PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION

DESIGN COMPUTATIONS
TALLGRASS EAST
DRAINAGE PLAN
for
CITY OF WICHITA, KANSAS

November 7, 1986

submitted by:
PROFESSIONAL ENGINEERING CONSULTANTS, P.A.
WICHITA, KANSAS 67211

owner: SLAWSON INVESTMENT CORPORATION
8100 EAST 22nd, BLDG 1900
WICHITA, KANSAS 67226

REVISED
DEC 3 1986

1440 EAST ENGLISH
WICHITA, KANSAS 67211
(316) 262-2691

MEMO

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
1440 EAST ENGLISH
WICHITA, KANSAS
ZIP CODE / 67211

TO: Design Division
8th Floor - City Hall
455 North Main
Wichita, KS 67202

ATTN: Vicki Huang

PROJECT NO. 36-86476-1104

PROJECT: Tallgrass East Drainage Plan - Revision

DATE: 12/3/86

COPIES TO:
Terry Smythe
Larry Chambers

FROM: M.W. Berry, P.E.

REFERENCE: Drainage Plan Revision - Southwest System

PLEASE ADVISE IMMEDIATELY OF ANY MISCONCEPTIONS OR OMISSIONS YOU BELIEVE TO BE CONTAINED HEREIN.

The Tallgrass East Drainage Plan was originally submitted in a memo dated 11/3/86. The plan therein proposed a pipe/inlet system for the southwest portion of the plat capable of conveying the entire 100-year design runoff.

Subsequently, an examination of the preliminary project costs prompted a look at alternative methods which would allow conveyance of a portion of the 100-year storm overland. The alternate solution is the subject of this memorandum.

Several drainage easements will be converted to reserves, with rights reserved for drainage. The proposed typical section of an overflow swale to be used in these reserves is shown on Sht. No. 23A. of the Hydraulics portion of this report.

By utilizing these overflow swales, major storm flows can be conveyed through reserves, drainage easements, and/or street rights-of-way to the outlet.

For simplification, the inlet capacity during the 100-year event was assumed to be restricted to the two-year flowrates, except at three (3) key points: Node 220, which serves a small isolated basin; Node 260, which is the lowest point on the street rights-of-way; and Node 310, which is the inlet end of the existing cross-road structure beneath 21st Street.

Inlet capacities and street flooding depths were re-analyzed for the above assumption. Note that a portion of Stoneybrook and Peppertree Court in Blocks 5 and 6 require a minimum walk grade of 0.5' above top of curb to confine the major storm runoff to the street right-of-way. Revised computations are presented on Sht. Nos. 16A-16C.

Storm sewer hydraulics were also recomputed. Results are summarized on Sheet No. 1A of 23, in the Hydraulics Section. Computer output from the STORM program is presented on Pages 18A-18D.

Overland flow hydraulics were computed for the reserves using the KDOT Manual previously referenced, assuming Class E Retardance (See Sht. Nos. 23A-C). Overland flow hydraulics across the future LC parcel were analyzed using Manning's Equation, for an assumed typical Section shown on Sht. No. 23D.

In summary, under this revised Drainage Plan, flows in excess of the two-year design storm are conveyed through reserves and/or street rights-of-way to the cul-de-sac at node 260. At this point, a portion is carried overland in a proposed reserve to the LC parcel drainage easement. Overland flow also flows through reserves to the LC parcel at Nodes 210 and 190. All overland flow concentrates at a future inlet at the north end of the 9'X4' RCB to be conveyed beneath 21st Street (Node 310).

MWB/mkm

MEMO

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
1440 EAST ENGLISH
WICHITA KANSAS
ZIP CODE / 67211

TO: Metropolitan Area Planning Dept.
10th Floor-City Hall
455 N. Main
Wichita, Kansas 67202

ATTN: Michael E. Lindebak, P. E.
Acting Director

PROJECT NO. 36-86476-1104

PROJECT: Tallgrass East Drainage Plan

DATE: 11/3/86

COPIES TO:

Terry Smythe
Larry Chambers

FROM: Michael W. Berry, P. E. MWB

REFERENCE: Drainage Plan Computations

PLEASE ADVISE IMMEDIATELY OF ANY MISCONCEPTIONS OR OMISSIONS YOU BELIEVE TO BE CONTAINED HEREIN.

Attached hereto are the computations for the referenced project.

The publication "Interim Drainage and Storm Sewer Policy for Design Criteria and Documentation, City of Wichita," as revised 4/15/86, was used as the reference for the hydrologic and hydraulic computations. This publication is hereinafter referred to as the "Design Manual".

Manual #1, as referenced herein, refers to "Design of Urban Highway Drainage-The State of the Art", by Reitz & Jens, Inc., April, 1980. Manual #2 refers to "Drainage of Highway Pavements, Hydraulic Engineering Circular #12," by Tye Engineering, Inc., March, 1984.

The analysis made herein is based on the available site data, which includes a 1" = 100' topographic map with 2' contours.

HYDROLOGIC ANALYSIS

The rational method was used for hydrologic analysis in accordance with the Design Manual. Runoff coefficients were based on the table provided in Attachment D, of the Design Manual.

The time of concentration for overland flow was determined by the velocities given in Attachment E, of the Design Manual. A check was made of overland flow times as computed by the Kinematic Wave Formulation in Section 4.1.3 of Manual #2. Due to the low rainfall intensities during the two-year design storm, the i x L > 500 criterion could not be met for the average residential lot in this subdivision. Strict adherence to the manual would have yielded two-year overland flow times of 4 to 6 minutes (as computed by the Velocity Method) and 100-year overland flow times of 13 to 17 minutes. To avoid this inconsistency, the velocity method was used for all basins, which generally yielded short flow times (and thus conservative design flow rates).

Time of travel in street gutters was determined by the method used in section 4.1.3. of Manual #2. The average gutter velocity was determined assuming curb deep flow at the inlets.

The overland flow time and gutter travel time were summed for each basin. A minimum time of concentration for design purposes was taken to be fifteen minutes.

HYDRAULIC ANALYSIS

For each inlet, street flooding and inlet capacity was checked for the minor storm. Conveyance in the street was based on the modified Manning Eq:

$$Q = 0.56 \ (S_x)^{5/3}(T)^{8/3}\sqrt{S}/n \quad \text{(Eq. 4, Manual \#2)}$$

It was assumed that t_c, for street flow, was equal to t_c, for pipe flow. This is a conservative assumption, as pipe velocities generally exceed gutter velocities.

For local streets, curb-deep flow is tolerable for the minor storm. For collectors, a single eight-foot center lane should remain unflooded for the minor storm.

Inlet capacities were determined by the methods presented in Manual #2, using chart nos. 9, 10 & 12.

In this analysis, City of Wichita Type 1A Inlets, 3/8 in/ft street cross-slope, and 6 5/8" standard curb and gutter were assumed to be utilized.

The storm sewer system serving Lots Nos. 16 through 46 in Block #1 has been designated the northwest system in this report. The south part of Lot 59, Block 1 drains through Clubhouse Drive and off the plat. The north part of Lot 59 and Reserve C drain through an open channel system to the north. A short inlet-pipe system drains Lots 47 through 58 in Block 1. (Fox Run Court system). The balance of the plat is served by a storm sewer designated the southwest system in this report.

The northwest system and the Fox Run Court system are designed for two-year inlet and pipe capacity, except at the cul-de-sac, where Q100 is conveyed through the pipe. The southwest system serves several 100-year sump collection points. Thus, it is designed for 100-year inlet and pipe capacity throughout.

To simplify analysis, the following assumptions were made:

1. The time of concentration is identical for both the major and minor storm.

2. The street conveyance was analyzed using only the street width. Depths above the curb up to the walk grade were used, but the conveyance of the parking was neglected. In general, the parking area conveyance is quite small, due to the relatively higher n factor. Again, Eq. 4, of Manual #2, was used.

Hydraulic computations for the pipe system was performed using PEC's Storm Program. This program uses Manning's Equation to calculate friction losses in pipes flowing full. Minor losses are accounted for using conservation of momentum principles. All pipes were assumed to be reinforced concrete with a Manning's "n" factor of 0.013. It is desirable to keep the hydraulic grade line approximately one-foot below the top of curb elevations for the minor storm.

Open channel flow analysis was analyzed using procedures set forth in "Design of Stable Roadside Channels" published by the Kansas Department of Transportation. This methodology uses a modification of conventional Manning's equation analysis to account for the retardance of the vegetation in a grassed channel. Retardance Class E (regularly mowed grass) was assumed to be maintained within the reserves.

GENERAL COMMENTS

Areas outside of the plat were analyzed in the preparation of this drainage plan. The preliminary plat of Tallgrass II was used for definition of street layout for areas off this plat. The area at the northwest corner of 21st & Webb noted as an Exception was assumed to be light commercial property having its own internal storm sewer system.

The existing drainage course flowing south from the 9' x 4' reinforced concrete box culvert is the outfall for the southwest system. Hydraulic analysis shows that this structure is adequate to convey the 100-year design storm beneath 21st Street. What is unknown at this time is whether its flowline elevation is compatible with proposed improvements for: a.) the subject plat; b.)the light commercial corner parcel; c.) the improvement of 21st Street to four lane urban arterial standards; and d.) the adjacent property south of 21st Street.

The drainage plan herein shows the 9' x4' RCB to be extended to both north and south, and to connect the 72" outfall pipe from the southwest system. Alternate designs may be considered during the project design phase when more information as to proposed grading of various improvements may be available.

DESIGN AIDS

All charts, graphs, tables, and nomographics used in the design are reprinted herein.

DRAINAGE MAP

A 1"=100' scale drainage map is included.

HYDROLOGY

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
EAST ENGLISH
WICHITA, KANSAS
ZIP CODE / 67211

Date 10-17-86 MWB Page 1 of 18

Project TALLGRASS EAST

Item DRAINAGE PLAN

HYDROLOGY

I. RUNOFF COEFFICIENT C

All lots are single family residential except duplex lots on Box Thorn Ct., Clubhouse site, & LC on exception parcel @ 21st & Webb

AREA	B SOIL GROUP % OF AREA IN			D SOIL GROUP % OF AREA IN			COMPOSITE C	
	1/4 Ac Lot	1/6 Lot Lot	Open Space	1/4 Ac Lot	1/6 Ac Lot	Open Space	2 Yr	100 Yr
110		35	15		35	15	0.46	0.67
120				100			0.50	0.76
130				100			0.50	0.76
135				100			0.50	0.76
140				100			0.50	0.76
160				100			0.50	0.76
170				100			0.50	0.76
180				100			0.50	0.76
200	— Multifamily D Soil			—			0.61	0.75
220				100			0.50	0.76
240				100			0.50	0.76
250				100			0.50	0.76
260				100			0.50	0.76
270	LC Parcel D Soil						0.68	0.80
290				100			0.50	0.76
310	LC Parcel D Soil						0.68	0.80

Date 10-17-86 MJB Page 2 of 18

Project Tallgrass East

Item Drainage Plan

HYDROLOGY

I. RUNOFF COEFF C (Con't)

AREA	B SOIL GROUP % OF AREA IN: 1/4 Ac Lot	1/8 Ac Lot	Open Space	D SOIL GROUP % OF AREA IN: 1/4 Ac Lot	1/8 Ac Lot	Open Space	COMPOSITE C 2 Yr	100 Yr
410	15		30	15		40	0.32	0.59
420	67		33				0.36	0.54
430	Clubhouse site B Soil						0.68	0.80
[illegible]								
570	100						0.44	0.61
580	100						0.44	0.61
590	50			50			0.47	0.68
600	50			50			0.47	0.68
500	100						0.44	0.61
700				25		75	0.35	0.68
710				33		67	0.37	0.69
720				20		80	0.34	0.67
730				25		75	0.35	0.68
800				(10% Street)		90	0.36	0.68
810	Clubhouse Site						0.68	0.80
[illegible]		do					0.68	0.80
[illegible]			80			20	[illegible]	[illegible]

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
40 EAST ENGLISH
WICHITA, KANSAS
ZIP CODE / 67211

Project TALLGRASS EAST

Item DRAINAGE PLAN

HYDROLOGY

II TIMES OF CONCENTRATION

$$t_c = 0.93 \frac{(L)^{0.6}(n)^{0.6}}{i^{0.4} S^{0.3}}$$

A. Overland flow - Yards

Assume residential lots are graded @ 2% from rear line to street.
Assume n = 0.45 (Bluegrass sod)

For L = 100'

Trial No.	Return Period (Yr)	Assume i in/hr	Tc min	Actual i in/hr	
1	2	5.57	14.9	3.9	
2	"	4.52	16.1	3.75	
3	2	3.9	17.1	3.63	
4	"	3.5	17.9	3.52	OK Tc_2 = 17.9 i x L < 500 NG use velocity method
1	100	10.32	11.6	8.1	
2	"	7	13.6	7.6	
3		7.57	13.1	7.75	
4		7.79	13.0	7.79	OK Tc_{100} = 13 min.

For L = 110'

1	2	3.42	19.11	3.4	i x L < 500 NG Use V method
1	100	7.57	13.9	7.55	OK Tc_{100} = 14 min.

For L = 120'

1	2.	3.33	20.4	3.30	
2	"	3.25	20.6	3.28	i x L < 500 NG Use V method
1	100	7.37	14.8	7.41	OK Tc_{100} = 15 min

For L = 130'

1	2	3.25	21.6	3.20	
2	2	3.17	21.8	3.19	OK but i x L < 500 NG
1	100	7.18	15.7	7.24	OK Tc_{100} = 16 min.

Professional Engineering Consultants
Professional Association
140 East English
Wichita, Kansas
Zip Code / 67211

Project Tallgrass East

Item Drainage Plan

Hydrology

II. A. Con't.

Trial No.	Return Period (Yr)	Assumed i (in/hr)	Tc (min)	Actual i (in/hr)	
For L = 140'					
1	2	3.10	23.0	3.10	OK but i x L < 500 Use V method
1	100	7.00	16.6	7.09	← Use Tc_{100} = 16 min
2	100	7.18	16.4	7.11	
For L = 150'					
1	2	3.03	24.2	3.01	OK but i x L < 500 Use V method
1	100	7.00	17.3	6.95	← Use Tc_{100} = 17 min.
2	100	6.84	17.4	6.93	

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
.40 EAST ENGLISH
.ICHITA, KANSAS
.IP CODE / 67211

Date 10/17/86 MNB

Project TALLGRASS EAST

Item DRAINAGE PLAN

HYDROLOGY

II. A. Cont.

VELOCITY METHOD

SLOPE = 2% ; LAWNS ; V = 0.45 ft/sec per Attachment E

For L = 100'; $T_c = \frac{100}{0.45} \times \frac{1}{60} = 3.7$ min

L = 110'; $T_c = \frac{110}{0.45} \times \frac{1}{60} = 4.1$ min

L = 120'; $T_c = \frac{120}{0.45} \times \frac{1}{60} = 4.4$ min.

L = 130'; $T_c = \frac{130}{0.45} \times \frac{1}{60} = 4.8$ min.

L = 140'; $T_c = \frac{140}{0.45} \times \frac{1}{60} = 5.2$ min.

L = 150'; $T_c = \frac{150}{0.45} \times \frac{1}{60} = 5.6$ min.

OVERLAND FLOW TIMES - LAWNS (S = 2%, n = 0.450)

LOT DEPTH	2 - YR	100 - YR
100'	3.7	13
110'	4.1	14
120'	4.4	15
130'	4.8	16
140'	5.2	16
150'	5.6	17

SEEMS UNREASONABLE.
USE SHORTER TIMES BASED ON VELOCITY METHOD

HYDROLOGY

B. Estimate Street Flow Times

For local streets (29 Bk-Bk), Assume curb deep. $T_2 = 14'$,
If $T_1 = 0$, then $T_a = 0.65 T_2 = 9.1'$ say $9'$. Solve for V's for various slopes using Chart 2, HEC-12.

For collector streets (37' Bk-Bk) Assume one 8' center lane clear i.e. $T_2 = 10'$. If $T_1 = 0$, $T_a = 0.65 T_2 = 6.5'$

$n = 0.015$ $S_x = 1/32$

LONG. GRADE %	AVG GUTTER VELOCITY (ft/sec) LOCAL	COLLECTOR
0.32	1.81	1.46
0.5	2.27	1.82
0.75	2.78	2.23
1.0	3.21	2.58
1.25	3.58	2.88
1.5	3.93	3.16
1.75	4.24	3.41
2.00	4.53	3.65
2.25	4.81	3.87
2.5	5.07	4.08

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
140 EAST ENGLISH
WICHITA, KANSAS
ZIP CODE / 67211

Project TALLGRASS EAST

Item DRAINAGE PLAN

HYDROLOGY

II. B. Con't.

AREA	OVERLAND FLOW L, ft	V, ft/s	T, min	GUTTER FLOW L, ft	V, ft/s	T, min	Total Time, min
110	150		5.6	200	1.9		
				500	2.7		
				200	4.4		
						5.6	11.2 USE 15
120	120		4.4	200	4.2	0.8	USE 15
130	120		4.4	300	3.2	1.6	USE 15
140	—			200	2.0	1.7	USE 15
135	100		3.7	200	4.1		
				350	3.2		
						Σ=2.6	USE 15
160				250	2.0	2.1	USE 15
170	—			110			USE 15 By Inspection
180	120		4.4	200	4.5	0.7	USE 15
200	150		5.6	600	2.5	4.0	USE 15
220	150		5.6	300	3.3	1.5	USE 15
240	150		5.6	400	2.0		
				250	3.6		
						4.5	USE 15
250	150		5.6	250	2.0		
				200	2.6		
						2.2	USE 15
260	150		5.6	350	2.0	2.9	USE 15
270				800	4.0	3.3	USE 15
290	150		5.6	500	3.3	2.6	USE 15
310	Assume storm sewer @ 5 ft/sec						
				1600	5	5	USE 15

Date 10/17/86 MWB Page 8 of 18

Project TALLGRASS EAST

Item DRAINAGE PLAN

HYDROLOGY

II. B. Con't.

AREA	OVERLAND FLOW L, ft	V ft/s	T min	GUTTER FLOW L, ft	V, ft/s	T, min	Total Time, min
410	0			500	2.1	4.0	USE 15
420	150		5.6	200	4.5	0.7	
				500	2.1	4.0	11.3 USE 15
430	0			300	4.2		USE 15
570	150		5.6	400	2.0	1.3	USE 15
580	200	0.45	7.4	100	2.0	0.8	USE 15
590	210		7.8	400	2.0	1.3	USE 15
500	150		5.6	200	4.2		
				150	5.6	1.2	USE 15
610	150		5.6	400	2.0		
				250	3.8		
				200	6.0		
				250	5.1		
						5.8	USE 15
700	130		4.8	200	2.0		USE 15
710	100		3.7	200	2.0		USE 15
720	—			450	2.0		USE 15
730	—			450	2.0		
				150	4.5		
						4.3	USE 15
800	—			600	4.0		USE 15
810	800	4.0					USE 15
820	600	4.0					USE 15
830	600	0.5	20				20

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
[illegible]40 EAST ENGLISH
[illegible]ICHITA, KANSAS
[illegible]IP CODE / 67211

Date 10/17/86 MMB

Project TALLGRASS EAST

Item DRAINAGE PLAN
HYDROLOGY

III. COMPUTATION OF DESIGN FLOWRATES

			TWO - YEAR			100 - YEAR		
BASIN	AREA (Ac)	Tc (min)	i in/hr	C	Q cfs	i in/hr	C	Q cfs
110	7.3	15	3.83	0.46	12.9	7.37	0.67	36.0
120	0.8	"	"	0.50	1.5	"	0.76	4.5
130	1.1	"	"	"	2.1	"	"	6.2
140	0.3	"	"	"	0.6	"	"	1.7
135	1.5	"	"	"	2.9	"	"	8.4
160	1.2	"	"	"	2.3	"	"	6.7
170	0.2	"	"	"	0.4	"	"	1.1
180	2.1	"	"	0.50	4.0	"	0.76	11.8
200	6.8	"	"	0.61	15.9	"	0.75	37.6
220	2.5	"	"	0.50	4.8	"	0.76	14.0
240	2.3	"	"	"	4.4	"	"	12.9
250N	2.9	"	"	"	5.5	"	"	16.3
250E	1.3	"	"	"	2.5	"	"	7.3
260	3.4	"	"	0.50	6.5	"	0.76	19.0
270	4.8	"	"	0.68	12.5	"	0.80	28.3
290	3.6	"	"	0.50	6.9	"	0.76	20.2
310	16.5	"	"	0.68	43.0	"	0.80	97.3
		"	"			"		
		"	"			"		
		"	"			"		
		15	3.83			7.37		

Date 10/17/86 MWB

Project TALLGRASS EAST

Item DRAINAGE PLAN

HYDROLOGY

III. COMPUTATION OF DESIGN FLOWRATES

BASIN	AREA (Ac)	Tc (min)	TWO-YEAR i in/hr	TWO-YEAR C	TWO-YEAR Q cfs	100-YEAR i in/hr	100-YEAR C	100-YEAR Q cfs
410	1.6	15	3.83	0.32	2.0	7.37	0.59	7.0
420	5.7	"	"	0.36	7.9	"	0.54	22.7
430	0.6	"	"	0.66	1.6	"	0.80	3.5
570	2.9	"	"	0.44	4.9	"	0.61	13.0
580	0.8	"	"	0.44	1.3	"	0.61	3.6
590	2.1	"	"	0.47	3.8	"	0.68	10.5
600	4.0	"	"	0.47	7.2	"	0.68	20.0
500	3.2	"	"	0.44	5.4	"	0.61	14.4
700	1.1	"	"	0.35	1.5	"	0.68	5.5
710	0.9	"	"	0.37	1.3	"	0.69	4.6
720	1.0	"	"	0.34	1.3	"	0.67	4.9
730	1.2	"	"	0.35	1.6	"	0.68	6.0
800	2.3	"	"	0.36	3.2	"	0.68	11.5
810	3.8	"	"	0.68	9.9	"	0.80	22.4
820	3.5	15	3.83	0.68	9.1	7.37	0.80	20.6
830	5.6	20	3.33	0.22	4.1	6.53	0.46	16.8

Professional Engineering Consultants
Professional Association
1440 East English
Wichita, Kansas
Zip Code / 67211

Date 10/29/86 MMB Comp by MMB

Project TALLGRASS EAST

Item SW SYSTEM 2 YR.

z/n = 2000

INLET CAPACITY

NODE No.	HYDROLOGY Q_o cfs	HYDROLOGY Q_o+Q_b cfs	APPROACHING FLOW S_o o/o	APPROACHING FLOW S_x in/ft	APPROACHING FLOW d ft	APPROACHING FLOW T ft	INLET TYPE	INLET L	ON-GRADE COMP Lt ft	ON-GRADE COMP L/Lt	ON-GRADE COMP E ft	SUMP COMP. di ft	SUMP COMP. d ft	SUMP COMP. T ft	Q_i cfs	Qb cfs
410	2.0	2.0	0.60	3/8	0.25	8	1A	5'	MINI SUMP = 0.35'			0.23	0.05	1.6	2.0	0
420	7.9 6.2 (W) 1.7 (N)	7.9	0.6	3/8	0.41 0.39 (W) 0.19 (N)	13	1A	5'	MINI SUMP = 0.40'			0.57	0.4	12.8	7.9	0
430	1.6	1.6	1.8	3/8	0.19	6	1A	5'	MINI SUMP = 0.4'			0.17	0	0	1.6	0
810	9.9	9.9	0.6	3/8	0.44	14	→ OFF PLAT - FLOODED WIDTH OK									

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
1440 EAST ENGLISH
WICHITA, KANSAS
ZIP CODE / 67211

Date 10/23/86 Page 12 of 18 Comp by MAB

Project TALLGRASS EAST

Item

z/n = 32/0.016 = 2000 **INLET CAPACITY** (2 PR)

NODE	HYDROLOGY		APPROACHING FLOW				INLET		ON-GRADE COMP			SUMP COMP.				
No.	Q_o cfs	Q_o+Q_b cfs	S_o o/o	S_x in/ft	d ft	T ft	TYPE	L	Lt ft	L/Lt	E ft	di ft	d ft	T ft	Q_i cfs	Qb cfs
110	12.9															
	6.5 PER SIDE		1.90	3/8	0.31	9.8	1A	10'							6.5	
	do	do			do	do	1A	10'				0.47	0.3	9.6	6.4	
															12.9	-0-
120	1.5	1.5	1.00	3/8	0.20	6.5	1A	5'	18	0.28	0.45				0.7	0.8
130	2.1	2.9	1.00	3/8	0.26	8.2	1A	5'	MINI	SUMP =	0.3'	0.27	0.10	3.2	2.9	0
220W	2.4	2.4	1.11	3/8	0.23	7.5	1A	10'				0.37	0.2	6.4	4.8	0
E	2.4	2.4	do	do	0.23	7.5	1A									
140	0.6	0.6	0.4	3/8	0.18	5.5	1A	5	MINI	SUMP					0.6	0
170	0.4	0.4	0.32	3/8	0.16	5	1A	5							0.4	0
135	2.9	2.9	1.00	3/8	0.26	8.2	1A	10	24	0.42	0.62				1.8	1.1
160	2.3 (1.3 (W), 1.0 (E))	3.4	0.4	3/8	0.32 (0.23 (W), 0.21 (E))	10.5	1A	5				0.3	0.13	4.2	3.4	0
180	4.0	4.0	2.0	3/8	0.26	8.2	1A	10				0.37	0.2	6.4	4.0	0

Date	10/24/86						Page	13	of	18		Comp by	MKB			
Project	TALLGRASS EAST															
Item	I-4R															
z/n = 2000							INLET CAPACITY									

