

**P**ROFESSIONAL  
**E**NGINEERING  
**C**ONSULTANTS  
PROFESSIONAL ASSOCIATION

DRAINAGE PLAN  
AND  
SUPPORTING CALCULATIONS

FOR  
TALLGRASS EAST 3RD ADDITION  
TO WICHITA, SEDGWICK COUNTY, KANSAS

PREPARED BY  
PROFESSIONAL ENGINEERING CONSULTANTS, P.A.  
ENGINEERS  
WICHITA, KANSAS

AUGUST 11, 1989



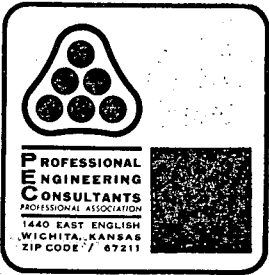
Date 8-8-89 Page 1 of 1

Project Tollgrass East 3rd Addition

Item Drainage Plan - Introduction

The proposed Tollgrass East 3rd Addition is the final segment of development within the Tollgrass East community. The original Tollgrass East Preliminary Plat was submitted to the City by Bill Yung Design in 198. Tollgrass East 3rd consists of the eastern portion of the original preliminary plat.

The proposed detention pond located north of the north line of Tollgrass East 3rd will accept drainage from parts of Tollgrass East 1st Add, Tollgrass East 3rd Addition, future Tollgrass East Business Park (C.U.P. now being prepared by Bill Yung Design), and an undeveloped tract owned by the Wichita Airport Authority located south of Jbara Airport. The proposed discharge from the detention pond will approximate the undeveloped runoff from the basin. It will discharge into the southwesterly ditch of the proposed K-96 Bypass now being designed by PEC.



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Project Tallgrass East 3rd Addition

Item Drainage Plan System 1

HYDROLOGY

Use Rational Method  $Q = C_i A$

- Determine "C"

<u>Node</u>	<u>Soil Type</u>	<u>Hyd. Group</u>	<u>Land Use</u>	<u>C<sub>2</sub></u>	<u>C<sub>100</sub></u>
117	Ia	D	1/4 Ac. Res.	0.50	0.73
116	Ia	D	1/4 Ac. Res.	0.50	0.73
115	Ia	D	1/4 Ac. Res.	0.50	0.73
114	Ia	D	1/4 Ac. Res.	0.50	0.73
113	Ia	D	1/4 Ac. Res.	0.50	0.73
112	Ia	D	1/4 Ac. Res.	0.50	0.73
111	Rd	D	1/4 Ac. Res.	0.50	0.73
110	Rd	D	1/4 Ac. Res.	0.50	0.73
109	Rd	D	1/4 Ac. Res.	0.50	0.73
108	Rd	D	1/4 Ac. Res.	0.50	0.73
107	Rd	D	1/4 Ac. Res.	0.50	0.73
106	Rd	D	1/4 Ac. Res.	0.50	0.73
105	Rd	D	1/4 Ac. Res.	0.50	0.73
104	Rd	D	1/4 Ac. Res.	0.50	0.73
103	Rd	D	1/4 Ac. Res.	0.50	0.73
102	Rd	D	1/4 Ac. Res.	0.50	0.73
101	(Manhole)				
100	(Headwall)				



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Project Tallgrass East 3rd Addition

Item Drainage Plan System 1

• Determine "i" and "A"

<u>No.</u>	<u>Node</u>	<u>t<sub>c</sub></u>	<u>i<sub>2</sub></u>	<u>i<sub>100</sub></u>	<u>A</u>
	117	15 min.	3.83 <sup>in</sup> /hr	7.37 <sup>in</sup> /hr	3.6 Ac.
	116	15	3.83	7.37	1.0
	115	15	3.83	7.37	0.9
	114	15	3.83	7.37	0.9
	113	15	3.83	7.37	1.7
	112	15	3.83	7.37	2.6
	111	15	3.83	7.37	1.5
	110	15	3.83	7.37	2.8
	109	15	3.83	7.37	2.9
	108	15	3.83	7.37	5.9
	107	15	3.83	7.37	5.9
	106	15	3.83	7.37	2.6
	105	15	3.83	7.37	1.8
	104	15	3.83	7.37	0.9
	103	15	3.83	7.37	4.9
	102	15	3.83	7.37	2.5
	101	(Manhole)			
	100	(Headwall)			



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Project Tallgrass East 3rd Addition

Item Drainage Plan System 1

• Determine  $Q_2$

<u>Node</u>	<u><math>C_2</math></u>	<u><math>i_2</math></u>	<u>A</u>	<u><math>Q_2</math></u>
117	0.50	3.83 $\frac{1"}{hr}$	3.6 Ac.	6.9 cfs
116	0.50	3.83	1.0	1.9
115	0.50	3.83	0.9	1.7
114	0.50	3.83	0.9	1.7
113	0.50	3.83	1.7	3.3
112	0.50	3.83	2.6	5.0
111	0.50	3.83	1.5	2.8
110	0.50	3.83	2.8	5.4
109	0.50	3.83	2.9	5.6
108	0.50	3.83	5.9	11.3
107	0.50	3.83	5.9	11.3
106	0.50	3.83	2.6	5.0
105	0.50	3.83	1.8	3.4
104	0.50	3.83	0.9	1.7
103	0.50	3.83	4.9	9.4
102	0.50	3.83	2.5	4.8
101	(Manhole)			
100	(Headwall)			



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Project Tallgrass East 3rd Addition

Item Drainage Plan System 1

6 Determine Q<sub>100</sub>

<u>Node</u>	<u>S<sub>100</sub></u>	<u>i<sub>100</sub></u>	<u>A</u>	<u>Q<sub>100</sub></u>
117	0.73	7.37 <sup>10%</sup>	3.6 Ac.	19.4 cfs
116	0.73	7.37	1.0	5.4
115	0.73	7.37	0.9	4.8
114	0.73	7.37	0.9	4.8
113	0.73	7.37	1.7	9.1
112	0.73	7.37	2.6	14.0
111	0.73	7.37	1.5	8.1
110	0.73	7.37	2.8	15.1
109	0.73	7.37	2.9	15.6
108	0.73	7.37	5.9	31.7
107	0.73	7.37	5.9	31.7
106	0.73	7.37	2.6	14.0
105	0.73	7.37	1.8	9.7
104	0.73	7.37	0.9	4.8
103	0.73	7.37	4.9	26.4
102	0.73	7.37	2.5	13.5
101	(Manhole)			
100	(Headwall)			





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Project Tallgrass East 3rd Addition

Item Drainage Plan System 1

STREET FLOW (2-yr.)

<u>Node</u>	<u>Q<sub>2</sub></u>	<u>Distribution</u>	<u>St. Slope (%)</u>	<u>d</u>	<u>d<sub>max</sub></u>	<u>Comment</u>
117	6.9	100% (sw)	0.32	0.44'	0.55'	OK
116	1.9	60% (w) = 1.1 40% (E) = 0.8	0.32	0.22'	0.30'	OK
115	1.7	100% (W)	0.32	0.26'	0.30'	OK
114	1.7 + 2.4 = 4.1	100% (sw)	1.80	0.25'	0.30'	OK
113	3.3 + 1.2 = 4.5	50% (s) = 2.25 50% (E) = 2.25	1.80	0.21'	0.30'	OK
112	5.0 + 0.7 = 5.7	40% (W) = 2.3 60% (S) = 3.4	1.00	0.23'	0.30'	OK
111	2.8	100% (S)	0.64	0.28'	0.30'	OK
110	5.4	40% (N) = 2.2 60% (S) = 3.2	2.20	0.21'	0.30'	OK
109	5.6	40% (N) = 2.3 60% (S) = 3.3	0.92	0.24'	0.30'	OK
108	11.3	90% (S) = 10.2 10% (W) = 1.1	0.42	0.32'	0.55'	OK
107	11.3	100% (S)	1.64	0.17'	0.30'	OK
106	5.0	100% (S)	0.56	0.48'	0.55'	OK
105	3.4 + 6.9 = 10.3	100% (S)	0.56	0.34'	0.55'	OK
104	1.7 + 5.2 = 6.9	100% (S)	0.45	0.45'	0.55'	OK
103	2.4 + 1.0 + 2.1 = 5.5	60% (E) = 3.3 40% (W) = 2.2	0.45	0.41'	0.55'	OK
102	4.8 + 2.8 = 7.6	50% (E) = 3.8 50% (W) = 3.8	0.40	0.43'	0.55'	OK
101	(Manhole)			0.37'	0.55'	OK
100	(Headwall)			0.33'	0.55'	OK



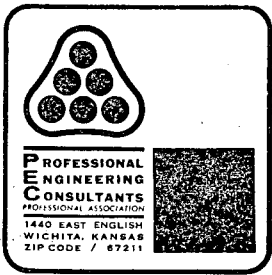
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Project Tallgrass East 3rd Addition

Item Drainage Plan System 1

STREET FLOW (cont.)  
(100-yr.)

<u>Location</u>	<u>Contrib. Areas</u>	<u>Q<sub>100</sub></u>	<u>Q<sub>pipe</sub></u>	<u>Q<sub>street</sub></u>	<u>Street slope</u>	<u>Q<sub>max</sub></u>	<u>Comment</u>
Approaching 113 from South	50% 112 =	17.0	2.9				
	50% 113 =	7.6	2.2				
	114 =	4.8	2.9				
	115 =	4.8	1.0				
	116 =	5.4	1.9		1.80%		
	117 =	19.4	4.5				
			<u>46.0</u>	<u>- 15.4</u>	<u>= 30.6</u>		<u>54.2</u>
Approaching Node 109 from South	117	19.4	4.5				
	116	5.4	1.9				
	115	4.8	1.0				
	114	4.8	2.9				
	113	9.1	4.5				
	112	14.0	5.7				
	111	8.1	1.8				
	110	15.1	5.4				
	50% 109	7.8	2.8				
	20% 103	6.3	2.5				
		<u>94.8</u>	<u>- 33.0</u>	<u>= 61.8</u>	0.40%	65.5	Ok Std. Curb 0.4' Wk.Gr.
Approaching Node 102 from West	117	19.4	4.5				
	116	5.4	1.9				
	115	4.8	1.0				
	114	4.8	2.9				
	113	9.1	4.5				
	112	14.0	5.7				
	111	8.1	1.8				
	110	15.1	5.4				
	109	15.6	5.6				
	40% 103	10.6	5.0				
70% 102	9.5	5.3					
		<u>116.4</u>	<u>- 43.6</u>	<u>72.8</u>	0.40%	83.9	Ok - Std. Cb. 0.5' Wk. Gr.



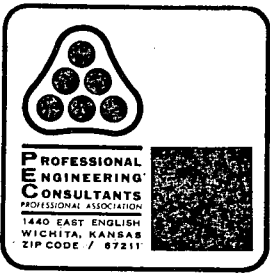
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Project Tallgrass East 3rd Addn.

Item Drainage Plan System 1

STREET FLOW (cont.)

(100-yr.)							
<u>Location</u>	<u>Contrib. Areas</u>	<u>Q<sub>100</sub></u>	<u>Q<sub>pipe</sub></u>	<u>Q<sub>street</sub></u>	<u>Street Slope</u>	<u>Q<sub>max</sub></u>	<u>Comment</u>
Approaching	108	31.7	11.3				
Node 105 from	107	31.7	4.4				
South	106	14.0					
	105	9.7					
		<u>87.1</u>	<u>-15.7</u>	<u>= 71.4</u>	<u>0.56%</u>	<u>77.4</u>	<u>OK</u> <u>Std. Curb</u> <u>0.4' Wk. Gr.</u>



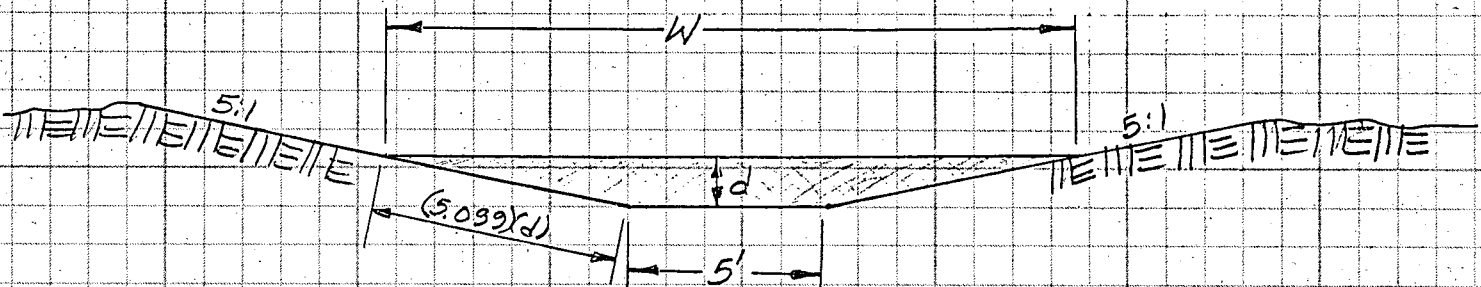
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Project Tallgrass East 3rd Addition

Item Drainage Plan System 1

OVERFLOW CHANNEL

50' Drainage Easement



$$Q_{\text{channel}} = Q_{100} - Q_2$$

$$= 228.1 - 81.2$$

$$= 146.9 \text{ cfs}$$

Assume longitudinal slope = 0.50%

Use Manning's Equation:

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

$$146.9 = \frac{1.486}{0.03} AR^{2/3} (0.005)^{1/2}$$

$$110.5 = 49.53 AR^{2/3} (0.0707)$$

$$AR^{2/3} = 41.94$$

$$A = (d)(5) + (d^2)(5)$$

$$P = 5' + (2)(d)(5.099)$$

<u>d</u>	<u>A</u>	<u>P</u>	<u>R = A/P</u>	<u>R<sup>2/3</sup></u>	<u>AR<sup>2/3</sup></u>
1.5'	18.75'	20.30'	0.9236	0.9484	17.78
2.25'	36.56	27.95	1.3084	1.1962	43.73
2.20'	35.20	27.44	1.2830	1.1807	41.56 ←

Use  $d = 2.20'$

$$V = Q/A = \frac{146.9}{35.20} = 4.17 \text{ fps } \underline{OK}$$

$$W = 5' + 2(5 \times 2.20) = 27.00' < 50' \underline{OK}$$



Date: 08-11-1989  
Time: 11:25:57

Input File: TALLSYS1.STM

TALLGRASS 3RD S W S - SYSTEM 1

Storm Frequency = 2-Year

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

*****												*****					
Tributary Area								Hydrology Summation				Conduit Data					
Node to	C	Area	Slope	Length	TC(0)	I(0)	O(0)	TC	I	O	Sum Q	Size	Velocity	Length	TT	TT+TC	
Node		(Ac)	(%)	(Ft)	(Min)	(In/Hr)	(CFS)	(Min)	(In/Hr)	(CFS)	(CFS)		(Ft/Sec)	(Ft)	(Min)	(Min)	
*****																	
116	115	.50	1.00	.00	.0	15.00	3.83	1.90	15.00	3.83	1.90	1.90	15"	1.55	60.00	.65	15.65
117	115	.50	3.60	.00	.0	15.00	3.83	6.90	15.00	3.83	6.90	6.90	15"	5.62	60.00	.18	15.18
115	114	.50	.90	.00	.0	15.00	3.83	1.00	15.18	3.81	.99	9.74	18"	5.51	300.00	.91	16.09
114	112	.50	.90	.00	.0	15.00	3.83	1.80	16.09	3.71	1.74	11.48	18"	6.50	210.00	.54	16.62
113	112	.50	1.70	.00	.0	15.00	3.83	4.50	15.00	3.83	4.50	4.50	15"	3.67	35.00	.16	15.16
112	110	.50	2.60	.00	.0	15.00	3.83	5.70	16.62	3.65	5.44	21.23	30"	4.32	325.00	1.25	17.88
111	110	.50	1.50	.00	.0	15.00	3.83	1.80	15.00	3.83	1.80	1.80	15"	1.47	35.00	.40	15.40
110	109	.50	2.80	.00	.0	15.00	3.83	5.40	17.88	3.53	4.97	27.88	36"	3.94	315.00	1.33	19.21
109	102	.50	2.90	.00	.0	15.00	3.83	5.60	19.21	3.40	4.98	32.86	42"	3.41	250.00	1.22	20.43
103	102	.50	4.90	.00	.0	15.00	3.83	12.50	15.00	3.83	12.50	12.50	30"	2.55	35.00	.23	15.23
102	101	.50	2.50	.00	.0	15.00	3.83	7.40	20.43	3.30	6.37	80.50	54"	5.06	175.00	.58	21.00
101	100	.00	.00	.00	.0	.00	.00	.00	21.00	3.25	.00	80.50	54"	5.06	30.00	.10	21.10
108	107	.50	5.90	.00	.0	15.00	3.83	11.30	15.00	3.83	11.30	11.30	24"	3.60	75.00	.35	15.35
107	105	.50	5.90	.00	.0	15.00	3.83	11.30	15.35	3.79	11.18	22.48	30"	4.58	515.00	1.87	17.22
106	105	.50	2.60	.00	.0	15.00	3.83	2.90	15.00	3.83	2.90	2.90	18"	1.64	35.00	.36	15.36
105	104	.50	1.80	.00	.0	15.00	3.83	4.10	17.22	3.59	3.84	29.08	30"	5.92	115.00	.32	17.55
104	102	.50	.90	.00	.0	15.00	3.83	3.20	17.55	3.56	2.97	32.05	36"	4.53	240.00	.88	18.43
*****																	

