STORM DRAINAGE ANALYSIS

Lots 11, 12 and 13
of
BASELINE PARK SUBDIVISION

Highway 41 North @ Baseline Road
Evansville, Indiana
BLA Project No. 101-0262-0PD

Prepared for:

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By:

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INTRODUCTION

Baseline Park Subdivision, located at the southeast quadrant of Highway 41 North and Baseline Road, was originally submitted, approved and platted in 1998. With this platted subdivision, preliminary and final drainage approval was granted.

As previously reported, all runoff within the project has been routed to the detention basin constructed along the western boundary of this project.

At the time of the original submittal, there were some questions as to how the area comprised of Lots 11, 12 and 13 would be developed should the area be sold as four individual lots. As multiple lots, it was understood that some additional storm water conveyance details would need to be addressed. However, if it were sold to one user, no additional storm water conveyance details would be required since the area then comprised of Lots 10, 11, 12 and 13 had storm sewers and stubs in the original design to accept the stormwater flow.

Although the original plan did not show in detail how this runoff would be routed from Lots 12 and 13 westward to the point where it would engage the storm sewer beneath Neely Drive, there was a commitment to route the runoff from all paved areas and rooftops constructed on all of these lots and that portion of the Steckler property west of the existing ridge to the large retention lake located along the western boundary of the project toward the large retention lake.

In addition, it was agreed that the roadside ditch along Baseline Road, east of the north/south frontage road (Neely Drive), would also be routed through the large lake.

It is now planned that this block of four lots will be developed individually. Plans are being submitted for Lot 13 that will be developed into a fitness center. Therefore, it is the intent of this report to address in detail how the runoff from Lot 13 will be directed toward Neely Drive and establish in greater detail how the runoff from Lots 11, 12 and 13 will be routed to a point at Neely Drive. Lot 10 need not connect or be made a part of this plan for there are sewer connections available at this lot.

From this point at Neely Drive all storm runoff is and will continue to be directed by way of storm sewer to the large lake as originally required per the previously approved plan.

In order to handle all future runoff from Lots 11, 12 and 13 in a manner deemed acceptable to the local authorities and the owners of these lots, the developer is proposing that a small lake be constructed on the line between Lots 11 and 12 and that all of the runoff from the development of Lots 11, 12 and 13 be captured in a storm sewer and routed to this proposed lake.

The outlet to this lake will be sized in accordance with the Vanderburgh County Drainage Ordinance, having a dual-stage outlet structure designed to limit the discharge to a minimal flow that will have no measurable impact on the roadside ditch.

METHOD

The Rational Method (Q = cia) will be used to compute the 1 and 10-year undeveloped flows. These values will be used as the allowable outflow rates for the developed site.

"c" = Runoff Coefficient. The existing land slopes from west to east. The area is currently cultivated fields ranging from 2% to 5% in slope. This suggests an undeveloped runoff coefficient of 0.30 be used as shown in Table 803 of the drainage ordinance.

"i" = Intensity. Kerby's Formula will be used to determine a Time of Concentration for the undeveloped site and the corresponding intensity will be calculated. In addition, a longer T_C
(60 minutes) will be evaluated to see how it will effect the outflow and storage rates.

"a" = Area. The contributory area will be considered the combined total area of Lots 11, 12 and 13. This value is 6.62 acres.

In addition a developed "c" value of 0.68 will be used which is based on the actual proposed development for Lot 13. This closely coincides with the 0.7 value originally reported and used as a basis of calculation for the entire subdivision.

To the product of the developed "c" value and the area "a", a range of intensity value for different duration storms having a 25 year and 100 year specified return rate will be multiplied to compute expected inflow rates.

A lake will be constructed on Lots 11 and 12 to detain the required runoff. The outflow from this pond will be sized to limit the outflow to a level that will have no measurable impact on the existing roadside ditch.

RESULTS

The required storage volume based on a 10/25 year analysis is 0.41 acre/feet (17,933 cubic feet) based on a 10 year outflow rate of 7.04 CFS.

The required storage volume based on a 10/100 year analysis is 0.61 acre/feet (26,401 cubic feet) based on a 10 year outflow rate of 7.04 CFS.

The required storage volume based on a 10/25 year analysis is 0.67 acre/feet (29,197 cubic feet) based on a 60 minute time of concentration and a reduced outflow rate of 2.91 CFS.

The required storage volume based on a 10/100 year analysis is 0.86 acre/feet (37,378 cubic feet) based on a 60 minute time of concentration and a reduced outflow rate of 2.91 CFS.

