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TECHNICAL MEMORANDUM

To: Town of Greentown and Howard County, Indiana

From: Wessler Engineering

Date: August 6, 2018

Subject: J Loop Legal Drain Constructed Marsh Analysis

Project No.: 200017-04-001

1.0 Project Overview

Howard County (County) and the Town of Greentown (Town) has requested a watershed analysis of the J Loop Legal Drain to determine the J Loop's capacity and feasibility of sending additional flow through the downstream section of the legal drain. This analysis is specifically related to the Town's upcoming stormwater improvements project which will include a new stormwater outfall to the J Loop. Refer to the **Attachment 1** for the J Loop Legal Drain Watershed Analysis.

As a result of the J Loop Legal Drain Watershed Analysis review meeting on July 18th with the Town and the County, an alternative solution to the J Loop capacity issues was proposed. The following considers the installation of a constructed marsh to relieve some of the stormwater runoff overtopping the banks of the J Loop Legal Drain under current conditions. A summary of additional scenarios considered and previous analysis results are also listed below.

2.0 Flow Analysis

2.1 J Loop Legal Drain Capacity

The peak runoff rates were determined for each sub-area and the total watershed. The drainage areas were routed through one to four modeled reaches of the J Loop depending on the outfall location of each area. The cross-sections of the J Loop were determined using LiDAR Digital Elevation data obtained from the *Open Topography Spatial Data Portal* and available survey data from past projects in the area. The 10-year, 25-year, and 100-year storms were simulated. The peak flow rate for the total watershed occurred during a 2-hour storm.

Refer to **Table 2-1** below for the results of the peak runoff analysis of the J Loop Legal Drain. The peak flow rates in cubic feet per second (cfs) summarized below are through the last segment of the J Loop prior to the outfall at Wildcat Creek. The weir elevation at the outfall of the Kokomo Reservoir/Wildcat Creek of 814 feet was simulated at the outfall to ensure existing backwater conditions were considered.

Table 2-1: Peak Flow Rates at J Loop Outfall to Wildcat Creek

Scenario	Peak Flow Rates (cfs)		
	10-year	25-year	100-year
1	286	374	545
2	361	467	680
3	362	477	707

Three modeling scenarios were analyzed during the J Loop Legal Drain Watershed Analysis:

1. J Loop Existing Conditions
2. Greentown Northwest Interceptor and J Loop Existing Conditions
3. Greentown Northwest Interceptor and J Loop Improvements

Three additional scenarios were investigated as a part of this analysis:

4. Greentown Northwest Interceptor and a Constructed Marsh Downstream
5. Greentown Northwest Interceptor and a Constructed Marsh Upstream
6. Greentown Northwest Interceptor and a New Two-Stage Ditch Path

2.2 Findings

2.2.1 Scenario 1 – J Loop Existing Conditions

Overall, the hydraulic capacity of the existing ditch is most significantly limited from Wildcat Parkway to Carter Street, where the peak runoff from a 25-year storm event is approximately 344 cfs and the available ditch capacity is 267 cfs. The existing conditions model shows flow overtopping the banks during the 25-year storm event within drainage area DA2. Legal drains are typically designed for the 25-year peak flow. Refer to **Table 2-2** below for a summary of existing undersized segments in the J Loop.

Table 2-2: Scenario 1 (Existing J Loop) Undersized Segment Summary

Segment	Available Capacity (cfs)	Needed Capacity (cfs)
J Loop (Wildcat Culvert to Carter St.)	267.59	343.07
Railroad Culverts	233.41	324.20

2.2.2 Scenario 4 – Greentown Northwest Interceptor and a Constructed Marsh Downstream

A retention pond was modeled at the downstream end of Greentown's Northwest Interceptor Project as part of this analysis. Although the retention pond reduced the peak discharge rate from the interceptor from 125 cfs to 96 cfs, it did not change the downstream water surface elevation. Therefore, more area is required to store the J Loop watershed runoff in order to decrease the downstream water surface elevation to an acceptable level.

According to the NRCS web soil survey, the water table in Greentown is very high, as high as 6 inches below the surface in some areas and is a restriction to be considered when designing

detention basins. Because the water table is so high, an average depth of 4 feet was used when determining the footprint of the proposed constructed marsh.

The parcel located west of the J Loop Legal Drain and Northwest Interceptor Outfall was considered for installation of a constructed marsh to provide the required volume to improve the capacity issues of the J Loop downstream. As a result of the Scenario 4 model and inflow versus outflow calculations, a constructed marsh of approximately 9 acres is required to reduce the peak 25-year flow rate to match the limiting ditch cross-section's capacity (267.59 cfs). Refer to **Attachment 2** for an overview of the proposed constructed marsh footprint and **Table 2-3** below for a summary of undersized segments in the J Loop with the NW Interceptor project and constructed marsh installed.

Table 2-3: Scenario 4 (Existing J Loop + NW Interceptor + Marsh) Undersized Segment Summary

Segment	*Available Capacity (cfs)*	*Needed Capacity (cfs)*
J Loop (Wildcat Culvert to Carter St.)	267.59	259.34
Railroad Culverts	233.41	324.20

Refer to **Figure 2-1** below for a comparison of the water surface elevation in the limiting segment during Scenario 1 and Scenario 4.

