

**DRAINAGE STUDY FOR
RICK BROERMAN**

SITE DESCRIPTION

The planned subdivision is located in Vanderburgh County, East of Eichoff Road and North of Hogue Road.

The site consists of 13.55 acres of which all but 0.9 acres drains into an on site ditch which runs through the property. In addition there is approximately 1.6 acres which drains onto the study area from the north. This planned subdivision is situated within an 87 acre that drains to an unnamed tributary to Wolf Creek.

The existing condition of the property is mostly rolling agricultural with some rolling woodland. Please consult drainage plan for soils map.

EXISTING GEOMETRY

Area_u = 87 acres (see attached copy of planimetric)
Area_d = 13.55 acres

Cu = 0.35, from the Vanderburgh County Drainage Ordinance for agricultural property at 2% to 5% grades

For the area to be developed:

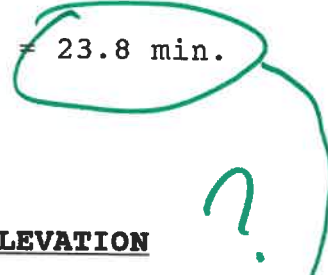
H = 386.4 - 343 = 43'
L = 1250'
S = 43/1250 = 0.035 = 3.5%
N = 0.20 from H.E.R.P.E.C Manual

1990 plan
2000

Tc (Kerby's Formula) = 0.827 [0.20*1250 / √ 0.09]^{0.467} = 23.8 min.

i₁₀ = 3.74" / hr. ✓

Q_u = C*i*A = 0.35 * 3.74 * 13.55 = 17.74 CFS ✓



RUNOFF FOR DETERMINATION OF 100 YEAR BASE FLOOD ELEVATION

Area_t = 87 acres (by U.S.G.S map)
Length of watershed = 3800 L.F.
Height of most remote point above outlet = 91 feet.
Time of concentration from nomograph = T_c = 19 X 2 = 39 min.
Intensity from Vanderburgh County Drainage Ordinance = 4.089"/hr. (for 100 year event)
Q = CiA = 87 * 0.35 * 4.089 = 124.5 CFS

see water surface profile detailed report.

base flood elevation from sec. 1 to sec. 9 = 444.00
base flood elevation from sec. 9 to sec. 11 = 444.00 to 448.00

DEVELOPED CONDITIONS

NEW STRUCTURES (54)*(2000)	= 108,000 @ 0.95 =	102,600
NEW PAVEMENT (STREETS)	= 74,908 @ 0.95 =	71,162
NEW WALKS, PATIOS, ETC.	= 27,000 @ 0.95 =	25,650
NEW PAVEMENT (DRIVEWAYS)	= 34,560 @ 0.95 =	32,832
LAWN AREA	= 345,054 @ 0.20 =	69,011
		301,255

$$Cd = 301,255 / 589,522 = 0.51$$

0.51 > 0.35 - detention/retention must be investigated
See form 800 for required calculation.

Storage required = 0.355 acre-feet = 15,463 cubic feet.

detention area as shown on plan
bottom of detention area slopes from 439.75 to 443.5
Top water surface elevation = 443.55 (overflow into release structure)
Slope of banks = 3:1, top width of berm = 10'

Release structure to pass 17.74 CFS, see detail

Detention area shall be approximately 3.8' deep at maximum and shall be configured approximately as shown on the site layout.

Inlet/Outlet control structure shall be as shown in the detail.

$$\begin{aligned} \text{Inlet design} &= Q = CA \sqrt{2 \cdot 32.2 \cdot H} \\ H &= 443.55 - 439.75 = 3.8' \\ 17.74 &= .6 * A \sqrt{2 \cdot 32.2 \cdot 3.8'} \\ A &= 1.89 \text{ S.F} \\ \text{Diameter of orifice} &= 18.6" \end{aligned}$$

Outlet discharge pipe was designed to discharge 98 CFS to accommodate the discharge from the 25 year event.

In addition, an emergency spillway is provided that will accommodate the runoff of the 100 year event. This spillway drains between lots 52 and 53 and the swale in between the two pads has a capacity of 124.5 CFS.

SUB-DRAINAGE AREA CALCULATION SHEET

SUB-BASIN **A** AREA **15493.78**

HOMES	2000.00	C=	0.95	n=	0.02
CONC. DRIVES & PATIO	700.00	C=	0.95	n=	0.02
LAWN OR GREEN SPACE	9187.00	C=	0.20	n=	0.40
ROADS	2808.00	C=	0.95	n=	0.02
SIDEWALKS	798.00	C=	0.95	n=	0.02

C= **0.51**

N= **0.25**

$t_c = 0.827 * [(N * L) / (S)]^{1/2}$ ^{0.467} **11.66, - 15 MINUTE MIN.**

H= **11.00**
 L= **245.00**
 S= **0.0449**

i25= **5.03**

Q=CiA= **0.90447262**

SUB-DRAINAGE AREA CALCULATION SHEET

SUB-BASIN **B** AREA **25605.47**

HOMES	6000.00	C=	0.95	n=	0.02
CONC. DRIVES & PATIO	2100.00	C=	0.95	n=	0.02
LAWN OR GREEN SPACE	16781.00	C=	0.20	n=	0.40
ROADS	0.00	C=	0.95	n=	0.02
SIDEWALKS	724.00	C=	0.95	n=	0.02

C= **0.46**

N= **0.27**

$t_c = 0.827 * [(N*L)/(S)]^{1/2}$ ^{0.467} **10.33, - 15 MINUTE MIN.**

H= **6.00**
 L= **160.00**
 S= **0.0375**

i₂₅= **5.03**

Q=CiA= **1.36**

SUB-DRAINAGE AREA CALCULATION SHEET

SUB-BASIN **P** AREA **2761.00**

HOMES	0.00	C=	0.95	n=	0.02
CONC. DRIVES & PATIO	2761.00	C=	0.95	n=	0.02
LAWN OR GREEN SPACE	0.00	C=	0.20	n=	0.40
ROADS	0.00	C=	0.95	n=	0.02
SIDEWALKS	0.00	C=	0.95	n=	0.02