NODE No.	HYDROLOGY Q_o cfs	Q_o+Q_b cfs	APPROACHING FLOW S_o o/o	S_x in/ft	d ft	T ft	INLET TYPE	L	ON-GRADE COMP Lt ft	L/Lt	E ft	SUMP COMP. di ft	d ft	T ft	Q_i cfs	Qb cfs
200	15.9	0	?	?	12 cfs OUTSIDE		1A	10				0.5	0.33	10.7	12	0
					4 cfs INSIDE		1A	10				0.25	0.05	2.6	4	0
220	4.8	0	1.11	3/8	0.29	9.2	1A	10				0.27	0.10	3.2	4.8	0
240	4.4	0	1.25	3/8	0.28	9	1A	10	29	0.34	0.52				2.3	2.1
250N	5.5	0	1.25	3/8	0.31	10										
250E	2.5	0	1.44	do	0.21	7										
			Σ =	Q = 7 cfs			1A	10				0.37	0.20	6.4	7.0	0
260N	3.2	5.3	0.32	3/8	0.41	13										
260E	3.3	3.3	0.32	3/8	0.35	11										
				Σ = 8.6 cfs			1A	10				0.42	0.25	8.0	8.6	0
290	6.9	6.9					1A	10				0.37	0.20	6.4	6.9	0
WEST		3.5	1.0	3/8	0.28	9										
EAST		3.4	1.0	3/8	0.28	9										

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
1440 EAST ENGLISH
WICHITA, KANSAS
ZIP CODE / 67211

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
1440 EAST ENGLISH
WICHITA KANSAS
ZIP CODE / 67211

Date 10/29/86 MMB Page 14 of 18 Comp by MMB

Project TALLGRASS EAST

Item SW SYSTEM 100 YR

z/n = 2000

INLET CAPACITY

NODE No.	HYDROLOGY		APPROACHING FLOW				INLET		ON-GRADE COMP			SUMP COMP.					
	Q_o cfs	Q_o+Q_b cfs	S_o o/o	S_x in/ft	d ft	T ft	TYPE	L	Lt ft	L/Lt	E ft	di ft	d ft	T ft	Q_i cfs	Qb cfs	
410	7.0	7.0	0.6	3/8	0.41	13	1A	5'	MINI SUMP = 0.33'			0.52	0.35	11.2	7	0	
420	22.7	22.7	0.6	3/8	0.59	14+	1A	5'	MINI SUMP = 0.4'			0.57	0.40	12.8	8	14.7	
430	3.5	18.2	1.8	3/8	0.25	8	1A	5'	MINI SUMP = 0.4'			0.57	0.40	12.8	8	10.2	TO → 810
810	32.4	32.6	0.6	3/8	0.75±	14'+	OFF	PLAT →		WITHIN	R/W	OK					

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
1440 EAST ENGLISH
WICHITA, KANSAS
ZIP CODE / 67211

Date 10/27/86 Page 15 of 18 Comp by MWB

Project TALL GRASS EAST

Item 100 YR SW SYSTEM

z/n = 3000

INLET CAPACITY

NODE No.	HYDROLOGY Q_o cfs	HYDROLOGY Q_o+Q_b cfs	APPROACHING FLOW S_o o/o	APPROACHING FLOW S_x in/ft	APPROACHING FLOW d ft	APPROACHING FLOW T ft	INLET TYPE	INLET L	ON-GRADE COMP Lt ft	ON-GRADE COMP L/Lt	ON-GRADE COMP E ft	SUMP COMP. di ft	SUMP COMP. d ft	SUMP COMP. T ft	Q_i cfs	Qb cfs
110	36								① 0.11 over crown							
	18 PER SIDE		1.9	3/8	0.44	14.1	1A	10				0.72	0.55	①	18	0
	do		do	do	do	do	1A	10				0.72	0.56	①	18	0
120	4.5	4.5	1.0	do	0.28	9	1A	5	28	0.18	0.3				1.4	3.1
130	6.2	9.3	1.0	do	0.41	13	1A	5	MIN SUMP = 0.3'			0.47	0.30	9.6	6.5	3.0
330W	7.0	10	1.11	do	0.41	13	1A	10				0.70	0.53	—	17	0
E	7.0	7	1.11	do	0.38	12	1A									
140	1.7	1.7	0.4	do	0.25	8	1A	5				0.17	—	0	1.7	0
170	1.1	1.1	0.32	do	0.22	7	1A	5				0.15	—	0	1.1	0
135	8.4	8.4	1.00	do	0.38	12	1A	10	37	0.27	0.42				3.5	4.9
160	6.7	11.6	0.4	do	0.53	②	1A	6				0.5	0.43	13.8	11.6	0
180	11.8	5.9 EA SIDE 5.9 EA SIDE	2.0	3/8	0.29	7.2	1A	10				0.5	0.43	13.8	11.8	0

② 0.09' over crown

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
1440 EAST ENGLISH
WICHITA, KANSAS
ZIP CODE / 67211

Date 10/27/86 Page 16 of 18 Comp by MWB

Project TALLGRASS EAST SW SYSTEM

Item 100 YR – SW SYSTEM

z/n = 2000

INLET CAPACITY

NODE No.	HYDROLOGY Q_o cfs	HYDROLOGY Q_o+Q_b cfs	APPROACHING FLOW S_o o/o	APPROACHING FLOW S_x in/ft	APPROACHING FLOW d ft	APPROACHING FLOW T ft	INLET TYPE	INLET L	ON-GRADE COMP Lt ft	ON-GRADE COMP L/Lt	ON-GRADE COMP E ft	SUMP COMP. di ft	SUMP COMP. d ft	SUMP COMP. T ft	Q_i cfs	Qb cfs
200	37.6	18.8	INSIDE	SPILL ACROSS			1A	10				0.77	0.6		37.6	0
		19.8	OUTSIDE	CROWN			1A	10				0.77	0.6			
220	14.0	14.0	1.11	3/8	0.38	12	1A	10				0.52	0.35	11.Z	14	0
240	12.9	12.9	1.25	3/8	0.41	13	1A	10	47	0.21	0.33				4.3	8.6
250N	16.3	16.3	1.35	3/8	0.47	(3)			(3) over crown 0.04'							
250E	7.3	7.3	1.44	3/8	0.34	11										
							1A	10	CAPACITY @ crown depth			0.60	0.43	14	14	9.6
260W	8.5	17.1	0.32	3/8	0.63		1A	10				0.70	0.53		17.1	0
260E	8.5	18.1	0.32	3/8	0.65		1A	10				0.73	0.56		18.1	0
290							1A	10				0.82	0.65		20.2	0
WEST		10.1	1.0	3/8	0.41	13										
EAST		10.1	1.0	3/8	0.41	13										

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
1440 EAST ENGLISH
WICHITA KANSAS
ZIP CODE / 67211

Date 12-4-86 Page 16A of 18 Comp by MWB

Project TALLGRASS EAST DRAINAGE PLAN

Item SOUTHWEST SYSTEM REVISED ASSUME $Q_{i\,100}$ = $Q_{1(2)}$ except @ node 220, 260, & 310

z/n = 2000

INLET CAPACITY

NODE No.	HYDROLOGY Q_o cfs	Q_o+Q_b cfs	APPROACHING FLOW S_o o/o	S_x in/ft	d ft	T ft	INLET TYPE	L	ON-GRADE COMP Lt ft	L/Lt	E ft	SUMP COMP. di ft	d ft	T ft	Q_i cfs	Qb cfs	
410	7.0	7.0	0.60	3/8	0.41	13	1A	5'				0.22			2.0	5.0	
420	22.7	29.7	0.60	3/8	0.66	18+	1A	5'				0.57			7.9	21.8	
430	3.5	25.3	1.8	3/8	0.50	13+	1A	5'				0.17			1.6	23.7	TO 810 →
110	36 →	18 PER SIDE 18	1.9 1.9	3/8 3/8	0.41 0.41	13 13	1A 1A	10' 10'				0.47			12.9	23.1	
120	4.5	27.6	1.0	3/8	0.56	13+	1A	5'							0.7	26.9	
130	6.2	33.1	1.0	3/8	0.66	13+	1A	5'				0.27			2.9	30.2	
810	22.4	46.1	0.6	3/8	0.78	20+	→ OFF PLAT — FLOODED WIDTH CK										

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
1440 EAST ENGLISH
WICHITA, KANSAS
ZIP CODE / 67211

Date 12-4-86

Project TALLGRASS EAST DRAINAGE

Item SOUTHWEST SYSTEM REVIS

$z/n = 2000$

INLET CA

NODE No.	HYDROLOGY Q_o cfs	Q_o+Q_b cfs	APPROACHING FLOW S_o o/o	S_x in/ft	d ft	T ft	INLET TYPE	L
410	7.0	7.0	0.60	3/8	0.41	13	1A	5'
420	22.7	29.7	0.60	3/8	0.66	18+	1A	5'
430	3.5	25.3	1.8	3/8	0.50	13+	1A	5'
110	36 →	18 PER SIDE 18	1.9 1.9	3/8 3/8	0.41 0.41	13 13	1A 1A	10' 10'
120	4.5	27.6	1.0	3/8	0.56	13+	1A	5'
130	6.2	33.1	1.0	3/8	0.66	13+	1A	5'
810	22.4	46.1	0.6	3/8	0.78	20+	→	→ [illegible]

Date 12/1/86 Page 16B of 18 Comp by MWB

Project Tallgrass East

Item SW System 100yr – Assume $Q_{i(100)} = Q_{i(2)}$ exc @ node 220, 260, 310

z/n = 2000

INLET CAPACITY

PROFESSIONAL ENGINEERING CONSULTANTS PROFESSIONAL ASSOCIATION 1440 EAST ENGLISH WICHITA, KANSAS ZIP CODE / 67211

NODE No.	HYDROLOGY Q_o cfs	HYDROLOGY Q_o+Q_b cfs	APPROACHING FLOW S_o o/o	APPROACHING FLOW S_x in/ft	APPROACHING FLOW d ft	APPROACHING FLOW T ft	INLET TYPE	INLET L	ON-GRADE COMP Lt ft	ON-GRADE COMP L/Lt	ON-GRADE COMP E ft	SUMP COMP. di ft	SUMP COMP. d ft	SUMP COMP. T ft	Q_i cfs	Q_b cfs	
140	1.7	35.7	0.4	3/8	0.78	14+	1A	5							0.6	35.1	
170	1.1	36.2	0.32	do	0.81	14+	1A	5							0.4	35.8	TO 240 →
135	8.4	8.4	1.00	do	0.38	12	1A	10	37						1.8	6.6	
160	6.7	13.3	0.4	do	0.53	14+	1A	5				0.3	0.13	4.2	3.4	9.7	TO 250 →
180	11.8 5.9 PER SIDE	5.9	2.0	3/8	0.29	9.2	1A	10				0.37	0.2	6.4	4.0	7.8	over land
			If	sized	for Q_{100}							0.52	0.35	11.2	11.8	0	
200	37.6 EA SIDE →	18.8 18.8					1A 1A	10 10						}	16	21.6	over land
220	14.0	14.0	1.11	3/8	0.38	12	1A	10	~~SIZE~~	~~FOR Q_2~~		~~0.27~~	~~0.10~~	~~3.2~~	~~4.8~~	~~9.8~~	over land
									SIZE	FOR Q_{100}		0.52	0.35	11.2	14	0	

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
1440 EAST ENGLISH
WICHITA KANSAS
ZIP CODE / 67211

Date 12/1/86 Page 16C of 18 Comp by MMB

Project Tallgrass East

Item SW System 100 yr – Assume $Q_{i(100)} = Q_{i(2)}$ exc @ node 220, 260, 310

z/n = 2000

INLET CAPACITY

NODE No.	HYDROLOGY Q_o cfs	Q_o+Q_b cfs	APPROACHING FLOW S_o o/o	S_x in/ft	d ft	T ft	INLET TYPE	L	ON-GRADE COMP Lt ft	L/Lt	E ft	SUMP COMP. di ft	d ft	T ft	Q_i cfs	Qb cfs	
240	12.9	48.7	1.25	3/8	0.69	14+	1A	10							4.3	44.4	260/261
250N	16.3	27.2	1.25	5/8	0.56	14+	1A	10				0.37	0.20	6.4	7.0	27.5	260/261
250E	7.3	7.3	1.44	3/8	0.34	11											
261 (EAST SIDE)	8.5 +	44.4															
260 (WEST SIDE)	8.5 +	27.5															
		89 CFS															
PER SIDE		45	0.32	3/8	0.88	14+	1A	10				1.0	0.63		25	20	TO [illegible]
							1A	10				1.0	0.83		25	20	
290							1A	10				0.82	0.65		20.2	0	
WEST		10.1	1.0	3/8	0.41	13											
EAST		10.1	1.0	3/8	0.41	13											

OVERFLOW THRU RESERVE = 35 CFS MAX
DESIGN INLET/PIPE FOR LARGEST OF
Q_{100} – 35 CFS = 54 CFS OR CAPACITY OF
TWO 10' INLETS @ d_i = 1.0' = 2 x 24 = 48 CFS
OK CLOSE ENOUGH

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
1440 EAST ENGLISH
WICHITA KANSAS
ZIP CODE / 67211

Date 10/29/86 Comp by MVB

Project TALLGRASS EAST DRAINAGE PLAN

Item NW SYSTEM 2 YR

z/n = 2000

INLET CAPACITY

NODE No.	HYDROLOGY Q_o cfs	HYDROLOGY Q_o+Q_b cfs	APPROACHING FLOW S_o o/o	APPROACHING FLOW S_x in/ft	APPROACHING FLOW d ft	APPROACHING FLOW T ft	INLET TYPE	INLET L	ON-GRADE COMP Lt ft	ON-GRADE COMP L/Lt	ON-GRADE COMP E ft	SUMP COMP. di ft	SUMP COMP. d ft	SUMP COMP. T ft	Q_i cfs	Qb cfs
570	4.9 3.2(W) 1.2(S)	4.9	0.36	3/8	0.41 0.33(W) 0.25(S)	13	1A	5'				0.39	0.22	7.0	4.9	0
580	1.3	1.3	0.40	3/8	0.33	7.5	1A	5'	MINI SUMP =		0.4'	<0.17	0	0	1.3	0
590	3.8	3.8	0.36	3/8	0.35	11	1A	5'	20	0.25	0.38				1.4	2.4
600N 600S	4.5 2.7	6.9 2.7	2.5 2.5	3/8 3/8	0.30 0.22	9.5 7	1A	10'				0.47	0.30	9.6	9.6	0
500N 500S	2.7 2.7	2.7 2.7	1.7 1.7	3/8 3/8	0.23 do	7.5 7.5	1A	10'				0.30	0.13	4.2	5.4	0

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
1440 EAST ENGLISH
WICHITA, KANSAS
ZIP CODE / 67211

Date 10/29/86 Page 18 of 18 Comp by MMB

Project TALLGRASS EAST DRAINAGE PLAN

Item NW SYSTEM 100 YR

z/n = 2000

INLET CAPACITY

Assume $Q_{i(100)} = Q_{i(z)}$

NODE No.	HYDROLOGY Q_o cfs	HYDROLOGY Q_o+Q_b cfs	APPROACHING FLOW S_o o/o	APPROACHING FLOW S_x in/ft	APPROACHING FLOW d ft	APPROACHING FLOW T ft	INLET TYPE	INLET L	ON-GRADE COMP Lt ft	ON-GRADE COMP L/Lt	ON-GRADE COMP E ft	SUMP COMP. di ft	SUMP COMP. d ft	SUMP COMP. T ft	Q_i cfs	Qb cfs	
570	13	13	0.36	3/8	0.56	14+	1A	5'							4.9	8.1	
580	3.6	11.7	0.40	3/8	0.53	14+	1A	5'							1.3	10.4	TO 600S
590	10.5	10.5	0.36	3/8	0.52	14+	1A	5'							1.4	9.1	TO 600N
600N 600S	12.5 7.5	21.6 17.9	2.5 2.5	3/8 3/8	0.44 0.41	14 13	1A	10'	MAX DEPTH = WK GRADE = 0.17+0.55+0.3			1.02	0.85	14+	24	15.5	
CHECK TWO INLETS : 20 CFS/EA												0.8	0.63	14+	20	0	
↳ EITHER ADD SWALE & SIZE PIPE FOR 32 CFS ± OR HAVE PIPE ONLY FOR 48 CFS																	
500N 500S	7.2 7.2	7.2 7.2	1.7 1.7	3/8 3/8	0.38 0.38	12 12	1A	10'				0.6	0.43	13.8	14.4	0	

ON GRADE INLET DESIGN DATA TABULATION

SH. NO. 1 OF

PROJECT ID: TALLGRASS EAST DRAINAGE PLAN

PROFESSIONAL ENGINEERING CONSULTANTS, P.A.
COMPUTED BY: MWB
DATE: 30OCT86

DESIGN STORM FREQUENCY (YEARS): 2
GUTTER DEPRESSION AT INLETS (IN): 2
WIDTH OF GUTTER DEPRESSION AT INLETS (FT): 2

INLET LOC-ATION	TOP OF INLET ELEV.	INLET DRAIN-AGE AREA (ACRES)	TIME OF CONCEN-TRATION Tc (MIN)	COMP-OSITE RUNOFF COEFF. C	RAIN-FALL INTEN-SITY (IN/HR)	INLET D.A. RUNOFF Q (CFS)	CARRY OVER FLOW Qb (CFS)	TOTAL FLOW Qt (CFS)	INLET LENGTH REQ'D Lt (FT)	INLET LENGTH PROV. L (FT)	EFFI-CIENCY E	INLET INTER. FLOW Qi (CFS)	BYPASS DOWN-STREAM Qb (CFS)	COMPUTED PONDING ELEV.	COMP. PAVT. SPREAD T (FT)	ALLOW. POND-ING ELEV.	ALLOW. PAVT. SPREAD (FT)	PAVT. WIDTH BK.-BK. (FT)	PAVT. CROSS SLOPE Sx (FT/FT)	LONG. PAVT. GRADE So (%)	STREET CLASSI-FICATION	REMARKS
590	226.20	2.10	15.00	0.47	3.83	3.78	0.00	3.78	20.00	5.00	0.38	1.40	2.38	226.00	14.00	226.20	14.00	29.00	0.03	0.36	LOCAL	
120	215.70	0.80	15.00	0.50	3.83	1.53	0.00	1.53	18.00	5.00	0.45	0.69	0.84	215.35	6.50	215.70	14.00	29.00	0.03	1.00	LOCAL	
135	212.50	1.50	15.00	0.50	3.83	2.87	0.00	2.87	24.00	10.00	0.62	1.78	1.09	212.21	8.20	212.50	14.00	29.00	0.03	1.00	LOCAL	
240	208.00	2.30	15.00	0.50	3.83	4.40	0.00	4.40	29.00	10.00	0.52	2.29	2.11	207.73	9.00	208.00	14.00	29.00	0.03	0.36	LOCAL	

18A/18

18B/18

ON GRADE INLET DESIGN DATA TABULATION

SH. NO. 1 OF

PROJECT ID: TALLGRASS EAST DRAINAGE PLAN

PROFESSIONAL ENGINEERING CONSULTANTS, P.A.
COMPUTED BY: MWB
DATE: 30OCT86

DESIGN STORM FREQUENCY (YEARS): 100
GUTTER DEPRESSION AT INLETS (IN): 2
WIDTH OF GUTTER DEPRESSION AT INLETS (FT): 2

INLET LOC-ATION	TOP OF INLET ELEV.	INLET DRAIN-AGE AREA (ACRES)	TIME OF CONCEN-TRATION Tc (MIN)	COMP-OSITE RUNOFF COEFF. C	RAIN-FALL INTEN-SITY (IN/HR)	INLET D.A. RUNOFF Q (CFS)	CARRY OVER FLOW Qb (CFS)	TOTAL FLOW Qt (CFS)	INLET LENGTH REQ'D Lt (FT)	INLET LENGTH PROV. L (FT)	EFFI-CIENCY E	INLET INTER. FLOW Qi (CFS)	BYPASS DOWN-STREAM Qb (CFS)	COMPUTED PONDING ELEV.	COMP. PAVT. SPREAD T (FT)	ALLOW. POND-ING ELEV.	ALLOW. PAVT. SPREAD (FT)	PAVT. WIDTH BK.-BK. (FT)	PAVT. CROSS SLOPE Sx (FT/FT)	LONG. PAVT. GRADE So (%)	STREET CLASSI-FICATION	REMARKS
590	226.20	2.10	15.00	0.68	7.37	10.52	0.00	10.52	32.00	5.00	0.20	1.40	9.12	226.17	14.00	226.50	14.00	29.00	0.03	0.36	LOCAL	ASSUME Qi(100)=Qi(2)
120	215.70	0.80	15.00	0.76	7.37	4.48	0.00	4.48	28.00	5.00	0.30	1.34	3.14	215.43	9.00	216.00	14.00	29.00	0.03	1.00	LOCAL	
135	212.50	1.50	15.00	0.76	7.37	8.40	0.00	8.40	37.00	10.00	0.42	3.53	4.87	212.33	12.00	212.80	14.00	29.00	0.03	1.00	LOCAL	
240	208.00	2.30	15.00	0.76	7.37	12.88	0.00	12.88	47.00	10.00	0.33	4.25	8.63	207.86	13.00	208.30	14.00	29.00	0.03	0.36	LOCAL	

SUMP INLET DESIGN DATA TABULATION SH. NO. OF

PROJECT ID: TALLGRASS EAST DRAINAGE PLAN

PROFESSIONAL ENGINEERING CONSULTANTS, P.A.
COMPUTED BY: MWB
DATE: 30OCT86

DESIGN STORM FREQUENCY (YEARS): 2
GUTTER DEPRESSION AT INLETS (IN): 2
WIDTH OF GUTTER DEPRESSION AT INLETS (FT): 2

INLET LOCATION	TOP OF INLET ELEVATION	INLET DRAINAGE AREA (ACRES)	TIME OF CONCEN-TRATION (MIN)	COMPOSITE RUNOFF COEFF. C	RAINFALL INTENSITY (IN/HR)	INLET D.A. RUNOFF (CFS)	CARRY OVER FLOW Qb (CFS)	INLET CAPACITY REQ'D Qi (CFS)	INLET LENGTH REQ'D (FT)	INLET LENGTH PROVIDED (FT)	COMPUTED PONDING ELEV.	COMPUTED PAVEMENT SPREAD (FT)	ALLOWABLE PONDING ELEV.	ALLOWABLE PAVEMENT SPREAD (FT)	PAV'T. WIDTH BK.-BK. (FT)	PAV'T. CROSS SLOPE (FT/FT)	STREET CLASSI-FICATION	REMARKS
570	226.20	2.90	15.00	0.44	3.83	4.90	0.00	4.90	5.00	5.00	225.87	7.00	226.20	14.00	29.00	0.03	LOCAL	
580	226.20	0.80	15.00	0.44	3.83	1.30	0.00	1.30	5.00	5.00	225.65	0.00	226.20	14.00	29.00	0.03	LOCAL	
600N	210.00	2.50	15.00	0.47	3.83	4.50	2.40	6.90										
600S	210.00	1.50	15.00	0.47	3.83	2.70	0.00	2.70	10.00	10.00	209.92	N/A	210.00	N/A	CULDESAC	0.03	LOCAL	100-YR SUMP LOCATION
410	219.10	1.60	15.00	0.32	3.83	1.96	0.00	1.96	5.00	5.00	218.60	1.60	218.98	14.00	37.00	0.03	COLLECTOR	
420	218.25	5.70	15.00	0.36	3.83	7.86	0.00	7.86	5.00	5.00	218.10	12.80	218.25	14.00	29.00	0.03	LOCAL	
430	218.25	0.60	15.00	0.68	3.83	1.56	0.00	1.56	5.00	5.00	218.70	0.00	218.25	14.00	29.00	0.03	LOCAL	
110	220.00	7.30	15.00	0.46	3.83	12.86	0.00	12.86	20.00	20.00	219.75	9.60	220.00	14.00	29.00	0.03	LOCAL	100 YR SUMP
130	212.80	1.10	15.00	0.50	3.83	2.11	0.80	2.91	5.00	5.00	212.35	3.20	212.80	14.00	29.00	0.03	LOCAL	
160	211.50	1.20	15.00	0.50	3.83	2.30	1.10	3.40	5.00	5.00	211.08	4.20	211.50	14.00	29.00	0.03	LOCAL	
140	211.70	0.30	15.00	0.50	3.83	0.57	0.00	0.57	5.00	5.00	211.15	0.00	211.70	14.00	29.00	0.03	LOCAL	
170	211.70	0.20	15.00	0.50	3.83	0.38	0.00	0.38	5.00	5.00	211.15	0.00	211.70	14.00	29.00	0.03	LOCAL	
180	209.00	2.10	15.00	0.50	3.83	4.02	0.00	4.02	10.00	10.00	208.65	6.40	209.00	N/A	CULDESAC	0.03	LOCAL	100-YR SUMP LOCATION
200	214.00	6.80	15.00	0.61	3.83	15.89	0.00	15.89	20.00	20.00	213.78	10.70	214.00	14.00	29.00	0.03	LOCAL	100-YR SUMP LOCATION
220	211.00	2.50	15.00	0.50	3.83	4.79	0.00	4.79	10.00	10.00	210.55	3.20	211.00	N/A	CULDESAC	0.03	LOCAL	100-YR SUMP LOCATION
250	207.50	4.20	15.00	0.50	3.83	8.04	0.00	8.04	10.00	10.00	207.15	6.40	207.50	14.00	29.00	0.03	LOCAL	
260	206.50	3.40	15.00	0.50	3.83	6.51	2.10	8.61	20.00	20.00	206.20	8.00	206.50	N/A	CULDESAC	0.03	LOCAL	100 YR SUMP LOCATION
290	210.00	3.60	15.00	0.50	3.83	6.89	0.00	6.89	10.00	10.00	209.65	N/A	210.00	N/A	CULDESAC	0.03	LOCAL	100 YR SUMP LOCATION