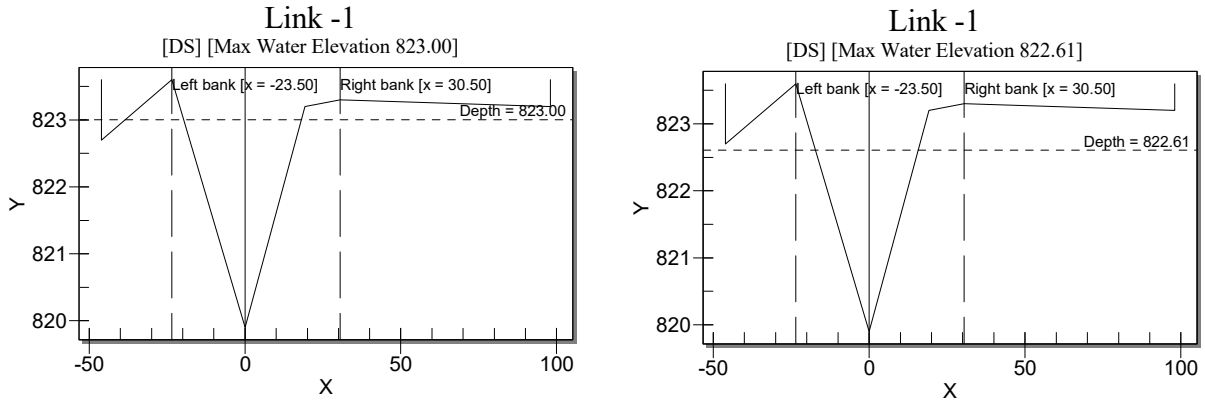

Figure 2-1: Ditch Cross-Sections and Water Surface Elevations

2.2.3 Scenario 5 – Greentown Northwest Interceptor and a Constructed Marsh Upstream

For Scenario 5, a different location was analyzed for the constructed marsh alternative. The proposed marsh location is in DA 5, just northwest of the trailer park. Scenario 5 also requires 9 acres of land for the construction of a detention pond. This alternative was eliminated because it did not reduce the volume of storage needed lower than that of Scenario 4.

2.2.4 Scenario 6 – Greentown Northwest Interceptor and a New Two-Stage Ditch Path

Scenario 6 included rerouting a portion of the flow through a new two-stage ditch that would eventually connect back in to the original flow path at the outfall of the J Loop Legal Drain. This alternative was eliminated because of the slope of the land throughout the proposed path. The

excavation depth would be up to 15 feet in some locations causing the width of excavation to be even wider in order to meet minimum recommended bank side slopes and to serve the runoff generated in the surrounding area.

3.0 Conclusion and Recommendations

The J Loop Legal Drain under current conditions is undersized and restricts flow in multiple locations. There are parcels of farmland to the north of the J Loop that may be purchased to achieve the acreage needed for the installation of Scenario 4. Overall project costs have been estimated for both the previously recommended improvements (Scenario 3) and the additional constructed marsh improvement (Scenario 4). Refer to **Table 3-1** below for a comparison of costs.

Table 3-1: Preliminary Estimates of Project Costs Comparison

Item Description	*Unit*	*Unit Price*	*J Loop Widening*		*Constructed Marsh*	
			Est Qty	*Total Price*	*Est Qty*	*Total Price*
Clear and Grub	ACRE	$1,500.00	27	$40,500	9	$13,500
Mass Cuts	CYD	$10.00	6,112	$61,120	64,534	$645,340
Haul Off Excess	CYD	$15.00	6,112	$91,680	64,534	$968,010
Layout/Staking	LS	$2,500.00	1	$2,500	1	$2,500
Maintenance	MO	$100.00	3	$300	3	$300
Seeding	SYS	$1.50	16,667	$25,000	48,400	$72,600
Blanket	SYS	$2.00	6,400	$32,000	48,400	$96,800
Total Probable Construction Costs				**$253,100**		**$1,799,050**

The costs of constructing the marsh are much higher than widening the J Loop, therefore, the previous recommendation has not changed. The downstream restrictions are still recommended to be upsized to handle the 25-year peak flow. Recommended improvements to the legal drain upstream of the proposed interceptor outfall include:

1. Replacement of the Payton Street culvert at a positive slope consistent with the existing J Loop ditch-line
2. Replacement and upsize of the railroad culvert to twin 60-inch pipes
3. Ditch clearing, regrading, and widening of the J Loop Legal Drain

Recommended improvements to the legal drain downstream of the interceptor outfall include:

1. Ditch clearing, regrading, and widening of the J Loop Legal Drain

END

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ATTACHMENT 1

J LOOP LEGAL DRAIN WATERSHED ANALYSIS

WESSLER ENGINEERING

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TECHNICAL MEMORANDUM

To: Town of Greentown and Howard County, Indiana

From: Wessler Engineering

Date: June 25, 2018

Subject: J Loop Legal Drain Watershed Analysis

Project No.: 200017-04-001

1.0 Project Overview

Howard County (County) and the Town of Greentown (Town) has requested a watershed analysis of the J Loop Legal Drain to determine the J Loop's capacity and feasibility of sending additional flow through the downstream section of the legal drain. This analysis is specifically related to the Town's upcoming stormwater improvements project which will include a new stormwater outfall to the J Loop.

2.0 Flow Analysis

2.1 Runoff Calculations

The J Loop Legal Drain Watershed boundary and soil type information was provided by the County. The watershed was then sub-divided and runoff rates were determined using XP-SWMM modeling software. Refer to **Attachment 1** for an overview of the J Loop Watershed and sub-drainage areas. Hydrographs were generated based on the NRCS TR-55 time of concentration (Tc) and curve number (CN) calculation methodologies. Precipitation frequency estimates for the City of Kokomo provided by NOAA and the Huff Rainfall Distributions were used for hydrograph computations as recommended in the *Indiana LTAP Stormwater Drainage Manual*. Refer to **Table 2-1** below for a summary of the runoff calculation values.

Table 2-1: J Loop Watershed Runoff Calculation Values

Drainage Area	*Area (acre)*	*Curve Number (CN)*	*Time of Concentration (Tc)*	*Downstream Feature*
DA 1	40.0	85	51	Wildcat Creek
DA 2	15.0	82	58	Wildcat Parkway Culvert
DA 3	16.4	84	36	Greentown's Project Outfall
DA 4	20.2	84	54	Carter Street Culvert
DA 5	131.2	86	108	Payton Street Culvert
DA 6	273.0	86	98	CR 850 E

2.2 J Loop Legal Drain Capacity

The peak runoff rates were determined for each sub-area and the total watershed. The drainage areas were routed through one to four modeled reaches of the J Loop depending on the outfall location of each area. The cross-sections of the J Loop were determined using LiDAR Digital Elevation data obtained from the *Open Topography Spatial Data Portal* and available survey data from past projects in the area. The 10-year, 25-year, and 100-year storms were simulated. The peak flow rate for the total watershed occurred during a 2-hour storm.

