Stormwater Calculations

Johnson County Board of Commissioners
Central Dispatch Building
1081 Hospital Road
Franklin, Indiana

Drainage Submittal:
3/19/15

Prepared By:

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Stormwater Calculations Summary

Pre-Development Conditions

The existing site consists of a developed +/-26.7 acre parcel with infrastructure, buildings, etc. to the north and a shooting range to the south. The project site is situated on the Johnson County Sheriff's complex located at 1081 Hospital Road, Franklin, Indiana. As described above, the existing land use is built out about the northern portions and contains heavy woods to the south. The existing drainage sheet flows into well-defined channels about the southern portion of the property before discharging directly into Young's Creek.

Portions of the subject property lie within Flood Hazard Zones X; Shaded X; and AE as plotted by hand on the Federal Emergency Management Agency Flood Insurance Rate Map for Johnson County, Indiana, community panel number 18081C0227D, which bears an effective date of August 2, 2007.

Post-Development Conditions

The proposed improvements include the construction of a new training facility, concrete sidewalks, and an asphalt parking lot. The proposed site grading results in runoff sheet flowing from west to east and from west to northeast towards Young's Creek. A storm sewer line consisting of (1) 15" RCP will discharge from west to east directly into Young's Creek. The proposed grading eliminates the need for storm sewer infrastructure in the post-development condition.

