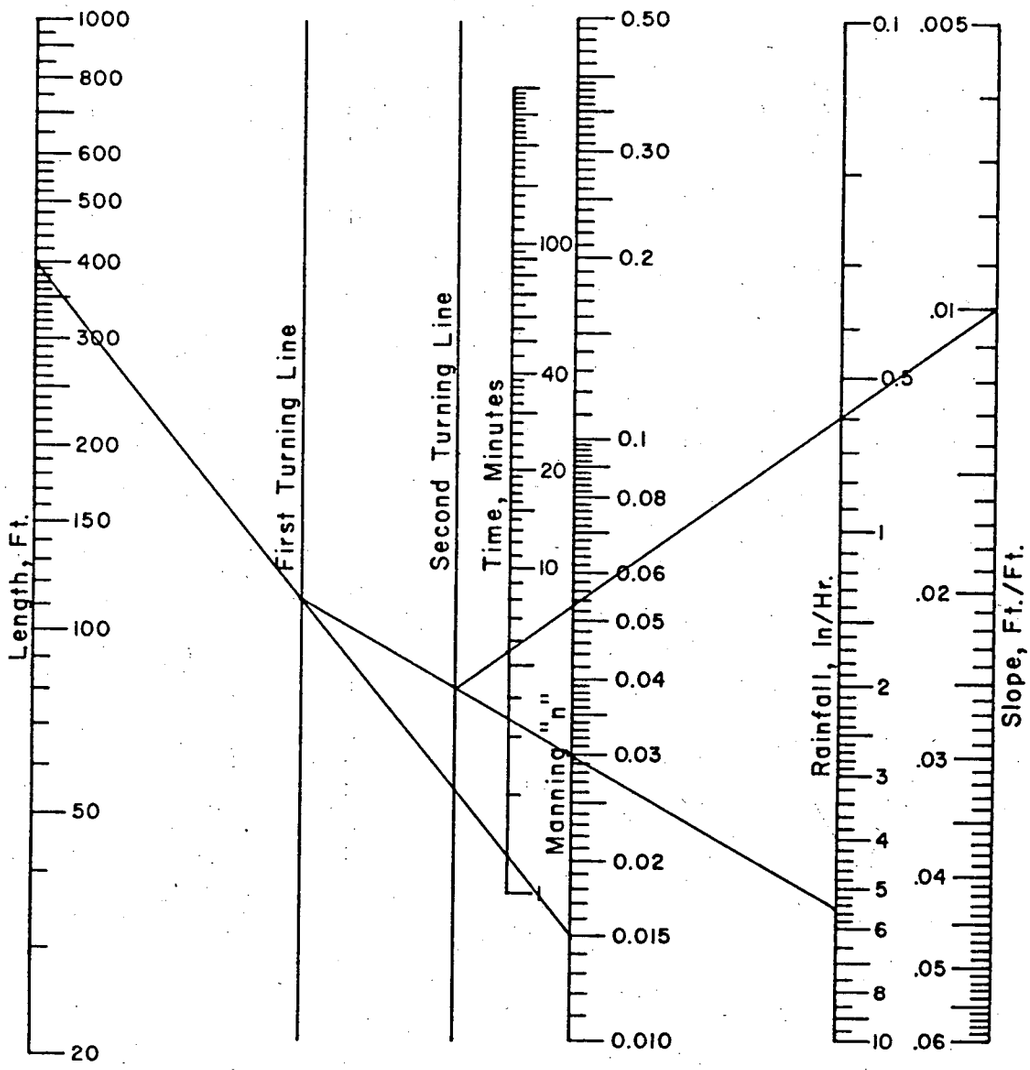
CITY OF WICHITA, KANSAS

AVERAGE OVERLAND FLOW VELOCITY FOR USE WITH URBANIZED AREAS

Surface Type	VELOCITY IN FEET/SECOND FOR SLOPES IN PERCENT SHOWN																		
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	20.0
Forest with Heavy Ground Litter or Meadow	0.03	0.04	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.16	0.21	0.28	0.33	0.39	0.46	0.53	0.60	0.72	1.10
Fallow or Minimum Tillage Cultivation	0.06	0.08	0.10	0.12	0.13	0.14	0.16	0.17	0.18	0.19	0.29	0.40	0.51	0.66	0.78	0.91	1.05	1.20	1.44	2.10
Short Grass Pasture or Lawns	0.09	0.13	0.15	0.18	0.20	0.21	0.23	0.25	0.26	0.28	0.45	0.60	0.77	0.96	1.17	1.33	1.50	1.68	1.98	3.20
Almost Bare Ground	0.16	0.22	0.28	0.31	0.35	0.38	0.41	0.44	0.46	0.49	0.70	0.85	1.05	1.26	1.50	1.75	2.03	2.32	2.79	4.40
Grassed Waterway	0.35	0.48	0.58	0.67	0.77	0.84	0.91	0.98	1.05	1.12	1.54	1.82	2.10	2.38	2.78	3.20	3.66	4.14	4.56	7.00
Paved Areas (Sheet Flow) or Shallow Gutter Flow	0.44	0.62	0.77	0.91	1.05	1.12	1.19	1.26	1.33	1.40	2.00	2.55	3.20	3.83	4.41	5.04	5.70	6.00	6.20	9.00

Equation solved by nomograph:

$$t_c\,(\text{Sec}) = 56\,\frac{L_o^{.6}\,n^{.6}}{i^{.4}\,S_o^{.3}}$$



The initially assumed value of i and the nomograph value of t must be checked against the applicable intensity-duration-frequency curve by trial and error.

Example:

L_o = 400 ft.
n = 0.015
i = 5.5 in./hr.
S_o = 0.01
t = 5.5 min.

ONE INCH is 25.4mm
ONE FOOT is 0.3048m

FIG. 3-5 Nomograph for determining time of concentration for overland flow, Kinematic Wave Formulation. *(After Ragan.)*