12/12

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Time: 11:25:57

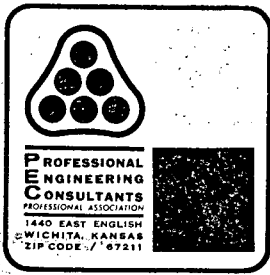
Input File: TALLSYS1.STM

TALLGRASS 3RD S W S - SYSTEM 1

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)
117	.01141	.6846	.0000	.0000	.0000	.0000	.0000	.6846	205.9255	211.4000	5.47
116	.00087	.0519	.0000	.0000	.0000	.0000	.0000	.0519	205.2929	211.4000	6.11
115	.00859	2.5782	.0000	.0039	.0000	.3123	.3157	3.2101	205.2410	211.4000	6.16
114	.01195	2.5087	.0000	.0184	.0000	.1026	.4199	3.0496	202.0309	206.5000	4.47
113	.00485	.1698	.0000	.0000	.0000	.0000	.0000	.1698	199.1512	201.5000	2.35
112	.00268	.8705	.0000	.0730	.0000	.0877	.1970	1.2282	198.9813	201.5000	2.52
111	.00078	.0272	.0000	.0000	.0000	.0000	.0000	.0272	197.7803	199.8000	2.02
110	.00175	.5503	.0000	.0098	.0000	.0389	.1122	.7112	197.7531	199.8000	2.05
109	.00107	.2666	.0000	.0121	.0000	.0526	.0154	.3467	197.0419	198.6000	1.56
108	.00250	.1871	.0000	.0000	.0000	.0000	.0000	.1871	200.7128	202.1000	1.39
107	.00300	1.5473	.0000	.0125	.0000	.0437	.4955	2.0991	200.5256	202.1000	1.57
106	.00076	.0267	.0000	.0000	.0000	.0000	.0000	.0267	198.4532	199.2000	.75
105	.00502	.5779	.0000	.0219	.0000	.0709	.4642	1.1349	198.4265	199.2000	.77
104	.00231	.5541	.0000	.0451	.0000	.1186	-.1214	.5964	197.2917	198.7000	1.41
103	.00093	.0325	.0000	.0000	.0000	.0000	.0000	.0325	196.7278	198.0000	1.27
102	.00168	.2933	.0000	.0217	.0000	.0727	.6490	1.0367	196.6953	198.0000	1.30
101	.00168	.0503	.0000	.0000	.0199	.0000	.0084	.0786	195.6586	197.0000	1.34
100	.00000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	195.5800	195.5800	.00



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 Project Tallgrass East 3rd Addition  
 Item Drainage Plan System 3

HYDROLOGY

Use Rational Method  $Q = CiA$

- Determine "C"

<u>Node</u>	<u>Soil Type</u>	<u>Hyd. Group</u>	<u>Land Use</u>	<u>C<sub>2</sub></u>	<u>C<sub>100</sub></u>
302	Ia	D	1/4 Ac. Res.	0.50	0.73
301	Ia	D	1/4 Ac. Res.	0.50	0.73
300	(Headwall)				

- Determine "i" & "A"

<u>Node</u>	<u>t<sub>c</sub></u>	<u>i<sub>2</sub></u>	<u>i<sub>100</sub></u>	<u>A (Acres)</u>
302	15	3.83	7.37	7.2
301	15	3.83	7.37	6.8
300	(Headwall)			

- Determine Q<sub>2</sub>

<u>Node</u>	<u>C<sub>2</sub></u>	<u>i<sub>2</sub></u>	<u>A</u>	<u>Q<sub>2</sub></u>
302	0.50	3.83	7.2	13.8
301	0.50	3.83	6.8	13.0
300	(Headwall)			



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Project Tallgrass East 3rd Addition

Item Drainage Plan System 3

• Determine  $Q_{100}$

<u>Node</u>	<u><math>C_{100}</math></u>	<u><math>i_{100}</math></u>	<u>A</u>	<u><math>Q_{100}</math> (cfs)</u>
302	0.73	7.37	7.2	38.7
301	0.73	7.37	6.8	36.6
300 (Headwall)				

INLET SIZING/FLOOD ROUTING (100-yr.)

<u>Node</u>	<u><math>Q_{100}</math></u>	<u>Inlet Cond.</u>	<u>L</u>	<u>LT</u>	<u><math>\frac{1}{2}</math>LT</u>	<u>Eff.</u>	<u>L</u>	<u><math>Q_{max}</math></u>	<u><math>Q_i^*</math></u>	<u><math>Q_{by}</math></u>
			<u>(Inlets on Grade)</u>				<u>(Inlets in sump)</u>		<u>(intercept)</u>	<u>(bypass)</u>
302	38.7	Sump					15'	49.5**	38.7	
301	36.6	Sump					15'	49.5**	36.6	
300 (Headwall)										

\* Input Q in "Storm" program

\*\* 0.7' Walk Grade Required

STREET FLOW

<u>(2-yr)</u>	<u>Node</u>	<u><math>Q_2</math></u>	<u>Distribution</u>	<u>Street Slope</u>	<u>d</u>	<u><math>d_{max}</math></u>	<u>Comment</u>
	302	13.8	30%(W)=4.1 70%(E)=9.7	1.64% 0.40%	0.27' 0.48'	0.30' 0.55'	OK OK
	301	13.0	30%(W)=3.9 70%(E)=9.1	1.64% 0.40%	0.27' 0.46'	0.30' 0.55'	OK OK

(100-yr)

<u>Location</u>	<u>Contrib. Areas</u>	<u><math>Q_{100}</math></u>	<u><math>Q_{pipe}</math></u>	<u><math>Q_{street}</math></u>	<u>Street Slope</u>	<u><math>Q_{max}</math></u>	<u>Comment</u>
Appr. Node	302	38.7					
301 from West	90%-301	11.7					
		50.4	38.7	11.7	0.40%	90.5	OK - Roll Curb 0.7' Wk. Gr.



Date: 07-28-1989  
Time: 16:04:39

Input File: tallsys3.stm

TALLGRASS 3RD S W S - SYSTEM 3

Storm Frequency = 100-Year

\*\*\* HYDROLOGY \*\*\*

Tributary Area										Hydrology Summation				Conduit Data				
Node to	C	Area	Slope	Length	TC(0)	I(0)	Q(0)	TC	I	Q	Sum Q	Size	Velocity	Length	TT	TT+TC		
Node		(Ac)	(%)	(Ft)	(Min)	(In/Hr)	(CFS)	(Min)	(In/Hr)	(CFS)	(CFS)		(Ft/Sec)	(Ft)	(Min)	(Min)		
302	301	.73	7.20	.00	.0	15.00	7.37	38.70	15.00	7.37	38.70	38.70	36"	5.47	110.00	.33	15.33	
301	300	.73	6.80	.00	.0	15.00	7.37	36.60	15.33	7.30	36.28	74.98	42"	7.79	200.00	.43	15.76	



## Worksheet 2: Runoff curve number and runoff

Project Tallgrass East 3rd Add By CMB Date 8.3.89

Location SEC 4, T27S, R2E Checked BdB Date 8-8-89

Circle one: Present Developed \_\_\_\_\_

### 1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN <sup>1/</sup>			Area <input type="checkbox"/> acres <input type="checkbox"/> mi <sup>2</sup> <input checked="" type="checkbox"/> %	Product of CN x area
		Table 2-2	Fig. 2-3	Fig. 2-4		
Ce C	Pasture ; Fair	79 ✓			10	790
Ma B	" "	69 ✓			10	690
Gb, Rd, Ta, Ia D	" "	84 ✓			80	6,720
Totals =					100	8200

<sup>1/</sup> Use only one CN source per line.

CN (weighted) =  $\frac{\text{total product}}{\text{total area}} = \frac{8200}{100} = 82$ ; Use CN = 82 ✓

### 2. Runoff

Frequency ..... yr  
 Rainfall, P (24-hour) ..... in  
 Runoff, Q ..... in  
 (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)

Storm #1	Storm #2	Storm #3
10	100	
5.3	7.8	
3.2	5.6	

### Worksheet 3: Time of concentration (T<sub>c</sub>) or travel time (T<sub>t</sub>)

Project Tellgrass East 3rd. Add By CSB Date \_\_\_\_\_

Location \_\_\_\_\_ Checked BdB Date 8-8-89

Circle one: Present Developed \_\_\_\_\_

Circle one: T<sub>c</sub> T<sub>t</sub> through subarea \_\_\_\_\_

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

<u>Sheet flow</u> (Applicable to T <sub>c</sub> only)	Segment ID		
1. Surface description (table 3-1) .....		Short Grass	
2. Manning's roughness coeff., n (table 3-1) ..		0.15 ✓	
3. Flow length, L (total L ≤ 300 ft) .....	ft	300	
4. Two-yr 24-hr rainfall, P <sub>2</sub> .....	in	35 ✓	
5. Land slope, s .....	ft/ft	0.02 ✓	
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T <sub>t</sub> .....	hr	0.376 + [ ] = 0.376 ✓	

<u>Shallow concentrated flow</u>	Segment ID		
7. Surface description (paved or unpaved) .....		Unpaved	
8. Flow length, L .....	ft	800	
9. Watercourse slope, s .....	ft/ft	0.016	
10. Average velocity, V (figure 3-1) .....	ft/s	2	
11. $T_t = \frac{L}{3600 V}$ Compute T <sub>t</sub> .....	hr	0.111 ✓ + [ ] = 0.111 ✓	

<u>Channel flow</u>	Segment ID		
12. Cross sectional flow area, a .....	ft <sup>2</sup>		
13. Wetted perimeter, p <sub>w</sub> .....	ft		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r .....	ft		
15. Channel slope, s .....	ft/ft		
16. Manning's roughness coeff., n .....			
17. $v = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V .....	ft/s	3	Assumed ✓
18. Flow length, L .....	ft	2000	
19. $T_t = \frac{L}{3600 V}$ Compute T <sub>t</sub> .....	hr	0.185 + [ ] = 0.185 ✓	
20. Watershed or subarea T <sub>c</sub> or T <sub>t</sub> (add T <sub>t</sub> in steps 6, 11, and 19) .....	hr		0.672 ✓

### Worksheet 4: Graphical Peak Discharge method

Project Tallgrass East 3rd Add By CSB Date \_\_\_\_\_

Location \_\_\_\_\_ Checked BdB Date 8-8-89

Circle one: Present Developed \_\_\_\_\_

1. Data:

Drainage area .....  $A_m = 0.1906$  mi<sup>2</sup> (acres/640) 122Ac.

Runoff curve number .... CN = 82 (From worksheet 2)

Time of concentration ..  $T_c = 0.672$  hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ..... = 0 percent of  $A_m$  (\_\_\_\_ acres or mi<sup>2</sup> covered)

2. Frequency ..... yr

3. Rainfall, P (24-hour) ..... in

4. Initial abstraction,  $I_a$  ..... in  
(Use CN with table 4-1.)

5. Compute  $I_a/P$  .....

6. Unit peak discharge,  $q_u$  ..... csm/in  
(Use  $T_c$  and  $I_a/P$  with exhibit 4-II)

7. Runoff, Q ..... in  
(From worksheet 2).

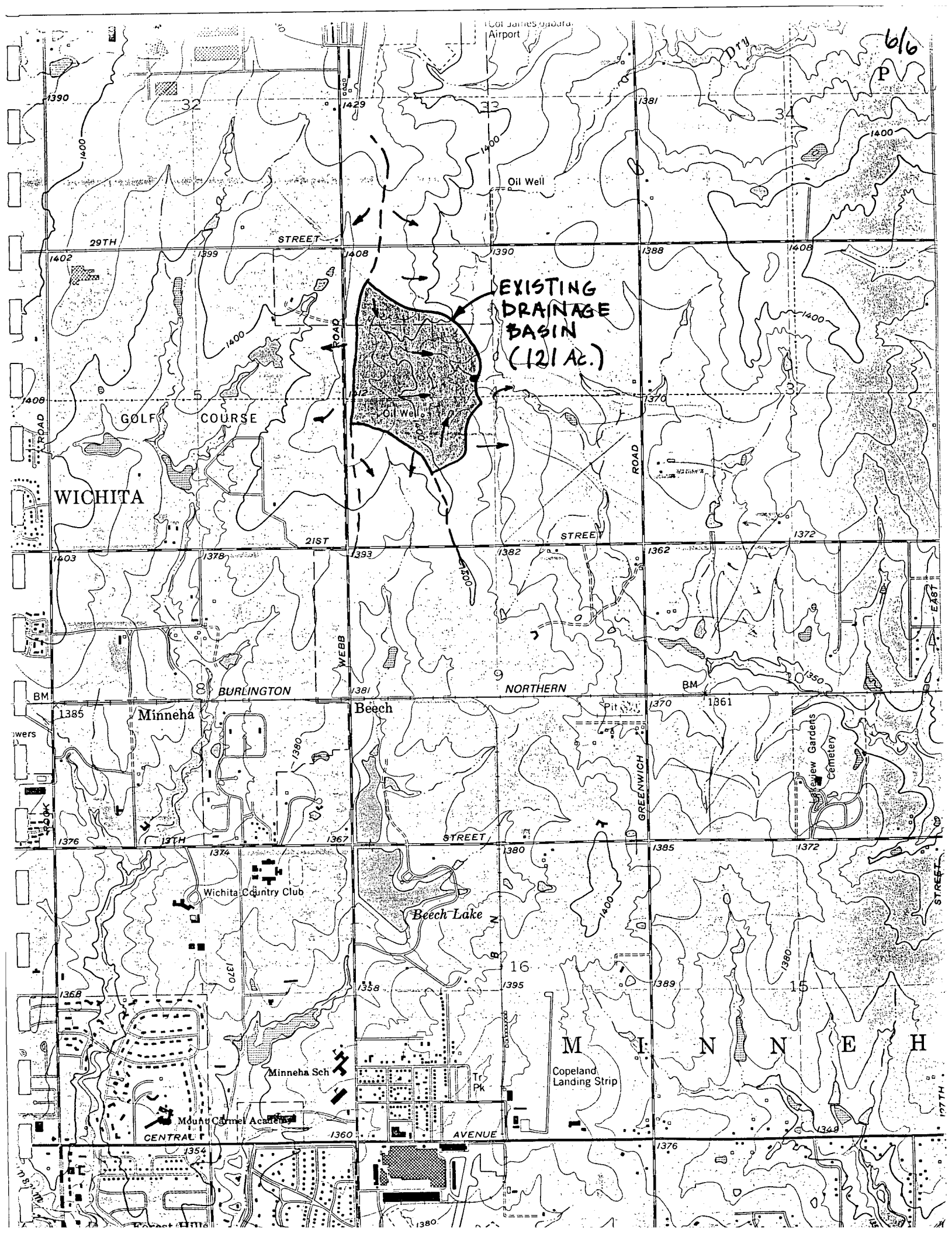
8. Pond and swamp adjustment factor,  $F_p$  .....  
(Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)

9. Peak discharge,  $q_p$  ..... cfs  
(Where  $q_p = q_u A_m Q F_p$ )

Storm #1	Storm #2	Storm #3
10	100	
5.3	7.8	
0.439	0.439	
0.083	0.056	
450	450	
3.2	5.6	
1.0	1.0	
274	480	







6/6

EXISTING  
DRAINAGE  
BASIN  
(121 AC.)

