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Executive Summary

Background

The Metropolitan Water Reclamation District of Greater Chicago (District) has authority for regional stormwater management within Cook County as granted by the Illinois General Assembly in Public Act 93-1049 (the Act). The Act requires the District to develop watershed plans for six Cook County watersheds, which include the North Branch of the Chicago River, Lower Des Plaines River, Calumet-Sag Channel, Little Calumet River, Poplar Creek, and Upper Salt Creek. The District published the *Cook County Stormwater Management Plan* (CCSMP) in February 2007 to identify stormwater management goals and to outline the District's approach to watershed planning. Chapter 6 of the CCSMP defines the District's approach and standards for Detailed Watershed Plans (DWPs), which address regional stormwater problems in Cook County. The six major watersheds for which DWPs are being developed cover approximately 730 square miles in Cook County. The primary goals of the DWPs are as follows:

- Document stormwater problem areas.
- Evaluate existing watershed conditions using hydrologic and hydraulic (H&H) models.
- Produce flow, stage, frequency, and duration information about flood events along regional waterways.
- Estimate damages associated with regional stormwater problems.
- Evaluate potential solutions to regional stormwater problems.

The Little Calumet River DWP was developed to meet the goals for the Little Calumet River Watershed as described in the CCSMP. The Act required the formation of Watershed Planning Councils (WPCs) to advise the District during development of its countywide stormwater management program; therefore, the DWPs were developed in coordination with the WPCs. Membership of the WPCs consists of the chief elected official of each municipality and township in each watershed, or their designees. Many municipalities and townships were represented by engineers, elected officials, or public works directors. WPC meetings were also open to the public. Frequent coordination with WPCs was performed to ensure that local knowledge is integrated into the DWP and the DWP reflects the communities' understanding of watershed issues as well as the practicability of proposed solutions.

Detailed Watershed Plan Scope

The scope of the Little Calumet River DWP includes the development of stormwater improvement projects to address regional problem areas along open waterways. Regional problems are defined as problems associated with waterways whose watersheds encompass multiple jurisdictions and drain an area greater than 0.5

square miles. Problems arising from capacity issues on local systems, such as storm sewer systems and minor open channel ditches, even if they drain more than one municipality, were considered local and beyond the scope of this study. Erosion problems addressed in this plan were limited to active erosion along regional waterways that pose an imminent risk to structures or critical infrastructure. Interstate highways, U.S. highways, state routes, county roads with four or more lanes, and smaller roads providing critical access that are impacted by overbank flooding of regional waterways at depths exceeding 0.5 feet were also considered regional problems.

Assistance with developing the Little Calumet River DWP was provided by a team of consulting firms led by CDM, including the following companies:

- AECOM
- FluidClarity
- Molly O'Toole and Associates
- EDI
- Terra Engineering
- Kabbes Engineering

Watershed Overview

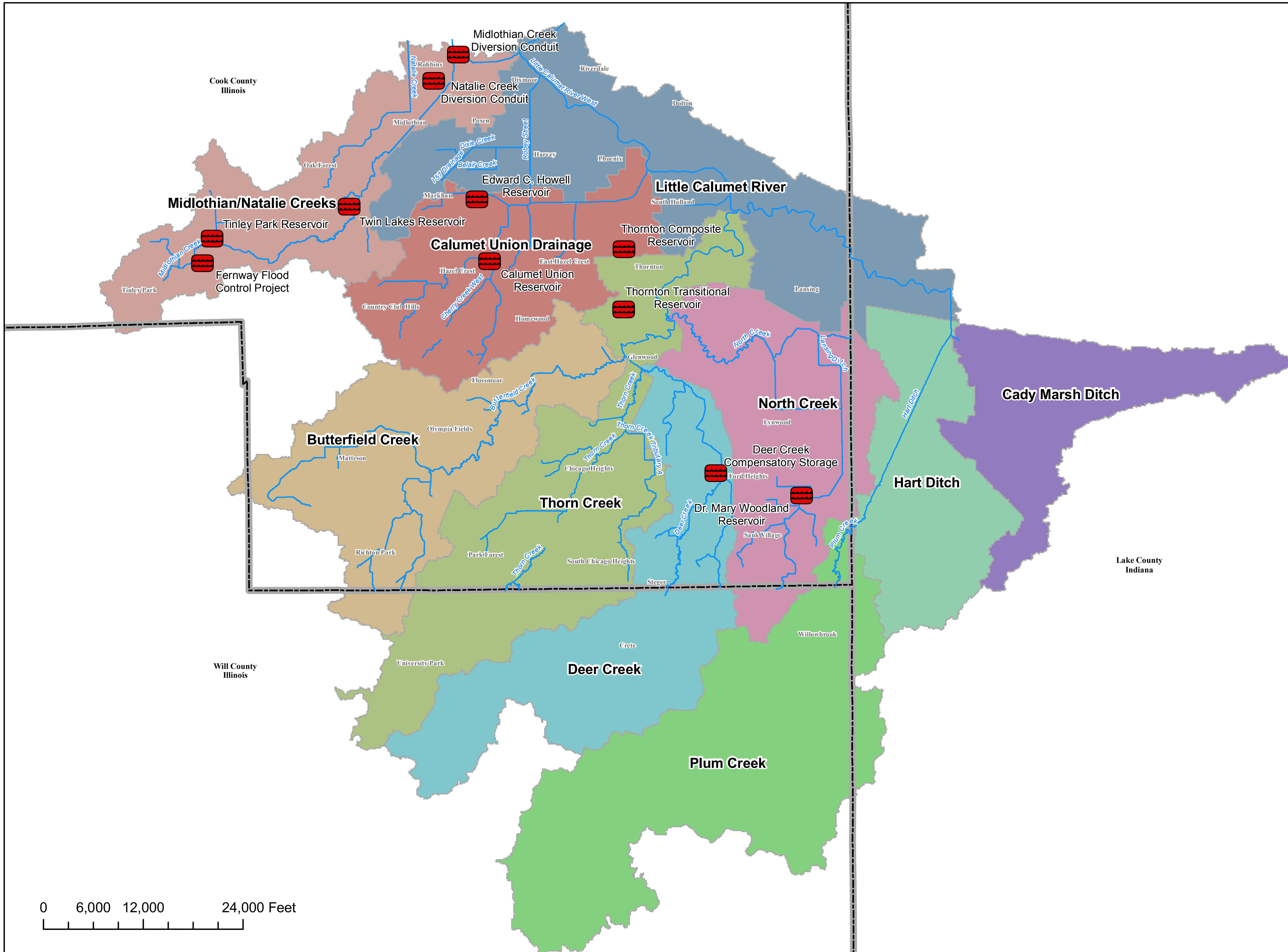
The Little Calumet River Watershed is located predominantly in the southeast portion of Cook County and has a total area of 264.6 square miles: 159.6 square miles lie in Cook County, 61.4 square miles in Will County, and 43.6 square miles in Lake County, Indiana. The watershed is bound on the north by Blue Island, on the south by Monee, on the west by Tinley Park, and on the east by Gary, Indiana. See **Figure ES.1**.

Figure ES.1

LITTLE CALUMET RIVER WATERSHED OVERVIEW MAP

Little Calumet River DWP

December, 2009



CDM

The watershed is delineated in nine (9) subwatersheds: Butterfield Creek, Cady Marsh Ditch, Calumet Union Drainage Ditch, Deer Creek, Little Calumet River, Midlothian Creek, North Creek, Plum Creek/Hart Ditch, and Thorn Creek. These subwatersheds are:

Butterfield Creek Subwatershed: The Butterfield Creek subwatershed drains approximately 26 square miles (24.35 in Cook County and 1.5 in Will County) from the headwaters near the intersection of Ridgeland Avenue and Lincoln Highway in Unincorporated Cook County and extends to the confluence with Thorn Creek, located near the Chicago Heights Glenwood Road and 187th Street intersection in Glenwood. Butterfield Creek is approximately 25 stream miles in length with 10 tributaries. There are no major regional flood control facilities within the Butterfield Creek subwatershed.

Cady Marsh Ditch Subwatershed: The Cady Marsh Ditch subwatershed is located in Indiana and drains approximately 16 square miles from the headwaters near north of 45th Avenue and east of Cleveland Street in Gary, Indiana to its confluence with Hart Ditch at West of US Route 41 and south of Ridge Road in Munster, Indiana. Cady Marsh Ditch is 6.8 stream miles in length and has one flood control facility.

Calumet Union Drainage Ditch Subwatershed: The Calumet Union Drainage Ditch subwatershed drains approximately 20 square miles and has 15 tributaries with headwaters starting near 161st Street and Central Park Avenue in Markham. The subwatershed discharges to the Little Calumet River just east of State Street in South Holland. The Calumet-Union Drainage Ditch is approximately 31 stream miles in length. There are two flood control facilities within this subwatershed.

Deer Creek Subwatershed: The Deer Creek subwatershed drains approximately 26 square miles (8.8 in Cook County and 17.5 in Will County) from the headwaters at Steger Road, 1.5 miles west of Illinois Route 394 (Calumet Expressway) and flows to the confluence with Thorn Creek within the Cook County Forest Preserve, 0.25 miles southwest of the intersection of State Street and Main Street in Glenwood. Deer Creek is approximately 15 stream miles in length. There is one flood control facility within this subwatershed, located within Ford Heights.

Little Calumet River Subwatershed: The Little Calumet River subwatershed includes the main stem of the Little Calumet River, with major tributaries including Midlothian Creek, Calumet Union Drainage Ditch, Thorn Creek, and Plum Creek. The subwatershed drainage area, not including the tributaries, is approximately 33 square miles (27.66 in Cook County and 4.86 in Lake County, IN) from the headwaters near west of Highway 41 at Hammond to its confluence with the Calumet-Sag Channel at Calumet Park. The length of the Little Calumet River within the Cook County is approximately 14 stream miles. There is one regional flood control facility within the Cook County portion of the subwatershed and one flood control facility on the Indiana portion of the subwatershed.

Midlothian Creek Subwatershed: The Midlothian Creek subwatershed drains approximately 21 square miles (20.57 in Cook County and 0.09 in Will County) from the headwaters near west of 84th Avenue and 175th Street extending to the confluence with the Little Calumet River. Midlothian Creek is approximately 23 stream miles in length with seven tributaries. There are five major flood control facilities within the subwatershed.

North Creek Subwatershed: The North Creek subwatershed drains approximately 23 square miles (19.46 in Cook County, 1.33 in Will County and 2.16 in Lake County, IN). There are seven tributaries within the subwatershed, including North Creek main tributary, totaling over 23 stream miles. The headwater starts near east of Wentworth Avenue in Lansing to the confluence with Thorn Creek in Thornton. There is one major flood control facility within the subwatershed.

Plum Creek/Hart Ditch Subwatershed: The Plum Creek/Hart Ditch subwatershed drains approximately 54 square miles (33.03 in Will County, 1.07 in Cook County and 19.82 in Lake County, IN) from the headwaters at south of Church Road and east of Western Avenue in Unincorporated Will County. The creek is named Plum Creek in Will and Cook Counties and Hart Ditch in Indiana. It flows northeasterly and crosses into Unincorporated Cook County at Steger Road (231st Street) east of Burnham Avenue, continues approximately 3 miles northeast through the Plum Creek Forest Preserve, and crosses into Indiana near Forest Park Drive in Dyer, Indiana. The creek continues as Hart Ditch for approximately 6 miles to its confluence with the Little Calumet River, approximately 0.5 miles southwest of Interstate 80 and US Route 41 in Munster, Indiana. There are no major flood control facilities within the subwatershed.

Thorn Creek Subwatershed: The Thorn Creek subwatershed includes the main stem of the Thorn Creek, with major tributaries including Butterfield Creek, Deer Creek and North Creek. The subwatershed drainage area, not including the major tributaries, is approximately 32 square miles (22.86 in Cook County and 8.92 in Will County) from the headwaters near Steger Road and Western Avenue at the boundary between Cook and Will counties in Park Forest to the confluence with the Little Calumet River 0.5 miles north of 170th Street in South Holland. Thorn Creek is approximately 27 stream miles in length and currently has two major flood control facilities: the Thornton Transitional Reservoir and Sauk Trail Lake. The Thornton Composite (CUP) Reservoir is planned to replace the Thornton Transitional Reservoir, estimated to be completed by 2014.

The predominant land use in the watershed (Cook and Will Counties, Illinois) is classified as residential (35%). Approximately 20% of the watershed is undeveloped land (agriculture and vacant land) and 28% is classified as open space (parks, cemeteries, golf courses, wetlands, etc.). The remaining land is mostly classified as commercial, industrial, and institutional, as shown in the following table.

Table ES.1: Little Calumet River Watershed - Land Use Status by Category (Only for Cook County)

Land Use	Area (acres)	Percentage of Watershed (%)
Residential	38,996	30.7
Forest/Open Land	22,815	29.5
Commercial/Industrial	11,482	4.6
Water/Wetland	1,997	1.7
Agricultural	9,151	30.9
Transportation/Utility	4,469	1.3
Institutional	4,048	1.2
TOTAL	**92,958**	**100**

Existing Conditions Evaluation

Locations with historic flooding and stream bank erosion problems on regional waterways exist throughout the watershed. Information on existing problem areas was solicited from WPC members as well as federal and state agencies and other stakeholders during the data collection and evaluation phase of DWP development, which also included the collection of data regarding the watershed and evaluation of the data's acceptability for use. The reported stormwater problems are summarized in **Section 2** and also discussed in each tributary subsection. Responses from stakeholders were used to help identify locations of concern, and where field assessment or surveys were needed to support hydrologic and hydraulic modeling.

Hydrologic models were developed to represent runoff generated by rainfall throughout the Little Calumet River Watershed. The runoff was then routed through hydraulic models, which were created for the major open channel waterways within the watershed. Design rainfall events were simulated for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval events based upon Bulletin 71 rainfall data (ISWS, 1992). The simulated water surface profiles were overlaid upon a ground elevation model of the study area to identify structures at risk of flooding.

Property damages due to flooding were estimated using a methodology consistent with the U.S. Army Corps of Engineers (USACE) Flood Damage Assessment program. Estimated flood damage resulting from a storm was considered in combination with the probability of the event occurring to estimate an expected annual damage. Erosion damages were assessed for structures or infrastructure at risk of loss due to actively eroding stream banks. Damages reported within this document refer to economic damages estimated over a 50-year period of analysis that results from regional overbank flooding or erosion of a regional waterway. The total property and transportation damages are estimated at $75,000,000. Additional damages throughout the watershed exist, including damages due to flooding from local waterways and storm sewer systems, and also damages not easily quantified in financial terms such as water quality, wetland, riparian, and habitat impact, loss of emergency access, and loss of business or operations due to limited transportation access.

Figure ES.2 summarizes the distribution of existing condition damages within the Little Calumet River Watershed over a planning period of analysis of 50 years.

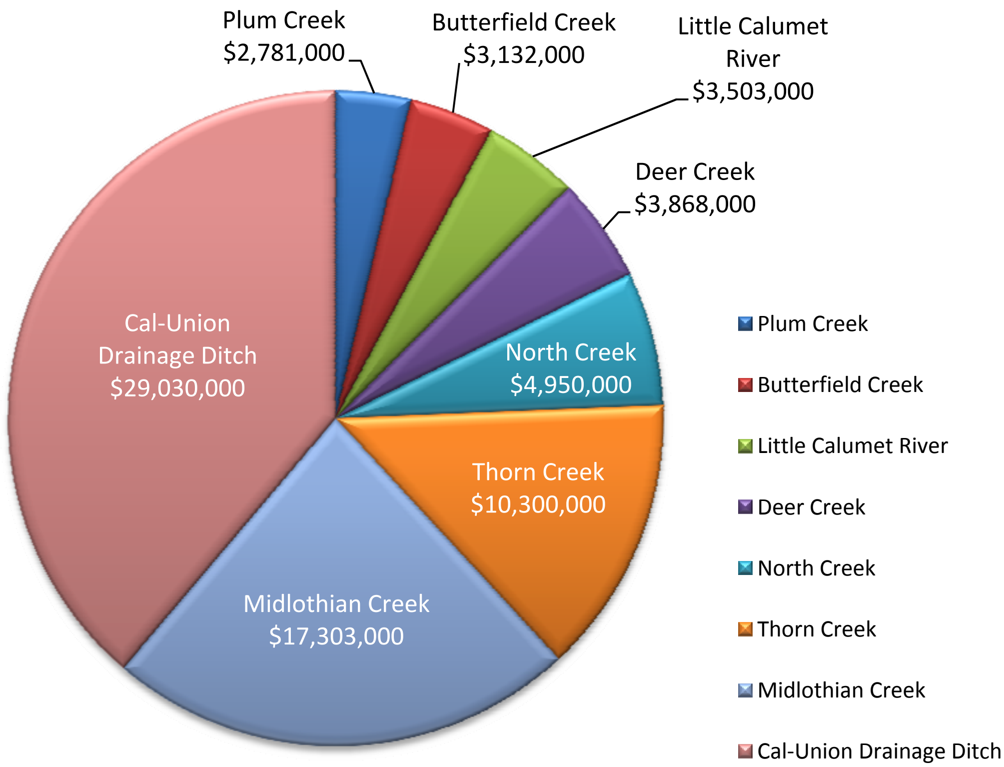


Figure ES.2: Distribution of Existing Condition Damages within the Little Calumet River Watershed

Existing condition damages within the Cal-Union Drainage Ditch subwatershed are significantly higher than that predicted within other subwatersheds. Due to relatively large areas of shallow flooding created by low topography, there are significantly larger numbers of impacted structures (over 1,250), and multiple impacted roadways. Damages predicted for other subwatersheds range according to the number of impacted structures and roadways, and the severity of the associated flooding.

The estimated damages summarized in **Figure ES.2** include calculated regional damages related to overbank flooding and erosion problems on regional waterways that threaten structures only and transportation damages. Localized problems, such as storm sewer capacity related problems, are not included in this estimate. Reported problems classified as local are presented in **Table 2.2.1** in **Section 2.2.1**. Also provided in **Table 2.2.1** is the reasoning behind classifying the problems as local or regional.

Evaluation of Alternatives

Stormwater improvements, or alternatives, were developed to address regional stormwater problems along intercommunity waterways. WPC members participated in the alternative development process by providing input on possible solutions and candidate sites for new stormwater infrastructure. It should be noted that the alternatives presented in the DWP are developed at a conceptual level of feasibility.

