STORM DRAINAGE ANALYSIS

NORTHWOOD BAPTIST CHURCH
9920 North Green River Road
Evansville, Indiana

prepared for:

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Evansville, Indiana

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Project Description and Method

The subject property and proposed plat is approximately 12.31 acres located at 9920 North Green River Road.

The existing surface drainage flows both west/southwest and east/southeast. The run-off flowing west/southwest shall remain as existing. A portion of the existing run-off flowing east shall continue to sheet flow east to the Green River Road ditch. The balance of the existing run-off shall flow into a new detention basin. The area flowing into the new detention basin shall include the new south parking lot, ½ of the new building and immediate grass areas around the developed areas.

This analysis will determine the proposed final developed requirements for storm water run-off.

The Rational Method will be used for the basis of this analysis.

Reference manual for design HERPICC Stormwater Drainage Manual.

Run-off coefficient listings are included in this analysis.

Rainfall intensity-duration-frequency table for Evansville included in this analysis.

Calculations for storm water run-off are included in this analysis.

Channel flow design calculations for the detention basin overflow spillway as well as the discharge channel are included.

Scouring and sediment will be taken into consideration and addressed.

Safety with regard to the detention basin will be addressed.

Maintenance of the detention basin, discharge channel and related structures shall be taken into consideration. A periodic maintenance plan should be in place describing maintenance procedures. Site preparation, seeding, seed mixture as well as a seeding program including long term maintenance should be a part of the maintenance plan as well.

Detention Basin Maintenance

Detention basin maintenance shall include, as a minimum, the following:

Periodic inspection of all permanent structures to identify and remove any obstructions and debris.

Grass shall be mowed along the basin perimeter and grass and weeds trimmed and (or) removed around all permanent structures related to the basin. Grass height shall not exceed 12" in height.

Periodic inspection of grass areas to maintain water quality re-seeding as required to keep detention basin from eroding.

Summary and Conclusion

Total Watershed area A = 12.31 acres

The calculated un-developed watershed flow is Q=12.80 cfs (for a 10 year storm return period and 42 min time of concentration).

The calculated required storage for a 25 year storm return period is .30 acre-feet.

During a 25 year storm event, the calculated pool elevation will be 409.50'.

Excess volume generated during storm events above 25 years will be discharged over a grass emergency overflow spillway.

The storm drainage system, when installed as designed, will perform as intended addressing the final intended development. Storm water for the new south parking lot and ½ of the new building will sheet flow south directly into the new detention basin. The detention basin discharge will be released at the calculated pre-development rate. The release rate shall be calculated to compensate for the north parking lot and other ½ of the new building structure. The detention basin water shall be released into a channel extending east to the Green River Road drainage ditch. The 25 year event has been identified and addressed as well as the 100 year event as related to the spillway and the discharge channel.

The discharge channel extending from the detention basin to the Green River Road drainage ditch shall have a 1' minimum base with 3:1 side slopes. It shall be designed to accommodate a 100 year event as well as the varying slope conditions.

A 10' wide safety ledge shall be constructed along the perimeter of the detention basin.

NORTHWOOD CHURCH

JAN. 2006

UNDEVELOPED CONDITIONS

IMPERVIOUS

POLE BARN	3200 ☐	(DEMO)
PARSONAGE	2100 ☐	(TO REMAIN)
MISC BLDG's.	1684 ☐	(DEMO)
DRIVEWAY	8800 ☐	(TO REMAIN)
	15,784 ☐	
	.36 ACRES	