WICHITA

GOLF COURSE

Minneha

Beech

Beech Lake

Wichita Country Club

Minneha Sch

Mount Carmel Academy

M I N N E H

Copeland Landing Strip

St. Andrew Gardens Cemetery

Col James Gaston Airport

Oil Well

Oil Well

STREET

STREET

BURLINGTON

NORTHERN

STREET

ROAD

WEBB ROAD

GREENWICH STREET

STREET

AVENUE

CENTRAL

Worksheet 2: Runoff curve number and runoff

Project Tallgrass East 3rd Add By CSP Date 8.4.89  
 Location 4.275.2E Checked BdB Date 8-8-89  
 Circle one: Present Developed

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN <sup>1/</sup>			Area <input checked="" type="checkbox"/> acres <input type="checkbox"/> mi <sup>2</sup> <input type="checkbox"/> %	Product of CN x area
		Table 2-2	Fig. 2-3	Fig. 2-4		
D	Residential 1/4 Ac. Lots	87			58.8	5,115.6
B	Residential 1/4 Ac. Lots	75			10.6	795.0
D	Multi-Fam.	92			20.0	1,840.0
C	Multi-Fam.	85			4.9	416.5
D	Commercial	95			16.9	1,605.5
C	Commercial	94			11.0	1,034.0
D	Ag (Pasture) - Airport Prop.	89			3.8	338.2
C	Ag (Pasture) - Airport Prop.	86			2.0	172.0
B	Pond Area - Open Space	79			4.2	331.8
Totals =					132.2	11,648.6

<sup>1/</sup> Use only one CN source per line.

CN (weighted) =  $\frac{\text{total product}}{\text{total area}} = \frac{11,648.6}{132.2} = 88.1$ ; Use CN = 88

2. Runoff

Frequency ..... yr  
 Rainfall, P (24-hour) ..... in  
 Runoff, Q ..... in  
 (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)

Storm #1	Storm #2	Storm #3
10	100	
5.3	7.8	
3.9	6.4	

### Worksheet 3: Time of concentration (T<sub>c</sub>) or travel time (T<sub>t</sub>)

Project Tellgrass East 3rd By CSB Date \_\_\_\_\_

Location 4.276-2E Checked B&B Date \_\_\_\_\_

Circle one: Present Developed

Circle one: T<sub>c</sub> T<sub>t</sub> through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

<u>Sheet flow</u> (Applicable to T <sub>c</sub> only)	Segment ID
1. Surface description (table 3-1) .....	
2. Manning's roughness coeff., n (table 3-1) ..	
3. Flow length, L (total L ≤ 300 ft) .....	ft
4. Two-yr 24-hr rainfall, P <sub>2</sub> .....	in
5. Land slope, s .....	ft/ft
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T <sub>t</sub> .....	hr


+


=

--

<u>Shallow concentrated flow</u>	Segment ID
7. Surface description (paved or unpaved) .....	
8. Flow length, L .....	ft
9. Watercourse slope, s .....	ft/ft
10. Average velocity, V (figure 3-1) .....	ft/s
11. $T_t = \frac{L}{3600 V}$ Compute T <sub>t</sub> .....	hr


+


=

--

<u>Channel flow</u>	Segment ID
12. Cross sectional flow area, a .....	ft <sup>2</sup>
13. Wetted perimeter, p <sub>w</sub> .....	ft
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r .....	ft
15. Channel slope, s .....	ft/ft
16. Manning's roughness coeff., n .....	
17. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V .....	ft/s
18. Flow length, L .....	ft
19. $T_t = \frac{L}{3600 V}$ Compute T <sub>t</sub> .....	hr
20. Watershed or subarea T <sub>c</sub> or T <sub>t</sub> (add T <sub>t</sub> in steps 6, 11, and 19) .....	hr


+


=

0.25
------

Assume  
(15 min.)

3/22

Worksheet 4: Graphical Peak Discharge method

Project Tallgrass East 3rd Add By CSB Date 8.4.89

Location 4-275-2E Checked BdB Date \_\_\_\_\_

Circle one: Present Developed

1. Data:

Drainage area .....  $A_m = \underline{0.207}$  mi<sup>2</sup> (acres/640)  
 Runoff curve number .... CN = 88 (From worksheet 2)  
 Time of concentration ..  $T_c = \underline{0.25}$  hr (From worksheet 3)  
 Rainfall distribution type = II (I, IA, II, III)  
 Pond and swamp areas spread throughout watershed ..... = 0 percent of  $A_m$  (\_\_\_\_ acres or mi<sup>2</sup> covered)

2. Frequency ..... yr

3. Rainfall, P (24-hour) ..... in

4. Initial abstraction,  $I_a$  ..... in  
 (Use CN with table 4-1.)

5. Compute  $I_a/P$  .....

6. Unit peak discharge,  $q_u$  ..... csm/in  
 (Use  $T_c$  and  $I_a/P$  with exhibit 4-II)

7. Runoff, Q ..... in  
 (From worksheet 2).

8. Pond and swamp adjustment factor,  $F_p$  ....  
 (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)

9. Peak discharge,  $q_p$  ..... cfs  
 (Where  $q_p = q_u A_m Q F_p$ )

	Storm #1	Storm #2	Storm #3
2. Frequency	10	100	
3. Rainfall, P (24-hour)	5.3	7.8	
4. Initial abstraction, $I_a$	0.273	0.273	
5. Compute $I_a/P$	0.052	0.035	
6. Unit peak discharge, $q_u$	730	730	
7. Runoff, Q	3.9	6.4	
8. Pond and swamp adjustment factor, $F_p$	1.0	1.0	
9. Peak discharge, $q_p$	589	967	



Worksheet 5b: Tabular hydrograph discharge summary

Project Tallgrass East 3rd Location \_\_\_\_\_

By CAB Date \_\_\_\_\_

Circle one: Present  Developed  Frequency (yr) 10 (100) Checked ELS Date \_\_\_\_\_

Subarea name	Basic watershed data used 1/		Select and enter hydrograph times in hours from exhibit 5-II 2/												
	Sub-area T <sub>c</sub> (hr)	I <sub>a</sub> /P <sub>a</sub>	A <sub>m</sub> Q <sub>m</sub> (mi <sup>2</sup> -in)	11.0	11.6	12.0	12.2	12.4	12.6	12.8	13.2	13.6	14.0	14.6	15.5
10-Yr	0.25	0.052	0.807	21	44	319	738	354	162	100	63	50	41	33	27
100-Yr	0.25	0.035	1.325	17	36	257	596	286	131	81	51	40	33	27	22
				28	58	423	978	469	215	133	83	67	54	44	36
Composite hydrograph at outlet															

10-Yr  
100-Yr

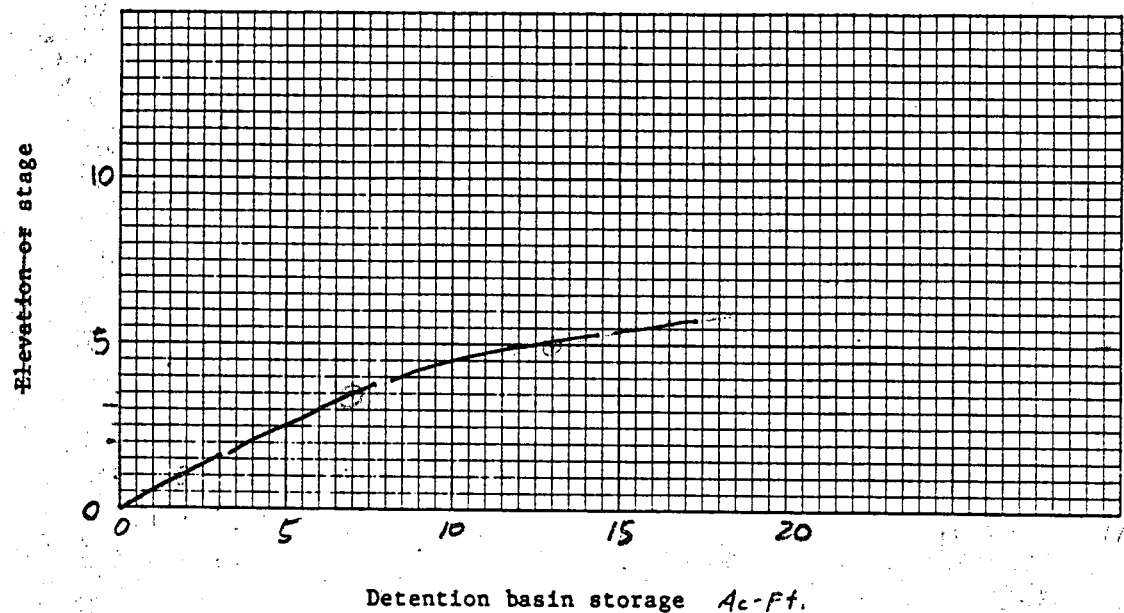
- 1/ Worksheet 5a. Rounded as needed for use with exhibit 5.
- 2/ Enter rainfall distribution type used.
- 3/ Hydrograph discharge for selected times is A<sub>m</sub>Q multiplied by tabular discharge from appropriate exhibit 5.

5/22

6/22

Worksheet 6a: Detention basin storage,  
peak outflow discharge ( $q_0$ ) known

Project Tollgrass East 3rd By CSM Date 8.4.89  
 Location \_\_\_\_\_ Checked \_\_\_\_\_ Date \_\_\_\_\_  
 Circle one: Present Developed



1. Data:  
 Drainage area .....  $A_m = 0.207 \text{ mi}^2$   
 Rainfall distribution type (I, IA, II, III) = II
2. Frequency ..... yr 

10	100
----	-----
3. Peak inflow discharge,  $q_1$  .... cfs 

589	967
-----	-----

  
(From worksheet 4 or 5b)
4. Peak outflow discharge,  $q_0$  .... cfs 

224	393
-----	-----

<sup>1/</sup>
5. Compute  $\frac{q_0}{q_1}$  ..... 

0.380	0.406
-------	-------
6.  $\frac{v_s}{v_r}$  ..... 

0.33	0.32
------	------

  
(Use  $\frac{q_0}{q_1}$  with figure 6-1)
7. Runoff,  $Q$  ..... in 

3.9	6.4
-----	-----

  
(From worksheet 2)
8. Runoff volume,  $V_r$  ..... ac-ft 

43.1	70.7
------	------

  
( $V_r = QA_m 53.33$ )
9. Storage volume,  $V_s$  ..... ac-ft 

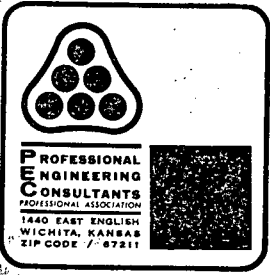
14.2	22.6
------	------

  
( $V_s = V_r \left(\frac{v_s}{v_r}\right)$ )
10. Maximum stage,  $E_{max}$  (From plot) 

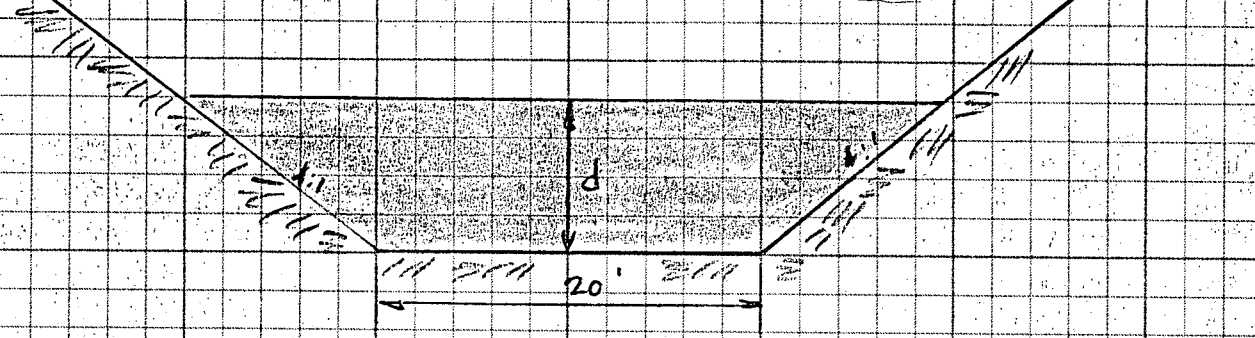
5.3	7±
-----	----

<sup>1/</sup> ~~2nd stage  $q_0$  includes 1st stage  $q_0$ .~~  
 = Pre-Developed  $Q$ 's ( $\frac{99}{121}$ ) (pro-rate of area. portion will be intercepted by K-96 & discharged downstream)





Check Capacity of K-96 ditch  
 & determine Weir Elev.



$Q = 393 \text{ cfs}$  (outflow from pond)

$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$

$393 = \frac{1.486}{0.035} A R^{2/3} (0.007)^{1/2}$

$393 = 42.457 A R^{2/3} 0.0837$

$A R^{2/3} = 110.64$

<u>d</u>	<u>A</u>	<u>p</u>	<u>R</u>	<u>R<sup>2/3</sup></u>	<u>A R<sup>2/3</sup></u>
2.0'	56.00	36.49	1.535	1.330	74.50
2.5'	75.00	40.62	1.847	1.505	112.89 ← USE
2.4'	71.04	39.79	1.785	1.472	104.55

$d = 2.5'$        $V = Q/A = 393/75 = 5.24$  (OK - Riprap lined)

Weir Elev =  $\# \text{ Ditch} + 2.5' = 189.5 + 2.5 = 192.0$

∴ Static Pool = 192.0



WEIR = 12'

WEIR = 20'

WEIR = 15'