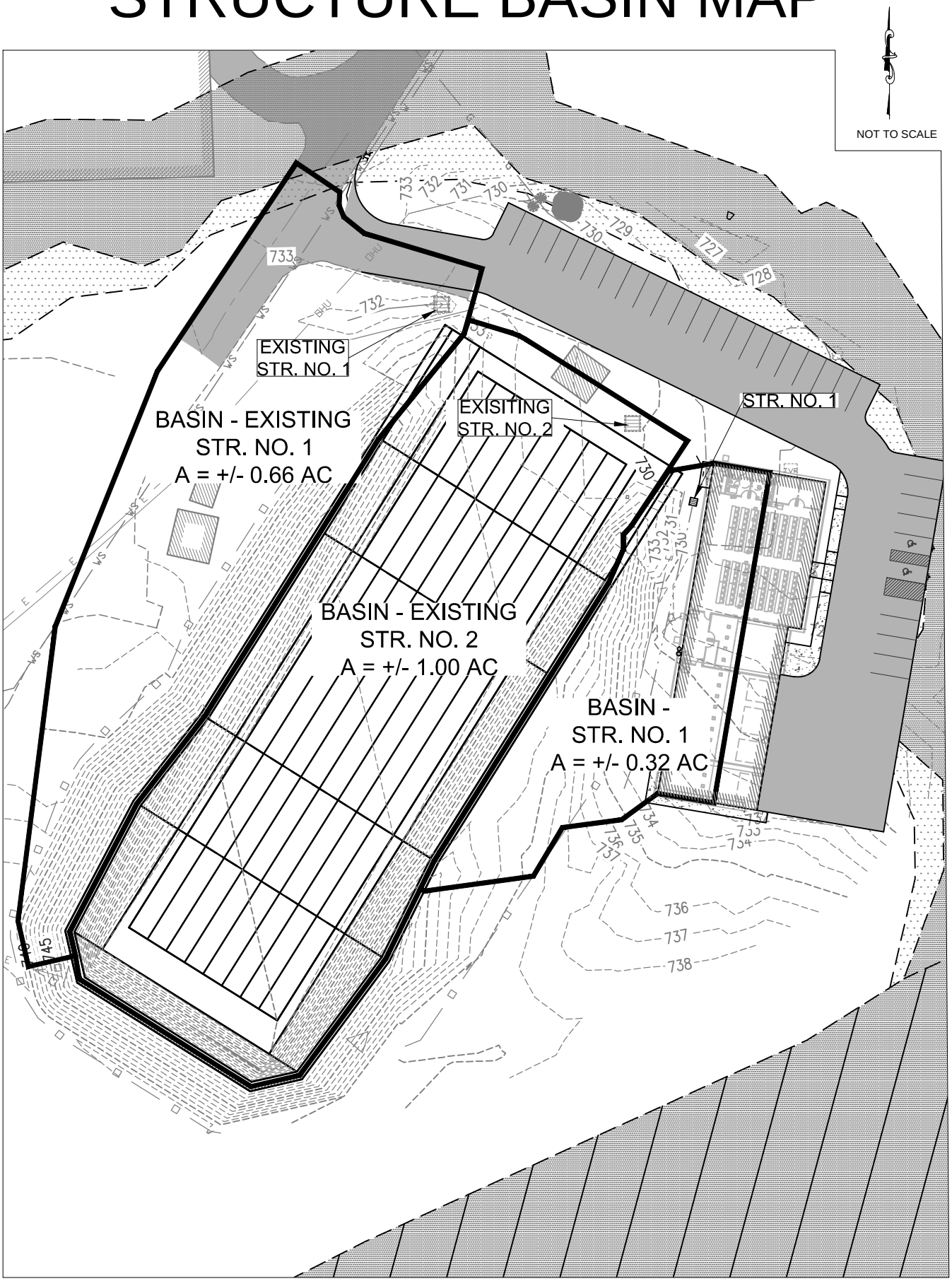
Detention Calculations

Due to the minimal impervious area being added and the project's vicinity to Young's Creek, a waiver from the City's detention requirements is being requested. Per the FEMA Flood Insurance Rate Map, the northern limit of the Young's Creek floodway is approximately 300 feet southeast of the project limits.

All drainage calculations were completed using the Rational Method. It can be seen in the ***Rational Pre-Post Comparison*** calculations contained herein that the minimal impervious area added to the site results in an increase of just over 4.0% in either the 10yr or 100yr storm events.

This increase is negligible and causes no undue burden to the receiving waters of Young's Creek. It should also be noted that stormwater quality is provided as a result of all runoff sheet flowing across the grass areas surrounding the proposed improvements. The existing grass ground cover will remain undisturbed during construction.

STRUCTURE BASIN MAP



Individual Inlet Calculations:

Structure 1 $Str.1_Rim := 729.50\ ft$ (Rim Elevation for Str. 1)

$A1_{grass} := 9902\ ft^2 = 0.23\ acre$ (Catchment Area containing grass)
$A1_{roof} := 3978\ ft^2 = 0.09\ acre$ (Catchment Area containing rooftop)

$t_c := 5\ min$ (Time of Concentration)

$i := 6.99\ \frac{in}{hr}$ (Rainfall Intensity)

$c_{grass} := 0.60$ (Runoff coefficient for steep grassed areas)
$c_{roof} := 0.90$ (Runoff coefficient for water tight roof surface)

$Q_{1_Local} := \left(\left(A1_{grass} \cdot c_{grass}\right) + \left(A1_{roof} \cdot c_{roof}\right)\right) \cdot i$

$Q_{1_Local} = 1.54\ \frac{ft^3}{sec}$ (Max flow for Inlet 1 and Str. 1 pipe run)

Max flow through Neenah R-4215-C Casting = 6.9 cfs

Pipe Calcs:
$cover := 1\ ft$ (Cover From Rim Elev. To Top of Pipe)
$HDPE_{12}Wall := 2\ in$ (12" HDPE Wall Thickness)
$HDPE_{12}Dia. := 1\ ft$ (12" HDPE Diameter)

$Invert_Out := Str.1_Rim - cover - \left(2 \cdot HDPE_{12}Wall\right) - HDPE_{12}Dia.$

$Invert_Out = 727.17\ ft$ (Invert Out Elev. for Str. 1 for 12" HDPE to the NW)

$\Delta_{1to3} := 45\ ft \cdot 0.27\% = 0.12\ ft$ (Pipe Slope From Str. 1 to Str. 3)

Q_max through 12" HDPE @ 0.27% = 2.0 cfs & Vel._max = 2.55 fps

Existing Structure 1 $Str.2_Rim := 730.86\ ft$ (Rim Elevation for Str. 2)