Three modeling scenarios were analyzed:

1. J Loop Existing Conditions
2. Greentown Northwest Interceptor and J Loop Existing Conditions
3. Greentown Northwest Interceptor and J Loop Improvements

Refer to **Table 2-2** below for the results of the peak runoff analysis of the J Loop Legal Drain. The peak flow rates in cubic feet per second (cfs) summarized below are through the last segment of the J Loop prior to the outfall at Wildcat Creek. The weir elevation at the outfall of the Kokomo Reservoir/Wildcat Creek of 814 feet was simulated at the outfall to ensure existing backwater conditions were considered.

Table 2-2: Peak Flow Rates at J Loop Outfall to Wildcat Creek

Scenario	*Peak Flow Rates (cfs)*		
	10-year	*25-year*	*100-year*
1	286	374	545
2	361	467	680
3	362	477	707

2.3 Findings

2.3.1 Scenario 1 – J Loop Existing Conditions

Under existing conditions, the J Loop Legal Drain serves the watershed without overflowing during the majority of storm events. The 25-year, 2-hour hydrograph peak occurs at 2 hours and 15 minutes through the last segment of the J Loop before the outfall to Wildcat Creek.

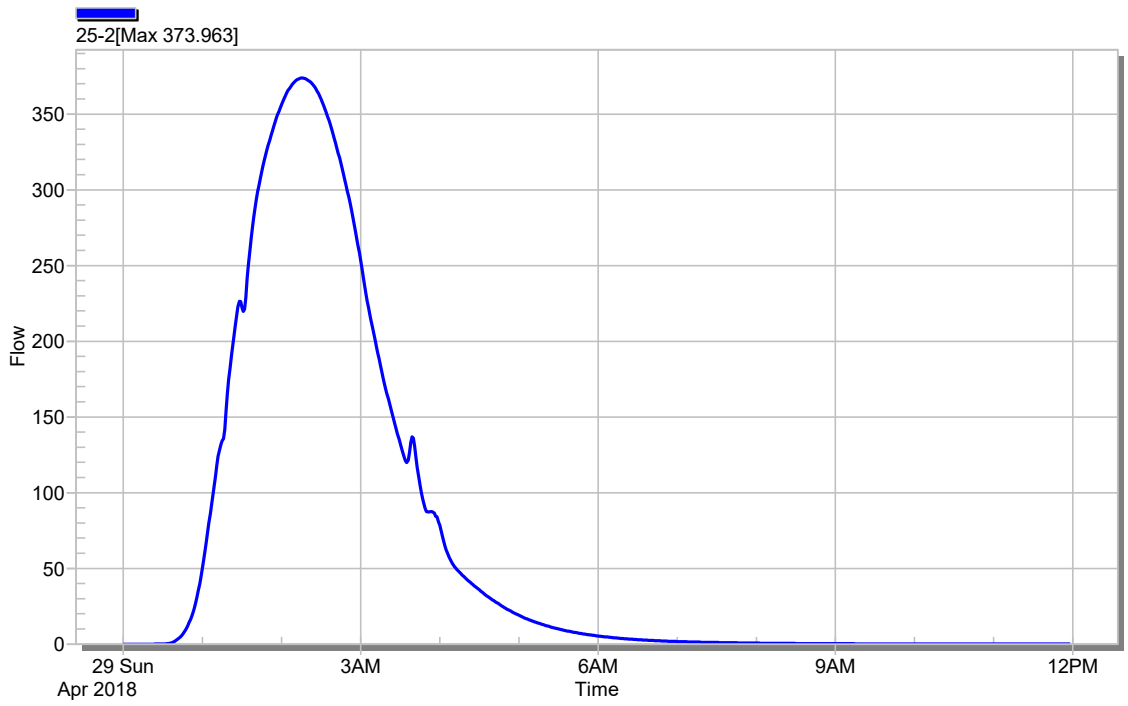

Figure 2-1: Scenario 1 (Existing J Loop) – 25-yr Storm Hydrograph

Problem areas identified include the twin 42-inch culvert crossing the railroad just south of Payton Street. The culvert is undersized and is a bottleneck in the system causing stormwater runoff to back-up and on occasion flood the nearby trailer park (see **Photo No. 2-1**), just east of the J Loop. The twin 42-inch culverts are also susceptible to debris building up at the inverts, as shown in **Photo No. 2-2** below.

While the Payton Street culvert is undersized, the model does not indicate that the existing ditch should overtop during any of the storm events simulated as part of this analysis. On July 11 and 12, 2017, the Town reported the trailer park flooded following the rain events over those two days. It is reported that the standing water level at some locations in the trailer park reached 18-inches. To correlate this known event to the watershed model, rainfall data for those dates was obtained from the Town's wastewater plant daily records and compared to the design storms used in the watershed model. Rainfall totals of 1.77" and 1.56", respectively, was measured on those two days.

While the storm duration was not documented, the total daily rainfalls are both less than the design rainfall depth for a 5-year, 2-hour storm event. Therefore, it is likely that debris accumulation in the culverts, storm sewer system serving the trailer park, or ditch-line, overgrown vegetation, and/or localized high spots in the ditch-line restricted the J Loop capacity sufficient to cause the flooding.

Photo No. 2-1: 6′ X 10′ culvert, looking upstream of J Loop crossing Payton Street

Photo No. 2-2: 6′ X 10′ culvert crossing Payton Street upstream to twin 42″ culverts crossing railroad downstream

Survey data from the Town's *2017 Water Systems Improvements Project* show the culvert crossing Payton Street at a negative slope. The model shows this culvert does not restrict the J Loop's capacity as much as the railroad crossing, but replacement should be considered to correct the slope in the future.

The LiDAR data used indicates that the J Loop's cross-section becomes progressively smaller, from 7 feet deep to 3 feet deep, with similar side slopes throughout. This decrease in ditch cross sectional area and associated flow capacity should be noted. For example, the cross-sectional area of the ditch upstream of Payton Street is approximately 175 square feet, while the cross-sectional area upstream of Wildcat Parkway is approximately 70 square feet.

Overall, the hydraulic capacity of the existing ditch is most significantly limited from Wildcat Parkway to Carter Street, where the peak runoff from a 25-year storm event is approximately 344 cfs and the available ditch capacity is 267 cfs. The existing conditions model shows flow overtopping the banks during the 25-year storm event within drainage area DA2. Legal drains are typically designed for the 25-year peak flow. Refer to **Table 2-3** below for a summary of existing undersized segments in the J Loop.