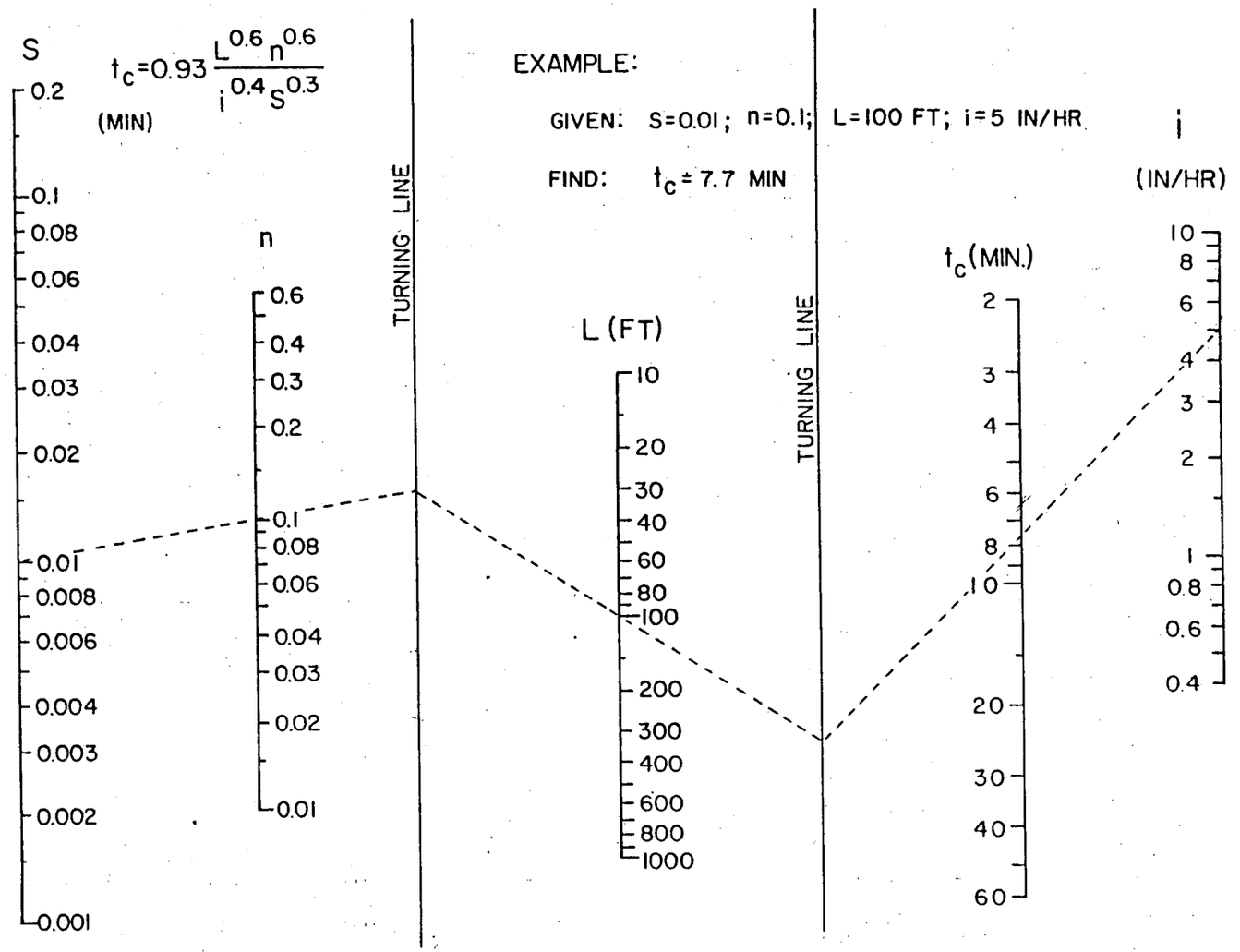


CHART 1. Kinematic wave formulation for determining time of concentration.