C= **0.95**

N= **0.02**

$t_c = 0.827 * [(N * L) / (S)^{1/2}]^{0.467}$ **3.51, - 15 MINUTE MIN.**

H= **12.00**
 L= **245.00**
 S= **0.0490**

$i_{25} =$ **5.03**

Q=CiA= **0.30306032**

SUB-DRAINAGE AREA CALCULATION SHEET

SUB-BASIN AREA

HOMES	<input type="text" value="6000.00"/>	<input type="text" value="0.95"/>	<input "="" type="text" value="n="/>	<input type="text" value="0.02"/>
CONC. DRIVES & PATIO	<input type="text" value="2100.00"/>	<input type="text" value="0.95"/>	<input "="" type="text" value="n="/>	<input type="text" value="0.02"/>
LAWN OR GREEN SPACE	<input type="text" value="8144.00"/>	<input type="text" value="0.20"/>	<input "="" type="text" value="n="/>	<input type="text" value="0.40"/>
ROADS	<input type="text" value="7559.00"/>	<input type="text" value="0.95"/>	<input "="" type="text" value="n="/>	<input type="text" value="0.02"/>
SIDEWALKS	<input type="text" value="1802.00"/>	<input type="text" value="0.95"/>	<input "="" type="text" value="n="/>	<input type="text" value="0.02"/>

C=

N=

$t_c = 0.827 * [(N*L)/(S)]^{1/2}$ ^{0.467}

H=
 L=
 S=

i25=

Q=CiA=

SUB-DRAINAGE AREA CALCULATION SHEET

SUB-BASIN AREA

HOMES	<input type="text" value="0.00"/>	<input type="text" value="0.95"/>	n=	<input type="text" value="0.02"/>
CONC. DRIVES & PATIO	<input type="text" value="0.00"/>	<input type="text" value="0.95"/>	n=	<input type="text" value="0.02"/>
LAWN OR GREEN SPACE	<input type="text" value="0.00"/>	<input type="text" value="0.20"/>	n=	<input type="text" value="0.40"/>
ROADS	<input type="text" value="4891.00"/>	<input type="text" value="0.95"/>	n=	<input type="text" value="0.02"/>
SIDEWALKS	<input type="text" value="0.00"/>	<input type="text" value="0.95"/>	n=	<input type="text" value="0.02"/>

C=

N=

$t_c = 0.827 * [(N*L)/(S)]^{1/2}$

H=
 L=
 S=

$i_{25} =$

Q=CiA=

SUB-DRAINAGE AREA CALCULATION SHEET

SUB-BASIN AREA

HOMES	<input type="text" value="8000.00"/>	ϕ	<input type="text" value="0.95"/>	n	<input type="text" value="0.02"/>
CONC. DRIVES & PATIO	<input type="text" value="3200.00"/>	ϕ	<input type="text" value="0.95"/>	n	<input type="text" value="0.02"/>
LAWN OR GREEN SPACE	<input type="text" value="26095.00"/>	ϕ	<input type="text" value="0.20"/>	n	<input type="text" value="0.40"/>
ROADS	<input type="text" value="0.00"/>	ϕ	<input type="text" value="0.95"/>	n	<input type="text" value="0.02"/>
SIDEWALKS	<input type="text" value="1132.00"/>	ϕ	<input type="text" value="0.95"/>	n	<input type="text" value="0.02"/>

C=

N=

$t_c = 0.827 \cdot [(N \cdot L) / (S)]^{1/2}$ ^{0.467}

H=

L=

S=

$i_{25} =$

Q=CiA=

SUB-DRAINAGE AREA CALCULATION SHEET

SUB-BASIN **G** AREA **41872**

HOMES	10000.00	C= 0.95	n= 0.02
CONC. DRIVES & PATIO	3500.00	C= 0.95	n= 0.02
LAWN OR GREEN SPACE	25782.00	C= 0.20	n= 0.40
ROADS	9930.00	C= 0.95	n= 0.02
SIDEWALKS	2352.00	C= 0.95	n= 0.02

C= **0.71**

N= **0.26**

$t_c = 0.827 * [(N * L) / (S)]^{0.467}$ **13.7, 15 MINUTES MIN.**

H= **27.00**

L= **405.00**

S= **0.0667**

$i_{25} =$ **5.03**

Q=CiA= **3.43**

SUB-DRAINAGE AREA CALCULATION SHEET

SUB-BASIN: AREA:

HOMES	<input type="text" value="0.00"/>	C=	<input type="text" value="0.95"/>	n=	<input type="text" value="0.02"/>
CONC. DRIVES & PATIO	<input type="text" value="0.00"/>	C=	<input type="text" value="0.95"/>	n=	<input type="text" value="0.02"/>
LAWN OR GREEN SPACE	<input type="text" value="0.00"/>	C=	<input type="text" value="0.20"/>	n=	<input type="text" value="0.40"/>
ROADS	<input type="text" value="4062.00"/>	C=	<input type="text" value="0.95"/>	n=	<input type="text" value="0.02"/>
SIDEWALKS	<input type="text" value="0.00"/>	C=	<input type="text" value="0.95"/>	n=	<input type="text" value="0.02"/>

C=

N=

$t_c = 0.827 * [(N*L)/(S)]^{1/2}$ ^{0.467}

H=
 L=
 S=

$i_{25} =$

Q=CiA=

SUB-DRAINAGE AREA CALCULATION SHEET

SUB-BASIN AREA

HOMES	<input type="text" value="0.00"/>	↑	<input type="text" value="0.95"/>	n=	<input type="text" value="0.02"/>
CONC. DRIVES & PATIO	<input type="text" value="0.00"/>	↑	<input type="text" value="0.95"/>	n=	<input type="text" value="0.02"/>
LAWN OR GREEN SPACE	<input type="text" value="0.00"/>	↑	<input type="text" value="0.20"/>	n=	<input type="text" value="0.40"/>
ROADS	<input type="text" value="5780.00"/>	↑	<input type="text" value="0.95"/>	n=	<input type="text" value="0.02"/>
SIDEWALKS	<input type="text" value="0.00"/>	↑	<input type="text" value="0.95"/>	n=	<input type="text" value="0.02"/>

C=

N=

$t_c = 0.827 * [(N*L)/(S)^{1/2}]^{0.467}$

H=
 L=
 S=

$t_{25} =$

Q-CIA=

SUB-DRAINAGE AREA CALCULATION SHEET

SUB-BASIN **J** AREA **49418.00**

HOMES	12000.00	C=	0.95	n=	0.02
CONC. DRIVES & PATIO	4200.00	C=	0.95	n=	0.02
LAWN OR GREEN SPACE	31214.00	C=	0.20	n=	0.40
ROADS	0.00	C=	0.95	n=	0.02
SIDEWALKS	2004.00	C=	0.95	n=	0.02

