

PROFESSIONAL
ENGINEERING
CONSULTANTS
PROFESSIONAL ASSOCIATION

**DRAINAGE PLAN
AND
SUPPORTING CALCULATIONS**

**FOR
REFLECTION RIDGE 9TH ADDITION
TO WICHITA, SEDGWICK COUNTY, KANSAS**

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

NOVEMBER 23, 1992

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MEMO



TO: Michael E. Lindebak, P.E.
455 N. Main - 7th Floor
Wichita, KS 67220

PROJECT NO. 36-92532-2273
PROJECT: Reflection Ridge
Drainage Plan

ATTN: Ms. Vicky, Huang, P.E. DATE: November 23, 1992

COPIES TO:

Marvin Schellenberg

FROM: Michael W. Berry, P.E. *MMB*
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 7/1/87, was used as the guideline 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 1992 topographic survey map, project plans for various improvements on adjacent lands, and the Drainage Plan for Reflection Ridge Addition and Reflection Ridge 7th Addition.

HYDROLOGIC ANALYSIS FOR STORM WATER SEWERS

For storm sewer design, 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 Rational Method assumes uniformly distributed rainfall, both temporally and spatially.

For this development, a uniform assumption of the minimum time of concentration value of 15 minutes was appropriate. For golf course areas, the time of concentration was estimated using flow velocities of 1 foot/second and were found also to yield time of concentration of approximately 15 minutes.

Travel time for flow-through defined channels, pipes, etc., for these basins was estimated on the basis of Manning's Equation.

HYDRAULIC ANALYSIS FOR STORM WATER SEWERS

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

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

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.

Inlet capacities were determined by the methods presented in Manual #2, using Chart No. 12.

In this analysis, City of Wichita Type 1A inlets and 3/8 in./ft. street cross-slope were assumed to be utilized. Minimum walk grade was assumed as 0.3 feet above the top of curb, except as otherwise noted. Local streets are assumed to have roll curb and gutter, unless otherwise noted.

All storm sewer systems serve residential streets. Therefore, the design minor storm has a recurrence interval of two years, and the major storm one hundred years. Systems are designed for the minor storm with major storm overflows directed around home sites across open space in the golf course, or down street rights-of-way.

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 were performed using PEC's Storm Program. This program uses Manning's Equation to calculate friction losses in pipes flowing full. Minor losses are computed by momentum principles at each structure. 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 Manning's Equation, in accordance with Section G3 of the Design Manual, using the charts presented in KDOT Design Manual Volume III.

CLUBHOUSE POND

This pond was originally sized to store the 100 year runoff volume from its basin without discharge. The static pool elevation was to be maintained via pumping through the golf course irrigation system.

With the development of this plat, there is an opportunity to install a small capacity drawdown pipe which can maintain the static pool elevation by means of a gravity storm sewer. This outlet pipe must be constructed with a constriction at the inlet end so as to minimize the discharge during a rainfall event.

This study has been performed assuming a constant discharge of 2 cfs, which would draw the pond down from its design volume in three days.

MAJOR STORM FLOW

This development will utilize the golf course open space to store/carry major storm flows. A continuous open channel system has not been designed; however, the adjacent homes are to be constructed higher than any adjacent critical overflow point. Ponding will occur on the golf course whenever the storm sewer system has reached capacity; however, positive grading will direct all ponded areas to an inlet and as the storm recedes, the ponding will recede.

Turfed open area ponding will serve the following functions:

1. Detain floodwaters and thus reduce peak flowrates by virtue of storage.
2. Detain floodwaters and thus reduce peak flowrates by virtue of infiltration.
3. Will allow suspended solids to settle out.
4. Will act to filter some stormwater pollutants.

DRAINAGE MAP

A 1" = 50' scale drainage map is included in a map pocket at the back of the report.

REFLECTION RIDGE 9TH ADDITION DRAINAGE PLAN
 HYDROLOGY ANALYSIS
 PROFESSIONAL ENGINEERING CONSULTANTS, P.A.
 M. W. BERRY, P.E. 11/21/92

NOTE: GC=GOLF COURSE
 RES=1/4 AC RESIDENTIAL (38% IMPERVIOUS)

TWO YEAR STORM

BASIN	HYDRO-LOGIC SOIL GROUP	LAND USE	RUNOFF COEFF C	TIME OF CONC Tc, MIN	RAINFALL INTENSITY i, IN/HR	AREA A, AC	RUNOFF Q CU FT/SEC
1105	B	100% GC	0.16	15.00	3.83	0.23	0.14
1106	B	33% RES; 67% GC	0.25	15.00	3.83	0.40	0.39
1107	B	100% RES	0.44	15.00	3.83	1.25	2.10
1108N	B	100% RES	0.44	15.00	3.83	1.07	1.80
1108S	B	100% RES	0.44	15.00	3.83	2.47	4.16
1109	B	33% RES; 67% GC	0.25	15.00	3.83	0.70	0.68
1110	B	33% RES; 67% GC	0.25	15.00	3.83	0.70	0.68
1111	B	33% RES; 67% GC	0.25	15.00	3.83	0.83	0.80
1112	B	33% RES; 67% GC	0.25	15.00	3.83	3.46	3.35
1200	B	33% RES; 67% GC	0.25	15.00	3.83	5.53	5.36
1300	B	100% RES	0.44	15.00	3.83	0.82	1.39

#####

100-YEAR STORM

BASIN	HYDRO-LOGIC SOIL GROUP	LAND USE	RUNOFF COEFF C	TIME OF CONC Tc, MIN	RAINFALL INTENSITY i, IN/HR	AREA A, AC	RUNOFF Q CU FT/SEC
1105	B	100% GC	0.37	15.00	7.37	0.23	0.63
1106	B	33% RES; 67% GC	0.45	15.00	7.37	0.40	1.34
1107	B	100% RES	0.61	15.00	7.37	1.25	5.61
1108N	B	100% RES	0.61	15.00	7.37	1.07	4.79
1108S	B	100% RES	0.61	15.00	7.37	2.47	11.11
1109	B	33% RES; 67% GC	0.45	15.00	7.37	0.70	2.33
1110	B	33% RES; 67% GC	0.45	15.00	7.37	0.70	2.33
1111	B	33% RES; 67% GC	0.45	15.00	7.37	0.83	2.75
1112	B	33% RES; 67% GC	0.45	15.00	7.37	3.46	11.47
1200	B	33% RES; 67% GC	0.45	15.00	7.37	5.53	18.33
1300	B	100% RES	0.61	15.00	7.37	0.82	3.70



Date 11/21/92 NWB Page _____ of _____

Project REFLECTION RIDGE 9TH DRAINAGE PLAN

Item INLET SIZING (2-yr)

All inlets are sumps.

<u>NODE</u>	<u>SIZE & TYPE</u>	<u>Q_{2yr}</u>	<u>PONDING DEPTH, ft</u>	<u>REMARKS</u>
1105	Ex. 4'x2' Area	0.14	<0.1'	OK
1106	4'x2' Area	0.4	<0.1'	OK
1107	5' 1A Curb	2.1	0.2'	OK
1108	5' 1A Curb	6.0	0.33'	OK
1109 1110	4'x2' Area	0.7	<0.1'	OK
1111	4'x2' Area	0.8	<0.1'	OK
1112	4'x2' Area	3.3	0.25'	OK



Date 11/21/92 MAB Page _____ of _____

Project REFLECTON RIDGE 9TH ADD.

Item STREET FLOW

1107

$$S = 0.4\%$$

$$Q_2 = 2.1 \text{ CFS}$$

$$Q_{100} = 5.6 \text{ CFS}$$

$$Z = 1/32 \quad n = 0.016 \quad Z/n = 2000$$

$$d_2 = 0.27' \text{ OK FOR ROLL CURB}$$

$$d_{100} = 0.39' \text{ OK " " "}$$

1108N

$$S = 0.5\% \quad Q_2 = 1.8 \text{ CFS} \quad Q_{100} = 4.8 \text{ CFS}$$

OK BY INSPECTION (SEE 1107) FOR ROLL CURB

1108S

$$S = 0.4\% \quad Q_2 = 4.2 \text{ CFS} \quad Q_{100} = 11.1 \text{ CFS}$$

$$d_2 = 0.36 \text{ FT } \approx \text{ TOP OF ROLL CURB OK}$$

$$d_{100} = 0.48 \text{ FT OK}$$

Roll Curb OK.

NOTE: CONDITIONS AT SUMP CHECKED ONLY.