Hydrologic and hydraulic models were used to determine the benefit of stormwater improvement alternatives. Models were run and damages were calculated for the existing conditions evaluation. Benefits were calculated for each project as the difference between existing and alternative condition damages. Only regional financial benefits (e.g., relief of flooding due to a regional problem as defined above) were considered. Local benefits (e.g., improved sewer drainage due to reduced outlet elevation) and non-economic benefits (e.g., improved emergency access, improved wetland, riparian, habitat, and improved access to businesses) are not included. The stormwater improvement alternatives may have significant local and non-economic benefits. Local benefits are not reported in the DWP, which focuses on regional benefits.

Conceptual level cost estimates were produced to represent the estimated costs for design, construction, and maintenance of a specific alternative over a 50-year period of analysis. The cost estimates were developed using standard unit cost items located within a District database and were used for all six watershed plans. In addition, standard markups on the estimated capital costs, such as utility relocation, design and engineering costs, profit and contingency were included.

A benefit-to-cost (B/C) ratio was developed for each alternative, which represents the ratio of estimated benefits to costs. The B/C ratios calculated may be used to rank the alternatives in a relative manner as the District's Board of Commissioners prioritizes the implementation of recommended stormwater improvement projects. Only regional financial benefits were considered in determination of the B/C ratios. The B/C ratios do not include local and non-economic benefits and should not be interpreted to be the sole measure of justification of an alternative. In addition to the B/C ratio, noneconomic criteria such as water-quality impact, number of structures protected, and impact on wetland and riparian areas were noted for each alternative. These criteria may also be considered along with the calculated B/C ratios as the District's Board of Commissioners prioritizes the implementation of recommended stormwater improvement projects.

Recommendations

Alternatives were recommended based upon consideration of their ability to reduce stormwater damages and to address problems reported by communities. **Table ES.2** lists the recommended alternatives, their costs, and regional financial benefits. Note that additional benefits to the local systems and non-economic benefits will result from the recommended alternative projects.

The Little Calumet River DWP integrated stormwater data from a large number of sources in order to identify and prioritize solutions to existing stormwater problems. An extensive data collection effort undertaken for the DWP development included surveying of streams, bridges, and culverts throughout the entire watershed. Field reconnaissance was performed throughout the watershed to understand conditions unique to the watershed. This compilation of current, accurate data was used by the District to document and identify existing stormwater problems throughout the study area.

A number of alternatives were developed and evaluated for their effectiveness in reducing regional damages within the Little Calumet River Watershed. The alternatives listed in **Table ES.2** were identified as the most effective improvements for reducing expected damages due to flooding within the watershed. Greater opportunities to reduce regional flooding were identified in some tributaries. Factors such as the lack of availability of land and location of structures relative to stream channels limited the practicality of alternatives to eliminate all flooding damages for all design storms evaluated.

The data provided in the Little Calumet River DWP will be used by the District, along with consistently developed data in the DWPs for the other five major Cook County watersheds, to prioritize the implementation of stormwater improvement projects.

Table ES.3 summarizes the extent to which recommended alternatives address existing regional financial damages within each tributary, ordered by increasing existing condition damages.

Table ES.2: Recommended Alternatives Summary for the Little Calumet River Watershed

ID	Category	Description	B/C Ratio	Total Benefits ($)	Total Project Cost ($)	Probable Construction Cost ($)	Cumulative Structures & Roadways Protected	Community Involvement
DRCR-G1	Channel Improvements/Detention	Increase channel capacity north of US 30 Highway and excavate existing reservoir to provide additional 24 acre-feet storage	0.49	$3,801,000	$8,331,000	$6,881,000	270 Structures	Ford Heights
DRCR-G2	Channel Improvements	Channel improvements for 1,800 linear feet upstream of Sauk Trail Road	< 0.01	$55,000	$14,312,000	$10,671,000	2 Structures	Steger
LDET-G1	Conveyance Improvements	Replace existing crossing on Katz Corner Road	0.29	$82,000	$287,000	$191,000	9 Structures, 1 Roadway	Sauk Village
NCLD-G1	Conveyance/Detention	Construct 700 acre-feet detention facility and replace crossings at 198th Street and downstream private drives	0.03	$2,364,000	$69,500,000	$52,247,000	49 Structures/ 10 Roadways	Lansing, Lynwood
NCLD-G2	Conveyance	Replace Bridge Street and Linda Lane and relocate mobile homes	< 0.01	$1,000	$357,000	$201,000	2 Structures, 1 Roadway	Bloom Township
NCLD-G3	Conveyance	Replace Torrence Avenue and Sauk Trail Road	< 0.01	$10,000	$2,180,000	$1,201,000	12 Structures, 1 Roadway	Sauk Village
NOCR-G1	Conveyance/Detention	Replace culvert from Wenworth Avenue and Grand Truck Railroad and construct a 12 acre-feet detention facility	0.05	$388,000	$7,126,000	$4,605,000	14 Structures, 4 Roadways	Lansing
PLCR-G1	Levee/Detention	Construct a levee with a compensatory storage	0.73	$2,781,000	$3,803,000	$2,540,000	1 Structure, 1 Roadway	Will County, Dyer, IN
THCR-G1	Detention/Levee/Diversion Conduit	Channel capacity improvements along Thorn Creel Tributary B, levees along Thorn Creek, a diversion conduit and modifications to Sauk Lake Dam	0.02	$717,000	$37,660,000	$25,880,000	51 Structures, 3 Roadways	Chicago Heights, Glenwood, South Chicago Heights

Table ES.2: Recommended Alternatives Summary for the Little Calumet River Watershed

ID	Category	Description	B/C Ratio	Total Benefits ($)	Total Project Cost ($)	Probable Construction Cost ($)	Cumulative Structures & Roadways Protected	Community Involvement
THCR-G2	Conveyance	Modify the roadway profile of Sauk Trail Road	0.63	$1,600,000	$2,543,000	$1,878,000	1 Roadway	Cook County FPD
TCTA-G1	Conveyance/Detention	Replace culvert from 26th Street and Stewart Avenue to State Street and 22nd Street	0.02	$1,415,000	$89,000,000	$65,426,000	51 Structures	Chicago Heights, South Chicago Heights, Steger
TCTB-G1	Conveyance	Channel improvements along Thorn Creek Tributary B	< 0.01	$8,000	$6,900,000	$3,825,000	4 Structures, 3 Roadways	Chicago Heights
TCTD-G1	Detention/Conveyance	Construct 530 acre-feet detention facility and replace culverts at Lakewood Boulevard and East of Gold Street and East Rocket Circle	0.08	$5,500,000	$65,442,000	$48,905,000	22 Structures, 1 Roadway	Park Forest
MTCR-G1	Levee	Construct a 700 linear feet levee along Overhill Avenue and Oleander Avenue	0.08	$134,000	$1,710,000	$1,118,000	25 Structures	Tinley Park
MTCR-G2	Streambank Stabilization	Streambank stabilization at Oak Park Avenue and 172nd Street and Hickory Street and 66th Court	0.71	$1,110,000	$1,569,000	$926,000	4 Structures	Tinley Park
MTCR-G3	Conveyance/Channel Improvements	Replace 160th and 159th Street culverts and channel improvements between 160th and Oak Avenue	0.01	$37,000	$3,455,000	$1,814,000	23 Structures, 2 Roadways	Oak Forest
MTCR-G4	Conveyance/Levee	Replace 155th Street and Kilpatrick Avenue culverts and construct a 700 linear feet floodwall along north bank downstream of Kilpatrick Avenue and construct a 350 linear feet floodwall on both banks upstream of Waverly Avenue	0.04	$1,143,000	$27,700,000	$15,996,000	12 Structures, 2 Roadways	Oak Forest

Table ES.2: Recommended Alternatives Summary for the Little Calumet River Watershed

ID	Category	Description	B/C Ratio	Total Benefits ($)	Total Project Cost ($)	Probable Construction Cost ($)	Cumulative Structures & Roadways Protected	Community Involvement
MTCR-G5	Detention/Conveyance/ Channel improvements	Construct a 25 acre-feet detention at Kilbourn Avenue and Waverly Avenue, channel improvements from 151st Street to Pulaski Road and between Kenton Avenue and Kilbourn Avenue	< 0.01	$58,000	$21,000,000	$12,673,000	25 Structures	Oak Forest
MTCR-G6	Channel Improvements	Channel improvements between 137th and 139th Street	0.23	$110,000	$479,000	$400,000	25 Structures	Robbins
NTCR-G1	Detention/Conveyance/ Diversion Conduit	Construct a 210 acre-feet detention facility at Leclaire Avenue and 153rd Street and a 6,600 linear feet diversion conduit from Kilpatrick to Keystone Avenue	0.24	$14,700,000	$61,940,000	$42,390,000	132 Structures	Oak Forest and Midlothian
BTCR-G1	Conveyance/Detention	Replace 206th Street culvert and construct new 65 acre-feet detention facility	0.18	$1,495,000	$8,494,000	$6,363,000	18 Structures	Unincorporated Cook County
BCEB-G1	Conveyance/Detention/Levee	Replace Sauk Trail Road culvert, construct 130 acre-feet detention facility and a levee along Governor's Highway	0.02	$515,000	$28,079,000	$19,462,000	6 Structures & 2 Roadways	Matteson
BTCR-G2	Levee	Construct a 700 linear feet levee along Greenwood Drive	<0.01	$13,000	$9,556,000	$5,567,000	4 Structures	Olympia Fields
BTCR-G3	Channel Improvements/Floodwall	Channel improvements near Laurel Avenue and construct a floodwall on west bank from Cambridge Avenue to Dixie Avenue	0.04	$1,109,000	$29,876,000	$17,572,000	12 Structures & 2 Roadways	Flossmoor

Table ES.2: Recommended Alternatives Summary for the Little Calumet River Watershed

ID	Category	Description	B/C Ratio	Total Benefits ($)	Total Project Cost ($)	Probable Construction Cost ($)	Cumulative Structures & Roadways Protected	Community Involvement
PKCR-G1	Detention/ Conveyance/Levee	Construct a 200 acre-feet detention facility, implement channel and conveyance improvements from Kedzie Avenue to I-57 and 1,000 linear feet levee between Kedzie Avenue and I-57	0.26	$5,187,000	$20,327,000	$15,819,000	53 Structures	Markham
BLCR-G1	Levee/ Detention/Diversion Conduit	Construct a levee along Belaire Creek from Albany Avenue to Afton Drive, a new 125 acre-feet storage area and diversion conduit	0.17	$2,293,000	$13,842,000	$10,600,000	15 Structures	Markham
CHEB-G3	Conveyance/Channel	Replace Governors Highway, Braemer Road Crossings and channel improvements	3.37	$7,680,000	$2,282,000	$849,000	9 Structures, 2 Roadways	Homewood
CHEB-G1	Conveyance/Channel/ Detention	Replace Governors Highway and 175th Street Crossings, channel improvements from Ravisloe Country Club to 175th Street and provide overbank storage at Hillcrest Park	0.05	$170,000	$3,300,000	$2,140,000	16 Structures, 2 Roadways	Homewood, Hazel Crest
CUTS-G1	Levee	Construct a 945 linear feet levee along Baker Avenue	0.02	$63,000	$2,917,000	$1,666,000	10 Structures, 2 Roadways	Country Club Hills
CUSW-G2	Conveyance	Construct a 860 linear feet diversion conduit parallel to Kedzie Avenue	<0.01	$6,000	$1,206,000	$735,000	1 Roadway	Hazel Crest
CUSW-G1	Conveyance	Replace California Avenue culvert	0.03	$15,000	$536,000	$328,000	1 Roadway	Hazel Crest
CUDD-G3	Floodwall/Conveyance/ Streambank Stabilization	Construct a floodwall from Hamlin to Central Park Avenue and streambank stabilization from Sunset to Central Park Avenue	0.40	$1,144,000	$2,852,000	$1,537,000	60 Structures	Markham

Table ES.2: Recommended Alternatives Summary for the Little Calumet River Watershed

ID	Category	Description	B/C Ratio	Total Benefits ($)	Total Project Cost ($)	Probable Construction Cost ($)	Cumulative Structures & Roadways Protected	Community Involvement
CUDD-G2	Conveyance/ Detention	Construct a 450 acre-feet detention facility and a new diversion conduit from Tri-State Tollway	0.07	$3,377,000	$50,406,000	$39,733,000	20 Structures	Markham, Harvey, Unincorporated Cook
CUDD-G1	Conveyance/Detention	Expansion and improvements to Calumet Union Reservoir and upsizing the Robey Street Diversion Conduit	0.03	$5,782,000	$165,318,000	$119,593,000	1,065 Structures	Markham, Harvey, Hazel Crest
LCRW-G1	Floodwall	Construct a 600 linear feet floodwall near Sibley Boulevard	< 0.01	$16,000	$3,412,000	$1,925,000	4 Structures	Harvey
LCRW-G2	Levee/Floodwall	Construct a 1,900 linear feet levee/floodwall near 158th Place and 159th Street	0.03	$148,000	$5,752,000	$3,102,000	6 Structures	South Holland
LCRW-G3	Floodwall	Construct a 850 linear feet floodwall near 158th Street and Chicago Avenue	< 0.01	$4,000	$4,332,000	$2,151,000	2 Structures	South Holland
LCRW-G4	Floodwall	Construct a 825 linear feet floodwall near Parkside Avenue and School Street	< 0.01	$3,000	$3,427,000	$1,913,000	1 Structures	South Holland
LCRW-G5	Levee/Floodwall	Construct a 930 linear feet levee/floodwall near 158th Street and Church Drive	2.21	$2,494,000	$1,126,000	$480,000	6 Structures	South Holland
LCRW-G6	Floodwall	Construct a 1,285 linear feet floodwall near Blouin Drive	0.03	$60,000	$2,401,000	$644,000	2 Structures	Dolton
LCRW-G7	Levee	Construct a 785 linear feet floodwall near 158th Street	0.01	$21,000	$3,040,000	$1,518,000	2 Structures	South Holland
LCRW-G8	Conveyance/Levee	Modify existing berm to act as a levee parallel to 158th Street near Greenwood Drive and Madison Avenue	0.30	$702,000	$2,373,000	$1,389,000	8 Structures	South Holland

Table ES.3: Little Calumet River Watershed Alternative Summary

Tributary	Existing Conditions Damages ($)	Benefits ($)	Percent Damages Addressed (%)	Benefit Cost Ratio
Calumet Union Drainage Ditch	$29,030,000	$29,029,900	100	0.110
Midlothian Creek	$17,303,000	$17,291,500	100	0.140
Thorn Creek	$10,300,000	$9,240,000	90	0.046
North Creek	$4,950,000	$2,845,000	57	0.036
Deer Creek	$3,868,000	$3,856,000	100	0.170
Little Calumet River	$3,503,000	$3,448,000	98	0.133
Butterfield Creek	$3,132,000	$3,132,000	100	0.041
Plum Creek	$2,781,000	$2,781,000	100	0.731

Section 1
Introduction

The Little Calumet River Watershed drains an area of 264.6 square miles in southeastern Cook County, which includes 45 total communities wholly or partly within the watershed. Portions of the watershed extend into northeast Will County and the northwest portion of Lake County, Indiana. The watershed is bounded to the north by Blue Island, on the south by Monee, on the west by Tinley Park, and on the east by Gary, Indiana. The watershed consists of nine subwatersheds: Midlothian Creek, Little Calumet River, Calumet Union Drainage Ditch, Butterfield Creek, Thorn Creek, Deer Creek, North Creek, Plum Creek (known as Hart Ditch in Indiana), and Cady Marsh Ditch. The Little Calumet River originates in Gary, Indiana and flows in a northwest direction along the northern boundary of the watershed. It bends and changes direction to the northeast at Blue Island, Illinois and continues flowing northeast until its confluence with the Calumet-Sag Channel. Flow continues westward in the Calumet-Sag Channel to the Chicago Sanitary and Ship Canal, tributary to the Des Plaines River, from the Des Plaines River to the Illinois River, and from the Illinois River to the Mississippi River basin. Under high flow conditions, the Little Calumet River flows to Lake Michigan through the O'Brien Locks and Dam. Land use within the watershed in Cook County is primarily residential, forested/open land, industrial, commercial and agricultural. Locations with historic flooding exist throughout the watershed.

The Little Calumet River Detailed Watershed Plan (DWP) was developed by the Metropolitan Water Reclamation District of Greater Chicago (District) with the participation of the Little Calumet River Watershed Planning Council (WPC), which provided local input to the District throughout the development process. The DWP was developed to accomplish the following goals:

- Document stormwater problem areas.
- Evaluate existing watershed conditions using hydrologic and hydraulic (H&H) models.
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- Estimate damages associated with regional stormwater problems.
- Evaluate solutions to regional stormwater problems.

Regional problems are defined as problems associated with waterways whose watersheds encompass multiple jurisdictions and drain an area greater than 0.5 square miles. Problems arising from capacity issues on local systems, such as storm sewer systems and minor open channel ditches, even if they drain more than one municipality, were considered local and beyond the scope of a regional stormwater management program. Streambank stabilization problems addressed in this plan were limited to active erosion along regional waterways within 30 feet of structures or critical infrastructure. Interstate highways, U.S. highways, state routes, county roads with four or more lanes, and smaller roads providing critical access that are impacted by overbank flooding of regional waterways at depths exceeding 0.5 feet were also considered regional problems.

1.1 Scope and Approach

The Little Calumet River DWP scope included data collection and evaluation, H&H modeling, development and evaluation of alternatives, and recommendation of alternatives. The data collection and evaluation task included collection and evaluation of existing H&H models, geospatial data, previous studies, reported problem areas, and other data relevant to the watershed plan. H&H models were developed to produce inundation mapping for existing conditions for the 100-year storm event and to evaluate stormwater improvement project alternatives. Stormwater improvement project alternatives were developed and evaluated to determine their effectiveness in addressing regional stormwater problems in Cook County. Estimates of damage reduction, or benefits, associated with proposed projects were considered along with conceptual cost estimates and non-economic criteria to develop a list of recommended improvement projects for the Little Calumet River Watershed.