C= **0.48**

N= **0.26**

$t_c = 0.827 * [(N*L)/(S)^{1/2}]^{0.467}$ **16.25. MINUTES**

H= **23.00**
 L= **490.00**
 S= **0.0469**

i25= **4.94**

Q=CiA= **2.67**

SUB-DRAINAGE AREA CALCULATION SHEET

SUB-BASIN **K** AREA **62813.00**

HOMES	12000.00	C= 0.95	n= 0.02
CONC. DRIVES & PATIO	4200.00	C= 0.95	n= 0.02
LAWN OR GREEN SPACE	32417.00	C= 0.20	n= 0.40
ROADS	11618.00	C= 0.95	n= 0.02
SIDEWALKS	2848.00	C= 0.95	n= 0.02

C= **0.57**

N= **0.22**

$t_c = 0.827 * [(N * L) / (S)]^{0.467}$ **16.49**

H= **19.00**
 L= **525.00**
 S= **0.0362**

i25= **4.94**

Q=CiA= **4.03910776**

SUB-DRAINAGE AREA CALCULATION SHEET

SUB-BASIN AREA

HOMES	<input type="text" value="0.00"/>	C=	<input type="text" value="0.95"/>	n=	<input type="text" value="0.02"/>
CONC. DRIVES & PATIO	<input type="text" value="0.00"/>	C=	<input type="text" value="0.95"/>	n=	<input type="text" value="0.02"/>
LAWN OR GREEN SPACE	<input type="text" value="0.00"/>	C=	<input type="text" value="0.20"/>	n=	<input type="text" value="0.40"/>
ROADS	<input type="text" value="7255.00"/>	C=	<input type="text" value="0.95"/>	n=	<input type="text" value="0.02"/>
SIDEWALKS	<input type="text" value="0.00"/>	C=	<input type="text" value="0.95"/>	n=	<input type="text" value="0.02"/>

C=

N=

$i_c = 0.827 * [(N * L) / (S)^{1/2}]^{0.467}$

H=
 L=
 S=

$i_{25} =$

Q=CiA=

SUB-DRAINAGE AREA CALCULATION SHEET

SUB-BASIN **M** AREA **5655**

HOMES	0.00	C=	0.95	n=	0.02
CONC. DRIVES & PATIO	0.00	C=	0.95	n=	0.02
LAWN OR GREEN SPACE	0.00	C=	0.20	n=	0.40
ROADS	5655.00	C=	0.95	n=	0.02
SIDEWALKS	0.00	C=	0.95	n=	0.02

C= **0.95**

N= **0.02**

$t_c = 0.827 * [(N * L) / (S)^{1/2}]^{0.467}$ **15 MINUTES MIN.**

H= **3.00**
 L= **300.00**
 S= **0.0100**

$i_{25} =$ **5.03**

Q=CiA= **0.62**

SUB-DRAINAGE AREA CALCULATION SHEET

SUB-BASIN **N** AREA **20333.00**

HOMES	2000.00	f = 0.95	n = 0.02
CONC. DRIVES & PATIO	700.00	f = 0.95	n = 0.02
LAWN OR GREEN SPACE	10237.00	f = 0.20	n = 0.40
ROADS	5552.00	f = 0.95	n = 0.02
SIDEWALKS	1844.00	f = 0.95	n = 0.02

C = **0.57**

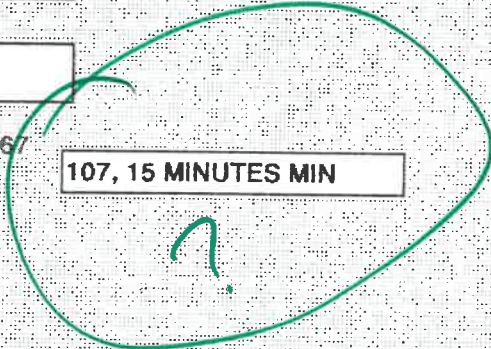
N = **0.21**

$t_c = 0.827 * [(N * L) / (S)]^{1/2}$ ^{0.467} **107, 15 MINUTES MIN**

H = **20.00**
 L = **300.00**
 S = **0.0667**

i25 = **5.03**

Q = CiA = **1.34474458**



SUB-DRAINAGE AREA CALCULATION SHEET

SUB-BASIN AREA

HOMES	<input type="text" value="0.00"/>	C=	<input type="text" value="0.95"/>	n=	<input type="text" value="0.02"/>
CONC. DRIVES & PATIO	<input type="text" value="0.00"/>	C=	<input type="text" value="0.95"/>	n=	<input type="text" value="0.02"/>
LAWN OR GREEN SPACE	<input type="text" value="0.00"/>	C=	<input type="text" value="0.20"/>	n=	<input type="text" value="0.40"/>
ROADS	<input type="text" value="7543.00"/>	C=	<input type="text" value="0.95"/>	n=	<input type="text" value="0.02"/>
SIDEWALKS	<input type="text" value="0.00"/>	C=	<input type="text" value="0.95"/>	n=	<input type="text" value="0.02"/>

C=

N=

$t_c = 0.827 * [(N * L) / (S)^{1/2}]^{0.467}$

H=

L=

S=

i₂₅=

Q=CiA=

SUB-DRAINAGE AREA CALCULATION SHEET

SUB-BASIN **R** AREA **1933.00**

HOMES	0.00	C= 0.95	n= 0.02
CONC. DRIVES & PATIO	0.00	C= 0.95	n= 0.02
LAWN OR GREEN SPACE	0.00	C= 0.20	n= 0.40
ROADS	1933.00	C= 0.95	n= 0.02
SIDEWALKS	0.00	C= 0.95	n= 0.02