IMPERVIOUS	.36A	C=.92	.33
GRASS	11.95A	C=.24	2.87
TOTAL	12.31A		3.20

3.2/12.31 = .26

Case = .26

$$t_c = K(LNS^{-.5})^{.467}$$

$$t_c = .83\left[(600)(.2)(.07)^{-.5}\right]^{.467}$$

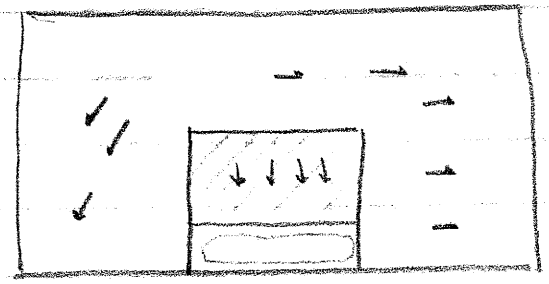
$$= 17.6 \text{ MIN.}$$

10 YR RET.; 20 MIN $I = 4$"/HR

$$Q = (.26)(4)(12.31)$$

$$Q = 12.80 \text{ CFS}$$

DEVELOPED RUN-OFF



RUNOFF @ SURROUNDING AREA TO REMAIN AS EXISTING:

25 YR 20 MIN $i = 4.4$ "/HR

$Q = (.26)(4.4)(10) = 11.44$ CFS

TOTAL UNDEVELOPED RUN-OFF $Q = 12.80$ CFS

$$12.80 - (11.44) = 1.36 \text{ CFS}$$

MAX DISCH FROM BASIN = 1.36 CFS

DEVELOPED RUN-OFF DIRECTED TO BASIN

BLDG. & PAVING 101,100 ft² 2.31 ACRES

$C = .92$ $t_c = 5$ MIN.

$Q = (.92)(7.208)(2.31) = 15.32$ CFS

PEAK STORAGE RATE .30 ACRE-FT

13,068 ft³

RESTRICTOR DISCH.

$Q = 1.36$ CFS

$1.36 = (.30)(A)\sqrt{(2)(32)(2)}$

$1.36 = 3.39\,A$

$A = .40\ Ft^2$

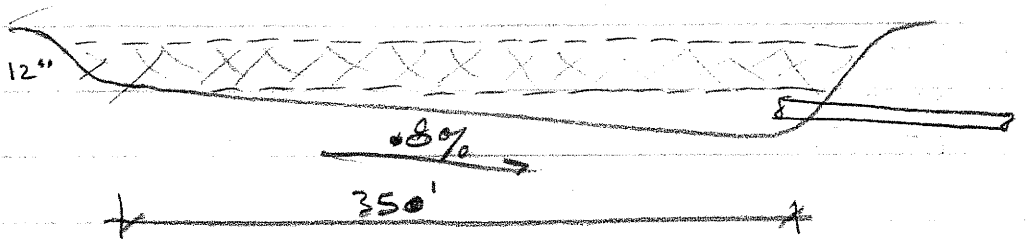
$A = \pi r^2$

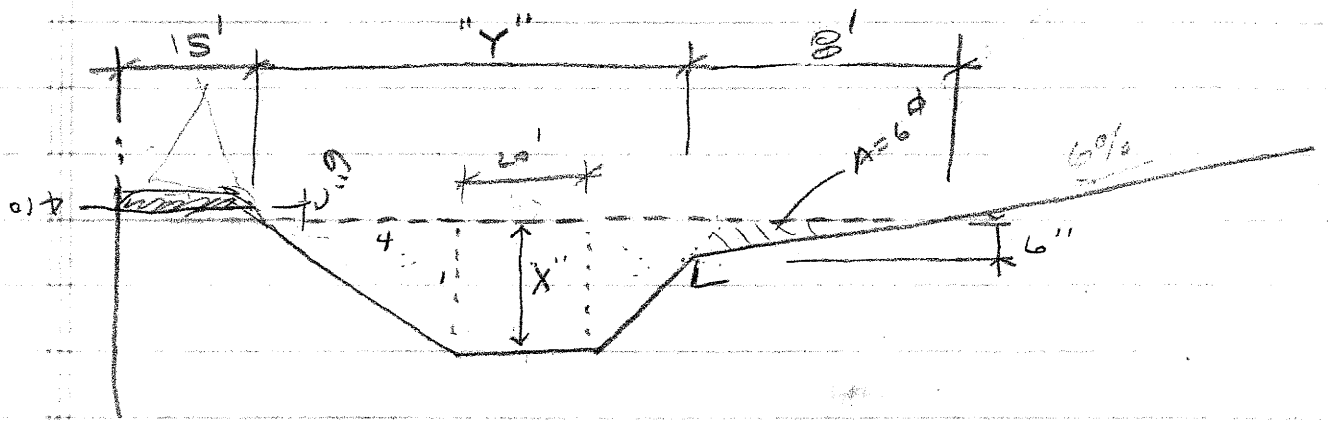
$r = \sqrt{\frac{A}{\pi}} = \sqrt{\frac{.40}{3.14}}$