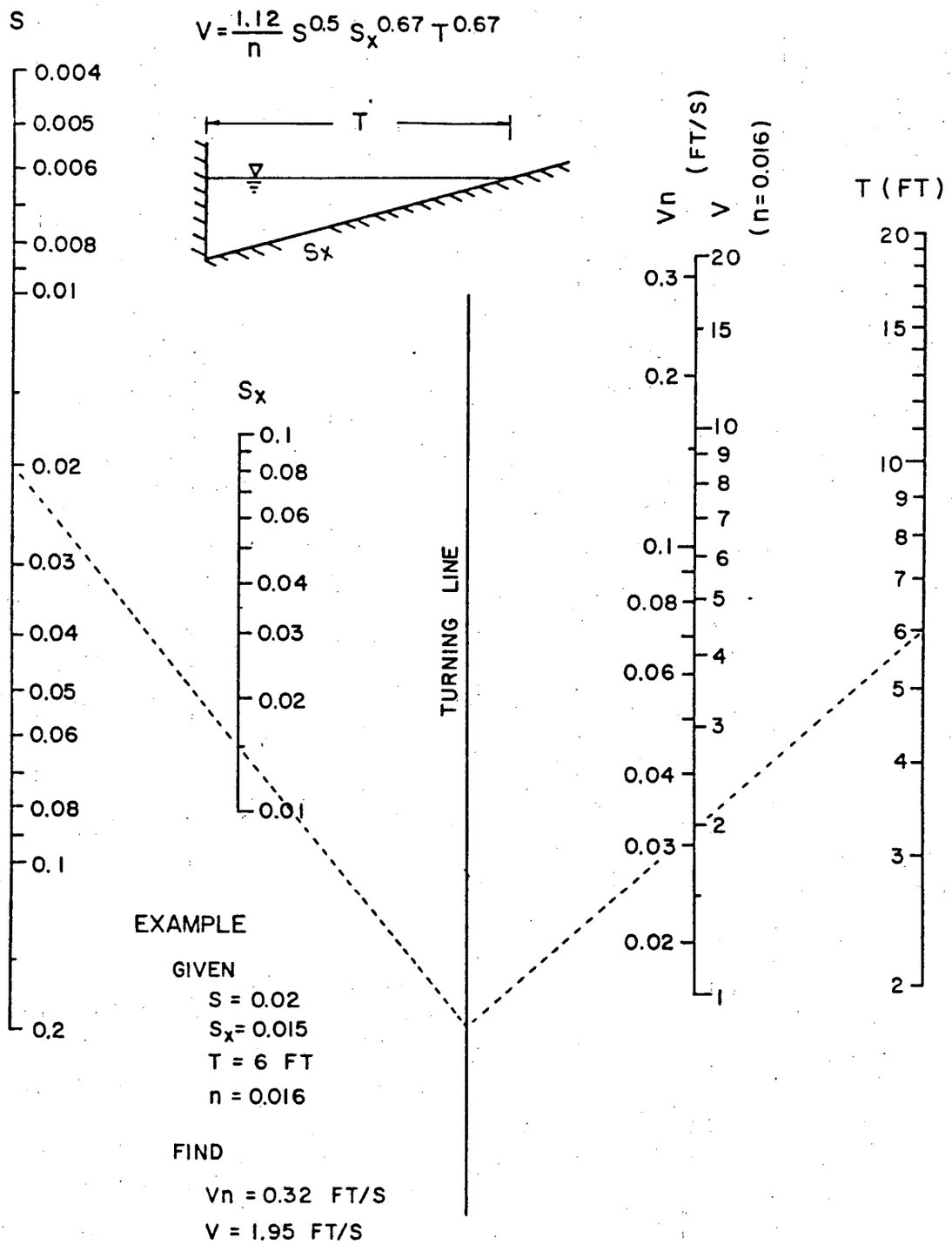
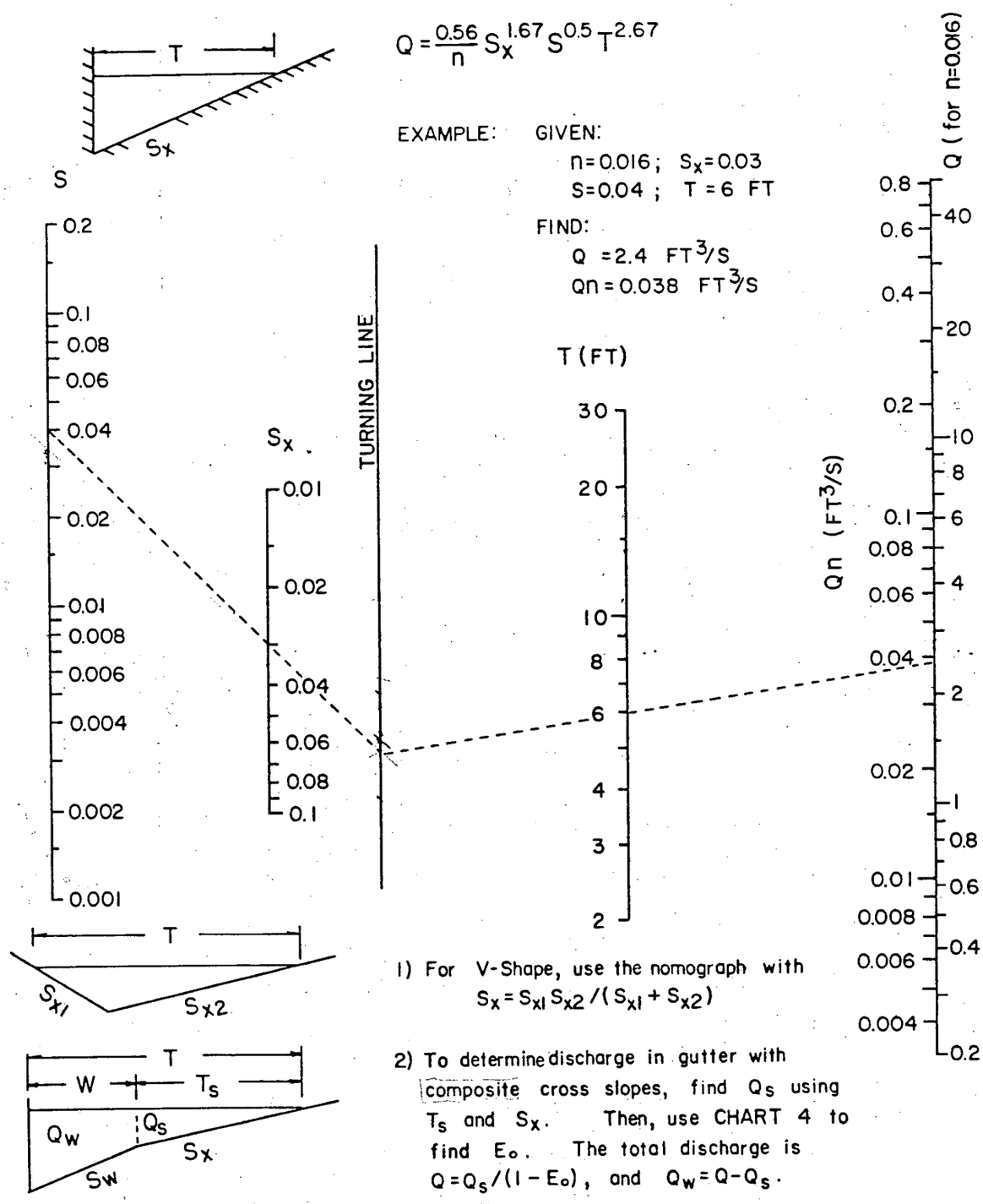


CHART 2. Velocity in triangular gutter sections.