DUE TO SMALLER Q'S & STEEPER GRADES, ALL OTHER CONDITIONS OK BY INSPECTION

1300

$$S = 1.2\% \quad Q_2 = 1.4 \text{ CFS} \quad Q_{100} = 3.70 \text{ CFS}$$

$$d_2 = 0.19' \text{ OK}$$

$$d_{100} = 0.27' \text{ OK}$$

USE ROLL CURB
THROUGHOUT

100 j, 141.7000 1105 4 9 8
 110 t, Reflection Ridge 9th Addition Drainage Plan
 120 t, Two Year Analysis
 130 t, Professional Engineering Consultants, P.A.
 140 t, Computed by M. W. Berry, P.E. 11/21/92 file:c:\rr9th\rr9th.stm
 150 i, 1113 0.00 0.00 0.00 0.00 2.00 15.00 145.00
 160 i, 1112 0.25 3.46 0.00 0.00 3.35 15.00 143.50
 170 i, 1111 0.25 0.83 0.00 0.00 0.80 15.00 143.50
 180 i, 1110 0.25 0.70 0.00 0.00 0.68 15.00 143.00
 190 i, 1109 0.25 0.70 0.00 0.00 0.68 15.00 143.00
 200 i, 1108 0.44 3.54 0.00 0.00 5.96 15.00 145.50
 210 i, 1107 0.44 1.25 0.00 0.00 2.10 15.00 145.50
 220 i, 1106 0.25 0.40 0.00 0.00 0.39 15.00 143.00
 230 i, 1105 0.16 0.23 0.00 0.00 0.14 15.00 142.75
 240 p, 1113 1112 140.00 12 0.013 0.00 0.00
 250 p, 1112 1111 135.00 24 0.013 40.00 0.00
 260 p, 1111 1110 260.00 24 0.013 0.00 0.00
 270 p, 1110 1109 170.00 24 0.013 0.00 0.00
 280 p, 1109 1106 170.00 24 0.013 70.00 0.00
 290 p, 1108 1107 30.00 15 0.013 15.00 0.00
 300 p, 1107 1106 130.00 18 0.013 20.00 0.00
 310 p, 1106 1105 110.00 30 0.013 50.00 0.00
 320 e

Date: 11-21-1992
 Time: 09:48:42

Input File: c:\rr9th\rr9th.stm

Reflection Ridge 9th Addition Drainage Plan
 Two Year Analysis
 Professional Engineering Consultants, P.A.
 Computed by M. W. Berry, P.E. 11/21/92 file:c:\rr9th\rr9th.stm

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)	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)
*****												*****				
1113 1112	.00	.00	.00	.0	15.00	3.83	2.00	15.00	3.83	2.00	2.00	12"	2.55	140.00	.92	15.92
1112 1111	.25	3.46	.00	.0	15.00	3.83	3.35	15.92	3.73	3.26	5.26	24"	1.67	135.00	1.34	17.26
1111 1110	.25	.83	.00	.0	15.00	3.83	.80	17.26	3.59	.75	6.01	24"	1.91	260.00	2.27	19.53
1110 1109	.25	.70	.00	.0	15.00	3.83	.68	19.53	3.37	.60	6.61	24"	2.10	170.00	1.35	20.87
1109 1106	.25	.70	.00	.0	15.00	3.83	.68	20.87	3.26	.58	7.19	24"	2.29	170.00	1.24	22.11
1108 1107	.44	3.54	.00	.0	15.00	3.83	5.96	15.00	3.83	5.96	5.96	15"	4.86	30.00	.10	15.10
1107 1106	.44	1.25	.00	.0	15.00	3.83	2.10	15.10	3.82	2.09	8.05	18"	4.56	130.00	.48	15.58
1106 1105	.25	.40	.00	.0	15.00	3.83	.39	22.11	3.16	.32	14.28	30"	2.91	110.00	.63	22.74
*****												*****				

Date: 11-21-1992
Time: 09:48:42

Input File: c:\rr9th\rr9th.stm

Reflection Ridge 9th Addition Drainage Plan
Two Year Analysis
Professional Engineering Consultants, P.A.
Computed by M. W. Berry, P.E. 11/21/92 file:c:\rr9th\rr9th.stm