$$Q = CLH^{3/2}$$

$$Q = 3.0 \times 12 \times H^{3/2}$$

$$Q = 36 H^{3/2}$$

$$Q = CLH^{3/2}$$

$$Q = 3.0 \times 20 \times H^{3/2}$$

$$Q = 60 H^{3/2}$$

$$Q = CLH^{1.5}$$

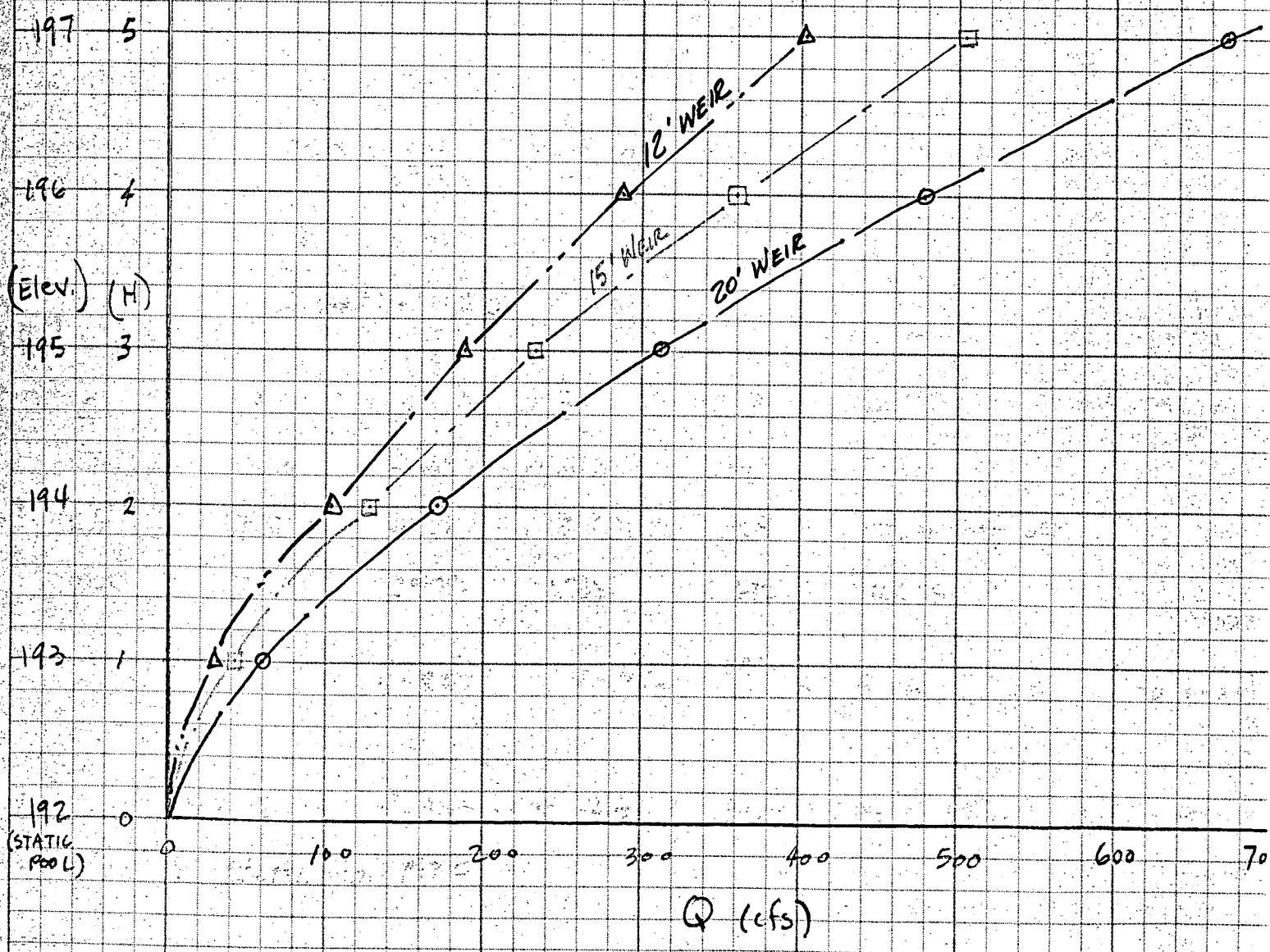
$$Q = 3.0 \times 15 \times H^{3/2}$$

$$Q = 45 H^{3/2}$$

H	Q
1.0	36
2.0	102
3.0	187
4.0	288
5.0	402

H	Q
1.0	60
2.0	170
3.0	312
4.0	480
5.0	671

H	Q
1.0	45
2.0	127
3.0	234
4.0	360
5.0	503





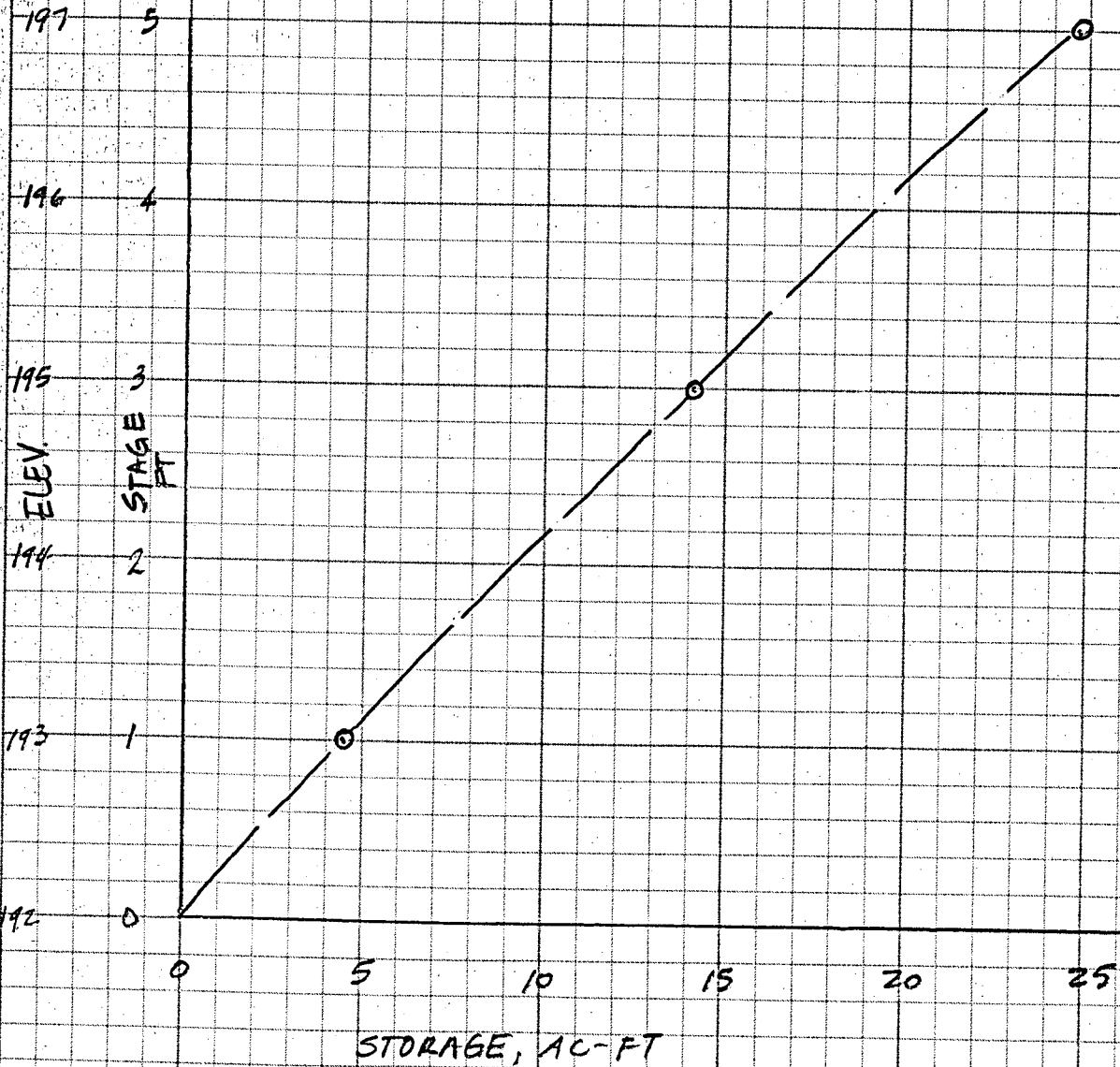
Date 8.11.89 Page 10 of 22

Project Tallgrass East 3rd Addition

Item Drainage Plan Detention Pond

Stage - Storage

	<u>ELEV</u>	<u>STAGE</u>	<u>AREA</u> <u>SF</u>	<u>AREA</u> <u>AC.</u>	<u>Δ d</u> <u>FT</u>	<u>Δ Vol</u> <u>Ac-FT</u>	<u>Σ Vol</u> <u>Ac-FT</u>
STATIC POOL	192	0.0	188,620	4.33	0.0	0.0	0.0
	193	1.0	199,060	4.57	1.0	4.45	4.45
	195	3.0	220,420	5.06	2.0	9.62	14.07
	197	5.0	243,060	5.58	2.0	10.64	24.71



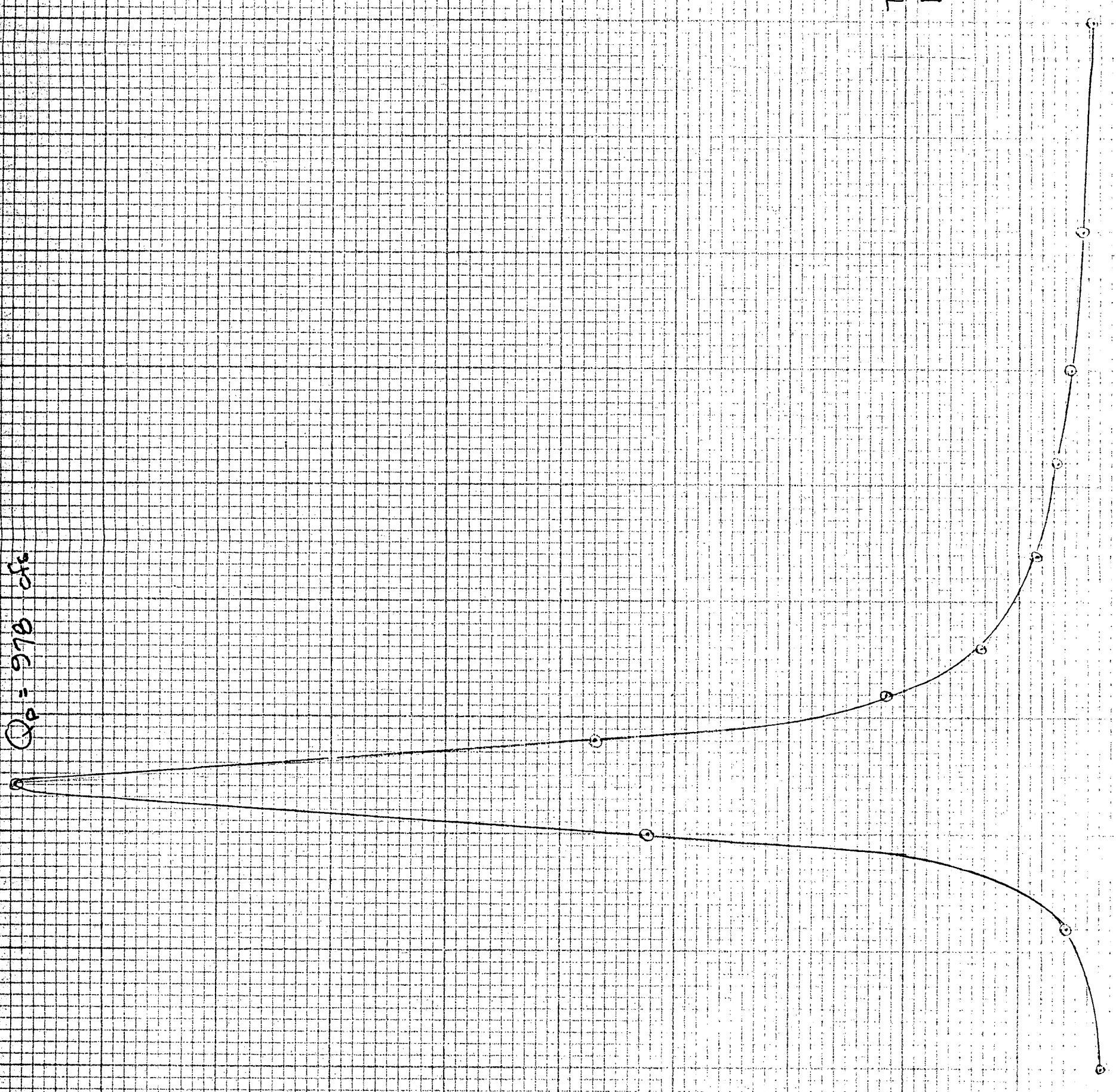
TALLGRASS EAST 3RD ADD.  
DRAINAGE PLAN 8-11-89  
INFLOW HYDROGRAPH

$Q_p = 978 \text{ cfs}$

$Q$   
cfs

1000  
900  
800  
700  
600  
500  
400  
300  
200  
100  
0

11.0 11.5 12.0 12.5 13.0 13.5 14.0 14.5 15.0 15.5  
T, hr



```
*****
* FLOOD HYDROGRAPH PACKAGE (HEC-1) *
* FEBRUARY 1981 *
* REVISED 02 AUG 88 *
* RUN DATE 08/10/1989 TIME 18:54:41 *
*****
```

```
*****
* U.S. ARMY CORPS OF ENGINEERS *
* THE HYDROLOGIC ENGINEERING CENTER *
* 609 SECOND STREET *
* DAVIS, CALIFORNIA 95616 *
* (916) 551-1748 *
*****
```

```
X X XXXXXX XXXX X
X X X X X XX
X X X X X X
XXXXXX XXXX X XXXX X
X X X X X X
X X X X X X
X X XXXXXX XXXX XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.  
 THE DEFINITION OF -AMSK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION  
 NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,  
 DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION  
 KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

NOTE: AFTER COMPLETION OF THIS COMPUTER RUN,  
 THE STATIC POOL WAS LOWERED FROM 193.0 TO 192.0  
 ∴ DWS ALSO WAS REDUCED FROM 197.95 TO 196.95  
 STORAGE REMAINED UNCHANGED  
 DISCHARGE BASED ON 12' WEIR

12/22

HEC-1 INPUT

PAGE 1

```

LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
1         ID   TALLGRASS EAST 3RD ADD'N DRAINAGE PLAN
2         ID   PEC PROJECT NO 36-89294-2051
3         ID   STAGE STORAGE ANALYSIS --- 100 YR
4         ID   PROFESSIONAL ENGINEERING CONSULTANTS, P.A.
5         ID   COMPUTED BY M.W.BERRY, P.E. 08/10/89
6         ID   FILENAME="A:TGRASSE3.HEC"  DISKNAME="MWB01"

*** LIST ***

7         *DIAGRAM
8         IT   15 10AUG89   1000   0 10AUG89   1630
          IO   0     2     0

9         KK   INFLO INFLOW HYDROGRAPH FOR DEVELOPED CONDITIONS
10        BA   0.207
11        IN   15 10AUG89   1045
12        QI   20    30    35    50    90    425   975   280   150   105
13        QI   80    70    60    55    50    47    44    41    39    38
14        QI   37    36    35    34

15        KK   POND1
16        RS   1     ELEV  193.0   0
17        SA   4.33  4.57  5.06  5.58
18        SE   193.0 194.0 196.0 198.0
19        SQ   0     36   102  187  288  402
20        SE   193.0 194.0 195.0 196.0 197.0 198.0
21        ZZ
    
```

13/22

SCHMATIC DIAGRAM OF STREAM NETWORK

INPUT	(V) ROUTING	(-->) DIVERSION OR PUMP FLOW
LINE		
NO.	(.) CONNECTOR	(<-->) RETURN OF DIVERTED OR PUMPED FLOW
9	INFLO	
	V	
	V	
15	POND1	

(\*\*\*) RUNOFF ALSO COMPUTED AT THIS LOCATION

14/22

```
*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1) *
* FEBRUARY 1981 *
* REVISED 02 AUG 88 *
*
* RUN DATE 08/10/1989 TIME 18:54:41 *
*
*****
```

```
*****
*
* U.S. ARMY CORPS OF ENGINEERS *
* THE HYDROLOGIC ENGINEERING CENTER *
* 609 SECOND STREET *
* DAVIS, CALIFORNIA 95616 *
* (916) 551-1748 *
*
*****
```

TALLGRASS EAST 3RD ADD'N DRAINAGE PLAN  
 PEC PROJECT NO 36-89294-2051  
 STAGE STORAGE ANALYSIS --- 100 YR  
 PROFESSIONAL ENGINEERING CONSULTANTS, P.A.  
 COMPUTED BY M.W.BERRY, P.E. 08/10/89  
 FILENAME="A:TGRASSE3.HEC" DISKNAME="MWB01"

```
8 IO OUTPUT CONTROL VARIABLES
    IPRNT 0 PRINT CONTROL
    IPILOT 2 PLOT CONTROL
    QSCAL 0. HYDROGRAPH PLOT SCALE

IT HYDROGRAPH TIME DATA
    NMIN 15 MINUTES IN COMPUTATION INTERVAL
    IDATE 10AUG89 STARTING DATE
    ITIME 1000 STARTING TIME
    NQ 27 NUMBER OF HYDROGRAPH ORDINATES
    NDDATE 10AUG89 ENDING DATE
    NDTIME 1630 ENDING TIME
    ICENT 19 CENTURY MARK

    COMPUTATION INTERVAL .25 HOURS
    TOTAL TIME BASE 6.50 HOURS
```

ENGLISH UNITS  
 DRAINAGE AREA SQUARE MILES  
 PRECIPITATION DEPTH INCHES  
 LENGTH, ELEVATION FEET  
 FLOW CUBIC FEET PER SECOND  
 STORAGE VOLUME ACRE-FEET  
 SURFACE AREA ACRES  
 TEMPERATURE DEGREES FAHRENHEIT

\*\*\* \*\* \*\* \*\* \*\*

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*****
*
* 9 KK INFO * INFLOW HYDROGRAPH FOR DEVELOPED CONDITIONS
*
*****
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11 IN TIME DATA FOR INPUT TIME SERIES
    JXMIN 15 TIME INTERVAL IN MINUTES
    JXDATE 10AUG89 STARTING DATE
    JXTIME 1045 STARTING TIME
```

SUBBASIN RUNOFF DATA

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10 BA SUBBASIN CHARACTERISTICS
    TAREA .21 SUBBASIN AREA
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HYDROGRAPH AT STATION INFLO

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DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW
10	AUG	1000	1	20.	*	10	AUG	1145	8	90.	*	10	AUG	1330	15	70.	*	10	AUG	1515	22	39.
10	AUG	1015	2	20.	*	10	AUG	1200	9	425.	*	10	AUG	1345	16	60.	*	10	AUG	1530	23	38.