Table 2-3: Scenario 1 (Existing J Loop) Undersized Segment Summary

Segment	*Available Capacity (cfs)*	*Needed Capacity (cfs)*
J Loop (Wildcat Culvert to Carter St.)	267.59	343.07
Railroad Culverts	233.41	324.2

2.3.2 Scenario 2 – Greentown Northwest Interceptor and J Loop Existing Conditions

Scenario 2 included the addition of the Town's Northwest Interceptor Project to the J Loop existing conditions model. The increase in flow augmented the capacity issues of the undersized downstream segments but did not result in any additional drainage issues. The model showed no ponding along the proposed Northwest Interceptor alignment as a result of the J Loop backing up.

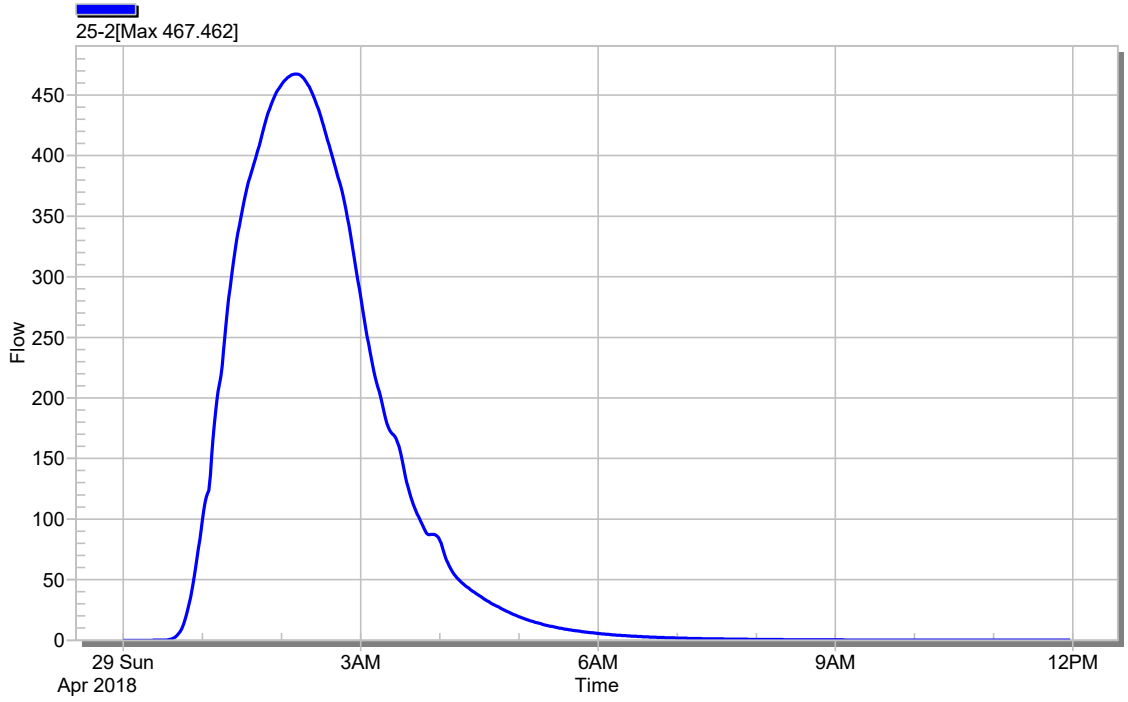

Figure 2-2: Scenario 2 (Existing J Loop + NW Interceptor) – 25-yr Storm Hydrograph

The Northwest Interceptor's outfall hydrograph shows a time to peak of about 1.5 hours and a peak flow of 125 cfs during the 25-year storm event. The interceptor's time to peak is before that of the overall watershed, indicating that peak runoff from the Northwest Interceptor will reach the J Loop before the J Loop's flow peaks at the interceptor's outfall location. Refer to **Table 2-4** below for a summary of undersized segments in the J Loop with the NW Interceptor project installed.

Table 2-4: Scenario 2 (Existing J Loop + NW Interceptor) Undersized Segment Summary

Segment	*Available Capacity (cfs)*	*Needed Capacity (cfs)*
J Loop (Wildcat Culvert to Carter St.)	267	433
Railroad Culverts	233	324

2.3.3 Scenario 3 - Greentown Northwest Interceptor and J Loop Improvements

Scenario 3 included the addition of the Northwest Interceptor Project to the J Loop existing conditions model and all needed improvements to the J Loop Legal Drain to adequately serve the watershed during a 25-year peak storm event. Relieving the bottleneck at Payton Street has a limited but increased effect on the peak flow through the J Loop.