Storm Frequency = 2-Year

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

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*****
Node    Hyd-Slope  Friction  Bend  Transition  Manhole  Deflection  Junction  Total  Hyd-Gl  Desired  Diff.
        (Ft/Ft)    (Ft)      (Ft)   (Ft)         (Ft)     (Ft)        (Ft)     (Ft)   Elevation Elevation (Ft)
*****
```

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)
1113	.00315	.4412	.0000	.0000	.0000	.0000	.0000	.4412	143.1020	145.0000	1.90
1112	.00054	.0730	.0000	.0114	.0000	.0000	.0681	.1525	142.6608	143.5000	.84
1111	.00071	.1835	.0000	.0013	.0000	.0082	.0297	.2228	142.5083	143.5000	.99
1110	.00085	.1451	.0000	.0012	.0000	.0000	.0277	.1740	142.2855	143.0000	.71
1109	.00101	.1716	.0000	.0013	.0000	.0000	.0299	.2028	142.1115	143.0000	.89
1108	.00851	.2554	.0000	.0000	.0000	.0000	.0000	.2554	143.1556	145.5000	2.34
1107	.00588	.7641	.0000	.0088	.0000	.0213	.1972	.9915	142.9002	145.5000	2.60
1106	.00121	.1334	.0000	.0382	.0000	.0265	.0106	.2087	141.9087	143.0000	1.09
1105	.00000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	141.7000	142.7500	1.05

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*****
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Date 11-21-92 MWS Page of

Project REFL R 9TH ADD DRAIN PLAN

Item DITCH ALONG NORTH SIDE CENTRAL PARK

REFERENCE
KDAT Vol III

DESIGN DITCH ALONG EDGE OF DRIVING RANGE

$$Q_2 = 5.4 \text{ CFS}$$

$$Q_{10} = 12 \text{ CFS}$$

$$Q_{100} = 18.3 \text{ CFS}$$

RETARDANCE CLASS E
10' FLAT BOTTOM 4:1
Slope 1 1/2'

FROM Fig 3D-4-1-1-E

$$\text{Maximum Permissible Depth (Non-Erosive)} = 0.62 \text{ ft}$$

From Fig 3D-4-1-1-3-A+B

$$\text{For } B = 10'$$

$$d = 0.6'$$

$$A = 7.6 \text{ ft}^2$$

$$R = 0.5'$$

From Fig 3D-4-1-1-E

$$V = 2.8 \text{ ft/s}$$

$$Q = AV = 21 \text{ cfs} \Rightarrow \text{OK } > 100 \text{ yr}$$

100 yr Non-Erosive if grass is established

CHECK Q_{10} ON SEEDED & MULCHED DITCH

From Fig 3D-4-1-1-3-A+B

$$B = 10'$$

$$d = 0.4'$$

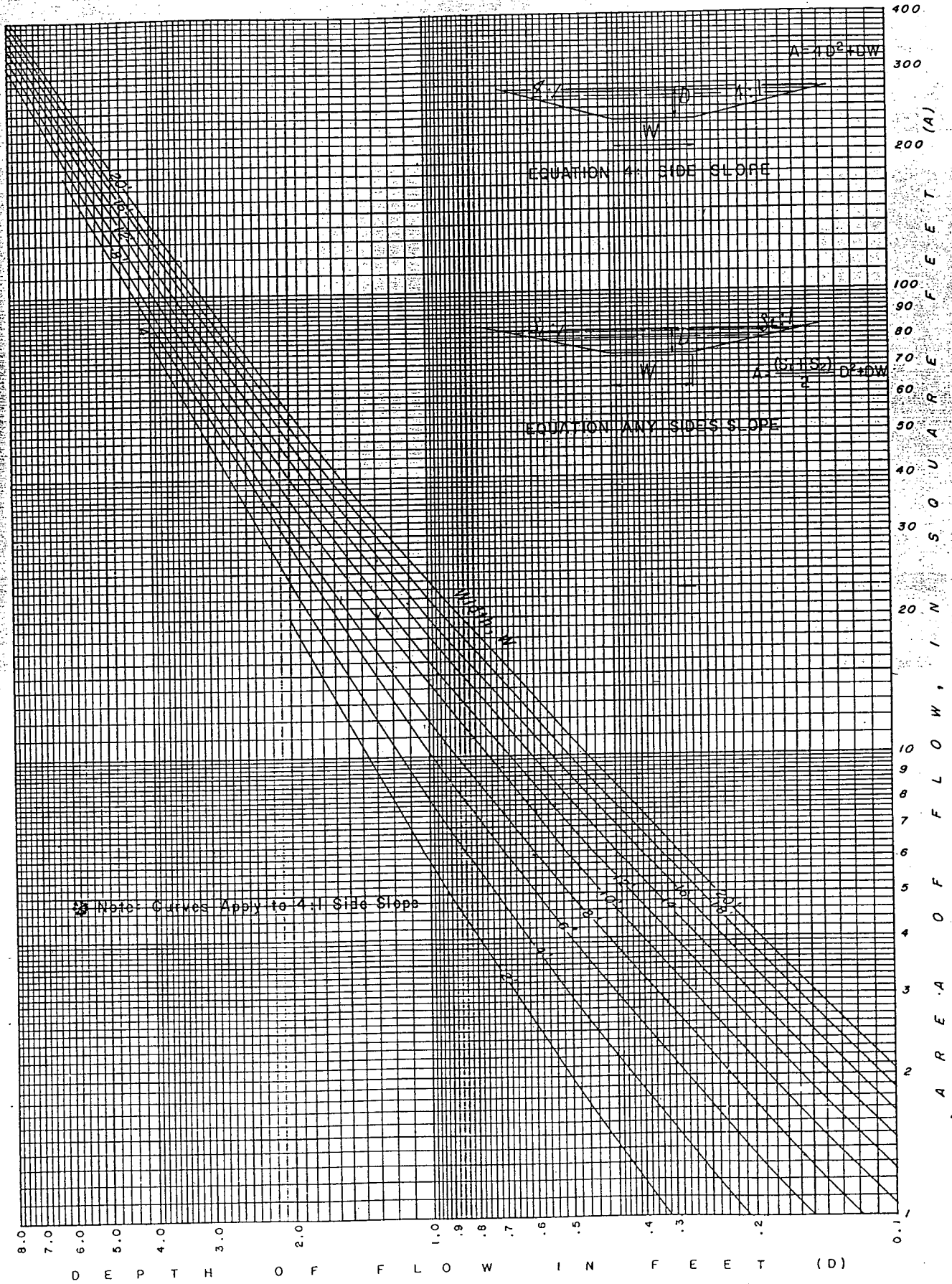
$$A = 4 \text{ ft}^2$$

$$R = 0.35'$$

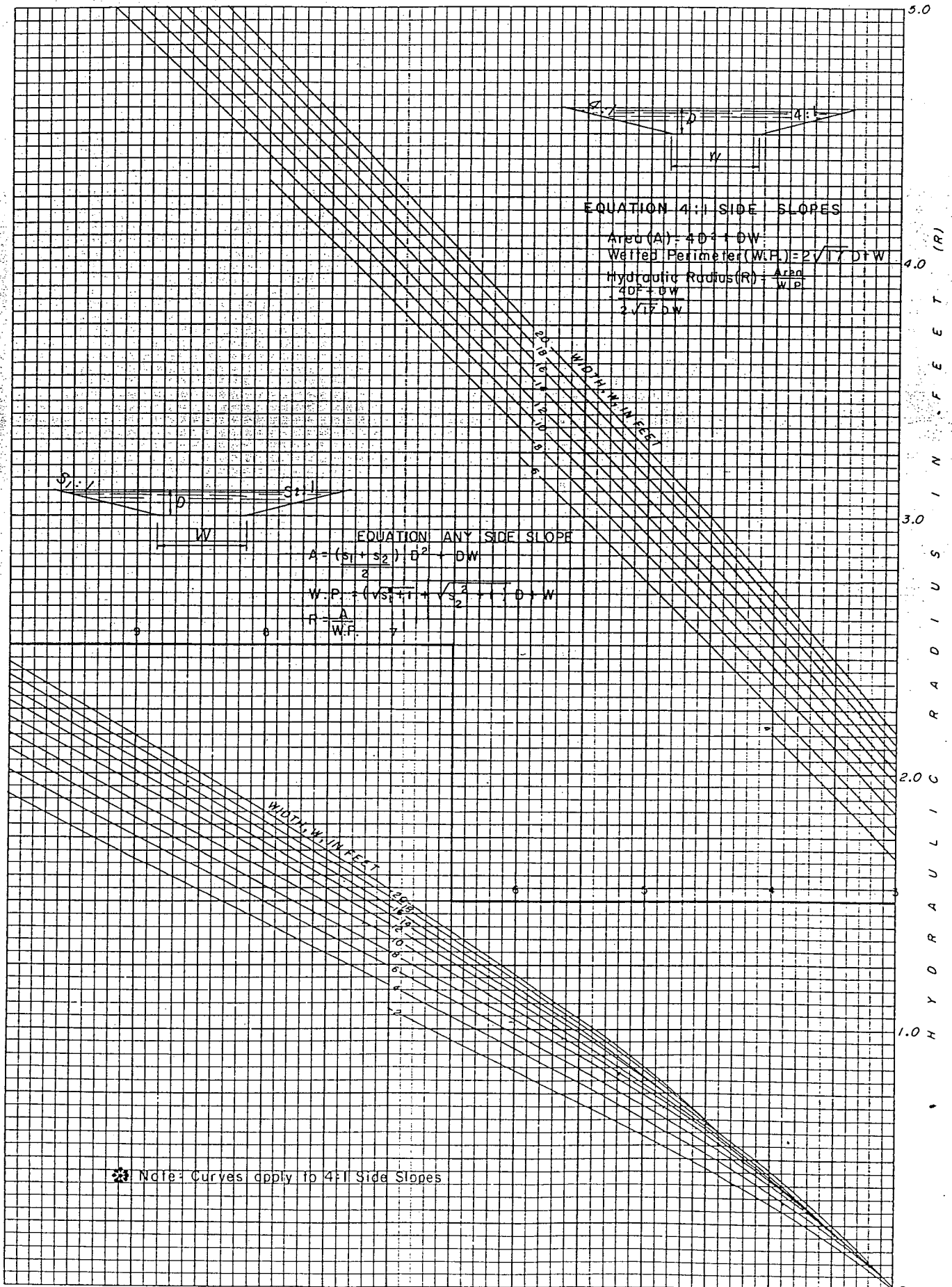
$$\text{Find } V = 32.766 R^{0.641} S^{0.387} = 2.8 \text{ ft/s (EQ. FROM FIG 3D-4-1-2-A)}$$

$$Q = AV = 4 \times 2.8 = 11.25 \text{ CFS} \Rightarrow \text{MARGINAL EROSION FOR } Q_{10} = 12 \text{ CFS.}$$

HYDRAULIC PROPERTIES OF TRAPEZOIDAL CHANNELS (AREA OF FLOW)



HYDRAULIC PROPERTIES OF TRAPEZOIDAL CHANNELS (HYDRAULIC RADIUS)



DEPTH OF FLOW IN FEET (D) WIDTH IN FEET HYDRAULIC RADIUS (R)

Figure 3D 4 1 1 2 D

RETARDANCE CLASS E