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*****
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15/22

10 AUG 1030	3	20.	*	10 AUG 1215	10	975.	*	10 AUG 1400	17	55.	*	10 AUG 1545	24	37.
10 AUG 1045	4	20.	*	10 AUG 1230	11	280.	*	10 AUG 1415	18	50.	*	10 AUG 1600	25	36.
10 AUG 1100	5	30.	*	10 AUG 1245	12	150.	*	10 AUG 1430	19	47.	*	10 AUG 1615	26	35.
10 AUG 1115	6	35.	*	10 AUG 1300	13	105.	*	10 AUG 1445	20	44.	*	10 AUG 1630	27	34.
10 AUG 1130	7	50.	*	10 AUG 1315	14	80.	*	10 AUG 1500	21	41.	*			

\*\*\*\*\*

PEAK FLOW (CFS)	TIME (HR)	MAXIMUM AVERAGE FLOW				
		6-HR	24-HR	72-HR	6.50-HR	
975.	2.25	117.	110.	110.	110.	
		(INCHES)	5.276	5.351	5.351	5.351
		(AC-FT)	58.	59.	59.	59.
CUMULATIVE AREA =		.21 SQ MI				

16/22

DAHRMN PER	(0) OUTFLOW												
	0.	100.	200.	300.	400.	500.	600.	700.	800.	900.	1000.	0.	0.
101000	1.	0											
101015	2.	0											
101030	3.	0											
101045	4.	0											
101100	5.	0											
101115	6.	0											
101130	7.	0											
101145	8.	0											
101200	9.					0							
101215	10.										0		
101230	11.			0									
101245	12.		0										
101300	13.		0										
101315	14.		0										
101330	15.		0										
101345	16.		0										
101400	17.		0										
101415	18.		0										
101430	19.		0										
101445	20.		0										
101500	21.		0										
101515	22.		0										
101530	23.		0										
101545	24.		0										
101600	25.		0										
101615	26.		0										
101630	27.		0										

17/22

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 \* \*  
 15 KK \* POND1 \*  
 \* \*  
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HYDROGRAPH ROUTING DATA

16 RS STORAGE ROUTING  
 NSTPS 1 NUMBER OF SUBREACHES  
 ITYP ELEV TYPE OF INITIAL CONDITION  
 RSVRIC 193.00 INITIAL CONDITION  
 X .00 WORKING R AND D COEFFICIENT

17 SA AREA 4.3 4.6 5.1 5.6

18 SE ELEVATION 193.00 194.00 196.00 198.00

19 SQ DISCHARGE 0. 36. 102. 187. 288. 402.

20 SE ELEVATION 193.00 194.00 195.00 196.00 197.00 198.00

\*\*\*

COMPUTED STORAGE-ELEVATION DATA

STORAGE .00 4.45 14.08 24.71  
 ELEVATION 193.00 194.00 196.00 198.00

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE .00 4.45 9.14 14.08 19.26 24.71  
 OUTFLOW .00 36.00 102.00 187.00 288.00 402.00  
 ELEVATION 193.00 194.00 195.00 196.00 197.00 198.00

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HYDROGRAPH AT STATION POND1

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DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE
10	AUG	1000	1	0.	.0	193.0	10	AUG	1215	10	270.	18.3	196.8	10	AUG	1430	19	83.	7.8	194.7
10	AUG	1015	2	3.	.4	193.1	10	AUG	1230	11	396.	24.4	197.9	10	AUG	1445	20	73.	7.1	194.6
10	AUG	1030	3	6.	.7	193.2	10	AUG	1245	12	332.	21.4	197.4	10	AUG	1500	21	66.	6.5	194.4
10	AUG	1045	4	8.	1.0	193.2	10	AUG	1300	13	261.	17.9	196.7	10	AUG	1515	22	59.	6.1	194.3
10	AUG	1100	5	11.	1.3	193.3	10	AUG	1315	14	204.	15.0	196.2	10	AUG	1530	23	54.	5.7	194.3
10	AUG	1115	6	14.	1.7	193.4	10	AUG	1330	15	164.	12.7	195.7	10	AUG	1545	24	50.	5.4	194.2
10	AUG	1130	7	18.	2.3	193.5	10	AUG	1345	16	134.	11.0	195.4	10	AUG	1600	25	46.	5.2	194.2
10	AUG	1145	8	26.	3.3	193.7	10	AUG	1400	17	111.	9.6	195.1	10	AUG	1615	26	44.	5.0	194.1
10	AUG	1200	9	79.	7.5	194.6	10	AUG	1415	18	95.	8.6	194.9	10	AUG	1630	27	41.	4.8	194.1

\*\*\*\*\*

PEAK FLOW	TIME		MAXIMUM	AVERAGE FLOW		
(CFS)	(HR)	(CFS)	6-HR	24-HR	72-HR	6.50-HR
+	396.	2.50	109.	101.	101.	101.
		(INCHES)	4.902	4.914	4.914	4.914
		(AC-FT)	54.	54.	54.	54.
PEAK STORAGE	TIME		MAXIMUM	AVERAGE STORAGE		
(AC-FT)	(HR)		6-HR	24-HR	72-HR	6.50-HR
+	24.	2.50	9.	8.	8.	8.
PEAK STAGE	TIME		MAXIMUM	AVERAGE STAGE		
(FEET)	(HR)		6-HR	24-HR	72-HR	6.50-HR
+	197.95	2.50	194.85	194.71	194.71	194.71

18/22

CUMULATIVE AREA = .21 SQ MI

19/22

DAHRMN PER	STATION		POND1		1000.	0.	0.	0.	0.	0.	0.	0.
	(I) INFLOW, 400.	(O) OUTFLOW 600.	800.	1000.								
	0.	200.	400.	600.	800.	1000.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	10.	(S) STORAGE 20.	30.	0.	0.
101000	10I						S					
101015	20I						S					
101030	30I						S					
101045	40I						S					
101100	5.0I						S					
101115	6.0I						S					
101130	7.0 I						S					
101145	8.0 I						S					
101200	9. 0						S					
101215	10.		0			I.			S			
101230	11.		I	0					S			
101245	12.		I	0					S			
101300	13.		I	0					S			
101315	14.		I	0					S			
101330	15.		I	0					S			
101345	16.		I	0					S			
101400	17.		I	0					S			
101415	18.		I	0					S			
101430	19.		I	0					S			
101445	20.		I	0					S			
101500	21.		IO						S			
101515	22.		IO						S			
101530	23.		IO						S			
101545	24.		I						S			
101600	25.		I						S			
101615	26.		I						S			
101630	27.		I						S			

20/22

21/22

RUNOFF SUMMARY  
 FLOW IN CUBIC FEET PER SECOND  
 TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
+									
HYDROGRAPH AT									
+	INFLO	975.	2.25	117.	110.	110.	.21		
ROUTED TO									
+	POND1	396.	2.50	109.	101.	101.	.21		
+								<del>197.95</del>	2.50

196.95

\*\*\* NORMAL END OF HEC-1 \*\*\*

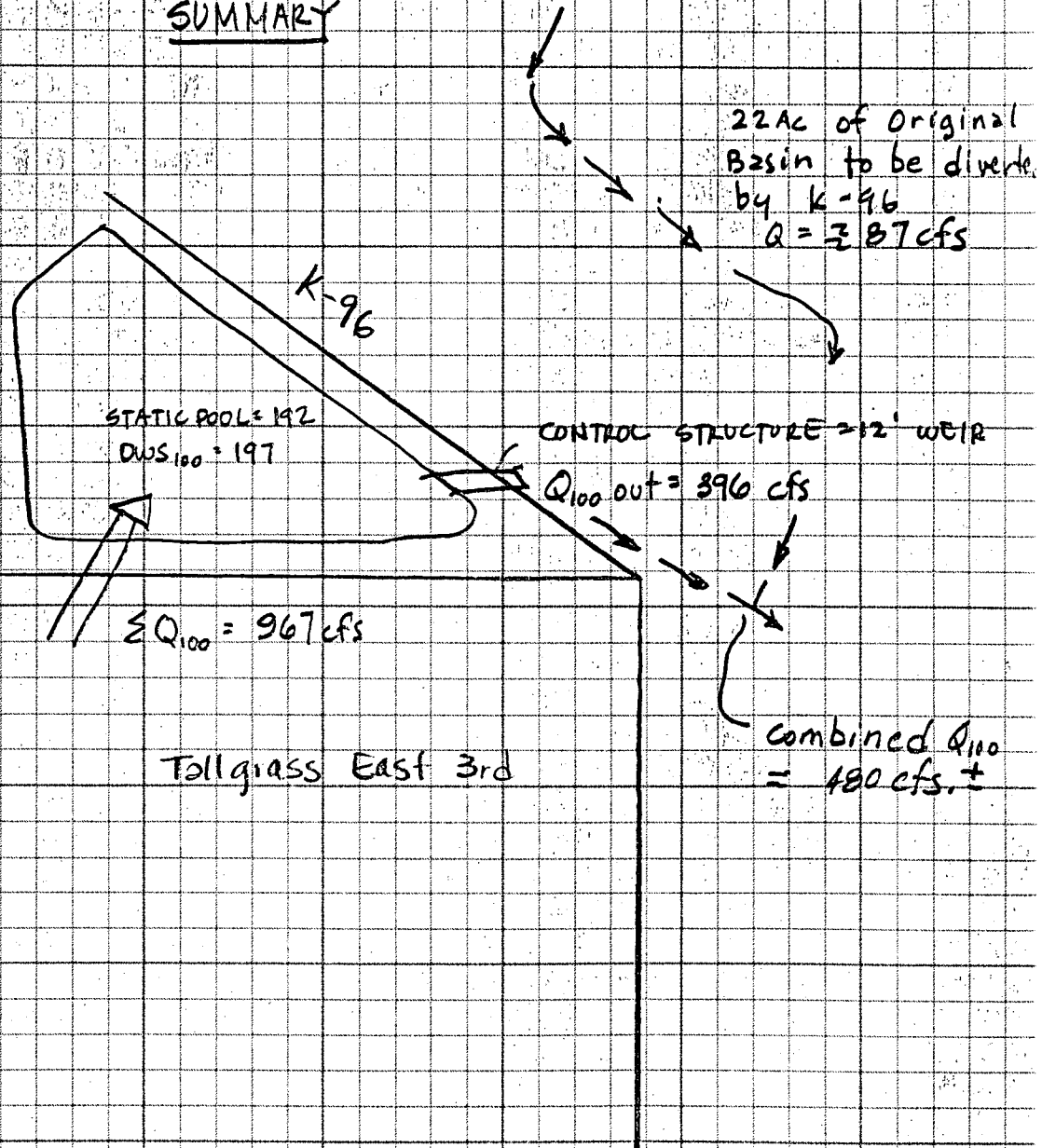


Date 8-11-89 Page 22 of 22

Project Tollgrass East 3rd Add.

Item Drainage Plan

SUMMARY



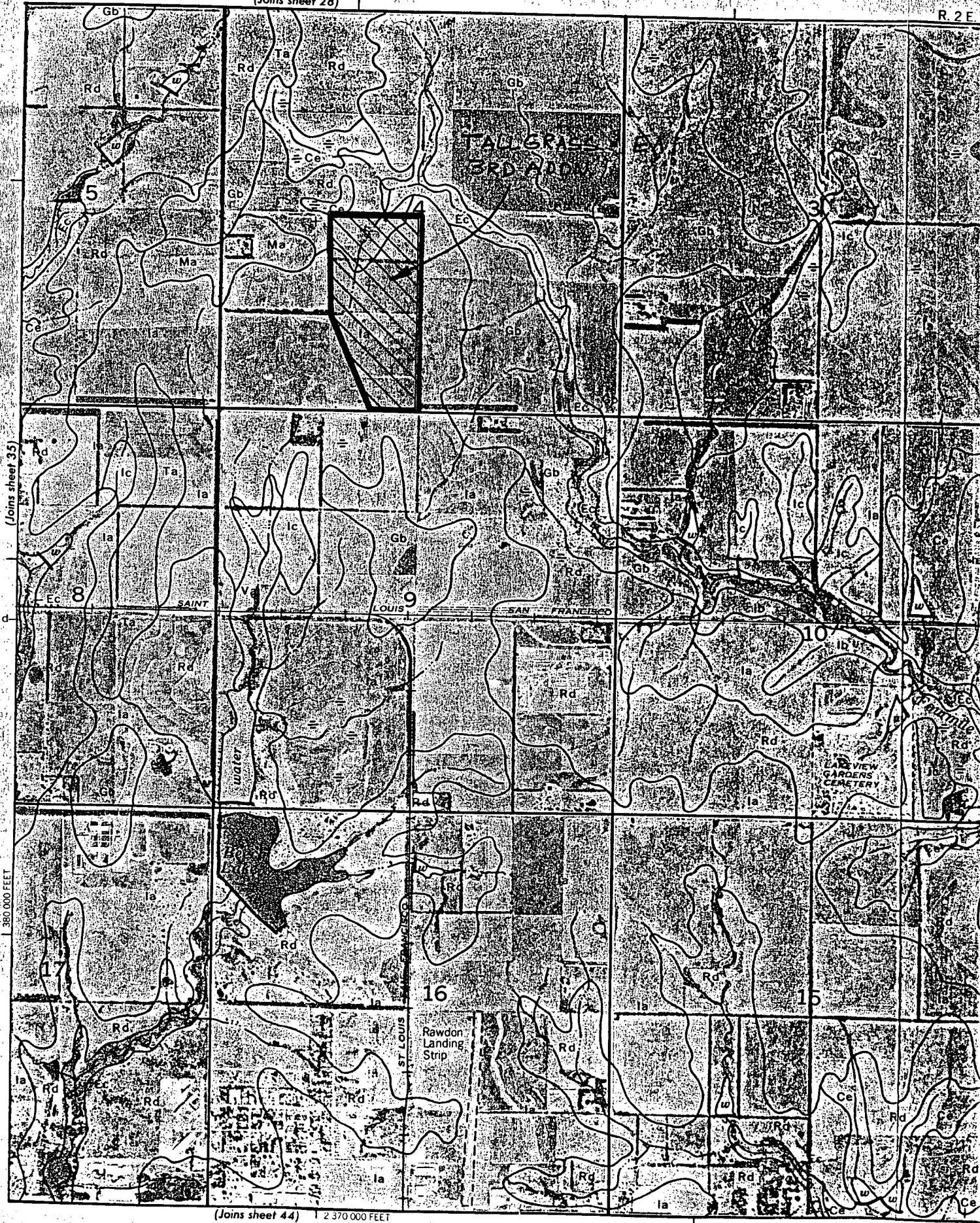
(Joins sheet 28)



5000 Feet

Scale 1:20000

0 1000 2000 3000 4000 5000



(Joins sheet 44) | 2 370 000 FEET

## EXHIBIT NO. 1

## SOIL LEGEND

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

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

<u>DURATION IN MINUTES</u>	<u>RETURN PERIODS OF</u>						
	<u>1-YR</u>	<u>2-YR</u>	<u>5-YR</u>	<u>10-YR</u>	<u>25-YR</u>	<u>50-YR</u>	<u>100-YR</u>
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

<u>DURATION IN MINUTES</u>	<u>RETURN PERIODS OF</u>						
	<u>1-YR</u>	<u>2-YR</u>	<u>5-YR</u>	<u>10-YR</u>	<u>25-YR</u>	<u>50-YR</u>	<u>100-YR</u>
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

<u>DURATION IN HOURS</u>	<u>RETURN PERIODS OF</u>						
	<u>1-YR</u>	<u>2-YR</u>	<u>5-YR</u>	<u>10-YR</u>	<u>25-YR</u>	<u>50-YR</u>	<u>100-YR</u>
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