1.2 Data Collection and Evaluation

The data collection and evaluation phase (Phase A) of the DWP development focused on obtaining data regarding the watershed and evaluation of the material's acceptability for use. The District contacted all WPC members, as well as federal and state agencies and other stakeholders, to request relevant data. Coordination with WPC members to support the DWP took place throughout development of the DWP. Existing and newly developed data was evaluated according to use criteria defined in the *Cook County Stormwater Management Plan* (CCSMP). Where data was unavailable or insufficient to complete the DWP, additional data was collected. This report includes information on all data collected and evaluated as a part of the Little Calumet River DWP development. **Table 1.2.1** lists key dates of coordination activities, including meetings with WPC members throughout DWP development.

Table 1.2.1: Little Calumet River DWP WPC Coordination Activities

Little Calumet River Detailed Watershed Plan - Phase A - contract (06-712-5C) start date	November 21, 2006
Little Calumet River Detailed Watershed Plan - Phase B - contract (07-713-5C) start date	June 1, 2007
Information Gathering	
Data Request (Forms A and B) sent out as part of Phase A	November 24, 2006
Open meetings with watershed representatives during Phase A to discuss Forms A and B	January 22, 2007, January 23, 2007
Will County GIS Department	October 2007
Office of the Lake County Surveyor, Indiana	August 2007

Table 1.2.1: Little Calumet River DWP WPC Coordination Activities

District phone calls to communities after the September 2008 storm event		September 15, 2008
Little Calumet River Watershed Planning Council Meetings		
June 7, 2007	June 5, 2008	May 7, 2009
September 6, 2007	September 4, 2008	September 10, 2009
November 29, 2007	November 20, 2008	November 5, 2009
March 6, 2008	February 19, 2009	
Modeling Results and Alternatives Review Meetings		
Little Calumet River / Calumet-Sag Channel Coordination		April 2, 2008
Third-Party Model Review Meeting		February 17, 2009
U.S. Army Corps of Engineers Coordination Meetings		April 16, 2009, August 12, 2009
Information Review and Alternatives Development Community Workshops		
Butterfield Creek Communities		August 27, 2008, October 29, 2008, July 23, 2009
Calumet Union Drainage Ditch Communities		August 27, 2008, October 29, 2008, July 30, 2009
Deer Creek Communities		August 27, 2008, October 29, 2008, July 23, 2009
Little Calumet River Communities		October 2, 2008, July 30, 2009
Midlothian Creek Communities		July 23, 2008, October 1, 2008, December 3, 2008
North Creek Communities		July 23, 2008, October 1, 2008, December 4, 2008
Plum Creek Communities		July 23, 2008, October 1, 2008, December 3, 2008
Thorn Creek Communities		October 2, 2008, December 4, 2008, July 23, 2009

1.3 Hydrologic and Hydraulic Modeling

This section provides a description of the H&H modeling completed to support the DWP development. H&H models were developed for all tributaries within the watershed containing open waterways. Most models were developed independent of any past H&H modeling efforts, but some existing models were used to support development of the DWP. Hydraulic model extent was defined based upon the extent of detailed study for effective Flood Insurance Rate Maps (FIRMs). Revised Digital Flood Insurance Rate Map (DFIRM) data produced by the Federal Emergency Management Agency's (FEMA) Map Modernization Program was unavailable at the time of model definition. Models were extended further, where appropriate, to aid evaluation of damages associated with regional stormwater problems. **Appendix A** includes a comparison of FEMA's revised DFIRM panels with inundation areas developed for DWP purposes. Tables comparing DWP inundation area to FEMA floodplain mapping by community and subwatershed are also included in **Appendix A**.

H&H models were developed to be consistent with the protocols defined in the CCSMP. In numerous instances, models included additional open channel or other drainage facilities not strictly required by the CCSMP to aid the evaluation of community reported problem areas. Available monitoring data, including United States Geological Survey (USGS) stream gage data, District facility data and high water marks observed following storm events were used to perform model verification and calibration consistent with the CCSMP. All H&H modeling data and documentation of the data development are included in the appendixes referenced in the report sections below.

1.3.1 Model Selection

H&H models were developed within the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center - Hydrologic Modeling System (HEC-HMS) Version 3.1.0 modeling application and Hydrologic Engineering Center - River Analysis System (HEC-RAS) Version 4.0. These applications were identified as acceptable in the CCSMP. The Soil Conservation Service (SCS) curve number (CN) loss module was used with the SCS Clark Unit Hydrograph methodology within HEC-HMS to model basin hydrology. The dynamic unsteady flow routing methodology was used within HEC-RAS. Both applications have an extensive toolkit to interface with geographic information systems (GIS) software to produce input data and display model results.

1.3.2 Model Setup and Unit Numbering

1.3.2.1 Hydrologic Model Setup

Hydrologic model data was primarily developed within the ArcHydro, HEC-GeoDozer, and HEC-GeoHMS extensions to Arc GIS Version 9.2. The extensions provide an interface to characterize subbasin parameters within the hydrologic model. HEC-GeoDozer was used to produce a hydrologically corrected Digital Elevation Model (DEM) for watershed delineation. ArcHydro was used to process the hydrologically correct DEM for subbasin delineation and to compute longest flow paths and subbasin slopes. HEC-GeoHMS was used to delineate the subbasins from the hydrologically correct DEM and compute parameters for the Natural Resources Conservation Service (NRCS) TR-55 time of concentration determination. The geoprocessing tools within ArcGIS were used to calculate the CN for each subbasin. HEC-HMS was used to create and sometimes route stormwater runoff hydrographs to the upstream extent of hydraulic models developed within HEC-RAS. Hydrologic model data was transferred between HEC-HMS and HEC-RAS through HEC-Data Storage System (DSS) files.

Subbasin Delineation. The subbasins for the entire Little Calumet River watershed were delineated in one ArcHydro/GeoHMS model. The subbasin delineation points were determined by identifying HEC-RAS stream confluence locations, problem area locations, restrictive bridges/culverts, USGS stream gage locations, and Combined Sewer Overflow (CSO) points. A total of 431 subbasins were delineated in the Little Calumet River watershed, ranging in size from 0.005 to 17.8 square miles. The average subbasin size was 1.40 square miles. In the portion of Cook County there are 331 subbasins. The size of these subbasins ranged from 0.005 to 3.51 square miles with an average of 0.49 square miles. The process used to delineate the subbasins is described in more detail in the following paragraphs.

A 25-foot grid cell Digital Elevation Model (DEM) was prepared to delineate the subbasin boundaries using ArcHydro, HEC-GeoHMS, and HEC-GeoDozer. The base data for the DEM used in the subbasin delineation was the Cook County Digital Terrain Map (DTM) provided by the District for the Cook County portions of the watershed, the State of Indiana 5-foot grid cell DEM available on the Indiana Spatial Data Portal, and the USGS 10-meter grid cell DEM data available from the National Elevation Dataset. A DEM was created from the Cook County DTM. The Indiana DEM was converted from a 5-foot grid cell to a 25-foot grid cell and reprojected to Illinois State Plane East NAD83 to be consistent with the Cook County DEM using ArcGIS Spatial Analyst. The USGS DEM was also converted to a 25-foot grid cell and reprojected using ArcGIS Spatial Analyst. The three DEM's were then combined using ArcGIS Spatial Analyst with the priority of the data being used in the order of Cook County, Indiana, and USGS.

A stream centerline file was created using the Cook County Hydroline Data, the USGS National Hydrography Dataset, and Illinois and Indiana 2005 aerial photographs. The stream centerline was delineated to assist in the automated delineation of the subbasin boundaries. This stream centerline was burned into the 25-foot grid cell DEM to force drainage patterns to follow the current drainage patterns. This stream centerline does not contain local storm sewer system data. The local storm sewer systems may drain some areas differently than indicated by the topographic data and stream centerline.

The Tunnel and Reservoir Plan (TARP) CSO boundaries were imported into ArcGIS from data provided by the Corps of Engineers. The interior drainage areas behind the Little Calumet River levees in northwest Indiana were delineated from maps prepared by the Corps of Engineers for the Little Calumet River feature design memoranda. These boundaries were extruded from the DEM to force the water in these areas to drain to the man-made outlet (i.e., pump station, drop shaft, etc.).

After incorporation of the stream centerlines and TARP CSO boundaries, the DEM was used to determine flow accumulation, flow direction, slopes, catchments, etc. in ArcHydro and HEC-GeoHMS. The drainage area criteria used in the delineation were that the minimum stream drainage area was to be 1 square mile or the drainage area of the existing FEMA FIS study if the FEMA FIS detailed study extended below 1 square mile. In the tributary areas outside of Cook County, the delineations were performed at confluences, stream gages, significant hydraulic structures, etc. The drainage areas were generally sized between 5 to 15 square miles outside of Cook County.

The watershed boundary between the Calumet-Sag Channel and Little Calumet River watersheds was coordinated with the Calumet-Sag Channel DWP. This overall boundary was implemented in the Little Calumet River models similar to the TARP CSO boundaries.

Runoff Volume Calculation. The NRCS CN methodology was used to determine runoff volumes from the pervious/impervious areas in each of the subbasins. The NRCS CN loss model uses the empirical CN parameter to calculate runoff volumes based on landscape characteristics such as soil type, land cover, imperviousness, and land use development. Areas characterized by saturated or poorly infiltrating soils, or impervious development, have higher CN values, converting a greater portion of rainfall volume into runoff. The NRCS methodology uses **Equation 1.1** to compute stormwater runoff volume for each time step:

$$Q = \frac{\left(P - I_a\right)^2}{\left(P - I_a\right) + S} \qquad (1.1)$$

where:

Q	=	runoff volume (in.)
P	=	precipitation (in.)
S	=	storage coefficient (in.)
I_a	=	initial abstractions (in.)

Rainfall abstractions due to ponding and evapotranspiration can be simulated using an initial abstractions (I_a) parameter. In the Little Calumet River watershed, the commonly used default value of I_a, estimated as $0.2 \times S$, where S is the storage coefficient for soil in the subbasin. S is related to CN through **Equation 1.2**:

$$S = \frac{1000}{CN} - 10 \qquad (1.2)$$

where:

CN	=	curve number (dimensionless)
S	=	storage coefficient (in,)

Table 1.3.2 describes the input data used to develop the CN values throughout the watershed.

Table 1.3.2: Description of Curve Number Input Data

Variable Used to Determine CN	Approach for Definition of Variable for Little Calumet River Watershed Hydrologic Modeling
Ground cover (Illinois)	Chicago Metropolitan Agency for Planning (CMAP) 2001 land use inventory (v.1.2 2006) was used to define land use. A lookup table was developed to link CMAP categories to CN values and soil types
Ground cover (Indiana)	USGS 2001 land cover was used to define land use. A lookup table was developed to link USGS categories to CN values and soil types
Soil type	The Natural Resources Conservation Service (NRCS) publishes county soil surveys that include a hydrologic classification of A, B, C, or D. If a soil group's infiltration capacity is affected by a high water table, it is classified as, for instance, "A/D," meaning the drained soil has "A" infiltration characteristics, undrained "D." It was assumed that half of these soil groups (by area) are drained
Antecedent moisture condition	Antecedent moisture condition (AMC) reflects the initial soil storage capacity available for rainfall. For areas within Northeastern Illinois, it is typical to assume an AMC of II

The subbasin curve numbers were determined based on existing land use and soil types. The NRCS soil maps were imported into ArcGIS. Northeastern Illinois Planning Commission (NIPC) 2001 land use and USGS 2001 land cover data were imported into ArcGIS. The USGS raster data was converted to a polygon file. The soil type polygons and land use polygons were intersected in ArcGIS to produce consistent land use and soil type in each polygon. A curve number was assigned to each polygon based on the land use and soil type. The land use/soil type/curve number assignment was based on *TR-55: Urban Hydrology for Small Watersheds* (U.S. Department of Agriculture [USDA], 1986). For the USGS land cover classifications, a similar assignment was made based on CH2MHill recommendations within other DWP development. These polygons were then converted to raster grid with 25-foot grid cells identical to the locations of the DEM grid cells. The Spatial Analyst extension was then used to calculate the average curve number for each subbasin.

For each subbasin, the directly connected impervious percentage was estimated. This estimate was based on the total impervious area within the subbasin. Directly connected impervious areas are impervious areas that drain directly to the waterway via sewers or other lined channels where infiltration will not occur before the runoff from the impervious area reaches the stream. The directly connected impervious percentage for each land use type varied from 20 to 50% of the total impervious percentage. **Table 1.3.3** shows the curve number and the percentage directly connected impervious area (%DCIA) by land use type.

Table 1.3.3: Curve Number and Directly Connected Impervious by Land Use Type

NIPC 2001 Land Use Code	Land Use Description	A	B	C	D	A/D	B/D	C/D	%DCIA
11	Open Water	100	100	100	100	100	100	100	0
21	Developed, Open Space	37	58	70	76	57	67	73	0
22	Developed, Low Intensity	51	67	76	81	66	74	78	5
23	Developed, Medium Intensity	58	71	79	83	70	77	81	7
24	Developed, High Intensity	78	84	87	88	83	86	88	37
31	Barren Land	72	81	85	86	79	84	86	0
41	Deciduous Forest	29	52	67	73	51	63	70	0
42	Evergreen Forest	29	52	67	73	51	63	70	0
43	Mixed Forest	29	52	67	73	51	63	70	0
52	Shrub/Scrub	29	46	62	69	49	57	66	0
71	Grassland	37	58	70	76	57	67	73	0
81	Pasture/Hay	29	55	67	74	51	65	71	0
82	Cultivated Crops	64	74	81	85	74	79	83	0
90	Woody Wetlands	46	64	73	79	62	71	76	0
95	Emergent Wetlands	65	75	82	85	75	80	83	0
1110	1110 RES/SF	54	68	77	82	68	75	80	6
1120	1120 RES/FARM	46	63	74	79	63	71	77	3
1130	1130 RES/MF	54	68	77	82	68	75	80	6
1140	1140 RES/MOBILE HM	73	81	86	87	81	85	86	13
1211	1211 MALL	85	87	89	90	87	89	90	40
1212	1212 RETAIL CNTR	85	87	89	90	87	89	90	40
1221	1221 OFFICE CMPS	85	87	89	90	87	89	90	40
1222	1222 SINGL OFFICE	85	87	89	90	87	89	90	40
1223	1223 BUS. PARK	85	87	89	90	87	89	90	40
1231	1231 URB MX W/PRKNG	85	87	89	90	87	89	90	40
1232	1232 URB MX NO PRKNG	77	84	86	88	83	86	87	35
1240	1240 CULT/ENT	85	87	89	90	87	89	90	40
1250	1250 HOTEL/MOTEL	85	87	89	90	87	89	90	40
1310	1310 MEDICAL	77	84	86	88	83	86	87	35
1320	1320 EDUCATION	77	84	86	88	83	86	87	35
1330	1330 GOVT	85	87	89	90	87	89	90	40
1340	1340 PRISON	77	84	86	88	83	86	87	35
1350	1350 RELIGOUS	85	87	89	90	87	89	90	40
1360	1360 CEMETERY	37	58	70	76	57	67	73	0
1370	1370 INST/OTHER	46	63	74	79	63	71	77	3
1410	1410 MINERAL EXT	72	81	85	86	80	84	86	0
1420	1420 MANUF/PROC	77	84	86	88	83	86	87	35
1430	1430 WAREH/DIST/WHOL	77	84	86	88	83	86	87	35
1440	1440 INDUST PK	77	84	86	88	83	86	87	35
1511	1511 INTERSTATE/TOLL	79	85	87	89	84	86	88	0

Table 1.3.3: Curve Number and Directly Connected Impervious by Land Use Type

NIPC 2001 Land Use Code	Land Use Description	A	B	C	D	A/D	B/D	C/D	%DCIA
1512	1512 OTHER ROADWY	79	85	87	89	84	86	88	35
1520	1520 OTH LINEAR TRAN	72	81	85	86	80	84	86	0
1530	1530 AIR TRANSPORT	66	76	82	85	75	80	84	0
1540	1540 INDEP AUTO PRK	85	87	89	90	87	89	90	40
1550	1550 COMMUNICATION	64	73	79	83	73	78	81	0
1560	1560 UTILITIES/WASTE	72	81	85	86	80	84	86	0
2100	2100 CROP/GRAIN/GRAZ	64	73	79	83	73	78	81	0
2200	2200 NRSRY/GRNHS/ORC	64	73	79	83	73	78	81	0
2300	2300 AG/OTHER	64	73	79	83	73	78	81	0
3100	3100 OPENSP REC	37	58	70	76	57	67	73	0
3200	3200 GOLF COURSE	37	58	70	76	57	67	73	0
3300	3300 OPENSP CONS	37	58	70	76	57	67	73	0
3400	3400 OPENSP PRIVATE	37	58	70	76	57	67	73	0
3500	3500 OPENSP LINEAR	37	58	70	76	57	67	73	0
3600	3600 OPENSP OTHER	37	58	70	76	57	67	73	0
4110	4110 VAC FOR/GRASS	37	58	70	76	57	67	73	0
4120	4120 WETLAND	29	55	67	74	51	65	71	0
4210	4210 CONST RES	72	81	85	86	80	84	86	0
4220	4220 CONST NONRES	72	81	85	86	80	84	86	0
4300	4300 OTHER VACANT	37	58	70	76	57	67	73	0
5100	5100 RIVERS/CANALS	100	100	100	100	100	100	100	0
5200	5200 LAKE/RES/LAGOON	100	100	100	100	100	100	100	0
5300	5300 LAKE MICHIGAN	100	100	100	100	100	100	100	0
9999	9999 OUT OF REGION	100	100	100	100	100	100	100	0

1.3.2.1.1 Unit Hydrograph Determination

The Clark's unit hydrograph method was used in the HEC-HMS model. The methodology used to compute the Clark's unit hydrograph parameters is described in the USGS publication Water Resources Investigation 82-22 titled "A Technique for Estimating Time of Concentration and Storage Coefficient Values for Illinois Streams." The length of the longest flow path and slope between the 10 and 85% points along the flow path were estimated using the ArcHydro extension. The regional factor for the relationship between R/(Tc + R) was set at 0.7. The equation used to determine Tc + R is shown below:

$$(Tc + R) = 35.2 \times L^{0.39} \times S^{-0.78}$$

1.3.2.1.2 Rainfall Data

Historic rainfall data for the calibration storms was obtained from the Illinois State Water Survey (ISWS) Cook County Network, National Weather Service (NWS), USGS, and the Community Collaborative Rain, Hail and Snow Network (CoCoRaHS).