The available storage volume in this pond at staged levels is as follows:

- From elevation 447.50 (pool) to elevation 448.00 = 9,892 cf
- From elevation 447.50 to elevation 449.00 = 21,854 cf
- From elevation 447.50 to elevation 450.00 = 36,745 cf
- From elevation 447.50 to elevation 451.00 = 54,792 cf

The allowable 10 year outflow rate for this basin is 7.04 CFS. However, a lesser outflow of 2.91 CFS produced a 100 year storage requirement of 0.86 acre/feet (37,378 cubic feet).

A third overland emergency spillway will be constructed at elevation 450.75 with the dam built to a elevation of 451.25.

An 8" diameter orifice placed in the front face of the outlet control structure at pool elevation to act as the primary outlet with a secondary spillway being the grated opening atop the outlet structure set 2.5 feet above the pool and the secondary outlet elevation to achieve the required 25 year storage capacity while limiting the discharge to 2.91 CFS.

SUMMARY

Initially the developer of the subdivision and later, upon development of Lots 11 and 12, the respective new lot owners, will assume maintenance of the proposed storm water facility.

All runoff from paved areas and roof tops constructed on Lots 11, 12 and 13 will be routed through this new basin. To further protect the downstream landowners the storm runoff, upon exiting the lake at a reduced rate, will be routed through the larger holding facility previously approved. This original basin was designed to handle the stormwater runoff from this area as previously reported.

The south roadside ditch along Baseline, east of the proposed north/south frontage road, will also be routed through the basin as previously reported.

Based on a allowable outflow rate equivalent to a 60 minute time of concentration, the required storage volume for this lake to detain the calculated stormwater storage for the 25 year storm is 29,197 cubic feet (0.67 acre/feet). To increase the storage to the 100 year storm detention, the required volume is 37,378 cubic feet (0.86 acre/feet).

By providing a dual outlet structure, storms of lesser frequency than required by local ordinances can be detained. In addition, the lake is sized to handle runoff for a 100 year storm should the need arise.

If overtopping of the facility were to occur due to unforeseen circumstances, the earthen spillway on the lake will redirect the runoff to the same storm sewer that will convey this runoff to the larger lake. None of the subject property lies within the 100 year flood plain, but due to the concern of increased storm runoff having an impact on the existing Baseline Road side ditch, a secondary (smaller) detention basin, connected by piping to the larger basin, will be constructed to further limit the discharge from Lots 11, 12 and 13.

Once the lake is in place, this site development should exceed the requirements of the current Vanderburgh County Drainage Ordinance, even more than originally reported and approved. This

will only further reduce any impact on the downstream properties that may be caused by this development.

APPENDICES INDEX

APPENDIX "A"
DRAINAGE PLAN

APPENDIX "B"
TIME OF CONCENTRATION/INTENSITY

TIME OF CONCENTRATION

SHEET FLOW

$$TC = .827\left[\frac{(N)(L)}{\sqrt{S}}\right]^{.467}$$ (Kerby's Formula)

N = 0.4 Coefficient Grass
L = Length
S = Slope

L = 450'
H = 462 - 450 = 12'
S = .0267

$$Tc = .827\left[\frac{(0.4)(450)}{\sqrt{.0267}}\right]^{.467} = 22 \text{ minutes}$$

INTENSITY

$$i( ) = \frac{C(T)^{\alpha}}{(Tc+d)^{\beta}}$$

Factors for Evansville

C = 1.9533 T = duration
α = 0.1747 Tc = Time of Concentration (10 yr. undeveloped)
d = 0.522
β = 1.6408

$$i_{10} = \frac{1.9533(10)^{0.1747}}{(34.5/60+0.522)\ 1.6408} = \frac{2.9361}{.8239} = 3.56$$

Case No. 2 (more conservative approach)

Assume T_C = 60 minutes

$$i_{10} = \frac{1.9533(10)^{0.1747}}{(60/60+0.522)^{1.6408}} = \frac{2.9361}{1.99} = 1.47$$

EXHIBIT B

Example 2.2.3

Using the IDF equation, determine the 10-year, 15-minute rainfall intensity for the City of Indianapolis.

From Table 2.2.2, c=2.1048 α=0.1733 d=0.470 β=1.1289

Referring to the IDF equation,

$$i = \frac{c\,T_r^{\alpha}}{(t+d)^{\beta}} = \frac{2.1048\ (10)^{0.1733}}{\left(\frac{15}{60}+0.470\right)^{1.1289}} = 4.545\ \textit{inches/hour}$$

Table 2.2.2
Regional Coefficients for the IDF Equation (Eq. 2.2.13)
(Purdue et al., 1992)

Station	c	α	d	β
0.083 hour < t ≤ 1 hour				
Indianapolis	2.1048	0.1733	0.470	1.1289
South Bend	1.7204	0.1753	0.485	1.6806
Evansville	1.9533	0.1747	0.522	1.6408
Fort Wayne	2.0030	0.1655	0.516	1.4643
1 hour < t < 36 hour				
Indianapolis	1.5899	0.2271	0.725	0.8797
South Bend	1.2799	0.1872	0.258	0.8252
Evansville	1.3411	0.2166	0.300	0.8154
Fort Wayne	1.4381	0.1878	0.525	0.8616