## ATTACHMENT D

## DRAINAGE CRITERIA

## CITY OF WICHITA, KANSAS

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

<u>Land Use or Surface Characteristics</u>	<u>Percent Impervious</u>	<u>Frequency</u>			
		<u>2</u>	<u>5</u>	<u>10</u>	<u>100</u>
<b>1. Business:</b>					
Downtown Areas	95	0.84	0.85	0.87	0.91
Neighborhood Areas	70	0.68	0.69	0.73	0.80
<b>2. Residential:</b>					
<u>Single Family (Soil Group D)</u>					
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
<u>Multi-Family (Soil Group D)</u>					
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
<u>Single Family (Soil Group C)</u>					
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
<u>Multi-Family (Soil Group C)</u>					
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
<u>Single-Family (Soil Group B)</u>					
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
<u>Multi-Family (Soil Group B)</u>					
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			
		<u>2</u>	<u>5</u>	<u>10</u>	<u>100</u>
<u>Single Family (Soil Group A)</u>					
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
<u>Multi-Family (Soil Group A)</u>					
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):					
<u>Soil Group A</u>					
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
<u>Soil Group B</u>					
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
<u>Soil Group C</u>					
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

<u>Land Use or Surface Characteristics</u>	<u>Percent Impervious</u>	<u>Frequency</u>			
		<u>2</u>	<u>5</u>	<u>10</u>	<u>100</u>
<u>Soil Group D</u>					
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

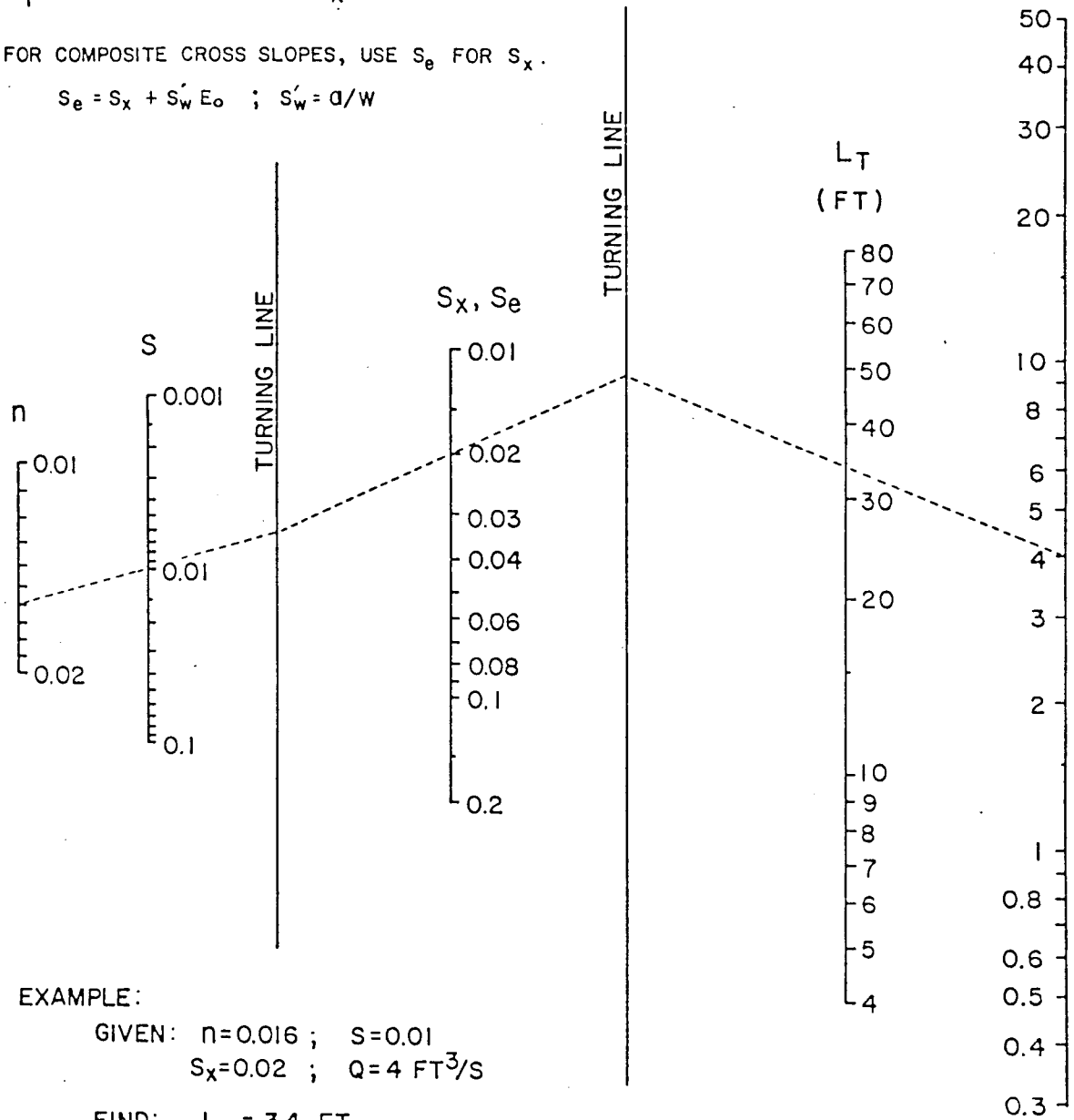
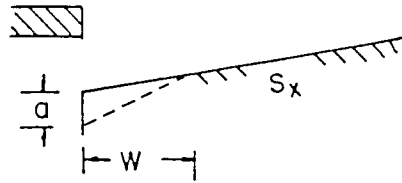
AVERAGE OVERLAND FLOW VELOCITY FOR USE WITH URBANIZED AREAS

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	

$$L_T = 0.6Q^{0.42} S^{0.3} (1/nS_x)^{0.6}$$

FOR COMPOSITE CROSS SLOPES, USE  $S_e$  FOR  $S_x$ .

$$S_e = S_x + S'_w E_o ; S'_w = a/W$$



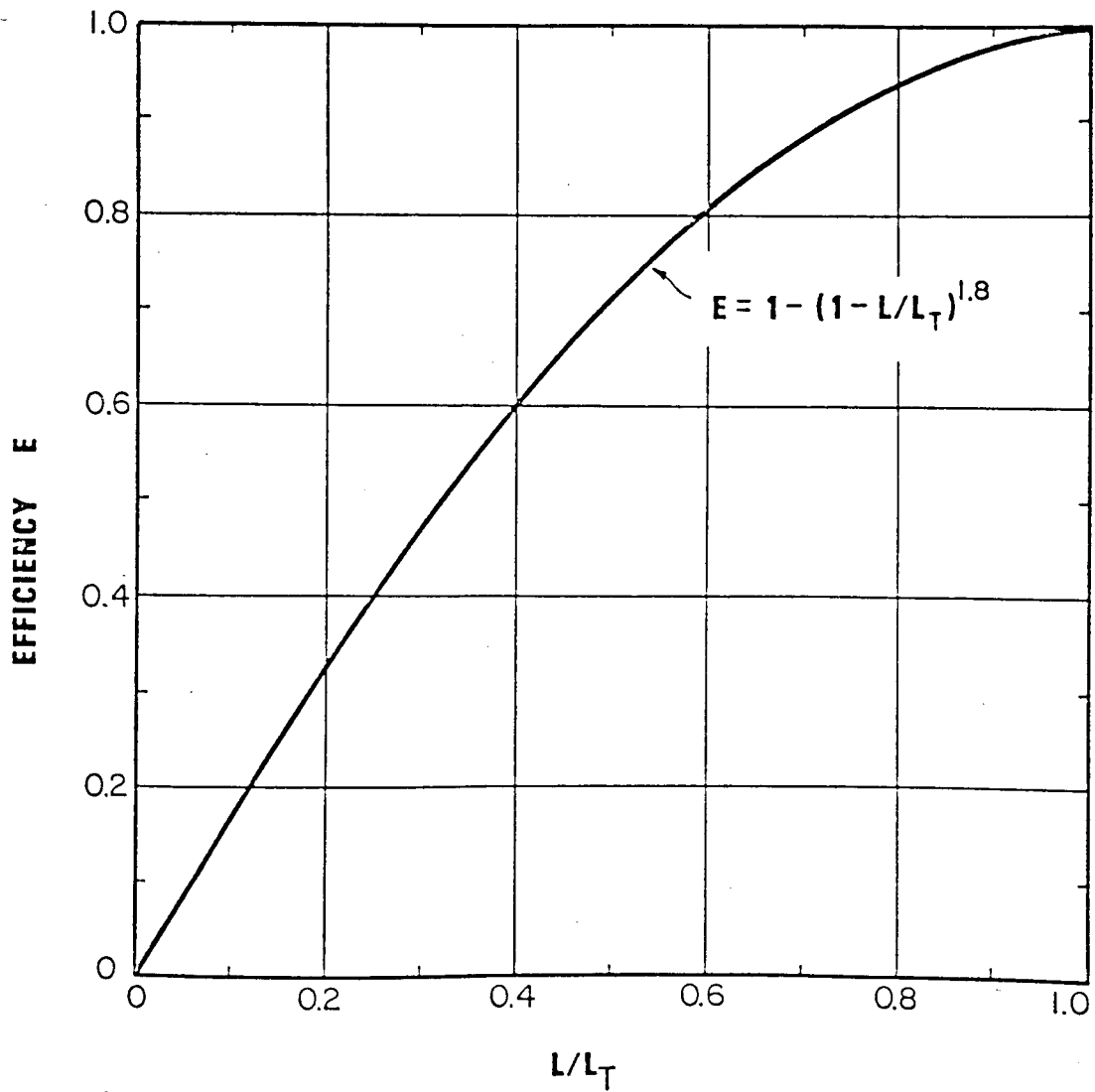
EXAMPLE:

GIVEN:  $n=0.016$  ;  $S=0.01$   
 $S_x=0.02$  ;  $Q=4 \text{ FT}^3/\text{S}$

FIND:  $L_T = 34 \text{ FT}$

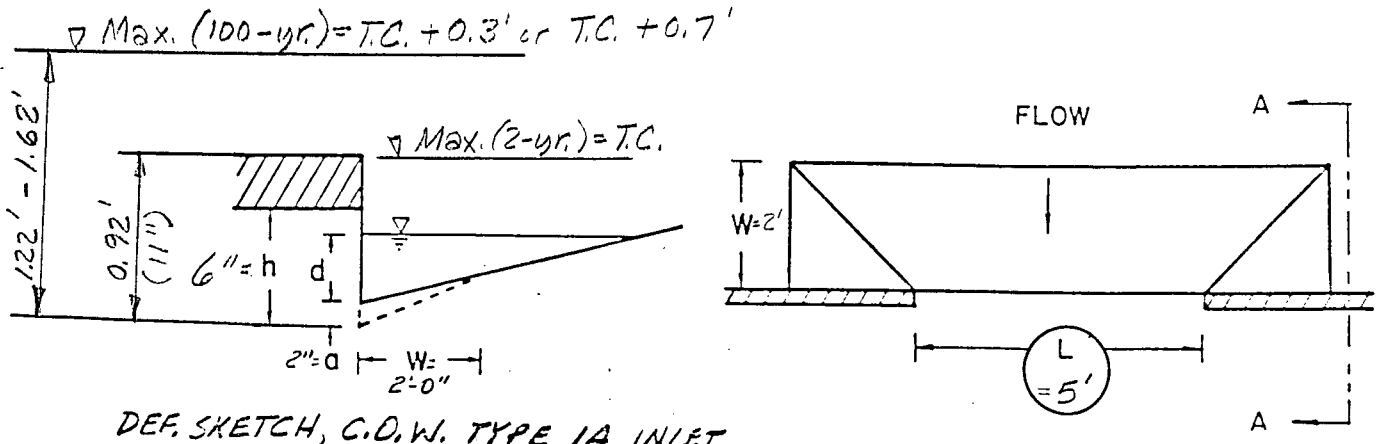
**CHART 9. Curb-opening and slotted drain inlet length for total interception.**

*FROM: HEC-12, DRAINAGE OF HIGHWAY PAVEMENTS, F.H.W.A., MAR. 1964.*



**CHART 10. Curb-opening and slotted drain inlet interception efficiency.**

*FROM HEC-12, DRAINAGE OF HIGHWAY PAVEMENTS, FHWA, Mar. 1954*



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

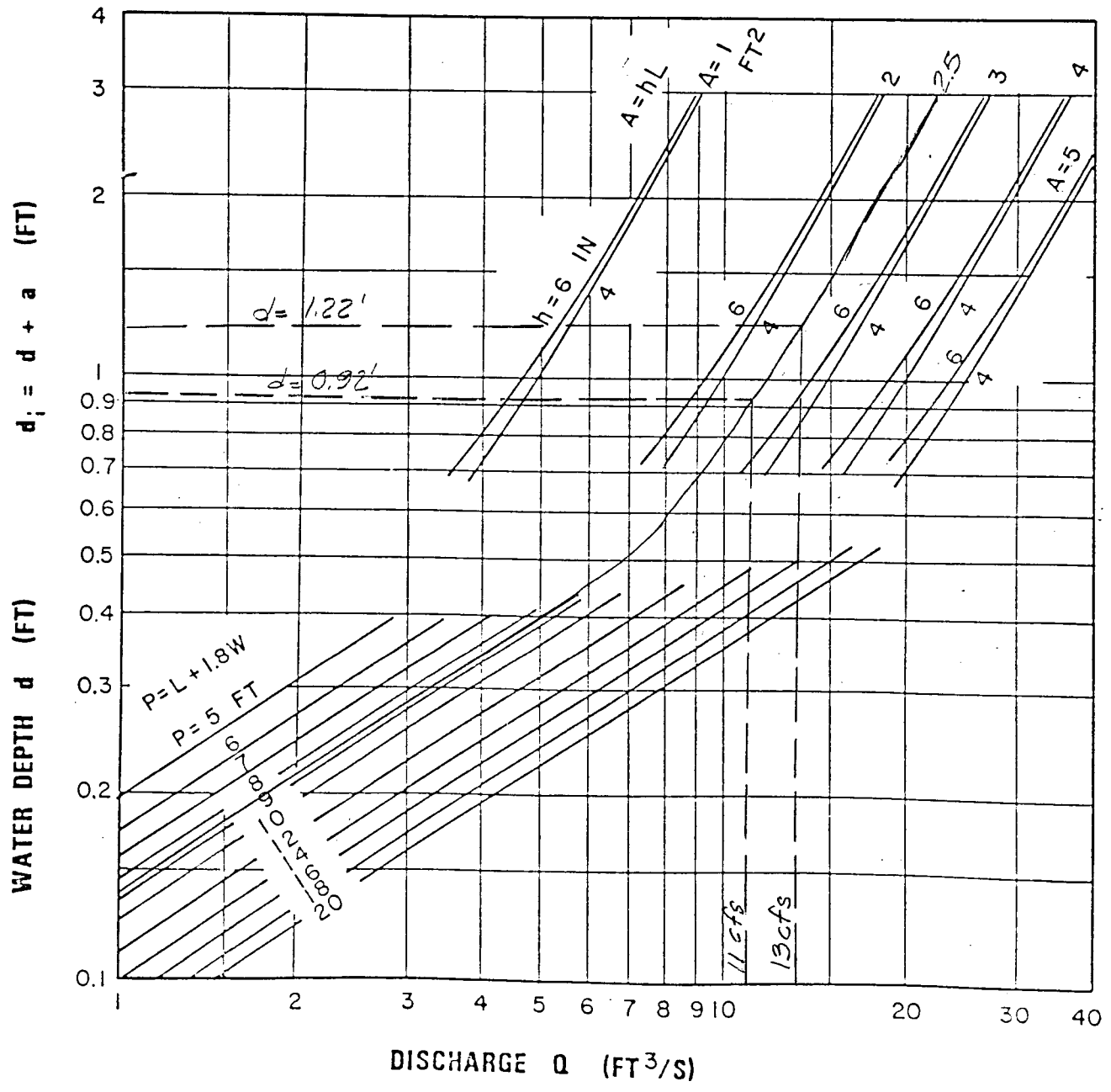


CHART 12. Depressed curb-opening inlet capacity in sump locations.