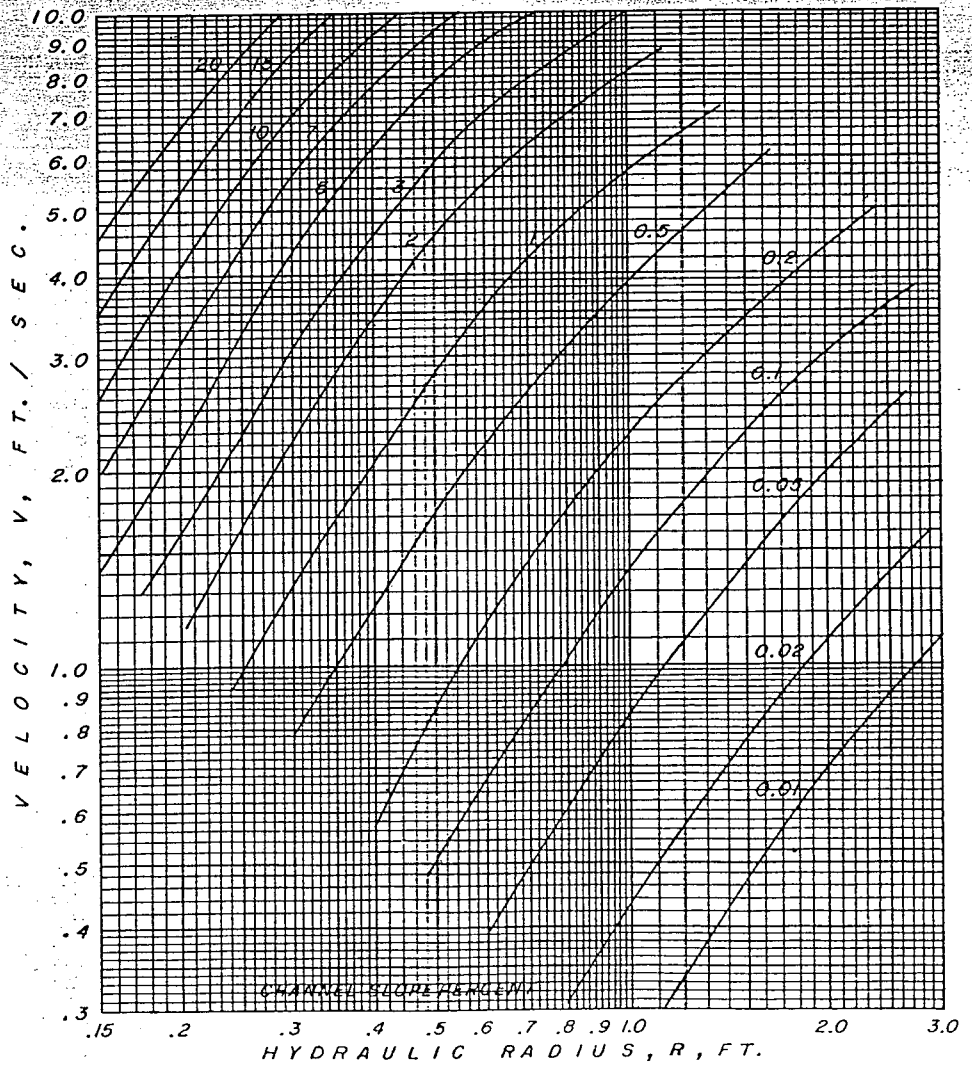
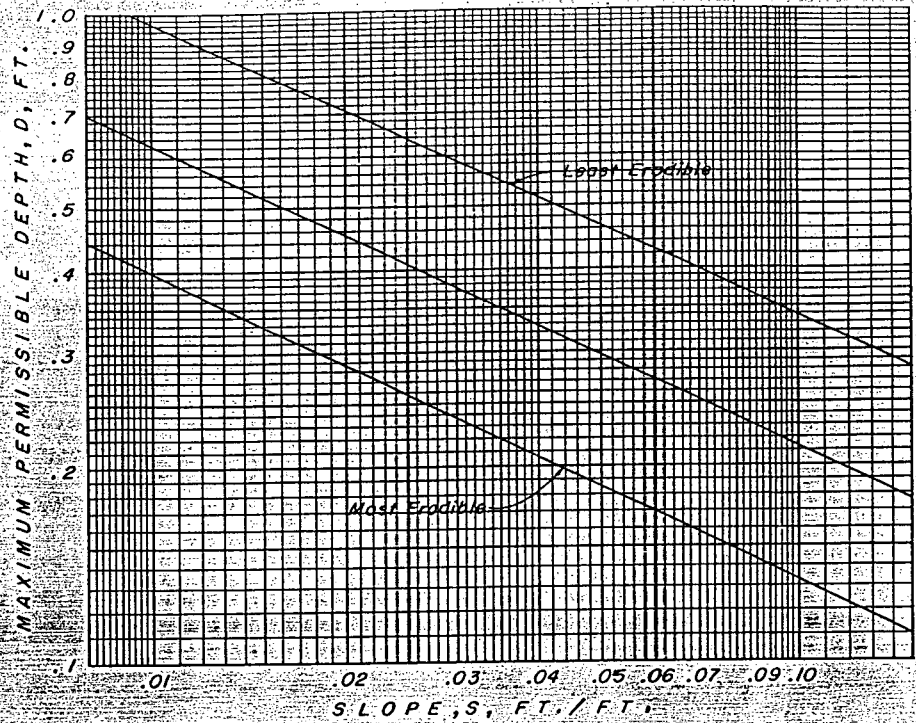


Figure 3D-4-1-1-E

Reflection Ridge 9th Add. - Node 1200 Pipe

CURRENT DATE: 11-21-1992
 CURRENT TIME: 10:57:40

FILE DATE: 11-21-1992
 FILE NAME: RR91200

 ***** FHWA CULVERT ANALYSIS *****
 ***** HY-8, VERSION 3.2 *****

C U L V #	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	141.25	138.00	75.07	1 RCP	1.50	1.50	.012	CONVENTIONAL
2								
3								
4								
5								
6								

 SUMMARY OF CULVERT FLOWS (CFS) FILE: RR91200 DATE: 11-21-1992

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
142.25	0	0	0	0	0	0	0	0	1
142.34	2	2	0	0	0	0	0	0	1
142.46	4	4	0	0	0	0	0	0	1
142.64	5	5	0	0	0	0	0	0	1
143.02	8	8	0	0	0	0	0	0	1
143.42	10	10	0	0	0	0	0	0	1
143.94	12	12	0	0	0	0	0	0	1
144.55	14	14	0	0	0	0	0	0	1
145.25	16	16	0	0	0	0	0	0	1
145.92	18	18	0	0	0	0	0	0	30
146.05	20	18	0	0	0	0	0	2	14
146.00	18	18	0	0	0	0	0	0	OVERTOPPING

 SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: RR91200 DATE: 11-21-1992

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
142.25	0.00	0	0	0.00
142.34	0.00	2	0	0.00
142.46	0.00	4	0	0.00
142.64	0.00	5	0	0.00
143.02	0.00	8	0	0.00
143.42	0.00	10	0	0.00
143.94	0.00	12	0	0.00
144.55	0.00	14	0	0.00
145.25	0.00	16	0	0.00
145.92	-0.01	18	0	1.72
146.05	-0.00	20	0	0.77

 <1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

Reflection Ridge 9th Add. - Node 1200 Pipe

CURRENT DATE: 11-21-1992
 CURRENT TIME: 10:57:40

FILE DATE: 11-21-1992
 FILE NAME: RR91200

 ***** CULVERT # 1 *****

 PERFORMANCE CURVE FOR 1 BARREL(S)

Q (cfs)	HWE (ft)	TWE (ft)	ICH (ft)	OCH (ft)	FLOW TYPE	CCE (ft)	FCE (ft)	TCE (ft)	VO (fps)
0	142.25	142.25	0.00	1.00	0-NF	0.00	141.25	0.00	0.00
2	142.34	142.25	0.70	1.09	1-S1	0.00	0.00	0.00	1.13
4	142.46	142.25	1.06	1.21	1-S1	0.00	0.00	0.00	2.26
5	142.64	142.25	1.26	1.39	1-S1	0.00	0.00	0.00	3.06
8	143.02	142.25	1.64	1.77	1-S1	0.00	0.00	0.00	4.53
10	143.42	142.25	1.99	2.17	4-FF	0.00	0.00	0.00	5.66
12	143.94	142.25	2.41	2.69	4-FF	0.00	0.00	0.00	6.79
14	144.55	142.25	2.91	3.30	4-FF	0.00	0.00	0.00	7.92
16	145.25	142.25	3.46	4.00	4-FF	0.00	0.00	0.00	9.05
18	145.92	142.25	3.98	4.67	4-FF	0.00	0.00	0.00	10.01
18	146.05	142.25	4.08	4.80	4-FF	0.00	0.00	0.00	10.19

El. inlet face invert 141.25 ft El. outlet invert 138.00 ft
 El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT *****
 INLET STATION (FT) 0.00
 INLET ELEVATION (FT) 141.25
 OUTLET STATION (FT) 75.00
 OUTLET ELEVATION (FT) 138.00
 NUMBER OF BARRELS 1.00
 SLOPE (V-FT/H-FT) 0.0433
 CULVERT LENGTH ALONG SLOPE (FT) 75.07