C= **0.95**

N= **0.02**

$t_c = 0.827 * [(N * L) / (S)]^{0.467}$ **15 MINUTES MIN.**

H= **1.00**
 L= **50.00**
 S= **0.0200**

i₂₅= **5.03**

Q=CiA= **0.21217515**

STORM SEWER DESIGN SHEET - RATIONAL METHOD

PROJECT ASHLEY PLACE DATE 6-9-59 SHEET 1 OF 1

ENGINEER T.J. KEITH DESIGN STORM 25 MANNINGS n 0.015

Line Number	Upstream Manhole	Downstream Manhole	Length (Ft)	Cj	Aj (Acre)	Cj1	ΣAjCj	tj (min)	ΣAjCj tj	Q (CFS)	Q (CFS) / (ΣAjCj tj)	Pipe Slope (%)	Pipe Capacity (CFS)	Velocity (Ft/Sec)	Travel Time (min)	Rim Elevation Upstream	Rim Elevation Downstream	Invert Elevation Upstream	Invert Elevation Downstream	Upstream Cover	Downstream Cover	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
11	11	10	52	.51	.35	.18	.18	15		5.03	90	12	15.4	3.47	4.41	20						
10	10	9	115	.95	.00	.06	.24	15.0	15.2	5.03	121	15	5.01	20.24	17.02	17						
9	9	8	113	.46	.59	.27	.51	15.0	15.3	5.03	257	15	2.99	16.13	13.15	14						
12	12	11	39	.95	.09	.09	.09	15	15	5.03	43	12	1.00	5.15	6.55	10						
8	8	7	50	.71	.59	.42	.62	15	15.3	5.03	51	15	5.50	21.8	17.8	105						
7	7	6	115	.75	.11	.11	.113	15	15.35	5.03	56	15	3.76	18.09	14.74	13						
13	13	12	109	.44	.88	.37	.52	15	15.48	5.03	76.4	15	3.30	16.95	13.81	13						
5	5	4	33	.95	.09	.09	.09	15	15	5.03	45	12	1.0	5.15	6.55	10						
4	4	3	48	.71	.56	.48	.28	15	15.4	5.03	115	18	1.49	12.6	7.13	11						
3	3	2	119	.95	.13	.12	.241	15	15.51	4.94	119	24	1.50	23.1	7.35	27						
2	2	1	108	.48	1.13	.54	.295	15	15.8	4.94	146	24	1.29	37.1	11.8	15						
14	14	13	41	.95	.13	.12	.12	12	15	5.03	16	12	0.50	3.64	4.63	-						
15	15	14	42	.57	1.44	.82	3.89	16.5	16.5	4.84	189	24	2.40	50.6	16.1	104						
19	19	18	66	.95	.17	.16	4.05	16.5	16.5	4.84	195	24	1.41	58.8	12.3	109						
20	20	19	50	.35	.87	.304	30.4	39	39	3.175	26.7	42	0.60	12.57	11.70	28						
16	16	15	150	-	-	30.4	30.4	-	39	3.175	16.7	42	0.60	12.57	11.70	28						
21	21	20	67	-	-	-	34.4	-	39	3.175	10.2	42	1.00	145.3	15.1							
22	22	21	30	.57	.47	.27	.27	15	15	5.03	134	15	1.00	4.33	7.66							
23	23	22	5	.75	.17	.14	.44	15	15	5.03	233	15	4.4	61.8	50							
23	23	22	15	-	-	-	34.8	39	39	3.175	110	42	6.0	358	57							

Figure 7.1 Storm Sewer Design Sheet - Rational Method

MAN-MADE CHANNELS

VARIABLES LIST:

- Y - FLOW DEPTH
- Q - FLOWRATE
- B - CHANNEL BOTTOM WIDTH
- M - CHANNEL SIDE SLOPE
- S - CHANNEL SLOPE
- N - CHANNEL ROUGHNESS