18C/18

SUMP INLET DESIGN DATA TABULATION SH. NO. OF

PROJECT ID: TALLGRASS EAST DRAINAGE PLAN
NORTHWEST SYSTEM
DESIGN STORM FREQUENCY (YEARS): 100
GUTTER DEPRESSION AT INLETS (IN): 2
WIDTH OF GUTTER DEPRESSION AT INLETS (FT): 2

PROFESSIONAL ENGINEERING CONSULTANTS, P.A.
COMPUTED BY: MWB
DATE: 30OCT86

INLET LOCATION	TOP OF INLET ELEVATION	INLET DRAINAGE AREA (ACRES)	TIME OF CONCEN-TRATION (MIN)	COMPOSITE RUNOFF COEFF. C	RAINFALL INTENSITY (IN/HR)	INLET D.A. RUNOFF (CFS)	CARRY OVER FLOW Qb (CFS)	INLET CAPACITY REQ'D Qi (CFS)	INLET LENGTH REQ'D (FT)	INLET LENGTH PROVIDED (FT)	COMPUTED PONDING ELEV.	COMPUTED PAVEMENT SPREAD (FT)	ALLOWABLE PONDING ELEV.	ALLOWABLE PAVEMENT SPREAD (FT)	PAV'T. WIDTH BK.-BK. (FT)	PAV'T. CROSS SLOPE (FT/FT)	STREET CLASSI-FICATION	REMARKS
570	226.20	2.90	15.00	0.61	7.37	13.00	0.00	4.90	5.00	5.00	226.10	14.00	226.50	14.00	29.00	0.03	LOCAL	8.1 CFS BYPASS TO 580
580	226.20	0.80	15.00	0.61	7.37	3.60	11.70	1.30	5.00	5.00	225.95	9.60	226.50	14.00	29.00	0.03	LOCAL	10.4 CFS BYPASS TO 600S
600N	210.00	2.50	15.00	0.68	7.37	12.50	9.10	21.60	10.00	10.00	210.10	N/A	210.30	N/A	CULDESAC	0.03	LOCAL	100-YR SUMP LOCATION
600S	210.00	1.50	15.00	0.68	7.37	7.50	10.40	17.90	10.00	10.00	210.02	N/A	210.30	N/A	CULDESAC	0.03	LOCAL	100-YR SUMP LOCATION
410	219.10	1.60	15.00	0.59	7.37	6.96	0.00	6.96	5.00	5.00	218.90	11.20	219.40	14.00	37.00	0.03	COLLECTOR	
420	218.25	5.70	15.00	0.54	7.37	22.68	0.00	22.68	5.00	5.00	218.10	14.00	218.55	14.00	29.00	0.03	LOCAL	MINI-SUMP BYPASS 14.7 CFS
430	218.25	0.60	15.00	0.80	7.37	3.54	14.70	18.24	5.00	5.00	218.10	14.00	218.55	14.00	29.00	0.03	LOCAL	MINI-SUMP:BYPASS 10.1 CFS TO INLET 810
110	220.00	7.30	15.00	0.67	7.37	36.05	0.00	36.05	20.00	20.00	220.00	14.00	220.30	14.00	29.00	0.03	LOCAL	100 YR SUMP
130	212.80	1.10	15.00	0.76	7.37	6.16	3.10	9.26	5.00	5.00	212.55	14.00	219.10	14.00	29.00	0.03	LOCAL	MINI-SUMP: BYPASS 3.0 CFS
160	211.50	1.20	15.00	0.76	7.37	6.72	4.90	11.62	5.00	5.00	211.38	13.80	211.50	14.00	29.00	0.03	LOCAL	
140	211.70	0.30	15.00	0.76	7.37	1.68	0.00	1.68	5.00	5.00	211.15	0.00	212.00	14.00	29.00	0.03	LOCAL	
170	211.70	0.20	15.00	0.76	7.37	1.12	0.00	1.12	5.00	5.00	211.15	0.00	212.00	14.00	29.00	0.03	LOCAL	
180	209.00	2.10	15.00	0.76	7.37	11.76	0.00	11.76	10.00	10.00	208.88	N/A	209.30	N/A	CULDESAC	0.03	LOCAL	100-YR SUMP LOCATION
200	214.00	6.80	15.00	0.75	7.37	37.59	0.00	37.59	20.00	20.00	214.05	14.00	214.30	14.00	29.00	0.03	LOCAL	100-YR SUMP LOCATION
220	211.00	2.50	15.00	0.76	7.37	14.00	0.00	14.00	10.00	10.00	210.80	N/A	211.30	N/A	CULDESAC	0.03	LOCAL	100-YR SUMP LOCATION
250	207.50	4.20	15.00	0.76	7.37	23.53	0.00	23.53	10.00	10.00	207.38	14.00	207.80	14.00	29.00	0.03	LOCAL	MINI-SUMP:BYPASS 9.6 CFS
260	206.50	3.40	15.00	0.76	7.37	19.04	18.20	37.24	20.00	20.00	206.50	N/A	206.80	N/A	CULDESAC	0.03	LOCAL	100 YR SUMP LOCATION
290	210.00	3.60	15.00	0.76	7.37	20.16	0.00	20.16	10.00	10.00	210.10	N/A	210.30	N/A	CULDESAC	0.03	LOCAL	100 YR SUMP LOCATION

18D/18

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
1440 EAST ENGLISH
WICHITA, KANSAS
ZIP CODE / 67211

Project Tallgrass East Drainage Plan

Item Estimate 100-Year Overflow Travel Time to Inlet 260

OVERFLOW ORIGINATES @ 110

110-120

Q = 23 cfs
V = 3 fps
L = 250'

T_t = 1.4 min
$T_c + T_t$ = 16.4 min

120-130

Q = 37 cfs
d = 0.66 S = 1.0%
V = 5.5 ft/s L = 300'

T_t = 0.9 min
$T_c + T_t$ = 17.3 min

130-140

Q = 36 cfs S_o = 0.4%
d = 0.78' T ≅ 25'
V = 3.8 ft/s L = 300'
T_t = 1.3 min
$T_c + T_t$ = 18.6 min.

140 - crest

Assume zero time

crest - PVI

Q = 49 cfs
d = 0.88' T ≅ 28'
V = 4.5 ft/s L = 400
T_t = 1.5 $T_c + T_t$ = 20.1 min

PVI to 240

Q = 49 cfs S_o = 1.25%
d = 0.69 T ≅ 22'
V = 5.5 ft/s L = 200'
T_t = 0.6 min
$T_c + T_t$ = 20.7 min

240 to 260

Q = 45 PER SIDE
d = 0.41 T = 13'
S_o = 0.4%
V = 2.5 ft/s L = 350
T_t = 2.3 min $T_c + T_t$ = 23 min.

HYDRAULICS

DESIGN COMPUTATIONS FOR STORM DRAINAGE

SH. NO. 1 OF 1

PROJECT ID: TALLGRASS EAST DRAINAGE PLAN
SOUTHWEST SYSTEM
WICHITA, KANSAS

DESIGN STORM (YEARS): 100
MANNING'S N: 0.013

PROFESSIONAL ENGINEERING CONSULTANTS, P.A.
COMPUTED BY: MWB DATE: 31 OCT 86

LINE UPPER	LINE LOWER	LENGTH (FEET)	UPPER STRUCT	AREA (AC) ADD	AREA (AC) TOTAL	UNIT RUNOFF (CFS/AC)	DIS-CHARGE (CFS)	SUM Q (CFS)	PIPE SIZE (IN)	FRICT HEAD (FT)	V (FT/S)	VEL. HEAD (FT)	TIME(MIN) T	TIME(MIN) SUM T	CONST SLOPE (FT/FT)	HYD. SLOPE (FT/FT)	HEAD LOSS (FT)	HYDR. ELEV. UPPER	HYDR. ELEV. LOWER	F.L. ELEV. UPPER	F.L. ELEV. LOWER	UPPER T.C. ELEV.	REMARKS
410	420	90.00	TY 1A L=5'	1.60	1.60	4.38	7.00	7.00	18	0.40	3.96	0.24	0.38	15.38	0.0111	0.0044	0.00	216.72	216.32	212.00	211.00	219.10	
420	430	35.00	TY 1A L=5'	5.70	7.30	1.39	7.92	14.92	24	0.15	4.75	0.35	0.12	15.50	0.0286	0.0043	0.67	215.65	215.50	210.00	209.00	218.25	
430	120	350.00	TY 1A L=5'	0.60	7.90	13.17	7.90	22.82	30	1.08	4.65	0.34	1.25	16.76	0.0026	0.0031	0.50	215.00	213.91	208.00	207.10	218.25	
110	120	250.00	2-1A L=10'	7.30	7.30	4.93	36.00	36.00	30	1.93	7.33	0.84	0.57	15.57	0.0076	0.0077	0.00	215.84	213.91	209.00	207.10	220.00	
120	130	300.00	TY 1A L=5'	0.80	16.00	1.68	1.34	59.14	42	1.04	6.15	0.59	0.81	17.57	0.0033	0.0035	0.53	213.38	212.35	206.10	205.10	215.70	
130	135	90.00	TY 1A L=5'	1.10	17.10	5.55	6.11	65.25	42	0.38	6.78	0.71	0.22	17.79	0.0033	0.0042	0.54	211.81	211.43	205.00	204.70	212.80	
135	160	200.00	TY 1A L=10'	1.50	18.60	2.18	3.27	68.52	42	0.93	7.12	0.79	0.47	18.26	0.0050	0.0046	0.20	211.23	210.30	204.60	203.60	212.50	
160	150	40.00	TY 1A L=5'	1.20	19.80	8.95	10.74	79.26	42	0.25	8.24	1.05	0.08	18.34	0.0125	0.0062	0.98	209.32	209.07	203.50	203.00	211.50	
140	150	70.00	TY 1A L=5'	0.30	0.30	5.67	1.70	1.70	15	0.05	1.39	0.03	0.84	15.84	0.0143	0.0007	0.00	209.12	209.07	206.00	205.00	211.70	
170	150	30.00	TY 1A L=5'	0.20	0.20	5.50	1.10	1.10	15	0.01	0.90	0.01	0.56	15.56	0.0333	0.0003	0.00	209.08	209.07	206.00	205.00	211.70	
150	180	200.00	MANHOLE	0.00	20.30		0.00	81.91	48	0.65	6.52	0.66	0.51	18.85	0.0030	0.0033	-0.15	209.22	208.57	202.50	201.90	211.20	
180	190	200.00	TY 1A L=10'	2.10	22.40	5.14	10.79	92.70	48	0.83	7.38	0.84	0.45	19.30	0.0040	0.0042	0.50	208.07	207.24	201.80	201.00	209.00	
200	210	250.00	2-1A L=10'	6.80	6.80	5.53	37.60	37.60	30	2.10	7.66	0.91	0.54	15.54	0.0104	0.0084	0.00	212.44	210.34	207.00	204.40	214.00	
210	230	250.00	MANHOLE	0.00	6.80		0.00	37.60	36	0.79	5.32	0.44	0.78	16.33	0.0028	0.0032	-0.13	211.13	210.34	204.30	203.60	211.50	
220	230	180.00	TY 1A L=10'	2.50	2.50	5.60	14.00	14.00	24	0.69	4.46	0.31	0.67	15.67	0.0044	0.0038	0.00	210.34	209.65	205.30	204.50	211.00	
230	190	300.00	MANHOLE	0.00	9.30		0.00	51.38	36	1.78	7.27	0.82	0.69	17.02	0.0050	0.0059	0.63	209.02	207.24	203.50	202.00	210.00	
190	270	530.00	MANHOLE	0.00	31.70		0.00	141.62	60	1.57	7.21	0.81	1.22	20.53	0.0028	0.0030	0.86	206.38	204.81	200.00	198.50	207.50	
240	250	50.00	TY 1A L=10'	2.30	2.30	1.87	4.30	4.30	15	0.22	3.50	0.19	0.24	15.24	0.0100	0.0044	0.00	207.23	207.01	203.50	203.00	208.00	
250	260	360.00	TY 1A L=10'	4.20	6.50	3.33	14.00	18.23	30	0.71	3.71	0.21	1.62	16.62	0.0022	0.0020	0.68	206.33	205.62	202.00	201.20	207.50	
260	270	140.00	2-1A L=10'	3.40	9.90	9.95	33.82	52.06	48	0.18	4.14	0.27	0.56	17.18	0.0014	0.0013	0.62	205.00	204.81	199.70	199.50	206.50	
270	280	200.00	AREA INLET	4.80	46.40	5.22	25.04	215.22	72	0.52	7.61	0.90	0.44	20.97	0.0010	0.0026	0.82	203.99	203.47	197.50	197.30	205.50	
290	300	250.00	TY 1A L=10'	3.60	3.60	5.61	20.20	20.20	24	1.99	6.43	0.64	0.65	15.65	0.0016	0.0080	0.00	208.71	206.71	204.00	203.60	210.00	
300	280	380.00	MANHOLE	0.00	3.60		0.00	20.20	24	3.03	6.43	0.64	0.98	16.63	0.0063	0.0080	0.21	206.50	203.47	203.50	201.10	208.00	
280	310	140.00	MANHOLE	0.00	50.00		0.00	233.68	72	0.43	8.26	1.06	0.28	21.25	0.0007	0.0030	0.66	202.81	202.39	197.20	197.10	205.00	
310	320	100.00	AREA INLET	16.50	66.50	5.15	84.94	318.62	9'X4'	0.39	8.85	1.22	0.19	21.44	0.0010	0.0039	1.00	201.39	201.00	197.10	197.00	204.00	

1/23

1A/23

DESIGN COMPUTATIONS FOR STORM DRAINAGE

SH. NO. 1 OF 1

PROJECT ID: TALLGRASS EAST DRAINAGE PLAN
SOUTHWEST SYSTEM-ASSUME Qi(100)=Qi(2) EXCEPT AT NODES 220,260, & 310
WICHITA, KANSAS

DESIGN STORM (YEARS): 100
MANNING'S N: 0.013

PROFESSIONAL ENGINEERING CONSULTANTS, P.A.
COMPUTED BY: MWB DATE: 03 DEC 1986

LINE UPPER	LINE LOWER	LENGTH (FEET)	UPPER STRUCT	AREA (AC) ADD	AREA (AC) TOTAL	UNIT RUNOFF (CFS/AC)	DIS-CHARGE (CFS)	SUM Q (CFS)	PIPE SIZE (IN)	FRICT HEAD (FT)	V (FT/S)	VEL. HEAD (FT)	TIME(MIN) T	TIME(MIN) SUM T	CONST SLOPE (FT/FT)	HYD. SLOPE (FT/FT)	HEAD LOSS (FT)	HYDR. ELEV. UPPER	HYDR. ELEV. LOWER	F.L. ELEV. UPPER	F.L. ELEV. LOWER	UPPER T.C. ELEV.	REMARKS
410	420	90.00	TY 1A L=5'	1.60	1.60	1.25	2.00	2.00	15	0.09	1.63	0.04	0.92	15.92	0.0111	0.0010	0.00	217.32	217.23	212.00	211.00	219.10	
420	430	35.00	TY 1A L=5'	5.70	7.30	1.39	7.90	9.78	18	0.30	5.53	0.48	0.11	15.11	0.0286	0.0087	1.14	216.09	215.79	210.00	209.00	218.25	
430	120	350.00	TY 1A L=5'	0.60	7.90	2.67	1.60	11.38	21	1.81	4.73	0.35	1.23	16.34	0.0026	0.0052	0.32	215.47	213.66	208.00	207.10	218.25	
110	120	250.00	2-1A L=10'	7.30	7.30	1.77	12.90	12.90	18	3.77	7.30	0.83	0.57	15.57	0.0076	0.0151	0.00	217.43	213.66	209.00	207.10	220.00	
120	130	300.00	TY 1A L=5'	0.80	16.00	0.85	0.68	24.73	30	1.09	5.04	0.39	0.99	17.33	0.0033	0.0036	0.39	213.27	212.18	206.10	205.10	215.70	
130	135	90.00	TY 1A L=5'	1.10	17.10	2.49	2.74	27.47	30	0.40	5.60	0.49	0.27	17.60	0.0033	0.0045	0.39	211.79	211.39	205.00	204.70	212.80	
135	160	200.00	TY 1A L=10'	1.50	18.60	1.13	1.69	29.16	30	1.01	5.94	0.55	0.56	18.16	0.0050	0.0051	0.17	211.22	210.21	204.60	203.60	212.50	
160	150	40.00	TY 1A L=5'	1.20	19.80	2.63	3.15	32.31	30	0.25	6.58	0.67	0.10	18.26	0.0125	0.0062	0.56	209.65	209.40	203.50	203.00	211.50	
140	150	70.00	TY 1A L=5'	0.30	0.30	2.00	0.60	0.60	15	0.01	0.49	0.00	2.39	17.39	0.0143	0.0001	0.00	209.41	209.40	206.00	205.00	211.70	
170	150	30.00	TY 1A L=5'	0.20	0.20	2.00	0.40	0.40	15	0.00	0.33	0.00	1.53	16.53	0.0333	0.0000	0.00	209.40	209.40	206.00	205.00	211.70	
150	180	200.00	MANHOLE	0.00	20.30		0.00	33.28	30	1.32	6.78	0.71	0.49	18.75	0.0030	0.0066	0.17	209.23	207.91	202.50	201.90	211.20	
180	190	200.00	TY 1A L=10'	2.10	22.40	1.75	3.67	36.95	36	0.61	5.23	0.42	0.64	19.39	0.0040	0.0031	0.01	207.90	207.29	201.80	201.00	209.00	
200	210	250.00	2-1A L=10'	6.80	6.80	2.34	15.90	15.90	24	1.23	5.06	0.40	0.82	15.82	0.0104	0.0049	0.00	211.23	210.00	207.00	204.40	214.00	
210	230	250.00	MANHOLE	0.00	6.80		0.00	15.90	24	1.23	5.06	0.40	0.82	16.65	0.0028	0.0049	0.14	211.23	210.00	204.30	203.60	211.50	
220	230	180.00	TY 1A L=10'	2.50	2.50	5.60	14.00	14.00	24	0.69	4.46	0.31	0.67	15.67	0.0044	0.0038	0.00	210.00	209.31	205.30	204.50	211.00	
230	190	300.00	MANHOLE	0.00	9.30		0.00	29.57	30	1.56	6.02	0.56	0.83	17.48	0.0050	0.0052	0.46	208.85	207.29	203.50	202.00	210.00	
190	270	530.00	MANHOLE	0.00	31.70		0.00	65.34	48	1.10	5.20	0.42	1.70	21.09	0.0028	0.0021	0.57	206.72	205.62	200.00	198.50	207.50	
240	250	50.00	TY 1A L=10'	2.30	2.30	1.87	4.30	4.30	15	0.22	3.50	0.19	0.24	15.24	0.0100	0.0044	0.00	207.17	206.95	203.50	203.00	208.00	
250	260	360.00	TY 1A L=10'	4.20	6.50	1.66	6.96	11.26	30	0.27	2.29	0.08	2.62	17.85	0.0022	0.0008	0.27	206.68	206.41	202.00	201.20	207.50	
260	270	140.00	2-1A L=10'	3.40	9.90	14.71	50.00	60.20	54	0.13	3.79	0.22	0.62	23.62	0.0014	0.0009	0.65	205.76	205.62	199.70	199.50	206.50	
270	280	200.00	AREA INLET	4.80	46.40	4.21	20.20	139.65	60	0.58	7.11	0.79	0.47	24.09	0.0010	0.0029	1.32	204.30	203.73	197.50	197.30	205.50	
290	300	250.00	TY 1A L=10'	3.60	3.60	1.92	6.90	6.90	18	1.08	3.90	0.24	1.07	16.07	0.0016	0.0043	0.00	206.53	205.45	204.00	203.60	210.00	
300	280	380.00	MANHOLE	0.00	3.60		0.00	6.90	18	1.64	3.90	0.24	1.62	17.69	0.0063	0.0043	0.08	205.37	203.73	203.50	201.10	208.00	
280	310	140.00	MANHOLE	0.00	50.00		0.00	145.76	60	0.44	7.42	0.86	0.31	24.40	0.0007	0.0031	0.51	203.22	202.78	197.20	197.10	205.00	
310	320	100.00	AREA INLET	16.50	66.50	12.42	205.00	315.33	9'X4'	0.38	8.76	1.19	0.19	24.59	0.0010	0.0038	1.40	201.38	201.00	197.10	197.00	204.00	

2/23

DESIGN COMPUTATIONS FOR STORM DRAINAGE

PROJECT ID: TALLGRASS EAST DRAINAGE PLAN
NORTHWEST SYSTEM
WICHITA, KANSAS

DESIGN STORM (YEARS): 100
MANNING'S N: 0.013

PROFESSIONAL ENGINEERING CONSULTANTS, P.A.
DESIGNED BY: MWB DATE: 11/7/86
CHECKED BY: DATE:

LINE UPPER	LINE LOWER	LENGTH (FEET)	UPPER STRUCT	AREA (AC) ADD	AREA (AC) TOTAL	UNIT RUNOFF (CFS/AC)	DIS-CHARGE (CFS)	SUM Q (CFS)	PIPE SIZE (IN)	FRICT HEAD (FT)	V (FT/S)	VEL. HEAD (FT)	TIME(MIN) T	TIME(MIN) SUM T	CONST SLOPE (FT/FT)	HYD. SLOPE (FT/FT)	HEAD LOSS (FT)	HYDR. ELEV. UPPER	HYDR. ELEV. LOWER	F.L. ELEV. UPPER	F.L. ELEV. LOWER	UPPER T.C. ELEV.	REMARKS
570	580	35.00	TY 1A L=5'	2.90	2.90	1.69	4.90	4.90	15	0.20	3.99	0.25	0.15	15.15	0.0071	0.0058	0.00	221.19	220.98	219.75	219.50	226.20	
580	590	70.00	TY 1A L=5'	0.80	3.70	1.63	1.30	6.20	15	0.64	5.05	0.40	0.23	15.38	0.0129	0.0092	0.48	220.50	219.86	219.40	218.50	226.20	
590	600	680.00	TY 1A L=5'	2.10	5.80	0.67	1.40	7.60	15	9.41	6.19	0.60	1.83	16.98	0.0153	0.0138	0.72	219.14	209.73	218.40	208.00	226.20	
600	610	150.00	TY 1A L=10'	4.00	4.00	9.88	39.50	46.11	36	0.72	6.52	0.66	0.38	15.00	0.0083	0.0048	2.01	207.72	207.00	206.25	205.00	210.00	

3/23


```
100 j,  201.0000  320    3   26   25
110 t,TALLGRASS EAST DRAINAGE PLAN--SOUTHWEST SYSTEM
120 t,MINIMUM TC = 15 MINUTES ; RCP : n=0.013
130 t,MWB 10/29/86 FILE = " /usr/mberry/talleast.proj/sw2.stm"
132 i,  410      0.32      1.60      0.00      0.00      2.00     15.00    219.10
134 i,  420      0.36      5.70      0.00      0.00      7.90     15.00    218.25
136 i,  430      0.68      0.60      0.00      0.00      1.60     15.00    218.25
140 i,  110      0.46      7.30      0.00      0.00     12.90     15.00    220.00
150 i,  120      0.50      0.80      0.00      0.00      0.70     15.00    215.70
160 i,  130      0.50      1.10      0.00      0.00      1.10     15.00    212.80
170 i,  135      0.50      1.50      0.00      0.00      1.80     15.00    212.50
180 i,  160      0.50      1.20      0.00      0.00      3.40     15.00    211.50
190 i,  140      0.50      0.30      0.00      0.00      0.60     15.00    211.70
200 i,  170      0.50      0.20      0.00      0.00      0.40     15.00    211.70
210 m,  150    211.20
220 i,  180      0.50      2.10      0.00      0.00      4.00     15.00    209.00
230 i,  200      0.61      6.80      0.00      0.00     15.90     15.00    214.00
240 m,  210    211.50
250 i,  220      0.50      2.50      0.00      0.00      4.80     15.00    211.00
260 m,  230    210.00
270 m,  190    207.50
280 i,  240      0.50      2.30      0.00      0.00      2.30     15.00    208.00
290 i,  250      0.50      4.20      0.00      0.00      7.00     15.00    207.50
300 i,  260      0.50      3.40      0.00      0.00      8.60     15.00    206.50
310 i,  270      0.68      4.80      0.00      0.00     12.50     15.00    205.50
320 i,  290      0.50      3.60      0.00      0.00      6.90     15.00    210.00
330 m,  300    208.00
340 m,  280    205.00
350 i,  310      0.68     16.50      0.00      0.00     43.00     15.00    204.00
360 m,  320    205.00
362 p,  410  420     90.00   15 0.013  70.00    0.00
364 p,  420  430     35.00   15 0.013 100.00    0.00
366 p,  430  120    350.00   21 0.013  30.00    0.00
370 p,  110  120    250.00   18 0.013  90.00    0.00
380 p,  120  130    300.00   30 0.013  80.00    0.00
390 p,  130  135     90.00   30 0.013  10.00    0.00
400 p,  135  160    200.00   30 0.013  90.00    0.00
410 p,  160  150     40.00   30 0.013  20.00    0.00
420 p,  140  150     70.00   15 0.013  90.00    0.00
430 p,  170  150     30.00   15 0.013  90.00    0.00
440 p,  150  180    200.00   30 0.013  30.00    0.00
450 p,  180  190    200.00   30 0.013  45.00    0.00
460 p,  200  210    250.00   21 0.013  45.00    0.00
470 p,  210  230    250.00   21 0.013   0.00    0.00
480 p,  220  230    180.00   15 0.013  45.00    0.00
490 p,  230  190    300.00   24 0.013  90.00    0.00
500 p,  190  270    530.00   48 0.013   0.00    0.00
510 p,  240  250     50.00   15 0.013 110.00    0.00
520 p,  250  260    360.00   24 0.013  70.00    0.00
530 p,  260  270    140.00   24 0.013  90.00    0.00
540 p,  270  280    200.00   48 0.013  90.00    0.00
550 p,  290  300    250.00   18 0.013  45.00    0.00
560 p,  300  280    380.00   18 0.013   0.00    0.00
570 p,  280  310    140.00   48 0.013  90.00    0.00
580 b,  310  320    100.00    9.00    4.00 0.013    0.00    0.00
```