FROM: HEC-12, DRAINAGE OF HIGHWAY PAVEMENTS, F.H.W.A., MAR., 1974

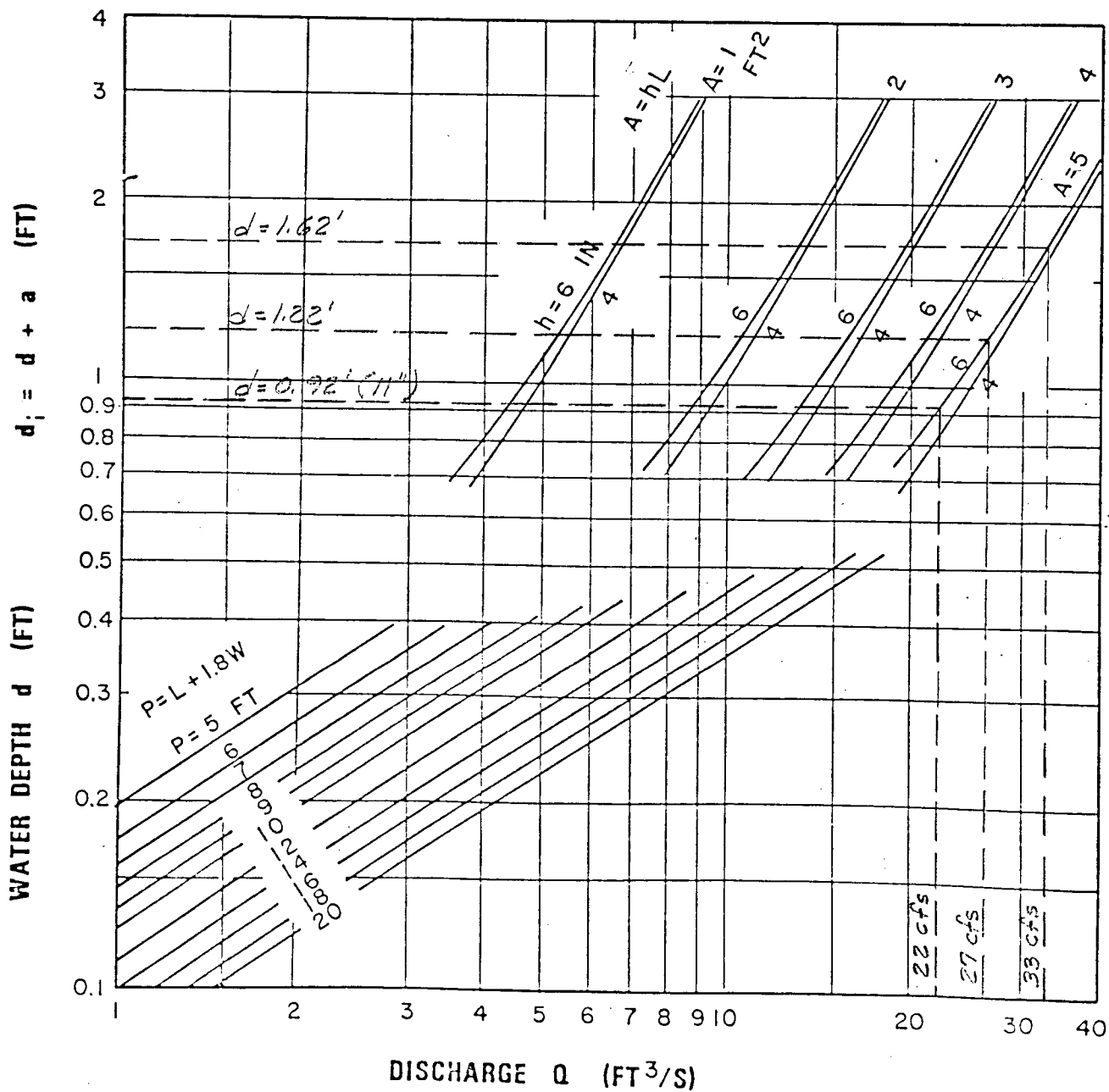
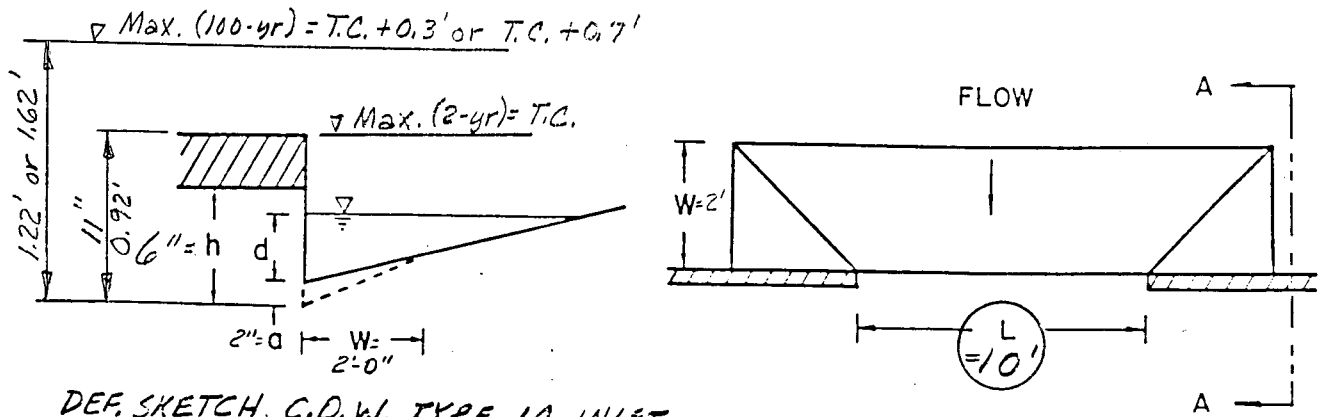
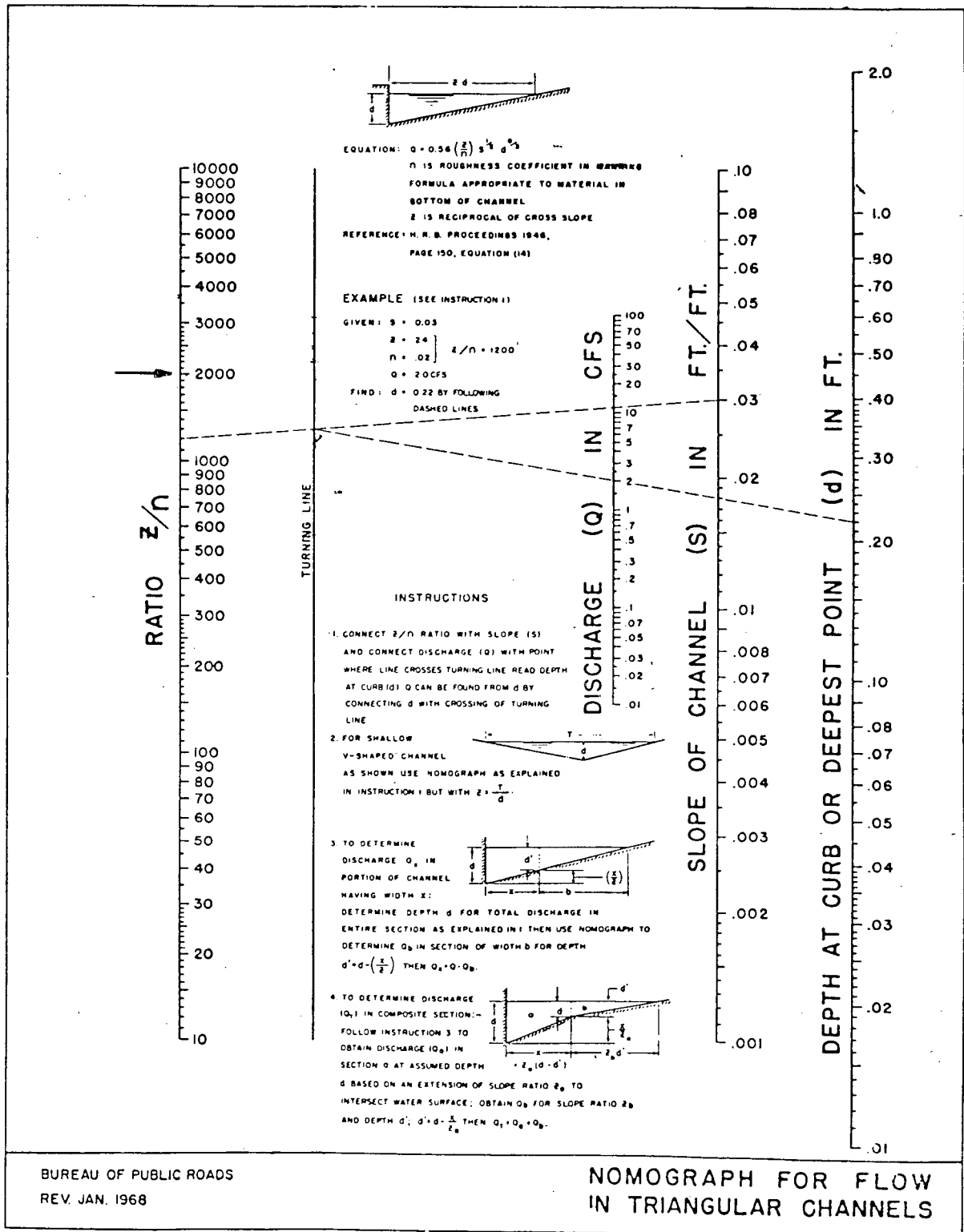
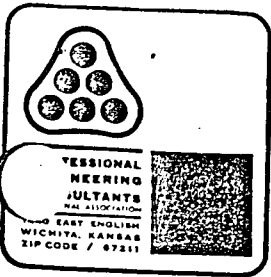


CHART 12. Depressed curb-opening inlet capacity in sump locations.

FROM: HEC-12, DRAINAGE OF HIGHWAY PAVEMENTS, FHWA, MAR., 1974

$x\text{-slope} = 3/8''/\text{ft.} = 0.03125\%$   
 $z = 1/x\text{-slope} = 1/0.03125 = 32$   
 $n = 0.016$   
 $z/n = 32/0.016 = 2000$





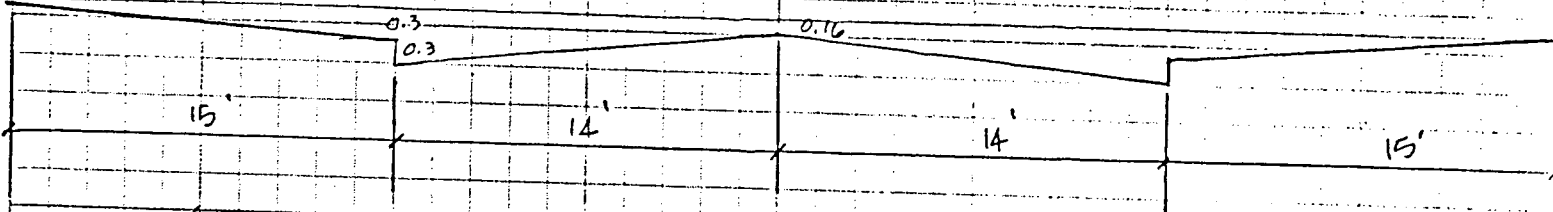
Date 8-1-89 Page \_\_\_\_\_ of \_\_\_\_\_

Project Tallgrass East 3rd Addn.

Item Drainage Plan

Determine Capacities of Roll-curb streets w/  
Various Walk Grades for 100-year storm analysis  
(58' R-O-W)

0.3'  
Walk Grade



$$n = \frac{(2 \times 14.5 \times 0.03) + (2 \times 2.8 \times 0.013) + (2 \times 12 \times 0.016)}{58.6}$$

$$= \frac{(0.87) + (0.0728) + (0.384)}{58.6} = \frac{1.3268}{58.6} = 0.0226$$

$$A = (2 \times \frac{1}{2} \times 15 \times 0.3) + (28 \times 0.16) + (2 \times \frac{1}{2} \times 14 \times 0.44)$$

$$= 4.5 + 4.48 + 6.16$$

$$= 15.14 \text{ SF}$$

$$P = 58.6$$

$$R = A/P = 15.14/58.6 = 0.258362$$

$$R^{2/3} = 0.40565$$

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

$$= \frac{1.486}{0.0226} \times 15.14 \times 0.40565 \times S^{1/2}$$

$$Q = 403.82 \sqrt{S}$$



Date 8-1-89 Page \_\_\_\_\_ of \_\_\_\_\_

Project Tallgrass East 3rd Addn.

Item Drainage Plan

### 0.4 Walk Grade

$$n = 0.0226$$

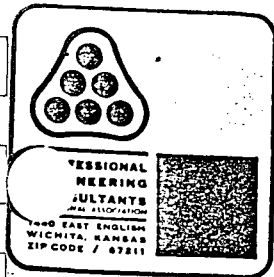
$$A = (2 \times \frac{1}{2} \times 15 \times 0.4) + (28 \times 0.26) + (2 \times \frac{1}{2} \times 14 \times 0.44)$$
$$= 6.0 + 7.28 + 6.16$$
$$= 19.44$$

$$p = 58.6$$

$$R = A/p = 19.44/58.6 = 0.33174 \quad R^{2/3} = 0.479217$$

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2} = \frac{1.486}{0.0226} \times 19.44 \times 0.479217 \times 5^{1/2}$$

$$Q = 612.55 \text{ cfs}$$



Date 8-1-89 Page \_\_\_\_\_ of \_\_\_\_\_

Project Tallgrass East 3rd Addn.

Item Drainage Plan

0.5 Walk Grade

$$n = 0.0226$$

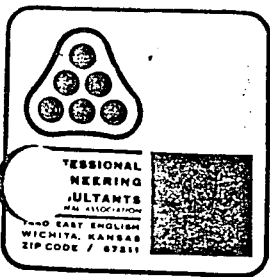
$$\begin{aligned} A &= (2 \times \frac{1}{2} \times 15 \times 0.5) + (28 \times 0.36) + (2 \times \frac{1}{2} \times 14 \times 0.44) \\ &= 7.5 + 10.08 + 6.16 \\ &= 23.74 \end{aligned}$$

$$p = 58.6$$

$$R = A/p = 23.74 / 58.6 = 0.40519 \quad R^{2/3} = 0.547506$$

$$Q = \frac{1.486}{0.0226} \times 23.74 \times 0.547506 \times 5^{1/2}$$

$$= 854.63 \sqrt{5}$$



Date 8-1-89 Page \_\_\_\_\_ of \_\_\_\_\_

Project Tallgrass East 3rd Addn.

Item Drainage Plan

### 0.6 Walk Grade

$$n = 0.0226$$

$$A = (2 \times \frac{1}{2} \times 15 \times 0.6) + (28 \times 0.46) + (2 \times \frac{1}{2} \times 14 \times 0.44)$$
$$= 9.0 + 12.88 + 6.16$$

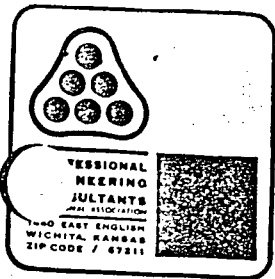
$$= 28.04$$

$$p = 58.6$$

$$R = A/p = 28.04 / 58.6 = 0.478498 \quad R^{2/3} = 0.611768$$

$$Q = \frac{1.486}{0.0226} \times 28.04 \times 0.611768 \times 5^{1/2}$$

$$= 1,127.91 \sqrt{5}$$



Date 8-1-89 Page \_\_\_\_\_ of \_\_\_\_\_

Project Tallgrass East 3rd Addn.

Item Drainage Plan

### 0.7 Walk Grade

$$n = 0.0226$$

$$A = (2 \times 1/2 \times 15 \times 0.7) + (28 \times 0.56) + (2 \times 1/2 \times 14 \times 0.44)$$
$$= 0.5 + 15.68 + 6.16$$

$$= 32.34$$

$$p = 58.6$$

$$R = A/p = 32.34/58.6 = 0.551877 \quad R^{2/3} = 0.672814$$

$$Q = \frac{1.486}{0.0226} \times 32.34 \times 0.672814 \times 5^{1/2}$$

$$Q = 1,430.69 \sqrt{5}$$



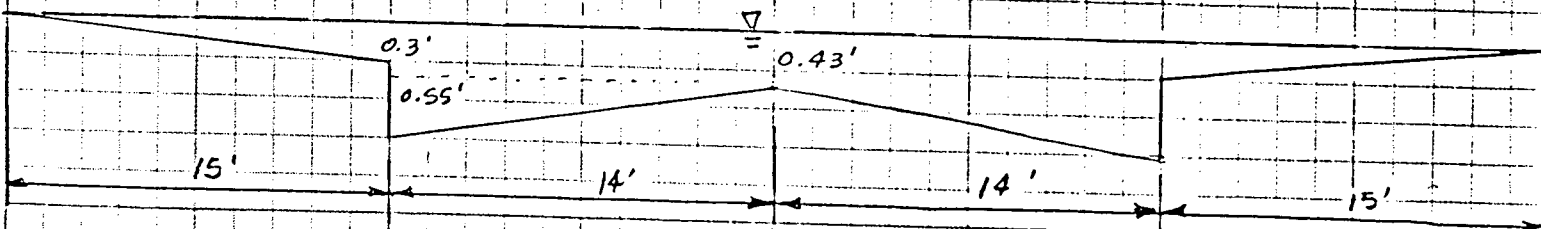
Date 8-1-89 Page \_\_\_\_\_ of \_\_\_\_\_

Project Tallgrass East 3rd Addn.