VARIABLE TO BE SOLVED (Y,Q,B,M,S OR N) ? Y

Q (CFS) ? 124.5
 B (FT) ? 5
 M (FT/FT) ? 3
 S (FT/FT) ? .0124
 N (FT^{1/6}) ? .030

RESULTS
 =====
 Y= 1.89 FT
 A= 20.12 SF
 P= 16.94 FT
 V= 6.19 FPS
 F= 0.98

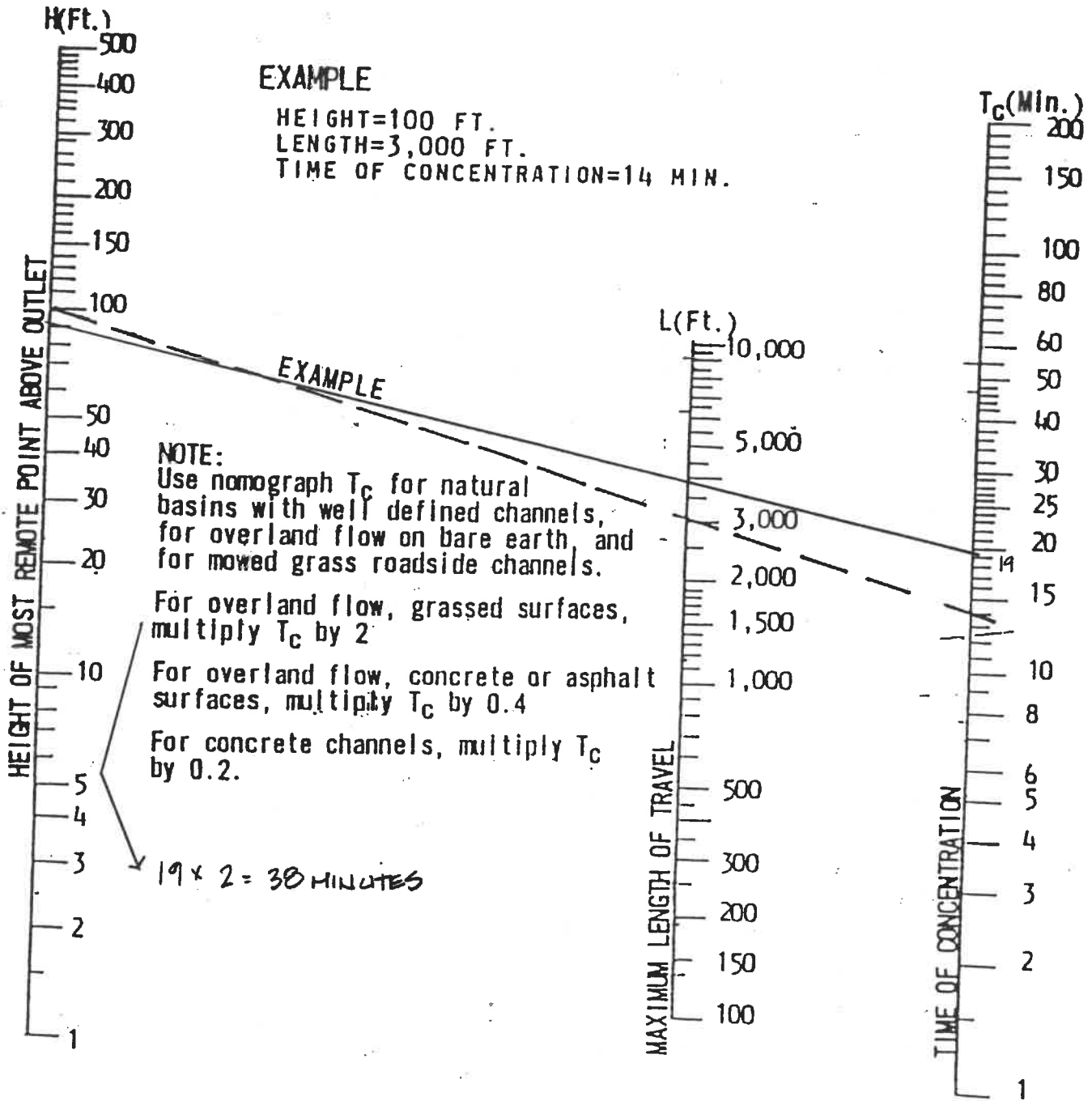
SUB-CRITICAL FLOW

<SHIFT> <PRT SC> PRINT <RETURN> REPEAT <SPACE BAR> BACK TO MENU

WEIRS

ENTER UP TO 10 WEIRS.
 ENTER <RETURN> ONLY FOR FLOWRATE AND LENGTH TO END.

FLOWRATE (CFS)	LENGTH (FT)	COEFF (-)	HEAD (FT)
124.50	20.0	3.388	1.50



TIME OF CONCENTRATION OF SMALL DRAINAGE BASINS

FOR EXAMPLE: SEE 3) PAGE 41

FIG. 7-425.04 A

J

42°30' 38"

R 12 W R 11 W

3480 II SW (KASSON)

40

41

40'

42



TABLE 807

RAINFALL INTENSITY-DURATION-FREQUENCY TABLE FOR EVANSVILLE

INTENSITY IN INCHES PER HOUR

STORM DURATION	STORM RETURN PERIOD IN YEARS				
	5	10	25	50	100
5 MIN	6.063	6.625	7.208	7.936	8.469
10 MIN	4.863	5.380	5.925	6.616	7.126
15 MIN	4.029	4.515	5.033	5.697	6.194
30 MIN	2.837	3.226	3.646	4.194	4.608
60 MIN	1.549	1.819	2.078	2.412	2.663
2.0 HRS	1.053	1.230	1.400	1.620	1.785
3.0 HRS	0.774	0.899	1.019	1.175	1.291
4.0 HRS	0.632	0.736	0.836	0.965	1.062
5.0 HRS	0.524	0.606	0.684	0.785	0.861
6.0 HRS	0.453	0.522	0.589	0.676	0.741
7.0 HRS	0.399	0.459	0.516	0.591	0.647
8.0 HRS	0.358	0.412	0.463	0.530	0.581
9.0 HRS	0.323	0.370	0.415	0.472	0.516
10 HRS	0.297	0.339	0.379	0.431	0.470
11 HRS	0.276	0.314	0.351	0.399	0.435
12 HRS	0.259	0.296	0.331	0.376	0.410
13 HRS	0.245	0.280	0.314	0.357	0.390
14 HRS	0.233	0.267	0.299	0.341	0.372
15 HRS	0.220	0.252	0.281	0.320	0.349
16 HRS	0.209	0.238	0.266	0.302	0.329
17 HRS	0.198	0.225	0.251	0.284	0.310

ENGINEERING DATA SYSTEMS CORPORATION
 Water Surface Profiling Detailed Report

Date 01/22/97
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 File BROERMAN.WPS
 1
 PROJECT: broerman

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Section 1 Channel Station 0 + 00 Discharge 147.00 cfs

	Q cfs	AREA ft ²	VEL ft/s	CONVEYANCE	n	RCH LGTH ft	WET PERM ft
Lft Ob	0.00	0.00	0.00	0.00	0.0300	66.94	0.00
Channel	147.00	69.35	2.12	7069.52	0.0300	66.94	23.49
Rgt Ob	0.00	0.00	0.00	0.00	0.0300	66.94	0.00

Water Elevation	zas	441.00 ft	Critical Water	zc	437.86 ft
Depth	Dep	5.70 ft	Normal water	zn	437.47 ft
Energy Grade Line-EGLas		441.07 ft	Flow SUBCRITICAL FLOW		
Energy Loss	ht	0.00 ft	METHOD Average Conveyance		
Min of Elev Shot	zmin	435.30 ft	Velocity Head	Hv	0.07 ft/s
Channel Slope	Sch	2.61 %	Velocity Coeff	alpha	1.00
Energy Loss Fr	hf	0.03 ft	Offs Lft Water Line	xlw	98.57 ft
Energy Loss Eddy	ho	0.00 ft	Offs Rgt Water Line	xrw	118.32 ft
Wetted Width	Wwet	19.76 ft	Jump Loss	hjump	N / A
Wave Reach Lgth	Lave	19.76 ft	Jump Elevation	zjump	N / A
			Station of Jump	Ljump	N / A

Cross Section Groundshots <ft>

1	83.4	442.2	2	97.6	441.9	3	104.3	436.0	4	110.4	435.3
5	119.1	441.5	6	144.3	441.1						

Date 01/22/97
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 PROJECT: broerman

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Section 2 Channel Station 0 + 66 Discharge 147.00 cfs

	Q	AREA	VEL	CONVEYANCE	n	RCH LGTH	WET PERM
	cfs	ft^2	ft/s			ft	ft
Lft Ob	0.00	0.00	0.00	0.00	0.0300	66.94	0.00
Channel	147.00	45.30	3.24	3972.94	0.0300	66.94	19.23
Rgt Ob	0.00	0.00	0.00	0.00	0.0300	66.94	0.00

