Big Cicero Creek
Flood Control Study

VOLUME 1

Tipton County

Prepared for

Big Cicero Creek Joint Drainage Board
101 East Jefferson Street
Tipton, Indiana 46072

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CBBEL Project No. 05-640

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EXECUTIVE SUMMARY

This report presents the Big Cicero Creek Flood Control Plan developed by Christopher B. Burke Engineering (CBBEL) for the Big Cicero Creek Joint Drainage Board (Board). The report presents alternatives formulated to mitigate known flooding problems along Big Cicero Creek. The focus of this study was the flooding issues from County Road 500 West downstream through the City of Tipton.

The Big Cicero Creek watershed area is approximately 80 square miles at the confluence with Buck Creek in the City of Tipton and 135 square miles at the upstream limit of Morse Reservoir. Most of the watershed is in Tipton County. Flooding often lasts up to several days at a time in the agricultural areas and backwater from Big Cicero Creek affects several residences along Buck Creek on the west side of town. Big Cicero Creek also floods streets and roads in Tipton and in the county.

Several alternatives were identified during the public information meeting, discussions with local officials, and during CBBEL's analysis. The alternatives were evaluated using the project performance criteria presented in **Chapter 3**. This evaluation narrowed the list to 34 promising options or combinations of options that were evaluated in detail. For the detailed evaluation, CBBEL staff developed hydrologic and hydraulic models of the watershed and modified the computer models to analyze the promising options. The detailed evaluation resulted in the selection of a set of recommended plan components as most appropriate for meeting the established performance criteria. Those recommended plan components are presented below. A limitation on available funding was an important factor in selecting the recommended plan components. Therefore, should additional funding become available in the future, the various options documented in this report should be considered again in light of the additional available funding.

RECOMMENDED PLAN COMPONENTS

1. Extend the hydraulic modeling downstream to evaluate the downstream impacts of the recommended plan. Include 500-year profile and floodway calculations allow for direct inclusion in the future update of the countywide Flood Insurance Study (FIS) mapping for Tipton County. The estimated cost of this component is about $60,000.

2. Complete a channel improvement project by constructing a 30-foot wide overbank shelf at an elevation 3-feet above the existing channel invert. The channel improvement would extend from about 2800' downstream of Tobin Ditch up to County Road 400 South. The estimated cost of this component is about $ 2.6 million.

3. Provide a copy of floodplain mapping and expected water surface elevations developed during this study to local planning officials and the Indiana Department of Natural Resources (IDNR) to assist in guiding future development away from areas of flood risks.

4. Amend existing floodplain and stormwater ordinances to include “no net loss floodplain storage” requirement and updated, on-site detention requirements, and strictly enforce these and other requirements in the updated ordinances. If runoff volumes are increased or present storage and flow capacity are not maintained, the benefits derived from other recommended plan components will be lost. Another component of the amended ordinances would be to require that all bridge construction/replacement be designed such that the 100-year and more frequent flood elevations are not increased.

5. Coordinate with the USGS to maintain the existing stream gage located in the vicinity of Arcadia and to add two additional gages along Big Cicero Creek and one on Prairie Creek. The estimated cost of this component would be about $30,000 for the installation of three new gages and about $15,000 per year for ongoing maintenance costs. This estimate assumes USGS funding 50% of the annual maintenance costs and no USGS funding for installation.

1.0 PROJECT OVERVIEW

1.1 INTRODUCTION

Analysis of the watershed included discussions with Drainage Board members, County staff, and interested citizens to determine the extent and nature of the flooding problems. CBBEL staff also developed a hydrologic model of the watershed and updated and extended the regulatory hydraulic model.

Some upstream portions of the Big Cicero Creek watershed are in Clinton, Boone, and Hamilton Counties. Water flows from these counties into the southwest part of Tipton County, through the town of Tipton, back into Hamilton County and empties into Morse Reservoir. The Big Cicero Creek watershed area is approximately 80 square miles at the confluence with Buck Creek in the City of Tipton and 135 square miles at the upstream limit of Morse Reservoir. Most of the watershed is in Tipton County. **Figure 1** shows the approximate watershed boundary for Big Cicero Creek**.** Big Cicero Creek is a County regulated drain, as are many of its tributaries.

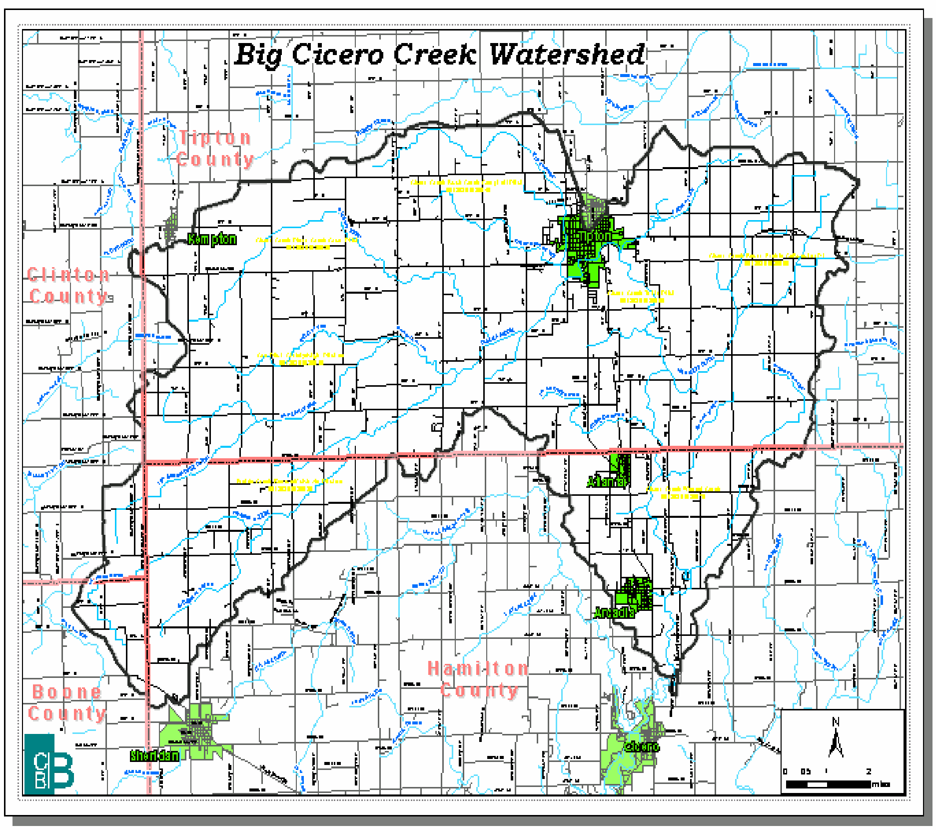


Figure 1: Big Cicero Creek Watershed Boundary

1.2 PURPOSE AND SCOPE

The main purpose of this study is to present alternatives to mitigate known flooding problems along Big Cicero Creek from County Road 500 West downstream through the City of Tipton. This area often experiences flooding that lasts up to several days at a time. The study focused on analyzing the amount of flow in Big Cicero Creek for various frequency floods, calculating the capacity of the existing creek from CR 500 West through the City of Tipton, identifying the existing flooding problems, and using the analysis to recommend solutions to the identified flooding problems.

The scope of services included the following tasks:

- Review of available studies done previously by others for projects in this watershed, and meeting with Tipton County and City officials to collect available information and to identify known flooding problems.

- Collecting additional field survey/structure data, as may be needed.

- Conducting field visits to verify the existing site conditions and features in the watershed and along the study reach.

- Developing hydrologic and hydraulic modeling of the watershed and Big Cicero Creek to analyze existing and proposed conditions. The hydrologic model was developed for the entire Big Cicero Creek watershed. The hydraulic model includes the reach of the Creek from County Road 500 West through the City of Tipton.

- Hydrologic and hydraulic modeling to simulate the stormwater flow along the existing creek and prepare a map showing the flooded areas resulting from the 2-, 10-, and 100-year storms. The documentation and hydraulic model was developed as required for the results to be incorporated as a leveraged study in the future countywide flood insurance study that is currently scheduled for completion by the Indiana Department of Natural Resources (IDNR) in 2008.

- Conducting one public information meeting in the City of Tipton. The meeting provided an opportunity for the public to present their perspective on the flooding problems, location of problems, potential information sources, historic flood information, and other issues. This meeting was held after completion of the initial floodplain modeling of the Creek.

- Establishing flood control/flood protection goals and develop evaluation criteria (technical, environmental, institutional, and economic) for screening and evaluating various flood protection alternatives.

- Completing detailed evaluations of the performance of various alternative solutions for identified problem areas. These detailed evaluations included additional hydrologic and hydraulic modeling of the proposed project conditions. Each proposed alternative was documented and explained.

- Completing an overall assessment and final screening of alternatives using the evaluation criteria. This resulted in recommending the most appropriate alternatives as proposed plan components.

- Preparing a conceptual plan and preliminary opinion of estimated cost for each proposed plan component.

- Preparing an implementation plan that includes a recommended sequential list of activities and projects.

- Developing a comprehensive report documenting the study and its results. This report includes exhibits, technical results, and appropriate appendices.

1.3 ORGANIZATION OF THIS DOCUMENT

This report is contained in two volumes. Volume 1 is divided into several chapters, sections, and appendices that generally describe the analysis of various alternatives for reducing the present flood problems. Volume 2 contains the detailed descriptions of the hydrologic and hydraulic modeling used to evaluate the various alternatives to reduce flooding and is intended for separate submittal to IDNR for incorporating the updated data into future flood maps. A brief summary of the contents of each chapter in Volume 1 is presented below:

- Chapter 1, **Introduction**, presents the purpose and scope of the project and a description of the project location.

- Chapter 2, **Data Collection**, summarizes information gathered from regulatory agencies, previous studies, and other sources.

- Chapter 3, **Problem Definition and Project Performance Criteria**, provides a clear definition of flooding problems and summarizes the criteria used to evaluate the suggested alternative solutions.

- Chapter 4, **Computer Modeling**, presents the methodology, assumptions, and data used to calculate peak flow rates and flood elevations along Big Cicero Creek for existing conditions and proposed alternatives.

- Chapter 5, **Initial Screening of Possible Alternative Solutions**, provides a listing of potential alternatives considered, explains whether the identified alternative should be carried to the short list of alternatives, and presents a short list of alternatives to be evaluated in detail.

- Chapter 6, **Detailed Evaluation of Alternatives**, provides a brief description of each short-listed alternative, summarizes the results of the detailed evaluation of each, and recommends whether the alternative should be included as a component of the recommended plan.

- Chapter 7, **Formulation of a Recommended Plan**, provides a summary of the recommended plan components.

- Chapter 8, **Implementation Plan**, provides a prioritized list of actions to be followed and a suggested timeline.

2.0 DATA COLLECTION

Data used in this study was collected from the Joint Drainage Board, Tipton County and Hamilton County staff, the Indiana Department of Natural Resources (IDNR), United States Geological Survey (USGS), Natural Resource Conservation Service (NRCS), EarthData, and the Federal Emergency Management Agency (FEMA). Each data source is listed below, along with the data obtained from that source:

Source	Data Provided
Indiana Department of Natural Resources (IDNR)	• Regulatory hydraulic model (HEC-2) • Coordinated Discharge Graph titled Big Cicero Creek • Coordinated Point Discharges at Arcadia • Historic Profile for Big Cicero Creek, June 1957 and January 1962 floods • B17B analysis of USGS gage records through 2003
City of Tipton, Indiana Flood Insurance Study (FIS) dated March 5, 1996	• Flood profiles • Flood Insurance Rate Maps • Floodway Data Tables, and other information
Tipton County Surveyor	• Tipton county watershed map (1994) • Various flood photos • Railroad Right-of-Way maps showing culverts through the RR bed • Regulated drain reconstruction plans for Cox, Dixon, and Crum Ditch (1/2001, 3/1984) • Bridge inventory information for the structures inventoried over Big Cicero Creek (most recent inventory as of May, 2006)
Hamilton County Surveyor	• Channel and some bridge deck survey information (February, 2005)

USGS	• Peak flow data at area gages • Daily Mean Discharges at Big Cicero Ck at/near Arcadia gage • Digital 10’ Contour interval quad mapping for watershed portions of Tipton, Clinton, and Boone Counties • 1999 National Land Cover Dataset
EarthData	• Digital 2’ contour interval mapping for a 4000’ wide corridor of the study reach of the creek (developed as part of the study and received May, 2006)
Natural Resource Conservation Service (NRCS) SSURGO	• Digital Soils data Boone County (12/6/05) Clinton County (8/1/05) Hamilton County (12/22/01) Tipton County (12/6/05)
National Climatic Data Center	• Historic hourly rainfall for area gages

3.0 PROBLEM DEFINITION AND PROJECT PERFORMANCE CRITERIA

This chapter presents the nature, type, and severity of the problems identified along Big Cicero Creek. This study focused specifically on flooding issues in the town of Tipton and agricultural areas between the City and County Road 500 West. This area is highlighted on the map in **Figure 2**.

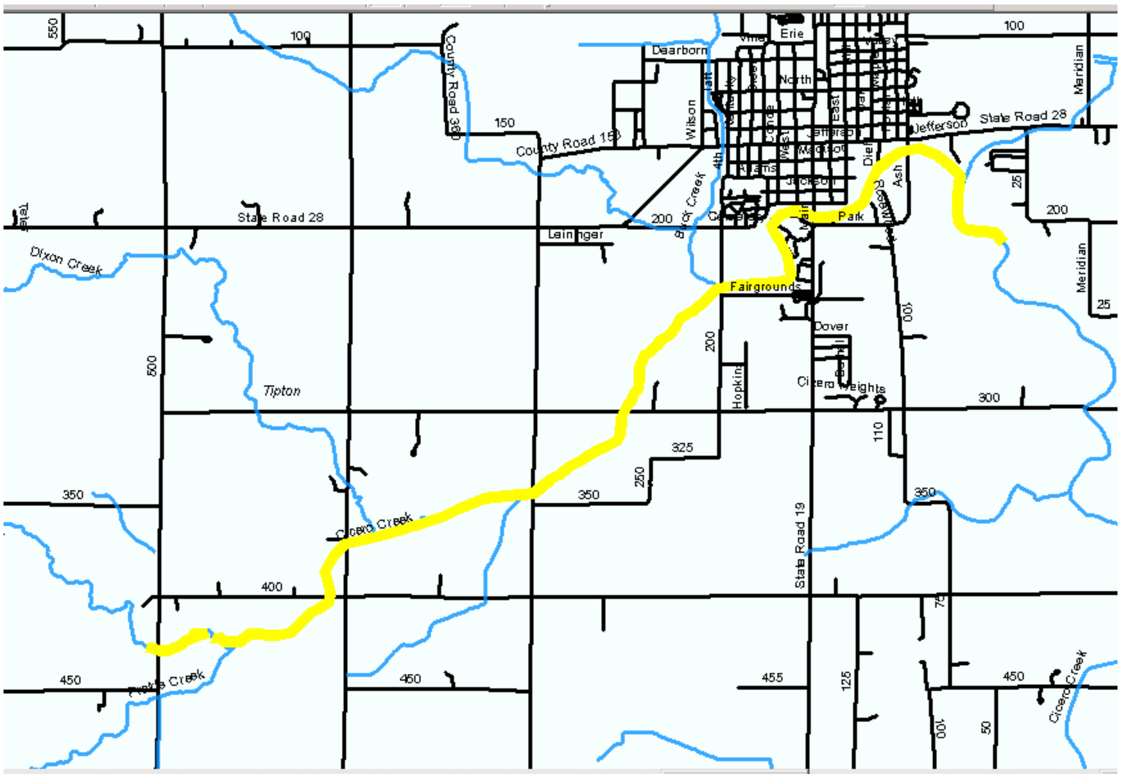


Figure 2: Highlighted Area Shows Reach of Big Cicero Creek to be Studied

3.1 PROBLEM DEFINITION

The Big Cicero Creek watershed is mainly agricultural. A significant number of open and closed drains have been constructed and reconstructed over the years to drain the ground for farming. Portions of the upper watershed are in Hamilton, Clinton, and Boone Counties. As stormwater from the upper watershed travels downstream, it combines into several tributaries before joining Big Cicero Creek. The larger tributaries include Buck Creek, Dixon Creek, Cox Ditch, and Prairie Creek. Prairie Creek joins Big Cicero Creek a short ways downstream of CR 500 West. Buck Creek enters Big Cicero Creek on the west side of Tipton. The creek enters Hamilton County again a few miles downstream of Tipton and ultimately flows into Morse Reservoir.

Based on the computer modeling, approximately 860 acres of agricultural area are flooded by the 2-year flood and 1300 Acres by the 10-year flood. Assuming the flooding causes a reduction in yield on a typical corn field of 100 bushel per acre and the price per bushel of corn was $2.25, this would mean $193,500 in crop loss every other year, or almost $100,000 per year, on the average.

According to the Tipton County Surveyor, the worst flooding problems are along Buck Creek in Tipton (due to backwater from Big Cicero Creek) and along Big Cicero Creek upstream (southwest) of town.