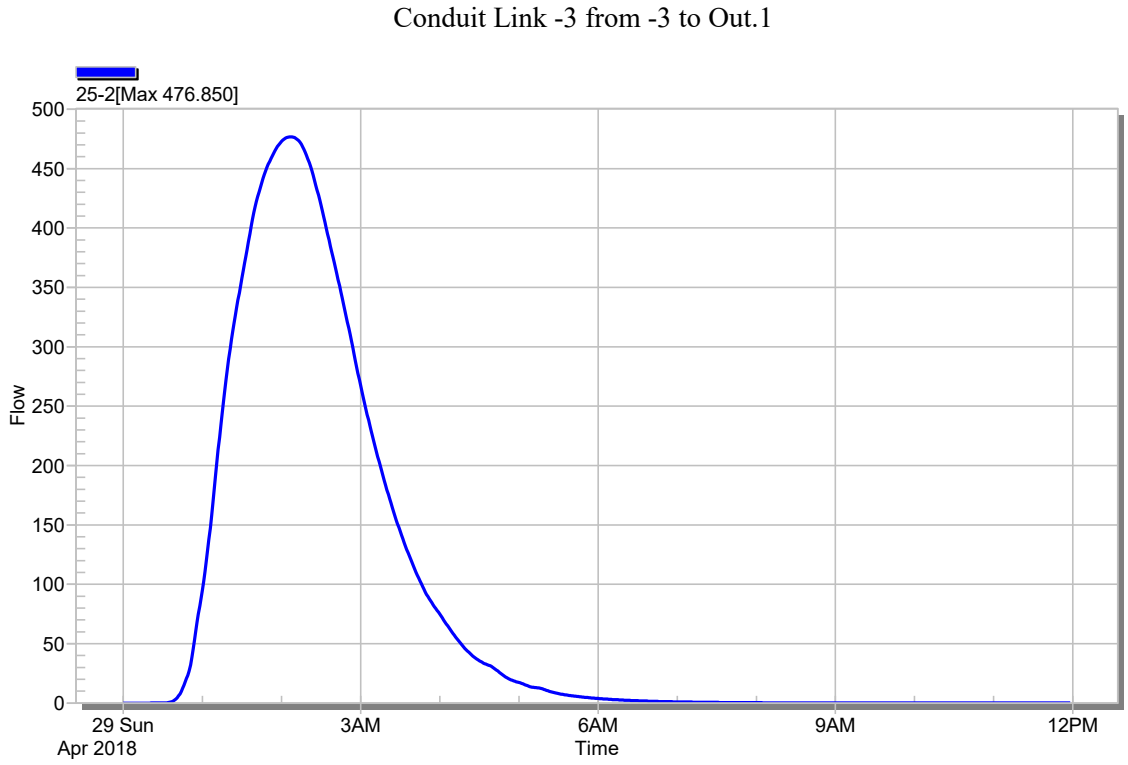

Figure 2-3: Scenario 3 (Upgraded J Loop + NW Interceptor) – 25-yr Storm Hydrograph

The proposed ditch cross section was developed with and without the Northwest Interceptor Flow. Cut volumes were calculated using AutoCAD Civil 3D comparing the LiDAR surface (existing grade) vs the two proposed ditch sections between the Northwest Interceptor Outfall and the Wildcat Creek. The two ditch cross sections are summarized in **Table 2-5** below:

Table 2-5: Scenario 3 Ditch Cross-Section Comparison

Parameter	*Without NW Interceptor*	*With NW Interceptor*
Stage 1 Width	6′	6′
Stage 1 Depth	2′	2′
Stage 1 Sideslope	3:1	3:1
Stage 2 Width	32′	40′
Stage 2 Depth	1.85′	1.85′
Stage 2 Sideslope	4:1	4:1
Calculated Cut (cys)	4,650	6,112
Linear Footage of Ditch	2,400′	2,400′

The model indicates that the increased ditch cross-section downstream of the Northwest Interceptor Outfall will reduce the 25-year ditch water surface elevation by 0.90′ below the existing conditions.

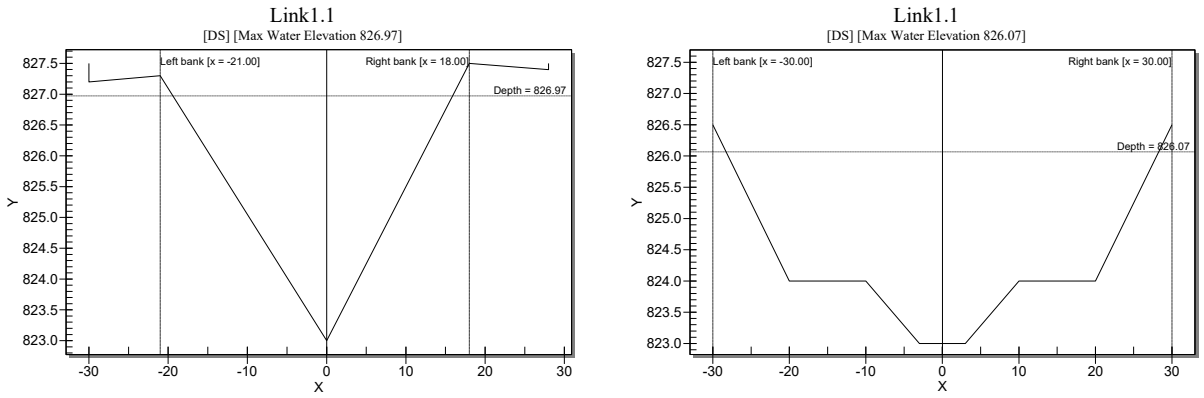

Figure 2-4: Ditch Sections and Water Surface Elevations

A retention pond was also modeled at the downstream end of Greentown's Northwest Interceptor Project as part of this analysis. Although the retention pond reduced the peak discharge rate from the interceptor from 125 cfs to 96 cfs, it did not change the downstream water surface elevation.

3.0 Conclusion and Recommendations

The J Loop Legal Drain under current conditions is undersized and restricts flow in multiple locations. These restrictions are recommended to be upsized to handle the 25-year peak flow.

Recommended improvements to the legal drain upstream of the proposed interceptor outfall include:

1. Replacement of the Payton Street culvert at a positive slope consistent with the existing J Loop ditch-line
2. Replacement and upsize of the railroad culvert to twin 60-inch pipes
3. Ditch clearing, regrading, and widening of the J Loop Legal Drain

Recommended improvements to the legal drain downstream of the interceptor outfall include:

1. Ditch clearing, regrading, and widening of the J Loop Legal Drain

Refer to **Attachment 2** for an overview of the proposed improvements to the J Loop Legal Drain.

The minimum cross-section required to serve the J Loop watershed and Northwest Interceptor service area is approximately 60 feet wide from top-of-bank to top-of-bank. The proposed cross-section is fairly consistent throughout the length of J Loop improvements. Erosion and sediment control will be required during construction. Refer to **Attachment 3** for the typical proposed versus existing cross-section.