APPENDIX "C"
STORAGE VOLUME DATA

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PROJECT: LOTS12/13 DATE: *********
ENGINEER:

	5\10\25\100		
RELEASE RATE PERIOD:	5\10\25\100		
WATERSHED AREA (ACRES):	6.62		
TIME OF CONCENTRATION UNDEV. (min):	22		
RAINFALL INTENSITY (INCHES/HR):	3.73	3.544689	3.07359
UNDEVELOPED RUNOFF COEFFICIENT:	0.3		
UNDEVELOPED RUNOFF RATE (CFS):	7.04		
DEVELOPED RUNOFF COEFFICIENT:	0.68		

25 YEAR STORM

STORM DURATION (HRS)	RAINFALL INTENSITY (INCH/HR)	INFLOW RATE (CFS)	OUTFLOW RATE (CFS)	STORAGE RATE (CFS)	REQUIRED STORAGE (ACRE-FT)	
0.08	8.02	36.08	7.04	29.04	0.194	6.85
0.17	6.20	27.90	7.04	20.86	0.296	5.45
0.25	5.26	23.70	7.04	16.66	0.347	4.65
0.33	4.62	20.79	7.04	13.76	0.378	4.15
0.42	4.09	18.40	7.04	11.36	0.397	3.80
0.50	3.72	16.75	7.04	9.71	0.405	3.40
0.58	3.42	15.41	7.04	8.37	0.405	3.20
0.67	3.15	14.17	7.04	7.13	0.398	2.85
0.75	2.94	13.24	7.04	6.20	0.387	2.75
0.83	2.76	12.44	7.04	5.40	0.373	2.60
0.92	2.59	11.65	7.04	4.61	0.354	2.45
1.00	2.45	11.04	6.10	4.94	0.412	2.30
1.25	2.11	9.52	6.10	3.41	0.356	2.05
1.50	1.86	8.38	6.10	2.28	0.285	1.85
1.75	1.67	7.50	6.10	1.40	0.204	1.60
2.00	1.51	6.80	6.10	0.69	0.115	1.40
2.50	1.27	5.73	6.10	-0.38	-0.078	1.25
3.00	1.10	4.95	6.10	-1.15	-0.287	1.10
4.00	0.87	3.90	6.10	-2.20	-0.734	0.84

PEAK STORAGE (ACRE/FT):	0.41
PEAK STORAGE (CUBIC FT):	17933.08

100 YEAR STORM

STORM DURATION (HRS)	RAINFALL INTENSITY (INCH/HR)	INFLOW RATE (CFS)	OUTFLOW RATE (CFS)	STORAGE RATE (CFS)	REQUIRED STORAGE (ACRE-FT)
0.08	9.52	42.87	7.04	35.83	0.239
0.17	7.40	33.29	7.04	26.25	0.372
0.25	6.30	28.36	7.04	21.32	0.444
0.33	5.54	24.94	7.04	17.90	0.492
0.42	4.91	22.10	7.04	15.06	0.527
0.50	4.48	20.15	7.04	13.11	0.546
0.58	4.12	18.57	7.04	11.53	0.557
0.67	3.80	17.09	7.04	10.05	0.561
0.75	3.55	15.99	7.04	8.95	0.559
0.83	3.34	15.04	7.04	8.00	0.553
0.92	3.13	14.10	7.04	7.06	0.542
1.00	2.97	13.38	6.10	7.27	0.606
1.25	2.57	11.56	6.10	5.45	0.568
1.50	2.27	10.20	6.10	4.09	0.512
1.75	2.03	9.14	6.10	3.04	0.443
2.00	1.84	8.29	6.10	2.19	0.365
2.50	1.56	7.01	6.10	0.90	0.188
3.00	1.35	6.08	6.10	-0.03	-0.007

PEAK STORAGE (ACRE/FT): 0.61
PEAK STORAGE (CUBIC FT): 26401.76

↕↕Æ PROJECT: lots 11/1 DATE: *********
ENGINEER:

RELEASE RATE PERIOD:	5\10\25\100	
RELEASE RATE PERIOD:	5\10\25\100	
WATERSHED AREA (ACRES):	6.62	
TIME OF CONCENTRATION UNDEV. (min):	60	
RAINFALL INTENSITY (INCHES/HR):	2.05	1.466098 1.783002
UNDEVELOPED RUNOFF COEFFICIENT:	0.3	
UNDEVELOPED RUNOFF RATE (CFS):	2.91	
DEVELOPED RUNOFF COEFFICIENT:	0.68	