Figure 3: Looking South on Fourth Street Towards Adams Street

Tipton residents living west of SR 19 and south of SR 28 voiced concerns about how much water is frequently on their property and the problems caused when it gets up in the crawl spaces of their homes. Water gets into heating ducts. Mold is another common problem. One home near Second Street and Adams Street has been condemned because flood waters moved it off its foundation. Residents also noted that hydrostatic pressure sometimes forces water to back up into their basements. When flood waters finally recede, yards and park property are typically damaged and covered with corn stalks and other debris from upstream. Residents also expressed concern that low areas that currently hold water in the field north of the cemetery would be filled and worsen the flooding on their properties.

Figure 4: Looking North from CR 300 South Across Field Towards Cicero Creek

Farmers along the creek voiced concerns about various problems that the flooding causes for them. They explained that if their crops are flooded for one day, they will recover, two days and there is some damage, three days and the crops are destroyed. The length of time water is on their crops is longer than the time the creek is out of its banks. In many areas, once water gets out of the banks it sits on the fields until it drains out through field tiles, which does not happen until the creek recedes. Another problem is that water sometimes flows across the fields fast enough to knock the crops over and destroy them.

Farmers and City of Tipton residents suggested that due to cleaning out upstream tributaries, water is now able to leave upstream drainage areas much faster and has solved some of the flooding problems previously experienced in those areas. However, when stormwater gets to Big Cicero Creek, there is not enough capacity to adequately convey the water downstream. The result is frequent flooding of overland areas downstream of the reaches that were cleaned out.

Figure 5: Looking West Towards Cicero Creek Along CR 300 South

The County Highway Department has also experienced problems due to the extensive flooding of the roadways. Flooding causes road bases to become saturated resulting in surface failures. There are also safety concerns because people will frequently attempt to drive through flooded roads and risk being washed off the road or driving off the road into the side ditches. They have also had problems with ice on the roadways for extended periods after flooding in the winter.

Areas downstream of Tipton reportedly do not have flooding problems, probably due to the large, well-defined channel along the lower reach.

Over the years, some efforts have been made to reduce the flooding including removal of beaver dams and clearing of log jams and other debris in the creek. However, most people believe the creek needs a major cleaning and increased capacity to properly convey stormwater flows.

3.2 PROJECT PERFORMANCE CRITERIA

Based on the nature and extent of flooding problems described above, criteria were developed to aid in the formulation of proposed projects and to screen alternatives. The following is a summary of the technical, environmental, institutional, and economic criteria used to formulate and/or screen proposed alternatives.

3.2.1 Technical Criteria

- The recommended plan should protect residential structures from the 100-year frequency storm.
- The recommended plan should eliminate flooding of roads from Big Cicero Creek flood waters during the 100-year frequency storm.
- The recommended plan must prevent increased future damage potential as a result of flooding.
- The recommended plan must reduce the frequency of flooding of agricultural areas along Big Cicero Creek upstream of Tipton to an average of no more than once every ten years.
- The recommended improvement plan must not increase the frequency with which any area is flooded.
- The recommended improvement plan must minimize maintenance requirements.

3.2.2 Environmental Criteria

- The recommended improvement plan must not have significant and /or permanent negative impacts on the environment, recreational opportunities, and/or fish and wildlife resources.

3.2.3 Institutional Criteria

- The recommended improvement plan must be acceptable to City of Tipton and Tipton County officials and the affected residents of Tipton and unincorporated areas of Tipton County.

- The recommended improvement plan must be permittable under existing federal, state, and local permit programs.

3.2.4 Economic Criteria

- The recommended improvement plan must be fundable and should significantly reduce the economic damages resulting from flood events. Per discussions with County Surveyors, the cost of acquiring agricultural land for construction of any recommended plan will be evaluated at $4,500 per acre. Residential acreage will be evaluated at $50,000 per acre.

4.0 COMPUTER MODELING

A comprehensive hydrologic model of the watershed, utilizing the US Army Corps of Engineers (USACE) computer model HEC-HMS, was developed to simulate stormwater runoff and evaluate potential solutions to flooding problems along Big Cicero Creek. Parameters for the model were derived from representative cross-sections from the two-foot contour mapping of Big Cicero Creek, Hamilton County one-foot contour mapping, and drain reconstruction plans for Cox Regulated Drain, Dixon Creek, Crum Drain, and tributaries. Subbasins were delineated using the Hamilton County one-foot contour mapping or the USGS quad 10-foot contour interval mapping in Tipton, Boone, and Clinton Counties.

Because historic high water marks were available for the June 1957 and January 1962 flood events, rainfall data for the corresponding dates was obtained from the National Oceanic and Atmospheric Administration (NOAA) for gages in Burlington, Tipton, Anderson, Lebanon, Hartford, Noblesville, and Frankfort. The June 1957 flood discharge at the Big Cicero Creek at Arcadia gage was close to a 100-year frequency storm. The 1962 flood was between a 5- and 10-year frequency storm. For the frequency storms, the NOAA Atlas 14 rainfall depths and 24 and 48 hour distributions were specified.

The computer model was calibrated to the June 1957 and January 1962 events within the limits of available data and model capabilities. A more detailed explanation of the hydrologic modeling process is included in **Volume 2** of this report. New values for the frequency discharges used in the FEMA Flood Insurance Study (FIS) models were determined to be necessary. These values are listed in **Volume 2**.

A new hydraulic model, utilizing USACE computer model HEC-RAS, was developed from about 3,000 feet downstream of the Tobin Ditch confluence upstream to County Road 500 West (approximately 7 miles) to calculate existing flood profiles and also to evaluate the impact of proposed flooding solutions. Cross-section geometric data for the hydraulic model was taken from the 2-foot contour mapping of Big Cicero Creek generated by EarthData, supplemented with field surveyed channel cross sections by staff from the Hamilton County Surveyor’s Office. The USGS quad maps were used for additional data beyond the limits of the 2’ contour mapping. Bridge information was taken from the Tipton County Bridge Inventory, Indiana Department of Transportation (INDOT) plans for the SR 19 bridge, and field measurements.

The model was calibrated to the June 1957 and January 1962 high water marks provided by IDNR. Based on this model, the area along the study reach that was inundated by the 1962 flood was more than 1,400 acres. Based on an analysis of the stream gage data for Arcadia, that flood was between a 5- and 10- year frequency flood. **Exhibit 1** shows the area inundated by the 2-, 10-, and 100-year floods under existing conditions. A more detailed description of the hydraulic model is included in **Volume 2**.

An unsteady flow model for the stream reach was also developed using the HEC-RAS unsteady flow model option. This model used hydrographs at different points along the stream from the HEC-HMS model for the frequency discharges combined with the cross section data used in the hydraulics model. The unsteady flow model provided a method of including the timing aspect of flooding along different reaches of the stream to be factored in. This allowed rough analysis of the effect of various alternatives on the time that flood waters would be expected to be out of banks. This effect is of special interest in evaluating alternatives that would benefit the agricultural lands.

5.0 INITIAL SCREENING OF POTENTIAL ALTERNATIVE SOLUTIONS

The main flooding problems along Big Cicero Creek are located within the City of Tipton along Adams Street between First and Fourth Streets as well as along South Street, in the agricultural areas upstream of Tipton, and along the county roads inundated by flood waters. This chapter presents the preliminary screening of suggested alternatives identified during CBBEL's analysis and discussions with Tipton residents, farmers, and County personnel. A listing of the noted alternatives and the preliminary screening results are presented in **Table 1**. The screening was performed using the evaluation criteria provided in **Chapter 3**.

Table 1
Initial Screening of Potential Alternatives

I.D.	Potential Alternative	Remarks	Area benefited	Carried to shortlist of promising alternatives?
A	Elevate all affected roads in the study reach to grades above the 100-year flood elevations	This alternative would be very expensive due to the miles of road affected. Raising the roads could also increase water surface elevations upstream if multiple culverts are not included through floodplain areas.	County roads	No
B	Control future floodplain development through accurate Flood Insurance maps for the City and the County and strictly enforce ordinances.	Would not reduce current damages but should prevent increased damages due to future development in the watershed.	residential	Yes
C	Floodproof affected structures	Could eliminate existing residential flooding but would not reduce frequency of street and property flooding.	residential	Yes
D	Buyout or relocate affected structures	Could eliminate existing residential flooding but would not reduce frequency of street and property flooding.	residential	yes
E	Construct levees through City of Tipton that would protect areas behind the levees from the 100-year flood.	Would protect structures and streets from the 100-year flood.	residential	Yes

F	Construct bypass channel for Buck Creek within the City of Tipton from Adams Street to the park.	Would not lower flood elevations since Big Cicero Creek controls the elevation in Buck Creek at this point and there is very little fall along Big Cicero Creek to the park.	residential	No
G	Construct upstream detention pond that would lower the 100-year discharge to reduce water surface elevations below the lowest grade of the existing homes.	Potentially very expensive. Would protect areas downstream from flood damages. Would not affect upstream flooding.	Residential, agricultural	Yes
H	Construct a diversion/bypass from just downstream of CR 200W around the City of Tipton that would lower the 100-year water surface elevations below the lowest grade of the existing houses.	Based on aerial photos, there is no reasonable path for such a bypass channel in this area due to existing development.	Residential, agricultural	No
I	Construct a major channel improvement through the City of Tipton that lowers 100-year flood elevations below the lowest grade of the existing houses.	Potentially very expensive. Would help Tipton residents, but likely provide little help upstream.	Residential, agricultural	Yes
J	Divert Buck Creek around the north end of town	Would not be a significant enough reduction in discharge to lower elevations below the lowest grades of structures.	residential	No
K	Participate in the NRCS Floodplain Easement Program.	Indiana has not received funds for this program for several years. There are already several requests for the funds in areas designated as priority areas for the state. The likelihood of funds being available for any property along Big Cicero Creek is very slim.	agricultural	No
L	Construct levees upstream of Tipton to protect agricultural areas from the 10-year flood	Would protect fields from flooding. Potentially expensive and a maintenance issue. Draining fields behind levees would be an issue.	Agricultural, roads	Yes

M	Construct a large upstream detention basin that would reduce 10-year discharges to the channel capacity discharge.	Would have the effect of keeping channel at bankfull capacity for longer periods thus preventing drainage from tiles for a longer time.	Agricultural, roads	Yes
N	Construct several small detention basins to reduce the 10-year discharge to bankfull capacity discharge.	Would have the effect of keeping channel at bankfull capacity for longer periods thus preventing drainage from tiles for a longer time.	Agricultural, roads	Yes
O	Construct a diversion /bypass from near Garhart Ditch at CR 300 S to Recobs Ditch to reduce the 10-year discharge downstream to bankfull capacity	Would involve constructing 3 new road crossings and one RR crossing. Would be expensive due to land acquisition costs on top of construction costs. However, has the potential for reducing flood elevations	Agricultural, residential, roads	Yes
P	Straighten the channel between Main Street and CR 200W in order to reduce upstream elevations and allow water to drain faster.	This would remove the meander which would increase the channel slope and, therefore, velocity of flow. There are many potential issues including land acquisition, potential erosion problems, and environmental issues.	Agricultural, residential	Yes
Q	Widen &/or deepen Big Cicero Creek channel upstream of the City of Tipton in order to confine the 10-year flood to the channel.	The goal here is to increase the conveyance capacity of the ditch through the farm fields west of Tipton. This would reduce the frequency and severity of flooding.	Agricultural, roads	Yes
R	Regrade fields to provide “sacrificial swales” so flood waters flowing across fields are spread out over less area.	Does not lessen the frequency with which overbank flooding occurs but may lessen the damage caused by the flooding. Does not lower flood elevations.	agricultural	Yes
S	Create a bypass channel from the tributary along CR 500W to Garhart Ditch to provide an overflow path that confines the 10-year flood discharge within its banks.	This alternative would concentrate the flow from the Creek backing up into a channel instead of running across the fields. It would require two new road crossings	Agricultural, roads	Yes

T	Remove abandoned interurban piers.	This would reduce potential for catching of debris and associated localized increases in flood elevations	Residential	Yes
U	Construct bypass channel from upstream of RR to downstream of Tobin Ditch confluence.	This would potentially allow for additional capacity to lower and remove flood waters from upstream properties faster.	residential	Yes
V	Remove CR 300 W	This would potentially remove an existing “bottleneck” to flow.	agricultural	Yes
W	Various combinations of above alternatives	Several alternatives presented above may not have a significant impact alone. However, when combined with other alternatives, the result may help meet the technical criteria.	Roads, agricultural, residential	Yes

Based on the screening process, a short-list of promising alternatives was compiled. In order to compare the relative effectiveness of the recommended alternatives and to act as a base-condition model, a “Do Nothing” scenario is included on the short-list, presented in **Table 2**.

Table 2
Short List of Promising Alternatives

Alternative #	Description
0	Do Nothing (Base-Condition)
1	Channel Improvement
2	Levees
3	Detention basin(s)
4	Bypass/auxiliary channel
5	Regrade fields to provide “sacrificial swale”
6	Remove old interurban RR piers
7	Remove CR 300 W road fill and structure
8	Voluntary buyouts of buildings in the floodplain
9	Floodproofing of Buildings in the Floodplain

Alternative #	Description
10	Control future floodplain development thru accurate FIS maps and enforcement of updated ordinances
11	Combinations of Alternatives

6.0 DETAILED EVALUATION OF ALTERNATIVES

Each alternative presented in **Table 2** was evaluated to determine effectiveness, economics, social and institutional impacts, and environmental feasibility. The results of the analyses are summarized in the following paragraphs.

Twelve alternatives are on the short-list. The first alternative is included for comparison purposes only. The other eleven alternatives and combinations of alternatives provide possible solutions to various aspects of the problems discussed in **Chapter 3**.

The analyses completed for each alternative were conceptual rather than design-level. In addition, the conceptual opinion of probable cost presented for each alternative in this report is based on limited information and a conceptual layout of the alternative and, therefore, would be subject to modification during the detailed design phase.

A comparison of the advantages and disadvantages associated with each alternative, and whether the alternative is recommended for implementation, is provided at the end of the chapter in **Table 4**.

6.1 ALTERNATIVE 0 – DO NOTHING

This alternative was included as the base-condition scenario for evaluating the other eleven short-listed alternatives. The hydraulic evaluation of this alternative was completed in developing the existing-condition hydraulic model.

Since the 100-year peak discharge (5,500 cfs) through town for this alternative is significantly larger than the no-damage elevation capacity of the channel and overbank (approximately 2,200 cfs), areas along Adams Street, Second Street, South Street, and West Street would remain subject to frequent flooding. Agricultural areas upstream of town would remain subject to frequent flooding because the 10-year discharge downstream of Dixon Creek (2,220 cfs) is nearly five times the existing channel capacity of about 480 cfs. These conditions are unacceptable to the residents of Tipton and agricultural landowners affected by the flooding.

6.2 ALTERNATIVE 1 – CHANNEL IMPROVEMENTS

Several variations of channel improvement options were analyzed. These variations are described below.

Option A - 200-Foot Channel Improvement Through City of Tipton

This option evaluated the option of constructing a channel improvement through town that would lower the 100-year flood elevations below the lowest grade of residential structures in town. Based on the two-foot contour mapping, the lowest elevation around the affected homes is about 862, NAVD ‘88. As shown in **Figure 6** below, the assumed channel improvement would extend about 2.5

miles downstream of CR 200 West. The channel was assumed to have a 200 foot bottom width and 2:1 side slopes with the channel invert unchanged from the existing invert. This is about the maximum size of channel that would fit through town. Manning's N values were assumed to be similar to the calibrated existing channel N values of 0.045. The old interurban piers upstream of the RR bridge were also assumed to be removed as part of the channel improvement. The resulting flood elevation in the area of Adams Street was 862.8 feet, NAVD '88, which is about 3 feet lower than the existing-condition but still about one foot above the grade of the lowest structure in the affected reach.

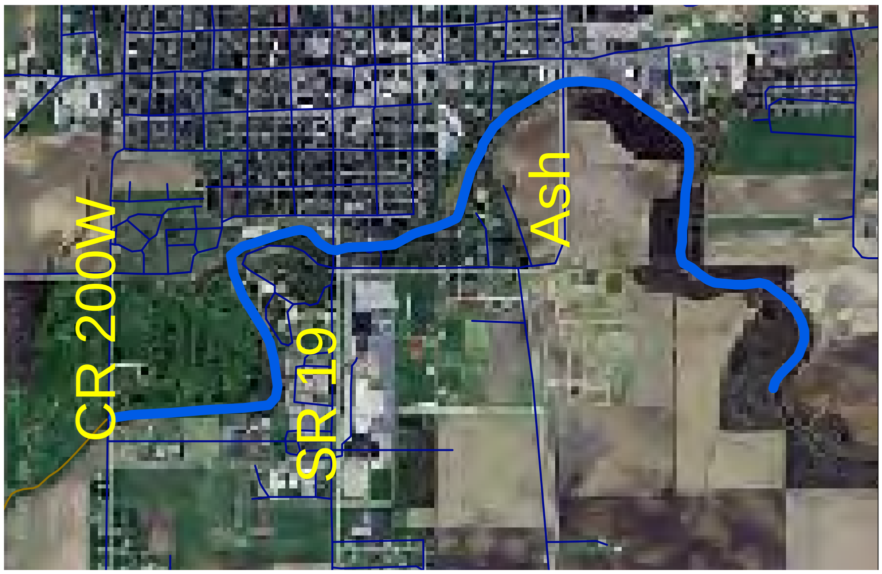


Figure 6: Alternative 1 Option A - Channel Improvement Reach

The estimated construction cost of the option would be in excess of $8 million. The HEC-RAS output for this option is provided in **Appendix 1.**

Option B - 100-Foot Channel Improvement Through City of Tipton

This option is the same extent and dimensions as option A except that the channel bottom width would be 100 feet. This option would result in flood elevations that are about 0.8 feet higher than Option A. The HEC-RAS output for this option is provided in **Appendix 1**. The estimated construction cost of this option would be about $4.25 million.