1) For V-Shape, use the nomograph with $S_x = S_{x1} S_{x2} / (S_{x1} + S_{x2})$

2) To determine discharge in gutter with composite cross slopes, find Q_s using T_s and S_x. Then, use CHART 4 to find E_o. The total discharge is $Q = Q_s / (1 - E_o)$, and $Q_w = Q - Q_s$.

CHART 3. Flow in triangular gutter sections.

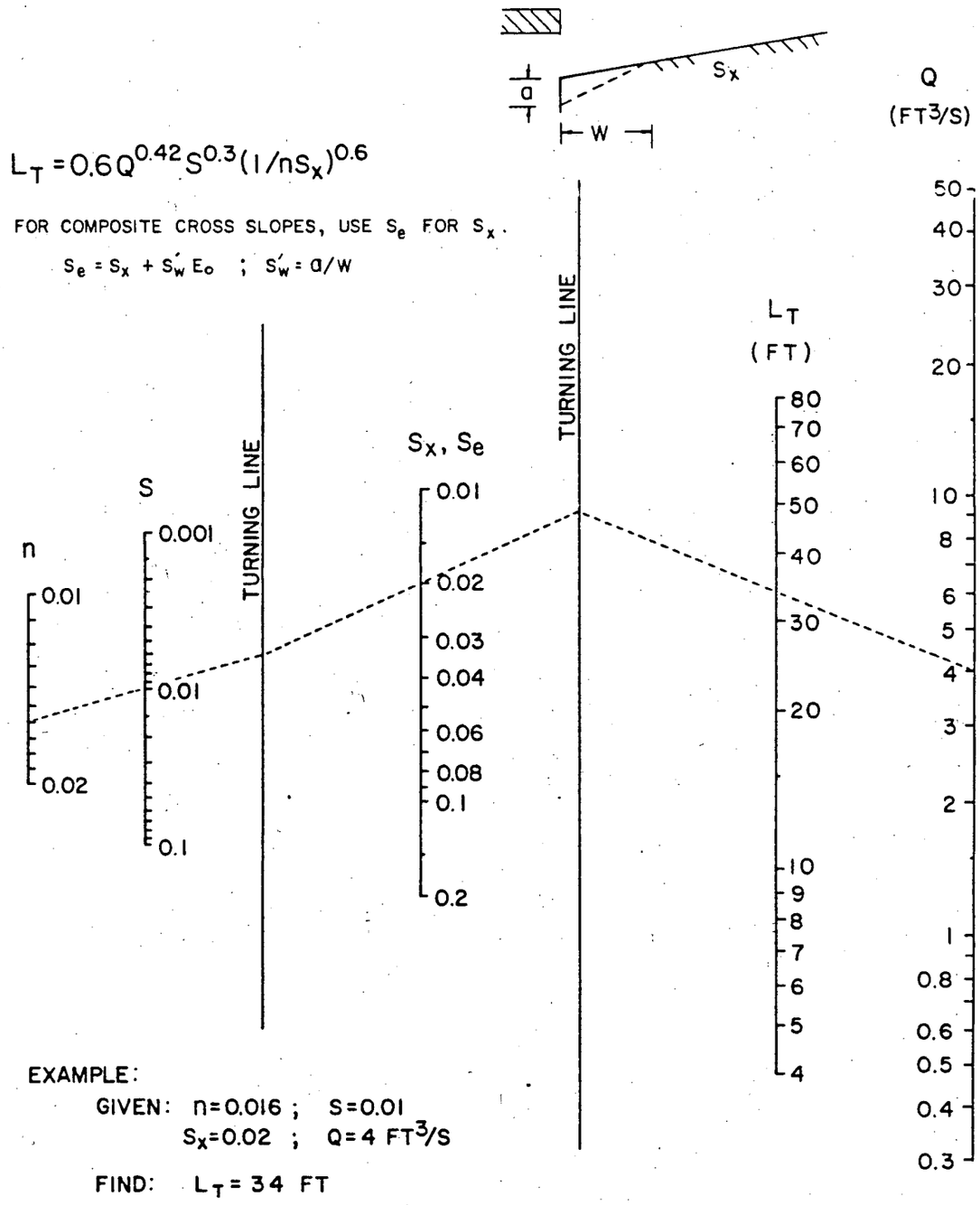


CHART 9. Curb-opening and slotted drain inlet length for total interception.