Date: 10-30-1986
Time: 11:13:30

4/23

Input File: sw2.stm

TALLGRASS EAST DRAINAGE PLAN--SOUTHWEST SYSTEM
MINIMUM TC = 15 MINUTES ; RCP : n=0.013
MWB 10/29/86 FILE = " /usr/mberry/talleast.proj/sw2.stm"

Storm Frequency = 2-Year

* * * HYDROLOGY * * *

Tributary Area									Hydrology Summation				Conduit Data				
Node	to Node	C	Area (Ac)	Slope (%)	Length (Ft)	TC(0) (Min)	I(0) (In/Hr)	Q(0) (CFS)	TC (Min)	I (In/Hr)	Q (CFS)	Sum Q (CFS)	Size	Velocity (Ft/Sec)	Length (Ft)	TT (Min)	TT+TC (Min)
410	420	0.32	1.60	0.00	0.0	15.00	4.06	2.00	15.00	4.06	2.00	2.00	15"	1.63	90.00	0.92	15.92
420	430	0.36	5.70	0.00	0.0	15.00	4.06	7.90	15.00	4.06	7.90	9.78	15"	7.97	35.00	0.07	15.07
430	120	0.68	0.60	0.00	0.0	15.00	4.06	1.60	15.07	4.05	1.60	11.38	21"	4.73	350.00	1.23	16.31
110	120	0.46	7.30	0.00	0.0	15.00	4.06	12.90	15.00	4.06	12.90	12.90	18"	7.30	250.00	0.57	15.57
120	130	0.50	0.80	0.00	0.0	15.00	4.06	0.70	16.31	3.93	0.68	24.73	30"	5.04	300.00	0.99	17.30
130	135	0.50	1.10	0.00	0.0	15.00	4.06	1.10	17.30	3.84	1.04	25.77	30"	5.25	90.00	0.29	17.58
135	160	0.50	1.50	0.00	0.0	15.00	4.06	1.80	17.58	3.81	1.69	27.46	30"	5.59	200.00	0.60	18.18
160	150	0.50	1.20	0.00	0.0	15.00	4.06	3.40	18.18	3.77	3.15	30.62	30"	6.24	40.00	0.11	18.29
140	150	0.50	0.30	0.00	0.0	15.00	4.06	0.60	15.00	4.06	0.60	0.60	15"	0.49	70.00	2.39	17.39
170	150	0.50	0.20	0.00	0.0	15.00	4.06	0.40	15.00	4.06	0.40	0.40	15"	0.33	30.00	1.53	16.53
150	180	0.00	0.00	0.00	0.0	0.00	0.00	0.00	18.29	3.76	0.00	31.59	30"	6.44	200.00	0.52	18.80
180	190	0.50	2.10	0.00	0.0	15.00	4.06	4.00	18.80	3.72	3.66	35.25	30"	7.18	200.00	0.46	19.27
200	210	0.61	6.80	0.00	0.0	15.00	4.06	15.90	15.00	4.06	15.90	15.90	21"	6.61	250.00	0.63	15.63
210	230	0.00	0.00	0.00	0.0	0.00	0.00	0.00	15.63	3.99	0.00	15.90	21"	6.61	250.00	0.63	16.26
220	230	0.50	2.50	0.00	0.0	15.00	4.06	4.80	15.00	4.06	4.80	4.80	15"	3.91	180.00	0.77	15.77
230	190	0.00	0.00	0.00	0.0	0.00	0.00	0.00	16.26	3.93	0.00	20.64	24"	6.57	300.00	0.76	17.02
190	270	0.00	0.00	0.00	0.0	0.00	0.00	0.00	19.27	3.68	0.00	54.92	48"	4.37	530.00	2.02	21.29
240	250	0.50	2.30	0.00	0.0	15.00	4.06	2.30	15.00	4.06	2.30	2.30	15"	1.87	50.00	0.44	15.44
250	260	0.50	4.20	0.00	0.0	15.00	4.06	7.00	15.00	4.06	7.00	9.23	24"	2.94	360.00	2.04	17.04
260	270	0.50	3.40	0.00	0.0	15.00	4.06	8.60	17.04	3.86	8.18	17.42	24"	5.54	140.00	0.42	17.46
270	280	0.68	4.80	0.00	0.0	15.00	4.06	12.50	21.29	3.54	10.90	81.94	48"	6.52	200.00	0.51	21.80
290	300	0.50	3.60	0.00	0.0	15.00	4.06	6.90	15.00	4.06	6.00	6.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

300	280	0.00	0.00	0.00	0.0	0.00	0.00	0.00	16.07	3.95	0.00	6.90	18"	3.90	380.00	1.62	17.69
280	310	0.00	0.00	0.00	0.0	0.00	0.00	0.00	21.80	3.51	0.00	88.30	48"	7.03	140.00	0.33	22.13
310	320	0.68	16.50	0.00	0.0	15.00	4.06	43.00	22.13	3.49	36.95	125.25	9.00 X 4.00	3.48	100.00	0.48	22.61

*** ************************** ***

5/23

Date: 10-30-1986
Time: 11:13:30

Input File: sw2.stm

TALLGRASS EAST DRAINAGE PLAN--SOUTHWEST SYSTEM
MINIMUM TC = 15 MINUTES ; RCP : n=0.013
MWB 10/29/86 FILE = " /usr/mberry/talleast.proj/sw2.stm"

6/23

Storm Frequency = 2-Year

* * * H Y D R A U L I C S * * *

Node	Hyd-Slope (Ft/Ft)	Friction (Ft)	Bend (Ft)	Transition (Ft)	Manhole (Ft)	Deflection (Ft)	Junction (Ft)	Total (Ft)	Hyd-Gl Elevation	Desired Elevation	Diff. (Ft)
410	0.00096	0.0863	0.0000	0.0000	0.0000	0.0000	0.0000	0.0863	217.2104	219.1000	1.89
420	0.02294	0.8030	0.0000	0.0946	0.0000	0.0153	1.9549	2.8677	217.1241	218.2500	1.13
430	0.00516	1.8058	0.0000	0.1279	0.0000	0.5601	-0.3434	2.1503	214.2563	218.2500	3.99
110	0.01508	3.7704	0.0000	0.0000	0.0000	0.0000	0.0000	3.7704	215.8764	220.0000	4.12
120	0.00363	1.0904	0.0000	0.0867	0.0000	0.4137	-0.1044	1.4864	212.1060	215.7000	3.59
130	0.00395	0.3552	0.0000	0.0034	0.0000	0.1711	0.0868	0.6165	210.6196	212.8000	2.18
135	0.00448	0.8965	0.0000	0.0058	0.0000	0.0153	0.1374	1.0550	210.0031	212.5000	2.50
160	0.00557	0.2229	0.0000	0.0118	0.0000	0.2430	0.2617	0.7394	208.9481	211.5000	2.55
140	0.00009	0.0060	0.0000	0.0000	0.0000	0.0000	0.0000	0.0060	208.2148	211.7000	3.49
170	0.00004	0.0012	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012	208.2099	211.7000	3.49
150	0.00593	1.1862	0.0000	0.0039	0.0000	0.0497	0.1069	1.3467	208.2087	211.2000	2.99
180	0.00739	1.4772	0.0000	0.0158	0.0000	0.0860	0.3494	1.9284	206.8620	209.0000	2.14
200	0.01007	2.5174	0.0000	0.0000	0.0000	0.0000	0.0000	2.5174	212.9395	214.0000	1.06
210	0.01007	2.5174	0.0000	0.0000	0.0339	0.1477	0.0504	2.7494	210.4221	211.5000	1.08
220	0.00552	0.9938	0.0000	0.0000	0.0000	0.0000	0.0000	0.9938	208.6666	211.0000	2.33
230	0.00833	2.4979	0.0000	0.0016	0.0000	0.0000	0.2396	2.7392	207.6727	210.0000	2.33
190	0.00146	0.7747	0.0000	0.1008	0.0000	0.1743	-0.0246	1.0252	204.9336	207.5000	2.57
240	0.00127	0.0634	0.0000	0.0000	0.0000	0.0000	0.0000	0.0634	206.5668	208.0000	1.43
250	0.00167	0.5998	0.0000	0.0080	0.0000	0.0347	0.3325	0.9749	206.5034	207.5000	1.00
260	0.00593	0.8298	0.0000	0.0343	0.0000	0.0496	0.7064	1.6201	205.5284	206.5000	0.97
270	0.00325	0.6509	0.0000	0.0364	0.0000	0.0000	0.7405	1.4277	203.9083	205.5000	1.59
290	0.00431	1.0787	0.0000	0.0000	0.0000	0.0000	0.0000	1.0787	205.2839	210.0000	4.72
300	0.00431	1.6396	0.0000	0.0000	0.0118	0.0515	0.0216	1.7246	204.2052	208.0000	3.79

280	0.00378	0.5291	0.0000	0.0106	0.0000	0.3301	0.1642	1.0341	202.4806	205.0000	2.52
310	0.00060	0.0600	0.0000	0.1158	0.0000	0.3834	-0.1127	0.4465	201.4465	204.0000	2.55
320	0.00000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	201.0000	205.0000	4.00

****

7/23

8/23


```
100 j,  201.0000  320    3   26   25
110 t,TALLGRASS EAST DRAINAGE PLAN--SOUTHWEST SYSTEM
120 t,MINIMUM TC = 15 MINUTES ; RCP : n=0.013
130 t,MWB 10/27/86 FILE="/usr/mberry/talleast.proj/sw100.stm"
150 i,  410      0.00      1.60      0.00      0.00      7.00     15.00    219.10
170 i,  420      0.000     5.70      0.00      0.00      8.00     15.00    218.25
160 i,  430      0.00      0.60      0.00      0.00      8.00     15.00    218.25
140 i,  110      0.00      7.30      0.00      0.00     36.00     15.00    220.00
150 i,  120      0.00      0.80      0.00      0.00      1.40     15.00    215.70
160 i,  130      0.00      1.10      0.00      0.00      6.50     15.00    212.80
170 i,  135      0.00      1.50      0.00      0.00      3.50     15.00    212.50
180 i,  160      0.00      1.20      0.00      0.00     11.60     15.00    211.50
190 i,  140      0.00      0.30      0.00      0.00      1.70     15.00    211.70
200 i,  170      0.00      0.20      0.00      0.00      1.10     15.00    211.70
210 m,  150    211.20
220 i,  180      0.00      2.10      0.00      0.00     11.80     15.00    209.00
230 i,  200      0.00      6.80      0.00      0.00     37.60     15.00    214.00
240 m,  210    211.50
250 i,  220      0.00      2.50      0.00      0.00     14.00     15.00    211.00
260 m,  230    210.00
270 m,  190    207.50
280 i,  240      0.00      2.30      0.00      0.00      4.30     15.00    208.00
290 i,  250      0.00      4.20      0.00      0.00     14.00     15.00    207.50
300 i,  260      0.00      3.40      0.00      0.00     35.20     15.00    206.50
310 i,  270      0.00      4.80      0.00      0.00     28.30     15.00    205.50
320 i,  290      0.00      3.60      0.00      0.00     20.20     15.00    210.00
330 m,  300    208.00
340 m,  280    205.00
350 i,  310      0.00     16.50      0.00      0.00     97.30     15.00    204.00
360 m,  320    205.00
362 p,  410  420     90.00    18 0.013  70.00    0.00
364 p,  420  430     35.00    24 0.013 100.00    0.00
366 p,  430  120    350.00    30 0.013  30.00    0.00
370 p,  110  120    250.00    30 0.013  90.00    0.00
380 p,  120  130    300.00    42 0.013  80.00    0.00
390 p,  130  135     90.00    42 0.013  10.00    0.00
400 p,  135  160    200.00    42 0.013  90.00    0.00
410 p,  160  150     40.00    42 0.013  20.00    0.00
420 p,  140  150     70.00    15 0.013  90.00    0.00
430 p,  170  150     30.00    15 0.013  90.00    0.00
440 p,  150  180    200.00    48 0.013  30.00    0.00
450 p,  180  190    200.00    48 0.013  45.00    0.00
460 p,  200  210    250.00    30 0.013  45.00    0.00
470 p,  210  230    250.00    36 0.013   0.00    0.00
480 p,  220  230    180.00    24 0.013  45.00    0.00
490 p,  230  190    300.00    36 0.013  90.00    0.00
500 p,  190  270    530.00    60 0.013   0.00    0.00
510 p,  240  250     50.00    15 0.013 110.00    0.00
520 p,  250  260    360.00    30 0.013  70.00    0.00
530 p,  260  270    140.00    48 0.013  90.00    0.00
540 p,  270  280    200.00    72 0.013  90.00    0.00
550 p,  290  300    250.00    24 0.013  45.00    0.00
560 p,  300  280    380.00    24 0.013   0.00    0.00
570 p,  280  310    140.00    72 0.013  90.00    0.00
580 b,  310  320    100.00  09.00    4.00 0.013    0.00    0.00
```

Date: 10-30-1986
Time: 11:08:09

9/23

Input File: sw100.stm

TALLGRASS EAST DRAINAGE PLAN--SOUTHWEST SYSTEM
MINIMUM TC = 15 MINUTES ; RCP : n=0.013
MWB 10/27/86 FILE="/usr/mberry/talleast.proj/sw100.stm"

Storm Frequency = 100-Year

* * * HYDROLOGY * * *

Tributary Area									Hydrology Summation				Conduit Data				
Node	to Node	C	Area (Ac)	Slope (%)	Length (Ft)	TC(0) (Min)	I(0) (In/Hr)	Q(0) (CFS)	TC (Min)	I (In/Hr)	Q (CFS)	Sum Q (CFS)	Size	Velocity (Ft/Sec)	Length (Ft)	TT (Min)	TT+TC (Min)
410	420	0.00	1.60	0.00	0.0	15.00	8.97	7.00	15.00	8.97	7.00	7.00	18"	3.96	90.00	0.38	15.38
420	430	0.00	5.70	0.00	0.0	15.00	8.97	8.00	15.38	8.89	7.92	14.92	24"	4.75	35.00	0.12	15.50
430	120	0.00	0.60	0.00	0.0	15.00	8.97	8.00	15.50	8.86	7.90	22.82	30"	4.65	350.00	1.25	16.76
110	120	0.00	7.30	0.00	0.0	15.00	8.97	36.00	15.00	8.97	36.00	36.00	30"	7.33	250.00	0.57	15.57
120	130	0.00	0.80	0.00	0.0	15.00	8.97	1.40	16.76	8.59	1.34	59.14	42"	6.15	300.00	0.81	17.57
130	135	0.00	1.10	0.00	0.0	15.00	8.97	6.50	17.57	8.44	6.11	65.25	42"	6.78	90.00	0.22	17.79
135	160	0.00	1.50	0.00	0.0	15.00	8.97	3.50	17.79	8.40	3.27	68.53	42"	7.12	200.00	0.47	18.26
160	150	0.00	1.20	0.00	0.0	15.00	8.97	11.60	18.26	8.31	10.74	79.27	42"	8.24	40.00	0.08	18.34
140	150	0.00	0.30	0.00	0.0	15.00	8.97	1.70	15.00	8.97	1.70	1.70	15"	1.39	70.00	0.84	15.84
170	150	0.00	0.20	0.00	0.0	15.00	8.97	1.10	15.00	8.97	1.10	1.10	15"	0.90	30.00	0.56	15.56
150	180	0.00	0.00	0.00	0.0	0.00	0.00	0.00	18.34	8.30	0.00	81.91	48"	6.52	200.00	0.51	18.85
180	190	0.00	2.10	0.00	0.0	15.00	8.97	11.80	18.85	8.21	10.79	92.70	48"	7.38	200.00	0.45	19.30
200	210	0.00	6.80	0.00	0.0	15.00	8.97	37.60	15.00	8.97	37.60	37.60	30"	7.66	250.00	0.54	15.54
210	230	0.00	0.00	0.00	0.0	0.00	0.00	0.00	15.54	8.85	0.00	37.60	36"	5.32	250.00	0.78	16.33
220	230	0.00	2.50	0.00	0.0	15.00	8.97	14.00	15.00	8.97	14.00	14.00	24"	4.46	180.00	0.67	15.67
230	190	0.00	0.00	0.00	0.0	0.00	0.00	0.00	16.33	8.68	0.00	51.38	36"	7.27	300.00	0.69	17.02
190	270	0.00	0.00	0.00	0.0	0.00	0.00	0.00	19.30	8.13	0.00	141.62	60"	7.21	530.00	1.22	20.53
240	250	0.00	2.30	0.00	0.0	15.00	8.97	4.30	15.00	8.97	4.30	4.30	15"	3.50	50.00	0.24	15.24
250	260	0.00	4.20	0.00	0.0	15.00	8.97	14.00	15.00	8.97	14.00	18.23	30"	3.71	360.00	1.62	16.62
260	270	0.00	3.40	0.00	0.0	15.00	8.97	35.20	16.62	8.62	33.82	52.06	48"	4.14	140.00	0.56	17.18
270	280	0.00	4.80	0.00	0.0	15.00	8.97	28.30	20.53	7.94	25.04	215.22	72"	7.61	200.00	0.44	20.97
290	300	0.00	3.60	0.00	0.0	15.00	8.97	20.20	15.00	8.97	20.20	20.20	24"	6.43	250.00	0.65	15.65

300	280	0.00	0.00	0.00	0.0	0.00	0.00	0.00	15.65	8.83	0.00	20.20	24"	6.43	380.00	0.98	16.63
280	310	0.00	0.00	0.00	0.0	0.00	0.00	0.00	20.97	7.87	0.00	233.68	72"	8.26	140.00	0.28	21.25
310	320	0.00	16.50	0.00	0.0	15.00	8.97	97.30	21.25	7.83	84.94	318.62	9.00 X 4.00	8.85	100.00	0.19	21.44

*** ************************** ***

10/23

Date: 10-30-1986
Time: 11:08:09

Input File: swl00.stm

11/23

TALLGRASS EAST DRAINAGE PLAN--SOUTHWEST SYSTEM
MINIMUM TC = 15 MINUTES ; RCP : n=0.013
MWB 10/27/86 FILE="/usr/mberry/talleast.proj/sw100.stm"

Storm Frequency = 100-Year

* * * H Y D R A U L I C S * * *

Node	Hyd-Slope (Ft/Ft)	Friction (Ft)	Bend (Ft)	Transition (Ft)	Manhole (Ft)	Deflection (Ft)	Junction (Ft)	Total (Ft)	Hyd-Gl Elevation	Desired Elevation	Diff. (Ft)
410	0.00444	0.3997	0.0000	0.0000	0.0000	0.0000	0.0000	0.3997	216.7177	219.1000	2.38
420	0.00435	0.1523	0.0000	0.0107	0.0000	0.0901	0.5690	0.8221	216.3180	218.2500	1.93
430	0.00310	1.0834	0.0000	0.0029	0.0000	0.1988	0.2908	1.5759	215.4959	218.2500	2.75
110	0.00770	1.9258	0.0000	0.0000	0.0000	0.0000	0.0000	1.9258	215.8458	220.0000	4.15
120	0.00346	1.0367	0.0000	0.0497	0.0000	0.4176	0.0608	1.5648	213.9200	215.7000	1.78
130	0.00421	0.3786	0.0000	0.0128	0.0000	0.2547	0.2747	0.9208	212.3552	212.8000	0.44
135	0.00464	0.9279	0.0000	0.0073	0.0000	0.0256	0.1694	1.1302	211.4344	212.5000	1.07
160	0.00621	0.2483	0.0000	0.0266	0.0000	0.3939	0.5609	1.2298	210.3042	211.5000	1.20
140	0.00069	0.0485	0.0000	0.0000	0.0000	0.0000	0.0000	0.0485	209.1229	211.7000	2.58
170	0.00029	0.0087	0.0000	0.0000	0.0000	0.0000	0.0000	0.0087	209.0831	211.7000	2.62
150	0.00325	0.6503	0.0000	0.0789	0.0000	0.0867	-0.3108	0.5052	209.0744	211.2000	2.13
180	0.00417	0.8330	0.0000	0.0185	0.0000	0.0883	0.3899	1.3297	208.5693	209.0000	0.43
200	0.00840	2.1008	0.0000	0.0000	0.0000	0.0000	0.0000	2.1008	212.4095	214.0000	1.59
210	0.00318	0.7945	0.0000	0.0943	0.0000	0.1983	-0.4282	0.6589	210.3087	211.5000	1.19
220	0.00383	0.6894	0.0000	0.0000	0.0000	0.0000	0.0000	0.6894	210.3392	211.0000	0.66
230	0.00593	1.7801	0.0000	0.0381	0.0000	0.0000	0.5920	2.4103	209.6498	210.0000	0.35
190	0.00296	1.5670	0.0000	0.0075	0.0000	0.1839	0.6700	2.4284	207.2395	207.5000	0.26
240	0.00443	0.2215	0.0000	0.0000	0.0000	0.0000	0.0000	0.2215	207.2209	208.0000	0.78
250	0.00198	0.7113	0.0000	0.0024	0.0000	0.1213	0.5500	1.3850	206.9994	207.5000	0.50
260	0.00131	0.1839	0.0000	0.0052	0.0000	0.0792	0.5349	0.8033	205.6143	206.5000	0.89
270	0.00258	0.5165	0.0000	0.0092	0.0000	0.0000	0.8150	1.3407	204.8111	205.5000	0.69
290	0.00797	1.9933	0.0000	0.0000	0.0000	0.0000	0.0000	1.9933	208.7052	210.0000	1.29
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

280	0.00304	0.4262	0.0000	0.0161	0.0000	0.4498	0.1936	1.0858	203.4704	205.0000	1.53
310	0.00388	0.3885	0.0000	0.0156	0.0000	0.5303	0.4503	1.3847	202.3847	204.0000	1.62
320	0.00000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	201.0000	205.0000	4.00

****

12/23

13/23


```
100 j,  207.0000  610    4    5    4
110 t,TALLGRASS EAST DRAINAGE PLAN
120 t,NORTHWEST SYSTEM
130 t,MINIMUM Tc= 15 MINUTES; RCP : n=0.013
140 t,MWB 10/29/86 FILE: /usr/mberry/talleast.proj/nw2.stm
150 i,  570     0.44     2.90     0.00     0.00     4.90    15.00   226.20
160 i,  580     0.44     0.80     0.00     0.00     1.30    15.00   226.20
170 i,  590     0.47     2.10     0.00     0.00     1.40    15.00   226.20
180 i,  600     0.47     4.00     0.00     0.00     9.60    15.00   210.00
190 m,  610   208.00
200 p,  570  580    35.00   15 0.013  90.00    0.00
210 p,  580  590    70.00   15 0.013 110.00    0.00
220 p,  590  600   680.00   15 0.013  20.00    0.00
230 p,  600  610   150.00   24 0.013   0.00    0.00
240 e
```

Date: 10-30-1986
Time: 11:06:41

Input File: nw2.stm

14/23

TALLGRASS EAST DRAINAGE PLAN
NORTHWEST SYSTEM
INIMUM Tc= 15 MINUTES; RCP : n=0.013
MWB 10/29/86 FILE: /usr/mberry/talleast.proj/nw2.stm

Storm Frequency = 2-Year

* * * H Y D R O L O G Y * * *

Tributary Area									Hydrology Summation				Conduit Data				
Node to Node		C	Area (Ac)	Slope (%)	Length (Ft)	TC(0) (Min)	I(0) (In/Hr)	Q(0) (CFS)	TC (Min)	I (In/Hr)	Q (CFS)	Sum Q (CFS)	Size	Velocity (Ft/Sec)	Length (Ft)	TT (Min)	TT+TC (Min)
570	580	0.44	2.90	0.00	0.0	15.00	4.06	4.90	15.00	4.06	4.90	4.90	15"	3.99	35.00	0.15	15.15
580	590	0.44	0.80	0.00	0.0	15.00	4.06	1.30	15.15	4.04	1.30	6.20	15"	5.05	70.00	0.23	15.38
590	600	0.47	2.10	0.00	0.0	15.00	4.06	1.40	15.38	4.02	1.39	7.58	15"	6.18	680.00	1.83	17.21
600	610	0.47	4.00	0.00	0.0	15.00	4.06	9.60	17.21	3.85	9.10	16.68	24"	5.31	150.00	0.47	17.68

Date: 10-30-1986
Time: 11:06:41

Input File: nw2.stm

15/23

TALLGRASS EAST DRAINAGE PLAN
NORTHWEST SYSTEM
INIMUM Tc= 15 MINUTES; RCP : n=0.013
MWB 10/29/86 FILE: /usr/mberry/talleast.proj/nw2.stm

Storm Frequency = 2-Year

*** HYDRAULICS ***

Node	Hyd-Slope (Ft/Ft)	Friction (Ft)	Bend (Ft)	Transition (Ft)	Manhole (Ft)	Deflection (Ft)	Junction (Ft)	Total (Ft)	Hyd-Gl Elevation	Desired Elevation	Diff. (Ft)
570	0.00575	0.2014	0.0000	0.0000	0.0000	0.0000	0.0000	0.2014	219.9461	226.2000	6.25
580	0.00920	0.6438	0.0000	0.0148	0.0000	0.1238	0.3343	1.1167	219.7447	226.2000	6.46
590	0.01377	9.3668	0.0000	0.0197	0.0000	0.2517	0.4521	10.0904	218.6280	226.2000	7.57
600	0.00544	0.8155	0.0000	0.0310	0.0000	0.0487	0.6424	1.5376	208.5376	210.0000	1.46
610	0.00000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	207.0000	208.0000	1.00