Option C - Shortened Channel Improvement Through City of Tipton

This option is the same as Option A except that it extends only from Ash Street to CR 200 W. This shorter distance resulted in 100-year water surface elevations about 2 feet higher than with Option A. The HEC-RAS output for this option is provided in **Appendix 1**. The estimated construction cost of this option is about $4.25 million. Due to the high cost and limited benefit, this option is not recommended and was not analyzed further.

Option D - Channel Realignment from Main Street (SR19) to County Road 200 West

This option is a relatively short channel improvement shown in **Figure 7** between Main Street and County Road 200 West. This reach is where the creek presently makes two very sharp bends and has obstructions in the overbanks that limit flow capacity. This option would shorten the reach between the roads by about 1,800 feet and eliminate the sharp bends. A channel similar in size to the existing channel with a bottom width of 40 feet and side slopes of 2:1 was assumed. The existing channel was assumed to be filled in.

Figure 7: Alternative 1 Option D Channel Improvement

This channel improvement would lower the 10-year water surface elevation by up to 1.2 feet through the improved reach but would have insignificant impact upstream in the agricultural areas. Additionally, state and federal regulatory agencies are generally opposed to channel relocations due to negative environmental impacts. Since this option would not accomplish the goals established for the recommended plan, it will not be analyzed further. The HEC-RAS model output for this option is provided in **Appendix 1**.

Option E - Channel Improvement from RR Downstream to Tobin Ditch Confluence

This option was to test the impact of a small channel improvement from downstream of the RR to downstream of the Tobin Ditch confluence as shown in **Figure 8**. It consisted of a 30-foot "shelf" on one side of the creek at an elevation about 3' above the creek invert. The result was to lower elevations minimally upstream to the park area.

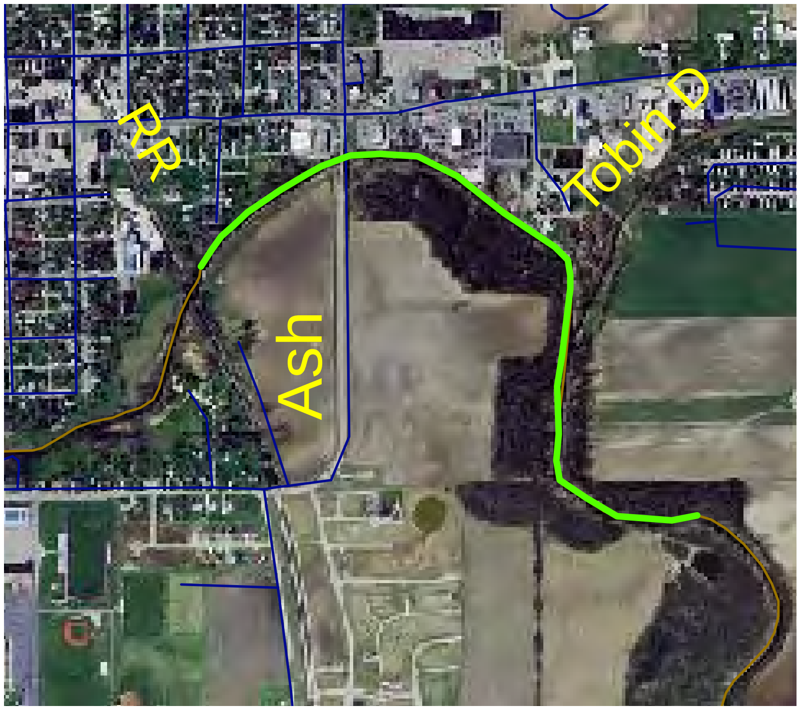


Figure 8: Alternative 1 Option E Channel Improvement

Calculation results for this option are included in **Appendix 1**. This option provided little benefit so will not be carried to the list of recommended plan components.

Option F - Channel Improvement from County Road 200 West Upstream to Confluence of Prairie Creek

This option would provide an improved channel from CR 200 West upstream to the confluence with Prairie Creek as shown in **Figure 9**. The channel improvement was selected with the goal of confining the 10-year flood to the channel banks.

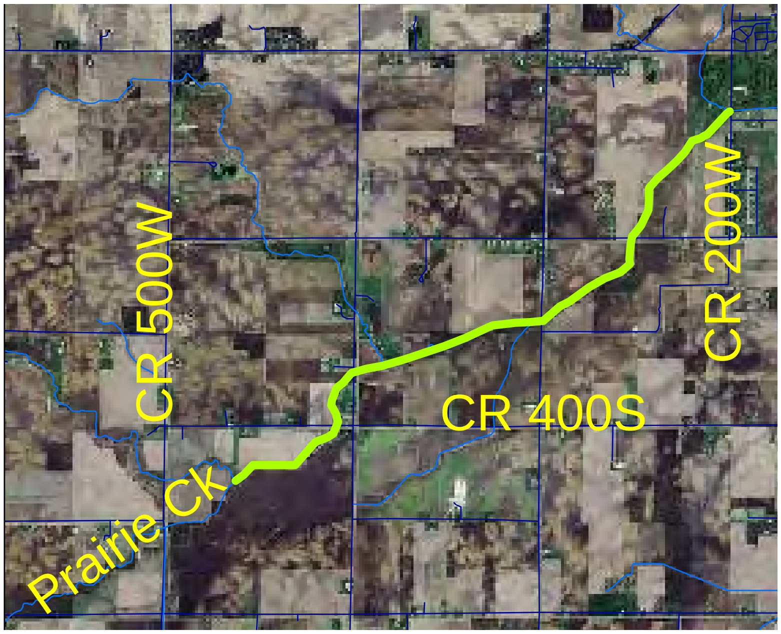


Figure 9: Alternative 1 Option F Channel Improvement

A channel with a 130-foot bottom width, a Manning's N value of 0.045, and 2:1 side slopes at an elevation 2 feet above the existing flow line was selected. The goal of confining the 10-year flood to the channel banks was not achieved except for the reach upstream of CR 400 West because the water surface elevation at CR 200W is higher than the banks upstream. The approximate time out of banks for the 10-year flood was reduced from about 105 to 75 hours upstream of CR 300 West and from 95 to 40 hours upstream of CR 300 West.

Results of this option show the need to lower elevations at CR 200 West in order to lower upstream elevations to within the channel banks. This option alone does not accomplish the project goals. However, in combination with an option that lowers elevations at CR 200W, it may accomplish the goals for the entire agricultural reach. HEC-RAS model output for this option is included in **Appendix 1**. The construction cost of this option would be approximately $6.2 million.

Option G - Combination of Options A and F

The combination of options A and F in essence creates a channel improvement project for the entire study reach. The bottom width of the channel through Tipton up to CR 200 W is 200 feet. Upstream from CR 200W to the confluence of Prairie Creek, the bottom width is 130 feet. Such a combination would come very close to achieving the goals of reducing the 100-year flood elevations below the lowest grade of residential structures and reducing the 10-year discharge to the channel capacity through the agricultural areas. In Tipton, one half to one foot of flooding could still occur at the lowest structures during the 100-year flood.

Between CR 300S and CR 400W, the 10-year water surface would still be about one to two feet over the bank elevations in places.

HEC-RAS model output is included in **Appendix 1**. The estimated construction cost of this option is $14.2 million.

<u>Option H - Channel Improvement from Downstream of CR 300S Upstream to CR 300W</u>

To investigate whether CR 300 W seems like a “bottle neck” because of downstream conditions, this option was modeled. It consisted of a 20-foot wide “shelf” channel improvement from about 2000’ downstream of CR 300 S upstream to CR 300 W as shown in **Figure 10**.

Figure 10: Alternative 1 Option H Channel Improvement

About 29,000 cubic yards of dirt would need to be excavated for this option. This channel improvement had a slight effect on elevations between CR 300 S and CR 300 W. It did reduce the time that the 10-year flood is out of banks by almost half a day. The time that the 2-year flood is out of banks on this option was reduced by about 18 hours for the agricultural land upstream of Buck Creek. Calculations for this option are included in **Appendix 1**. The construction cost for this option was estimated at $0.6 million. This option may be considered in connection with another option.

Option I - Combination of Options H and D

This option combined the 20-foot wide “shelf” channel improvement from midway between CR 200W and CR 300 S upstream to CR 300 W with Option 6 D, the straightening of the channel through the golf course and park between Main Street and CR 200 W. These locations are shown in **Figure 11**.

Figure 11: Alternative 1 Option I Channel Improvements

Individually, each of these options provided minimal benefit. When combined, they did not produce much benefit as far as reducing the 10 year water surface elevations. They did, however, slightly reduce the time out of the banks through the agricultural areas. The 10-year flood time out of banks was reduced by about 20 hours while the 2- year out of bank time was reduced by about 30 hours. The 10-year water surface downstream of the project was increased by slightly more than 0.2 feet. About 139,000 cubic yards would need to be excavated for this option. Calculations for this option are included in **Appendix 1**. The estimated construction cost is $2.9 million. Due to the minimal benefit for the cost, this option will not be carried to the list of recommended plan components.

Option J - 60-Foot Shelf Channel Improvement from CR 200W to CR 400W

This option includes construction of a 60-foot wide “shelf” about 3’ above the channel bottom elevation on one side of the ditch between CR 200 W and CR 400 W as shown below in **Figure 12**.

Figure 12: Alternative 1 Option J Channel Improvement

This would require the excavation of about 200,000 cubic yards of dirt. The channel improvement did lower the 10-year elevations but only to the 5-year elevations which are still out of bank. The benefit did not extend much beyond the channel improvement reach as far as the elevation reduction aspect.

When the option was evaluated using unsteady flow methods, it showed a reduction of a day or more in the time that the 10-year flood would be out of banks and almost 2 days reduction in flooding duration for the 2-year flood. The unsteady flow model also gives an indication of impacts on downstream water surface elevations due to the increased capacity upstream. For this option, it showed a 0.2 foot increase in downstream water surface elevations. Construction costs for this option were estimated at $2.4 million. Calculation results for this option are included in **Appendix 1**.

<u>Option K - Combination of Option J and 60-Foot Shelf Channel Improvement from Downstream of Tobin Ditch Upstream to Main Street (SR19)</u>

This option was to construct a 60-foot wide “shelf” about 3’ above the channel bottom elevation on one side of the ditch between CR 200 W and CR 400 W and from about 2800’ downstream of Tobin Ditch upstream to Main Street (SR19) as shown below in **Figure 13**. Removal of the old interurban piers just upstream of the railroad was also included as part of this option.

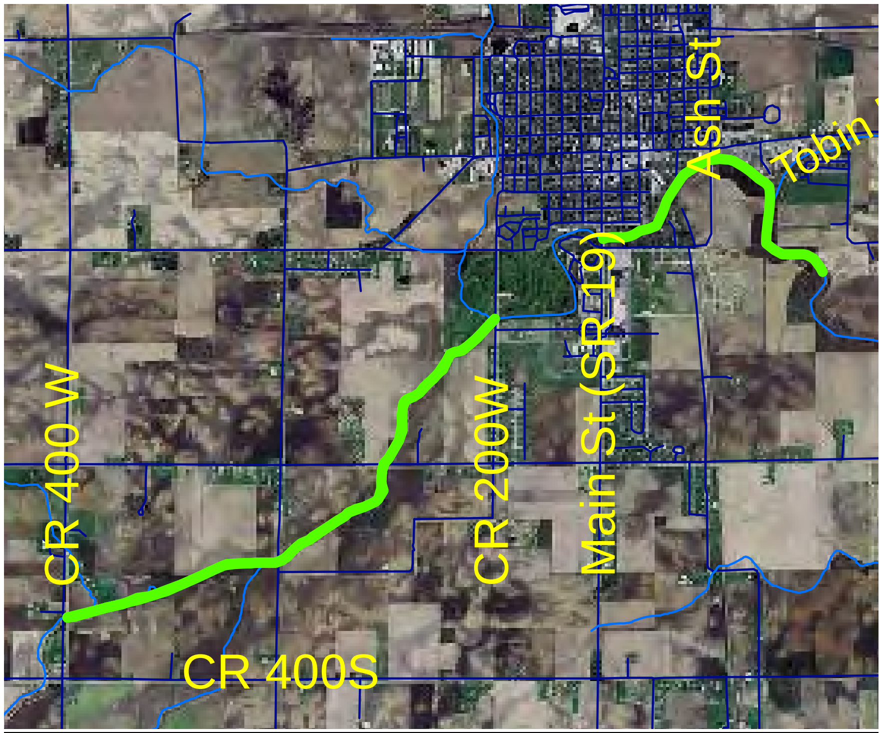


Figure 13: Alternative 1 Option K Channel Improvement Reach

This would require the excavation of about 335,000 cubic yards of dirt. In the residential reach through town, the channel improvement lowered the 100-year elevations slightly. Instead of just the 2-year flood being below the flood damage elevations, the 10-year flood was below the damage elevations, except near the Buck Creek confluence where very little reduction in flood elevations was achieved.

When the option was evaluated by unsteady flow methods, it showed a reduction of almost two days in the time that the 10- and 2-year floods would be out of banks. Construction costs for this option were estimated at $ 3.0 million. Calculation results for this option are included in **Appendix 1**.

Option L - 60-Foot Shelf Channel Improvement from Downstream of Tobin Ditch Upstream to CR 400W

This option is the same as Option K except that it adds the 60-foot shelf channel improvement through the park and golf course between Main Street and CR 200 W. The channel improvement reach is shown in **Figure 14**. This additional reach added an extra 65,000 cubic yards of dirt to excavate compared to the previous option and increased the construction cost to $3.5 million.

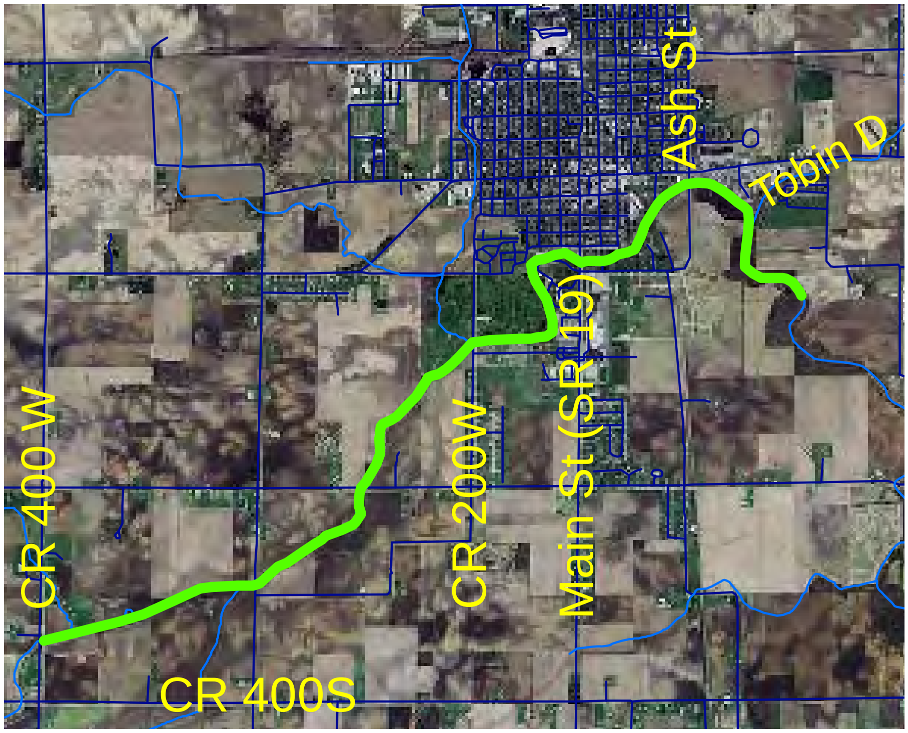


Figure 14: Alternative 1 Option L Channel Improvement

Adding the channel improvement to this reach has significant impact on the properties affected by backwater from Big Cicero Creek along Buck Creek. This option would reduce the 10-year flood below the flood damage elevations in this reach. It would also reduce the time that flood elevations in the agricultural reaches are out of bank by 50% for the 10-year flood and 75% for the 2-year flood. Steady flow calculations results for the option are included in **Appendix 1**.