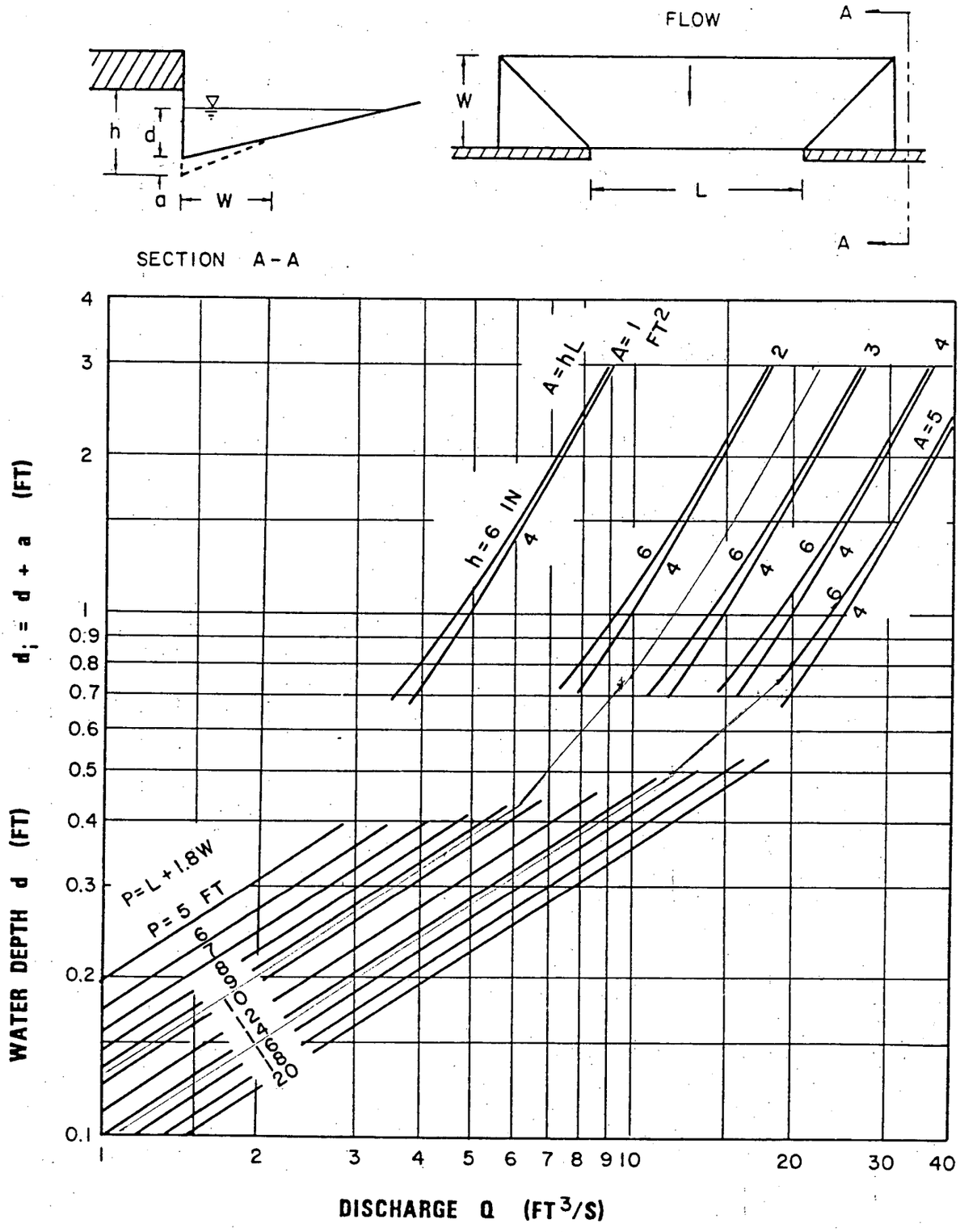
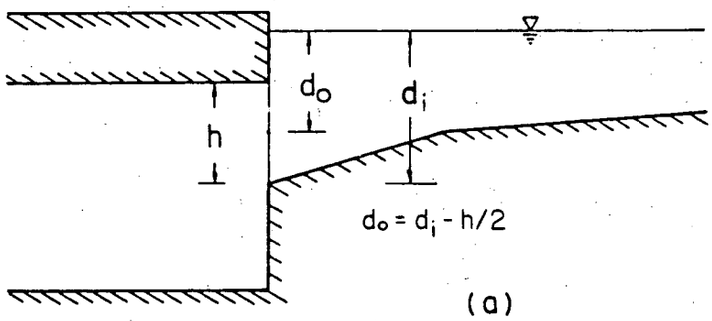


CHART 12. Depressed curb-opening inlet capacity in sump locations.