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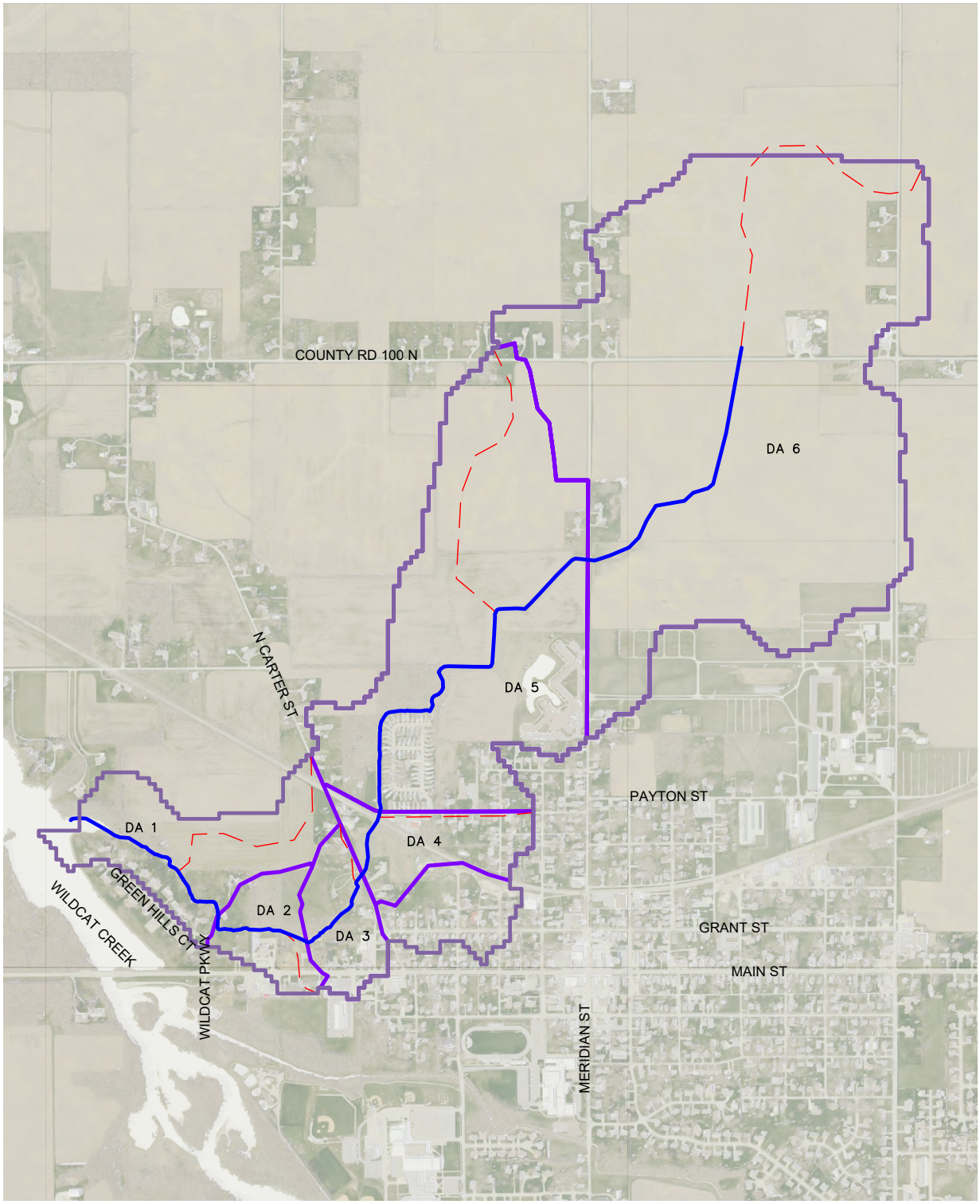

ATTACHMENT 1
J LOOP WATERSHED OVERVIEW

LEGEND:

- TIME OF CONCENTRATION PATH
- DRAINAGE AREAS
- J LOOP LEGAL DRAIN

J Loop Legal Drain
Watershed Analysis
Town of Greentown, Indiana

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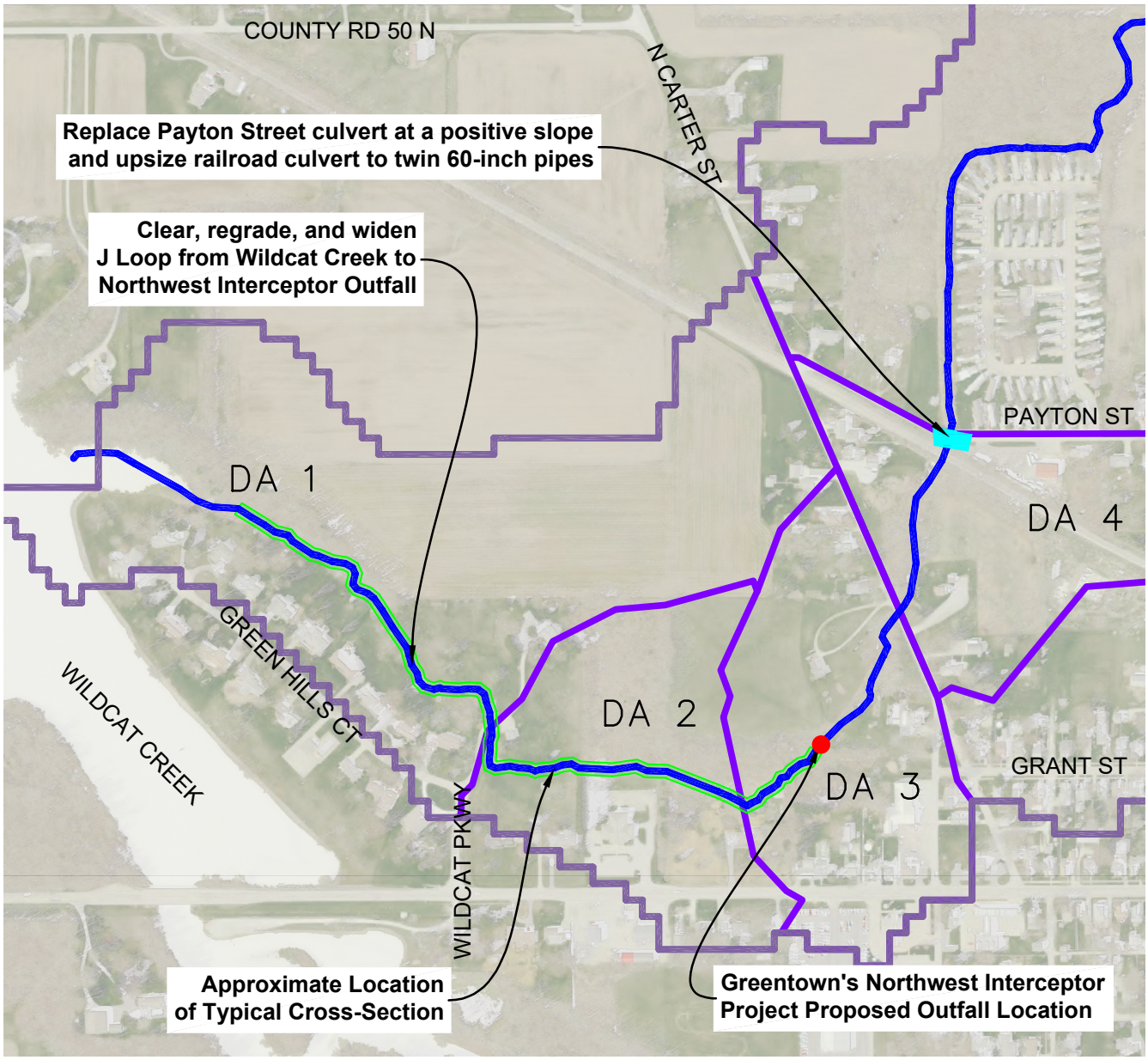