16/23


```
100 j,  207.0000  610    5    5    4
110 t,TALLGRASS EAST DRAINAGE PLAN
120 t,NORTHWEST SYSTEM
130 t,MINIMUM Tc= 15 MINUTES; RCP : n=0.013
140 t,MWB 10/29/86 FILE: /usr/mberry/talleast.proj/nw100.stm
150 t,.ASSUME Qi(100)=Qi(2) EXCEPT AT NODE 600
160 i,  570      0.61      2.90      0.00      0.00      4.90     15.00    226.20
170 i,  580      0.61      0.80      0.00      0.00      1.30     15.00    226.20
180 i,  590      0.68      2.10      0.00      0.00      1.40     15.00    226.20
190 i,  600      0.68      4.00      0.00      0.00     39.50     15.00    210.00
200 m,  610    208.00
210 p,  570  580    35.00    15 0.013  90.00   0.00
220 p,  580  590    70.00    15 0.013 110.00   0.00
230 p,  590  600   680.00    15 0.013  20.00   0.00
240 p,  600  610   150.00    36 0.013   0.00   0.00
250 e
```

Date: 10-30-1986
Time: 11:07:27

Input File: nw100.stm

TALLGRASS EAST DRAINAGE PLAN
NORTHWEST SYSTEM
MINIMUM Tc= 15 MINUTES; RCP : n=0.013
MWB 10/29/86 FILE: /usr/mberry/talleast.proj/nw100.stm
.ASSUME Qi(100)=Qi(2) EXCEPT AT NODE 600

17/23

Storm Frequency = 100-Year

* * * HYDROLOGY * * *

Tributary Area									Hydrology Summation				Conduit Data				
Node	to Node	C	Area (Ac)	Slope (%)	Length (Ft)	TC(0) (Min)	I(0) (In/Hr)	Q(0) (CFS)	TC (Min)	I (In/Hr)	Q (CFS)	Sum Q (CFS)	Size	Velocity (Ft/Sec)	Length (Ft)	TT (Min)	TT+TC (Min)
570	580	0.61	2.90	0.00	0.0	15.00	8.97	4.90	15.00	8.97	4.90	4.90	15"	3.99	35.00	0.15	15.15
580	590	0.61	0.80	0.00	0.0	15.00	8.97	1.30	15.15	8.94	1.30	6.20	15"	5.05	70.00	0.23	15.38
590	600	0.68	2.10	0.00	0.0	15.00	8.97	1.40	15.38	8.89	1.39	7.58	15"	6.18	680.00	1.83	17.21
600	610	0.68	4.00	0.00	0.0	15.00	8.97	39.50	15.00	8.97	39.50	46.11	36"	6.52	150.00	0.38	15.38

Date: 10-30-1986
Time: 11:07:27

Input File: nw100.stm

18/23

TALLGRASS EAST DRAINAGE PLAN
NORTHWEST SYSTEM
MINIMUM Tc= 15 MINUTES; RCP : n=0.013
MWB 10/29/86 FILE: /usr/mberry/talleast.proj/nw100.stm
.ASSUME Qi(100)=Qi(2) EXCEPT AT NODE 600

Storm Frequency = 100-Year

* * * HYDRAULICS * * *

Node	Hyd-Slope (Ft/Ft)	Friction (Ft)	Bend (Ft)	Transition (Ft)	Manhole (Ft)	Deflection (Ft)	Junction (Ft)	Total (Ft)	Hyd-Gl Elevation	Desired Elevation	Diff. (Ft)
570	0.00575	0.2014	0.0000	0.0000	0.0000	0.0000	0.0000	0.2014	221.1318	226.2000	5.07
580	0.00920	0.6438	0.0000	0.0148	0.0000	0.1238	0.3343	1.1167	220.9304	226.2000	5.27
590	0.01377	9.3668	0.0000	0.0197	0.0000	0.2517	0.4521	10.0904	219.8137	226.2000	6.39
600	0.00478	0.7168	0.0000	0.0068	0.0000	0.0487	1.9509	2.7233	209.7233	210.0000	0.28
610	0.00000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	207.0000	208.0000	1.00

Date: 12-03-1986
Time: 08:56:07

18A/23

Input File: swl00r.stm

TALLGRASS EAST DRAINAGE PLAN--SOUTHWEST SYSTEM
MINIMUM TC = 15 MINUTES ; RCP : n=0.013
ASSUME Qi(100)=Qi(2) EXCEPT AT NODES 220,260,& 310
MWB 12/02/86 FILE = /usr/mberry/talleast.proj/swl00r.stm

Storm Frequency = 100-Year

* * * HYDROLOGY * * *

Tributary Area									Hydrology Summation				Conduit Data				
Node	to Node	C	Area (Ac)	Slope (%)	Length (Ft)	TC(0) (Min)	I(0) (In/Hr)	Q(0) (CFS)	TC (Min)	I (In/Hr)	Q (CFS)	Sum Q (CFS)	Size	Velocity (Ft/Sec)	Length (Ft)	TT (Min)	TT+TC (Min)
410	420	0.32	1.60	0.00	0.0	15.00	8.97	2.00	15.00	8.97	2.00	2.00	15"	1.63	90.00	0.92	15.92
420	430	0.36	5.70	0.00	0.0	15.00	8.97	7.90	15.00	8.97	7.90	9.78	18"	5.54	35.00	0.11	15.11
430	120	0.68	0.60	0.00	0.0	15.00	8.97	1.60	15.11	8.95	1.60	11.38	21"	4.73	350.00	1.23	16.34
110	120	0.46	7.30	0.00	0.0	15.00	8.97	12.90	15.00	8.97	12.90	12.90	18"	7.30	250.00	0.57	15.57
120	130	0.50	0.80	0.00	0.0	15.00	8.97	0.70	16.34	8.68	0.68	24.72	30"	5.04	300.00	0.99	17.33
130	135	0.50	1.10	0.00	0.0	15.00	8.97	2.90	17.33	8.48	2.74	27.46	30"	5.59	90.00	0.27	17.60
135	160	0.50	1.50	0.00	0.0	15.00	8.97	1.80	17.60	8.43	1.69	29.15	30"	5.94	200.00	0.56	18.16
160	150	0.50	1.20	0.00	0.0	15.00	8.97	3.40	18.16	8.33	3.16	32.31	30"	6.58	40.00	0.10	18.26
140	150	0.50	0.30	0.00	0.0	15.00	8.97	0.60	15.00	8.97	0.60	0.60	15"	0.49	70.00	2.39	17.39
170	150	0.50	0.20	0.00	0.0	15.00	8.97	0.40	15.00	8.97	0.40	0.40	15"	0.33	30.00	1.53	16.53
150	180	0.00	0.00	0.00	0.0	0.00	0.00	0.00	18.26	8.31	0.00	33.28	30"	6.78	200.00	0.49	18.75
180	190	0.50	2.10	0.00	0.0	15.00	8.97	4.00	18.75	8.22	3.67	36.95	36"	5.23	200.00	0.64	19.39
200	210	0.61	6.80	0.00	0.0	15.00	8.97	15.90	15.00	8.97	15.90	15.90	24"	5.06	250.00	0.82	15.82
210	230	0.00	0.00	0.00	0.0	0.00	0.00	0.00	15.82	8.79	0.00	15.90	24"	5.06	250.00	0.82	16.65
220	230	0.50	2.50	0.00	0.0	15.00	8.97	14.00	15.00	8.97	14.00	14.00	24"	4.46	180.00	0.67	15.67
230	190	0.00	0.00	0.00	0.0	0.00	0.00	0.00	16.65	8.62	0.00	29.57	30"	6.02	300.00	0.83	17.48
190	270	0.00	0.00	0.00	0.0	0.00	0.00	0.00	19.39	8.12	0.00	65.34	48"	5.20	530.00	1.70	21.09
240	250	0.50	2.30	0.00	0.0	15.00	8.97	4.30	15.00	8.97	4.30	4.30	15"	3.50	50.00	0.24	15.24
250	260	0.50	4.20	0.00	0.0	15.00	8.97	7.00	15.24	8.92	6.96	11.26	30"	2.29	360.00	2.62	17.85
260	270	0.50	3.40	0.00	0.0	23.00	7.60	50.00	23.00	7.60	50.00	60.20	54"	3.79	140.00	0.62	23.62
270	280	0.68	4.80	0.00	0.0	15.00	8.97	20.20	23.62	7.52	16.92	139.65	60"	7.11	200.00	0.47	24.09

290	300	0.50	3.60	0.00	0.0	15.00	8.97	6.90	15.00	8.97	6.90	6.90	18"	3.90	250.00	1.07	16.07
300	280	0.00	0.00	0.00	0.0	0.00	0.00	0.00	16.07	8.74	0.00	6.90	18"	3.90	380.00	1.62	17.69
280	310	0.00	0.00	0.00	0.0	0.00	0.00	0.00	24.09	7.46	0.00	145.76	60"	7.42	140.00	0.31	24.40
310	320	0.68	16.50	0.00	0.0	15.00	8.97	205.00	24.40	7.42	169.57	315.33	9.00 X 4.00	8.76	100.00	0.19	24.59

*** ************************** **

18B/23

18C/23

Date: 12-03-1986
Time: 08:56:07

Input File: sw100r.stm

TALLGRASS EAST DRAINAGE PLAN--SOUTHWEST SYSTEM
MINIMUM TC = 15 MINUTES ; RCP : n=0.013
ASSUME Qi(100)=Qi(2) EXCEPT AT NODES 220,260,& 310
MWB 12/02/86 FILE = /usr/mberry/talleast.proj/sw100r.stm

Storm Frequency = 100-Year

* * * H Y D R A U L I C S * * *

Node	Hyd-Slope (Ft/Ft)	Friction (Ft)	Bend (Ft)	Transition (Ft)	Manhole (Ft)	Deflection (Ft)	Junction (Ft)	Total (Ft)	Hyd-Gl Elevation	Desired Elevation	Diff. (Ft)
410	0.00096	0.0863	0.0000	0.0000	0.0000	0.0000	0.0000	0.0863	217.3288	219.1000	1.77
420	0.00868	0.3037	0.0000	0.0435	0.0000	0.0153	1.0821	1.4445	217.2425	218.2500	1.01
430	0.00516	1.8054	0.0000	0.0257	0.0000	0.2701	0.0297	2.1308	215.7980	218.2500	2.45
110	0.01508	3.7704	0.0000	0.0000	0.0000	0.0000	0.0000	3.7704	217.4375	220.0000	2.56
120	0.00363	1.0894	0.0000	0.0868	0.0000	0.4137	-0.1054	1.4845	213.6671	215.7000	2.03
130	0.00448	0.4033	0.0000	0.0092	0.0000	0.1709	0.2050	0.7884	212.1826	212.8000	0.62
135	0.00505	1.0101	0.0000	0.0062	0.0000	0.0174	0.1475	1.1811	211.3942	212.5000	1.11
160	0.00620	0.2481	0.0000	0.0125	0.0000	0.2738	0.2786	0.8130	210.2130	211.5000	1.29
140	0.00009	0.0060	0.0000	0.0000	0.0000	0.0000	0.0000	0.0060	209.4061	211.7000	2.29
170	0.00004	0.0012	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012	209.4012	211.7000	2.30
150	0.00658	1.3165	0.0000	0.0041	0.0000	0.0553	0.1144	1.4904	209.4001	211.2000	1.80
180	0.00307	0.6136	0.0000	0.0579	0.0000	0.0955	-0.1447	0.6223	207.9097	209.0000	1.09
200	0.00494	1.2350	0.0000	0.0000	0.0000	0.0000	0.0000	1.2350	211.9044	214.0000	2.10
210	0.00494	1.2350	0.0000	0.0000	0.0199	0.0866	0.0247	1.3662	210.6695	211.5000	0.83
220	0.00383	0.6894	0.0000	0.0000	0.0000	0.0000	0.0000	0.6894	209.9927	211.0000	1.01
230	0.00520	1.5597	0.0000	0.0166	0.0000	0.0000	0.4397	2.0159	209.3033	210.0000	0.70
190	0.00207	1.0968	0.0000	0.0009	0.0000	0.0923	0.4777	1.6677	207.2874	207.5000	0.21
240	0.00443	0.2215	0.0000	0.0000	0.0000	0.0000	0.0000	0.2215	207.1612	208.0000	0.84
250	0.00075	0.2712	0.0000	0.0218	0.0000	0.1213	0.1220	0.5362	206.9396	207.5000	0.56
260	0.00094	0.1312	0.0000	0.0141	0.0000	0.0302	0.6082	0.7837	206.4034	206.5000	0.10
270	0.00287	0.5750	0.0000	0.0366	0.0000	0.0000	1.2749	1.8865	205.6197	205.5000	-0.12
290	0.00431	1.0787	0.0000	0.0000	0.0000	0.0000	0.0000	[illegible]	[illegible]	[illegible]	[illegible]

300	0.00431	1.6396	0.0000	0.0000	0.0118	0.0515	0.0216	1.7246	205.4578	208.0000	2.54
280	0.00313	0.4385	0.0000	0.0070	0.0000	0.3927	0.1133	0.9515	203.7332	205.0000	1.27
310	0.00380	0.3805	0.0000	0.0336	0.0000	0.4279	0.9398	1.7817	202.7817	204.0000	1.22
320	0.00000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	201.0000	205.0000	4.00

****

180/23

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
1440 EAST ENGLISH
WICHITA, KANSAS
ZIP CODE / 67211

Date MWS 10/29/86

Project TALLGRASS EAST DRAINAGE PLAN

Item NODE 500 - HYDRAULICS

DESIGN PIPE FOR Q_{100}

$Q = 14.4$ CFS

T.C. = 214.0

Assume H.G.L = 213.0

Assume 1.0' head loss @ inlet.

D.S. ℄ = 209

Assume D.S. HGL = 211

L = 150'

Slope of HGL = $\frac{213 - 211 - 1}{150} = \frac{1}{150} = 0.67\%$

Assume n = 0.013 (RCP)

$K = \frac{Q}{\sqrt{S}} = \frac{14.4}{\sqrt{0.0067}} = 176 \Longrightarrow$ USE 24" RCP

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
1440 EAST ENGLISH
WICHITA, KANSAS
ZIP CODE / 67211

Date 10/28/86 MWB

Project TALLGRASS EAST DRAINAGE PLAN

Item SWALE DESIGN — BLOCK 2

I. DESIGN FLOWS

BASIN	TWO YEAR	100-YEAR	Time of conc.
510 outlet	16 cfs	24 cfs	20 min.
610 outlet	11 cfs	41 cfs	15 min.
820	9 cfs	21 cfs	15 min
830	4 cfs	17 cfs	20 min.
Σ (Peak on Peak) (Conservative)	40 cfs	103 cfs	

II. DITCH GEOMETRICS

RESERVE WIDTH ≈ 70 ft

$$\text{SLOPE} = \frac{210 - 202}{700} = 1.14\%$$

USE 6:1 SLOPES OR FLATTER.

III HYDRAULICS

Ref: Vol III, KDOT Design Manual

Assume Class D Retardance

Check Two Year for Erosion, 100 Yr for Capacity

Low erodibility soil (n=0.035)

Max. Permissible depth = 0.9'

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
1440 EAST ENGLISH
WICHITA, KANSAS
ZIP CODE / 67211

Date 10/28/86 Page 2A of

Project TALLGRASS EAST

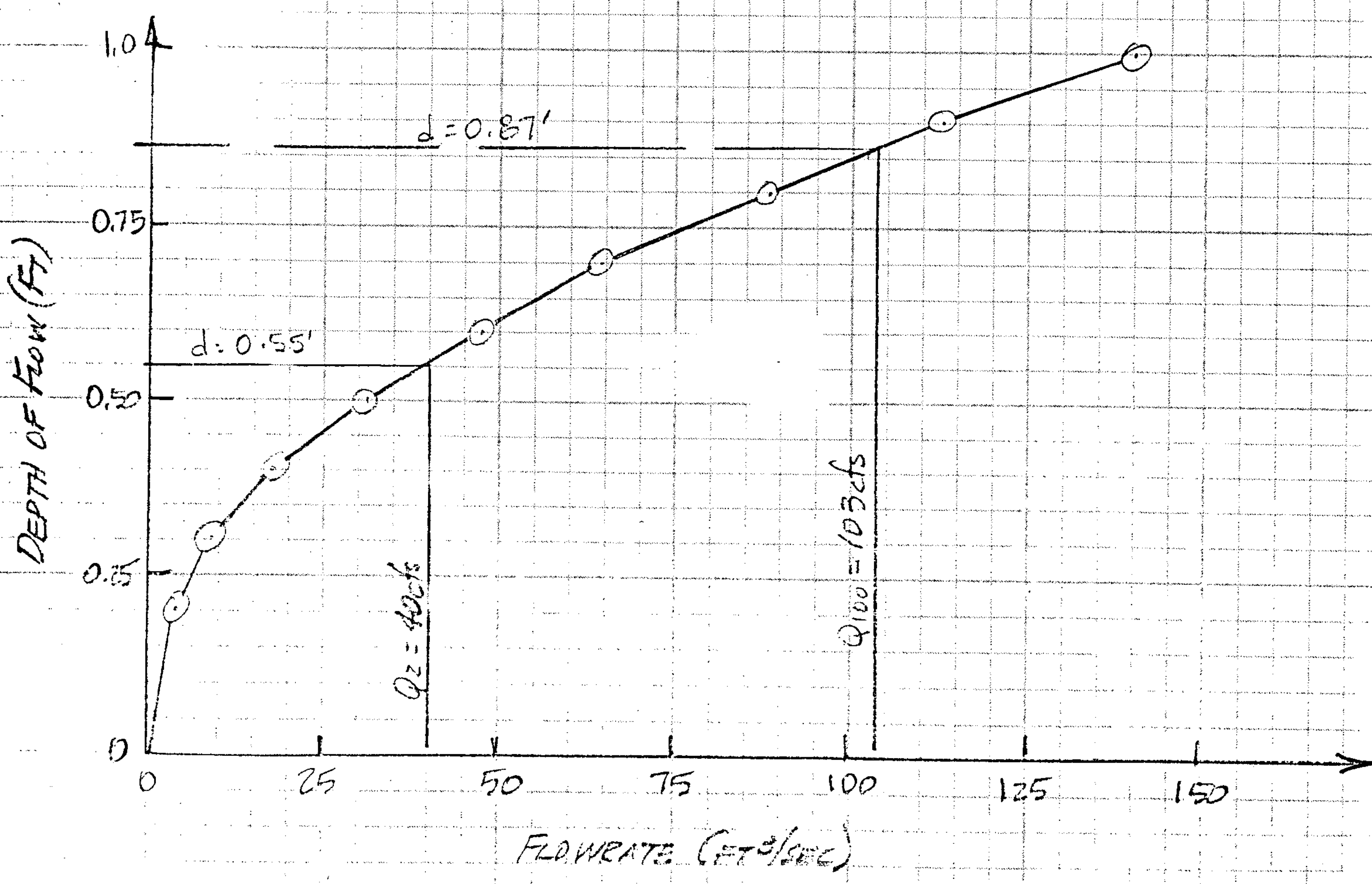
Item SWALE DESIGN - BLOCK 2

TRIAL 2

Slope = 1.14%
Bottom Width =20.00 Ft.
Left Sideslope = 8.00 to 1
Right Sideslope = 8.00 to 1
RETARDANCE CLASS E

MAX PERMISSIBLE DEPTH = 0.9' FOR NO EROSION

DEPTH (FT)	AREA (SQFT)	R 2/3	R	V	Q
0.10	2.08	0.21001	0.10	—	
0.20	4.32	0.32585	0.19	0.8	3.5
0.30	6.72	0.41832	0.27	1.3	8.7
0.40	9.28	0.49745	0.35	1.9	17.7
0.50	12.00	0.56760	0.43	2.6	31.2
0.60	14.88	0.63117	0.50	3.2	47.6
0.70	17.92	0.68968	0.57	3.6	64.5
0.80	21.12	0.74416	0.64	4.2	88.7
0.90	24.48	0.79535	0.71	4.6	112.6
1.00	28.00	0.84380	0.78	5.0	140.0



PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
1440 EAST ENGLISH
WICHITA, KANSAS
ZIP CODE / 67211

Date 10/28/86 MMB

Project TALLGRASS EAST DRAINAGE PLAN

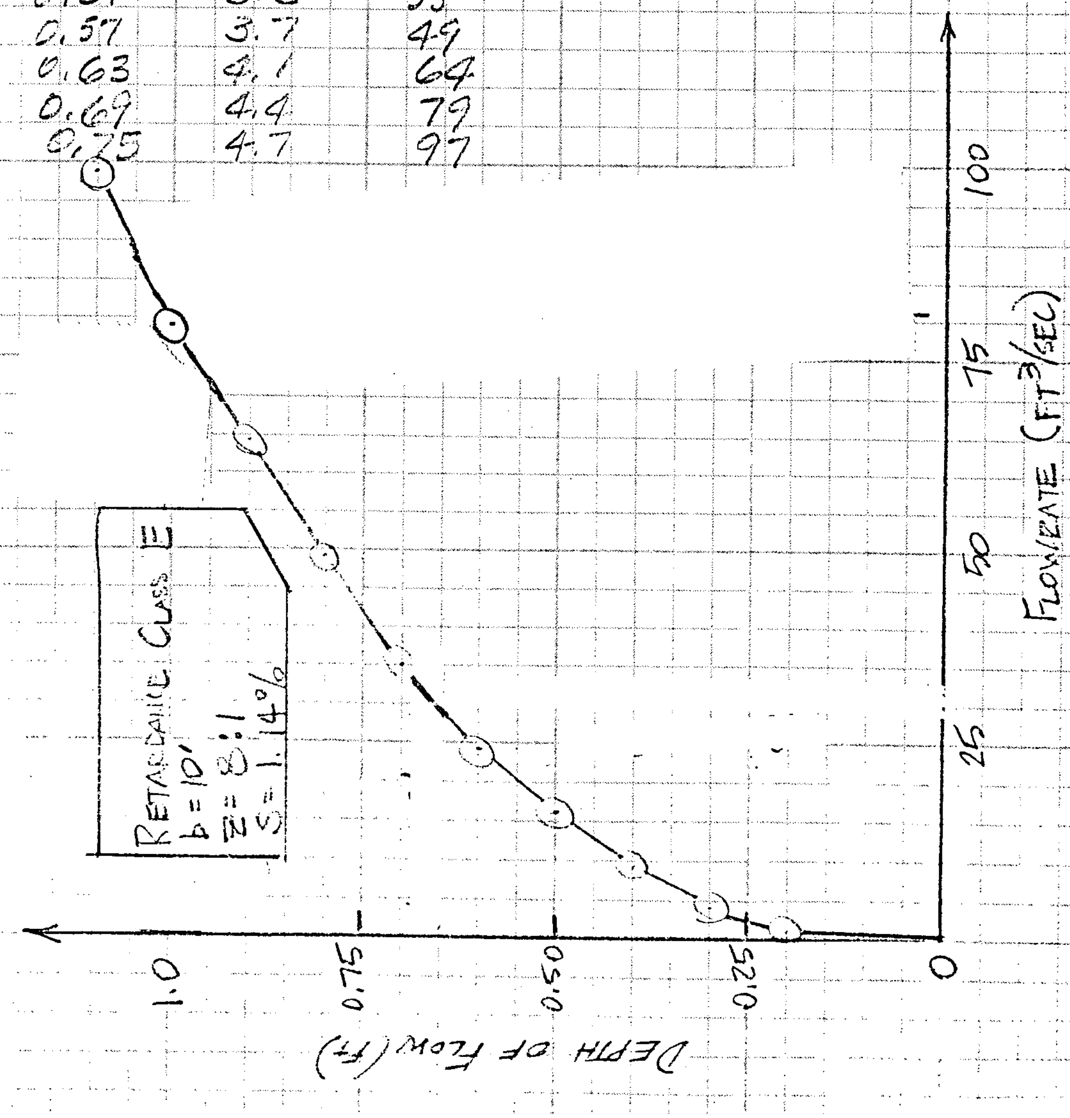
Item SWALE DESIGN - BLOCK 2

III HYDRAULICS CON'T

Retardance Class E, S = 1.14 %

TRIAL #1, 10' flat bottom, 8:1 slopes

DEPTH	A	R	V	Q
0.1	1.08	0.09	—	
0.2	2.32	0.18	0.68	1.6
0.3	3.72	0.25	1.15	4.3
0.4	5.28	0.32	1.7	9.0
0.5	7.00	0.39	2.3	16.1
0.6	8.88	0.45	2.7	24.0
0.7	10.92	0.51	3.2	35
0.8	13.12	0.57	3.7	49
0.9	15.48	0.63	4.1	64
1.0	18.00	0.69	4.4	79
1.1	20.68	0.75	4.7	97



PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
1440 EAST ENGLISH
WICHITA, KANSAS
ZIP CODE / 67211

Date 10/28/86 MMB

Project TALLGRASS EAST DRAINAGE PLAN

Item SWALE DESIGN - BLOCK C

IV DESIGN SECTION

Recommend 8:1 side slope, 20' bottom, grassed channel. Suggest paved pilot channel for chronic low flow from irrigation overflow, etc.