<u>Option M - 30-Foot Shelf Channel Improvement from Downstream of Tobin Ditch Upstream to CR 400 West</u>

This option is the same as Option L except that the shelf is reduced to 30-foot wide. Comparison of these two options can provide a means of optimizing available funds for the project and potential benefits. The estimated construction costs for this option are about $1.65 million. It lowers the 10-year water surface elevation about 1’ at the Buck Creek confluence compared to about 2’ for Option L. Lengths of time out of bank in the agricultural reaches are reduced by about 50%. Steady flow calculations results for the option are included in **Appendix 1**.

<u>Option N - 30-Foot Shelf Channel Improvement from Downstream of Tobin Ditch Upstream to CR 400 S</u>

This option is the same as Option M except that it continues the channel improvement up to CR 400 S instead of stopping at CR 400 W. The entire reach for this option is shown in **Figure 15**. Steady flow calculations results for the option are included in **Appendix 1**.

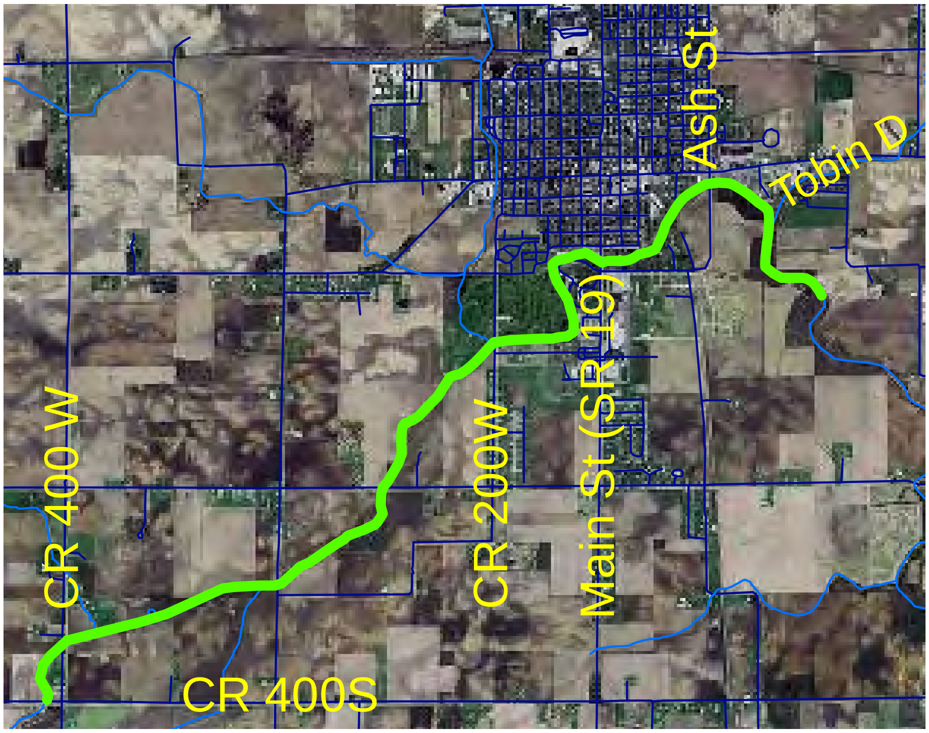


Figure 15: Alternative 1 Option N Channel Improvement

This additional length increases the estimated construction costs to a total of $1.9 million. Adding this short reach has a significant effect on the time out of banks in the added reach and upstream to the confluence with Prairie Creek.

6.3 ALTERNATIVE 2 – LEVEES

Levees that would provide the level of protection noted in the technical criteria were evaluated. A description of each levee option is described below.

Option A - Construct 100-Year Protection Levees in the City of Tipton

This option would include the construction of levees in the City of Tipton that would provide protection from the 100-year flood. In order to tie in to high ground, the levee alignment would have to be similar to that shown in **Figure 16**. This option would provide 100-year flood protection to the structures within the levee. However, upstream and downstream of the levee, flood elevations could be increased. Before this option could be selected, additional analysis would be needed to determine the extent of adverse impacts upstream and downstream of the levee reach.

Figure 16: Approximate Levee Location for Alternative 2 Option A

Looking at aerial photography, there does not appear to be enough room to construct these levees without either putting at least two businesses inside the levee or acquiring them and also acquiring about four blocks of houses and street to make room for the levees. Main Street (SR 19) would need to be elevated over the levee but there doesn't appear to be enough room to do this without a very steep road or raising the road starting on the south side of the bridge.

The estimated construction cost for the levee is about $1.2 million. This does not include right of way acquisition, required road work, required buyouts of businesses, stormwater pump stations behind the levees, etc.

Option B - Construct Agricultural Levees to Provide 10-Year Flood Protection

This option focused on protection of agricultural areas. An initial levee alignment was drawn as shown in **Figure 17**. In general, it was assumed to be about 140 to 200 feet wide. A couple places, it was assumed to extend around wooded areas to minimize disturbance of these areas. A total of about 9.2 miles of levee was needed on both sides of the stream for this option for the reach from CR 200 West upstream to CR 500 West.

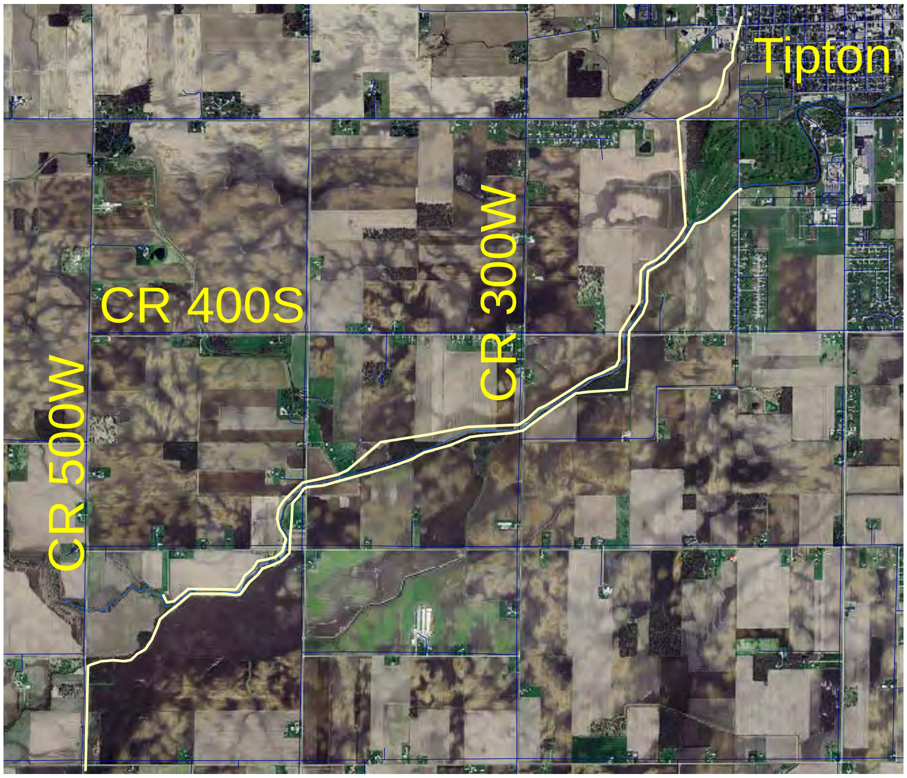


Figure 17: Alternative 2 Option B Levee Alignment

The levees would have to average about six feet high to contain the 10-year flow. The 10-year water surface elevations would increase up to 3 feet above existing conditions due to the reduced flow area. Additionally, downstream flow rates would increase by about 5 percent because overbank flood storage would be eliminated. This would be a minimal increase that is expected to have little effect on downstream flood elevations. However, further consideration of this option would require more extensive investigation of potential adverse impacts downstream.

The existing field tiles would take longer to drain as Big Cicero Creek would stay higher longer due to the reduced conveyance. The HEC-RAS output for this option is included in **Appendix 1**.

Construction of the levees would cost about $3.1 million. This does not include the cost of any needed interior drainage facilities for draining the areas behind the levees and continual maintenance. It also does not include the cost of additional levees required to contain increased water surface elevations to prevent flooding of upstream properties along the tributaries.

6.4 ALTERNATIVE 3 – DETENTION BASIN(S)

Option A - Construct Large Detention Basin Upstream of City of Tipton to Lower Elevations In Tipton Below Lowest Residential Structure Grades

This option would involve construction of a large detention basin just upstream of CR 200 West to reduce discharges so that 100-year water surface elevations would be below the lowest grade of residential structures in town.

The maximum allowable flow through Tipton would need to be reduced to about 2,250 cfs for elevations to be below the control elevation of approximately 862 feet, NAVD '88. The required storage volume for this option would be about 6,400 Ac-ft. Assuming a depth of 14 feet could be provided, the detention basin would require 456 acres of area. The relative size of the basin is shown in **Figure 18**.

Figure 18: Relative Size of Alternative 3 Option A Detention Basin

Calculations for this option are included in **Appendix 2**. The estimated construction cost of this option is about $66 million.

Option B - Option A with Larger Outlet Discharge

To test the possibility of having a smaller basin and allowing a little more residual flooding, Option B was created. This option assumed the detention basin output would be equivalent to the 10-year discharge. In other words, the volume needed to reduce the 100-year flood discharge to the 10-year discharge of 2,850 cfs was calculated. The resulting volume was 4,440 Ac-Ft. At 14 feet of depth, this would translate to an area of 317 Acres compared to the 456 Acres in Alternative 3 Option A. The estimated construction cost of this option would be about $47 million. Calculations for this option are included in **Appendix 2**.

Option C -Construct Large Detention Basin Upstream of Dixon Creek

This option involves the construction of a large detention basin on Big Cicero Creek somewhere between Prairie and Dixon Creeks. The goal of this option would be to reduce the 10-year discharge downstream of the basin to the channel capacity discharge of approximately 480 cfs along this reach of the creek. The approximate volume of storage required would be about 3,125 Ac-ft. The depth of flow in the channel for the existing-condition 10-year flood event is about 12 feet. Assuming that 12 feet is also the available storage depth, the basin size would be about 260 acres. **Figure 19** shows the relative size of the basin that would be required. The general location is for illustrative purposes only. The estimated construction cost of this option would be about $32.5 million.

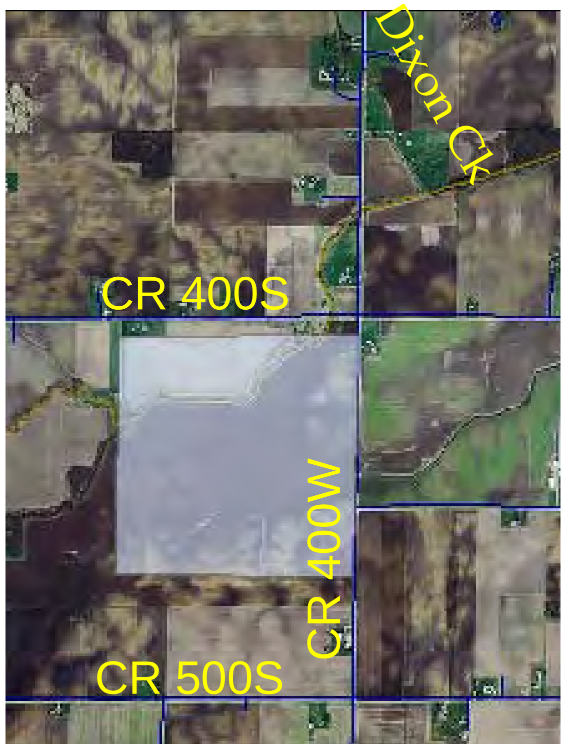


Figure 19: Relative Size of Alternative 3 Option C Detention Basin

Although this option would result in the desired reduction in flow for the reach of creek upstream of Dixon Creek, the existing channel capacity downstream of Dixon Creek would still be exceeded. The bankfull capacity downstream of Dixon Creek is about 500 cfs. The 10-year runoff from Dixon Creek alone is 610 cfs meaning even with a $32.5 million detention basin, 10-year flows would still be outside the channel banks downstream of Dixon Creek. HEC-HMS output for this option is provided in **Appendix 3**. These results would suggest that several smaller detention basins on each of the major tributaries (Alternative 3 Option D) might have more of the desired effect than one large basin.

Option D - Construction of Several Smaller Detention Basins in the Upper Watershed

The subarea delineation map used for the hydrologic modeling was consulted for the selection of tributaries for possible detention basins. The darker shaded subareas shown in **Figure 20** were chosen for controlling runoff by constructing detention basins. These basins would have the affect of controlling most of Buck Creek, all of Dixon Creek, Kigin Ditch, the upstream portion of Cox Drain, Endicott Drain, and Pierce Drain.

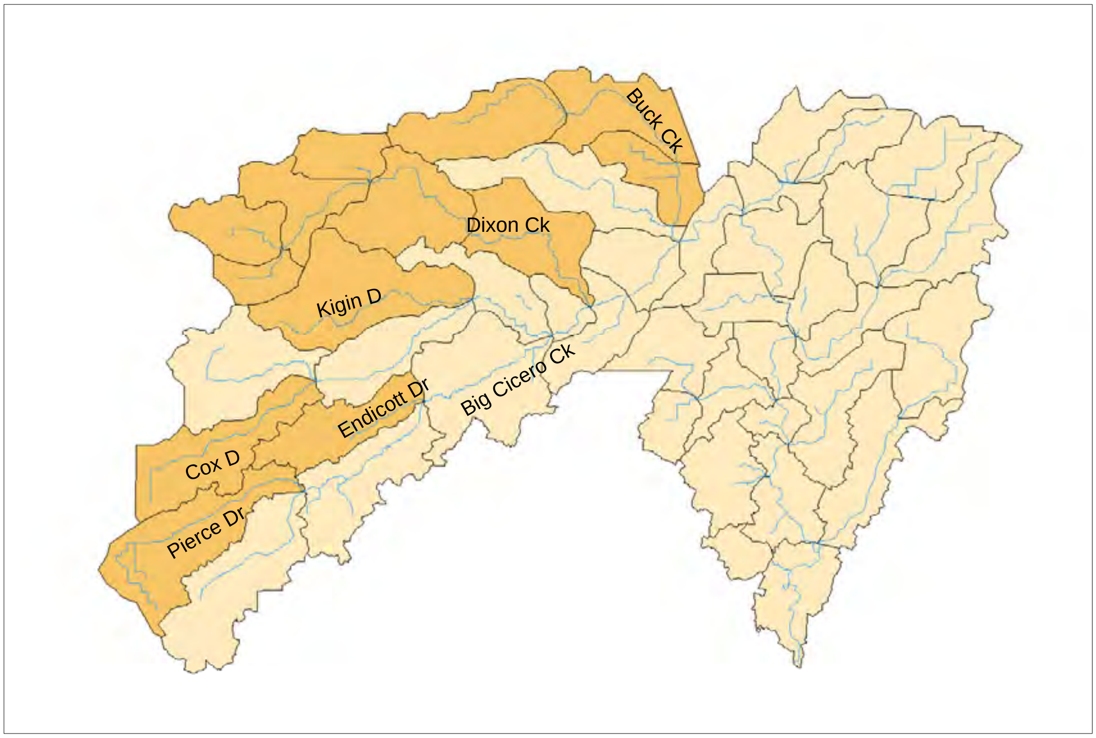


Figure 20: Dark Areas are Alternative 3 Option D Watershed Areas Prevented from Contributing to Peak Discharge

As a test to determine the potential effect of detention on the major tributaries, the hydrologic model was modified to show what would happen if there was no flow from the selected tributaries. Just downstream of Dixon Creek, where the channel capacity is 500 cfs, the resulting 10-year discharge was about 1,060 cfs. Just upstream of Buck Creek, where the channel capacity is 700 cfs, the resulting discharge was 1,220 cfs. Even with providing over 6,000 acre-feet of storage in the upper watershed and effectively eliminating runoff from 42 of the 80 square miles of drainage area contributing to Big Cicero Creek, the resulting discharges still greatly exceeded the channel capacity. A comparison of 10-year discharges with and without this detention is given below in **Table 3**. HEC-HMS output for this option is provided in **Appendix 3**.

Table 3
Comparison of 10-Year Discharges

location	Existing Condition Discharge, cfs	Alternative 4, Option D Discharge, cfs	Approximate Bankfull Discharge, cfs
Just d/s of Buck Ck	2,850	1,462	850
Just u/s of Buck Ck	2,380	1,221	700
Just d/s of Dixon Ck	2,220	1,056	500
Just d/s of Prairie Ck	1,700	1,053	480

Based on the results of this analysis, it is obvious that detention can not reduce the 10-year discharges sufficiently to confine them to the channel.

6.5 ALTERNATIVE 4 – BYPASS/AUXILIARY CHANNEL

Alternative 4 evaluated the benefits of bypass or auxiliary channels at various locations.