The storm periods modeled were the July 17-23, 1996; July 20-25, 2003; May 29-June 5, 2004; April 15-21, 2006; April 24-30, 2007; August 22-27, 2007; and September 11-20, 2008. The storms used for calibration varied by tributary watershed.

ISWS Bulletin 71 "Rainfall Frequency Atlas of the Midwest" was used to obtain the rainfall data for storm durations of 1 hour to 48 hours for the 2- through 100-yr frequencies. The Bulletin 71 data was used for the design storms used in evaluating the current flooding conditions and the benefits of the proposed alternatives. **Table 1.3.4** lists the rainfall depths for the 2- through 500-year frequency for a 48-hour duration.

Table 1.3.4: Rainfall Depths

Recurrence Interval (year)	48-hr Duration Rainfall Depth (inches)*
2	3.30
5	4.09
10	4.81
25	5.88
50	6.84
100	8.16
500	12.0[a]

*Aerial reduction factor not applied

[a] 500-year rainfall depth was determined based on a logarithmic relationship between rainfall depth and recurrence interval.

1.3.3 Storm Duration

A critical duration analysis was performed to determine the storm duration that generally results in higher water surface estimates for a range of tributary sizes within the Little Calumet River Watershed. The critical storm duration varied by tributary watershed. For several watersheds, more than one critical duration was used in the analysis. These watersheds had existing flood control reservoirs located within the watershed that controlled flooding to some extent downstream and resulted in longer duration storms being more critical downstream of the reservoirs. The 48-hr storm was the critical duration for Little Calumet River, Plum Creek, and the downstream portion of all the other tributary watersheds. The critical duration varied for the upstream portions of the tributary watersheds. **Table 1.3.5** lists the critical durations by subwatershed.

Table 1.3.5: Critical Duration by Tributary Watershed

Subwatershed	100 Year Critical Durations (hr)
Butterfield Creek	12 and 48
Deer Creek	48
Calumet-Union Drainage Ditch	6 and 48
Little Calumet River	48
Midlothian Creek	12 and 48
North Creek	12 and 48
Plum Creek/Hart Ditch	48
Thorn Creek	6 and 48

1.3.4 Areal Reduction Factor

The Bulletin 71 rainfall amounts for the various duration and frequency storm events were adjusted based on an average tributary watershed size of 25 square miles. The areal reduction factors for the various storm durations are shown in **Table 1.3.6**

Table 1.3.6: Areal Reduction Factors for Various Storm Durations

Storm Duration	Areal Reduction Factor (25 sq. mi.)	Areal Reduction Factor (400 sq. mi.)
1 hour	0.87	-
3 hour	0.93	-
6 hour	0.94	-
12 hour	0.96	-
24 hour	0.97	-
48 hour	0.98	0.94
72 hour	0.98	-

For the Little Calumet River, the 25 square mile watershed areal reduction factor was not correct in modeling the critical duration storms. This resulted in over predicted stages and flows along the Little Calumet River. The drainage area at the USGS South Holland gage is 208 square miles and the entire Little Calumet River drainage area is approximately 605. The tributary and local runoff hydrographs to the Little Calumet River were multiplied by 0.96 to adjust the flow rates to match the areal reduction factors for 400 square miles.

1.3.5 Hydrologic Routing

Hydrologic routings were performed for the portions of the tributary watersheds located in Will County, Illinois and Lake, Porter, and LaPorte Counties, Indiana. The Muskingum-Cunge method was used for channel routings. An 8-point cross section was determined using the DEM developed for the watershed delineation and USGS 7.5-minute quadrangle maps. Manning's n values were estimated from aerial photos. A modified Puls reservoir routing was used to simulate Lake George on Deep River.

Hydrologic routings were also used in the CSO areas tributary to the Little Calumet River and Calumet-Union Drainage Ditch. A 3-point curve was established for each of the CSO areas that limited the peak flow from the CSO area to the maximum capacity of the outfall at the TARP drop shaft. The capacities of the outfalls at the TARP drop shafts were obtained from the Corps of Engineers TARP models used for the design of the Thornton Composite Reservoir. The Thornton Composite Reservoir volume reserved for CSO volumes was prorated to each of the CSO areas based on drainage area. This volume was diverted from the CSO runoff hydrographs when generating the runoff hydrographs from the CSO areas.

1.3.6 Hydraulic Model Setup

Hydraulic model data typically was developed through field surveys with some additional definition of channel overbank areas and roadway crests defined using Cook County topographic data. Cross section locations were developed in HEC GeoRAS, and surveyed channel geometry were inserted into topographically generated cross-sectional data. Cross sections were generally surveyed at intervals of 500 to 1,000 feet. Interpolated cross sections were added at many locations to the models to increase stability and reduce errors. Bridges, culverts, and other major hydraulic structures were surveyed within the hydraulic model extent. The locations of all surveyed and modeled cross sections, bridges, culverts, and other structures are shown in a figure within **Appendix D**.

1.3.6.1 Bridges, Culverts, and Hydraulic Structures

Bridges, culverts, and hydraulic structures were surveyed consistent with FEMA mapping protocol as identified in *Guidelines and Specifications for Flood Hazard Mapping Partners*, "Guidance for Aerial Mapping and Surveying" (FEMA 2003). A State of Illinois licensed professional land surveyor certified each location as FEMA compliant. Documentation of certifications is provided in **Appendix D**. Bridges, culverts, and hydraulic structures were surveyed consistent with the NAVD 1988 datum using 5-centimeter or better Global Positioning System (GPS) procedures (as specified in NGS-58 for local network accuracy) or third-order (or better) differential leveling, or trigonometric leveling for short distances. In a few cases, information from construction plans was used for recently constructed bridges in lieu of surveying. Ineffective flow areas were placed at cross sections upstream and downstream of crossings, generally assuming a contraction ratio of 1:1 and an expansion ratio of 2:1. Contraction and expansion coefficients generally were increased to 0.3 and 0.5, respectively, at cross sections adjacent to crossings.

1.3.6.2 Cross-Sectional Data

Cross-sectional data was surveyed consistent with FEMA mapping protocol as identified in *Guidelines and Specifications for Flood Hazard Mapping Partners*, "Guidance for Aerial Mapping and Surveying" (FEMA 2003).

All survey work, including survey of cross sections, was certified as compliant to FEMA mapping protocol by a licensed professional land surveyor. Documentation of certifications is provided in **Appendix D**. Cross sections were surveyed consistent with the North American Vertical Datum, 1988 (NAVD 1988) using 5-centimeter or better GPS procedures (as specified in NGS-58 for local network accuracy) or third-order (or better) differential leveling, or trigonometric leveling for short distances. Cross sections were interpolated at many locations within the hydraulic models, to aid model stability and reduce errors.

1.3.6.3 Boundary Conditions

A downstream boundary condition was used at the most downstream cross section for each subwatershed model. In most cases, normal depth was used. In situations where a backflow condition existed at the downstream end of the reach, a stage hydrograph generated by the subbasin model for the receiving reach was entered as the boundary condition. Boundary conditions for each subwatershed are further defined in the individual tributary sections in **Section 3**.

1.3.6.4 Model Run Settings

All hydraulic model simulations were carried out using the fully dynamic, unsteady flow simulation settings within HEC-RAS. The Saint-Venant equations, or the continuity and momentum balance equations for open channel flow, were solved using implicit finite difference schemes. HEC-RAS has the ability to model storage areas and hydraulic connections between storage areas and between stream reaches. The computational time step for model runs varied between 1 and 60 seconds, as necessary for model stability.

1.3.7 Model Calibration and Verification

A detailed calibration was performed for each subwatershed using historic gage records under the guidelines of the CCSMP. A minimum of three historical storms were used for calibration and verification. Runoff hydrographs from each historical storm were routed through the HEC-RAS hydraulic models for each subwatershed. The peak flow rate, hydrograph shape and timing, and total volume matched were compared between the observed hydrographs and the model output. During calibration, the curve number, directly connected impervious area percentage, and storage coefficients were adjusted so the modeled hydrographs were within the CCSMP's criteria of peak flow (within 30%) and peak stage (within 0.5 ft) of observed data.

To aid in calibration, high water mark data was collected from the Illinois Department of Natural Resources (IDNR), USGS, and from survey information collected after the September 2008 storm event. The peak stages reported by the various sources were compared to those predicted by the hydraulic model. This provided a verification of stages at locations other than those with reporting gages.

Subwatershed-specific explanations of model calibration and verification are included in **Section 3** for each tributary.

1.3.8 Flood Inundation Mapping

Flood inundation maps were produced to display the inundation areas associated with the 100-year event. The flood inundation maps were produced by overlaying the results of the hydraulic modeling on the ground elevation model of the watershed, which was derived from Cook County LiDAR data.

1.3.9 Discrepancies Between Inundation Mapping and Regulatory Flood Maps

Discrepancies may exist between inundation mapping produced under this DWP and regulatory flood maps. Discrepancies may be the result of updated rainfall data, more detailed topographic information, updated land use data, and differences in modeling methodology. A discussion of discrepancies is included in **Appendix A**.

1.3.10 Model Review

The hydrologic and hydraulic models developed under this DWP were independently reviewed by Christopher B. Burke Engineering, Ltd (CBBEL). CBBEL's review of the hydrologic models included a general verification of drainage areas, subbasin divides, and hydrologic model parameters such as Curve Number and time of concentration. CBBEL's review of the hydraulic models included a general verification of roughness values, bank stations, ineffective flow areas, hydraulic structures, boundary conditions and connectivity with the hydrologic model output files. A recommendation from the independent review was to calibrate the models to a large storm event which occurred in the watershed in mid September, 2008. This and other recommendations from the independent review have been addressed in the hydrologic and hydraulic models developed to support the Little Calumet River DWP.

1.3.11 Problem Area Identification

Problem area data for the Little Calumet River Watershed was generated from two sources. The first was community, agency and stakeholder response data that identified flooding, erosion, water quality, and maintenance problems recognized by the communities to be problems. In addition, problem areas were identified by overlaying the results of H&H modeling on the ground elevation model of the watershed to identify structures at risk of flooding along regional waterways. Modeled problems generally corroborated the communities' reported problems; however, in many instances the model results also showed additional areas at risk of flooding for larger magnitude events. A secondary source of problem area identification was the existing FEMA FIRM panel maps. Areas shown within FEMA floodplain were carefully considered in H&H modeling and communication with communities in order to identify problem areas.

1.3.12 Economic Analysis

1.3.12.1 Flood Damages

Property damages due to flooding were assessed based upon the intersection of inundation areas for modeled recurrence intervals (2-, 5-, 10-, 25-, 50-, and 100-year) with the Cook County parcel data, considering ground elevation data, to calculate estimated flood depths. Damages were estimated using a methodology consistent with one developed by the USACE that estimates structure and contents damage as a fraction of structure value and based upon the estimated depth of flooding (USACE 2003). The general procedure for estimating property damage due to flooding is outlined in the CCSMP. This method of damage calculation requires estimating a number of parameters for properties at risk of flooding which are detailed below.

The foundation for property damage values due to flooding is derived from the 2006 Cook County Tax Assessor (CCTA) data multiplied by a standard factor derived from a statistical analysis comparing recent sales data to the CCTA property values. The CCTA data includes tax assessed value of land, improvements, total tax assessed value, structure class (residential single family, multi-family, industrial etc.), number of stories, basement information, land area (square footage), and other data fields not relevant to this study.

1.3.12.2 Identification of Parcels at Risk of Flooding

Parcel boundaries were converted to points within the GIS application, and then the points were moved to the low side of structures at risk of flooding. Intersection of floodplain boundaries with parcel data was then performed for each modeled recurrence interval storm and used to identify parcels within the subwatershed that may, based upon their zero-damage elevations, be subject to property damage due to flooding for a particular recurrence interval.

1.3.12.3 Parcel Zero-Damage Elevation

Structures do not incur damage due to flooding until the water surface exceeds the zero-damage elevation, at which water is assumed to begin flowing into the structure and causing damages. For most structures, the zero-damage elevation is the ground surface. Floodwaters exceeding the ground surface may enter the structure through doorways, window wells, and other openings within the structure. The zero-damage elevation was assumed to be the ground elevation for all parcels within the Little Calumet River Watershed. The ground elevation estimate was obtained at the point representing the parcel, generally on the lower, stream-side of the actual structure.

1.3.12.4 Parcel First Floor Elevation

USACE depth-damage curves relate flooding depths to the first floor elevation of the structure, a value not provided within the CCTA data. First floor elevations (FFE) generally were not surveyed for the Little Calumet River DWP, as that would require several thousand measurements. During field reconnaissance, the typical structure in the residential area and a typical height above ground was determined near each stream crossing. This information was used to estimate the first floor elevations for the inundated parcels.

1.3.12.5 Estimated Structure Value

The estimated value of flooded structures is an input to damage calculations. The CCTA data identified land value as well as the improvement value (i.e., building, garage, etc.). The values in the CCTA data are assessed valuations of the estimated property value, which require a factor to bring the value, depending on the structure's use, to the CCTA estimation of property value. For example, residential structures receive an assessed valuation of 16 percent, thus the value identified by CCTA is the CCTA estimated value divided by a standardized value of 0.16. The adjusted CCTA data (reported values divided by the assessed valuation factor) was then compared with recent sales data throughout the county to statistically derive a multiplier that brings the 2006 CCTA estimated value of the properties to 2008 market value. This multiplier was calculated to be 1.66. Since this plan analyzes damage to structures, the land component of the property value was removed from the analysis by applying the assessed valuation multiplier and the District calculated market value multiplier to the improvement value identified in the CCTA data to produce a value of the structure. This method was used on all property types to generate information to be used in the damage calculations.

1.3.12.6 Depth-Damage Curves

Six residential depth-damage curves were obtained from the USACE technical guidance memorandum EGM 04-01 (USACE, 2003) to relate estimated structure and contents damage to structure replacement value as a function of flooding depth. These damage curves are one story, two-story, and split-level resident structures, either with or without basements. For non-residential structures, a depth-damage curve representing the average of structure and contents depth-damage curves for a variety of structure types, generated by the Galveston District of the USACE was selected for use. **Appendix F** contains the depth-damage curves used to calculate property damage due to flooding. CCTA data was analyzed to identify the number of stories on residential structures and the presence or absence of a basement.

1.3.12.7 Property Damage Calculation

The estimated structure value, flooding depth, and depth-damage curve information were used to estimate the property damage from flooding for a specific structure due to a storm of given recurrence interval. Higher magnitude events, such as the 100-year event, cause higher damages for flooded properties but also have a lower likelihood of occurring in a given year. **Figure 1.4.1** shows the hypothetical relationship between expected damage and modeled recurrence interval. Estimated annual damages were calculated according to the CCSMP, essentially weighting the expected annual damages by their annual probability of occurrence. Damages were then capitalized over a 50-year period of analysis, consistent with the period of analysis over which maintenance and replacement costs were calculated, using the federal discount rate for 2008 of 4.875 percent.

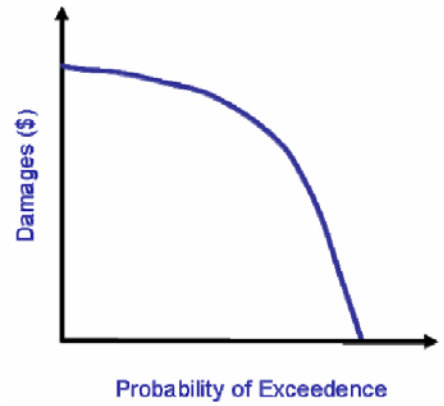


Figure 1.4.1: Hypothetical Damage-Frequency Relationship

1.3.12.8 Erosion Damages

Locations of potential erosion risk were identified through community response data. The CCSMP contains direction that erosion damages be estimated as the full value of structures at "imminent risk" of damage due to stream bank erosion, and that erosion damages not be assessed for loss of land. Field visits to areas identified as erosion problems were performed. Properties and infrastructure were judged to be at risk if they were located within 30 feet of a site of active erosion, characterized by exposed earth, lack of vegetation, or collapsing banks. The estimated market value of the structure derived from CCTA data was used to estimate erosion damages for structures deemed at imminent risk. For infrastructure other than property at risk, such as roads and utilities, an estimate of the replacement value of these structures was used to assess erosion damages.

1.3.12.9 Transportation Damages

Transportation damage generally was estimated as 15 percent of property damage due to flooding. In some specific instances, significant transportation damages may occur in absence of attendant property damage due to flooding. For the Little Calumet River Watershed, specific transportation damages were calculated when flooding fully blocked all access to a specific area in the watershed and these damages were not adequately captured as a fraction of property damages. In such instances, transportation damages were calculated according to FEMA guidance in the document "What Is a Benefit?" (FEMA, 2001). The duration of road closure was estimated for the modeled storms, and transportation damage was calculated according to a value of $32.23 per hour of delay per vehicle based on average traffic counts.

1.3.13 Alternative Development and Evaluation

Potential stormwater improvements, referred to within the DWP as alternatives, were developed using a systematic procedure to screen, develop, and evaluate technologies consistently throughout the Little Calumet River Watershed. Tributary-specific technologies were screened and evaluated in consideration of the stormwater problems identified through community response data and modeling. An alternative is a combination of the technologies developed to address the identified stormwater problems. In many instances, communities had ideas or suggestions regarding potential resolution of their stormwater problems, and these ideas were solicited during workshops and subsequent comment periods and were considered during alternative development.

Alternatives were evaluated with respect to their ability to reduce flooding, erosion, and other damages under existing conditions. The reduction in expected damages for an alternative was called a benefit. Conceptual level costs were developed for each alternative using countywide unit cost data that considered expected expenses such as land acquisition, excavation, pipe costs, channel lining, etc. Standard countywide markups were used to account for the cost of utility relocation, design engineering and construction management costs, profit, and contingency. Expected maintenance and replacement costs were considered over a 50-year design period. Detailed design studies are required to confirm details associated with the feasibility of construction and precise configuration of proposed facilities.

Additional non-economic factors, such as the number of structures protected, the expected water-quality benefit, and the impact on wetland or riparian areas were considered in alternative development and evaluation.