Professional Engineering Consultants
Professional Association
1440 East English
Wichita, Kansas
Zip Code / 67211

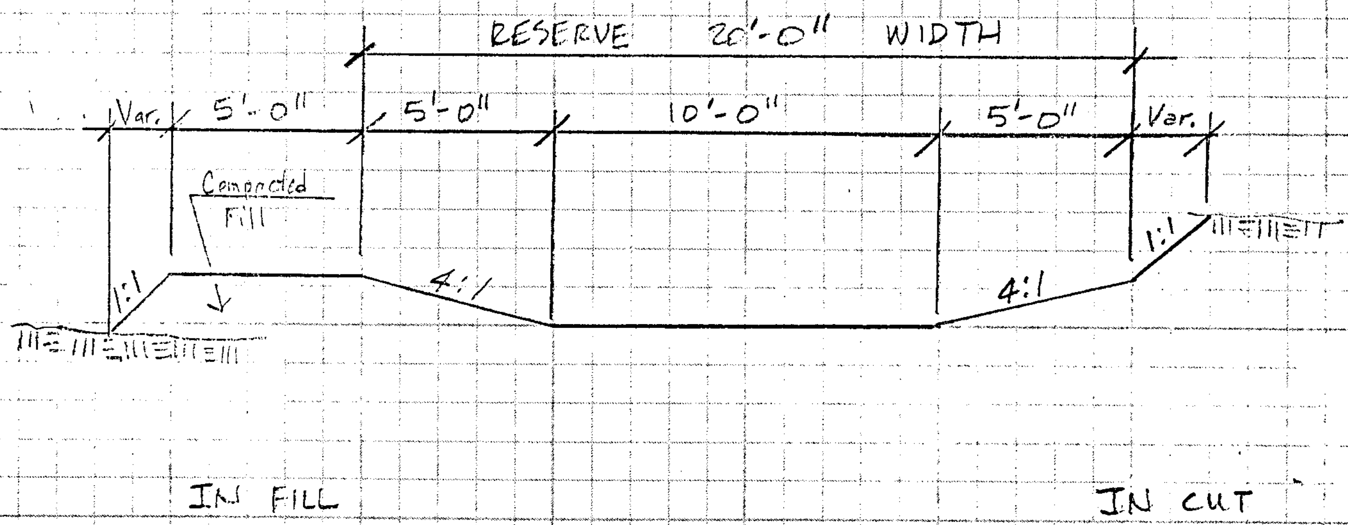
Date 11-25-86 MMB Page 23A of 23

Project Tallgrass East

Item 20' Reserve overflow capacity

Computation Method: As given in Design of Stable Roadside Channels by K.D.O.T.

Retardance Class E
Section as shown below.
Assume avg. erodibility



Compute $(Q_{100} - Q_2)$ at four critical points & determine overland flow parameters through the Reserve

NODE 110   S = 0.0187 ft/ft

d, ft	A ft²	R ft	V ft/s	Q ft³/s
0.2	2.1	0.15	0.7	1.5
0.4	4.0	0.35	2.4	9.6
0.6	7.5	0.50	4.0	30.0
0.8	11.0	0.65	5.3	58.3
1.0	14.0	0.77	6.0	84

Q_{100} = 36 cfs
Q_2 = 13

Diff = 23 cfs
depth ≈ 0.5'
V ≈ 3 ft/s

NODE 180   S = 0.75%

d, ft	A, ft²	R, ft	V, ft/s	Q, ft³/s
0.2	2.1	0.15	0.4	0.8
0.4	4.0	0.35	1.3	5.2
0.6	7.5	0.50	2.2	16.5
0.8	11.0	0.65	3.2	35.2
1.0	14.0	0.77	3.8	53.2
1.2	18.0	0.90	4.4	79.2

Q_{100} = 11.8 cfs
Q_2 = 4.0 cfs

diff = 7.8 cfs
depth = 0.4'+
V = 1.4 ft/s

NODE 200   S = 1.00%

d, ft	A, ft²	R, ft	V, ft/s	Q, ft³/s
0.2	2.1	0.15	0.47	1.0
0.4	4.0	0.35	1.7	6.8
0.6	7.5	0.50	2.8	21.0
0.8	11.0	0.65	4.0	44
1.0	14.0	0.77	4.6	64.4

Q_{100} = 38 cfs
Q_2 = 16 cfs

diff = 22 cfs
depth ≈ 0.6'
V = 3 ft/s

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
1440 EAST ENGLISH
WICHITA, KANSAS
ZIP CODE / 67211

Date 12/3/86 MWB

Project Tallgrass East Drainage Plan

Item Reserves – Overflow Capacity

NODE 260 $S = 0.75\%$

$A = (b + zy)y$
$P = b + 2y\sqrt{1+z^2}$

$Q_{100} = 90$ cfs
$Q_i = 50$ cfs

Diff = 40 cfs ⟶ From prev sh d = 0.85', V = 3.5 f/s

Would be desirable to increase to 30' Reserve, 20' bottom width

NODE 260 $S = 0.75\%$, $b = 20'$,

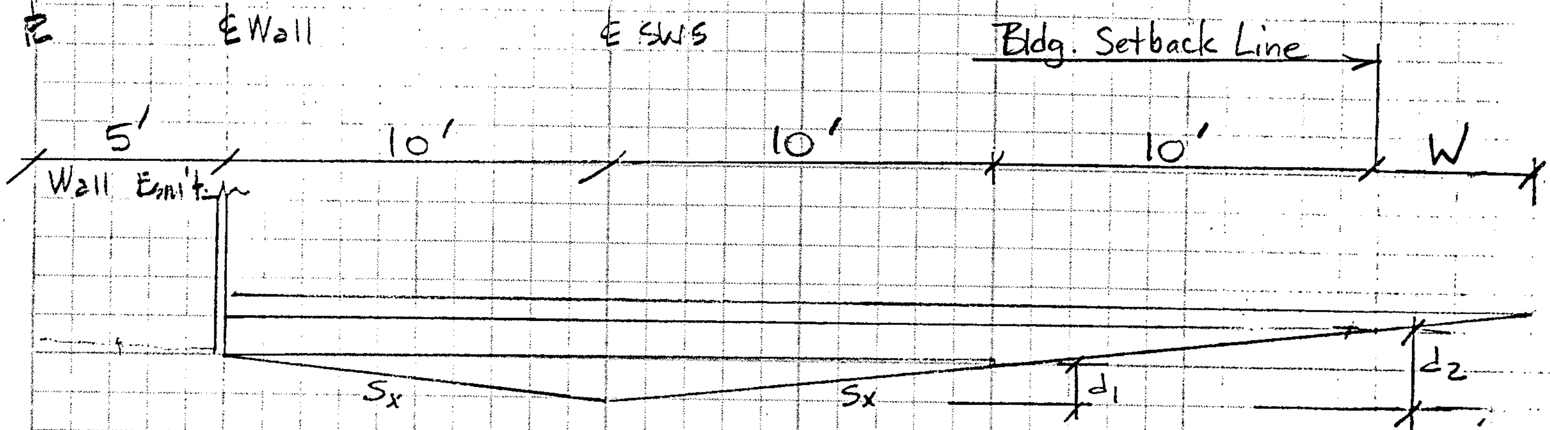
d, ft	A, ft²	R, ft	V, ft/s	Q, ft³/s
0.2	4.2	0.19	0.5	2.1
0.4	8.6	0.37	1.5	12.9
0.6	13.4	0.54	2.4	32.2
0.8	18.6	0.70	3.4	63.2
1.0	24.0	0.85	4.2	100.8

— d = 0.65'
V = 2.5 ft/s

PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION
1440 EAST ENGLISH
WICHITA, KANSAS
ZIP CODE / 67211

Project Tallgrass East Drainage Plan

Item LC Parcel - Overland Flow



TYPICAL SECTION

$n = 0.015$
$S_o = 0.005$ ft/ft

(I) For $S_x = 4\%$ ($1/2''$/ft)

(A) $d = d_1 = 0.4'$ $A = \frac{1}{2} \times 20 \times 0.4 = 4$ ft^2 $P = 2\sqrt{0.2^2 + 10^2} = 20.0$ $R = 0.2'$

$$Q = \frac{1.49}{0.015}(4)(0.2)^{2/3}\sqrt{0.005} = 9.6 \text{ cfs}$$

(B) $d = d_2 = 0.8'$ $A = \frac{1}{2}(0.8 + 0.4)(10) + \frac{1}{2}(20)(0.8) = 14.0$ ft^2

$P = 30.4'$ $R = 0.46$ $Q = 1.49(14.0)(0.46)^{2/3}\sqrt{0.005}/0.015 = 59$ cfs

(C) $d = d_3 = 1.0'$ ($W = 5'$)

$A = \left(\frac{1.0 + 0.6}{2}\right)(10) + \frac{1}{2}(25)(1.0) = 20.5$ ft^2 $P = 30.4 + 5.0 + 0.2 = 35.6$

$R = 0.58$ $Q = 1.49(20.5)(0.58)^{2/3}\sqrt{0.005}/0.015 = 100$ cfs

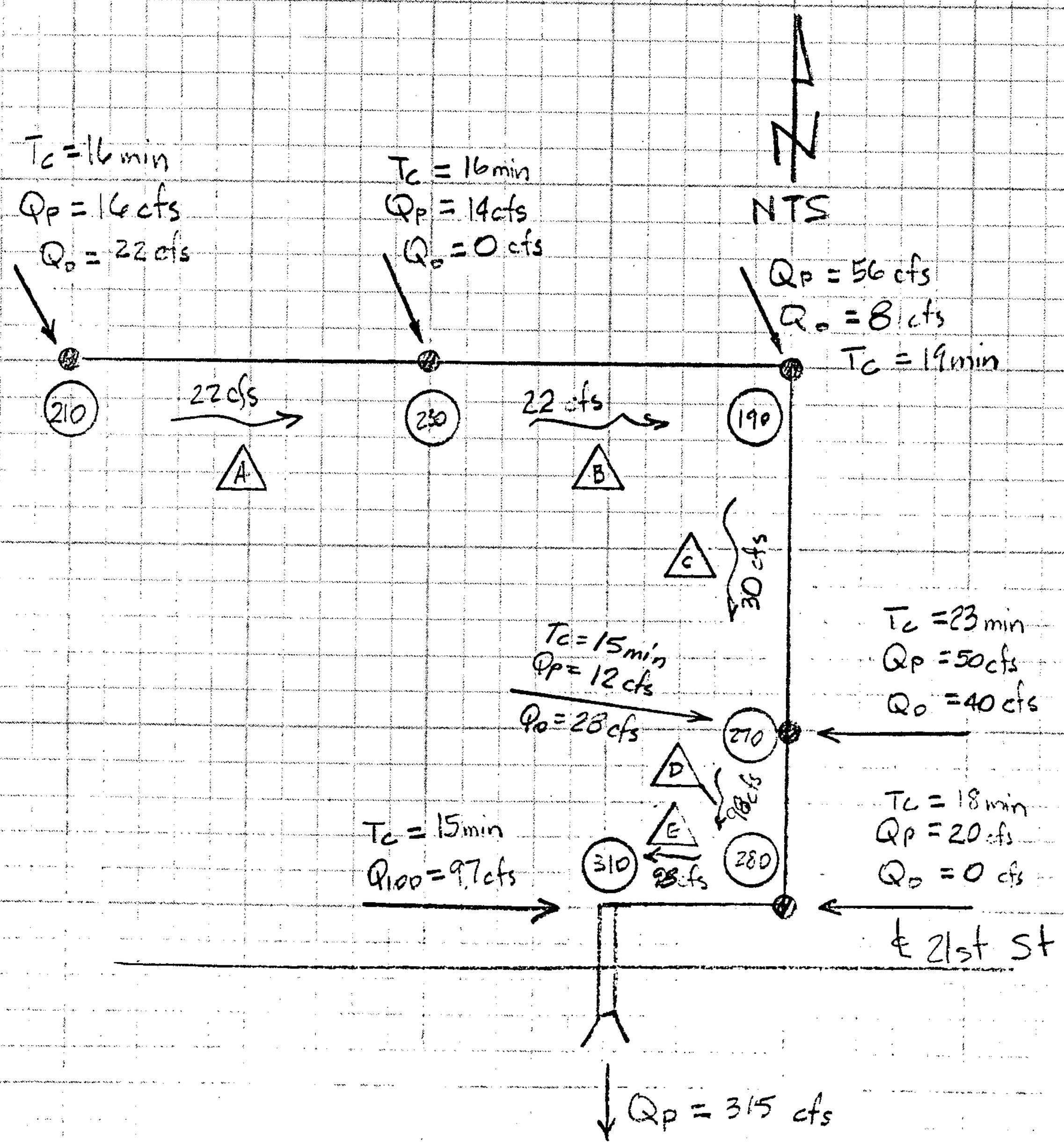
Professional Engineering Consultants, Professional Association
1440 East English, Wichita, Kansas, Zip Code / 67211

Date 11-25-86 MNB

Project Tallgrass East Drainage Plan

Item LC Parcel Overland Flow

Add Flows Peak-on-Peak



For Reaches A-C, 30' wide overland easement is sufficient.

For Reaches D-E, 35' wide overland easement is req'd.

DESIGN AIDS

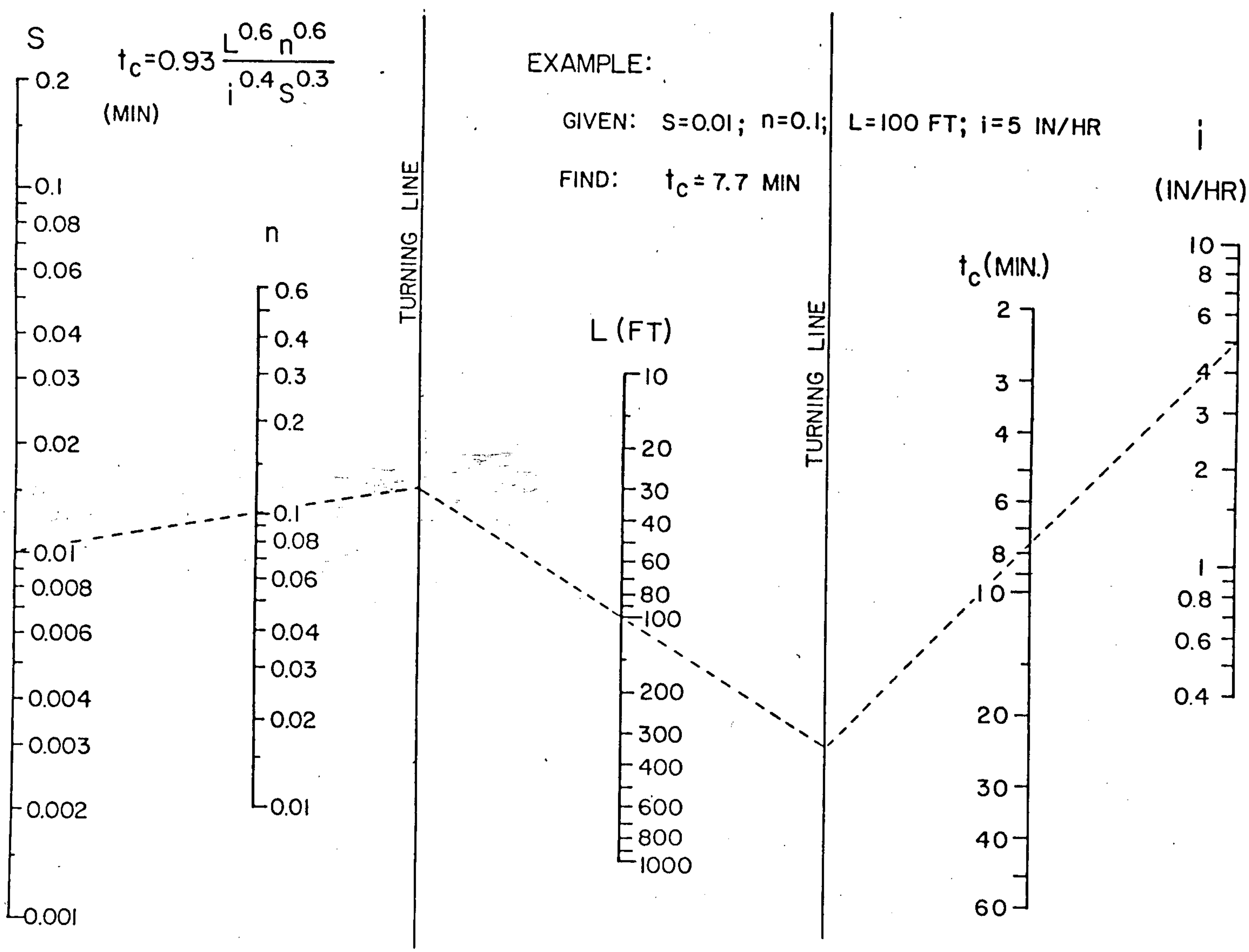


CHART 1. Kinematic wave formulation for determining time of concentration.

From: HEC-12, Drainage of Highway Pavements, FHWA, Mar. 1984

Table 3. Spread at average velocity in a reach of triangular gutter.

T_1/T_2	Ø	Ø.1	Ø.2	Ø.3	Ø.4	Ø.5	Ø.6	Ø.7	Ø.8
T_a/T_2	Ø.65	Ø.66	Ø.68	Ø.7Ø	Ø.74	Ø.77	Ø.82	Ø.86	Ø.9Ø

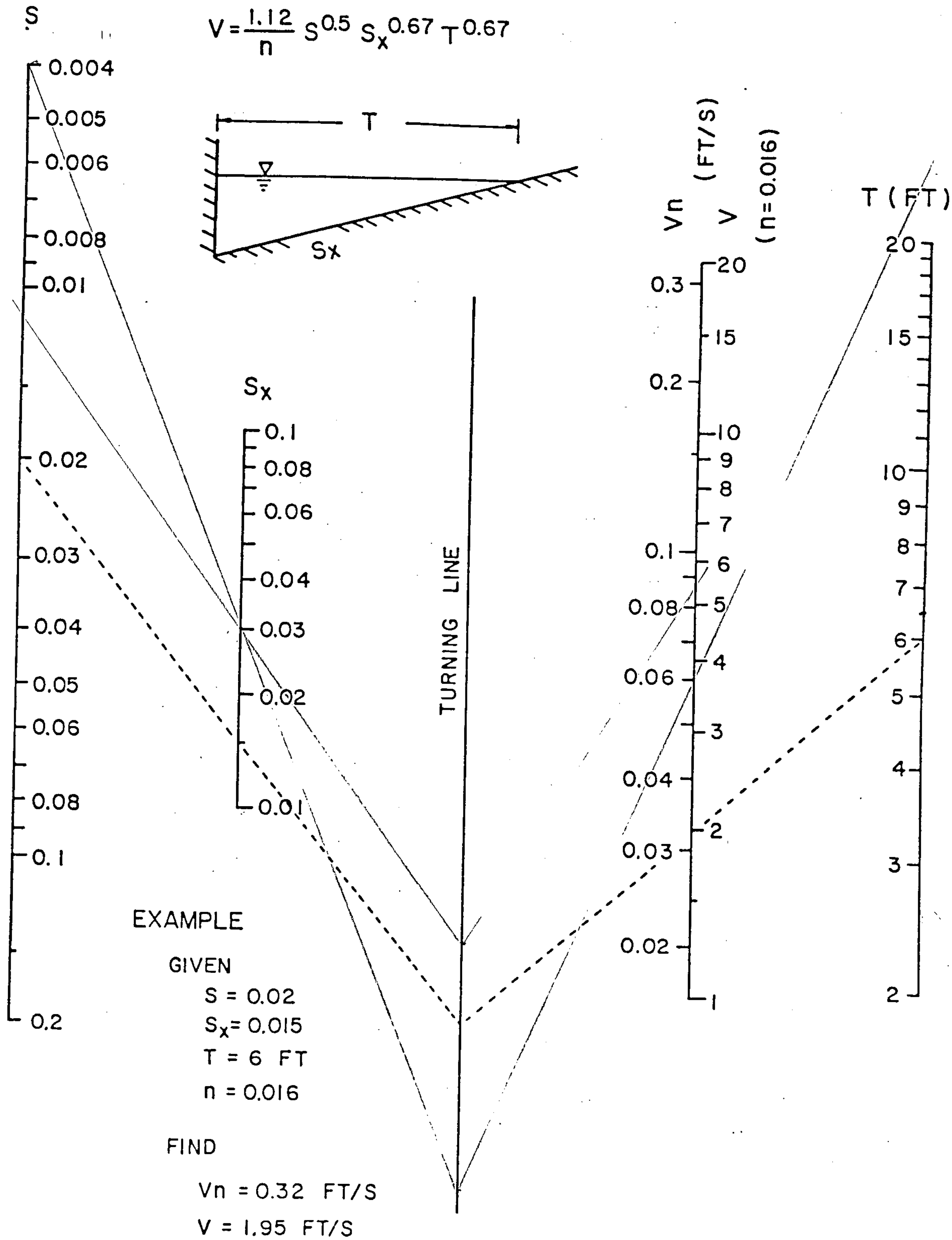


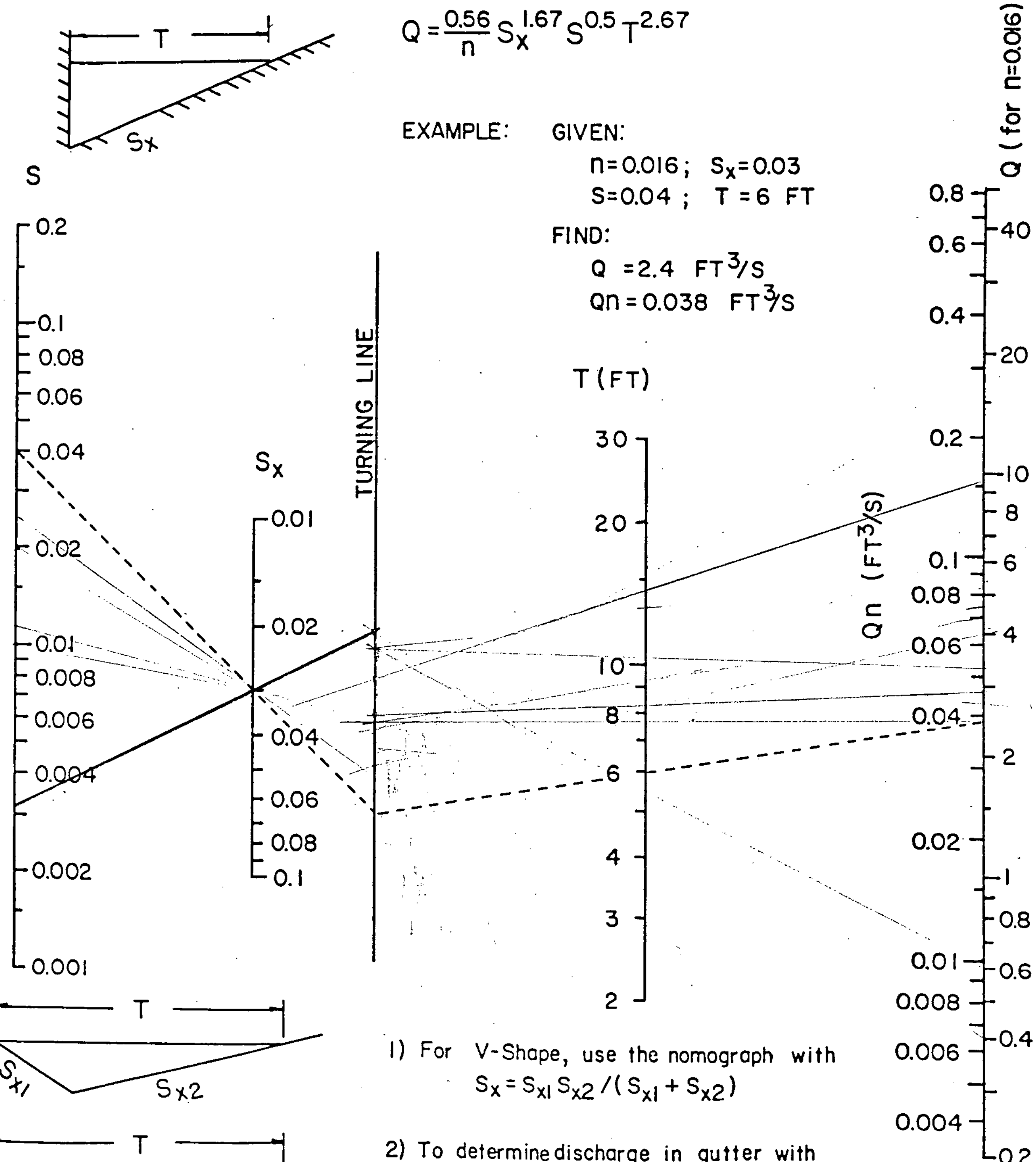
CHART 2. Velocity in triangular gutter sections.

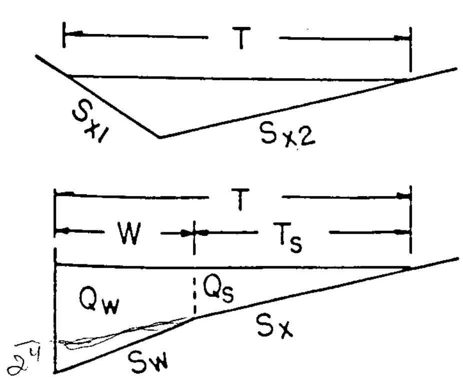
From HEC-12: Drainage of Highway Pavements, F.H.W.A., Mar. 1984

$$Q = \frac{0.56}{n} S_x^{1.67} S^{0.5} T^{2.67}$$

EXAMPLE: GIVEN:
$n = 0.016$; $S_x = 0.03$
$S = 0.04$; $T = 6$ FT

FIND:
$Q = 2.4\ FT^3/S$
$Qn = 0.038\ FT^3/S$





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.