Option A - Diversion/Bypass Channel from Confluence with Garhart Ditch to Recobs Ditch

This option involves the construction of a new channel that would convey the 10-year flood waters that are in excess of downstream channel capacity from Big Cicero Creek at Garhart Ditch to the Recobs Ditch downstream of the City of Tipton. The bypass channel would be approximately 18,000 feet long, including the portion that follows the existing Recobs Ditch. As shown in **Figure 21**, the channel could extend from the confluence of Garhart Ditch south about one quarter mile then turn east and continue straight until reaching the existing Recobs Ditch.

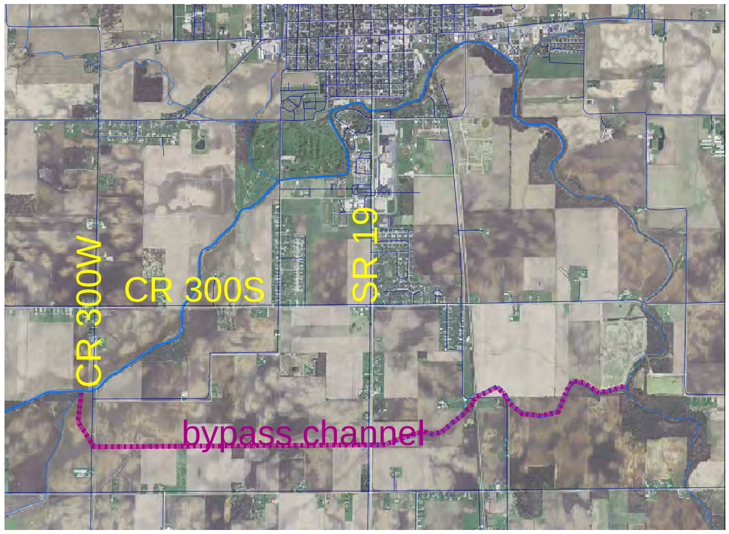


Figure 21: Alternative 4 Option A Auxiliary Channel Location

This path would require the construction of one new bridge over CR 300W in addition to the improvement of the structures under CR 150W and CR 100W as well as the RR.

To model this option, various channel sizes were modeled in HEC-RAS using a range of assumed overland discharges. A slope of .001 was assumed to be available for the channel based on the USGS contours for the points of connection with Big Cicero Creek. A rating curve for each of these channels was then added to the existing condition HEC-RAS model for Big Cicero Creek at model section 30.524 just downstream of Garhart Ditch. The discharges in the model were then optimized to properly distribute the flow between the main channel and the bypass channel. The goal was to find a channel size that would leave only the bankfull discharge of 700 cfs in the main channel during the 10-year flood. For a 10-year flood, the bypass channel had to convey the flow at a depth less than 6 feet at the entrance to the diversion ditch. This value was calculated based on the existing-condition 10-year flood depth calculated at 12 feet minus two feet to bring it within the channel banks and allowing for 4 feet of flow in the main channel before the bypass channel would be used. A Manning's N value of 0.04 was assumed meaning that the channel would have to be mowed occasionally to keep brush from growing too thick. Using 3:1 side slopes, a channel bottom width of 76 feet for the bypass channel resulted in 490 cfs in the main channel through Tipton.

The 100-year discharge was also run through the HEC-RAS model to calculate what the depths in the bypass channel would be. The resulting depth was less than 7 feet. This means the bypass channel would need to be at least 7 feet deep to contain the flow from the 100-year flood.

Downstream of Garhart Ditch, this option would reduce discharges by up to 80 percent and lower the 10-year water surface elevation within the channel banks.

Upstream of Garhart Ditch, the reduction in 10-year water surface elevation dissipates by the confluence with Dixon Creek. The 10-year flood would be above the lower channel bank elevations by about 1.5 feet just upstream of Garhart Ditch to about 2.5 feet at CR 400 West.

This option would reduce the 10-year flood downstream of Garhart Ditch to be contained within the channel and also reduce the 100-year flood elevation through the City of Tipton to just above the approximate grade of the lowest residential structure. This means the 100-year flooding of homes in Tipton would be greatly reduced, if not eliminated.

The approximate length of time that floodwater would be out of bank for the 10- and 2-year floods downstream of CR 300 West is reduced from about 105 to 35 hours and 100 to 0 hours, respectively. Upstream of CR 300 West, the reduction is from 95 to 90 hours and 95 to 60 hours for the 10- and 2-year floods, respectively.

The bypass channel would increase discharges downstream of Recob Drain by up to 6 percent. That increase would likely have minimal impact on downstream flood elevations. More data would have to be collected and calculations performed to determine the effect this would have on flood depths on downstream property. HEC-RAS model output is included in **Appendix 1**. The estimated construction cost of this option is about $7.9 million.

Option B - Narrower Version of Option “A” Auxiliary Channel

This option is the same as Alternative 4 Option A except that the bypass channel bottom width would be 38 feet instead of 76 feet. Based on hydraulic analysis, the 100-year water surface elevations through Tipton for this scenario would be about 1.5 feet higher than with the 76 foot bottom width channel. In the agricultural areas upstream of CR 200 W, the 10-year flood elevation would be reduced to approximately the 2-year flood elevation. The HEC-RAS model output for this option is provided in **Appendix 1**.

The approximate length of time that floodwater would be out of bank for the 10- and 2-year floods downstream of CR 300 West is reduced from about 105 to 45 hours and 100 to 20 hours, respectively. Upstream of CR 300 West, the reduction is from about 95 to 90 hours and 95 to 60 hours for the 10- and 2-year flood respectively. Constructions costs for this option are estimated to be $6.9 million.

Option C - Auxiliary Channel to Convey Flow from County Road 500W to the Confluence of Garhart Ditch and Big Cicero Creek

During large flood events under present conditions, flow in Big Cicero Creek backs up Prairie Creek from the confluence of Prairie and Big Cicero Creeks. When it backs up, it eventually flows upstream in the roadside ditch along County

Road 500 West then overflows into the fields and floods all the way down to the point where Garhart Ditch meets Big Cicero Creek. This option would provide an auxiliary channel large enough to ensure the flows from a 10-year flood would be contained within the channel banks of the main channel and the auxiliary channel. As shown in **Figure 22**, the path of this auxiliary channel would be along the swale that the water presently follows, a distance of about 2.7 miles. The new auxiliary channel would be constructed between the roadside ditch and the upstream end of Garhart Ditch. The entire reach of Garhart Ditch would also need to be enlarged. The auxiliary channel depth would vary from 6 to 10 feet and have a bottom width of approximately 88 feet with 2:1 side slopes.

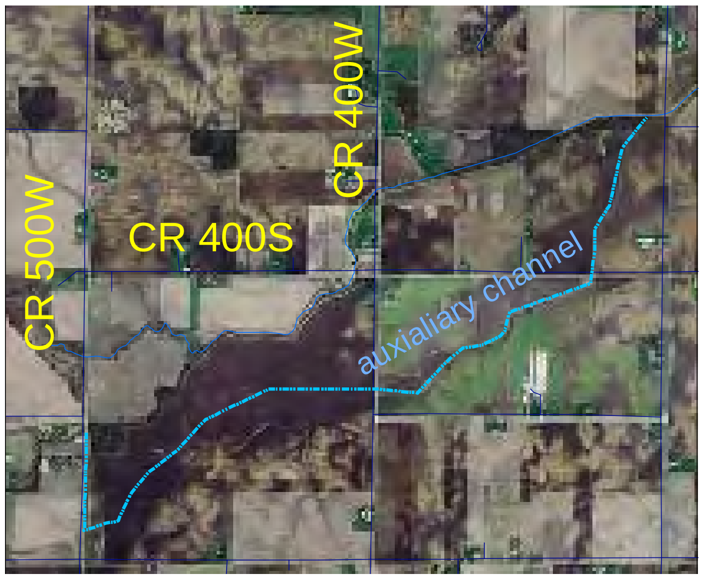


Figure 22: Alternative 4 Option C Auxiliary Channel

Due to the backwater from Big Cicero Creek at the Garhart Ditch confluence, very little benefit would be derived downstream of CR 400 South. Between CR 400 South and CR 500 West, the 10-year water surface elevations would be confined or close to confined to the channel banks of Big Cicero Creek and the auxiliary channel. The auxiliary channel would lower water surface elevations in this reach by up to about two feet meaning the existing extent of flooding from up to a 10-year flood would be almost eliminated between CR 400 South and CR 500 West.

HEC-RAS model output for this option is included in **Appendix 4**. The estimated construction cost of the option is about $4.5 million.

<u>Option D - Combination of Options C and A</u>

The bypass channel of Alternative 4 Option A and the auxiliary channel of Alternative 4 Option C were combined for this option. It added benefit to the area between CR 400W and CR 500W that is not provided by either option alone. The HEC-RAS model output for this option is provided in **Appendix 4**. The estimated construction cost of this option is $12.4 million. This option would provide 10-year flood protection to residential structures and 5-year or more flood protection to most of the agricultural reach of the study.

Option E - Bypass Channel from Upstream of RR to Downstream of Tobin Ditch Confluence

This option was a smaller, downstream version of the bypass in Alternative 4 Option A. It extends about 2600' from about 100 feet upstream of the RR to the swale downstream of the Tobin Ditch confluence as shown in **Figure 23**. It was assumed to have a thirty- foot bottom width and 3:1 side slopes up to existing ground elevations. This option would require the construction of new bridges at Ash Street and the railroad. The bypass invert was assumed to be 4' above the main channel invert so that low flows would continue in the existing creek.

Figure 23: Alternative 4 Option E Auxiliary Channel

This option lowered the 100-year elevations downstream of Main Street (SR 19) to approximately the 10-year elevations. Upstream to Buck Creek, elevations were reduced some but not significantly. Calculation results for this option are included in **Appendix 5**.

This option requires the excavation of about 120,000 cubic yards of dirt and has an estimated construction cost of $1.8 million. This option provides little benefit for the cost so will not be carried to the list of recommended plan components.

6.6 ALTERNATIVE 5 – REGRADE FIELDS TO PROVIDE "SACRIFICIAL SWALES"

This option involves the selected regrading of fields with a goal of limiting the flooded areas to these swales instead of spreading out over large areas of a field. This has reportedly been tried in a few areas with limited success. Certain frequency floods are confined to the swale but tend to cause more damage to crops in the swale area due to increased velocities. This alternative may reduce some of the damages during a 2-year or possibly a 10-year flood but it does not accomplish the goal of preventing crop damage during the 10-year flood. It could still be considered by individual farmers even though it is not a part of the recommended plan.

6.7 ALTERNATIVE 6 – REMOVE ABANDONED INTERURBAN PIERS AND RR PIERS

This alternative can not currently be done since the Railroad is still active. However, it was investigated just to document whether or not the impact of removing the obstruction in the channel caused by the RR and old interurban piers would be significant. These piers are located as shown in **Figure 24** below. The estimated construction cost of this alternative is $83,000.

The reduction in the 100-year water surface elevation was minimal and was dissipated by Main Street (SR 19). For other frequency floods, the reduction in water surface elevation was up to about a half foot, but again, was dissipated by Main Street. This alternative would also have the benefit of reducing maintenance needs by removing obstructions that catch debris. Calculations for this alternative are included in **Appendix 1**.

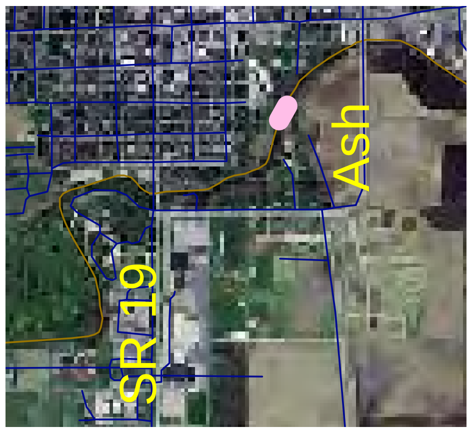


Figure 24: Location of RR and Interurban Piers Shown in Pink

6.8 ALTERNATIVE 7 – REMOVE CR 300 W ROAD FILL AND STRUCTURE

At one of the meetings, a resident commented that CR 300 West appeared to be a bottle neck that prevented upstream water from receding more quickly. This alternative evaluated that theory. The bridge deck, road fill, and ineffective flow areas associated with the bridge were removed from the model. 10-year elevations in the first mile upstream of the removed structure were lowered slightly. Time that the 10-year flood waters were out of bank was reduced by a few hours. This alternative provided little benefit for the cost so will not be carried to the list of recommended components. Calculations for this alternative are included in **Appendix 1**.

6.9 ALTERNATIVE 8 – VOLUNTARY BUYOUTS OF BUILDINGS IN THE FLOODPLAIN

This alternative would involve purchasing the approximate 250 structures located in the 100-year floodplain of Big Cicero Creek. Approximately 65 of these structures are also located in the 10-year floodplain. The construction cost of this alternative could be on the order of $12.5 million assuming $50,000 per structure.

6.10 ALTERNATIVE 9 – FLOODPROOFING OF BUILDINGS IN THE FLOODPLAIN

This alternative would provide floodproofing to protect the buildings located in the floodplain of Big Cicero Creek. There are approximately 250 structures located in the area that would be inundated during a 100-year flood. Floodproofing would not lower flood elevations or eliminate street flooding or existing sewer backup problems. The cost of floodproofing would be on the order of $25,000 per residence. Therefore, the total cost is expected to be about $6.3 million.

6.11 ALTERNATIVE 10 – ACCURATE FEMA MAPS AND ASSOCIATED CONTROL OF FLOODPLAIN DEVELOPMENT THROUGH STRICT ENFORCEMENT OF ORDINANCES

This alternative would provide accurate flood risk maps along the reach of Big Cicero Creek analyzed for the seven miles covered by this study as well as the approximate 10 mile reach that is downstream of the studied section and upstream of the portion already covered in the Hamilton County Flood Insurance Study. This alternative would also require strict enforcement of the floodplain and stormwater ordinances within the Big Cicero Creek watershed. The primary objective of this alternative would be to effectively prevent the increase of flooding damages within the Big Cicero Creek stream reach covered by the more accurate maps. The approximate cost for the additional 10 miles of stream needing studied would be about $50,000 plus about $10,000 for additional two-foot contour mapping downstream of Tipton to the Hamilton County line.

The use and strict enforcement of the updated, state-of-the-art floodplain and storm drainage ordinances would provide the following benefits for the Big Cicero Creek watershed:

1. Ensure new development does not increase the flood or drainage hazards to others.

2. Protect new buildings and major improvements to buildings from flood damages.

3. Manage and mitigate the effects of future development on stormwater drainage throughout the watershed.

4. Require appropriate and adequate provision for site runoff control.

5. Encourage the use of stormwater storage in preference to stormwater conveyance, which would have additional water quality benefits.

6. Lessen taxpayer burden for flood-related disasters, repairs to flood-damages public facilities and utilities, and flood rescue and relief operations.

At a minimum, the updated ordinances would need to include provisions for assuring no net loss of floodplain storage and on-site detention basins that would reduce the developed condition 100-year discharges to allowable release rates that would mimic the existing-condition 10-year flows. Also, any construction in the floodplain such as bridges, should not increase any frequency flood elevations. The enforcement of the floodplain and stormwater ordinances is important for preventing future increases of flood damages in the watershed. Although this alternative would not reduce the existing damages and the effectiveness would depend on proper enforcement, the benefits would be substantial. The approximate cost of this alternative is $10,000 for updating ordinances plus the $60,000 to continue the floodplain delineation downstream.

6.12 ALTERNATIVE 11 – COMBINATIONS OF OTHER ALTERNATIVES/OPTIONS

Option A - Combination of Alternative 1 Option F and Alternative 3 Option C

This option combines the detention basin upstream of Dixon Creek from Option 3 with the channel improvement of Option 7 from the basin downstream to CR 200 West. Adding the channel improvement increases the channel capacity approximately to the expected 10-year discharge of the basin in Option 3 for the reach downstream of the basin to CR 300 S. The estimated construction cost for this option is $38.5 million.

Option B - Combination of Alternative 4 Option C, Alternative 1 Option F, and Alternative 1 Option A

This option tested whether the addition of the bypass channel in Option 4C would be able to confine to the channel the excess flow above the channel capacity from Option 1G. Very little benefit was achieved by adding the bypass channel to Option 1G. The HEC-RAS model output for this option is provided in **Appendix 4**. The estimated construction cost would be $18.7 million.

Option C - Combination of Alternative 3 Option B and Alternative 1 Option B

In order to test what would be needed to make a significantly smaller detention basin accomplish the flood reduction goals, the 100-foot bottom width channel from Option 1B was added downstream of the basin described in Option 3B. The capacity of the channel and overbanks below the residential lowest grades with the Alternative 1 Option B channel improvement was approximately 4,350 cfs. The volume of pond needed to reduce the existing-condition 100-year discharge to the noted discharge value was about 1,010 Ac-Ft. At 14 feet of depth, this translates to an area of 72 Acres. This combination option would lower the 100-year flood elevation to an elevation very close to the assumed lowest grade of the structures in the floodplain. The estimated construction cost of this option is about $ 18.4 million. Volume computations for this option are provided in **Appendix 2**.