Water Elevation	zas	440.96 ft	Critical Water	zc	439.22 ft
Depth	Dep	3.91 ft	Normal water	zn	438.88 ft
Energy Grade Line-EGL	Las	441.12 ft	Flow	SUBCRITICAL FLOW	
Energy Loss	ht	0.05 ft	METHOD	Average Conveyance	
Min of Elev Shot	zmin	437.05 ft	Velocity Head	Hv	0.16 ft/s
Channel Slope	Sch	2.61 %	Velocity Coeff	alpha	1.00
Energy Loss Fr	hf	0.05 ft	Offs Lft Water Line	xlw	127.16 ft
Energy Loss Eddy	ho	0.00 ft	Offs Rgt Water Line	xrw	143.20 ft
Wetted Width	Wwet	16.04 ft	Jump Loss	hjump	N / A
Wave Reach Lgth	Lave	16.04 ft	Jump Elevation	zjump	N / A
			Station of Jump	Ljump	N / A

Cross Section Groundshots <ft>

1	102.6	443.2	2	126.9	441.1	3	131.2	437.6	4	140.3	437.0
5	143.8	441.8	6	159.9	441.8						

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Section 3 Culvert Station 1 + 10 Discharge 147.00 cfs

	Q cfs	AREA ft ²	VEL ft/s	CONVEYANCE	n	RCH LGTH ft	WET PERM ft
Lft Ob	0.00	0.00	0.00	0.00	0.0300	43.69	0.00
Channel	147.00	49.47	2.97	4437.33	0.0300	43.69	20.30
Rgt Ob	0.00	0.00	0.00	0.00	0.0300	43.69	0.00
Culvert	121.43	13.81	8.79	N/A	0.0200	15.00	10.62
Overflow	25.56	7.79	3.28	N/A	N/A	40.00	N/A

Water Elevation	zas	443.25 ft	Critical Water	zc	440.90 ft
Depth	Dep	6.13 ft	Normal water	zn	443.72 ft
Energy Grade Line-EGL	Las	443.39 ft	Flow SUBCRITICAL FLOW		
Energy Loss	ht	2.27 ft	METHOD Average Conveyance		
Station of Elev Shot	zmin	437.12 ft	Velocity Head	Hv	0.14 ft/s
Channel Slope	Sch	0.16 %	Velocity Coeff	alpha	1.00
Energy Loss Fr	hf	0.05 ft	Offs Lft Water Line	xlw	125.97 ft
Energy Loss Eddy	ho	0.00 ft	Offs Rgt Water Line	xrw	142.12 ft
Corrected Width	Wwet	16.14 ft	Jump Loss	hjump	N / A
Ave Reach Lgth	Lave	16.14 ft	Jump Elevation	zjump	N / A
			Station of Jump	Ljump	N / A

Flow Type INLET CONTROL & OVERFLOW

CULVERT REPORT

Tail Water	TW	3.84 ft	D/s EGL	EGLds	441.12 ft
Critical depth	yc	3.27 ft	Normal depth	yn	3.40 ft
Inlet ctrl EGL	EGLic	443.39 ft	Inlet Ctrl dischg	Qic	121.43 cfs
Outlet Ctrl EGL	EGLoc	443.35 ft	Outlet Ctrl dischg	Qoc	123.07 cfs
Exit loss	Lx	1.07 ft	Culvert length	Lcv	15.00 ft
Friction loss	Lf	0.15 ft	Culvert slope	Scv	1.20 %
Entrance loss	Le	1.01 ft	Length full	Lfull	0.00 ft
Culvert Depth	D	4.33 ft	Length Corrected	Lcorr	15.00 ft
U/s Inv Elev	ziu	437.30 ft	Culvert Area	Acv	14.75 ft ²

Inlet, Equation type, and Coefficients

Type CIR.CORR.METAL PIPE w/ Projecting

q 1
 Coefs { K=0.0340; M=1.5000; c=0.0553; Y=0.5400 }

OVERFLOW REPORT

Ovrfl dischg	Qovf	25.56 cfs	Crest elevation	zcrest	442.60 ft
/s Wa Surf	zus	443.25 ft	D/s Wa Surf	zds	440.96 ft
/s Vel Head	Hvus	0.14 ft	Overflow Vel	Vovf	3.28 ft/s
Eff Weir Lgth	Leff	12.00 ft	Submergence Coef	Ct	1.0000
Weir Coefficient	Cw	3.0564			

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Section 4 Channel Station 1 + 28 Discharge 147.00 cfs

	Q cfs	AREA ft ²	VEL ft/s	CONVEYANCE	n	RCH LGTH ft	WET PERM ft
Lft Ob	0.00	0.00	0.00	0.00	0.0300	17.91	0.00
Channel	147.00	67.49	2.18	5238.97	0.0300	17.91	34.40
Rgt Ob	0.00	0.00	0.00	0.00	0.0300	17.91	0.00

Water Elevation	zas	443.35 ft	Critical Water	zc	440.04 ft
Depth	Dep	6.05 ft	Normal water	zn	440.26 ft
Energy Grade Line--EGL	zas	443.42 ft	Flow	SUBCRITICAL FLOW	
Energy Loss	ht	0.04 ft	METHOD	Average Conveyance	
Min of Elev Shot	zmin	437.30 ft	Velocity Head	Hv	0.07 ft/s
Channel Slope	Sch	1.00 %	Velocity Coeff	alpha	1.00
Energy Loss Fr	hf	0.02 ft	Offs Lft Water Line	xlw	123.52 ft
Energy Loss Eddy	ho	0.02 ft	Offs Rgt Water Line	xrw	153.48 ft
Wetted Width	Wwet	29.96 ft	Jump Loss	hjump	N / A
Ave Reach Lgth	Lave	29.96 ft	Jump Elevation	zjump	N / A
			Station of Jump	Ljump	N / A

Cross Section Groundshots <ft>

1	108.4	444.0	2	124.9	443.3	3	130.2	437.4	4	132.0	437.3
5	136.0	438.2	6	141.3	442.8	7	164.0	443.8			

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Section 5 Channel Station 1 + 69 Discharge 147.00 cfs

	Q	AREA	VEL	CONVEYANCE	n	RCH LGTH	WET PERM
	cfs	ft ²	ft/s			ft	ft
Lft Ob	0.00	0.00	0.00	0.00	0.0300	41.26	0.00
Channel	147.00	66.80	2.20	5570.08	0.0300	41.26	30.58
Rgt Ob	0.00	0.00	0.00	0.00	0.0300	41.26	0.00