1.3.13.1 Flood Control

Flood control technologies were considered during the development of alternatives for addressing flooding problems, as summarized in **Table 1.4.1**. After selection of an appropriate technology or technologies for a problem area, and review of information provided by communities and obtained from other sources (such as aerial photography and parcel data) regarding potentially available land, conceptual alternatives were developed.

Hydrologic or hydraulic models for alternative conditions were created to analyze the effect of the conceptual alternatives. Initial model runs were performed to determine whether an alternative significantly affected water surface elevation (WSEL) near the target problem area, or had negative impacts in other parts of the tributary area. For models that resulted in significant reduction in WSEL, a set of alternative condition model runs was performed, and expected damages due to flooding were evaluated for the alternative conditions. Benefits were calculated based on damages reduced from existing to proposed conditions.

1.3.13.2 Floodproofing and Acquisition

Alternatives consisting of structural flood control measures may not feasibly provide a 100-year level of protection for all structures. The DWP identifies areas that will experience flooding at the 100-year event, even if recommended alternatives are implemented. Floodproofing and/or acquisition of such structures are non-structural flood control measures that may reduce or eliminate damages during flood events, which is why these measures are listed in **Table 1.4.1**. However, due to the localized nature of implementing such solutions, the District may look to address structures that are candidates for non-structural flood control measures under separate initiatives, outside of the Capital Improvement Program (CIP).

1.3.13.3 Streambank Stabilization

Streambank stabilization alternatives were developed to address problem areas where erosion problems on regional waterways were determined to threaten structures. Damages were calculated based on the value of the threatened structures. Streambank stabilization alternatives considered a range of alternative technologies as summarized in **Table 1.4.2**.

1.3.13.4 Water Quality

The potential effect of alternatives on water quality was considered qualitatively. Most detention basins built for flood control purposes have an ancillary water quality benefit because pollutants in sediment will settle out while water is detained. Sediments can be removed as a part of maintenance of the detention basin, preventing the pollutants from entering the waterway. Detention basins typically have a sediment forebay specifically designed for this purpose. Some detention basins could be designed as constructed wetland basins with wetland plants included which could naturally remove pollutants and excess nutrients from the basin. Streambank stabilization alternatives can help address water quality problems through reduction of sedimentation.

Table 1.4.1: Flood Control Technologies

Flood Control Option	Description	Technology Requirements
Detention/Retention		
Detention facilities (Dry basins)	Impoundments to temporarily store stormwater in normally dry basins	Open space, available land. Only an upstream option
Retention facilities (Wet basins)	Impoundments that include a permanent pool which stores stormwater and removes it through infiltration and evaporation. Retention facilities generally have an outfall to the receiving waterway that is located at an elevation above the permanent pool	Open space, available land. Only an upstream option
Pumped detention	Similar to detention or retention facilities, but includes a portion of the impoundment which cannot be drained by gravity and must be pumped out	Open space, available land. Only an upstream option. Best applied when significant area is available to allow for filling only during large storms
Underground detention	A specialized form of storage where stormwater is detained in underground facilities such as vaults or tunnels. Underground detention may also be pumped	Space without structures, available land. Only an upstream option. Significantly more expensive than above ground facilities. Surface disruption must be acceptable during construction

Table 1.4.1: Flood Control Technologies

Flood Control Option	Description	Technology Requirements
Bioretention	Decentralized microbasins distributed throughout a site or watershed to control runoff close to where it is generated. Runoff is detained in the bioretention facilities and infiltrated into the soil and removed through evapotranspiration	Open space, multiple available opportunities for various sizes of open space
Conveyance Improvement		
Culvert/bridge replacement	Enhancement of the hydraulic capacity of culverts or bridges through size increase, roughness reduction, and removal of obstacles (for example, piers)	Applicable only if restricted flow and no negative impact upstream or downstream. May require compensatory storage to prevent negative downstream impact. Permitting requirements and available adjacent land
Channel improvement	Enhancement of the hydraulic capacity of channels by enlarging cross sections (for example, floodplain enhancement), reducing roughness (for example, lining), or channel realignment	No negative upstream or downstream impact of increased conveyance capacity. Permitting requirements and available adjacent land. Permanent and/or construction easements
Flood Barriers		
Levees	Earth embankments built along rivers and streams to keep flood waters within a channel	Permitting requirements and available adjacent land. Wide floodplains will be analyzed. Requires 3 feet of freeboard to remove structures behind levees from regulatory floodplain. Often requires compensatory storage
Floodwalls	Vertical walls typically made of concrete or other hard materials built along rivers and streams to keep flood waters within a channel	Permitting requirements and available adjacent land. Permanent and/or construction easements
Acquisition	Acquisition and demolition of properties in the floodplain to permanently eliminate flood damages. In some cases, acquired property can be used for installation of flood control facilities	Severe flooding, repetitive losses, other alternatives are not feasible
Floodproofing		
Elevation	Modification of a structure's foundation to elevate the building above a given flood level. Typically applied to houses	Severe flooding, repetitive losses, other alternatives are not feasible
Dry floodproofing	Installation of impermeable barriers and flood gates along the perimeter of a building to keep flood waters out. Typically deployed around commercial and industrial buildings that cannot be elevated or relocated	Better suited for basement or shallow flooding. Need the ability to provide closure of openings in walls or levees. Plan for emergency access to permit evacuation

Table 1.4.1: Flood Control Technologies

Flood Control Option	Description	Technology Requirements
Wet floodproofing	Implementation of measures that do not prevent water from entering a building but minimize damages; for example, utility relocation and installation of resistant materials	Most applicable for larger buildings where content damage due to flooding can be minimized. Waterproofing sealant applied to walls and floors, a floor drain and sump pump

Table 1.4.2: Streambank Stabilization Technologies

Streambank Stabilization Option	Description	Technology Requirements
Natural (vegetated or bioengineered) stabilization	The stabilization and protection of eroding overland flow areas or stream banks with selected vegetation using bioengineering techniques. The practice applies to natural or excavated channels where the stream banks are susceptible to erosion from the action of water, ice, or debris and the problem can be solved using vegetation. Vegetative stabilization is generally applicable where bankfull flow velocity does not exceed 5 ft/sec and soils are more erosion resistant, such as clayey soils. Combinations of the stabilization methods listed below and others may be used	Requires stream bank slopes flat enough to prevent slope failure based upon underlying soils. Channels with steep banks with no room for expansion or high bank full velocities (> 5 ft/sec) should avoid these technologies
Vegetating by sodding, seeding, or planting	Establishing permanent vegetative cover to stabilize disturbed or exposed areas. Required in open areas to prevent erosion and provide runoff control. This stabilization method often includes the use of geotextile materials to provide stability until the vegetation is established and able to resist scour and shear forces	
Vegetated armoring (joint planting)	The insertion of live stakes, trees, shrubs, and other vegetation in the openings or joints between rocks in riprap or articulated block mat (ABM). The object is to reinforce riprap or ABM by establishing roots into the soil. Drainage may also be improved through extracting soil moisture	

Table 1.4.2: Streambank Stabilization Technologies

Streambank Stabilization Option	Description	Technology Requirements
Vegetated cellular grid (erosion blanket)	Lattice-like network of structural material installed with planted vegetation to facilitate the establishment of the vegetation, but not strong enough to armor the slope. Typically involves the use of coconut or plastic mesh fiber (erosion blanket) that may disintegrate over time after the vegetation is established	
Reinforced grass systems	Similar to the vegetated cellular grid, but the structural coverage is designed to be permanent. The technology can include the use of mats, meshes, interlocking concrete blocks, or the use of geocells containing fill material	
Live cribwall	Installation of a regular framework of logs, timbers, rock, and woody cuttings to protect an eroding channel bank with structural components consisting of live wood	
Structural stabilization	Stabilization of eroding stream banks or other areas by use of designed structural measures, such as those described below. Structural stabilization is generally applicable where flow velocities exceed 5 ft/sec or where vegetative stream bank protection is inappropriate	Applicable to areas with steep stream bank slopes (> 3:1) and no room for channel expansion, or areas with high velocities (> 5 ft/sec) can benefit from this technology
Interlocking concrete	Interlocking concrete may include A-Jacks®, ABM, or similar structural controls that form a grid or matrix to protect the channel from erosion. A-Jacks armor units may be assembled into a continuous, flexible matrix that provides channel toe protection against high velocity flow. The matrix of A-Jacks can be backfilled with topsoil and vegetated to increase system stability and to provide in-stream habitat. ABM can be used with or without joint planting with vegetation. ABM is available in several sizes and configurations from several manufacturers. The size and configuration of the ABM is determined by the shear forces and site conditions of the channel	

Table 1.4.2: Streambank Stabilization Technologies

Streambank Stabilization Option	Description	Technology Requirements
Riprap	A section of rock placed in the channel or on the channel banks to prevent erosion. Riprap typically is underlain by a sand and geotextile base to provide a foundation for the rock, and to prevent scour behind the rock	
Gabions	Gabions are wire mesh baskets filled with river stone of specific size to meet the shear forces in a channel. Gabions are used more often in urban areas where space is not available for other stabilization techniques. Gabions can provide stability when designed and installed correctly, but failure more often is sudden rather than gradual	
Grade control	A constructed concrete channel designed to convey flow at a high velocity (greater than 5 ft/sec) where other stabilization methods cannot be used. May be suitable in situations where downstream areas can handle the increase in peak flows and there is limited space available for conveyance	
Concrete channels	Prevent stream bank erosion from excessive discharge velocities where stormwater flows out of a pipe. Outlet stabilization may include any method discussed above	

Section 2
Watershed Characteristics

2.1 General Watershed Description

Figure 2.1.1 shows the municipal boundaries and the major streams within the Little Calumet River Watershed. **Figure 2.1.1** also shows the subwatershed divides for the major streams within the Little Calumet River Watershed. **Table 2.1.1** lists the municipalities within the Little Calumet River Watershed. **Table 2.1.2** lists the major streams tributary to the Little Calumet River and their lengths. Each stream is briefly described in the following subsection.

Table 2.1.1: Municipalities in the Little Calumet River Watershed

Municipality	% of Municipality Area within Little Calumet River Watershed	% of Little Calumet River Watershed Area by Municipality	Municipality	% of Municipality Area within Little Calumet River Watershed	% of Little Calumet River Watershed Area by Municipality
Blue Island	29	0.75	Matteson	100	4.08
Calumet City	34	1.59	Midlothian	82	1.43
Calumet Park	< 1	0.00	Oak Forest	74	2.50
Chicago Heights	100	5.65	Olympia Fields	100	1.79
Country Club Hills	100	2.88	Orland Hills	19	0.13
Crestwood	5	0.09	Orland Park	8	0.64
Dixmoor	100	0.78	Park Forest	100	2.41
Dolton	50	1.46	Phoenix	100	0.28
East Hazel Crest	100	0.48	Posen	100	0.71
Flossmoor	100	2.14	Richton Park	100	1.79
Ford Heights	100	0.65	Riverdale	51	1.20
Frankfort Square	100	0.00	Robbins	78	0.71
Glenwood	100	1.38	Sauk Village	100	1.63
Harvey	100	3.87	South Chicago Heights	100	0.97
Hazel Crest	100	2.12	South Holland	100	4.56
Homewood	100	3.29	Steger	100	0.40
Lansing	100	4.10	Thornton	100	1.50
Lynwood	100	2.69	Tinley Park	94	5.58
Markham	100	3.26	University Park	100	0.07

Table 2.1.2: Little Calumet River Watershed Open Channel Stream Lengths

Channel Name	Length (miles)	Channel Name	Length (miles)
Butterfield Creek	24.4	Midlothian Creek	23
Cady Marsh	6.8	North Creek	23
Calumet-Union Drainage Ditch	24.5	Plum Creek	3
Deer Creek	15.1	Thorn Creek	27.0
Hart Ditch	6	Little Calumet River	45.3
		Total	**198.1**

Table 2.1.3 lists the subwatersheds each municipality drains to, with subwatersheds listed in decreasing order based upon the area within the municipality. Although municipalities contribute stormwater to the listed subwatersheds, the actual stream may not be included within the municipality's boundaries.

Table 2.1.3: Municipalities and Their Subwatershed Tributary Drainage Areas

Municipality	Subwatershed	Tributary Drainage Area (sq. mi.)
Blue Island	Midlothian Creek	0.74
	Little Calumet River	0.16
Calumet City	Little Calumet River	2.48
	Thorn Creek	<0.01
Calumet Park	Little Calumet River	<0.01
Chicago Heights	Butterfield Creek	0.91
	Deer Creek	1.10
	Thorn Creek	7.03
Country Club Hills	Butterfield Creek	0.28
	Cal-Union Drainage Ditch	3.38
	Midlothian Creek	0.50
Crestwood	Midlothian Creek	0.07
Dixmoor	Little Calumet River	1.24
	Midlothian Creek	<0.01
Dolton	Little Calumet River	2.43
East Hazel Crest	Cal-Union Drainage Ditch	0.72
	Thorn Creek	0.05
Flossmoor	Butterfield Creek	2.27
	Cal-Union Drainage Ditch	1.08
	Thorn Creek	0.07
Ford Heights	Deer Creek	1.04
	North Creek	<0.01
Frankfort Square	Butterfield Creek	<0.01
	Little Calumet River	<0.01
	Thorn Creek	<0.01

Table 2.1.3: Municipalities and Their Subwatershed Tributary Drainage Areas

Municipality	Subwatershed	Tributary Drainage Area (sq. mi.)
Glenwood	Butterfield Creek	0.56
	Deer Creek	0.04
	North Creek	0.65
	Thorn Creek	0.96
Harvey	Cal-Union Drainage Ditch	1.84
	Little Calumet River	4.35
Hazel Crest	Cal-Union Drainage Ditch	3.39
Homewood	Butterfield Creek	1.61
	Cal-Union Drainage Ditch	3.48
	Thorn Creek	0.17
Lansing	Little Calumet River	6.56
	North Creek	1.95
	Thorn Creek	2.21
Lynwood	Deer Creek	<0.01
	Hart Ditch	<0.01
	North Creek	4.29
Markham	Cal-Union Drainage Ditch	2.96
	Little Calumet River	2.25
Matteson	Butterfield Creek	6.07
	Thorn Creek	0.28
Midlothian	Midlothian Creek	1.42
	Natalie Creek	0.37
Oak Forest	Cal-Union Drainage Ditch	0.07
	Little Calumet River	2.10
	Midlothian Creek	1.58
	Natalie Creek	1.63
Olympia Fields	Butterfield Creek	2.79
	Thorn Creek	0.07
Orland Hills	Midlothian Creek	0.20
Orland Park	Midlothian Creek	0.93
Park Forest	Butterfield Creek	0.46
	Thorn Creek	3.39
Phoenix	Cal-Union Drainage Ditch	0.02
	Little Calumet River	0.43
Posen	Little Calumet River	0.16
	Midlothian Creek	0.97
Richton Park	Butterfield Creek	2.31
	Thorn Creek	0.34
Riverdale	Little Calumet River	2.07
Robbins	Midlothian Creek	0.75

Table 2.1.3: Municipalities and Their Subwatershed Tributary Drainage Areas

Municipality	Subwatershed	Tributary Drainage Area (sq. mi.)
Sauk Village	Deer Creek	0.14
	North Creek	2.47
	Plum Creek	<0.01
South Chicago Heights	Deer Creek	0.24
	Thorn Creek	1.32
South Holland	Cal-Union Drainage Ditch	2.11
	Little Calumet River IL	4.20
	Thorn Creek	0.99
Steger	Deer Creek	0.02
	Thorn Creek	0.61
Thornton	Cal-Union Drainage Ditch	0.29
	Thorn Creek	2.10
Tinley Park	Midlothian Creek	5.47
	Natalie Creek	0.05
University Park	Butterfield Creek	0.11
Unincorporated and Forest Preserve	Butterfield Creek	6.57
	Cal-Union Drainage Ditch	1.19
	Deer Creek	0.60
	Little Calumet River IL	2.51
	Midlothian Creek	3.61
	Natalie Creek	0.79
	North Creek	4.59
	Thorn Creek	2.97

2.2 Stormwater Problem Data

To support DWP development, the District solicited input from stakeholders within the watershed. Municipalities, townships, countywide, statewide, and national agencies such as Cook County Highway Department (CCHD), Illinois Department of Natural Resources (IDNR), Illinois Department of Transportation (IDOT), Federal Emergency Management Agency (FEMA) and the USACE, for example, were asked to fill out two forms with information to support DWP development. Organizations such as ecosystem partnerships were also contacted by the District as part of this information-gathering effort. Form A included questions on stormwater data and regulations, Form B included questions on known flooding, erosion, and stream maintenance problem areas. In addition to problem areas reported by municipalities, townships, public agencies and other stakeholders, results from H&H modeling performed as a part of DWP development was used to identify stormwater problem areas. The H&H modeling process is described in general in **Section 1.3** and specifically for each modeled tributary in **Section 3**.

Figure 2.2.1 and **Table 2.2.1** summarize the responses to Form B questions about flooding, erosion, and stream maintenance problem areas. As noted, the scope of the DWP addresses regional problems along open channel intercommunity waterways. The definition of regional problems is provided in **Section 1**.