***** CULVERT DATA SUMMARY *****
 BARREL SHAPE CIRCULAR
 BARREL DIAMETER 1.50 FT
 BARREL MATERIAL CONCRETE
 BARREL MANNING'S N 0.012
 INLET TYPE CONVENTIONAL
 INLET EDGE AND WALL GROOVED END IN HEADWALL
 INLET DEPRESSION NONE

CURRENT DATE: 11-21-1992
CURRENT TIME: 10:57:40

FILE DATE: 11-21-1992
FILE NAME: RR91200

***** TAILWATER *****

CONSTANT WATER SURFACE ELEVATION = 1' below T.C.
142.25

***** ROADWAY OVERTOPPING DATA *****

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	4.00
CREST LENGTH (FT)	50.00
OVERTOPPING CREST ELEVATION (FT)	146.00



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

Date 11/21/92 MWS Page _____ of _____

Project REFLECTION RIDGE 9TH ADDITION

Item CLUBHOUSE POND LAKE #3

DESIGN PARAMETERS: (SEE 6 SHEETS FROM REFLECTION RIDGE DRAINAGE PLAN)

DESIGN STATIC POOL = 140.8
100 YR DWS = 146.0
STORAGE VOLUME = 12 AC-FT

Problem: Drain lake down to static pool in reasonable time

$$12 \text{ AC FT} \times \frac{43560 \text{ FT}^2}{\text{AC}} = 522,000 \text{ CU FT}$$

$$\text{ONE DAY} \times \frac{24 \text{ HR}}{\text{DAY}} \times \frac{60 \text{ MIN}}{\text{HR}} \times \frac{60 \text{ SEC}}{\text{MIN}} = 86,400 \text{ SEC}$$

$$\text{TO DRAIN IN ONE DAY: } \frac{522,000}{86,400} = 6.0 \text{ CFS}$$

TWO DAY: 3 CFS

THREE DAY 2 CFS \approx 900 GPM

WK \approx 1 CFS

SELECT 3 DAYS

PROJECT DESIGN MUST INCORPORATE

A WEIR OR ORIFICE PLATE AT THE POND
OUTLET TO RESTRICT FLOWS TO \approx 2 CFS.

2 CFS WILL BE ADDED TO STORM
SEWER SYSTEM AT NODE 1113 FOR 2-YR
ANALYSIS

CURRENT DATE: 11-21-1992
 CURRENT TIME: 09:42:18

FILE DATE: 11-21-1992
 FILE NAME: RR9POND3

 ***** FHWA CULVERT ANALYSIS *****
 ***** HY-8, VERSION 3.2 *****

C U L V #	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	140.80	139.00	140.01	1 RCP	1.00	1.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

 SUMMARY OF CULVERT FLOWS (CFS) FILE: RR9POND3 DATE: 11-21-1992

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
143.50	0	0	0	0	0	0	0	0	1
143.62	1	1	0	0	0	0	0	0	1
143.99	2	2	0	0	0	0	0	0	1
144.61	3	3	0	0	0	0	0	0	1
145.48	4	4	0	0	0	0	0	0	1
145.57	5	4	0	0	0	0	0	0	30
145.71	6	4	0	0	0	0	0	0	30
145.85	7	4	0	0	0	0	0	0	30
145.99	8	4	0	0	0	0	0	0	30
146.03	9	5	0	0	0	0	0	4	20
146.04	10	5	0	0	0	0	0	5	10
146.00	4	4	0	0	0	0	0	0	OVERTOPPING

 SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: RR9POND3 DATE: 11-21-1992

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
143.50	0.00	0	0	0.00
143.62	0.00	1	0	0.00
143.99	0.00	2	0	0.00
144.61	0.00	3	0	0.00
145.48	0.00	4	0	0.00
145.57	-0.00	5	1	18.30
145.71	-0.00	6	2	29.63
145.85	-0.00	7	3	37.77