ATTACHMENT 2
J LOOP IMPROVEMENTS

J Loop Legal Drain
Watershed Analysis
Town of Greentown, Indiana

LEGEND:

DRAINAGE AREAS

J LOOP LEGAL DRAIN

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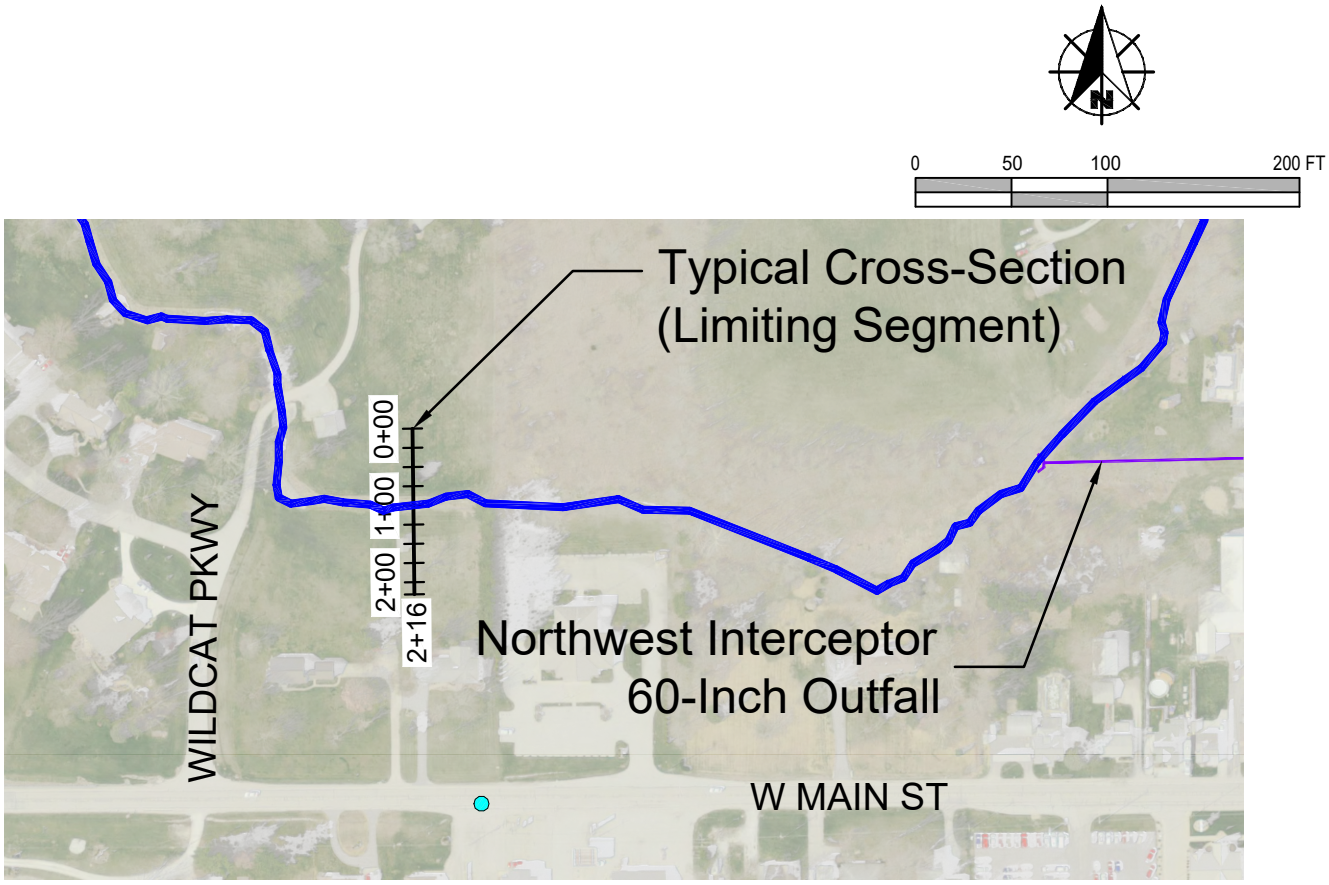