Table 2.2.1: Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
BL01	Bloom Township	Storm sewer flow restriction, other	Steger Road from Wallace Avenue to Indiana State Line	Storm sewer flow restriction	Local	5
BL02	Bloom Township	Storm sewer flow restriction, other	Sauk Trail Road from Western Avenue to Torrence Avenue	Partially related to local storm sewer system; maintenance issue and overbank flooding near State Street	Local	5
BL03	Bloom Township	Vegetation and drifting of creek	26th Street from East End Avenue to State Street	Culvert and channel blockage	Local	6
BL04	Bloom Township	Storm sewer flow restriction	Glenwood Lansing Road from Glenwood Dyer Road to Indiana State Line	Undersized trunk storm sewer	Local	5
BL05	Bloom Township	Storm sewer flow restriction, other	State Street from Sauk Trail Road to Main Street	Local drainage issue	Local	5
BL06	Bloom Township	Siltation and stream migrating	Cottage Grove Avenue from Steger Road to 183rd Street	Siltation and stream migrating	Local	6
BL07	Bloom Township	Silt and debris accumulating under the bridge	Stony Island Avenue from Joe Orr Road to 183rd Street	Silt and debris accumulating under the bridge	Local	6
BL08	Bloom Township	Storm sewer flow restriction	Torrence Avenue from Steger Road to Sauk Trail	Undersized storm sewer, high water level at outfall	Local	5
BL09	Bloom Township	Overbank Flooding	West side of Torrence Avenue, south of Katz Corner Road (223rd Street)	Flooding due to roadway overtopping of Katz Corner and backflow to Torrence Avenue	Regional	1
BLI1	Blue Island	Flooding due to culvert blockages	Western Avenue and 139th Street	Stream maintenance	Local	6
BRE1	Bremen Township	Storm sewer flow restriction	175th Street from Oak Park Avenue to Argyle Avenue	Siltation	Local	5
BRE2	Bremen Township	Storm sewer flow restriction	167th Street from Harlem Avenue to Cicero Avenue	Stream maintenance	Local	5
BRE3	Bremen Township	Debris at the upstream end of culvert	167th Street from Kilbourn Avenue to Western Avenue	Stream maintenance	Local	6
BRE6	Bremen Township	Storm sewer flow restriction	Central Avenue from 183rd Street to Midlothian Turnpike	Stream maintenance	Local	5
BRE7	Bremen Township	Storm sewer flow restriction	Ridgeland Avenue from 147th Street to 135th Street	Stream maintenance	Local	5

Table 2.2.1: Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
BRE8	Bremen Township	Storm sewer flow restriction	Kedzie Avenue from 183rd Street to 135th Street	Debris, siltation, storm sewer restriction	Local	5
CAC1	Calumet City	Basement flooding, ponding	East State Street to 4 blocks south, between Calhoun Avenue and Hoxle Avenue	Storm sewer flow restriction	Local	5
CAC2	Calumet City	Basement flooding, ponding, storm sewer flow restriction	10 blocks centered at Wilson Avenue and Manistee Avenue	Storm sewer flow restriction	Local	5
CAC3	Calumet City	Basement flooding, ponding, storm sewer flow restriction	154th Place to 155th Street by Price Street to Freeland Avenue	Storm sewer flow restriction	Local	5
CAC4	Calumet City	Pavement flooding	Route 6 from I-94 to Torrence Avenue	IDOT reported pavement flooding, storm sewer flow restriction	Local	5
CAC5	Calumet City	Pavement flooding	Route 83 at Torrence Avenue	IDOT reported pavement flooding, storm sewer flow restriction	Local	5
CAC6	Calumet City	Bank erosion and sedimentation	160th Street and Torrence Avenue	Bank erosion and sedimentation	Local	8
CAC7	Calumet City	Wetlands and riparian areas at risk	Wenworth Avenue and River Oaks Drive	Water quality problems from wetland and riparian areas	Local	8
CAP1	Calumet Park	Basement flooding, ponding	North half of town (near Ashland Avenue; and 127th Street to 123rd Street)	Basement flooding, ponding	Local	5
CCU1	Unincorporated Cook County	Pavement flooding	Steger Road between Burnham Avenue and Indiana border	Cook County Highway Department reported pavement flooding	Local	2
CHT1	Chicago Heights	Overbank flooding, basement flooding	Miller Avenue (Chicago, Route 1) to Jackson – railroad tracks	Problem is due to local drainage issues.	Local	5
CHT2	Chicago Heights	Overbank flooding	26th Street and Chicago Vincennes Road	Problem is due to local drainage issues.	Local	5
CHT3	Chicago Heights	Pavement flooding	Route 30 at Cottage Grove Avenue	Roadway flooding at US 30; properties flooded north of US 30	Local	2

Table 2.2.1: Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
CHT4	Chicago Heights	Pavement flooding	Route 30 at Orchard Street	IDOT reported pavement flooding, storm sewer flow restriction	Local	5
CHT5	Chicago Heights	Pavement flooding	Route 30 at Halsted Street	Problem is due to local drainage issues	Local	5
CHT6	Chicago Heights	Pavement flooding	Route 30 at State and East End Avenue	Problem is due to local drainage issues	Local	5
CHT7	Chicago Heights	Overbank flooding	Chicago Vincennes Road and South of Flossmoor Road	Problem is due to local drainage issues	Local	5
CHT8	Chicago Heights	Ponding, water quality and bank erosion and sedimentation	12th Street and Halsted Avenue	Problem is due to local drainage issues	Local	5
CHT9	Chicago Heights	Pavement flooding	Center Street/Illinois Central/Canadian National Railroad Ditch	Cook County Highway Department reported pavement flooding	Local	2
COU1	Country Club Hills	Ponding	NE corner of Pulaski Road and 175th Street	Ponding	Local	5
COU2	Country Club Hills	Pavement flooding	Route 50 at 189th Street	IDOT reported pavement flooding, storm sewer flow restriction	Local	2
DIX1	Dixmoor	Pavement flooding	Wood Street at Thornton Road	IDOT reported pavement flooding, storm sewer flow restriction	Local	5
DOL1	Dolton	Ponding	Between Main Street and 146th Street and Ingleside Avenue and Dante Avenue	Ponding	Local	5
DOL2	Dolton	Ponding	Park Avenue from Main Street to Lincoln Avenue	Ponding	Local	5
DOL3	Dolton	Ponding	144th Street from Indiana Avenue to Jackson Street	Ponding	Local	5
DOL4	Dolton	Ponding	Between State Street and Indiana Avenue from 146th Street to village limits south of 149th Street	Ponding	Local	5

Table 2.2.1: Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
DOL5	Dolton	Pavement flooding	Indiana Avenue between 146th to 147th Streets	IDOT reported pavement flooding	Local	2
EHC1	East Hazel Crest	Pavement flooding	171st Street between Ashland Avenue and South Park Avenue	Cook County Highway Department reported pavement flooding	Local	2
FLO1	Flossmoor	Overbank flooding, basement flooding, storm sewer flow restriction	Intersection of Kathleen Lane and Alexander Crescent	Storm sewer flow restriction	Local	5
FLO2	Flossmoor	Overbank flooding, basement flooding, storm sewer flow restriction	Dartmouth Road and Flossmoor Road	Overbank flooding	Regional	1
FLO3	Flossmoor	Overbank flooding, basement flooding, storm sewer flow restriction	Dartmouth Road and Flossmoor Road	Overbank flooding	Regional	1
FLO4	Flossmoor	Overbank flooding, basement flooding, storm sewer flow restriction	Brockwood Road/ Butterfield Road	Overbank flooding	Regional	1
FLO5	Flossmoor	Pavement flooding	Dixie Highway at Flossmoor Road	Pavement flooding	Local	5
FLO6	Flossmoor	Pavement flooding	Dixie Highway at Holbrook Road to Vollmer Road	Pavement flooding	Local	5
FLO7	Flossmoor	Pavement flooding	Western Avenue between Vollmer Road and Flossmoor Road	Pavement flooding	Local	5
FLO8	Flossmoor	Pavement flooding	Vollmer Road at Butterfield Creek	IDOT reported pavement flooding	Local	2
FHT1	Ford Heights	New reservoir not in service	Woodlawn Avenue and 17th Street	Overbank flooding South of US HWY 30	Regional	1
GLW1	Glenwood	Overbank flooding	187th Street/ 193rd Street/193rd Place/194th Street/Minerva Avenue and Jane Street	Flooding within local subdivision. Located on local tributary to North Creek	Local	5
GLW2	Glenwood	Overbank flooding, basement flooding	187th Street and Glenwood-Chicago Heights Road	Low lying residential area and Boy's school is inundated from overbank flooding from Thorn and Butterfield Creek	Regional	1

Table 2.2.1: Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
GLW3	Glenwood	Prone to beaver dams	Deer Creek/Thorn Creek confluence	Local drainage issue	Local	6
GLW4	Glenwood	Bank erosion and sedimentation, storm sewer restriction, water quality, wetland/riparian areas at risk	Cottage Grove Avenue and Glenwood Lansing Road	Local channel and storm sewer backups	Local	5
HAR1	Harvey	Basement flooding, ponding	Entire village	Local drainage causing basement and street flooding	Local	5
HAR2	Harvey	Pavement flooding	Route 1 at 151st Street	Local channel and storm sewer backups	Local	5
HAR3	Harvey	Pavement flooding	Route 6 at Park Avenue (River Oaks Golf Course)	Local drainage may be causing basement and street flooding. Modeling shows flooding due to CUDD overtopping during the 100 year event	Local	5
HAR4	Harvey	Pavement flooding	Route 6 between Park Avenue and Center Street	IDOT reported pavement flooding	Local	2
HAR5	Harvey	Pavement flooding	Route 83 at Clinton Street	IDOT reported pavement flooding	Local	2
HAR6	Harvey	Pavement flooding	Route 83 at Illinois Route 1	Local drainage problem at this underpass	Local	2
HAR7	Harvey	Pavement flooding	Route 83 at Illinois Central Railroad	IDOT reported pavement flooding	Local	2
HAR8	Harvey	Siltation and vegetation	Lathrop Avenue and 161st Street	Siltation and vegetation	Local	6
HCT1	Hazel Crest	Siltation pond needs regular dredging	172nd Street and Palmer Avenue	Siltation pond needs regular dredging	Local	6
HWD1	Homewood	Pavement flooding	Route 1 at 183rd Street to 195th Street	IDOT reported pavement flooding	Local	2
LAN1	Lansing	Overbank flooding	South of 188th Street and Torrence Avenue to north of 188th Place and Park Avenue	Overbank flooding in topographically flat area causes overtopping of local roads and flooding on residential properties	Regional	1

Table 2.2.1: Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
LAN2	Lansing	Basement flooding	Between Wildwood Avenue and Greenbay Avenue, and North Creek and 190th Street	Basement backups caused by high water level at outfall for local sewer system	Local	5
LAN3	Lansing	Basement flooding	South Manor Drive to Otto Street, and Burnham Avenue to Wentworth Avenue	Basement backups caused by high water level at outfall for local sewer system and water entering homes via overland flooding	Local	5
LAN4	Lansing	Pavement flooding	Burnham Avenue at 170th Street (at river)	Road overtop from Little Calumet River	Regional	3
LAN5	Lansing	Pavement flooding	I-80 at Torrence Avenue	IDOT reported pavement flooding	Local	2
LAN6	Lansing	Bank erosion and sedimentation	Torrence Avenue to Stony Island Avenue	Beaver dams in North Creek	Local	8
LAN7	Lansing	Bank erosion and sedimentation	Lake Wampum Forest Preserve	Erosion along the banks of Forest Preserve Lake. Appeared that problem had been resolved during field inspection	Regional	9
LAN8	Lansing	Pavement flooding	Wenworth Avenue at North Creek	Cook County Highway Department reported pavement flooding	Local	2
LYN1	Lynwood	Overbank flooding, ponding, storm sewer flow restriction, bank erosion and sedimentation	202nd Street to 203rd Street and Burnham Avenue	Widespread flooding due to overbank flooding of Lansing Ditch and Lynwood Tributary, undersized hydraulic openings of crossings	Regional	1
LYN2	Lynwood	Overbank flooding, basement flooding, ponding, storm sewer flow restriction, bank erosion and sedimentation	Joe Orr Road and Bluestem Parkway	Flooding due to local storm sewer system backups and local detention pond performance	Local	5
LYN3	Lynwood	Overbank flooding, basement flooding, ponding, storm sewer flow restriction, bank erosion and sedimentation	Lincoln Lansing Drainage Ditch and Lake Lynwood	Lack of channel conveyance capacity and undersized hydraulic structures at crossings causing overbank flooding	Regional	1

Table 2.2.1: Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
LYN4	Lynwood	Heavy siltation	Lincoln Highway and Sauk Trail Road	Heavy siltation	Local	6
LYN5	Lynwood	Silt and sedimentation	Near Glenwood Lansing Road and Burnham Avenue	Sedimentation at cross culvert under roadway	Local	6
MAT1	Matteson	Channel blockages	Route 30 and Governors Highway	Stream maintenance	Local	6
MAT12	Matteson	Overbank flooding	Chicago Vincennes Road and South of Flossmoor Road	Pavement flooding	Local	5
MAT2	Matteson	Storm sewer flow restriction	Cicero Avenue and Vollmer Road	Stormsewer flow restriction	Local	5
MAT3	Matteson	Storm sewer flow restriction	Route 30 and Ridgeland Avenue	Storm sewer flow restriction	Local	5
MAT4	Matteson	Storm sewer flow restriction	Lindenwood - Rose Lane	Storm sewer flow restriction	Local	5
MAT5	Matteson	Storm sewer flow restriction	1/4 to 1/2 mile south of Route 30 and Kostner Avenue	Storm sewer flow restriction	Local	5
MAT6	Matteson	Pavement flooding	Crawford Avenue at 216th and 219th Streets	IDOT reported pavement flooding	Regional	1
MAT7	Matteson	Pavement flooding	Crawford Avenue at 221st Street (North of Sauk Trail Road)	IDOT reported pavement flooding	Regional	1
MAT8	Matteson	Pavement flooding	Governors Highway at E, J, and E Railroad tracks viaduct (North of 219th Street)	IDOT reported pavement flooding	Regional	1
MAT9	Matteson	Pavement flooding	Governors Highway from Route 30 to 216th Street	Pavement flooding	Local	5
MAT10	Matteson	Pavement flooding	Route 30 at Central Avenue to Ridgeland Avenue	IDOT reported pavement flooding	Local	5
MAT11	Matteson	Pavement flooding	Route 30 at Illinois Route 50 (Cicero Avenue)	IDOT reported pavement flooding	Local	5
MID1	Midlothian	Overbank flooding, ponding, storm sewer flow restriction	149th Street and Kilpatrick Avenue	Natalie Creek Overbank flooding	Regional	1
MID2	Midlothian	Overbank FLOODING, PONDING	149th Street and Kenton Avenue	Natalie Creek Overbank flooding	Regional	1
MID3	Midlothian	Overbank flooding, basement flooding, ponding	147th Street and Kolmar Avenue	Natalie Creek Overbank flooding	Regional	1

Table 2.2.1: Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
MID4	Midlothian	Overbank flooding	147th Street and Kilbourn Avenue	Natalie Creek Overbank flooding	Regional	1
MID5	Midlothian	Overbank flooding, basement flooding, ponding, storm sewer flow restriction	146th Street and Keeler Avenue	Natalie Creek Overbank flooding	Regional	1
MID6	Midlothian	Overbank flooding, basement flooding, ponding, storm sewer flow restriction	146th Street and Karlov Avenue	Natalie Creek Overbank flooding	Regional	1
MID7	Midlothian	Overbank flooding, ponding	146th Street and Keystone Avenue	Natalie Creek Overbank flooding	Regional	1
MID8	Midlothian	Basement flooding, ponding and storm sewer flow restriction	151st Street and Ridgeway Avenue	Basement Flooding, Ponding and Storm Sewer Flow Restriction	Local	5
MID9	Midlothian	Pavement flooding	Route 50 at 151st Street	Natalie Creek overbank flooding	Regional	1
MID10	Midlothian	Pavement flooding	Route 6 at Crawford Avenue to Cicero Avenue	Overbank flooding	Regional	1
MID11	Midlothian	Pavement flooding	Route 83 at Kostner Avenue	Natalie Creek overbank flooding	Regional	1
MID12	Midlothian	Restriction from intersection to drainage ditch system	151st Street and Kilbourn Avenue	Natalie Creek overbank flooding	Regional	1
MID13	Midlothian	Lack of proper grade to Calumet Union Drainage Ditch	153rd Street and Lawndale Avenue	Storm sewer flow restriction	Local	5
MRK1	Markham	Overbank flooding	Arthur Terrace and Blackstone Avenue/ Lawndale Avenue	Lack of channel conveyance capacity and undersized hydraulic strictures at crossings causing overbank flooding.	Regional	1
MRK2	Markham	Ponding	Dixie Highway and Western Avenue/159th Street and 156th Place	Local flooding due to local drainage problems, not overbank flooding from CUDD or Belaire Creek	Local	5
MRK3	Markham	Overbank flooding, ponding	Dixie Highway and Park Avenue/167th and 161st Streets	Overbank flooding from CUDD and additional basement flooding due to local drainage problems	Regional	1

Table 2.2.1: Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
MRK4	Markham	Overbank flooding, ponding	Lincoln Highway and Parkside Avenue/California and Lincoln Highway	Overbank flooding from Belaire Creek with additional basement flooding likely due to local drainage problems	Regional	1
MRK5	Markham	Storm sewer flow restriction	Lawndale Avenue and 167th Street	Basement flooding due to local drainage problems	Local	5
MRK6	Markham	Ponding	Oxford Drive and Richmond Avenue/2800 Circle Drive	Storm sewer flow restriction	Local	5
MRK7	Markham	Ponding	Magnolia Drive and Alta Road	Ponding	Local	5
MRK8	Markham	Ponding	155th Street and Lawndale Avenue	Ponding	Local	5
MRK9	Markham	Basement flooding, ponding	West to Rockwell Avenue and 162nd to 159th Streets	Basement flooding, ponding	Regional	1
MRK10	Markham	Ponding, storm sewer flow restriction	154th Street to 155th Street/Crawford Avenue to Hamlin Avenue	Ponding, storm sewer flow restriction	Local	5
MRK11	Markham	Pavement flooding	Route 6 at 6000 West	IDOT reported pavement flooding	Local	2
OKF1	Oak Forest	Ponding	151st Street and Boca Rio Drive	Ponding	Local	5
OKF2	Oak Forest	Overbank flooding, basement flooding, ponding, storm sewer flow restriction, bank erosion and sedimentation , wetland/riparian at risk	Natalie Creek,159th Street to 151st Street	Overbank flooding	Regional	1
OKF3	Oak Forest	Pavement flooding	Route 50 at 158th Street (Metra viaduct)	IDOT reported pavement flooding	Local	2
OKF4	Oak Forest	Pavement flooding	Route 6 at Central Avenue to Oak Park Avenue	IDOT reported pavement flooding	Local	2
OKF5	Oak Forest	Bank erosion and sedimentation	North of 155th Street and Long Avenue	Culverts in need of maintenance	Local	6
OLY1	Olympia Fields	Basement flooding and public areas	Suburban Woods Subdivision (near 207th Street and Olympian Way)	Basement flooding and ponding	Local	5