$A_{grass} := 22387\ ft^2 = 0.51\ acre$ (Catchment Area containing grass)
$A_{imp} := 6577\ ft^2 = 0.15\ acre$ (Catchment Area containing rooftop)

$t_c := 5\ min$ (Time of Concentration)

$i := 6.99\ \frac{in}{hr}$ (Rainfall Intensity)

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$c_{grass} := 0.20$ (Runoff coefficient for grass areas)
$c_{imp} := 0.85$ (Runoff coefficient for impervious surfaces)

$Q_{2_Local} := (\langle A_{grass} \cdot c_{grass} \rangle + \langle A_{imp} \cdot c_{imp} \rangle) \cdot i$

$Q_{2_Local} = 1.63 \ \frac{ft^3}{s}$ (Max flow for Inlet 2 and Str. 2 pipe run)

Max flow through Neenah R-4215-C Casting = 6.9 cfs

Existing Structure 2:

$Str.3_Rim := 730.13 \ ft$ (Rim Elevation for Str. 3)

$A_{grass} := 14542 \ ft^2 = 0.33 \ acre$
$A_{imp} := 29250 \ ft^2 = 0.67 \ acre$

$t_c := 5 \ min$ (Time of Concentration)

$i := 6.99 \ \frac{in}{hr}$ (Rainfall Intensity)

$c_{grass} := 0.20$ (Runoff coefficient for grass areas)

$c_{imp} := 0.85$ (Runoff coefficient for impervious surfaces)

$Q_{3_Local} := (\langle A_{grass} \cdot c_{grass} \rangle + \langle A_{imp} \cdot c_{imp} \rangle) \cdot i$

$Q_{3_Local} = 4.49 \ \frac{ft^3}{s}$ (Max flow for Inlet 3 and Str. 3 pipe run)

Max flow through Neenah R-4215-C Casting = 6.9 cfs

$cover := 2.03 \ ft$

$Invert_In(SE) := 727.05 \ ft$ (Invert In for 12" HDPE from Str. 1 to the SE)

$Invert_In(NW) := 726.93 \ ft$ (Invert In for 12" HDPE from Exist Str. to the NW)

$Invert_Out := 726.90 \ ft$ (Invert Out Elev. for Str. 3 18" HDPE to the NE)

$\Delta_{3toD.S.} := 105 \ ft \cdot 1.25\% = 1.31 \ ft$ (Pipe Slope From Str. 3 to the End Section.)

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$D.S._{Elev} := Invert_{Out} - \Delta_{3toD.S.}$

$D.S._{Elev} = 725.59\ ft$

$Q_{3_Total} := Q_{1_Local} + Q_{2_Local} + Q_{3_Local}$

$Q_{3_Total} = 7.66\ \frac{ft^3}{s}$

Q_max through 15" HDPE @ 1.25% = 7.82 cfs & Vel._max = 6.37 fps

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Stormwater Calculations

Rational Method - Pre/Post Conditions Comparison

Existing Conditions

$A_{imp} := 8.64\ acre$ $\qquad$ $c_{imp} := 0.85$

$A_{grass} := 5.75\ acre$ $\qquad$ $c_{grass} := 0.20$

$A_{woods} := 12.31\ acre$ $\qquad$ $c_{woods} := 0.20$

$A_{total} := A_{imp} + A_{grass} + A_{woods} = 26.7\ acre$

Assuming Tc = 5.0 min.

$i_{10} := 6.99\ \frac{in}{hr}$ $\qquad$ $i_{100} := 9.69\ \frac{in}{hr}$

$Pre_Q_{10} := \left(\left(A_{imp} \cdot c_{imp}\right) + \left(A_{grass} \cdot c_{grass}\right) + \left(A_{woods} \cdot c_{woods}\right)\right) \cdot i_{10}$

$Pre_Q_{10} = 77.22\ \frac{ft^3}{s}$

$Pre_Q_{100} := \left(\left(A_{imp} \cdot c_{imp}\right) + \left(A_{grass} \cdot c_{grass}\right) + \left(A_{woods} \cdot c_{woods}\right)\right) \cdot i_{100}$