$r = .356'$

$D = .7136'$

$D = 9''$ (ORIFICE DISCH SIZE)





13,000 44# Reg'd − 6# = 38#

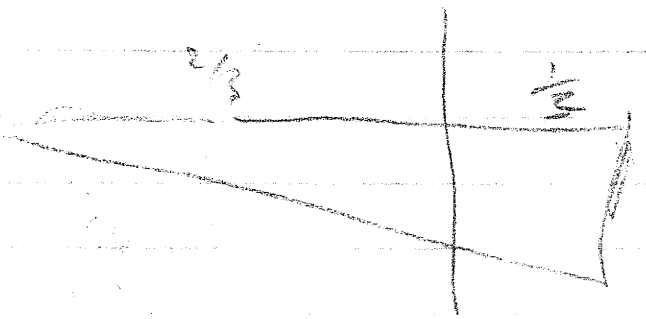
"X" = 18"

$(\frac{1}{2})(1.5)(6) \times 2$ = TRIANGLE AREA = 9#

36 − 9 = 27#

27 ÷ 1.5 = 18'

Y = 30'



Project NORTH WOOD Detention Facility Design Return Period 25 yrs.

Designer LANDMARK Release Rate Return Period 10 yrs.

Watershed Area 2,31 acres

Time of Concentration (undeveloped watershed) 20 minutes

Rainfall Intensity (i_U) 4.0 inches/hr

Undeveloped Runoff Coefficient (C_U) .26

Undeveloped Runoff Rate ($O = C_U i_U A_U$) 12.80 - 11.44 = 1.36 cfs

Developed Runoff Coefficient (C_D) .92

Storm Duration t_d (hrs)	Rainfall Intensity i_d (inches/hr)	Inflow Rate $I(t_d)$ $(C_D i_d A_D)$ (cfs) 2.13	Outflow Rate O $(C_U i_U A_U)$	Storage Rate $I(t_d) - O$ (cfs)	Required Storage $\left[I(t_d) - O\right]\frac{t_d}{12}$ (acre-ft)
0.17	5.925	12.62	1.36	11.26	.16
0.33	4.571	9.74	"	8.38	.23
0.50	3.646	7.76	"	6.40	.27
0.67	3.123	6.66	"	5.30	.30
0.83	2.601	5.54	"	4.18	.29
1.0	2.078	4.43	"	3.07	.25
1.5					
2.0					
3.0					
4.0					
5.0					
6.0					
7.0					
8.0					
9.0					
10.0					

Figure 6.2.2
Computation Sheet for Detention Storage Calculations Using the Rational Method

GRASS OVERFLOW / EMERGENCY SPILLWAY (DET. BASIN)

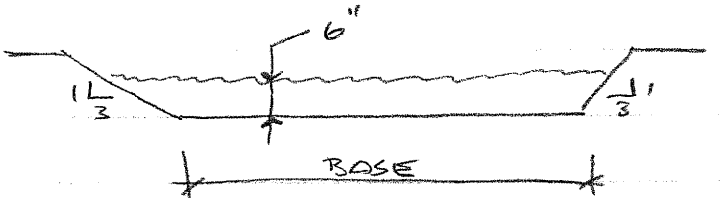
ASSUME 8"Ø DISCH PIPE IS OBSTRUCTED

FOR 100 YR. EVENT

13,200 Ft^3 STOR VOL AVAIL.

@ .303 ACRE-FT. OVERFLOW WILL BEGIN TO OCCUR. (≈ 30 MIN.)