6.13 COMPARISON OF SHORT-LISTED ALTERNATIVES

Table 4 below provides a comparison of the advantages and disadvantages for each of the alternatives included on the short list in **Chapter 3**. Calculations of the cost estimates for various alternatives are included in **Appendix 6**.

Table 4
Comparison of Short-Listed Alternatives

I.D.	DESCRIPTION	ADVANTAGES	DISADVANTAGES	RECOMMEND?
1	**Channel Improvement**			
	A – 200' wide thru town	• Provides close to 100-year protection thru town	• No benefit to agr. areas	NO
	B – 100' wide thru town	• Provides 10-yr protection thru town	• No benefit to agr. areas	NO
	C – 200' wide ½ the length of "A"	• Provides 10-yr protection thru town	• No benefit to agr. areas	NO
	D – realignment Main St – CR 200W	• Provides negligible reduction in flood elevations	• Increases stages downstream without providing much benefit	NO
	E – RR – Tobin D confluence	• Almost provides 10-yr protection between Main St. and CR 200W	• Provides minimal benefits for the cost	NO
	F – CR 200W – Prairie Ck	• Provides from 2- to 20-yr protection in ag reaches	• Provides no benefit thru town	NO
	G – "F" & "A"	• Almost provides 100-yr protection thru town and 5- to 10- yr protection in ag reaches	• Increases stages downstream	NO
	H – CR 300S – CR 300W	• Negligible benefits	• Provides minimal benefit for the cost	NO
	I - "H" & "D	• Almost provides 10-yr protection along Buck Ck., reduces time flood waters are out of bank slightly.	• Provides minimal benefit for the cost	NO

I.D.	DESCRIPTION	ADVANTAGES	DISADVANTAGES	RECOMMEND?
	J – 60' shelf CR 200W – CR 400W	• 10-yr flood elevations are reduced to 5-yr elevations in ag reaches, time out of bank is reduced over 25%	• Other options provide more benefit with similar cost	NO
	K – "J" & 60' shelf Tobin D. – Main St	• 5- to 10-yr protection provided thru town, time out of bank in ag reaches reduced about 40%	• Provides little flood relief along Buck Ck	NO
	L – 60' shelf Tobin D. – CR 400 W	• 10-yr protection provided thru town, time out of bank in ag reaches reduced over 50%	• Increases downstream flood stages	NO
	M – 30' shelf Tobin D – CR 400S	• Almost 10-yr protection provided thru town, time out of bank in ag. Reaches reduced about 45%	• Option N provides more benefit with little additional cost	NO
	N – 30' shelf Tobin D – CR 400W	• Same as option M, but extends benefit upstream	• Increases downstream flood stages	YES
2	**Levees** **A** – 100-yr protection levees for town **B** – 10-yr protection levees for agr. reaches	• Provides significant protection if adequately maintained	• Space is limited thru town • potential negative impacts downstream and upstream • significant maintenance requirements • requires internal drainage facilities	NO
3	**Detention Basin(s)**			
	A – u/s of CR 200W	• Protects most structures from 100-yr flood	• Extremely expensive	NO
	B – same as A but allow 10-yr discharge	• Protects most structures from the 10-yr flood		

I.D.	DESCRIPTION	ADVANTAGES	DISADVANTAGES	RECOMMEND?
	C – u/s Dixon Ck	• 10-yr flood almost confined to channel in ag reaches		
	D – several smaller basins in upper watershed			
4	**Bypass or Auxiliary channel**			NO
	A – 76'BW bypass from Garhart to Recobs D.	• Provides near 100-yr protection thru town • Provides 5- to 10-yr protection thru d/s half of ag reach	• Increases d/s discharges • additional channel requiring maintenance • may put flooding on ground that not flooded under existing conditions • takes farm ground out of production • provides little benefit u/s of CR 300W	
	B– 38'BW bypass from Garhart to Recobs D.	• Provides 10-yr protection thru town • Provides 2- yr protection thru d/s half of ag reach	• Increases d/s discharges • additional channel requiring maintenance • may put flooding on ground that not flooded under existing conditions • takes farm ground out of production • provides little benefit u/s of CR 300W	
	C – 88' BW 500W – Garhart	• Provides 5-yr protection u/s of CR 400W	• Small area benefited for the cost	
	D – A & C	• Same as for each option independently	• Very little additional benefit for the substantial cost increase.	
	E – u/s RR – d/s Tobin D.	• Slightly lowers elevations thru town	• Little benefit for the cost	

I.D.	DESCRIPTION	ADVANTAGES	DISADVANTAGES	RECOMMEND?
5	**Regrade fields to provide "sacrificial swales"**	• Could reduce the extent of crop damage in localized areas.	• Would not reduce flood elevations	NO
6	**Remove old interurban piers**	• Slight localized reduction in flood elevations • could reduce maintenance needs of the drain	• Provides no significant flood relief	NO
7	**Remove CR 300W road fill and structure**	• Localized reduction in elevations, • slight reduction in time out of banks	• Little benefit for the cost	NO
8	**Voluntary Buyouts**	• Would remove structures from the floodplain	• Potentially expensive due to about 250 structures in the 100-yr floodplain	NO
9	**Floodproof**	• Would protect structures during the 100-yr storm • No negative environmental impact • Benefits can be realized even with small amount of funding.	• Would not lower flood elevations • Flooding of streets and driveways would continue in the floodproofed areas • Would not protect floodproofed structures during larger events.	NO
10	**Control future floodplain development thru accurate FIS maps and ordinance enforcement.**	• Would prevent further increase in potential damages • Implementation cost would be relatively small • Could be implemented immediately.	• Would not reduce the existing damage potentials • Increased initial construction cost for developments	YES
11	**Combinations of other Alternatives**			
	A – 1G & 3C	• Almost contains 10-yr flood to channel in ag reaches	• Extremely expensive	NO
	B – 1A, 1F, & 4 C	• Similar to 1G	• Little additional benefit for the large additional cost	
	C – 1B & 3A	• Provides slightly less than 100-yr protection thru town	• Extremely expensive provides no benefit to ag reaches	

7.0 FORMULATION OF A RECOMMENDED PLAN

The recommended plan was chosen after a comparison of cost, feasibility, local acceptance, and benefits of the various options. Based on the detailed evaluation of the eleven alternatives and their variants presented in the previous chapter, Alternative 1 Option N (30-foot shelf from downstream of Tobin Ditch upstream to CR 400S) and Alternative 10 (update and enforce ordinances) are recommended. This recommended plan does not entirely meet the criteria developed in Chapter 3. However, because cost is a limiting factor, a recommended plan was chosen that maximized benefit for the expected available funding.

If additional funding becomes available, the alternatives should be reevaluated. For example, Alternative 1 Option G (200-foot channel improvement thru town and 130-foot channel improvement from CR 200W upstream to Prairie Creek) would provide 100-year protection through the City of Tipton and 5- to 10-year protection in the agricultural reaches. Estimated costs for this option were $17.4 million. Another example is Alternative 1 Option L (60-foot shelf channel improvement from downstream of Tobin Ditch upstream to CR 400S) which is a more extensive version of the recommended plan. For the $4.9 million required to construct the latter alternative, the time that flood waters are out of bank in the agricultural reaches could be reduced to about 24 hours for the 2-year flood, about half the time of that achieved with the recommended plan.

Based on current expected funding availability and the analysis of the options presented in Chapter 6, Alternative 1 Option N (30-foot shelf from downstream of Tobin Ditch upstream to CR 400S) and Alternative 10 (update and enforce ordinances) are selected as the Recommended Plan. **Exhibits 2, 3,** and **4** show the approximate 2-, 10-, and 100-year floodplains, respectively, for the recommended plan compared to the existing-condition floodplains. **Exhibits 5**, **6**, and **7** provide the same information but with more detail for the flooded areas in town. Details regarding each recommended plan component are provided below.

7.1 RECOMMENDED PLAN COMPONENT 1 – EXTEND HYDRAULIC MODEL DOWNSTREAM TO MORSE RESERVOIR

This plan component would allow the evaluation of impacts to downstream properties if the recommended plan is constructed. The additional modeling would include a total of about 10 miles, approximately 5 miles in Tipton County for which additional topographic mapping or survey data would need to be obtained and approximately 5 miles in Hamilton County for which the Hamilton County GIS data could be used. Existing FIS modeling for the remaining reach downstream to the reservoir could be used to complete the model for the entire reach. Data for approximately 8 bridge openings would also have to be obtained.

It is recommended that although only the 2-, 10-, and 100-year floods would need to be modeled to determine any negative impacts, the 500-year flood and floodway calculations should be included. The addition of these two items is minimal in terms of cost but has the benefit of providing more complete modeling to IDNR for inclusion in the future Countywide updated FIS. This information would then be readily available for floodplain management and regulatory purposes. The estimated cost of this recommended plan component is about $60,000.

7.2 RECOMMENDED PLAN COMPONENT 2 – 30-FOOT SHELF CHANNEL IMPROVEMENT FROM ABOUT 2800' DOWNSTREAM OF TOBIN DITCH UPSTREAM TO CR 400 SOUTH

This plan component, previously identified as Alternative 1 Option N, would consist of a channel improvement along the entire reach from about 2,800 feet downstream of Tobin Ditch upstream to CR 400 South that consists of a 3-foot' shelf at an elevation 3 feet above the existing channel invert. The shelf would have a 1% slope towards the ditch and would slope at 2:1 back up to existing grade. A typical cross section with and without the proposed channel improvement is shown below in **Figure 25**. The channel improvement would extend from about 2,800 feet downstream of Tobin Ditch up to County Road 400 South. The estimated construction cost of this component is about $1.9 million. Adding land acquisition costs brings the estimated cost to about $2.7 million.

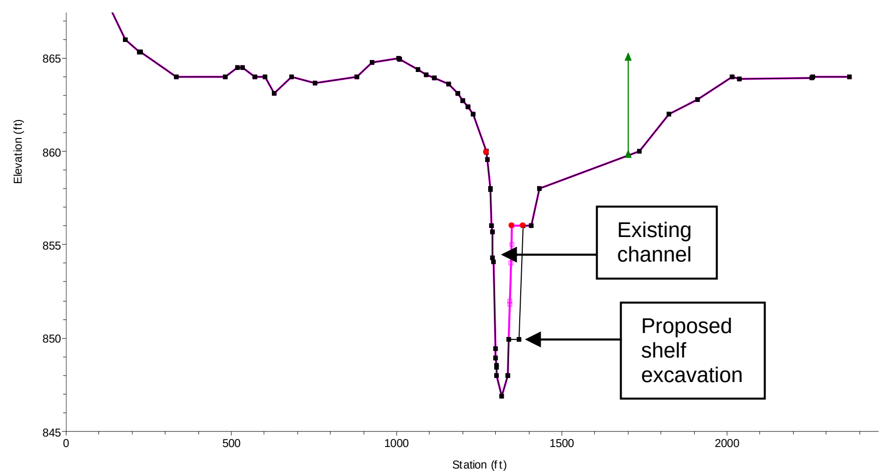


Figure 25: Typical proposed and existing condition cross section

This component would accomplish a portion of the objectives by eliminating flood damages below the 10-year frequency flood in the town of Tipton and reducing the time that crops would be flooded by the 2-year flood to less than two days and about two and a half days for the 10-year flood.

A comparison of the 10-year frequency flood profile with and without Alternative 1, Option N is shown below in **Figure 26**. Existing conditions are shown in the solid line. The proposed condition is shown by the dashed line.

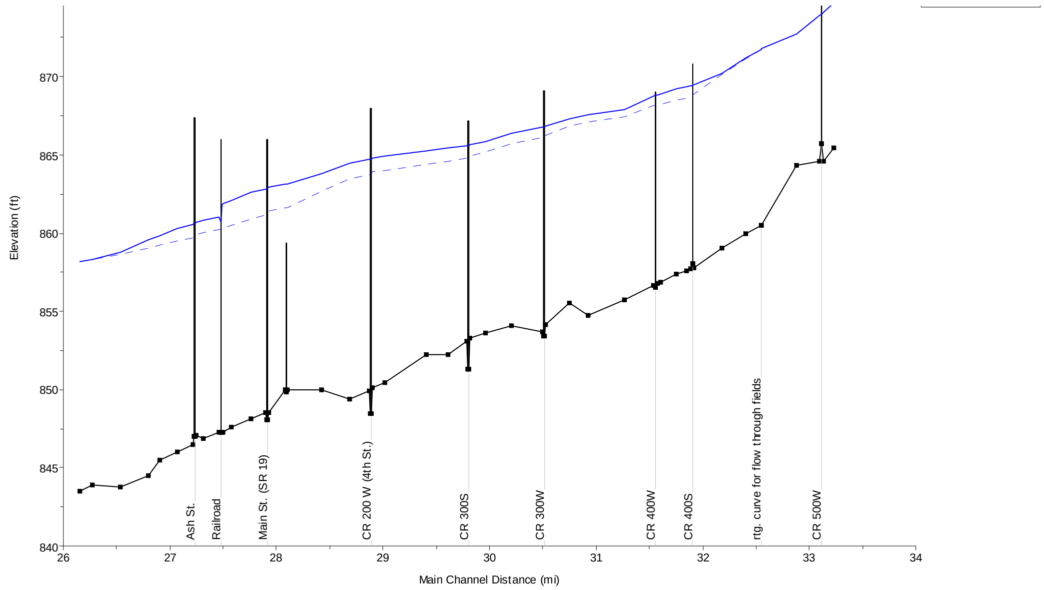


Figure 26: Comparison of 10-year Frequency Profile With and Without Recommended Plan

A comparison to the 2-year frequency flood profile with and without Alternative 1, Option N is shown below in **Figure 27**. Existing conditions are shown in the solid line. The proposed condition is shown by the dashed line.

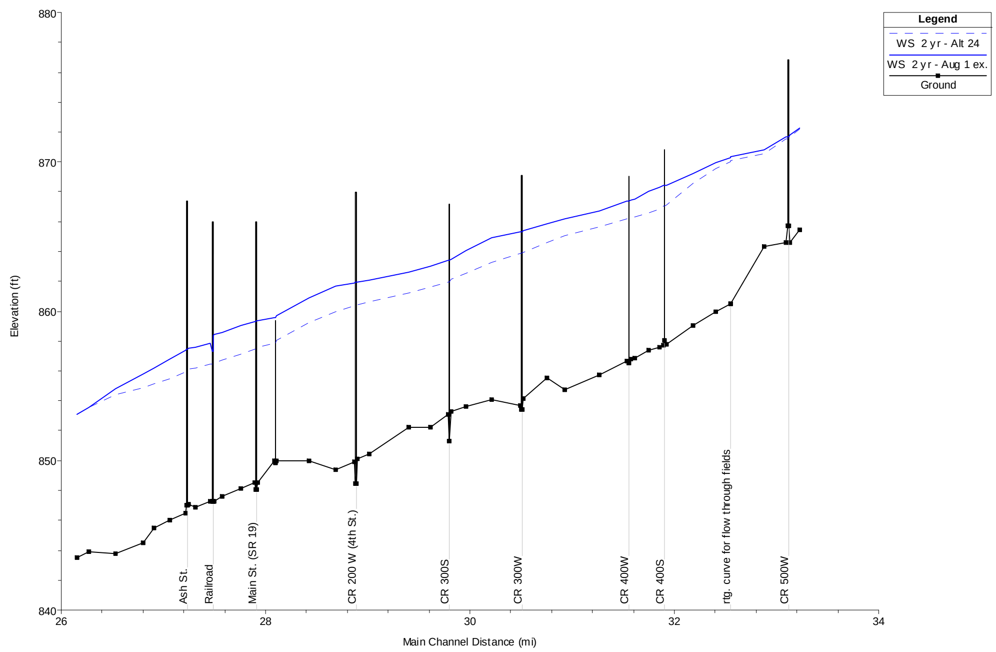


Figure 27: Comparison of 2-year Frequency Profile With and Without Recommended Plan

This project would produce about 195,000 cubic yards of excavated soil that will need to be disposed of or stockpiled. Location of the stockpile will impact construction cost due to haul distances.

7.3 RECOMMENDED PLAN COMPONENT 3 – PROVIDE A COPY OF STUDY RESULTS TO LOCAL PLANNING OFFICIALS AND SUBMIT TO IDNR FOR INCLUSION IN FUTURE COUNTYWIDE FIS

This component would provide a copy of the floodplain mapping and expected water surface elevations developed during this study to local planning officials for use as best available data to assist them in guiding future development away from areas of flood risks. The analysis would also be submitted to IDNR to be incorporated into the upcoming Countywide FIS mapping initiative.

7.4 RECOMMENDED PLAN COMPONENT 4 – MINIMIZE THE IMPACTS ON FLOODPLAINS THROUGH STRICT ENFORCEMENT OF STORMWATER AND FLOODPLAIN ORDINANCES

This plan component, previously identified as Alternative 10, would require strict enforcement of updated stormwater (especially, requiring on-site detention without exceptions) and updated floodplain (requiring compensatory floodplain storage and appropriate flood protection grade elevations) ordinances within the Big Cicero Creek watershed. Bridge construction/replacement should also be required to be designed such that the 100-year and more frequent flood elevations are not increased.