$Pre_Q_{100} = 107.05\ \frac{ft^3}{s}$

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Stormwater Calculations

Rational Method - Pre/Post Conditions Comparison

Proposed Conditions

$A_{imp} := 8.98\ acre$ $\qquad$ $c_{imp} := 0.85$

$A_{grass} := 5.41\ acre$ $\qquad$ $c_{grass} := 0.20$

$A_{woods} := 12.31\ acre$ $\qquad$ $c_{woods} := 0.20$

$A_{total} := A_{imp} + A_{grass} + A_{woods} = 26.7\ acre$

Assuming Tc = 5.0 min.

$i_{10} := 6.99\ \frac{in}{hr}$ $\qquad$ $i_{100} := 9.69\ \frac{in}{hr}$

$Post_Q_{10} := \left(\left(A_{imp} \cdot c_{imp}\right) + \left(A_{grass} \cdot c_{grass}\right) + \left(A_{woods} \cdot c_{woods}\right)\right) \cdot i_{10}$

$Post_Q_{10} = 78.78\ \frac{ft^3}{s}$

$Post_Q_{100} := \left(\left(A_{imp} \cdot c_{imp}\right) + \left(A_{grass} \cdot c_{grass}\right) + \left(A_{woods} \cdot c_{woods}\right)\right) \cdot i_{100}$

$Post_Q_{100} = 109.21\ \frac{ft^3}{s}$

$\frac{Post_Q_{10}}{Pre_Q_{10}} = 1.02$ $\qquad$ $\frac{Post_Q_{100}}{Pre_Q_{100}} = 1.02$

*Net increase of 1.56 cfs (+/- 2.0%) in 10 yr. scenario
& Net increase of 2.16 cfs (+/- 2.0%) in 100 yr. scenario

NEGLIGBILE INCREASE WITH NO DETRIMENTAL IMPACTS TO RECEIVING WATERS

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Free Online Manning Pipe Flow Calculator

Manning Formula Uniform Pipe Flow at Given Slope and Depth

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Johnson County New Training Facility

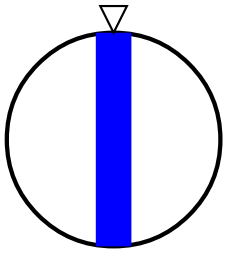
Str. 1

Set units: m mm ft inches

Pipe diameter, d_0	12	inches
Manning roughness, n ?	.012	
Pressure slope (possibly ? equal to pipe slope), S_0	.27	% rise/run
Percent of (or ratio to) full depth (100% or 1 if flowing full)	100	%

Results:

Flow, q	2.0054	cfs
Velocity, v	2.5534	ft/sec
Velocity head, h_v	0.1013	ft
Flow area	0.7854	ft^2
Wetted perimeter	3.1416	ft
Hydraulic radius	0.2500	ft
Top width, T	0.0000	ft
Froude number, F	0.00	
Shear stress (tractive force), tau	0.1686	psf



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Free Online Manning Pipe Flow Calculator

Manning Formula Uniform Pipe Flow at Given Slope and Depth

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Johnson County New Training Facility

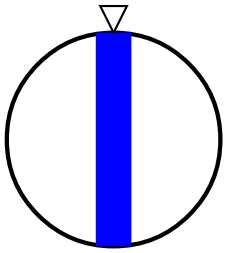
Existing Str. No. 2

Set units: m mm ft inches

Pipe diameter, d_0	15	inches
Manning roughness, n ?	.012	
Pressure slope (possibly ? equal to pipe slope), S_0	1.2	% rise/run
Percent of (or ratio to) full depth (100% or 1 if flowing full)	100	%

Results:

Flow, q	7.6653	cfs
Velocity, v	6.2464	ft/sec
Velocity head, h_v	0.6064	ft
Flow area	1.2272	ft^2
Wetted perimeter	3.9270	ft
Hydraulic radius	0.3125	ft
Top width, T	0.0000	ft
Froude number, F	0.00	
Shear stress (tractive force), tau	0.9366	psf



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