Water Elevation	zas	443.38 ft	Critical Water	zc	440.59 ft
Depth	Dep	5.03 ft	Normal water	zn	440.21 ft
Energy Grade Line-EGLas		443.46 ft	Flow	SUBCRITICAL FLOW	
Energy Loss	ht	0.04 ft	METHOD	Average Conveyance	
Min of Elev Shot	zmin	438.35 ft	Velocity Head	Hv	0.08 ft/s
Channel Slope	Sch	2.54 %	Velocity Coeff	alpha	1.00
Energy Loss Fr	hf	0.03 ft	Offs Lft Water Line	xlw	109.79 ft
Energy Loss Eddy	ho	0.00 ft	Offs Rgt Water Line	xrw	137.16 ft
Wetted Width	Wwet	27.37 ft	Jump Loss	hjump	N / A
Live Reach Lgth	Lave	27.37 ft	Jump Elevation	zjump	N / A
			Station of Jump	Ljump	N / A

Cross Section Groundshots <ft>

1	82.6	444.4	2	109.4	443.8	3	115.2	438.4	4	121.0	438.4
5	130.1	443.2	6	154.2	443.7						

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Section 6 Channel Station 2 + 07 Discharge 147.00 cfs

	Q cfs	AREA ft ²	VEL ft/s	CONVEYANCE	n	RCH LGTH ft	WET PERM ft
Lft Ob	0.00	0.00	0.00	0.00	0.0300	37.77	0.00
Channel	147.00	40.34	3.64	3328.82	0.0300	37.77	18.76
Rgt Ob	0.00	0.00	0.00	0.00	0.0300	37.77	0.00

Water Elevation	zas	443.39 ft	Critical Water	zc	441.55 ft
Depth	Dep	4.96 ft	Normal water	zn	443.90 ft
Energy Grade Line-EGL	Las	443.60 ft	Flow	SUBCRITICAL FLOW	
Energy Loss	ht	0.14 ft	METHOD	Average Conveyance	
Min of Elev Shot	zmin	438.43 ft	Velocity Head	Hv	0.21 ft/s
Channel Slope	Sch	0.21 %	Velocity Coeff	alpha	1.00
Energy Loss Fr	hf	0.04 ft	Offs Lft Water Line	xlw	96.06 ft
Energy Loss Eddy	ho	0.09 ft	Offs Rgt Water Line	xrw	110.01 ft
Wetted Width	Wwet	13.95 ft	Jump Loss	hjump	N / A
ave Reach Lgth	Lave	13.95 ft	Jump Elevation	zjump	N / A
			Station of Jump	Ljump	N / A

Cross Section Groundshots <ft>

1	81.1	444.4	2	94.1	444.3	3	106.2	438.4	4	108.6	438.5
5	110.0	443.5	6	154.2	443.6						

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Section 7 Channel Station 2 + 60 Discharge 147.00 cfs

	Q cfs	AREA ft ²	VEL ft/s	CONVEYANCE	n	RCH LGTH ft	WET PERM ft
Lft Ob	0.00	0.00	0.00	0.00	0.0300	53.22	0.00
Channel	147.00	63.88	2.30	4173.85	0.0300	53.22	42.16
Rgt Ob	0.00	0.00	0.00	0.00	0.0300	53.22	0.00

Water Elevation	zas	443.63 ft	Critical Water	zc	441.48 ft
Depth	Dep	4.73 ft	Normal water	zn	441.72 ft
Energy Grade Line-EGL	Las	443.71 ft	Flow	SUBCRITICAL FLOW	
Energy Loss	ht	0.12 ft	METHOD	Average Conveyance	
Min of Elev Shot	zmin	438.90 ft	Velocity Head	Hv	0.08 ft/s
Channel Slope	Sch	0.88 %	Velocity Coeff	alpha	1.00
Energy Loss Fr	hf	0.08 ft	Offs Lft Water Line	xlw	70.77 ft
Energy Loss Eddy	ho	0.04 ft	Offs Rgt Water Line	xrw	110.03 ft
Wetted Width	Wwet	39.26 ft	Jump Loss	hjump	N / A
Wave Reach Lgth	Lave	39.26 ft	Jump Elevation	zjump	N / A
			Station of Jump	Ljump	N / A

Cross Section Groundshots <ft>

1	53.7	445.8	2	69.6	445.1	3	74.6	439.0	4	78.1	438.9
5	88.3	442.8	6	110.0	443.6						

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 PROJECT: broerman

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Section 8 Channel Station 3 + 69 Discharge 147.00 cfs

	Q	AREA	VEL	CONVEYANCE	n	RCH LGTH	WET PERM
	cfs	ft ²	ft/s			ft	ft
Lft Ob	0.00	0.00	0.00	0.00	0.0300	108.72	0.00
Channel	147.00	36.35	4.04	2824.76	0.0300	108.72	18.50
Rgt Ob	0.00	0.00	0.00	0.00	0.0300	108.72	0.00

Water Elevation	zas	443.77 ft	Critical Water	zc	442.69 ft
Depth	Dep	3.58 ft	Normal water	zn	442.73 ft
Energy Grade Line-EGL	as	444.03 ft	Flow	SUBCRITICAL FLOW	
Energy Loss	ht	0.32 ft	METHOD	Average Conveyance	
Min of Elev Shot	zmin	440.19 ft	Velocity Head	Hv	0.25 ft/s
Channel Slope	Sch	1.19 %	Velocity Coeff	alpha	1.00
Energy Loss Fr	hf	0.19 ft	Offs Lft Water Line	xlw	60.62 ft
Energy Loss Eddy	ho	0.12 ft	Offs Rgt Water Line	xrw	77.29 ft
Wetted Width	Wwet	16.67 ft	Jump Loss	hjump	N / A
Ave Reach Lgth	Lave	16.67 ft	Jump Elevation	zjump	N / A
			Station of Jump	Ljump	N / A

Cross Section Groundshots <ft>

1	35.6	445.8	2	58.8	444.8	3	66.7	440.2	4	70.7	440.3
5	77.5	443.9	6	92.3	444.4						

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PROJECT: broerman

Section	9	Channel	Station 4 + 41	Discharge	147.00 cfs
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	Q	AREA	VEL	CONVEYANCE	n	RCH LGTH	WET PERM
	cfs	ft^2	ft/s			ft	ft
Lft Ob	0.00	0.00	0.00	0.00	0.0300	71.91	0.00
Channel	147.00	22.18	6.63	1587.28	0.0300	71.91	12.77
Rgt Ob	0.00	0.00	0.00	0.00	0.0300	71.91	0.00