145.99	-0.00	8	4	43.93
146.03	-0.00	9	0	0.99
146.04	-0.00	10	0	0.76

 <1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

Reflection Ridge 9th Addition Drainage Plan

CURRENT DATE: 11-21-1992
CURRENT TIME: 09:42:18

FILE DATE: 11-21-1992
FILE NAME: RR9POND3

***** TAILWATER *****

CONSTANT WATER SURFACE ELEVATION
143.50

***** ROADWAY OVERTOPPING DATA *****

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	8.00
CREST LENGTH (FT)	270.00
OVERTOPPING CREST ELEVATION (FT)	146.00



Date 4.2.87 Page 1 of 6
Project Reflection Ridge Addition
Item Drainage Plan Pond No.3

Determine Total Q entering pond during
100-yr. storm:

A) Overflow From System 200
 $= Q_{100} - Q_z$
 $= 110.0 - 42.4 = 75.6 \text{ cfs @ } t_c 26.8 + \text{Travel}$
 $\text{Time to Pond 3} = 33.5$

B) Q_{100} System 300 = 98.1 cfs @ $t_c 26.7$

C) Area Adjacent to Pond which drains
directly into pond.

$$Q_{100} = C_{100} I_{100} A$$

$C =$ 90% Golf Course, Type B, 1-4%
5% Res.
5% Drives, Walks

$$C = (0.9 \times 0.41) + (0.05 \times 0.61) + (0.05 \times 0.89)$$
$$= 0.44$$

$$t_c = 400' @ \approx 1\% \text{ overland} = 0.28 \text{ fps} = 23.8$$
$$+ 1000' \text{ swale @ } \approx 3 \text{ fps} = 5.5$$
$$\underline{\quad\quad\quad} = 29.3$$

$$I_{100} = 5.46$$

$$A = 26.45$$

$$Q_{100} = 0.44 \times 5.46 \times 26.45$$

$$= 63.5 \text{ cfs @ } t_c 29.3 \text{ min.}$$

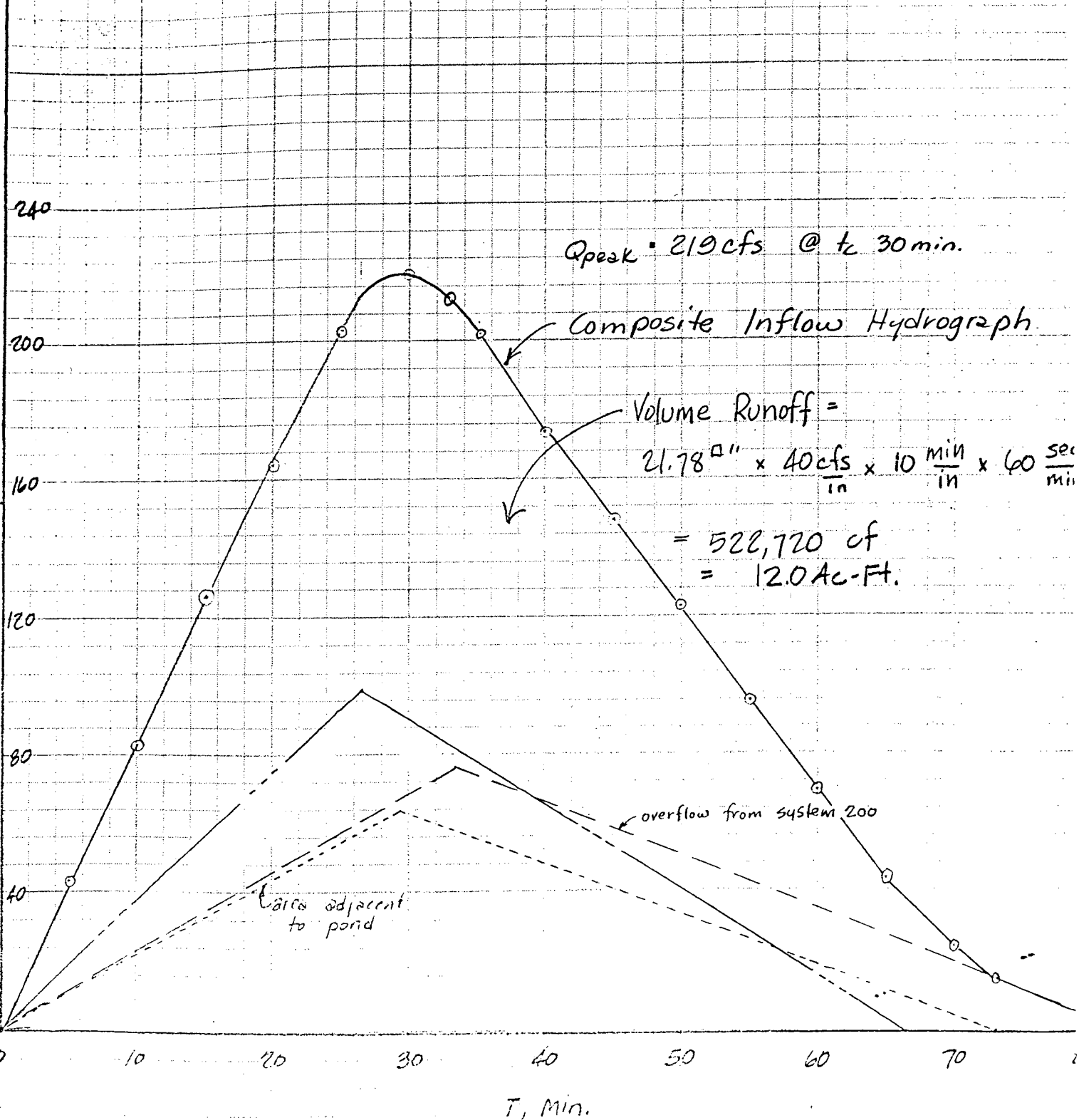


Date 4.2.87 Page 2 of 6

Project Reflection Ridge

Item Drainage Plan Pond No. 3

Inflow Hydrograph





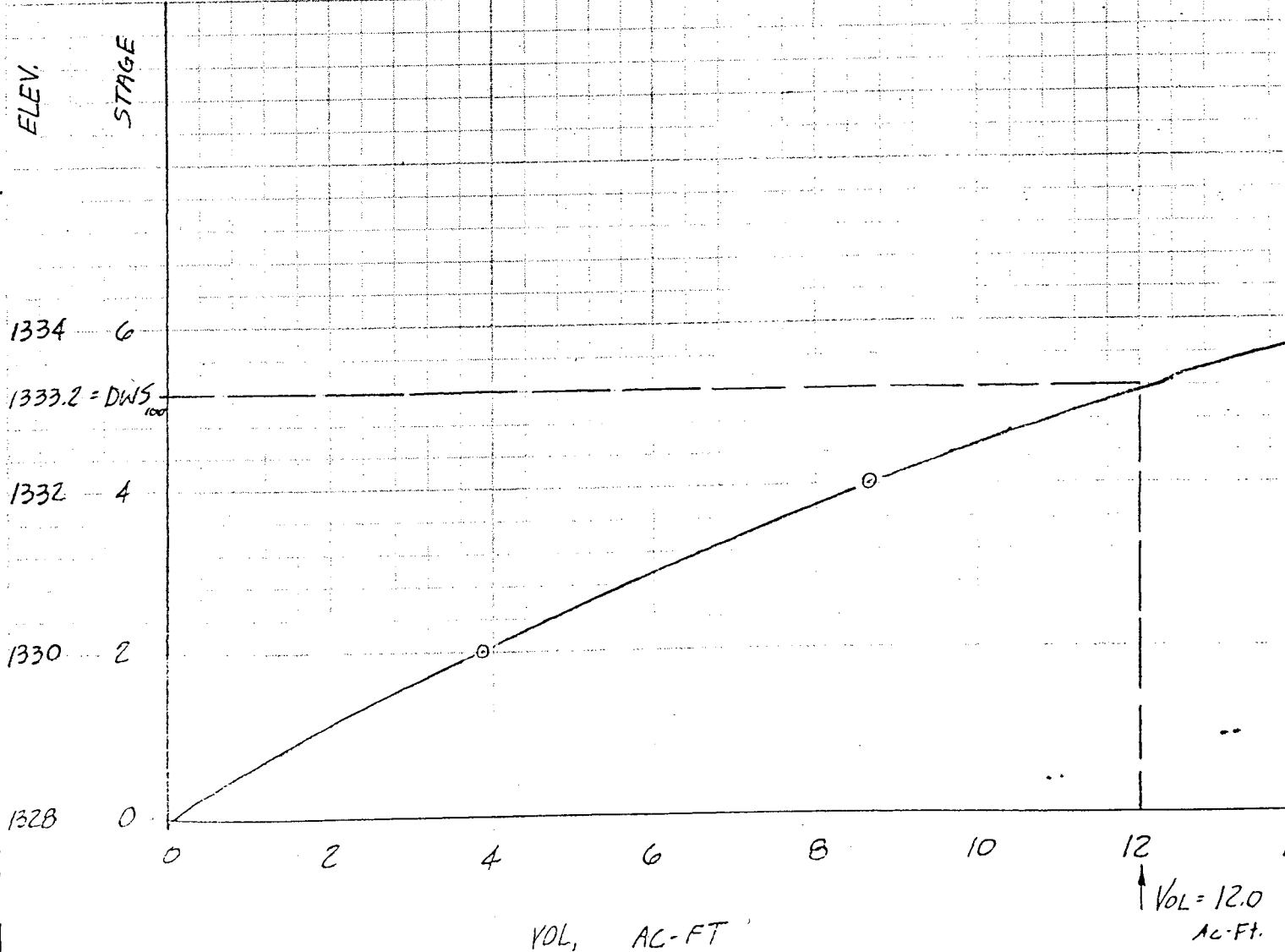
Date 7.27.07 Page 3 of 6

Project Reflection Ridge

Item Drainage Plan Pond No. 3

<u>Elev.</u>	<u>Stage</u>	<u>Area</u>	<u>Δd</u>	<u>Volume</u>	<u>Σ Vol.</u>
1328.0	0	1.79 Ac.	0	0	0
1330.0	2'	2.10	2'	3.89	3.89
1332.0	4'	2.66	2'	4.74	8.63
1334.0	6'	4.03	2'	6.64	15.27

(Based on Grading Plan - See Page 7)





Date 7-27-87 Page 4 of 6
Project Reflection Ridge
Item Drainage Plan Pond No. 3

SUMMARY

Inflow Q_{peak} (100-yr) = 219 cfs @ $t_c = 30$ min.

Inflow Volume (100-yr) = 12.0 Ac-Ft.

Based on Preliminary Grading Plan $DWS_{100} = 1333.2$
Static Pool = 1320.0 (see Page 6)

Static Pool Elevation to be maintained via pumping & irrigation system associated with golf course.

Entire 100 year storm can be stored in pond without discharge.

Emergency Overflow Swale to be provided. Assume Pond No. 3 is full. Design swale for 2-year storm. (See Page 5 of this section).



Date July 28, 1987 Page 5 of 6

Project Reflection Ridge

Item Drainage Plan Pond No. 3

DESIGN EMERGENCY OVERFLOW CHANNEL. FDR 2-YEAR