This component would accomplish the objective of reducing additional flooding problems due to future development. This component is especially important in the vicinity of Buck Creek. If present storage and flow capacity is not maintained or runoff volumes are increased, flooding along Buck Creek will be due to the Buck Creek watershed itself and not backwater from Big Cicero Creek. The benefit derived from the recommended plan will be lost in the Buck Creek vicinity if this happens. The estimated cost of developing new ordinances is approximately $10,000.

7.5 RECOMMENDED PLAN COMPONENT 5 – MAINTAIN THE CURRENT USGS STREAM GAGE ON BIG CICERO CREEK AND ADD ADDITIONAL GAGES AT KEY LOCATIONS IN THE WATERSHED

Plan Component 5 would have the Drainage Board, County, and/or City of Tipton coordinate with the USGS to ensure the existing stream gage located near Arcadia is maintained and that additional gages be added in the watershed.

Based on a review of the watershed, it is recommended that additional stream gages be installed at Ash or Main Street in Tipton and at the CR 500 West crossings of Big Cicero Creek and Prairie Creek. These stream gages would provide ongoing data regarding stream flow that can be used in the future to update hydrologic analyses of the watershed and to evaluate impacts of various projects in the watershed.

The cost to the local entity for each gage would be approximately $10,000 for the initial installation and an additional $5,000 per year for maintenance. The total cost of this component would be approximately $30,000 with ongoing annual maintenance costs of about $15,000.

8.0 IMPLEMENTATION PLAN

The following suggested implementation plan is provided to guide completion of the recommended plan components. The items are listed in the recommended order of priority. Item 3 is the biggest part of the proposed plan. It includes Recommended Plan Component 1 as presented in the previous chapter.

1 – Updating and Enforcement of Stormwater Management and Floodplain Ordinances

The existing stormwater and floodplain ordinances for Tipton County and the Town of Tipton need to be updated to include several "no adverse impact" provisions to insure flood damages are not increased and that the positive effect of other recommended plan components are not lost. In addition, it is critical that City and County officials strictly enforce these updated stormwater management and floodplain ordinances to prevent further increases in potential flood damages in the watershed. All future proposed construction should be forced to meet all requirements of the ordinances to include on-site detention necessary to reduce future-condition flow rates, i.e., no direct release, and no net loss of floodplain storage due to development. Future proposed construction such as bridges should also not increase flood elevations of any frequency flood. This component should be implemented immediately.

In addition to the FEMA FIS maps, the floodplain mapping from this study could be made available to the City and the County to use as an aid in keeping construction out of the floodplain.

2 – Extend Hydraulic Model Downstream To Morse Reservoir and Incorporate into IDNR Updated Countywide FIS Mapping

To complete this component, the following actions would be needed:

- Submit the detailed report contained in Volume 2 presenting the revised hydrologic modeling for the watershed and request concurrence with the proposed revised Coordinated Discharge values.

- Obtain two-foot contour mapping of the reach between the mapping obtained for this project and the Hamilton County line, approximately 5 miles long.

- Obtain survey data for the approximately eight bridges in the reach from the existing study downstream to the existing FIS reach near Morse Reservoir in Hamilton County.

- Complete 2-, 10-, 100-year modeling of the additional approximate 10 mile reach.

- Perform the necessary calculations to determine the 500-year floodplain and the floodway limits for the entire study reach (the 10 mile extended reach and the 7 mile reach studied for this report.)

- Prepare and submit a detailed report presenting the revised and extended hydraulic analysis of Big Cicero Creek.

- Coordinate with IDNR and FEMA staff regarding their review of the reports.

<u>3 – Design and Construct Channel Improvements</u>

The following actions would be required to complete this component:

a. <u>Funding Analysis and Plan</u>

In order to manage the anticipated costs associated with the construction of the Channel Improvement project and to assure the timely availability of funds for project completion, a funding plan should be prepared. The noted funding plan should examine the benefits of completing the project. This data may be available for promotion of the project to the public or for further refinement and use by the Big Cicero Creek Joint Drainage Board. It is anticipated that this plan element would be performed primarily by the Board or their designated funding consultant. This analysis and plan may incorporate some of the following tasks.

- Coordinate the refinement of anticipated project costs with engineering staff.

- Determine the availability of funds for the project.

- Examine funding needs and timing of available funds.

- If private funds or donation of services and/or land easements are to be used in completing the project and associated goals, then formalization of these commitments should be pursued.

- Formal applications and support documentation for non-local funds should be pursued.

It is anticipated that the funding would come from increases in the assessments charged to land owners within the watershed. This could be done for up to eight years to accumulate money for the project. Future costs of construction would have to be factored in if construction is to be postponed until sufficient funds can be accumulated.

Other potential sources of funding to deal with various aspects of the flood mitigation aspects include the following. A community can contact the Indiana Department of Homeland Security, Mitigation branch about available monies. Some of the funds are disaster declaration driven. Other funds are available to communities with all hazard mitigation plans. There has been at least one County that applied for money from the riverboat funds at the State that were used for buyouts of floodprone property. The Department of Commerce may also be developing a program that would make monies available for communities as well.

b. Detailed Survey and Data Acquisition

In order to develop design plans and final construction drawings, detailed survey data of the selected project sites and adjacent areas need to be collected. This survey would be of a detailed level adequate for the remaining tasks relating to the project.

c. Negotiation and Acquisition of Easements

The easements required for construction must be acquired. This should be done before initiating detailed design activities.

d. Design Plan Development

Upon the Drainage Board's approval of project concepts and availability of detailed survey information, design plans in sufficient detail would need to be produced for the ultimate submittal to the IDNR and other regulatory agencies. Preliminary project details and specifications would also be generated as necessary for agency submittal.

e. Hydrologic and Hydraulic Evaluation of Proposed Project

The results of the modeling developed by CBBEL for the alternatives analysis would need to be refined to reflect the project design plans. Refinements must be made to reflect the specific site characteristics and their effects on the hydrologic and hydraulic modeling previously developed, and to finalize the parameters needed for design.

f. Construction Permit Submittals

The proposed project incorporates engineering and environmental factors which would require the review of the construction to assure acceptability to the applicable state and federal review agencies. It is assumed for the implementation plan that local approval of the project is granted due to Board sponsorship. Other agency submittals will require varied information depending on the particular agency and submittals will be made at varied times. Each of the anticipated primary permits is outlined within this plan.

1. **<u>IDNR Construction in a Floodway Permit Application</u>**

   This permit would be required to evaluate the project's impact on the conveyance of flood flows and to ensure the project will not impact persons, property, or the environment as stated in the 1945 Flood Control Act, as amended.

2. **<u>US Army Corps of Engineers Section 404 Waters of the United States, Wetland Permit</u>**

   The channel construction will likely fall under USACE jurisdiction and require a permit under Section 404.

3. **<u>Indiana Department of Environmental Management, Section 401, Water Quality Certification and Rule 5 Permit</u>**

   This project will likely require a Section 401 Water Quality Certification and Rule 5 Permit from the IDEM.

g. <u>Permit Review Coordination</u>

This component would consist of tracking the advancement of permit applications through the permit review process. During this period, any concerns or questions regarding the project from the agencies will be addressed. Reports of project status, and any potential amendments to the plan will be documented and coordinated with the City during this period.

h. <u>Preparation of Construction Drawings, Specifications, and Bid Documents</u>

Some of work to be completed during this period would include the following.

- Development of final construction drawings based on detailed design plans that include grading, erosion control, structural plans, and associated details and specifications.

- Bid documents would need to be prepared in order to put the project to bid.

i. <u>Acquire Contractor Bids</u>

The final design plans, specifications, and bid documents would need to be submitted for bid. This task would be coincidental with several other implementation tasks. It is anticipated that a standard bid process would be undertaken.

j. Project Construction

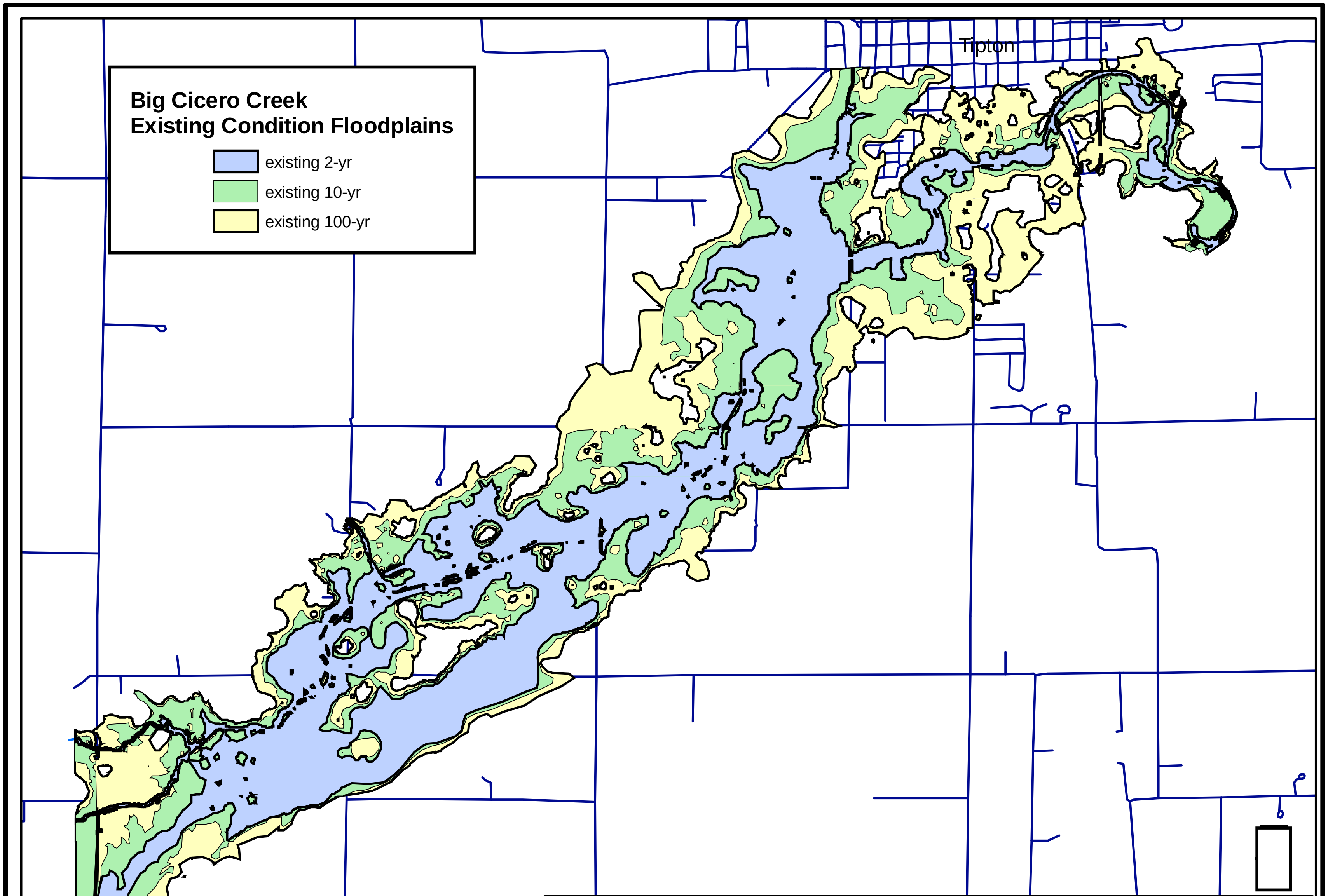
After awarding the contract, issuance of all applicable permits, securing of funds, and any other required tasks are performed, the City may issue notice to proceed to the contractor. Construction of the project is anticipated to have inspection by the City or their designee to assure compliance with the proposed design.

k. Public Information Meetings

To allow public input and to describe the project to applicable elected officials, meetings regarding the project plan, design, construction, agency qualification or related project elements may be part of the implementation plan. These tasks would need to be implemented throughout the project.

APPENDIX 1

HEC-RAS Steady Flow Output for Existing Conditions 1A, 1B, 1C, 1D, 1E, 1F, 1G, 1H, 1I, 1J, 1K, 1L, 1M, 1N, 2B, 4A, 4B, 5, 6, and 7.



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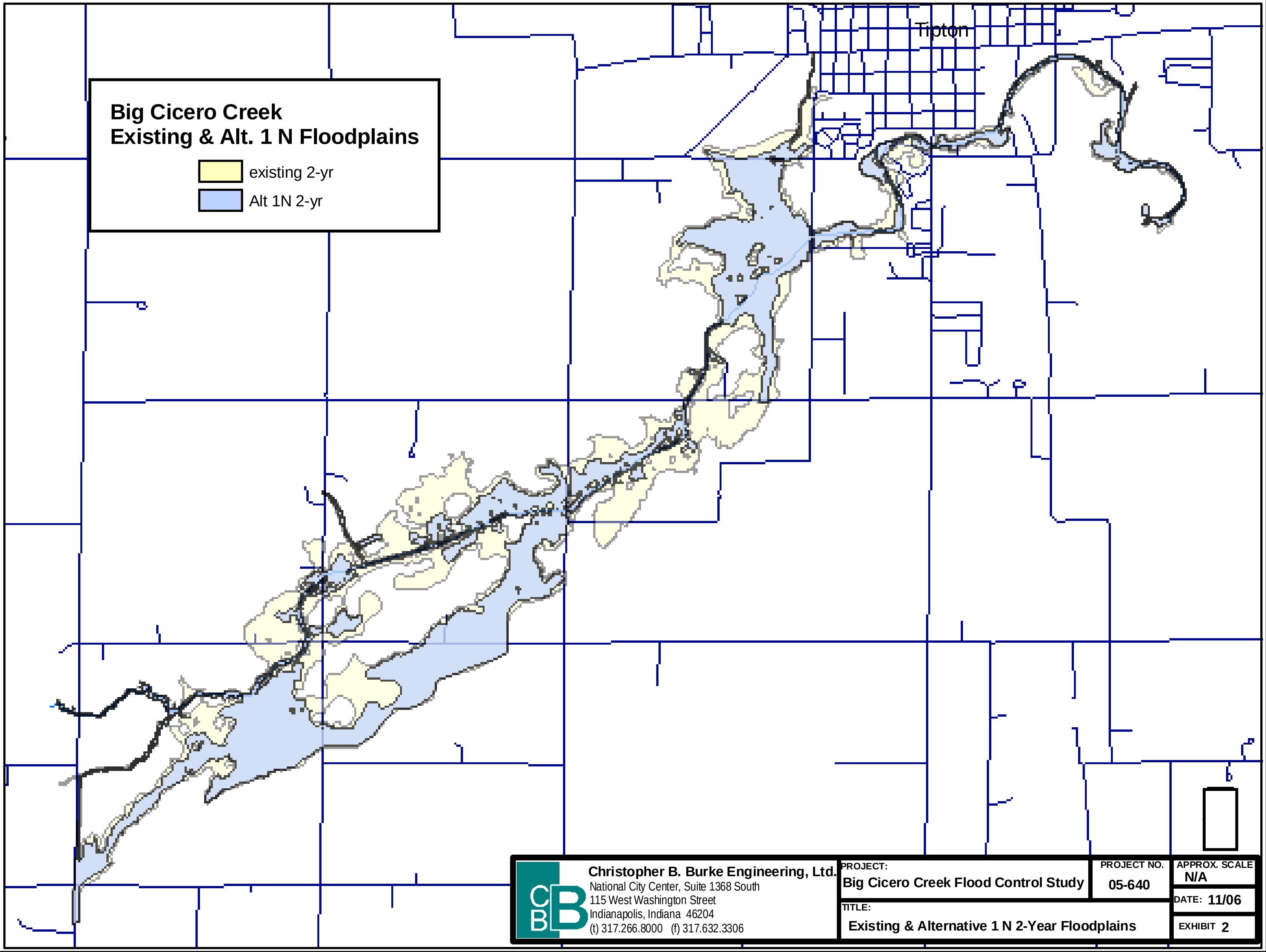
PROJECT:	Big Cicero Creek Flood Control Study
PROJECT NO.	05-640
APPROX. SCALE	N/A
DATE:	11/06
TITLE:	Existing Condition 2-, 10-, and 100-yr Floodplain
EXHIBIT	1