From: HEC-12: Drainage of Highway Pavements, F.H.W.A., Mar. 1984

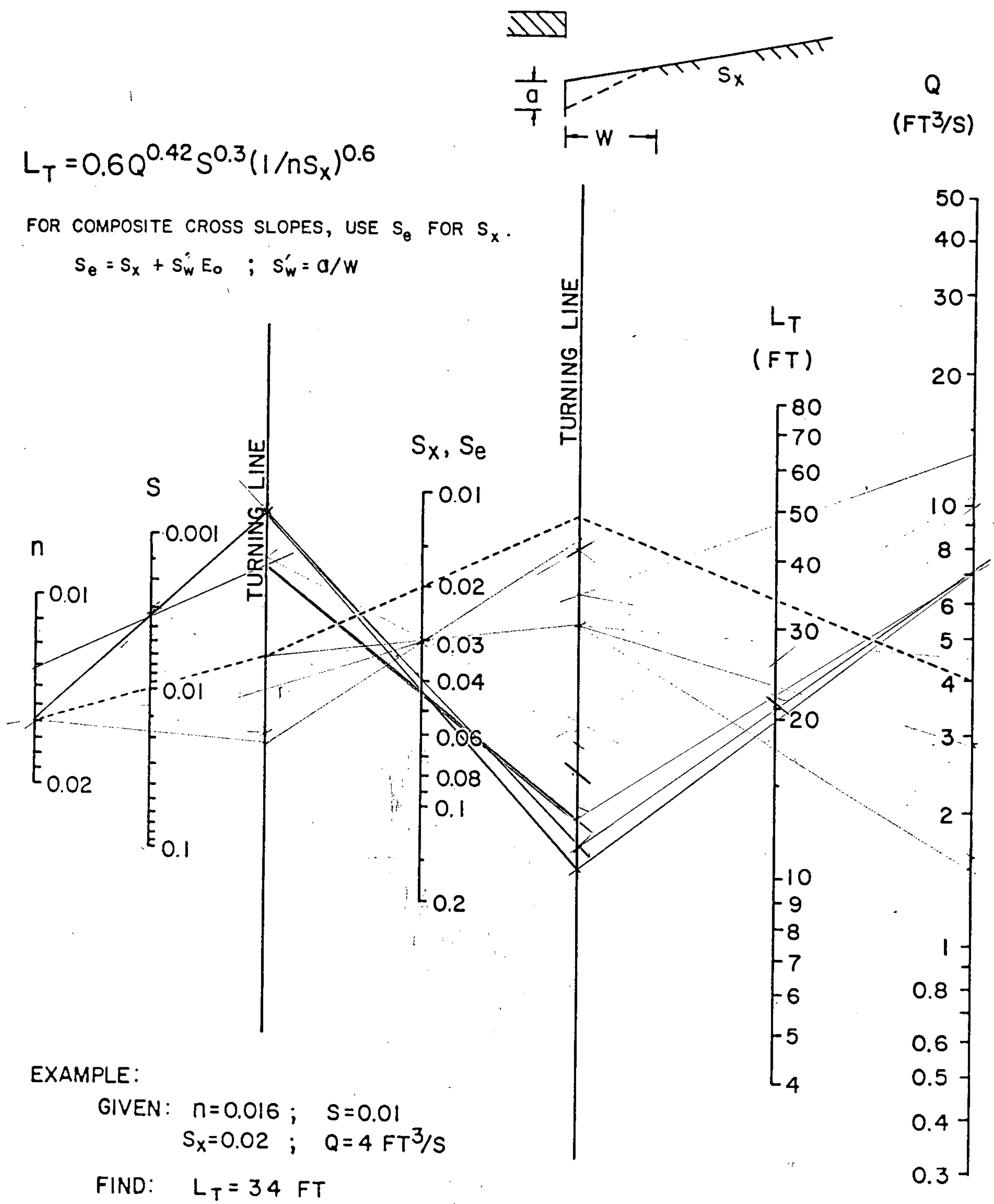


CHART 9. Curb–opening and slotted drain inlet length for total interception.

From: HEC-12, Drainage of Highway Pavements, F.H.W.A., Mar. 1984

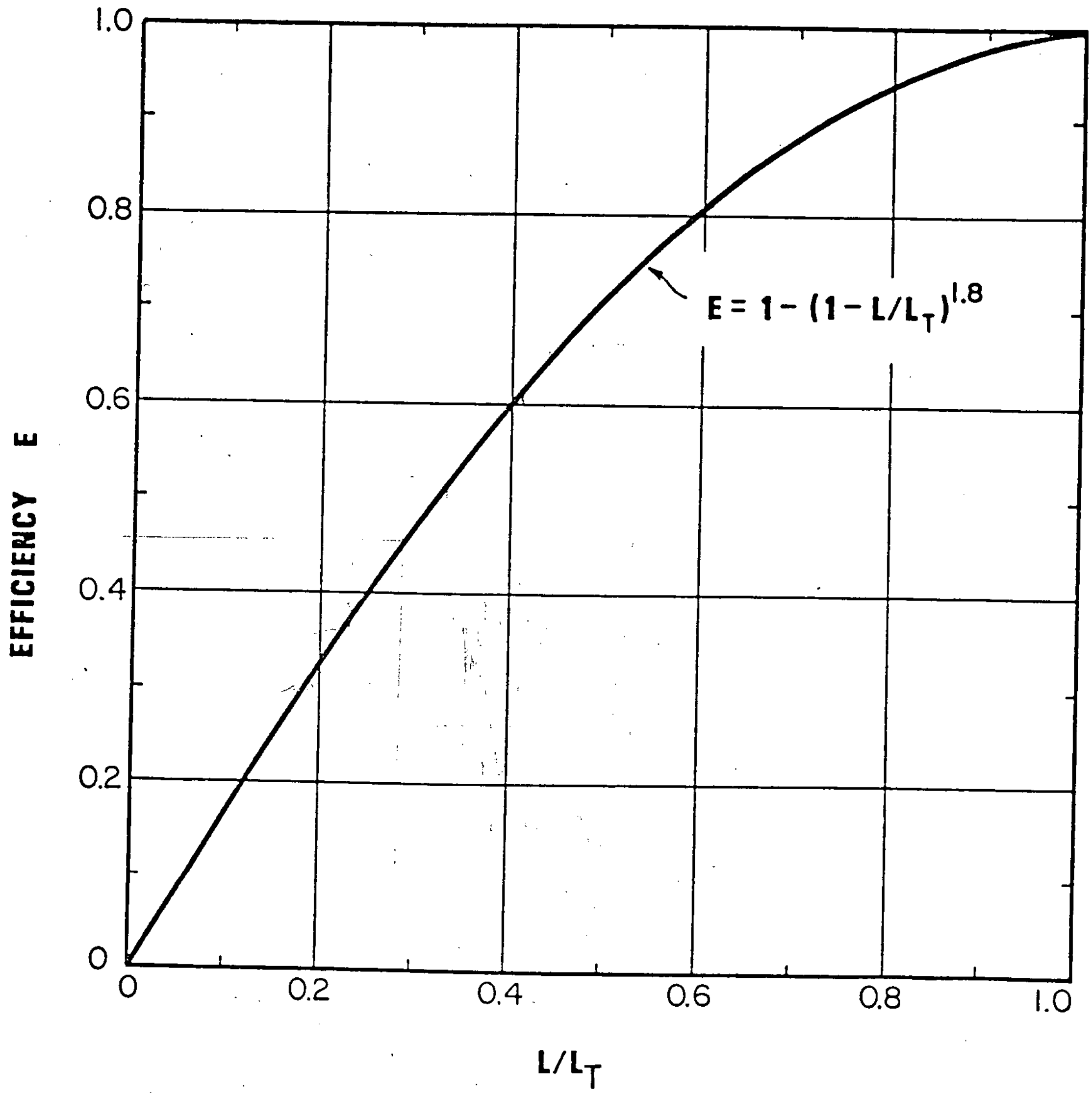
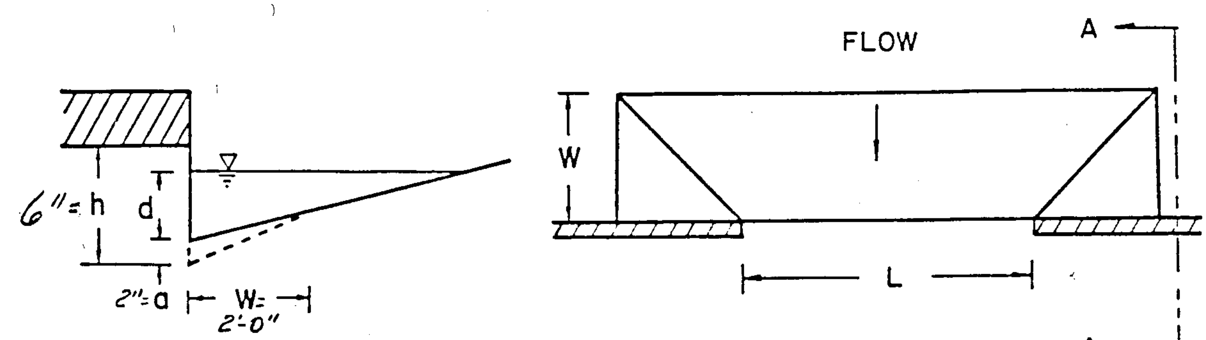


CHART 10. Curb–opening and slotted drain inlet interception efficiency.

FROM: HEC-12, DRAINAGE OF HIGHWAY PAVEMENTS, F.H.W.A., Mar. 1984



DEF. SKETCH, C.O.W. TYPE 1A INLET

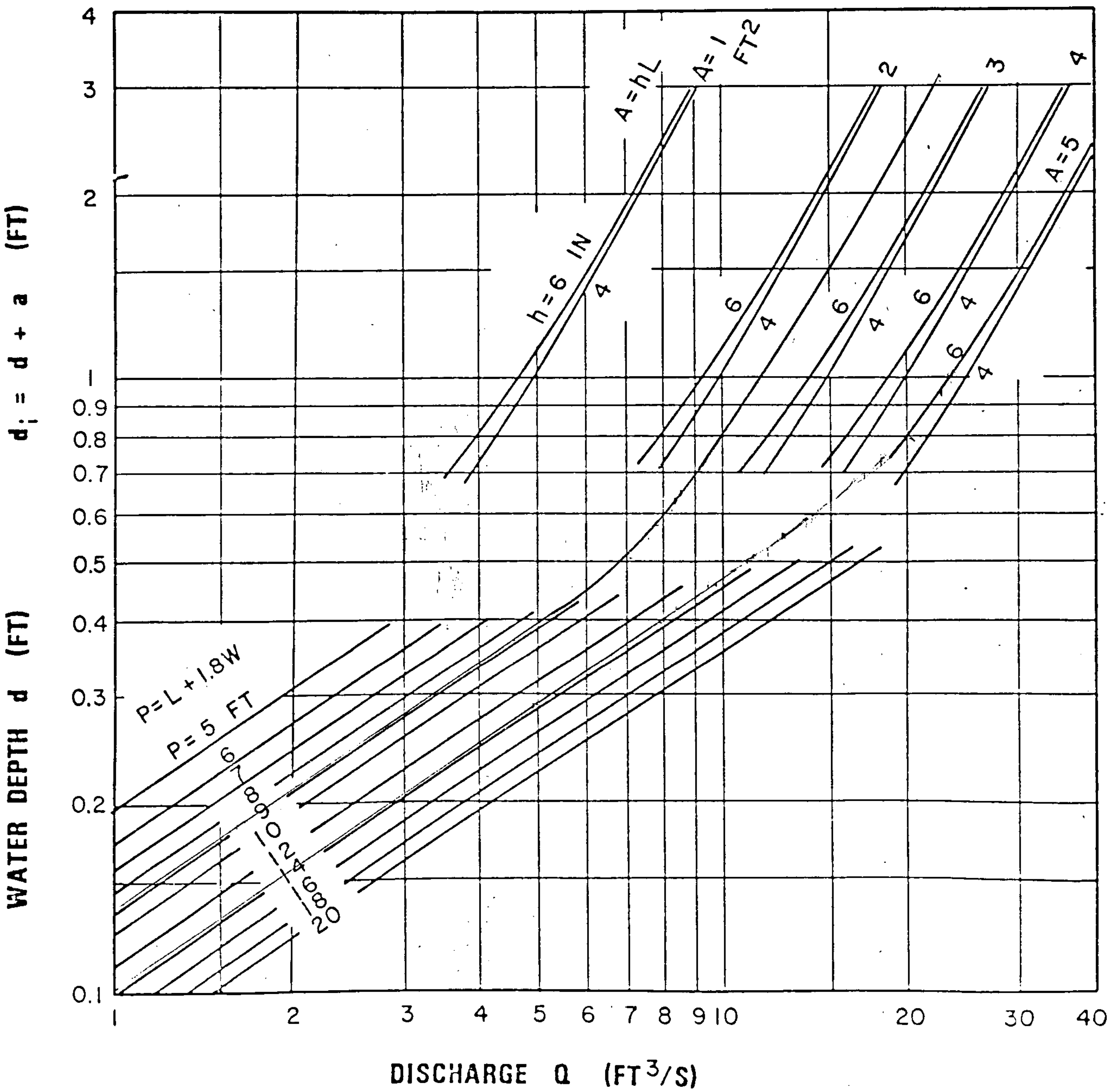
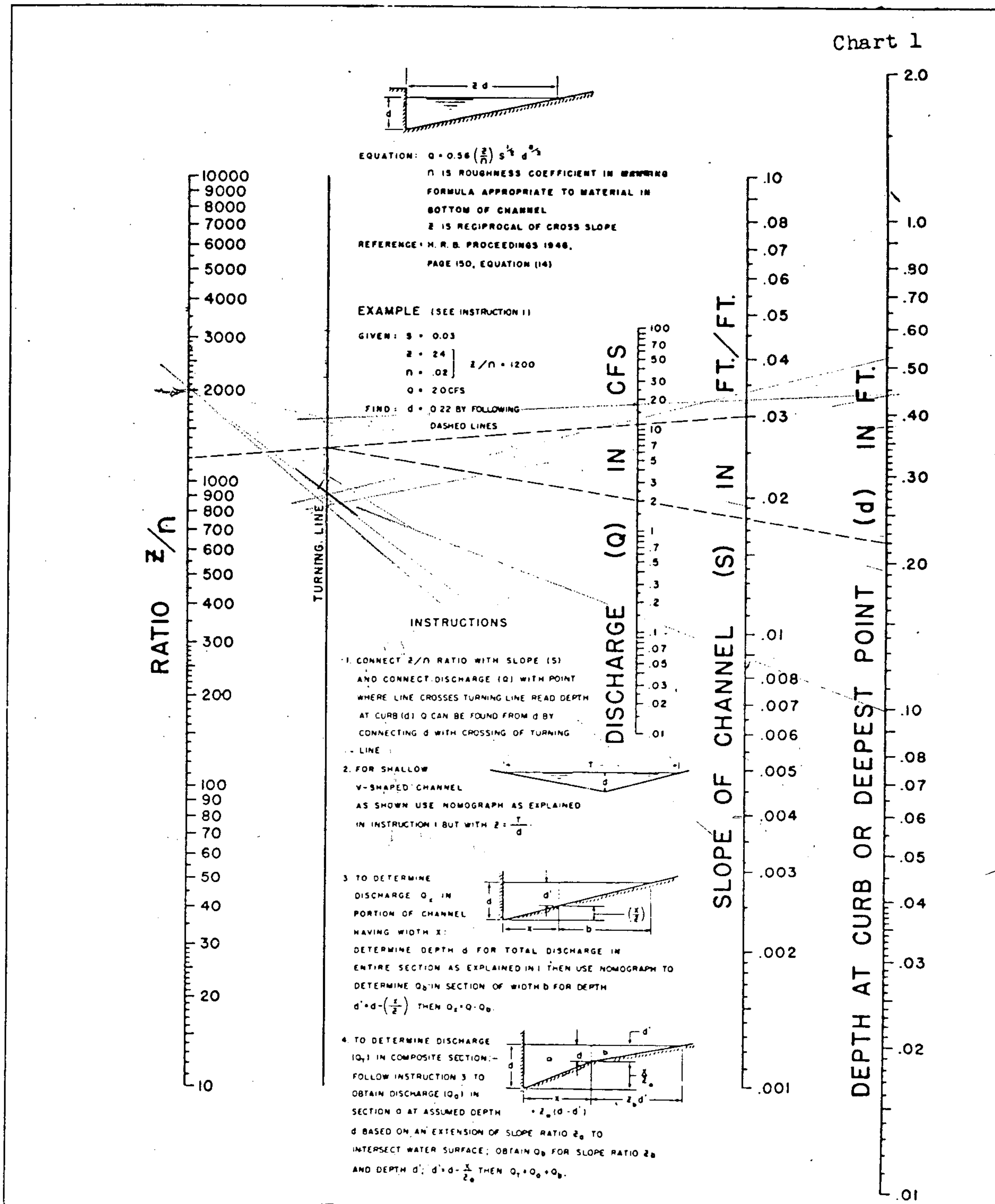


CHART 12. Depressed curb-opening inlet capacity in sump locations.

FROM: HEC-12, Drainage of Highway Pavements, F.H.W.A., MAR., 1984

3/8"/Ft
.016

Appendix C - CAPACITY OF GUTTERS AND GRATE INLET



BUREAU OF PUBLIC ROADS
REV. JAN. 1968

NOMOGRAPH FOR FLOW IN TRIANGULAR CHANNELS

April 15, 1986

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 A CONTINUED
Page 2

DURATION IN MINUTES	RETURN PERIODS OF 1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
46	1.70	2.05	2.54	2.97	3.48	3.93	4.33
47	1.67	2.02	2.50	2.93	3.44	3.88	4.28
48	1.66	2.00	2.47	2.90	3.39	3.84	4.23
49	1.64	1.97	2.44	2.86	3.35	3.79	4.18
50	1.61	1.95	2.41	2.83	3.32	3.75	4.13
51	1.59	1.92	2.38	2.79	3.28	3.71	4.09
52	1.56	1.89	2.35	2.76	3.24	3.67	4.05
53	1.54	1.86	2.33	2.73	3.20	3.63	4.00
54	1.52	1.84	2.30	2.70	3.17	3.59	3.96
55	1.50	1.81	2.27	2.67	3.14	3.55	3.92
56	1.47	1.79	2.25	2.64	3.10	3.51	3.88
57	1.45	1.76	2.22	2.61	3.07	3.48	3.84
58	1.43	1.74	2.20	2.59	3.04	3.44	3.81
59	1.42	1.72	2.18	2.56	3.01	3.41	3.77
60	1.40	1.69	2.15	2.53	2.98	3.37	3.73
61	1.38	1.67	2.13	2.51	2.95	3.34	3.70
62	1.36	1.65	2.11	2.48	2.92	3.31	3.67
63	1.34	1.63	2.09	2.46	2.89	3.28	3.63
64	1.33	1.61	2.07	2.44	2.86	3.25	3.60
65	1.31	1.59	2.05	2.41	2.84	3.22	3.57
66	1.30	1.57	2.03	2.39	2.81	3.19	3.54
67	1.28	1.56	2.01	2.37	2.79	3.16	3.51
68	1.26	1.54	1.99	2.35	2.76	3.13	3.48
69	1.25	1.52	1.97	2.33	2.74	3.10	3.45
70	1.24	1.50	1.95	2.31	2.71	3.08	3.42
71	1.22	1.49	1.93	2.28	2.69	3.05	3.39
72	1.21	1.47	1.92	2.26	2.67	3.02	3.36
73	1.20	1.46	1.90	2.25	2.64	3.00	3.34
74	1.18	1.44	1.88	2.23	2.63	2.98	3.31
75	1.17	1.43	1.86	2.21	2.61	2.95	3.29
76	1.16	1.41	1.85	2.19	2.58	2.93	3.26
77	1.15	1.40	1.83	2.17	2.55	2.90	3.24
78	1.13	1.38	1.82	2.15	2.53	2.88	3.22
79	1.12	1.37	1.80	2.14	2.50	2.86	3.19
80	1.11	1.36	1.79	2.12	2.48	2.84	3.16
81	1.10	1.34	1.77	2.10	2.46	2.82	3.13
82	1.09	1.33	1.76	2.08	2.43	2.79	3.10
83	1.08	1.32	1.74	2.06	2.41	2.76	3.07
84	1.07	1.31	1.73	2.04	2.39	2.74	3.04
85	1.06	1.30	1.72	2.02	2.37	2.71	3.01
86	1.05	1.28	1.70	2.00	2.34	2.69	2.99
87	1.04	1.27	1.69	1.99	2.32	2.66	2.96
88	1.03	1.26	1.68	1.97	2.30	2.64	2.93
89	1.02	1.25	1.68	1.95	2.28	2.62	2.91
90	1.01	1.24	1.66	1.93	2.26	2.59	2.88

DURATION IN MINUTES	1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
			RETURN PERIODS OF				
91	1.00	1.23	1.65	1.92	2.24	2.57	2.86
92	1.00	1.22	1.63	1.90	2.22	2.55	2.83
93	0.99	1.21	1.62	1.89	2.20	2.53	2.81
94	0.98	1.20	1.61	1.87	2.19	2.51	2.79
95	0.97	1.19	1.59	1.85	2.17	2.49	2.76
96	0.96	1.18	1.58	1.84	2.15	2.46	2.74
97	0.96	1.17	1.57	1.82	2.13	2.44	2.72
98	0.95	1.16	1.56	1.81	2.12	2.42	2.70
99	0.94	1.15	1.54	1.80	2.10	2.41	2.67
100	0.93	1.14	1.53	1.78	2.08	2.39	2.65
101	0.93	1.13	1.52	1.77	2.07	2.39	2.65
102	0.92	1.13	1.51	1.75	2.05	2.35	2.61
103	0.91	1.12	1.50	1.74	2.04	2.33	2.59
104	0.90	1.11	1.49	1.73	2.02	2.31	2.57
105	0.90	1.10	1.47	1.72	2.01	2.30	2.55
106	0.89	1.09	1.46	1.70	1.99	2.28	2.54
107	0.88	1.09	1.45	1.69	1.98	2.26	2.52
108	0.88	1.08	1.44	1.68	1.96	2.25	2.50
109	0.87	1.07	1.43	1.67	1.95	2.23	2.48
110	0.87	1.06	1.42	1.65	1.93	2.21	2.46
111	0.86	1.06	1.41	1.64	1.92	2.20	2.45
112	0.85	1.05	1.40	1.63	1.91	2.18	2.43
113	0.85	1.04	1.39	1.62	1.89	2.17	2.41
114	0.84	1.03	1.38	1.61	1.88	2.15	2.40
115	0.84	1.03	1.37	1.60	1.87	2.14	2.38
116	0.83	1.02	1.36	1.59	1.86	2.12	2.36
117	0.82	1.01	1.36	1.58	1.84	2.11	2.35
118	0.82	1.01	1.35	1.57	1.83	2.09	2.33
119	0.81	1.00	1.34	1.56	1.82	2.08	2.32
120	0.81	0.99	1.33	1.55	1.81	2.07	2.30

DURATION IN HOURS	1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
			RETURN PERIODS OF				
2	0.81	0.99	1.33	1.55	1.81	2.07	2.30
3	0.59	0.72	0.97	1.13	1.32	1.51	1.68
4	0.47	0.58	0.78	0.91	1.06	1.21	1.35
5	0.40	0.49	0.66	0.77	0.89	1.02	1.14
6	0.35	0.42	0.57	0.67	0.78	0.89	0.99
8	0.28	0.34	0.46	0.53	0.62	0.71	0.79
10	0.23	0.29	0.39	0.45	0.52	0.60	0.67
12	0.20	0.25	0.33	0.39	0.45	0.52	0.58
18	0.15	0.18	0.24	0.28	0.33	0.38	0.42
24	0.12	0.15	0.20	0.23	0.27	0.31	0.34

TABLE 7.—Recommended Manning's Roughness Coefficients for Overland Flow

Cover or treatment (1)	Residue rate (ton/acre) (2)	Value recommended (3)	Range (4)
Concrete or asphalt[a]		0.011	0.01–0.013
Bare sand[a]		0.01	0.010–0.016
Graveled surface[a]		0.02	0.012–0.03
Bare clay-loam (eroded)[a]		0.02	0.012–0.033
Fallow—no residue		0.05	0.006–0.16
Chisel plow	<1/4	0.07	0.006–0.17
	<1/4–1	0.18	0.07–0.34
	1–3	0.30	0.19–0.47
	>3	0.40	0.34–0.46
Disk/harrow	<1/4	0.08	0.008–0.41
	1/4–1	0.16	0.10–0.25
	1–3	0.25	0.14–0.53
	>3	0.30	—
No till	<1/4	0.04	0.03–0.07
	1/4–1	0.07	0.01–0.13
	1–3	0.30	0.16–0.47
Moldboard plow (Fall)		0.06	0.02–0.10
Coulter		0.10	0.05–0.13
Range (natural)		0.13	0.01–0.32
Range (clipped)		0.10	0.02–0.24
Grass (bluegrass sod)		0.45	0.39–0.63
Short grass prairie[a]		0.15	0.10–0.20
Dense grass[b]		0.24	0.17–0.30
Bermuda grass[b]		0.41	0.30–0.48

[a]From Woolhiser, Ref. 26.
[b]Weeping lovegrass, bluegrass, buffalo grass, blue gramma grass, native grass mix (OK), alfalfa, lespedeza (from Palmer, Ref. 18).

for conditions greatly different from the field experiments. These data should be valid for so-called sheet flow or shallow-depth overland flow that match the conditions in the experimental plots. Channelized flow was present in many of the experimental runs, especially where tillage marks were present or when rilling had occurred. Channelization was not so obvious when the residue rates were greater than 1/4 ton per acre (5.6 metric ton/ha) (G. R. Foster, personal communication).