FLOW RATE @ 30 MIN. = 9.78 CFS



$Q = \frac{1.49}{n} A R^{2/3} \sqrt{S}$ $\quad S = .0025 \quad n = .03$

$A = (BASE + (3)(.5))(.5) =$

$P = (BASE + (2)(.5)\sqrt{1 + 3^2} = BASE + 3.16$

BASE	A	P	R	Q
10'	5.75	13.16	.437	4.94
12'	6.75	15.16	.445	5.87
15'	8.25	18.16	.454	7.27
18'	9.75	21.16	.461	8.67
20'	10.75	23.16	.464	9.61

Project Nora Woods Detention Facility Design Return Period 100 yrs.

Designer [illegible] Release Rate Return Period 5 yrs.

Watershed Area 2.31 acres

Time of Concentration (undeveloped watershed) 5 minutes

Rainfall Intensity (i_U) 8.469 inches/hr

Undeveloped Runoff Coefficient (C_U) .26

Undeveloped Runoff Rate ($O = C_U i_U A_U$) 12.80 cfs

Developed Runoff Coefficient (C_D) .92

ASSUME DISCH. PIPE IS OBSTRUCTED

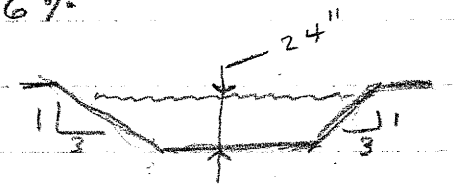
Storm Duration t_d (hrs)	Rainfall Intensity i_d (inches/hr)	Inflow Rate $I(t_d)$ $(C_D i_d A_D)$ (cfs) 2.125	Outflow Rate O $(C_U i_U A_U)$	Storage Rate $I(t_d) - O$ (cfs)	Required Storage $\left[I(t_d) - O\right]\frac{t_d}{12}$ (acre-ft)
0.17	7.126	15.14	9	15.14	.214
0.33			↓		
0.50	4.608	9.79		9.79	.302
0.67					
0.83					
1.0	2.663	5.66		5.66	.470
1.5					
2.0	1.785	3.79		3.79	.631
3.0	1.291	2.74		2.74	.685
4.0	1.062	2.26		2.26	.752
5.0					
6.0	.741	1.57		1.57	.787
7.0					
8.0	.541	1.27		1.27	.823
9.0					
10.0					

Figure 6.2.2
Computation Sheet for Detention Storage Calculations Using the Rational Method

UPSLOPE DISCHARGE CHANNEL

$Q = 9.70$ CFS

$S = 6\%$



$$Q = \frac{1.49}{.05} A R^{2/3} \sqrt{.06}$$

$$Q = 7.3 A R^{2/3}$$

$$A = (\text{BASE} + (3)(2))\,2$$

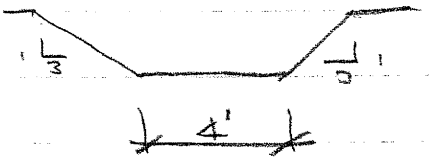
$$P = \text{BASE} + (2)(2)\sqrt{1+3^2} = \text{BASE} + 12.65$$

DEPTH	BASE	A	P	R	Q	V
24"	4'	20	16.65	1.20	165	8.25
12"	4'	7	13.49	.519	33	4.71 FPS
6"	4'	2.75	7.16	.384	10.6	3.86
12"	12"	4	7.32	.546	19.5 CFS	4.88 FPS

DOWNSLOPE (MIN. SLOPE) DITCH CHANNEL

$Q = 9.7$ CFS

$S = 2\%$



$$Q = \frac{1.49}{.05} A R^{2/3} \sqrt{.02} = 4.21 A R^{2/3}$$

$$A = \left[\text{BASE } 4' + (3)(y)\right] Y$$

$$P = \text{BASE } 4' + (2)(Y)\sqrt{1+3^2} = 4' + 6.32\,Y$$

	DEPTH	A	P	R	Q	V
	12"	7	10.32	.68	22.7	3.25 FPS
12" BASE	12"	4	7.32	.546	11.20	2.8

Table 13.04.205-C
RAINFALL INTENSITY-DURATION-FREQUENCY
TABLE FOR EVANSVILLE
Intensity in Inches Per Hour