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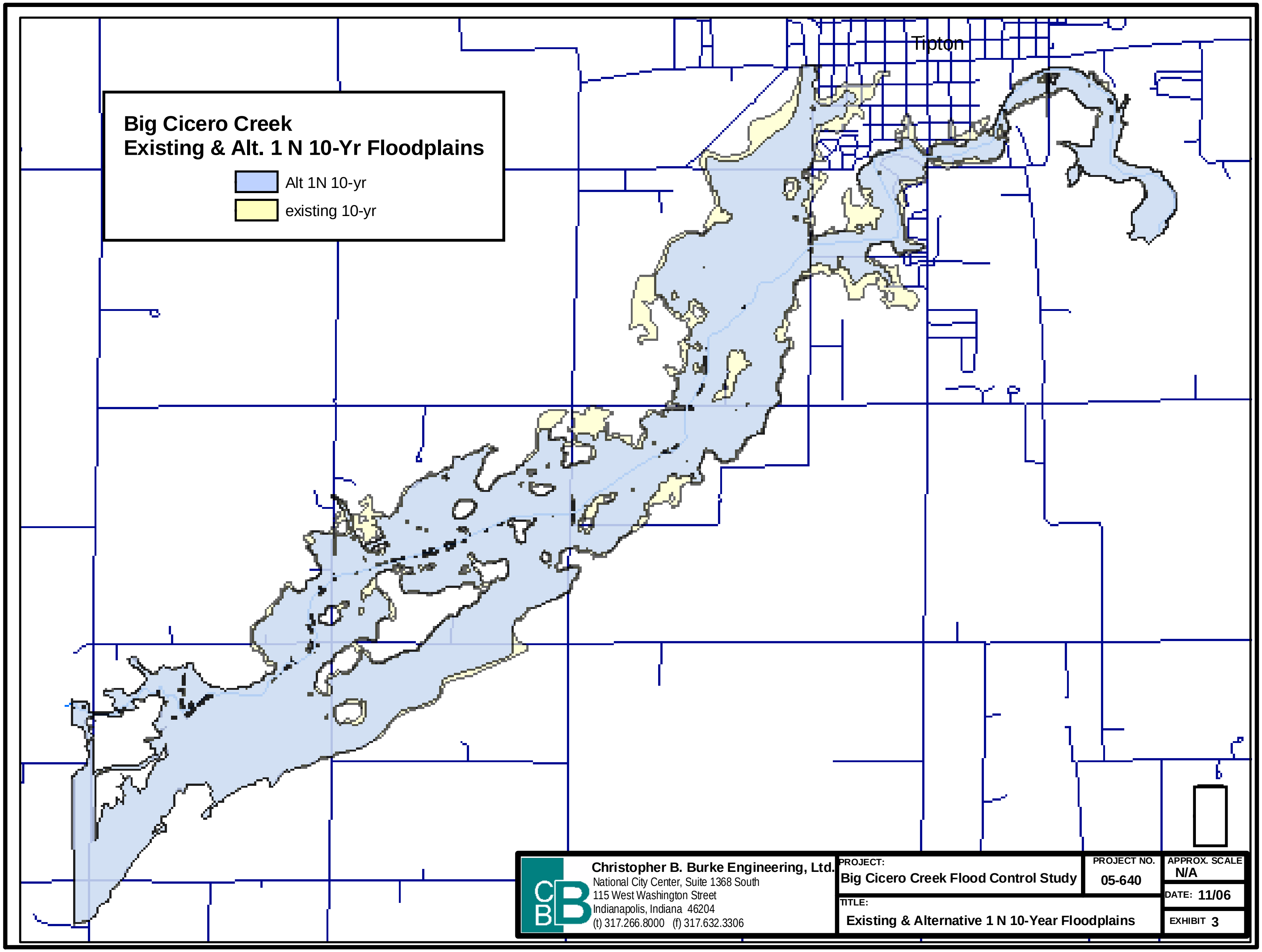
PROJECT: Big Cicero Creek Flood Control Study	PROJECT NO. 05-640	APPROX. SCALE N/A	
		DATE: 11/06	
TITLE: Existing & Alternative 1 N 2-Year Floodplains		EXHIBIT 2	


Big Cicero Creek
Existing & Alt. 1 N 10-Yr Floodplains
Alt 1N 10-yr
existing 10-yr
Tipton
Christopher B. Burke Engineering, Ltd.
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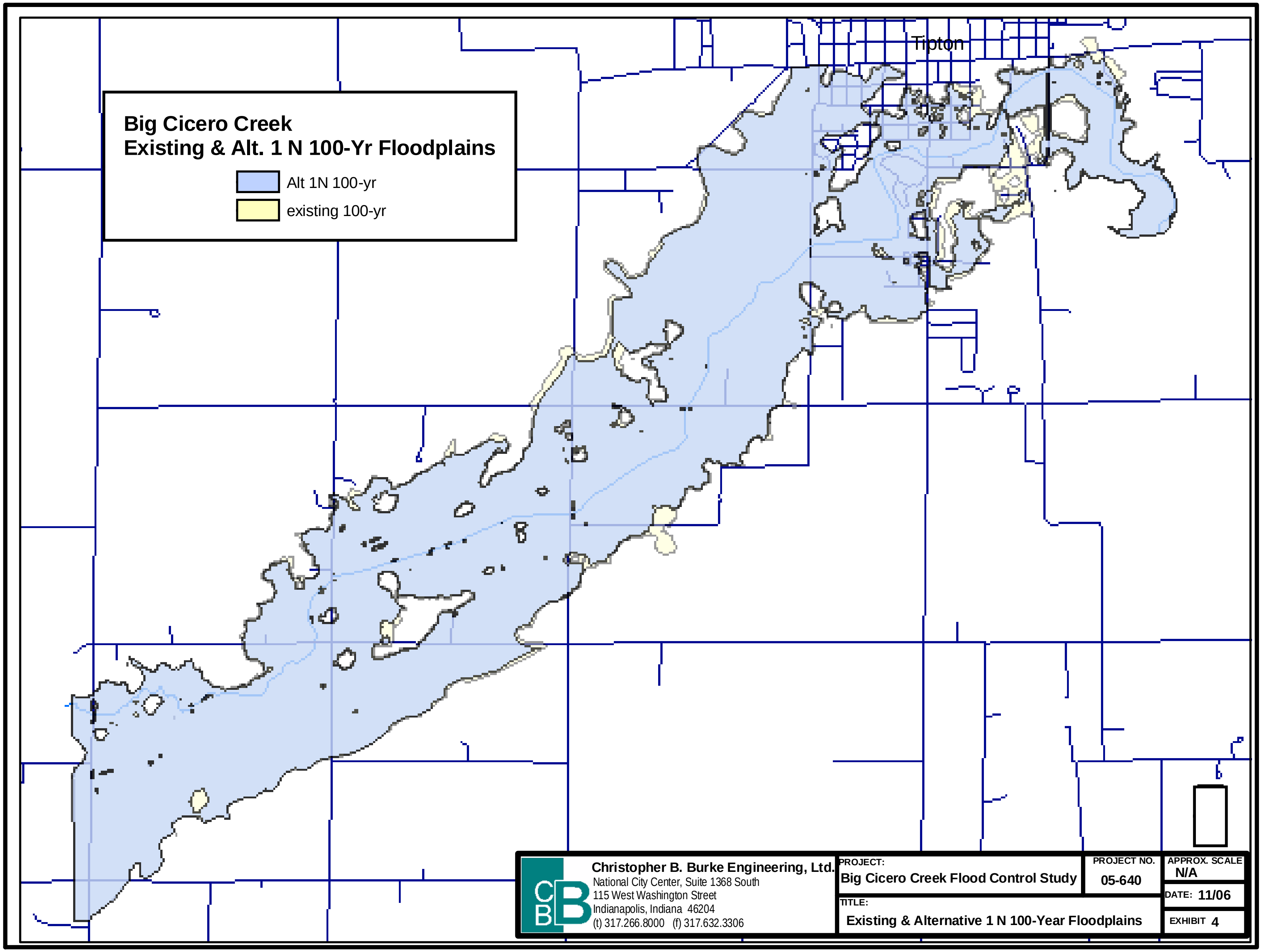
PROJECT:
Big Cicero Creek Flood Control Study
PROJECT NO.
05-640
APPROX. SCALE
N/A
DATE: 11/06
TITLE:
Existing & Alternative 1 N 10-Year Floodplains
EXHIBIT 3


Big Cicero Creek
Existing & Alt. 1 N 100-Yr Floodplains
Alt 1N 100-yr
existing 100-yr
Tipton
Christopher B. Burke Engineering, Ltd.
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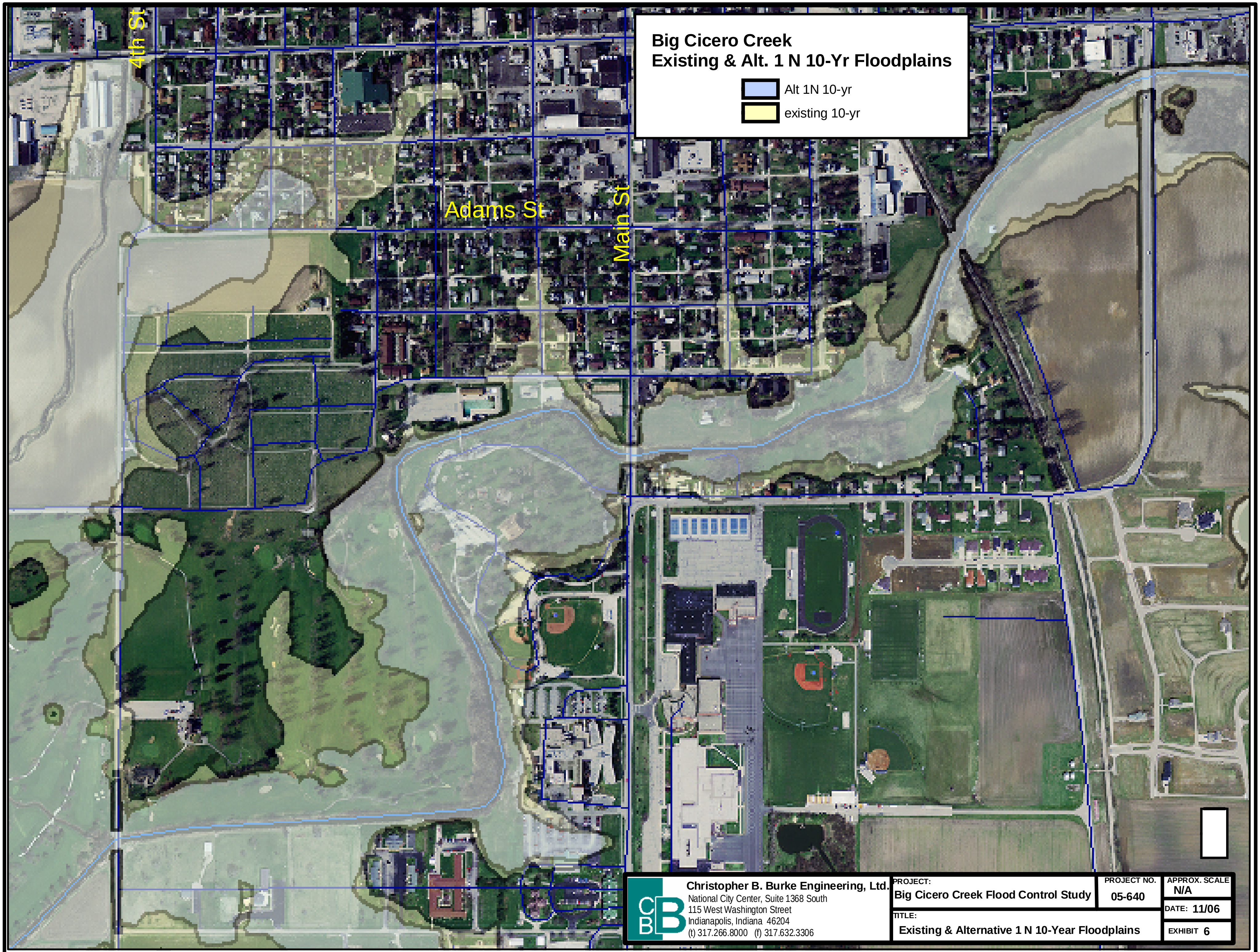
PROJECT NO.
05-640
APPROX. SCALE
N/A
DATE: 11/06
TITLE:
Existing & Alternative 1 N 100-Year Floodplains
EXHIBIT 4

Big Cicero Creek
Existing & Alt. 1 N Floodplains
existing 2-yr
Alt 1N 2-yr
4th St
Adams St
Main St
Christopher B. Burke Engineering, Ltd.
National City Center, Suite 1368 South
115 West Washington Street
Indianapolis, Indiana 46204
(t) 317.266.8000 (f) 317.632.3306
PROJECT:
Big Cicero Creek Flood Control Study
PROJECT NO.
05-640
APPROX. SCALE
N/A
DATE: 11/06
TITLE:
Existing & Alternative 1 N 2-Year Floodplains
EXHIBIT 5


Big Cicero Creek
Existing & Alt. 1 N 10-Yr Floodplains
Alt 1N 10-yr
existing 10-yr
4th St
Adams St
Main St
Christopher B. Burke Engineering, Ltd.
National City Center, Suite 1368 South
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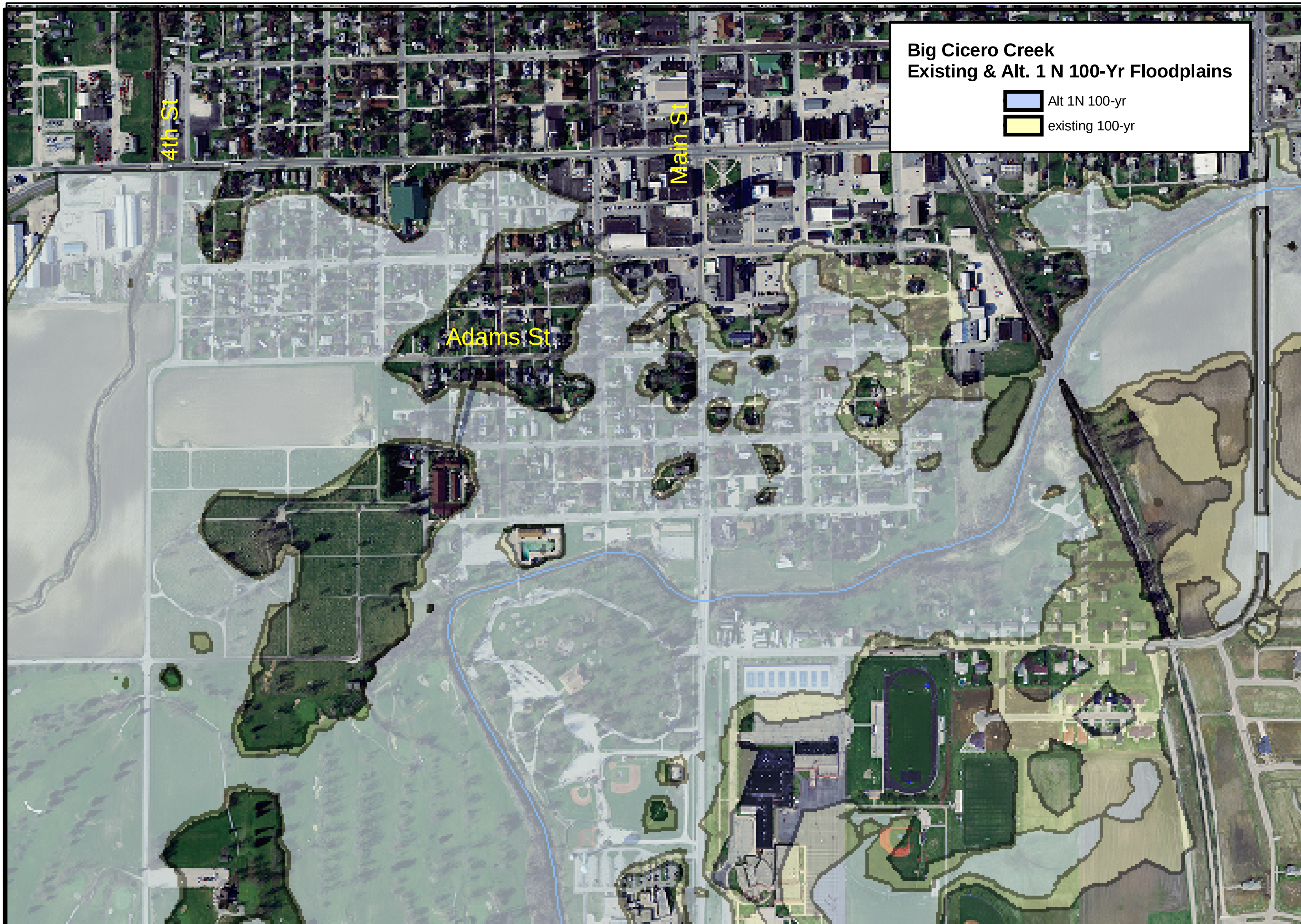
PROJECT:
Big Cicero Creek Flood Control Study
PROJECT NO.
05-640
APPROX. SCALE
N/A
DATE: 11/06
TITLE:
Existing & Alternative 1 N 10-Year Floodplains
EXHIBIT 6



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PROJECT:	PROJECT NO.	APPROX. SCALE
Big Cicero Creek Flood Control Study	05-640	N/A
TITLE: Existing & Alternative 1 N 100-Year Floodplains		DATE: 11/06
		EXHIBIT 7

APPENDIX 2

Detention Basin Calculations for Options 3A, 3B and 11C

APPENDIX 3

HEC-HMS Results for Options 3C and 3D

APPENDIX 4

HEC-RAS Steady Flow Output for Option 4C, 4D, and 11B

APPENDIX 5

HEC-RAS Steady Flow Output for Option 4E

APPENDIX 6

Cost Estimates