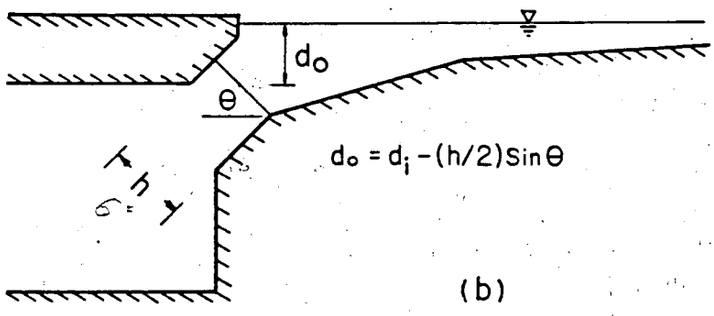


(a)

Horizontal throat

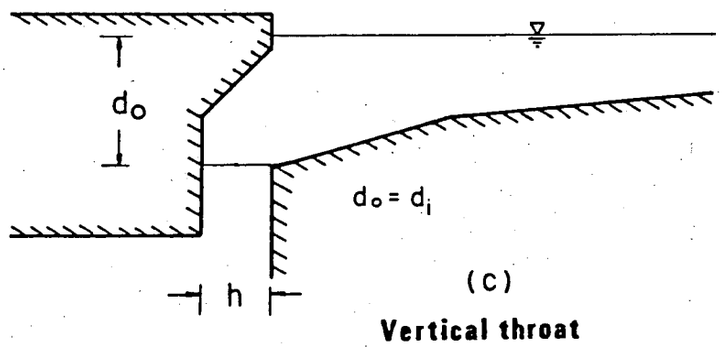
$Q = 0.67\ hL\sqrt{2gd_o}$

L = LENGTH OF OPENING



(b)