Item Drainage Plan

Determine Capacities of Standard Curb Streets w/  
Various Walk Grades for 100-year storm analysis  
(58' R-O-W)

0.3' WALK GRADE



$$P = \frac{(2 \times 14.5 \times 0.03) + (2 \times 3.05 \times 0.013) + (2 \times 12 \times 0.016)}{59.1}$$

$$= \frac{(0.87) + (0.0793) + (0.384)}{59.1} = \frac{1.3333}{59.1} = 0.0226$$

$$A = (2 \times \frac{1}{2} \times 15 \times 0.3) + (28 \times 0.43) + (2 \times \frac{1}{2} \times 14 \times 0.42)$$

$$= (4.5) + (12.04) + (5.88)$$

$$= 22.42$$

$$P = 59.1$$

$$R = A/P = 22.42/59.1 = 0.379357$$

$$R^{2/3} = 0.52404$$

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

$$Q = \frac{1.486}{0.0226} \times 22.42 \times 0.52404 \times S^{1/2}$$

$$Q = 772.5 \sqrt{S}$$



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ZIP CODE / 67211

Date 8-1-89 Page \_\_\_\_\_ of \_\_\_\_\_

Project Tallgrass East 3rd Addn.

Item Drainage Plan

0.4' WALK GRADE

$$n = 0.0226$$

$$A = (2 \times \frac{1}{2} \times 15 \times 0.4) + (28 \times 0.53) + (2 \times \frac{1}{2} \times 14 \times 0.42)$$
$$= (6.00) + (14.84) + (5.88)$$

$$= 26.72$$

$$p = 59.1$$

$$R = A/p = 26.72/59.1 = 0.452115 \quad R^{2/3} = 0.589069$$

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

$$Q = \frac{1.486}{0.0226} \times 26.72 \times 0.589069 \times S^{1/2}$$

$$Q = 1,034.93 \sqrt{S}$$



Date 8-1-89 Page \_\_\_\_\_ of \_\_\_\_\_

Project Tallgrass East 3rd Addn.

Item Drainage Plan

0.5' WALK GRADE

$$n = 0.0226$$

$$A = (2 \times \frac{1}{2} \times 15 \times 0.5) + (28 \times 0.63) + (2 \times \frac{1}{2} \times 14 \times 0.42)$$

$$= (7.5) + (17.64) + (5.88)$$

$$= 31.02 \text{ SF}$$

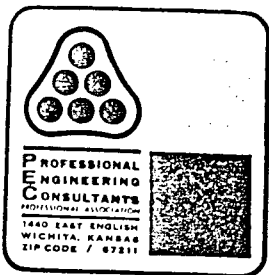
$$p = 59.1$$

$$R = A/p = 31.02/59.1 = 0.524873 \quad R^{2/3} = 0.650683$$

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

$$Q = \frac{1.486}{0.0226} \times 31.02 \times 0.650683 \times S^{1/2}$$

$$Q = 1,327.15 \sqrt{S}$$



Date 8-1-89 Page \_\_\_\_\_ of \_\_\_\_\_

Project Tallgrass East 3rd Addn.

Item Drainage Plan

0.6' WALK GRADE

$$n = 0.0226$$

$$\begin{aligned} A &= (2 \times \frac{1}{2} \times 15 \times 0.6) + (28 \times 0.73) + (2 \times \frac{1}{2} \times 14 \times 0.42) \\ &= (9.0) + (20.44) + (5.88) \\ &= 35.32 \end{aligned}$$

$$p = 59.1$$

$$R = A/p = 35.32/59.1 = 0.597631 \quad R^{2/3} = 0.709505$$

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

$$Q = \frac{1.486}{0.0226} \times 35.32 \times 0.709505 \times S^{1/2}$$

$$Q = 1,647.73 \sqrt{S}$$



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Project Tallgrass East 3rd Addn.

Item Drainage Plan

0.7' WALK GRADE

$$n = 0.0226$$

$$A = (2 \times \frac{1}{2} \times 5 \times 0.7) + (28 \times 0.83) + (2 \times \frac{1}{2} \times 14 \times 0.42)$$

$$= (10.5) + (23.24) + (5.88)$$

$$= 39.62$$

$$p = 59.1$$

$$R = A/p = 39.62/59.1 = 0.670389 \quad R^{2/3} = 0.765981$$

$$Q = \frac{1.486}{n} AR^{2/3} s^{1/2}$$

$$Q = \frac{1.486}{0.0226} \times 39.62 \times 0.765981 \times s^{1/2}$$

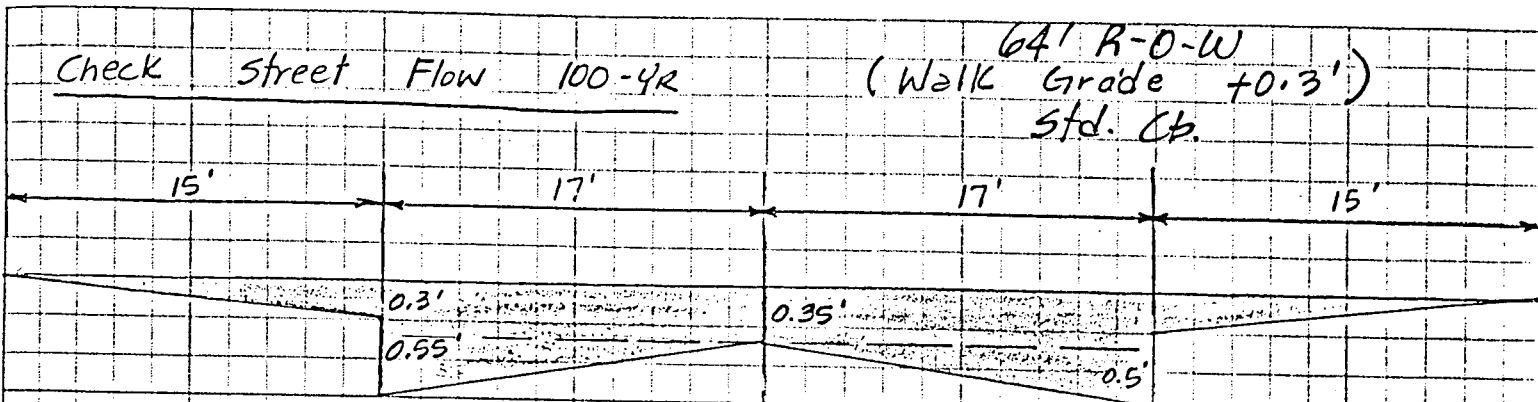
$$Q = 1,995.46 \sqrt{s}$$



Date 8-1-89 Page      of     

Project Tallgrass East 3rd Addn.

Item Drainage Plan



Determine  $Q_{max}$  in Street R-O-W

Use Mannings Eq'n  $Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$

$$n = \frac{2(14.5 \times 0.030) + 2(1.05 \times 0.013) + 2(17 \times 0.016)}{65.1}$$

$$n = \frac{1.4413}{65.1} = 0.0221$$

$$A = 2\left(\frac{1}{2} \times 15 \times 0.3\right) + (34 \times 0.35) + 2\left(\frac{1}{2} \times 0.5 \times 17\right) = 24.90 \text{ SF}$$

$$p = (2 \times 15) + (2 \times 17) + (2 \times 0.55) = 65.1'$$

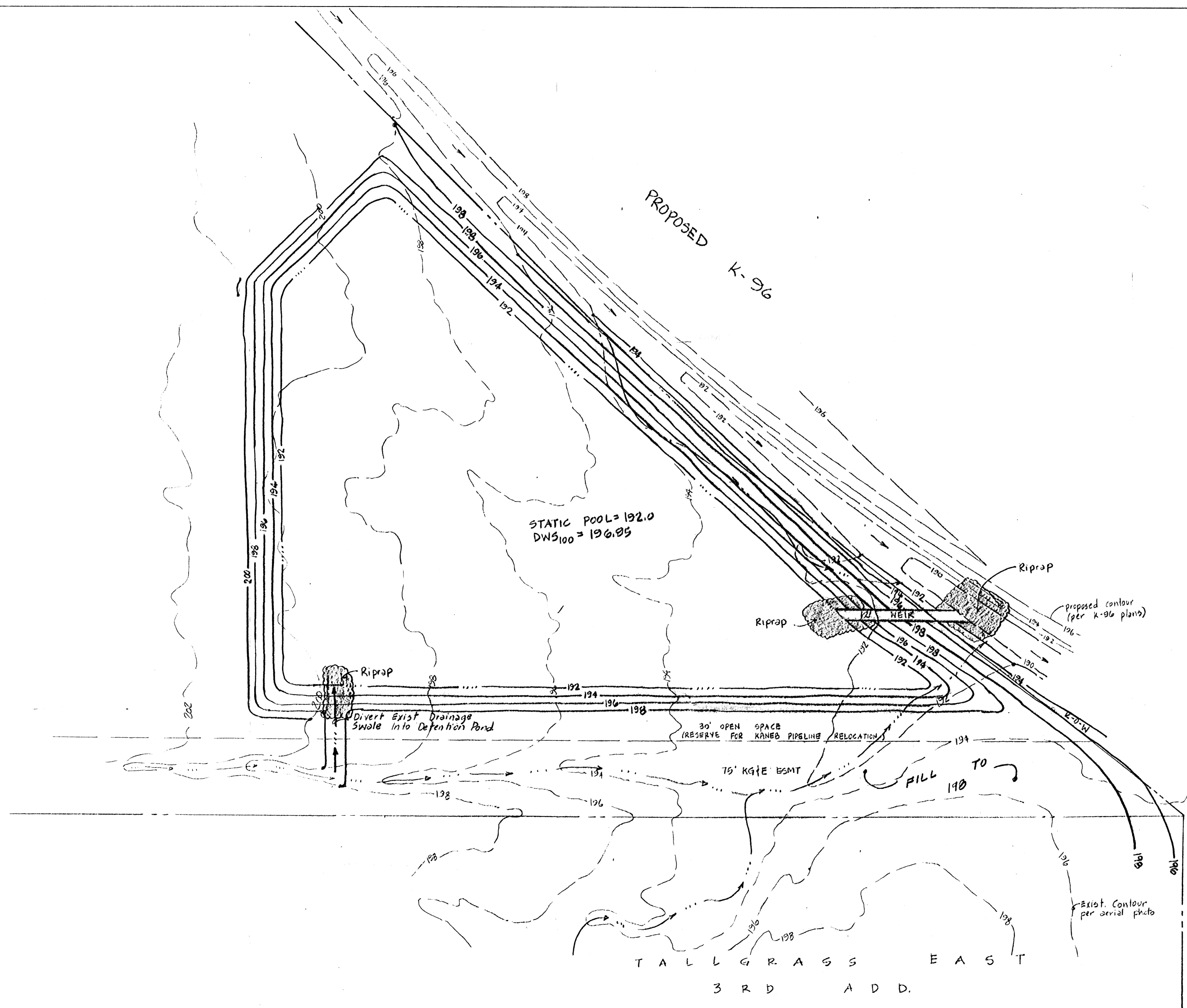
$$R = A/p = 24.9/65.1 = 0.38249$$

$$R^{2/3} = 0.527$$

$$Q = \frac{1.486}{0.0221} \times 24.90 \times 0.527 \times S^{1/2}$$

$$Q = 882.3 \times S^{1/2}$$

STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS
KANSAS			



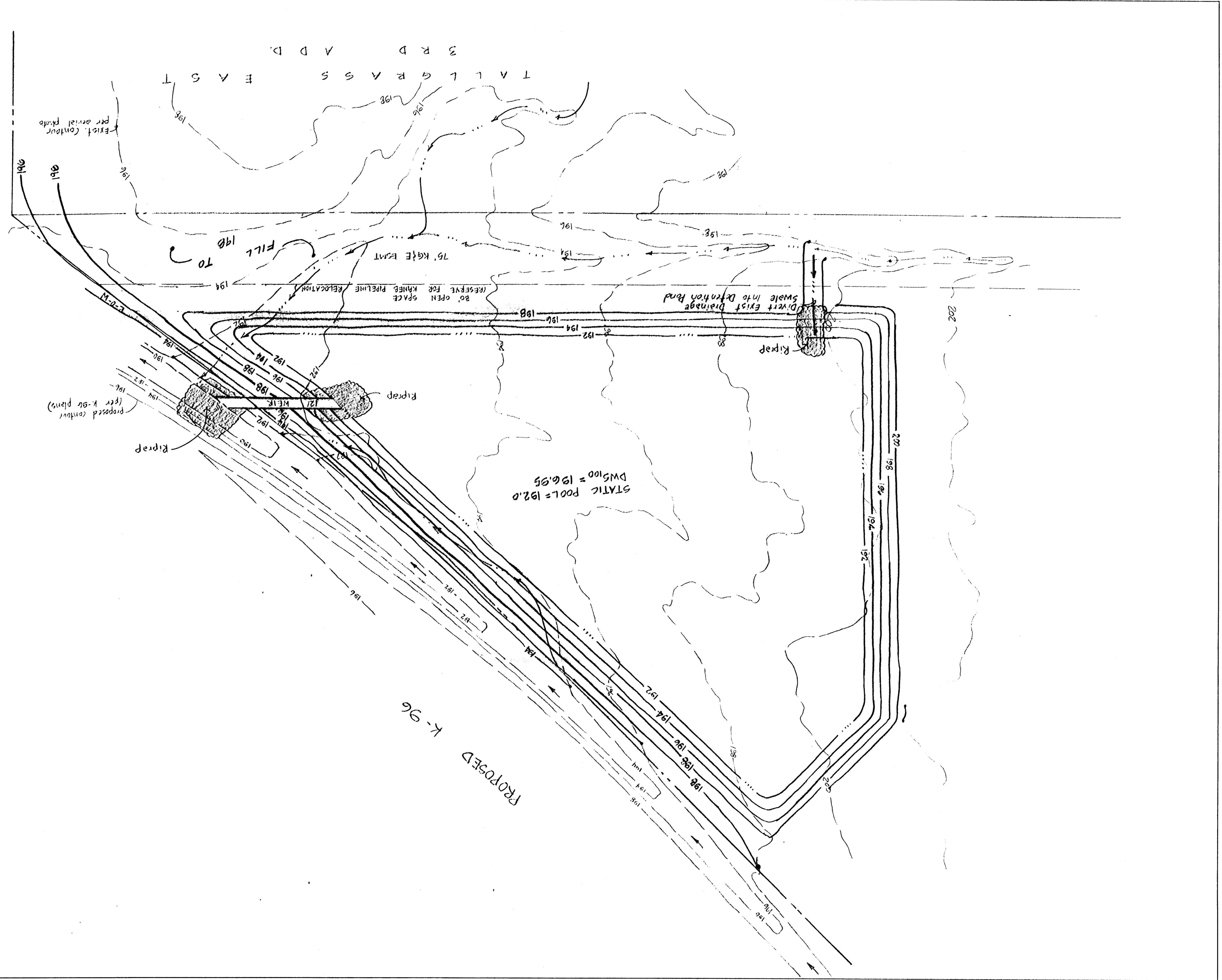
Note: Final pond shape subject to change by Final Plat of Tallgrass East Business Park.

TALLGRASS EAST 3RD

PRELIMINARY GRADING PLAN  
DETENTION POND

PROFESSIONAL ENGINEERING CONSULTANTS, P.A.  
ENGINEERS  
WICHITA, KANSAS

Designed by	CSB	Checked by	
Drawn by	CSB	Date	
		Job No.	



Note: Final pond shape subject to change by final plat of Taligpass East Business Park.