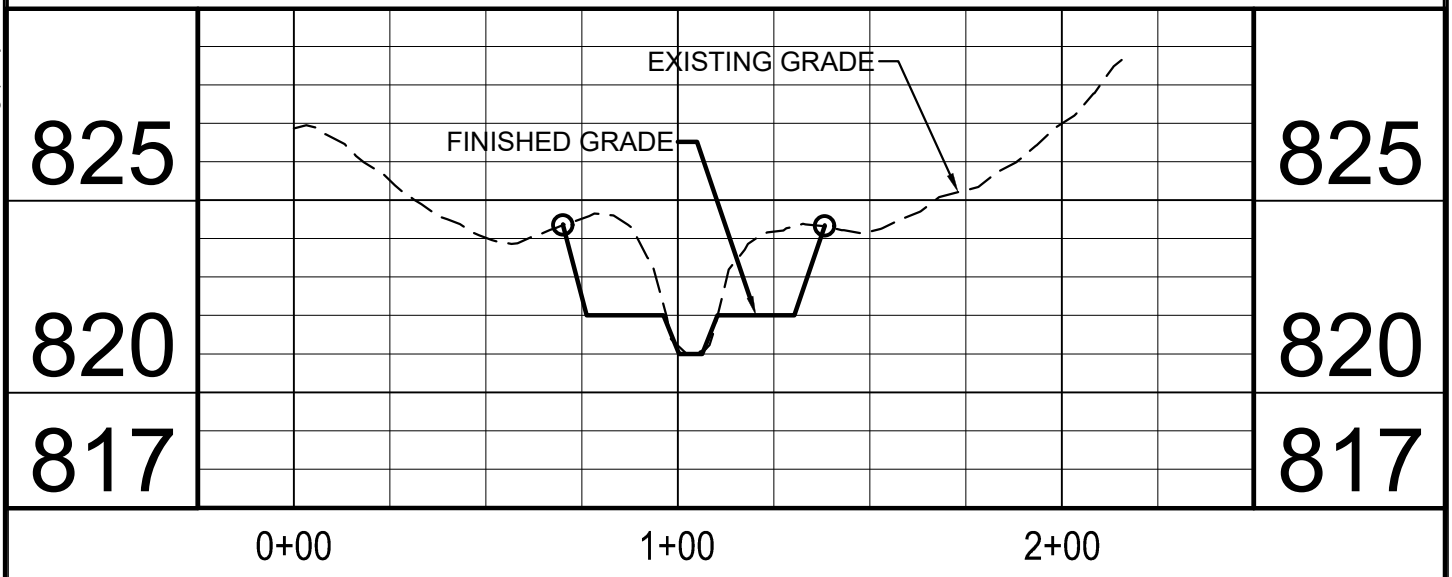

PROFILE - TYPICAL CROSS-SECTION

HORIZ SCALE: 1" = 50'
VERT SCALE: 1" = 5'

ATTACHMENT 3
TYPICAL CROSS-SECTION

J Loop Legal Drain
Watershed Analysis
Town of Greentown, Indiana

June 2018
200017-01-001
PG. 1

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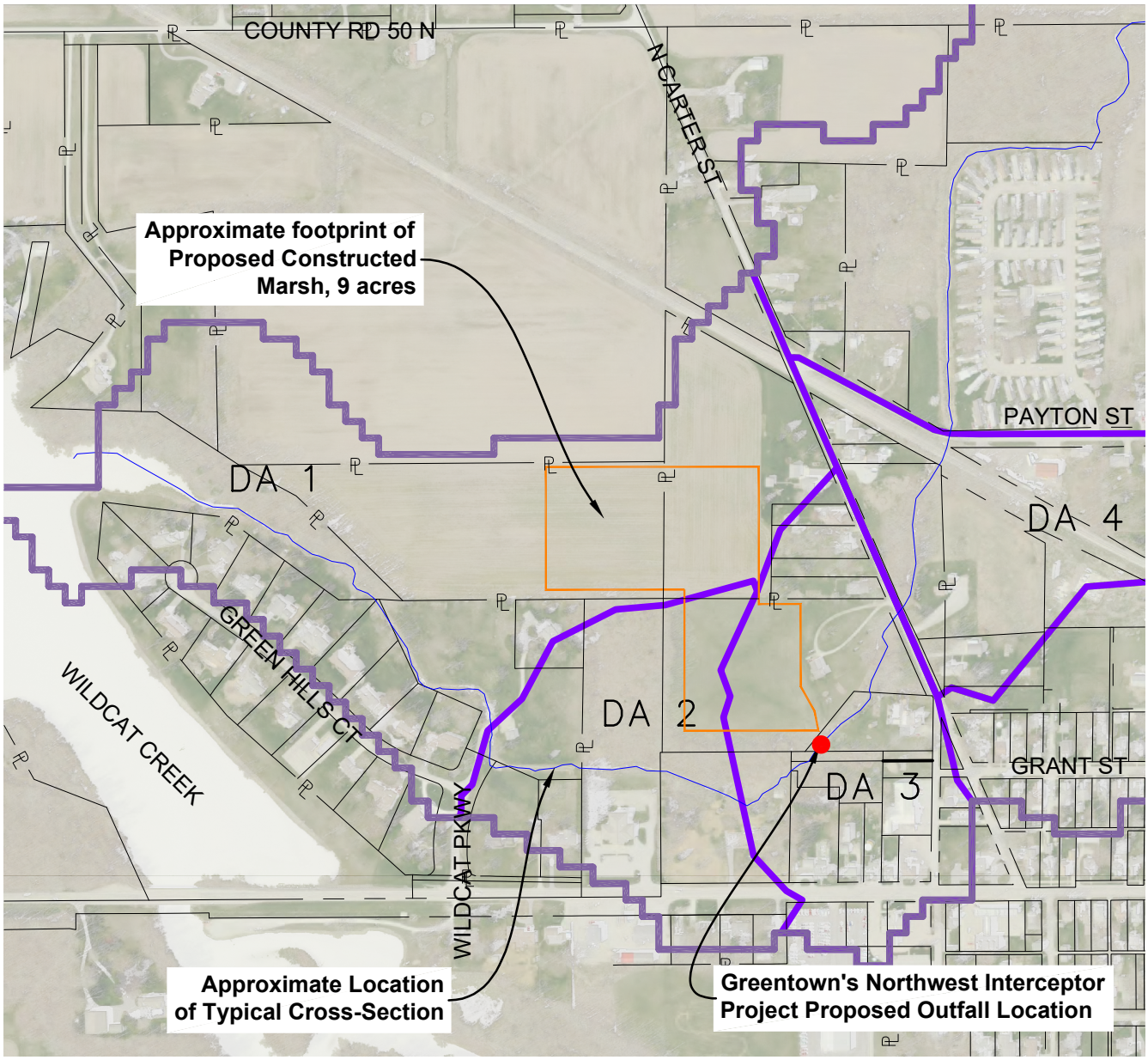
ATTACHMENT 2

SCENARIO 4 - MARSH FOOTPRINT



ATTACHMENT 2
MARSH FOOTPRINT

J Loop Legal Drain
Watershed Analysis
Town of Greentown, Indiana

LEGEND:

- DRAINAGE AREAS
- J LOOP LEGAL DRAIN
- PROPOSED CONSTRUCTED MARSH

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