The depth of calculated flow should not become too large. On long flow planes, the routing models may calculate depths that may be unrealistically large. The users must be aware of this and limit the flow plane lengths. It appears that excessive depths would not be encountered if the slope lengths are on the order of 150–300 ft (50–100 m).

These roughness values include the effect of rain drop impact, which tends to increase the effective roughness. The rainfall intensities used in these erosion plots are fairly high, ranging from 2–4 in./hr (50–100 mm/h). The effective roughness will probably be less than these values if no rainfall is considered to be falling.

From "Roughness Coefficients for Routing Surface Runoff," by Edwin T. Engman, <u>Journal of Irrigation and Drainage Engineering</u>, vol 112, no. 1, Feb, 1986, pp39-53.

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 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

TABLE 3

FULL FLOW COEFFICIENT VALUES CIRCULAR CONCRETE PIPE

$Q = K\sqrt{S}$

$K = \frac{Q}{\sqrt{S}}$

D Pipe Diameter (inches)	A Area (Square Feet)	R Hydraulic Radius (Feet)	Value of $C_1 = \frac{1.486}{n} \times A \times R^{2/3} = K$			
			n=0.010	n=0.011	n=0.012	n=0.013
8	0.349	0.167	15.8	14.3	13.1	12.1
10	0.545	0.208	28.4	25.8	23.6	21.8
12	0.785	0.250	46.4	42.1	38.6	35.7
15	1.227	0.312	84.1	76.5	70.1	64.7
18	1.767	0.375	137	124	114	105
21	2.405	0.437	206	187	172	158
24	3.142	0.500	294	267	245	226
27	3.976	0.562	402	366	335	310
30	4.909	0.625	533	485	444	410
33	5.940	0.688	686	624	574	530
36	7.069	0.750	867	788	722	666
42	9.621	0.875	1308	1189	1090	1006
48	12.566	1.000	1867	1698	1556	1436
54	15.904	1.125	2557	2325	2131	1967
60	19.635	1.250	3385	3077	2821	2604
66	23.758	1.375	4364	3967	3636	3357
72	28.274	1.500	5504	5004	4587	4234
78	33.183	1.625	6815	6195	5679	5242
84	38.485	1.750	8304	7549	6920	6388
90	44.170	1.875	9985	9078	8321	7681
96	50.266	2.000	11850	10780	9878	9119
102	56.745	2.125	13940	12670	11620	10720
108	63.617	2.250	16230	14760	13530	12490
114	70.882	2.375	18750	17040	15620	14420
120	78.540	2.500	21500	19540	17920	16540
126	86.590	2.625	24480	22260	20400	18830
132	95.033	2.750	27720	25200	23100	21330
138	103.870	2.875	31210	28370	26010	24010
144	113.100	3.000	34960	31780	29130	26890

n = 0.024

TABLE 4

FULL FLOW COEFFICIENT VALUES ELLIPTICAL CONCRETE PIPE

Pipe Size R x S (HE) S x R (VE) (Inches)	Approximate Equivalent Circular Diameter (Inches)	A Area (Square Feet)	R Hydraulic Radius (Feet)	Value of $C_1 = \frac{1.486}{n} \times A \times R^{2/3} = K$			
				n = 0.010	n = 0.011	n = 0.012	n = 0.013
14 x 23	18	1.8	0.367	138	125	116	108
19 x 30	24	3.3	0.490	301	274	252	232
22 x 34	27	4.1	0.546	405	368	339	313
24 x 38	30	5.1	0.613	547	497	456	421
27 x 42	33	6.3	0.686	728	662	607	560
29 x 45	36	7.4	0.736	891	810	746	686
32 x 49	39	8.8	0.812	1140	1036	948	875
34 x 53	42	10.2	0.875	1386	1260	1156	1067
38 x 60	48	12.9	0.969	1878	1707	1565	1445
43 x 68	54	16.6	1.106	2635	2395	2196	2027
48 x 76	60	20.5	1.229	3491	3174	2910	2686
53 x 83	66	24.8	1.352	4503	4094	3753	3464
58 x 91	72	29.5	1.475	5680	5164	4734	4370
63 x 98	78	34.6	1.598	7027	6388	5856	5406
68 x 106	84	40.1	1.721	8560	7790	7140	6590
72 x 113	90	46.1	1.845	10300	9365	8584	7925
77 x 121	96	52.4	1.967	12220	11110	10190	9403
82 x 128	102	59.2	2.091	14380	13070	11980	11060
87 x 136	108	66.4	2.215	16770	15240	13970	12900
92 x 143	114	74.0	2.340	19380	17620	16150	14910
97 x 151	120	82.0	2.461	22190	20180	18490	17070
106 x 166	132	99.2	2.707	28630	26020	23860	22020
116 x 180	144	118.6	2.968	36400	33100	30340	28000

TABLE 5

FULL FLOW COEFFICIENT VALUES CONCRETE ARCH PIPE

Pipe Size R x S (Inches)	Approximate Equivalent Circular Diameter (Inches)	A Area (Square Feet)	R Hydraulic Radius (Feet)	Value of $C_1 = \frac{1.486}{n} \times A \times R^{2/3} = K$			
				n = 0.010	n = 0.011	n = 0.012	n = 0.013
11 x 18	15	1.1	0.25	65	59	54	50
13½ x 22	18	1.6	0.30	110	100	91	84
15½ x 26	21	2.2	0.36	165	150	137	127
18 x 28½	24	2.8	0.45	243	221	203	187
22½ x 36¼	30	4.4	0.56	441	401	368	339
26⅝ x 43¾	36	6.4	0.68	736	669	613	566
31 5/16 x 51⅛	42	8.8	0.80	1125	1023	938	866
36 x 58½	48	11.4	0.90	1579	1435	1315	1214
40 x 65	54	14.3	1.01	2140	1945	1783	1646
45 x 73	60	17.7	1.13	2851	2592	2376	2193
54 x 88	72	25.6	1.35	4641	4219	3867	3569
62 x 102	84	34.6	1.57	6941	6310	5784	5339
72 x 115	90	44.5	1.77	9668	8789	8056	7436
77¼ x 122	96	51.7	1.92	11850	10770	9872	9112
87⅛ x 138	108	66.0	2.17	16430	14940	13690	12640
96⅞ x 154	120	81.8	2.42	21975	19977	18312	16904
106½ x 168¾	132	99.1	2.65	28292	25720	23577	21763

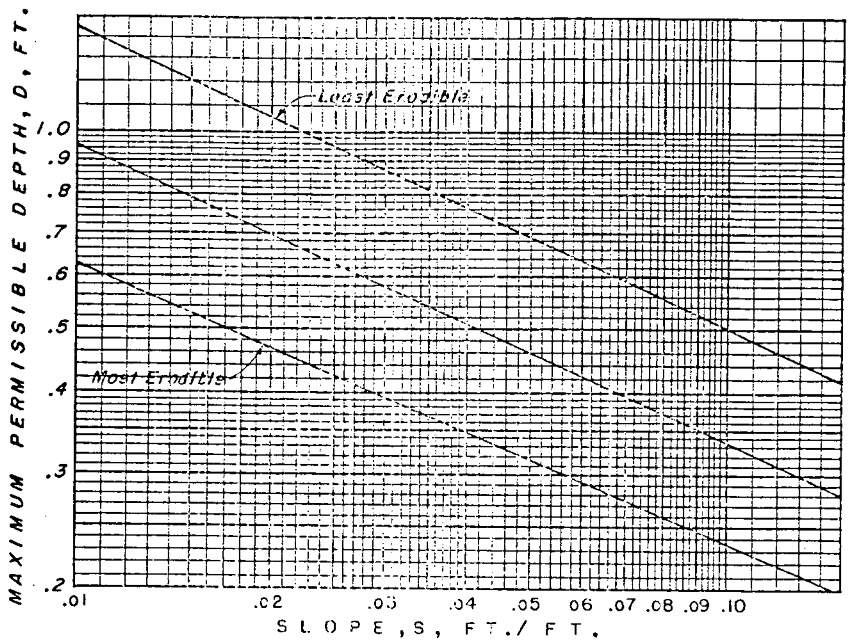
3D-4-1-1-1 Retardance Class: The roughness of a grassed channel, as well as the ability of the channel to withstand erosive forces, is dependent upon the height and quality of vegetation established within the channel. Grassed channels are broken into five retardance classes based on these factors. The following table gives a guide for determining the retardance class for grassed channels.

GUIDE TO SELECTION OF VEGETAL RETARDANCE

Quality of Stand	Average Length of Vegetation	Retardance Class
Good	Longer than 30"	A
Fair	Longer than 30"	B
Good	11" to 24"	B
Fair	11" to 24"	C
Good	6" to 10"	C
Fair	6" to 10"	D
Good	2" to 6"	D
Fair	2" to 6"	D
Good	Less than 2"	E
Fair	Less than 2"	E

The Landscape Section of the Design Department will specify grass types and seeding procedures that will result in a stand of grass providing Class B retardance. The retardance class in medians and ditches in urban areas will be Class D, as these areas are mowed regularly.

RETARDANCE CLASS D



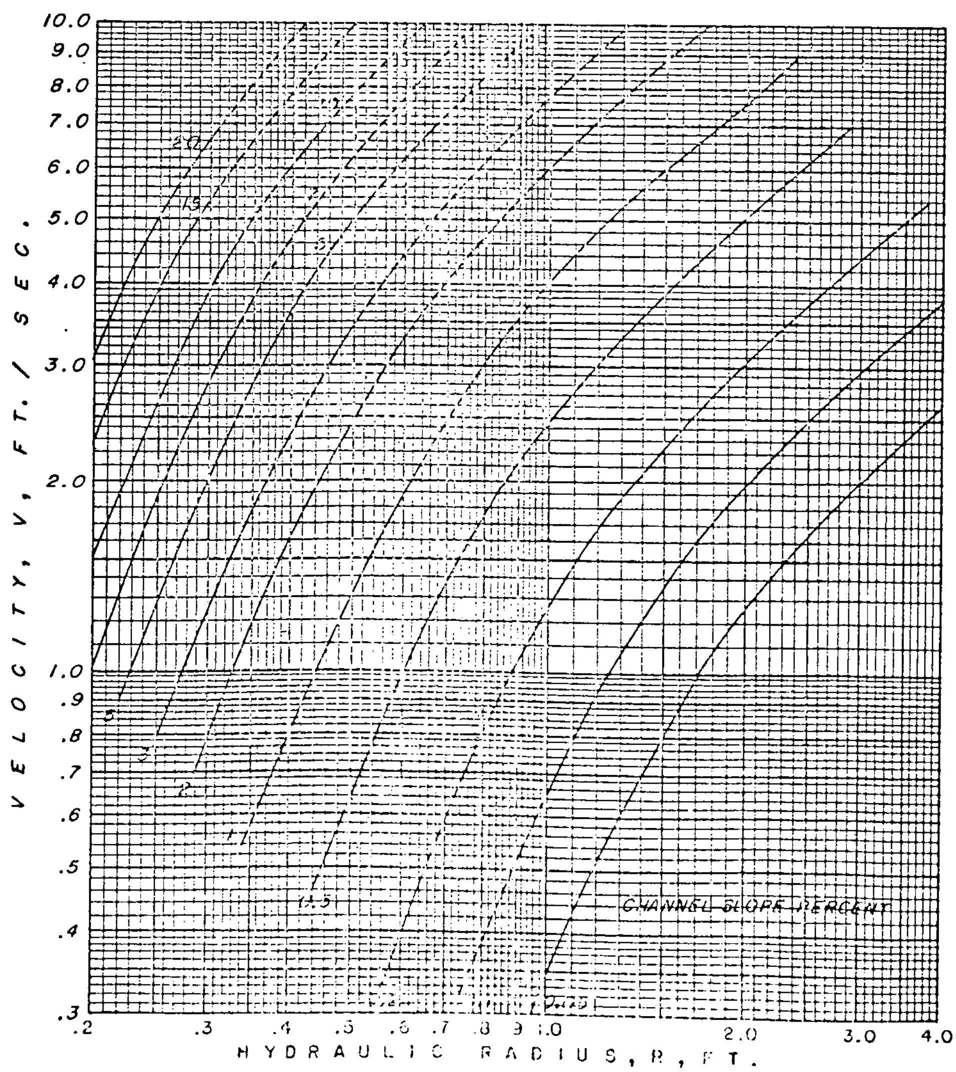
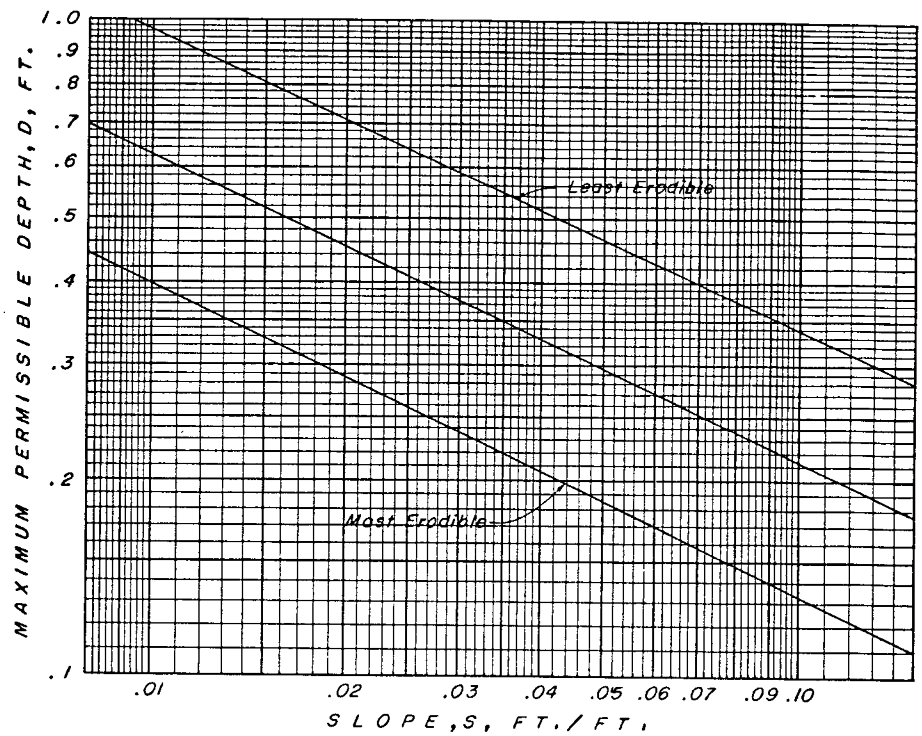


Figure 5D-4-1-1-D

RETARDANCE CLASS E



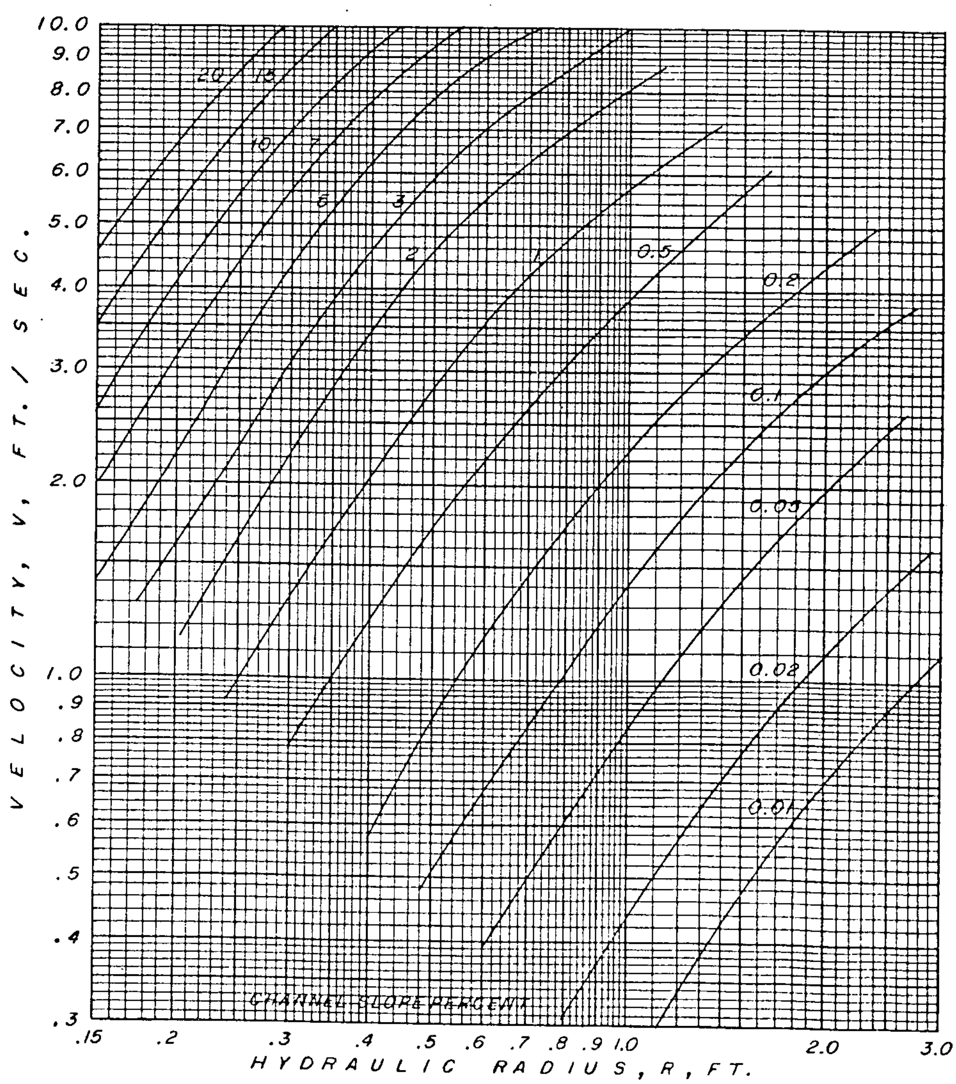


Figure 3D-4-1-1-E

HYDRAULIC PROPERTIES OF TRAPEZOIDAL CHANNELS (AREA OF FLOW)

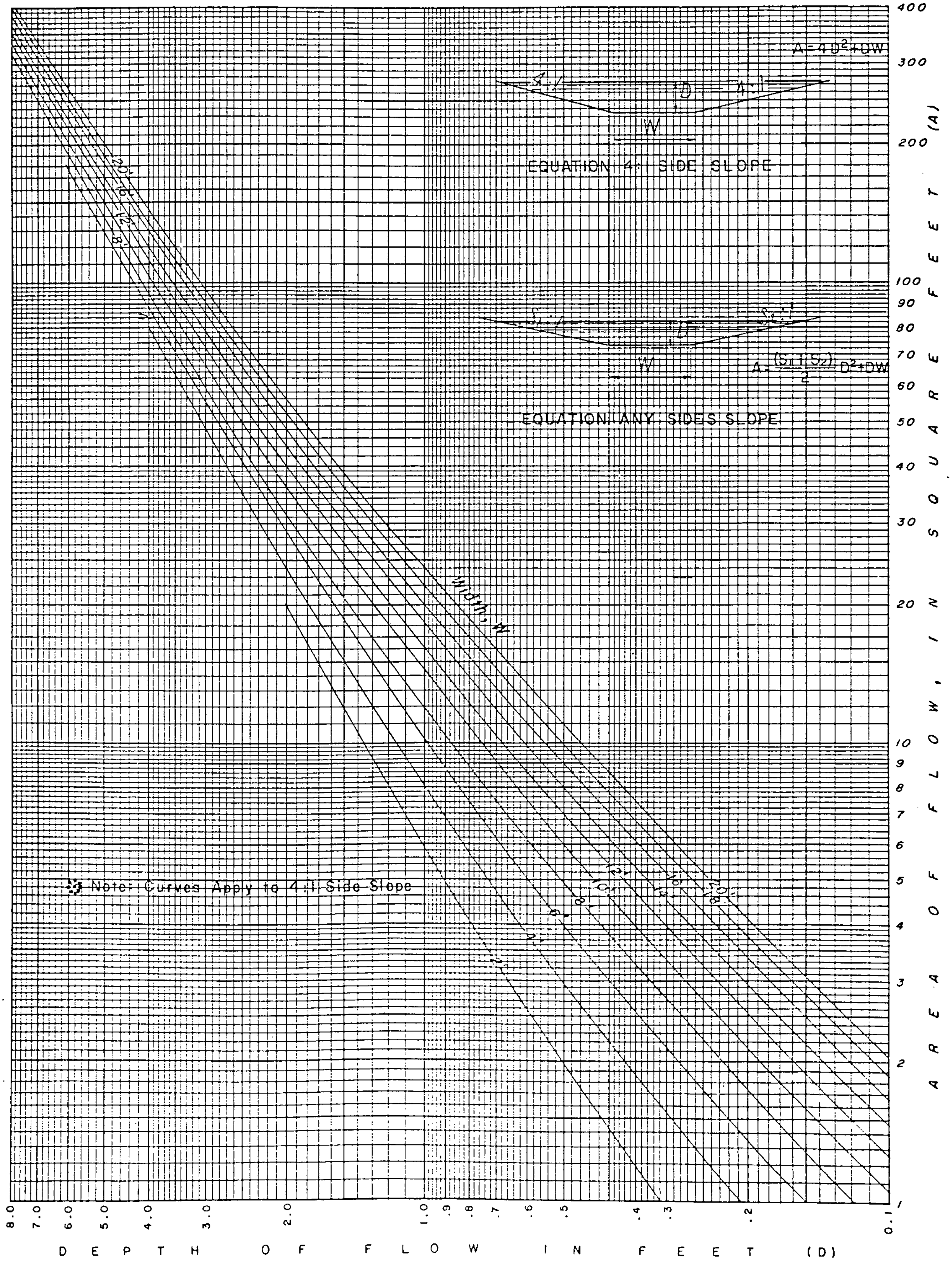


Figure 3D-4-1-1-3-A

HYDRAULIC PROPERTIES OF TRAPEZOIDAL CHANNELS (HYDRAULIC RADIUS)

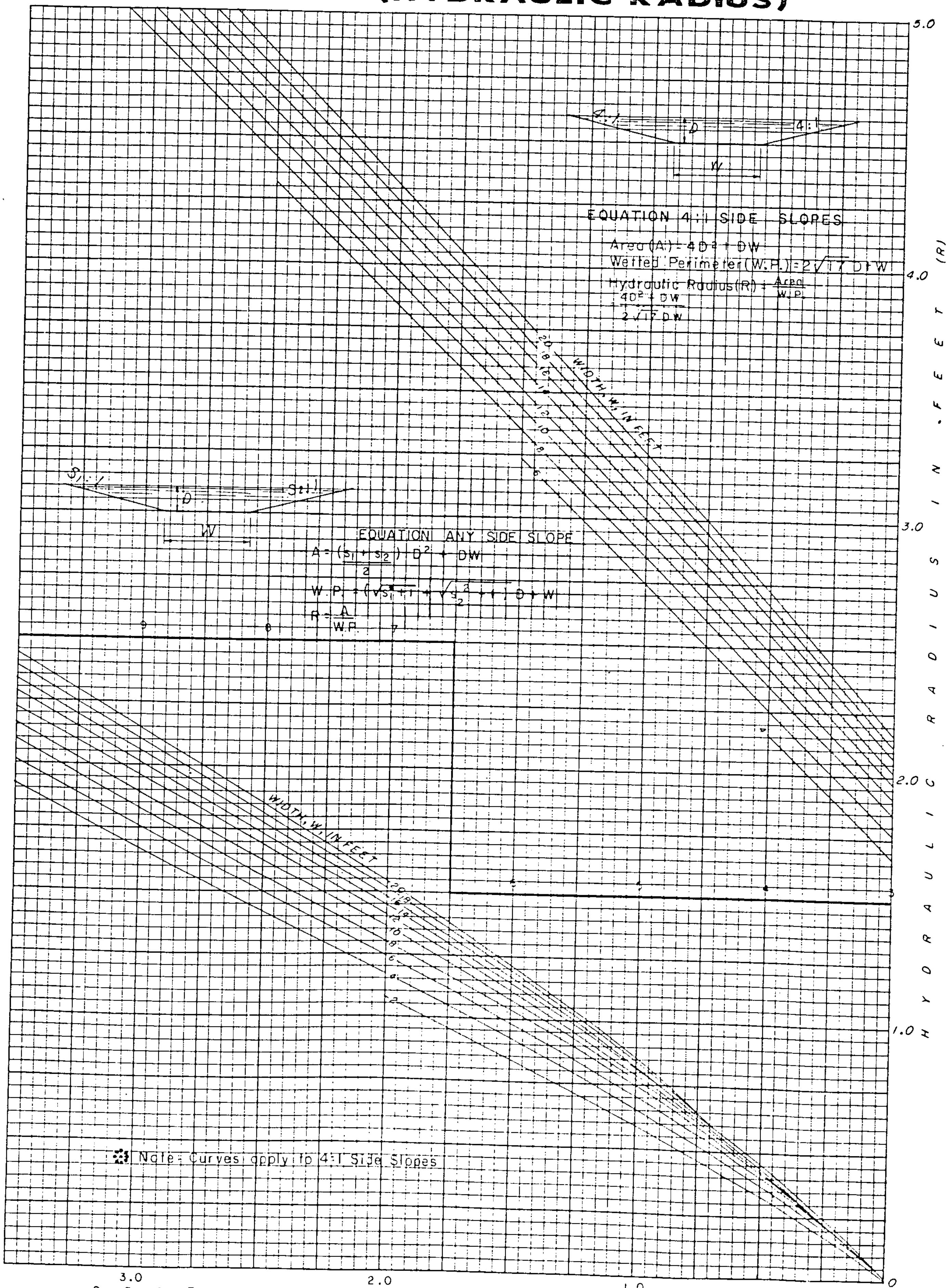


Figure 3D-4-1-1-3-B