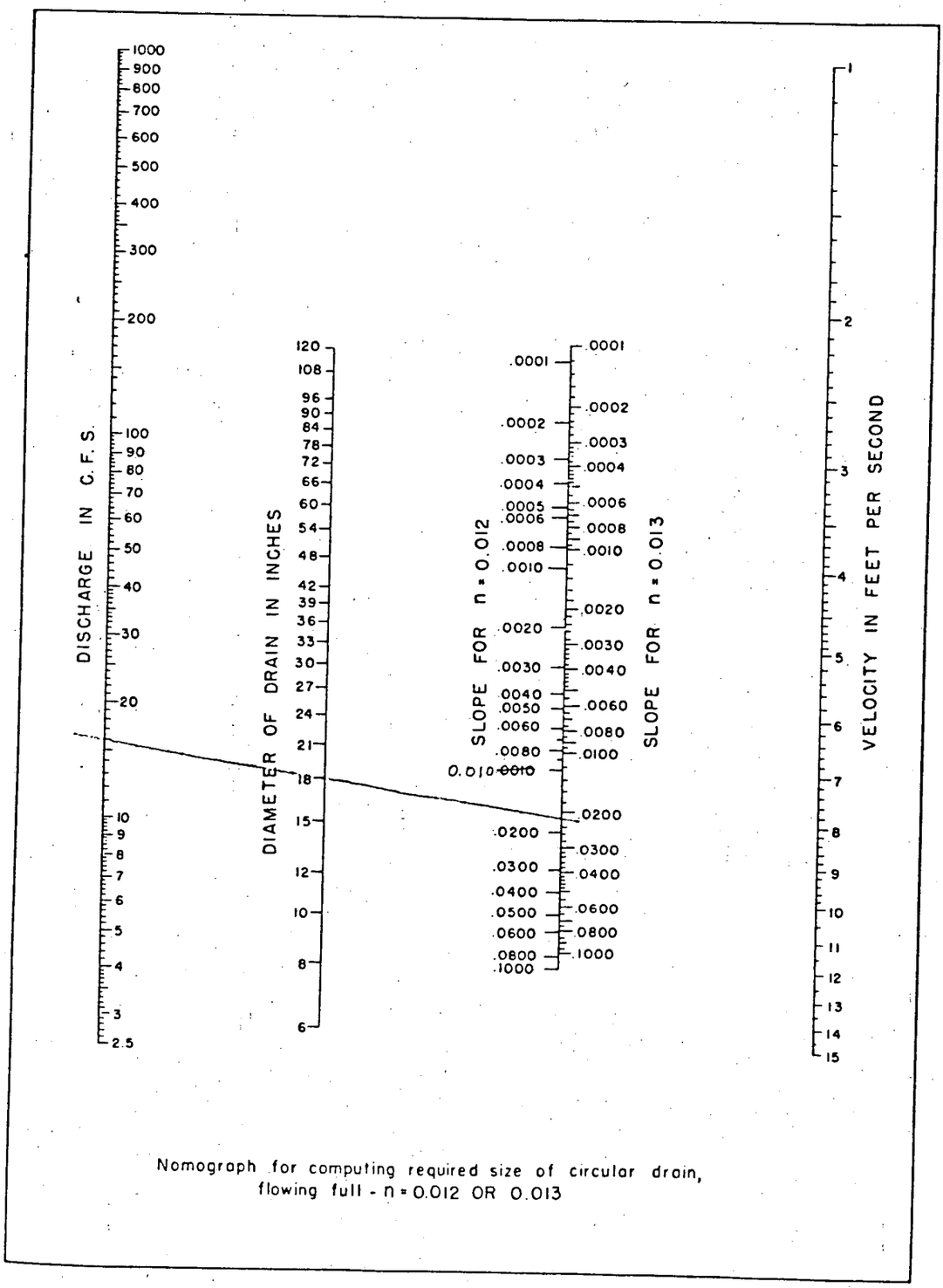
Inclined throat



(c)

Vertical throat

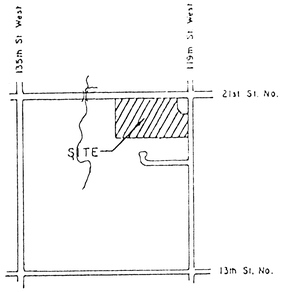
Figure 21. Curb-opening inlets.



Nomograph for computing required size of circular drain, flowing full - n = 0.012 OR 0.013

DRAINAGE STUDY

SUNRIDGE ADDITION
&
TEAL BROOK ADDITION



VICINITY MAP
No Scale

N

1" = 100'

Thimble - N.W. Cor., NE 1/4 12 - 27 - 2 W.

Flood Plain Limit & B.F.E.'s From FEMA Rate Map Panel 125.

21 ST.

7'x 3' R.C.B.C.

B.M. #2 F.L.=1346.90

2593.15' N. 88° 01' 40" E.

EXCEPTION

1332.93'

Complete Access Control

R/W Acquired By Warranty Deeds, Film 191, Pages 1603, 1605 and 1607.

Thimble - NE Cor., NE 1/4 Sec. 12, T. 27 S., R. 2 W.

B.M. #1

SW Bell Warning Sign

Exception 2.51 Ac.±

SUNRIDGE COURT

PINTAIL COURT

TEAL BROOK COURT

TEAL BROOK CT.

POND No. 1

POND No. 2

SUNRIDGE DRIVE

HILL STREET

19th STREET NORTH

Exception 2.07 Ac.±

Exception (The W. 10.0 Ac. of the N. 1/2 of the N.E. 1/4 Sec. 12 - 27 - 2 W.)

N. 01° 45' 52" W. 1323.74'

N. 01° 45' 52" W. 1243.43'

S. 87° 58' 25" W. 2223.34'

1248.34'

329.11'

Iron - S.W. Cor., N. 1/2, N.E. 1/4

Benchmark -
#1- City Disc, 79' South and 46' East of Thimble (NE Cor. Sec. 12). Elev. = 1359.48 M.S.L. = 172.08 City Datum

#2-"O" Cut in Center of South Hubguard of 7'x3' R.C.B.C., Under 21st Street. Elev. = 1351.48 M.S.L. = 164.08 City Datum

Stone w/Nail in Cir. - S.E. Cor., North 1/2, N.E. 1/4, 12 - 27 - 2 W.

MOEHRING & ASSOCIATES
CONSULTING ENGINEERS
WICHITA