A) STORM SEWER SYSTEM 200 29.2 cfs

B) AREA ADJACENT TO POND:

$$Q_2 = C_2 I_2 A$$

$$= 0.3 \times 2.71 \times 26.45$$

$$= 21.5$$

21.5

50.7 cfs

Use Manning's Eq'n $Q = \frac{1.486}{n} AR^{2/3}$

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

where

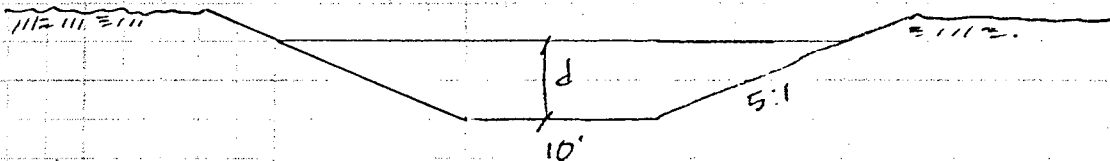
$$Q = 50.7$$

$$n = 0.03$$

$$S = 0.50\%$$

$$AR^{2/3} = \frac{50.7 \times 0.03}{1.486 \times 0.07071} = \frac{1.521}{0.105}$$

$$= 14.4$$



d	A	p	R	$A^{2/3}$	$AR^{2/3}$
1.0	15.0	20.20	0.74	0.820	12.3
1.1	17.05	21.22	0.80	0.864	14.7

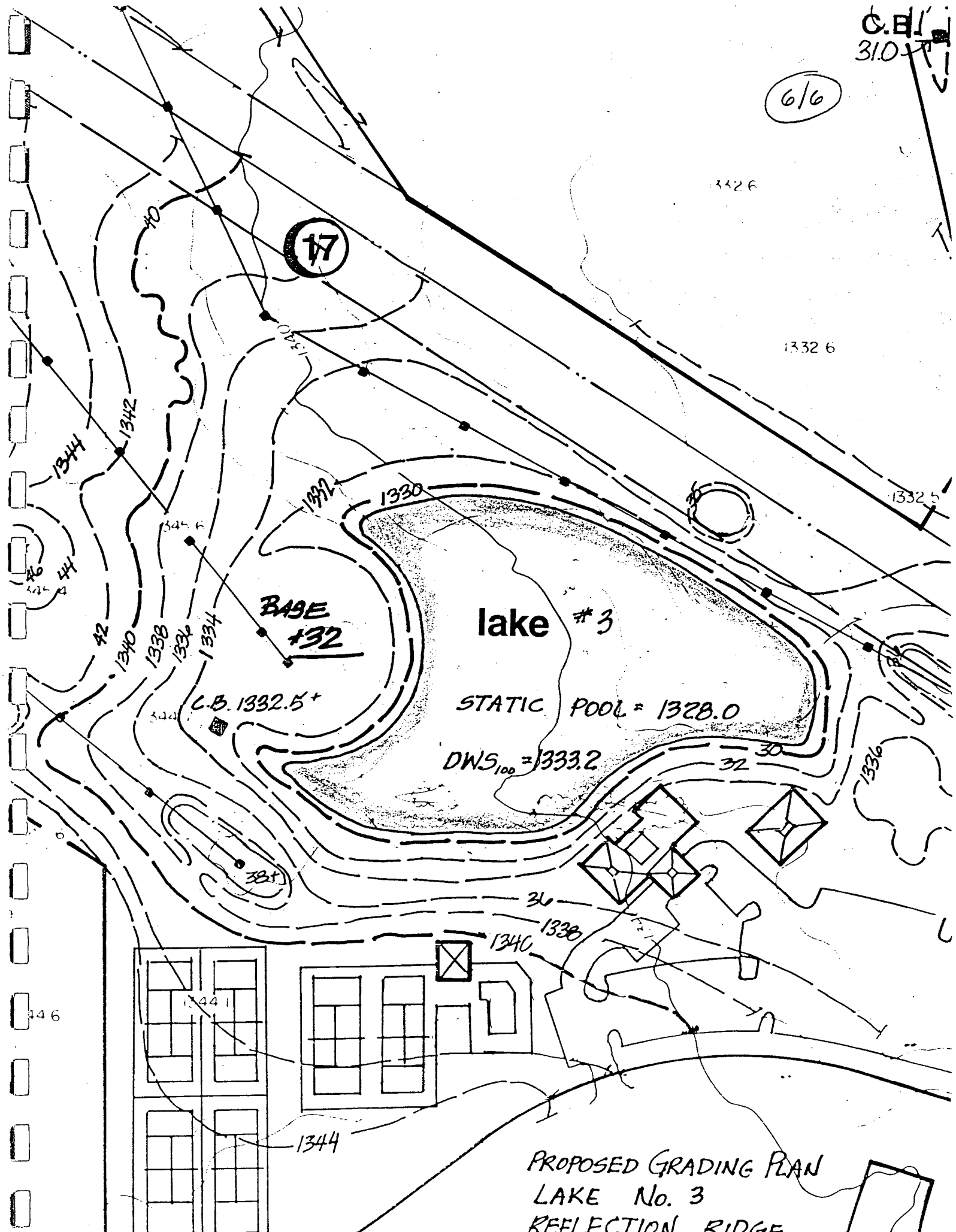
← USE $d = 1.1'$
 $V = Q/A = 3.0 \text{ fps.}$

$$\begin{aligned} \text{Emergency Elev.} &= \text{E overflow} + 1.1' \\ &= 1333.5 + 1.1 \\ &= 1334.6 \end{aligned}$$

Set minimum pad 1335.0

C.B.I.
31.0

6/6



PROPOSED GRADING PLAN
LAKE No. 3
REFLECTION RIDGE

R. 1 W.

PI

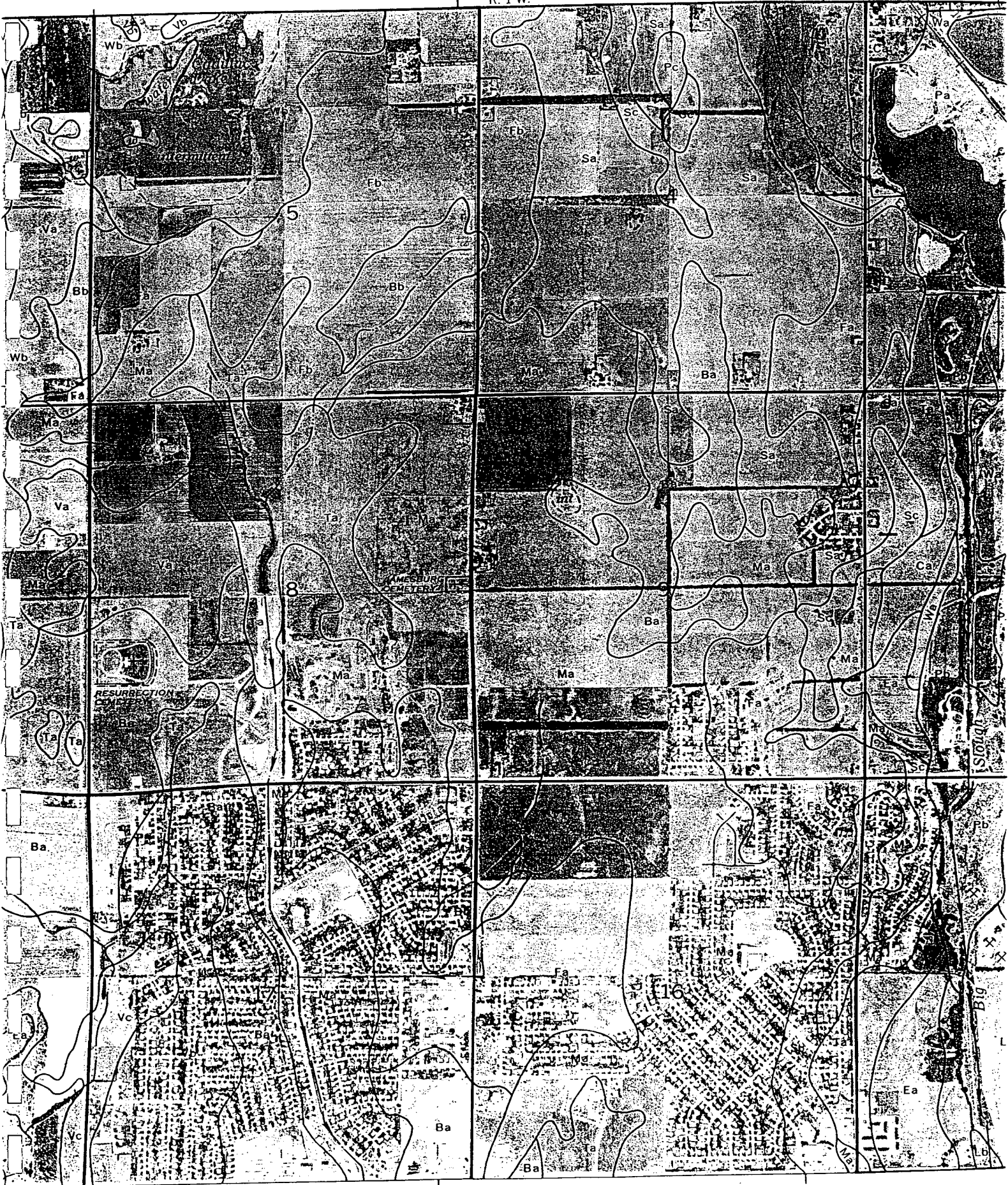


EXHIBIT NO. 1

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	Cline 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
Wh	D	Waurika silt loam

ATTACHMENT D

DRAINAGE CRITERIA

CITY OF WICHITA, KANSAS

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

Land Use or Surface Characteristics	Percent Impervious	Frequency			
		2	5	10	100
1. Business:					
Downtown Areas	95	0.84	0.85	0.87	0.91
Neighborhood Areas	70	0.68	0.69	0.73	0.80
2. Residential:					
<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 Face 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
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

Land Use or Surface Characteristics	Percent Impervious	Frequency			
		<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 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

<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>
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

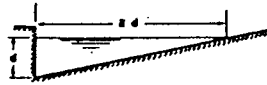
ATTACHMENT A CONTINUED
Page 2

<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

DURATION IN MINUTES	RETURN PERIODS OF						
	1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
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	RETURN PERIODS OF						
	1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
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

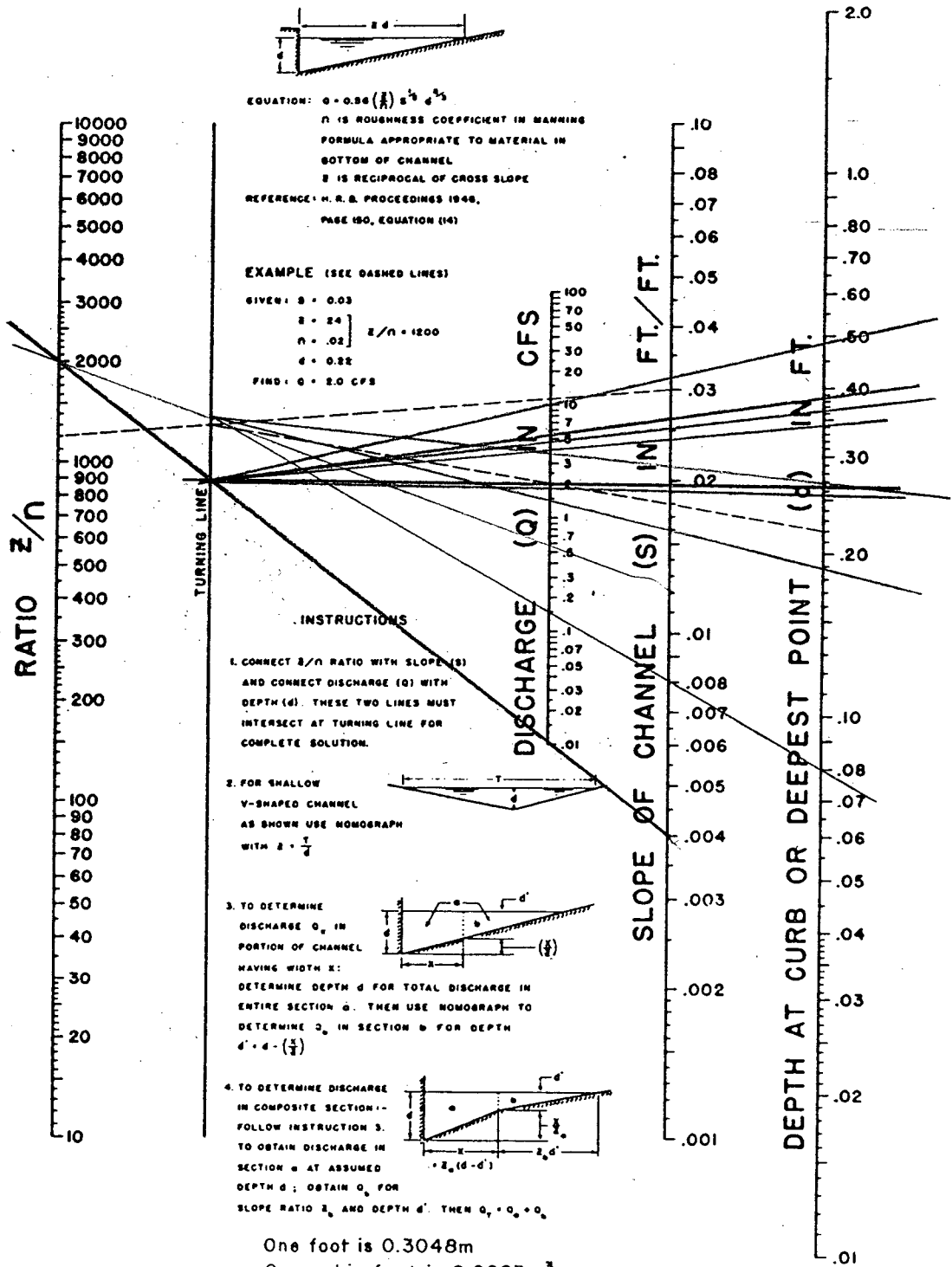
NOMOGRAPH FOR FLOW IN TRIANGULAR CHANNELS



EQUATION: $Q = 0.36 \left(\frac{Z}{n}\right)^{3/2} d^{5/2}$
 n IS ROUGHNESS COEFFICIENT IN MANNING
 FORMULA APPROPRIATE TO MATERIAL IN
 BOTTOM OF CHANNEL
 Z IS RECIPROCAL OF CROSS SLOPE
 REFERENCE: H. R. B. PROCEEDINGS 1946,