Table 2.2.1: Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
OLY2	Olympia Fields	Basement flooding and public areas	Fairway Estates/ Olympia Woods Subdivision (near Promethian Way and Chariot Lane)	Storm sewer flow restriction and ponding	Local	5
OLY3	Olympia Fields	Basement flooding and public areas	Graymoor Subdivision (near Western Avenue and Vollmer Road)	Storm sewer flow restriction and ponding	Local	5
OLY4	Olympia Fields	Intersection flooding	Vollmer Road and Crawford Avenue	Storm sewer flow restriction and ponding	Local	5
OLY5	Olympia Fields	Inadequate viaduct capacity	Vollmer Road Metra Viaduct (near Kedzie Avenue)	Stormsewer flow restriction and ponding	Local	5
OLY6	Olympia Fields	Inadequate capacity at intersection inlet	US Route 30 at Western Avenue	IDOT reported pavement flooding	Local	5
OLY7	Olympia Fields	Inadequate capacity at intersection inlet	Orchard Drive and US Route 30	Storm sewer flow restriction and ponding	Local	5
OLY8	Olympia Fields	Inadequate capacity at intersection inlet	203rd Street east of Crawford Avenue in front of St. James Hospital and Health Center	Storm sewer flow restriction and ponding	Local	5
OLY9	Olympia Fields	Basement flooding and public areas	Sparta Court off of Brockwood Drive	Storm sewer flow restriction and ponding	Local	5
OLY10	Olympia Fields	Pavement flooding	Governors Highway at Pulaski Road	IDOT reported pavement flooding	Local	2
OLY11	Olympia Fields	Pavement flooding	US Route 30 at Western Avenue	IDOT reported pavement flooding	Local	2
OLY12	Olympia Fields	Pavement flooding	Route 30 at railroad bridge (viaduct) w/o Olympian Way	IDOT reported pavement flooding	Local	2
ORH2	Orland Hills	Overbank flooding, ponding, bank erosion and sedimentation, wetland/riparian areas at risk	88th Court Detention Pond (near 167th Street and 88th Avenue)	Problem is due to local drainage issues. Appears to the same problem as OLY6	Local	5
ORP5	Orland Park	Overbank flooding, bank erosion and sedimentation	167th Street and 88th Avenue	Stream maintenance	Local	6
ORT2	Orland Township	Storm sewer flow restriction, bank erosion and sedimentation	80th Avenue from 183rd Street to 151st Street	Stream maintenance	Local	6

Table 2.2.1: Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
PAR1	Park Forest	During large rain events, drainageway becomes flooded and ponds. Water levels rise into backyards of residents that reside adjacent to this drainageway	East Rocket Circle/ West Rocket Circle (near Lakewood Boulevard/Orchard Drive)	Residences ponding from Thorn Creek Tributary D due to undersized culverts	Regional	1
PAR2	Park Forest	Stormwater flow restriction at twin culvert pipes crossing under Western Avenue	Western Avenue and EJ&E Railroad (South Street)	Local drainage obstructions	Local	5
PAR3	Park Forest	Pavement flooding	26th Street at Euclid Avenue to Western Avenue	IDOT reported pavement flooding	Regional	3
PAR4	Park Forest	Pavement flooding	Western Avenue at Route 30 to 26th Parkway	Flooding due to local drainage issues	Local	2
RIT2	Rich Township	Siltation and vegetation	Sauk Trail Road from Harlem Avenue to Western Avenue	Siltation and vegetation	Local	6
RIT3	Rich Township	Debris in channel	Vollmer Road from Harlem Avenue to Western Avenue	Debris in channel	Local	6
RIT4	Rich Township	Siltation	Flossmoor Road from Ridgeland Avenue to Governors Highway	Siltation	Local	6
RIT6	Rich Township	Siltation and debris	Ridgeland Avenue from Steger Road to 183rd Street	Siltation and debris	Local	6
RIC1	Richton Park	Overbank flooding and street flooding	North of Maple Avenue, west of Governors Highway, along Butterfield Creek	Overbank flooding from Butterfield Creek	Regional	1
RIC2	Richton Park	Flooding due to beaver dams	North of Poplar Avenue, along Butterfield Creek Tributary	Local drainage issue	Local	6
RIC3	Richton Park	Flooding on tributary upstream of Lake George	North of Steger Road, west of Lakeshore Drive	Problem is due to local drainage issues	Local	5
RIC4	Richton park	Flooding on Hickory Creek	Northwest corner of Sauk Trail Road and Central Avenue	Flooding on Hickory Creek	Outside Watershed	9
RIC5	Richton Park	Flooding occurs at two locations along this tributary. The flooding takes place primarily with rain events of 1-inch or more	Tributary crossing with Central Park Avenue	Undersized culverts	Local	2

Table 2.2.1: Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
RIC6	Richton Park	Pavement flooding	Governors Highway at Sauk Trail Road	Overbank flooding	Regional	1
RVD1	Riverdale	Pavement flooding	Ashland Avenue at near 138th Street	IDOT reported pavement flooding	Local	2
RVD2	Riverdale	Pavement flooding	Ashland Avenue at 134th Street Crossing	IDOT reported pavement flooding	Local	2
RVD3	Riverdale	Pavement flooding	Ashland Avenue at 142nd Street Crossing	IDOT reported pavement flooding	Local	2
ROB1	Robbins	Overbank flooding	137th Street and 139th Street from Kedzie Avenue 3 blocks east	Overbank flooding	Regional	1
ROB2	Robbins	Overbank flooding	Kedzie Avenue and 139th Street	Overbank flooding	Regional	1
SKV1	Sauk Village	Pavement flooding	Route 30 at Torrence Avenue	Pavement flooding due to undersized culvert	Local	2
SKV2	Sauk Village	Overbank flooding	Torrence Avenue and 223rd Street/Katz Corner Road	Pavement flooding due to undersized culvert	Regional	1
SHO1	South Holland	Overbank flooding	Little Calumet River throughout South Holland	Pavement flooding due to undersized culvert	Regional	1
SHO2	South Holland	Pavement flooding	I-94 at 159th Street (to I.80)	Flooding of highway. Residents stated that problem no longer exists since Thornton Transitional Quarry came online. No flooding shown in model	Regional	9
SHO3	South Holland	Pavement flooding	I-94 at 170th Street	Overtopping of major roadway	Regional	3
STE1	Steger	Pavement flooding	State Street at 227th Place	Overtopping of major roadway	Regional	1
TRN1	Thornton	Basement flooding, ponding	400 East Margaret Street (Brownell)	Overbank flooding from Thorn Creek tributary	Regional	1
THO1	Thornton Township	Bank erosion and sedimentation	Thornton Road from Dixie Highway (Chatham) to Wood Street	Bank Erosion and Sedimentation	Local	5
THO2	Thornton Township	Storm sewer flow restriction	171st Street from Robey Street to Halsted Street	Other (siltation, storm sewer flow restriction	Local	5

Table 2.2.1: Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
THO3	Thornton Township	Storm sewer flow restriction	Center Street from 175th Street to 159th Street	Other (debris)	Local	2
TIN1	Tinley Park	Bank erosion and sedimentation	Near Central Avenue and 167th Street	Erosion on 2.7 miles of Midlothian Creek. Building structures are 30 feet away from the erosion	Local	8
TIN2	Tinley Park	Basement flooding, ponding	Oak Park Avenue and 167th Street	Ponding and basement flooding	Local	5
TIN3	Tinley Park	Pavement flooding	Illinois Route 43 at 159th Street to 165th Street	IDOT reported pavement flooding	Local	2
TIN4	Tinley Park	Pavement flooding	Illinois Route 43 at 175th Street railroad underpass	IDOT reported pavement flooding	Local	2
TIN5	Tinley Park	Pavement flooding	Route 6 at Illinois Route 43 (Harlem Avenue)	IDOT reported pavement flooding	Local	2
TIN6	Tinley Park	Pavement flooding	Illinois Route 43 at Rock Island Railroad	IDOT reported pavement flooding	Local	2
TIN7	Tinley Park	Ponding	Ridgeland Avenue and 167th Street	Ponding	Local	5
TIN8	Tinley Park	Ponding	Oak Park Avenue on the west, 179th Street to the north, 183rd Street to the south and 1/4 mi east of Ridgeland Avenue	Ponding	Local	5
TIN9	Tinley Park	Streambank erosion	17251 66th Court	Streambank erosion	Regional	7
TIN10	Tinley Park	Streambank erosion	17147 South Oak Park Avenue	Streambank erosion	Regional	7

Reasons for Regional/Local Classifications:

1- Located on an open channel intercommunity waterway with greater than 0.5 square mile drainage area
2- Roadway culvert (two-lane road)
3- Roadway culvert (greater than two-lane road)
4- Located in headwater area (less than 0.5 square mile drainage area)
5- Located within local storm sewer system (regardless of drainage area)
6- Local stream maintenance problem
7- Streambank erosion on intercommunity waterways, structures within 30 feet of active erosion
8- Streambank erosion on Intra-community (local) waterways
9- Flooding problems not studied in the DWP. Problems are already addressed or located outside of the watershed

2.3 Watershed Analysis Data

2.3.1 Monitoring Data

2.3.1.1 USGS Gage Data

Stage and flow data from 10 USGS stream gages within the Little Calumet River watershed in Cook County, IL and Lake County, IN were used for DWP development. The 15 minute flow and stage data, when available, were used in the calibration of the HEC-HMS and HEC-RAS models. A summary of the gages is shown in **Table 2.3.1** and **Figure 2.3.1** shows the locations these gages.

Table 2.3.1: Stream Gage Locations

Gage	Gage No.	Drainage Area (sq. mi.)	Period of Record	Maximum Flow (cfs)	Maximum Stage (ft)
Hart Ditch at Dyer, IN	USGS 05536179	37.6	2005 - present	3,010	15.69
Hart Ditch at Munster, IN	USGS 05536190	70.7	1942 - present	3,260	8.72
Little Calumet River at Munster, IN	USGS 05536195	90	1958 - present	1,510	17.03
Deer Creek near Chicago Heights, IL	USGS 05536235	23.1	1948 - present	1,380	12.37
Butterfield Creek at Flossmoor, IL	USGS 05536255	23.5	1948 - present	2,640	13.08
Thorn Creek at Thornton, IL	USGS 05536275	104	1948 - present	4,700	17.06
Midlothian Creek at Oak Forest, IL	USGS 05536340	12.6	1950 - present	382	6.15
Little Calumet River at South Holland, IL	USGS 05536290	208	1947 - present	4,760	20.50
Lansing Ditch at Lansing, IL	USGS 05536265	8.84	1948 - present	208	9.52
Thorn Creek at Glenwood, IL	USGS 05536215	24.7	1949 - present	2,600	11.26

2.3.1.2 Rainfall Data

The Illinois State Water Survey (ISWS) owns and maintains 25 rain gages in Cook County. There are 7 ISWS rain gages (Alsip, Tinley Park, Harvey, Lansing, Matteson, Chicago Heights and Wolf Lake) that cover the Little Calumet River Watershed. Rainfall is recorded continuously at 10-minute intervals, processed by the ISWS to ensure quality, and available for purchase. ISWS rainfall data was obtained for these gages for the calibration storms listed in **Section 1.3.2** to support calibration of the Little Calumet River Watershed models In addition to the ISWS gages, National Weather Service gages at Crete, Monee Reservoir, Crown Point, La Porte, Indiana Dunes, and Valparaiso, USGS rain gages at Chicago Heights, Dyer, Gary, Hobart, Taft, and South Holland and the Community Collaborative Rain, Hail, and Snow Network (CoCoRAHS) daily rainfall totals for various locations were used in the HEC-HMS model for calibration. The NWS, USGS, and CoCoRAHS gages used varied by storm depending on which gages were available. **Figure 2.3.1** shows the locations of the rain gages used for the Little Calumet River DWP.

2.3.2 Subwatershed Delineation

Subbasins were delineated in the Little Calumet River Watershed as described in **Section 1.3.2.1**. Within the watershed, 431 subbasins were delineated ranging in size from 0.005 to 17.8 square miles. The delineation was based on Cook County topographic data, Indiana 5-foot grid cell DEM's, and USGS National Elevation Dataset information for Will County. The subbasin boundaries for the Little Calumet River watershed are shown in **Figure 2.3.2.1**. The subbasin boundaries in Cook County are shown in **Figure 2.3.2.2**.

2.3.3 Drainage Network

The principal waterways of the Little Calumet River Watershed were defined during Phase A of DWP development. Initial identification of the stream centerline was made using planimetric data obtained from Cook County. Stream centerlines were reviewed against aerial photography and Cook County contour data at a 1:500 scale, and modified to best represent existing conditions. These stream lines were included in the topographic model of the Little Calumet River Watershed (see **Section 2.3.4**), and collect runoff from upland drainage areas. Secondary drainageways were identified based upon review of contour data. In flat, heavily sewered areas, consultation of sewer atlases and discussion with community representatives helped to identify significant drainage paths. This identified secondary drainageways were used to define flow paths in the hydrologic models for individual tributaries. **Figure 2.3.3** shows the major drainageways within the Little Calumet River Watershed superimposed upon an elevation map of the watershed.

2.3.4 Topography and Benchmarks

Topographic data for the Little Calumet River watershed was developed from Cook County light detection and ranging (LiDAR) data generated from a 2003 LiDAR mission (Cook County, 2003). The LiDAR data was obtained along with break lines from Cook County. A digital elevation model (DEM) was developed for the Little Calumet River watershed model based upon a subset of filtered elevation points. **Figure 2.3.3** shows elevations within the watershed.

Stream channel cross section and stream crossing structure (such as bridge and culvert) topographic data was collected during field survey work conducted primarily between December 2007 and May 2008 to support the DWP. Some additional field survey work was performed during 2009.

The reference benchmarks created during the Cook County aerial mapping project completed in 2003 were used to establish first-order control for field survey work. One hundred thirty-five control points were established during the mapping project. Of those, 25 are National Geodetic Survey (NGS)/High Accuracy Reference Network (HARN) control stations within Cook County and Environs. The remaining points were either existing or new points identified as photo control specifically for the

2.3.5 Soil Classifications

NRCS soil data representative of 2005 conditions was obtained for Cook and Will Counties in Illinois and Lake, Porter, and La Porte Counties in Indiana. There are several unmapped areas which include the City of Chicago and some portions of nearby communities that consist primarily of urban land forms. These urban land forms were assumed to be Hydrologic Soil Group C.

The NRCS soil data includes the hydrologic soil group, representing the minimum infiltration rate of the soil after wetting. **Table 2.3.2** summarizes the hydrologic soil groups.

Table 2.3.2: Hydrologic Soil Groups

Hydrologic Soil Group	Description	Texture	Infiltration Rates (in/hr)
A	Low runoff potential and high infiltration rates even when wetted	Sand, loamy sand, or sandy loam	> 0.30
B	Moderate infiltration rates when wetted	Silt loam or loam	0.15 - 0.30
C	Low infiltration rates when wetted	Sandy clay loam	0.05 - 0.15
D	High runoff potential and very low infiltration when wetted	Clay loam, silty clay loam, sandy clay, silty clay, or clay	0 - 0.05

All data from *Technical Release 55, Urban Hydrology for Small Watersheds*, NRCS, June 1986

Table 2.3.3: Hydrologic Soil Group Distribution

Hydrologic Soil Group	% of Little Calumet River Watershed
Unmapped	15.7
A	9.1
A/D	0.2
B	21.0
B/D	5.1
C	42.7
C/D	2.0
D	4.2

Soil groups with drainage characteristics affected by a high water table are indicated with a "/D" designation, where the letter preceding the slash indicates the hydrologic group of the soil under drained conditions. Thus, an "A/D" indicates that the soil has characteristics of the A soil group if drained but the D group if not. Because of the difficulty of establishing the extent of drainage of these soils for each mapped soil polygon, it was assumed that 50 percent (by area) of the soil types are drained. **Table 2.3.3** summarizes the distribution of hydrologic soil type throughout the Little Calumet River watershed. **Figure 2.3.4** shows the distribution of soil types throughout the watershed.

2.3.6 Land Use

Land use has a significant effect on basin hydrology, affecting the volume of runoff produced by a given area and the speed of runoff delivered to the receiving system. Impervious areas restrict infiltration and produce more runoff, which is often delivered to receiving systems more rapidly through storm sewer networks. Land use was one of two principal inputs into the calculation of CN for the Little Calumet River watershed, detailed more extensively in **Section 1.3.2**.

Table 2.3.4: Land Use Distribution for Little Calumet River Watershed Within Cook County

Land Use Type	Area (acres)	Percentage of Watershed (%)
Residential	38,996	30.7
Forest/Open Land	22,815	29.5
Commercial/Industrial	11,482	4.6
Water/Wetland	1,997	1.7
Agricultural	9,151	30.9
Transportation/Utility	4,469	1.3
Institutional	4,048	1.2

A 2001 land use inventory for the Chicago metropolitan area was received from CMAP in GIS format. The data was used to characterize existing conditions land use within the Little Calumet River watershed. The data include 49 land use classifications, grouped into seven general categories for summarizing land use within the DWP. **Table 2.3.4** summarizes the land use distribution within the Little Calumet River watershed. **Figure 2.3.5** shows the distribution of general land use categories throughout the watershed.

2.3.7 Anticipated Development and Future Conditions

Anticipated development within the Little Calumet River watershed was analyzed using population projection data. Projected future conditions land use data for the Little Calumet River watershed are unavailable from CMAP or other regional agencies. Projected 2030 population data for Cook County was obtained from CMAP. Population data was overlaid upon subwatershed boundaries to identify the potential for increases in subwatershed populations. **Table 2.3.5** shows subwatersheds with a projected population increase from the year 2000 population. Projected increases in population along with current subwatershed land use conditions make it likely that there will also be a corresponding increase in impervious surface area. This potential change in impervious surface area could contribute to higher flow rates and volumes of stormwater runoff drained by those tributaries.

Table 2.3.5: Projected Populations for Little Calumet River Watershed

Name	2000 Population	2030 Population	Population Change	% Change
Butterfield Creek	44,333	85,752	41,419	93
Cal Union Drainage Ditch	67,054	72,882	5,828	9
Deer Creek	6,965	9,526	2,561	37
Little Calumet River	119,853	128,344	8,491	7
Midlothian Creek	59,829	72,583	12,754	21
North Creek	10,075	11,852	1,777	18
Thorn Creek	65,873	76,769	10,896	17
Plum Creek	219	383	164	7

Management of future development may be regulated through both local ordinances and the WMO as described below in **Section 2.3.9**. This regulation would be an effort to prevent an increase in peak flows via the construction of site-specific stormwater controls. The impact of the modified hydrologic and hydraulic characteristics of the subwatersheds due to changing land use over time may require the recommended projects to be re-evaluated under the conditions at the time of implementation to refine the details of the final design. To accomplish this, it is recommended that at the time projects are implemented, the H&H models be rerun incorporating any new or updated land use and topographic information.