Water Elevation	zas	443.96 ft	Critical Water	zc	443.53 ft
Depth	Dep	3.69 ft	Normal water	zn	446.20 ft
Energy Grade Line--EGL	zas	444.64 ft	Flow	SUBCRITICAL FLOW	
Energy Loss	ht	0.61 ft	METHOD	Average Conveyance	
Min of Elev Shot	zmin	440.27 ft	Velocity Head	Hv	0.68 ft/s
Channel Slope	Sch	0.11 %	Velocity Coeff	alpha	1.00
Energy Loss Fr	hf	0.32 ft	Offs Lft Water Line	xlw	62.61 ft
Energy Loss Eddy	ho	0.30 ft	Offs Rgt Water Line	xrw	72.43 ft
Wetted Width	Wwet	9.82 ft	Jump Loss	hjump	N / A
Wave Reach Lgth	Lave	9.82 ft	Jump Elevation	zjump	N / A
			Station of Jump	Ljump	N / A

Cross Section Groundshots <ft>

1	35.1	446.4	2	62.1	444.5	3	65.9	440.5	4	68.5	440.3
5	74.0	445.4	6	119.6	447.1						

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Section 10 Channel Station 5 + 26 Discharge 147.00 cfs

	Q cfs	AREA ft ²	VEL ft/s	CONVEYANCE	n	RCH LGTH ft	WET PERM ft
Lft Ob	0.00	0.00	0.00	0.00	0.0300	84.81	0.00
Channel	147.00	23.30	6.31	1664.90	0.0300	84.81	13.45
Rgt Ob	0.00	0.00	0.00	0.00	0.0300	84.81	0.00

Water Elevation	zas	444.73 ft	Critical Water	zc	444.32 ft
Depth	Dep	3.31 ft	Normal water	zn	444.32 ft
Energy Grade Line-EGL	Las	445.35 ft	Flow	SUBCRITICAL FLOW	
Energy Loss	ht	0.71 ft	METHOD	Average Conveyance	
Min of Elev Shot	zmin	441.42 ft	Velocity Head	Hv	0.62 ft/s
Channel Slope	Sch	1.36 %	Velocity Coeff	alpha	1.00
Energy Loss Fr	hf	0.69 ft	Offs Lft Water Line	xlw	53.21 ft
Energy Loss Eddy	ho	0.02 ft	Offs Rgt Water Line	xrw	64.31 ft
Wetted Width	Wwet	11.10 ft	Jump Loss	hjump	N / A
Wave Reach Lgth	Lave	11.10 ft	Jump Elevation	zjump	N / A
			Station of Jump	Ljump	N / A

Cross Section Groundshots <ft>

1	33.2	446.3	2	51.6	446.0	3	57.3	441.4	4	60.3	441.4
5	66.0	446.1	6	89.9	448.0						



INDIANA DEPARTMENT OF NATURAL RESOURCES

PATRICK R. RALSTON, DIRECTOR

Division of Water
402 W. Washington St., Rm. W264
Indianapolis, Indiana 46204-2748
317-232-4160
FAX: 317-233-4579

January 31, 1997
REC # 82-970128-1

Mr. Thomas Keith
Andy Easley Engineering
1133 West Mill Road, Number 205
Evansville, Indiana 47710

Re: Vanderburgh - West Franklin
R - UNT Wolf Creek

Dear Mr. Keith

Thank you for your letter of January 22, 1997 requesting information concerning a proposed subdivision along an unnamed tributary to Wolf Creek. Based on your description, the parcel, which lies in the SE 1/4 of Section 19, Township 6S, Range 11W, extends from about 1700 to 2600 feet north of the south section line and extends from about 400 to 1400 feet west of the east section line near Evansville, Vanderburgh County.

IC 14-28-1 prohibits constructing abodes or residences in or on a floodway and requires the prior approval of the Department of Natural Resources for any other type of construction, excavation, or filling in or on a floodway.

Topographic mapping indicates that the drainage area above the site is less than 1 square mile. Approval of the Department of Natural Resources under IC 14-28-1 is not required for construction, excavation or filling at this site unless a dam is to be constructed. This site may, however, have localized drainage problems, which you may want to address as you develop your projects plans.

The Hydrology and Hydraulics Section does not provide engineering services to develop 100-year frequency flood elevations on sites along streams which have drainage areas of less than one square mile. We consider these sites, with small drainage areas, to be better addressed through local floodplain management and stormwater management ordinances. Unfortunately, it is up to the local community or applicant to hire an engineering consultant to establish 100-year frequency flood elevations and address any local drainage problems which may exist at these sites.

You may, however, have to obtain a permit from the Corps of Engineers under Section 404 of the Federal Water Pollution Control Act or Section 10 of the Rivers and Harbors Act. Information relative to the Corps' of Engineers permits may be obtained from:

**U.S. Army Corps of Engineers
Louisville District Office
P.O. Box 59
Louisville, Kentucky 40201
(502) 582-5607**

"EQUAL OPPORTUNITY EMPLOYER"

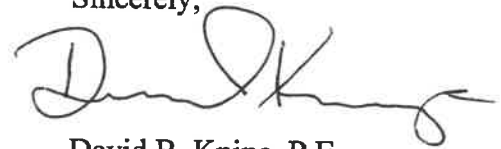


Letter to Mr.
January 31, 1997
REC #
Page Two

You should not construe this letter to be a building permit, approval of the proposed project, or a waiver of the provisions of local building or zoning ordinances.

Thank you for this opportunity to be of assistance; your interest in providing safe flood plain development is appreciated. **If you have any questions regarding this letter, please contact Mr. Jonathan Heald, Hydraulic Engineer, in our Hydrology and Hydraulics Section, at (317) 232-4164.**

Sincerely,

A handwritten signature in cursive script, appearing to read "David B. Knipe".

David B. Knipe, P.E.
Head, Hydrology and Hydraulics
Division of Water

DBK/JWH
pc: Vanderburgh County Plan Commission
Louisville District, Corps of Engineers