25 YEAR STORM

STORM DURATION (HRS)	RAINFALL INTENSITY (INCH/HR)	INFLOW RATE (CFS)	OUTFLOW RATE (CFS)	STORAGE RATE (CFS)	REQUIRED STORAGE (ACRE-FT)	
0.08	8.02	36.08	2.91	33.17	0.221	6.85
0.17	6.20	27.90	2.91	24.99	0.354	5.45
0.25	5.26	23.70	2.91	20.79	0.433	4.65
0.33	4.62	20.79	2.91	17.88	0.492	4.15
0.42	4.09	18.40	2.91	15.48	0.542	3.80
0.50	3.72	16.75	2.91	13.84	0.577	3.40
0.58	3.42	15.41	2.91	12.50	0.604	3.20
0.67	3.15	14.17	2.91	11.26	0.628	2.85
0.75	2.94	13.24	2.91	10.33	0.645	2.75
0.83	2.76	12.44	2.91	9.52	0.659	2.60
0.92	2.59	11.65	2.91	8.74	0.670	2.45
1.00	2.45	11.04	3.54	7.50	0.625	2.30
1.25	2.11	9.52	3.54	5.98	0.623	2.05
1.50	1.86	8.38	3.54	4.84	0.605	1.85
1.75	1.67	7.50	3.54	3.96	0.578	1.60
2.00	1.51	6.80	3.54	3.26	0.543	1.40
2.50	1.27	5.73	3.54	2.19	0.456	1.25
3.00	1.10	4.95	3.54	1.41	0.353	1.10
4.00	0.87	3.90	3.54	0.36	0.121	0.84

PEAK STORAGE (ACRE/FT):	0.67
PEAK STORAGE (CUBIC FT):	29196.65

100 YEAR STORM

STORM DURATION (HRS)	RAINFALL INTENSITY (INCH/HR)	INFLOW RATE (CFS)	OUTFLOW RATE (CFS)	STORAGE RATE (CFS)	REQUIRED STORAGE (ACRE-FT)
0.08	9.52	42.87	2.91	39.96	0.266
0.17	7.40	33.29	2.91	30.38	0.430
0.25	6.30	28.36	2.91	25.45	0.530
0.33	5.54	24.94	2.91	22.02	0.606
0.42	4.91	22.10	2.91	19.19	0.672
0.50	4.48	20.15	2.91	17.24	0.718
0.58	4.12	18.57	2.91	15.65	0.757
0.67	3.80	17.09	2.91	14.18	0.792
0.75	3.55	15.99	2.91	13.08	0.817
0.83	3.34	15.04	2.91	12.12	0.839
0.92	3.13	14.10	2.91	11.19	0.858
1.00	2.97	13.38	3.54	9.84	0.820
1.25	2.57	11.56	3.54	8.01	0.835
1.50	2.27	10.20	3.54	6.66	0.832
1.75	2.03	9.14	3.54	5.60	0.817
2.00	1.84	8.29	3.54	4.75	0.792
2.50	1.56	7.01	3.54	3.47	0.722
3.00	1.35	6.08	3.54	2.53	0.634
4.00	1.07	4.80	3.54	1.26	0.421
			3.54		

PEAK STORAGE (ACRE/FT): 0.86
PEAK STORAGE (CUBIC FT): 37378.34

APPENDIX "D"
OUTLET CONTROL STRUCTURE ANALYSIS

OUTLET CONTROL STRUCTURE

$cd = Cc \times Cv = (.62)(.97) = .60$

$Q = cdA\sqrt{2gh}$

Allow Outflow Q = 2.91 CFS

Allow HW = Top Box Outlet Str. To IE Lower-Water Outlet Pipe

$$(2.91) = Q = (.60)(A)\sqrt{2(32.2)(2.5)}$$

$$A = \frac{2.91}{7.6131} = 0.3822 = \frac{\Pi d^2}{4}$$

d = 0.70 = 8-3/8" ≅8" dia. primary orifice

The primary spillway will be an 8" diameter primary outlet pipe under which a 2.5' of head will pass 2.9 cfs. This smaller primary outlet pipe with an open grate set atop the box, will provide for a dual staged outlet. The secondary outlet pipe should be no smaller than 12" dia. to avoid future maintenance concerns.

EXHIBIT D

APPENDIX "E"
BASIN VOLUMES

BASIN VOLUMES

ELEVATION	SURFACE AREA (SFT)	STAGED VOLUME (CFT)	ACCUMULATED VOLUME (CFT)	ACCUMULATED VOLUME (ACRE/FEET)
Pool 447.50	9,231	-0-	-0-	
448.00	10,554	9,892	9,892	0.23
449.00	13,370	11,962	21,854	0.50
450.00	16,413	14,892	36,745	0.84
451.00	19,681	18,047	54,792	1.26

37,378.34