 PAGE 150, EQUATION (14)

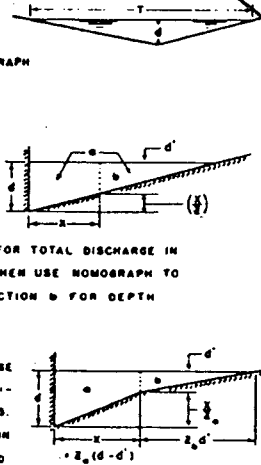
EXAMPLE (SEE DASHED LINES)

GIVEN: $S = 0.03$
 $Z = 24$
 $n = .02$ $Z/n = 1200$
 $d = 0.22$
 FIND: $Q = 2.0$ CFS

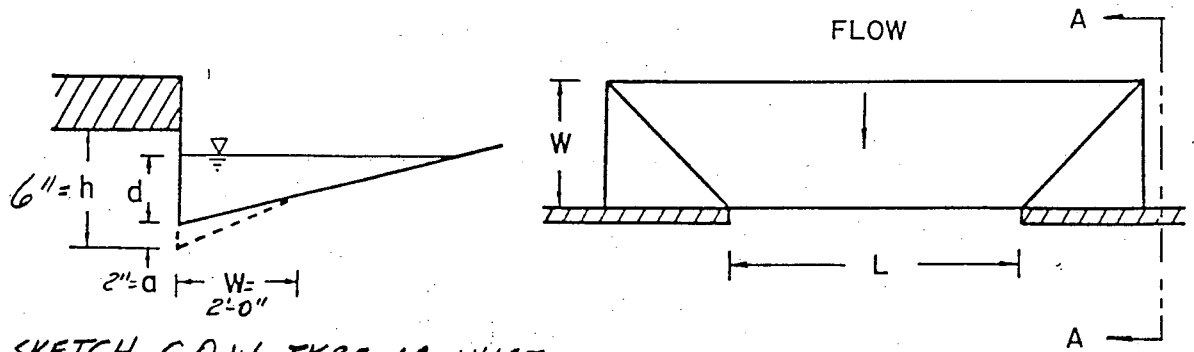


INSTRUCTIONS

1. CONNECT Z/n RATIO WITH SLOPE (S) AND CONNECT DISCHARGE (Q) WITH DEPTH (d). THESE TWO LINES MUST INTERSECT AT TURNING LINE FOR COMPLETE SOLUTION.
2. FOR SHALLOW V-SHAPED CHANNEL AS SHOWN USE NOMOGRAPH WITH $Z = \frac{1}{S}$
3. TO DETERMINE DISCHARGE Q_1 IN PORTION OF CHANNEL HAVING WIDTH x : DETERMINE DEPTH d FOR TOTAL DISCHARGE IN ENTIRE SECTION b . THEN USE NOMOGRAPH TO DETERMINE Q_1 IN SECTION b FOR DEPTH $d' = d \cdot \left(\frac{x}{b}\right)$
4. TO DETERMINE DISCHARGE IN COMPOSITE SECTION -- FOLLOW INSTRUCTION 3. TO OBTAIN DISCHARGE IN SECTION b AT ASSUMED DEPTH d ; OBTAIN Q_2 FOR SLOPE RATIO Z_2 AND DEPTH d' . THEN $Q_1 + Q_2 = Q_3$



One foot is 0.3048m
 One cubic foot is 0.0283m³



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

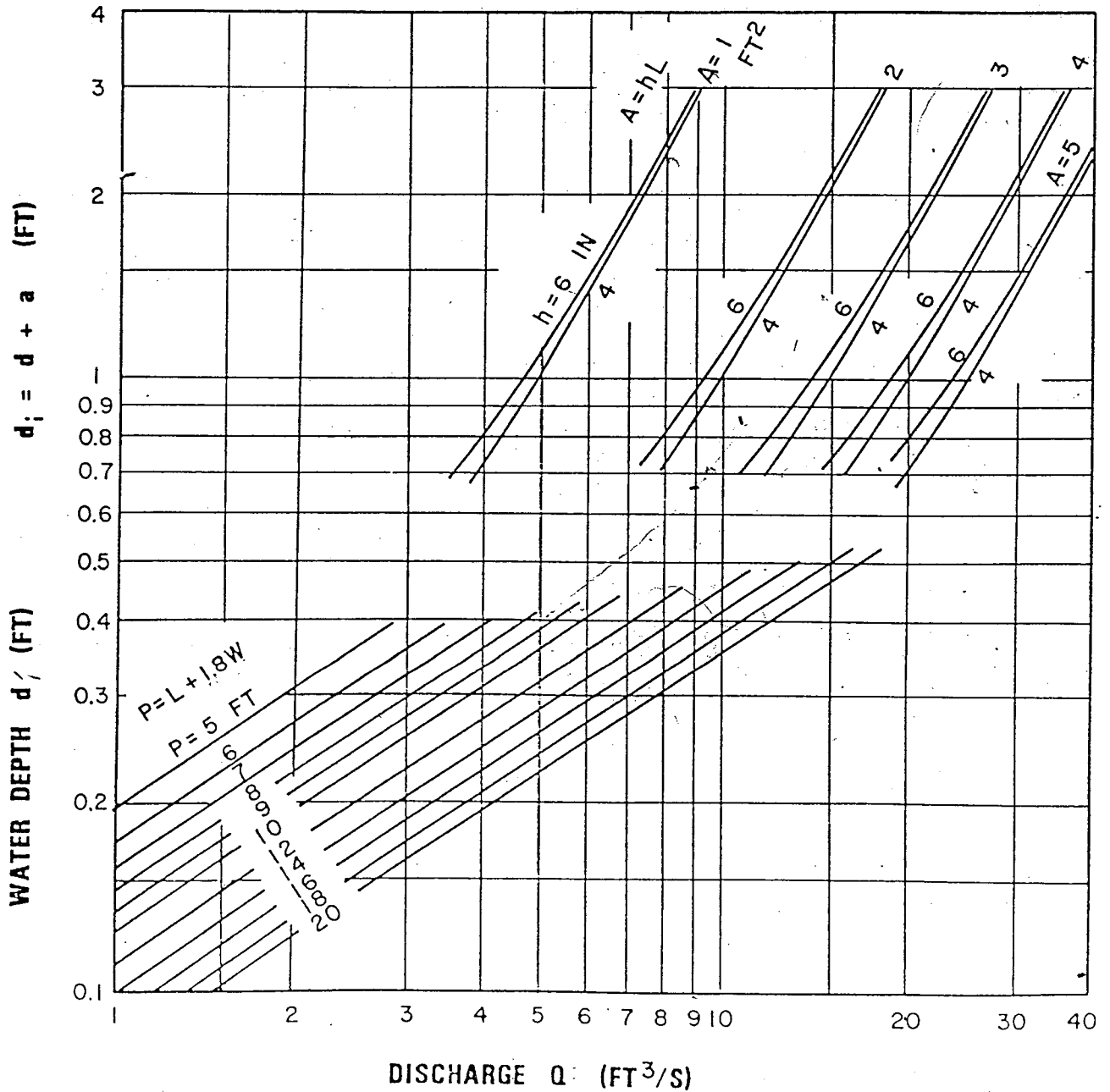


CHART 12. Depressed curb-opening inlet capacity in sump locations.

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

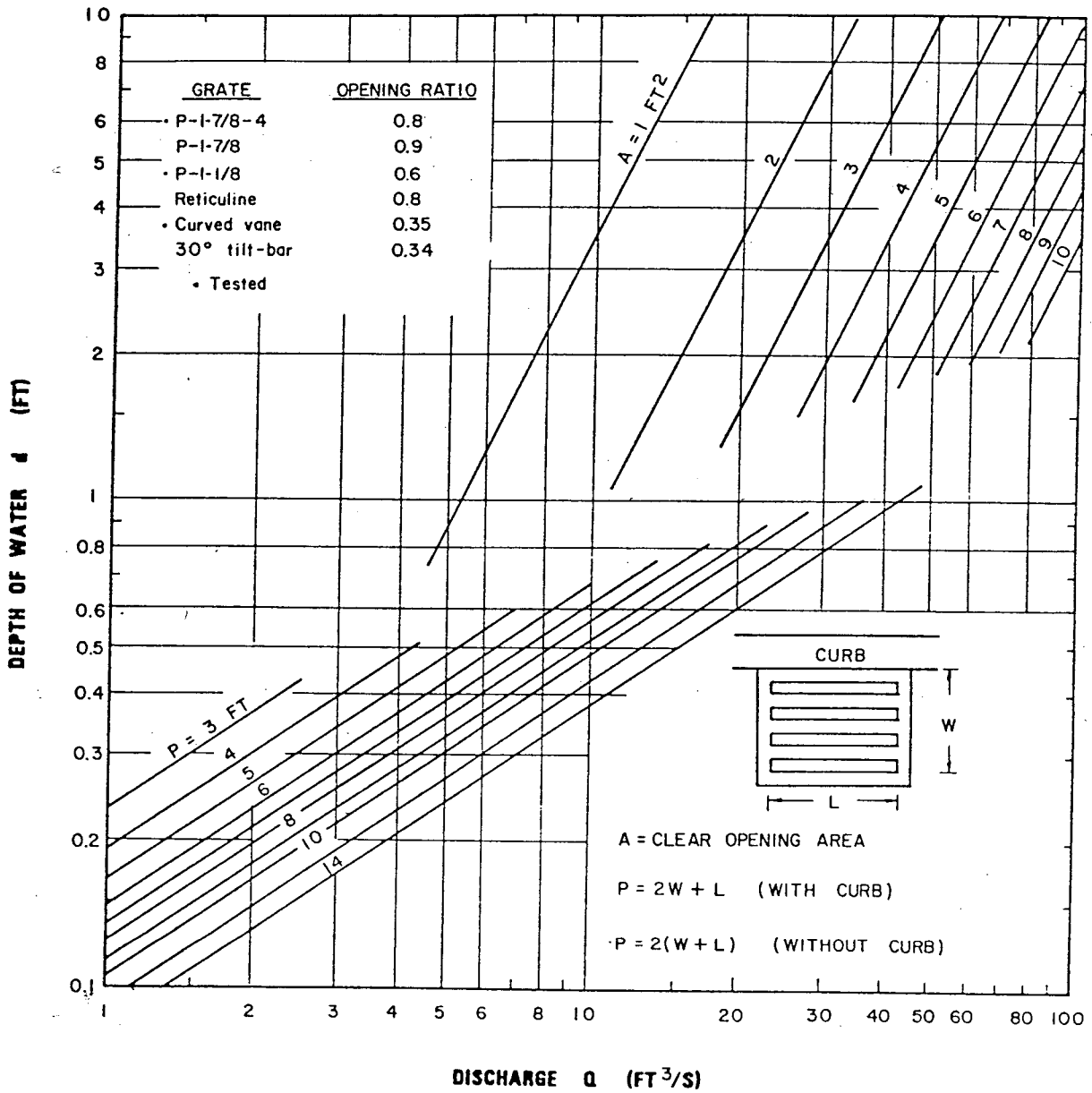


CHART 11. Grate inlet capacity in sump conditions.

From: HEC-12, DRAINAGE OF HIGHWAY PAVEMENTS, F.H.W.A., Nov 1984

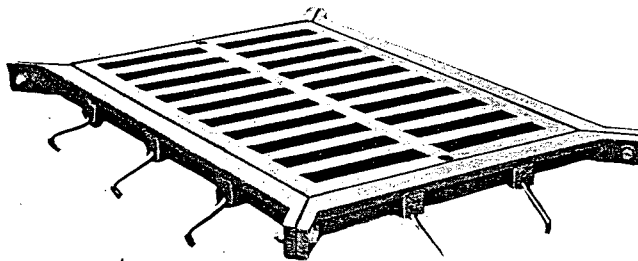
2425 Inlet Grate & Sectional Frame

Heavy Duty

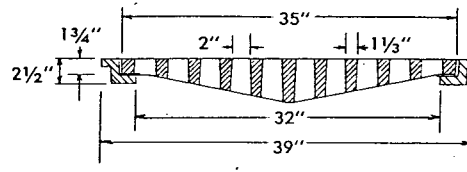
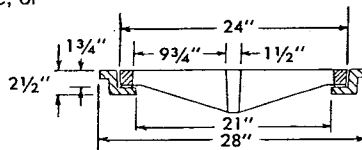
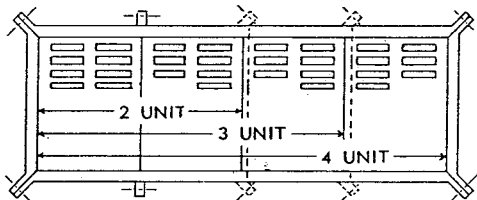
Total Wt. for single unit — 380#

Open Area for single unit — 390 Sq. In.

1. Grates can be bolted to frames with $\frac{3}{8}$ " x 2" brass bolts.
2. Frequently used for airport installations.
3. If multiple units are desired specify double, triple, or quadruple units.



Drawing
Illustrating Multiple
2425 Inlet Units



Also: Western Iron & Fdy Co.

400G Grate

2433-2434 Catch Basin Inlet Grate & Frame

Heavy Duty

Open Area

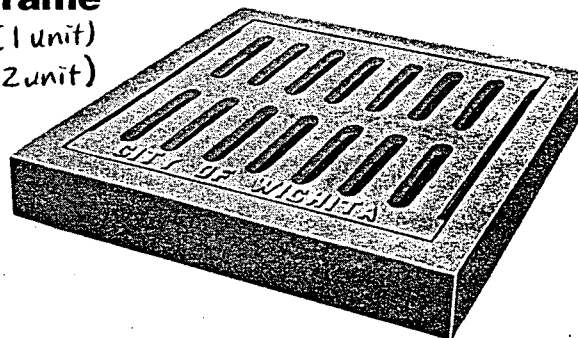
Total Wt. — 2433 — 520# — 184 Sq. In.

2434 — 890# — 368 Sq. In.

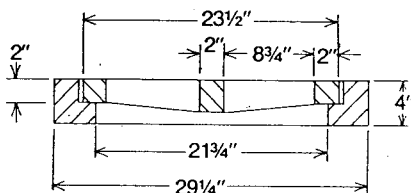
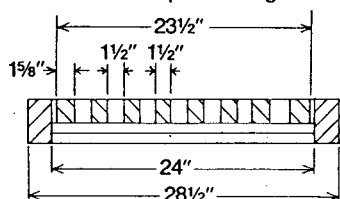
400F Frame (1 unit)

400E Frame (2 unit)

1. 2434 frame requires two grates.

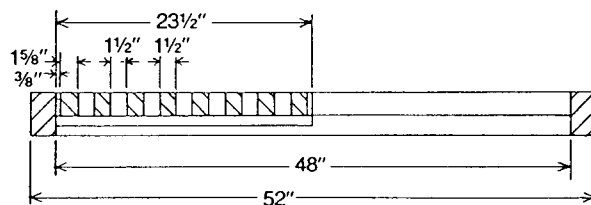


Illustrating 2433
Catch Basin Grate & Frame



Drawing
Illustrating 2433 Catch
Basin Grate & Frame

Drawing
Illustrating 2434 Catch
Basin Grate & Frame



2435 Catch Basin Inlet Grate & Frame

Heavy Duty

Total Wt. — 1105#

Open Area — 473 Sq. In.

1. Frame requires two grates.