	Storm Return Period in Years				
Storm Duration	5	10	25	50	100
5 minutes	6.063	6.625	7.208	7.936	8.469
10 minutes	4.863	5.380	5.925	6.616	7.126
15 minutes	4.029	4.515	5.033	5.697	6.194
30 minutes	2.837	3.226	3.646	4.194	4.608
60 minutes	1.549	1.819	2.078	2.412	2.663
2 hours	1.053	1.230	1.400	1.620	1.785
3 hours	0.774	0.899	1.019	1.175	1.291
4 hours	0.632	0.736	0.836	0.965	1.062
5 hours	0.524	0.606	0.684	0.785	0.861
6 hours	0.453	0.522	0.589	0.676	0.741
7 hours	0.399	0.459	0.516	0.591	0.647
8 hours	0.358	0.412	0.463	0.530	0.581
9 hours	0.323	0.370	0.415	0.472	0.516
10 hours	0.297	0.339	0.379	0.431	0.470
11 hours	0.276	0.314	0.351	0.399	0.435
12 hours	0.259	0.296	0.331	0.376	0.410
13 hours	0.245	0.280	0.314	0.357	0.390
14 hours	0.233	0.267	0.299	0.341	0.372
15 hours	0.220	0.252	0.281	0.320	0.349
16 hours	0.209	0.238	0.266	0.302	0.329
17 hours	0.198	0.225	0.251	0.284	0.310
18 hours	0.189	0.215	0.240	0.272	0.296
19 hours	0.181	0.206	0.299	0.260	0.282
20 hours	0.175	0.199	0.222	0.251	0.273
21 hours	0.169	0.193	0.215	0.244	0.266
22 hours	0.164	0.187	0.208	0.236	0.257
23 hours	0.160	0.181	0.202	0.229	0.250
24 hours	0.154	0.174	0.194	0.219	0.239
24 hours	0.149	0.168	0.187	0.212	0.230
26 hours	0.143	0.162	0.180	0.204	0.221
27 hours	0.139	0.156	0.174	0.196	0.212
28 hours	0.135	0.152	0.169	0.190	0.206
29 hours	0.132	0.149	0.165	0.186	0.201
30 hours	0.129	0.145	0.161	0.182	0.197
31 hours	0.126	0.142	0.158	0.178	0.193
32 hours	0.122	0.138	0.153	0.173	0.188
33 hours	0.119	0.135	0.149	0.168	0.183
34 hours	0.116	0.131	0.146	0.164	0.178
35 hours	0.113	0.128	0.142	0.160	0.174
36 hours	0.111	0.125	0.139	0.157	0.171

weighted average value for the total area calculated from a breakdown of individual areas having different surface types.

Table 13.04.205-A

UNDEVELOPED RUNOFF COEFFICIENTS (Cu)

Surface Type—Woodland, Turfed Meadows, Rough Pasture, Fallow Brush.

Slope:
Less than 2% C = 0.12
2% to 5% C = 0.24
5+% to 10% C = 0.36
Over 10% C = 0.48

Surface Type—Cultivated Fields.

Slope:
Less than 2% C = 0.20
2% to 5% C = 0.35
5+% to 10% C = 0.50
Over 10% C = 0.65

Table 13.04.205-B

DEVELOPED RUNOFF COEFFICIENTS (Cd)

Surface Type—Pavement, Rooftop, Other Impervious Surfaces:

Slope:
Less than 2% C = 0.92
2% to 5% C = 0.94
5+% to 10% C = 0.96
Over 10% C = 0.98

Surface Type—Lawns with Turf.

Slope:
Less than 2% C = 0.15
2% to 5% C = 0.25
5+% to 10% C = 0.40
Over 10% C = 0.55

Surface Type—All Water Surfaces, Basins, Ponds and Lakes.

C = 1.00

C. Determination of Rainfall Intensity.

1. "I" or rainfall intensity shall be determined from data interpolated from the weather bureau rainfall frequency curves, which data is shown in Table 13.04.205-C.

2. When using the Rational Method, the storm duration is equal to the "time of concentration" (tc),