2.3.8 Wetland and Riparian Areas

Wetland areas within the Little Calumet River watershed were identified using National Wetlands Inventory (NWI) mapping. NWI data includes approximately 5.7 square miles of wetland areas in the Little Calumet River watershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provide flood management, habitat, and water quality enhancement. Identified riparian areas defined as part of the DWP offer potential opportunities for restoration. **Figures 2.3.6** and **2.3.7** contain mapping of wetland and riparian areas in the Little Calumet River watershed.

2.3.9 Management of Future Conditions Through the Regulations of Site Stormwater Management

The District regulates the discharge of stormwater runoff from development projects located within separate sewer areas within the District's corporate boundaries through its Sewer Permit Ordinance. Currently, development projects meeting certain thresholds must provide stormwater detention in an effort to restrict the post-development flow rate to the pre-development flow rate. A number of communities enforce standards beyond the District's currently required standards and thresholds. This DWP supports the continued regulation of future development through countywide stormwater management.

The Cook County Watershed Management Ordinance (WMO) is under development and is proposed to provide uniform minimum countywide standards for site stormwater runoff for events up to and including the 100-year event that are appropriate for Cook County. This effort seeks to prevent post-development flows from exceeding pre-development conditions. The WMO is proposed to be a comprehensive ordinance addressing site runoff, floodplains, floodways, wetlands, soil erosion and sedimentation, water quality, and riparian environments.

Section 3
Tributary Characteristics and Analysis

3.1 Butterfield Creek

The Butterfield Creek subwatershed encompasses approximately 26 square miles (24.35 in Cook County and 1.50 in Will County) within the Little Calumet River watershed. There are ten tributaries within the subwatershed, including Butterfield Creek, totaling over 24 stream miles. **Table 3.1.1** lists the communities that lie within the subwatershed and the associated drainage area for each community contained within the subwatershed.

Table 3.1.1: Communities Draining to Butterfield Creek Subwatershed Within Cook County

Community	Tributary Area (mi^2)
Chicago Heights	0.91
Country Club Hills	0.28
Flossmoor	2.27
Frankfort Square	<0.01
Glenwood	0.57
Homewood	1.61
Matteson	6.08
Olympia Fields	2.80
Park Forest	0.46
Richton Park	2.31
University Park	0.11
Unincorporated/Forest Preserve	6.96

Table 3.1.2 lists the land use breakdown by area within the Butterfield Creek subwatershed. **Figure 3.1.1** provides an overview of the tributary area of the subwatershed. Reported stormwater problem areas and proposed alternative projects are also shown on the figure, and are discussed in the following subsections.

Within the Butterfield Creek subwatershed, a total of 24.4 stream miles were studied among the ten tributaries: Butterfield Creek Main Tributary, Butterfield Creek East Branch, Butterfield Creek East Branch Tributary, Butterfield Creek East Branch Tributary A, Butterfield Creek Tributary 1, Butterfield Creek Tributary 3, Butterfield Creek Tributary 4, Unnamed Tributary to Butterfield Creek East, Unnamed Tributary to Butterfield Creek West, Unnamed Tributary to Butterfield Creek East Branch, and Unnamed Tributary to Butterfield Creek East Branch South.

Table 3.1.2: Land Use Distribution for Butterfield Creek Subwatershed Within Cook County

Land Use	Acres	%
Commercial/Industrial	1,026	6.5
Forest/Open Land	3,568	22.8
Institutional	642	4.1
Residential	7,010	44.9
Transportation/Utility	488	3.1
Water/Wetland	596	3.8
Agricultural	2,253	14.4

- Butterfield Creek Main Tributary (BTCR) – headwaters start near the intersection of Ridgeland Avenue and Lincoln Highway in Unincorporated Cook County and extend to the confluence with Thorn Creek, located near the Chicago Heights Glenwood Road and 187th Street intersection in the Village of Glenwood.

- Butterfield Creek East Branch (BCEB) – extends from the Cook/Will County line near the intersection of Kostner Avenue and Steger Road in the Village of University Park to the confluence with Butterfield Creek Main Tributary, located east of the intersection of Governors Highway and Crawford Avenue in the Village of Olympia Fields.

- Butterfield Creek East Branch Tributary (BEBT) – extends from the Cook/Will County line near the intersection of Lakeshore Drive and Steger Road in the Village of Richton Park to the confluence with Butterfield Creek East Branch at Lake George in the Village of Matteson.

- Butterfield Creek East Branch Tributary A (BETA) – headwaters start near the intersection of Imperial Drive and Lorraine Court in the Village of Richton Park and extend to the confluence with Butterfield Creek East Branch Tributary at Lake George in the Village of Richton Park.

- Butterfield Creek Tributary 1 (BCT1) – headwaters start southeast of the intersection of Western Avenue and Vollmer Road in the Village of Olympia Fields and extend to the confluence with Butterfield Creek Main Tributary in the Village of Flossmoor.

- Butterfield Creek Tributary 3 (BCT3) – headwaters start south of the intersection of Kedzie Avenue and Governors Highway and extend to the confluence with Butterfield Creek Main Tributary in the Village of Flossmoor.

- Butterfield Creek Tributary 4 (BCT4) – extends from the intersection of Vollmer Road and Metra Railway Tracks to the confluence with Butterfield Creek Tributary 3 in the Village of Flossmoor.

- Unnamed Tributary to Butterfield Creek East (UBCE) – headwaters start near the intersection of 187th Street and Halsted Street and extend to the confluence with Butterfield Creek main stem in the Village of Glenwood.

- Unnamed Tributary to Butterfield Creek West (UBCW) – extends from northeast of the intersection of Lincoln Highway and Central Avenue to the confluence with Butterfield Creek main tributary located in the Village of Matteson.

- Unnamed Tributary to Butterfield Creek East Branch (UBEN) – headwaters start near the intersection of Quinn Avenue and 214th Street and extend to the confluence with Butterfield Creek East Branch located in the Village of Matteson.

- Unnamed Tributary to Butterfield Creek East Branch South (UBES) – headwaters start west of the intersection of Imperial Drive and Lorraine Court and extend to the confluence with Butterfield Creek East Branch in the Village of Richton Park.

- All of the above tributaries drain to the Butterfield Creek Main Tributary and then to Thorn Creek. There are no major regional flood control facilities within the Butterfield Creek subwatershed.

3.1.1 Sources of Data

3.1.1.1 Previous Studies

Several studies have been performed related to the Butterfield Creek subwatershed to assess stormwater flooding problems and evaluate solutions. Below is a list of studies that have been performed since the mid 1970's:

- *Interim Review Report of Little Calumet River*, U.S. Army Corps of Engineers, December 1973

- *Little Calumet River Watershed Engineering Design Report (Revised)*, U.S. Department of Agriculture, Metropolitan Sanitary District of Greater Chicago and the Illinois Department of Conservation, January 1977

- *Floodplain Management Study Butterfield Creek and Tributaries, Cook-Will Counties, Illinois*, Prepared by United States Department of Agriculture, Soil Conservation Service, Illinois Department of Transportation and Division of Water Resources, November 1987

- Study of the Flossmoor Tributary to Butterfield Creek, Lindley and Sons, Inc., 1990

- Revised Computer Analysis of the Flossmoor Tributary to Butterfield Creek, Lindley and Sons, Inc., July 1997

- Stormwater Analysis and Recommendation Study for Village of Flossmoor, Prepared by Christopher B. Burke Engineering, LTD., August 1998

The studies listed above were consulted during development of the DWP.

3.1.1.2 Water Quality Data

Water quality for the Butterfield Creek subwatershed is monitored by two agencies, Illinois Environmental Protection Agency (IEPA) and the United States Geological Survey (USGS). IEPA monitors water quality at four locations in the Butterfield Creek subwatershed as part of the Ambient Water Quality Monitoring Network (AWQMN), shown in **Table 3.1.3**.

Table 3.1.3: IEPA Water Quality Monitoring Stations in Butterfield Creek Subwatershed

Station ID	Waterbody	Road Crossing, Municipality
HBDB-01	Butterfield Creek	Glenwood Road, Village of Glenwood
HBDB-02	Butterfield Creek	Crawford Avenue, Village of Olympia Fields
HBDB-03	Butterfield Creek	Chicago Road, Village of Homewood
HBDB-04	Butterfield Creek	Lincoln Highway, Village of Matteson

USGS also monitors water quality at USGS Gage 5536255 located downstream of Riegel Road crossing in Village of Flossmoor, Illinois.

IEPA's 2008 Integrated Water Quality Report, which includes the Clean Water Act (CWA) 303(d) and the 305(d) lists, identifies reach IL_HBDB-03 (Butterfield Creek Main Tributary) as impaired for Aquatic Life designated uses, with potential causes being DDT, Nitrogen (Total), Dissolved Oxygen, Phosphorous (Total) and Total Dissolved Solids. Additionally, a Stage 1 Total Maximum Daily Load (TMDL) analysis has been developed for Butterfield Creek reach IL_HBDB-01 (Butterfield Creek Main Tributary) for dissolved oxygen.

There are two National Pollutant Discharge Elimination System (NPDES) permits issued by IEPA for discharges into Butterfield Creek: permit IDs IL0072362 and IL0029211. No further details about the discharges were readily available. In addition to the point source discharges listed, municipalities discharging to Butterfield Creek or its tributaries are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement six minimum control measures for limiting runoff pollution to receiving systems. Also as part of the Phase II Stormwater Permit Program, construction sites disturbing greater than 1 acre of land are required to get a construction permit.

3.1.1.3 Wetland and Riparian Areas

Figures 2.3.6 and **2.3.7** contain mapping of wetland and riparian areas in the Little Calumet River watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 645 acres of wetland areas in the Butterfield Creek subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.1.1.4 Floodplain Mapping

The floodplain boundaries for Butterfield Creek subwatershed were revised in 2008 as part of the FEMA's Map Modernization program. The Butterfield Creek subwatershed floodplain boundaries were revised based upon updated Cook County topographic data, and the boundary condition at the Thorn Creek confluence was adjusted to account for the Thornton Transitional Reservoir. The effective model developed in the mid 1980s by the National Resources Conservation Services was used to create the floodplain boundaries. The 2008 Flood Insurance Rate Maps (FIRMs) show a detailed study was performed for all the Butterfield Creek tributaries and hence was mapped as Zone AE.

Appendix A contains a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the Little Calumet River DWP.

3.1.1.5 Stormwater Problem Data

There were a total of 44 stormwater problems reported for the Butterfield Creek subwatershed. The problem area data was obtained primarily from questionnaire response data (FORM B) provided by the watershed's communities to the District. **Table 3.1.4** lists the details of these stormwater problems. All the problems were classified as a regional or local stormwater problem based on the criteria established in **Section 2.1.1**. All the listed regional problems were addressed based on the alternative analysis, as discussed in the following sections.

Table 3.1.4: Community Response Data for Butterfield Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
CHT4	Chicago Heights	Pavement flooding	US 30 at Orchard Street	Pavement flooding	Local	Not located on a regional waterway. This is a local drainage issue.
COU2	Country Club Hills	Pavement flooding	IL 50 at 189th Street.	Pavement flooding	Local	Not located on a regional waterway. This is a local drainage issue.
FLO1	Flossmoor	Road overtopping and first floor flooding	Kathleen Lane/ Alexander Crescent Intersection to Kedzie Avenue	Storm sewer flow restriction	Local	Not located on a regional waterway. This is a local drainage issue.
FLO2	Flossmoor	Overbank flooding	Dartmouth Road (south sag) to Flossmoor Road	Overbank flooding	Regional	Construct floodwall and channel improvements (Alternative BTCRG3-A4).
FLO3	Flossmoor	Overflows from Flossmoor Country Club	Dartmouth Road (Butterfield sag) to Flossmoor Road	Overbank flooding	Regional	Construct floodwall and channel improvements (Alternative BTCRG3-A4).
FLO4	Flossmoor	Overflows from Flossmoor Country Club	Brockwood Road/ Butterfield Road	Overbank flooding	Regional	Sufficient land was not available to address all flooding in this area. Properties at risk of flooding in this area are candidates for protection using non-structural measures, such as floodproofing or acquisition.

Table 3.1.4: Community Response Data for Butterfield Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
FLO5	Flossmoor	Pavement flooding	Dixie Highway at Flossmoor Road	Pavement flooding	Local	Not located on a regional waterway. This is a local drainage issue.
FLO6	Flossmoor	Pavement flooding	Dixie Highway at Holbrook Road to Vollmer Road	Pavement flooding	Local	Not located on a regional waterway. This is a local drainage issue.
FLO7	Flossmoor	Pavement flooding	Western Avenue between Vollmer Road and Flossmoor Road	Pavement flooding	Local	Not located on a regional waterway. This is a local drainage issue.
FLO8	Flossmoor	Pavement flooding	Vollmer Road at Butterfield Creek	Pavement flooding	Local	Not located on a regional waterway. This is a local drainage issue.
HWD1	Homewood	Pavement flooding	IL 1 at 183rd to 195th Street	Pavement flooding	Local	Not located on a regional waterway. This is a local drainage issue.
MAT1	Matteson	Channel blockages	US 30 and Governors Highway	Storm sewer flow restriction	Local	Not located on a regional waterway. This is a local drainage issue.
MAT2	Matteson	Channel blockages	Cicero to Vollmer	Storm sewer flow restriction	Channel maintenance	Removal of debris to be addressed by stream maintenance.
MAT3	Matteson	Channel blockages	US 30/Ridgeland	Storm sewer flow restriction	Channel maintenance	Removal of debris to be addressed by stream maintenance.
MAT4	Matteson	Channel blockages	Lindenwood to Rose Lane	Storm sewer flow restriction	Channel maintenance	Removal of debris to be addressed by stream maintenance.
MAT5	Matteson	Channel blockages	1/4 to 1/2 mile south of US 30/ Kostner	Storm sewer flow restriction	Channel maintenance	Removal of debris to be addressed by stream maintenance.
MAT6	Matteson	Pavement flooding	Crawford Avenue at 216th to 219th	Pavement flooding	Regional	Construct detention facility, culvert improvements, channel improvements and earthen levee (Alternative BCEBG1-A5).
MAT7	Matteson	Pavement flooding	Crawford Avenue at 221st (N/O Sauk Trail Road)	Pavement flooding	Regional	Construct detention facility, culvert improvements, channel improvements and earthen levee (Alternative BCEBG1-A5).

Table 3.1.4: Community Response Data for Butterfield Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
MAT8	Matteson	Pavement flooding	Governors Highway at EJ&E Viaduct (N/O 219th Street)	Pavement flooding	Regional	Construct detention facility, culvert improvements, channel improvements and earthen levee (Alternative BCEBG1-A5).
MAT9	Matteson	Pavement flooding	Governors Highway from US 30 to 216th Street	Pavement flooding	Local	Not located on a regional waterway. This is a local drainage issue.
MAT10	Matteson	Pavement flooding	US 30 at Central Avenue to Ridgeland Road	Pavement flooding	Local	Not located on a regional waterway. This is a local drainage issue.
MAT11	Matteson	Pavement flooding	US 30 at IL 50 (Cicero Avenue)	Pavement flooding	Local	Not located on a regional waterway. This is a local drainage issue.
MAT12	Matteson	Overbank flooding in rains	Vincennes and south of Flossmoor Road	Pavement flooding	Local	Not located on a regional waterway. This is a local drainage issue.
OLY1	Olympia Fields	Basement flooding, ponding, storm sewer flow restriction	Suburban Woods Subdivision (near 207th and Olympian Way)	Flooding of basements and public areas	Local	Not located on a regional waterway. This is a local drainage issue.
OLY2	Olympia Fields	Basement flooding, ponding, storm sewer flow restriction	Fairway Estates/ Olympia Woods Subdivision (near Promethean Way and Chariot Lane)	Flooding of basements and public areas	Local	Not located on a regional waterway. This is a local drainage issue.
OLY3	Olympia Fields	Basement flooding, ponding, storm sewer flow restriction	Graymoor Subdivision (near Western Avenue and Vollmer Road)	Flooding of basements and public areas	Local	Not located on a regional waterway. This is a local drainage issue.
OLY4	Olympia Fields	Storm sewer flow restriction and ponding	Vollmer Road and Crawford Avenue	Ponding at intersection	Local	Not located on a regional waterway. This is a local drainage issue.
OLY5	Olympia Fields	Storm sewer flow restriction and ponding	Vollmer Road Metra Viaduct (near Kedzie Avenue)	Inadequate viaduct capacity	Local	Not located on a regional waterway. This is a local drainage issue.
OLY7	Olympia Fields	Storm sewer flow restriction and ponding	Orchard Drive and US 30	Insufficient inlet capacity on roadway	Local	Not located on a regional waterway. This is a local drainage issue.
OLY8	Olympia Fields	Storm sewer flow restriction and ponding	203rd Street east of Crawford Avenue in front of St. James	Insufficient inlet capacity on roadway	Local	Not located on a regional waterway. This is a local drainage issue.

Table 3.1.4: Community Response Data for Butterfield Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
OLY9	Olympia Fields	Storm sewer flow restriction and ponding	Sparta Court off of Brockwood Drive	Flooding of basements and public areas	Local	Not located on a regional waterway. This is a local drainage issue.
OLY10	Olympia Fields	Pavement flooding	Governors Highway. at Pulaski	Pavement flooding	Local	Problem not located on a regional waterway. This is a local problem.
OLY12	Olympia Fields	Pavement flooding	US 30 at railroad bridge (viaduct) w/o Olympian Way	Pavement flooding	Local	Problem not located on a regional waterway. This is a local problem.
RIC1	Richton Park	Overbank and street flooding	Maple Avenue west of Governors Highway, along Butterfield Creek	Overbank flooding	Regional	Construct detention facility, culvert improvements, channel improvements and earthen levee (Alternative BCEBG1-A5).
RIC2	Richton Park	Overbank flooding	North of Poplar Avenue, along Butterfield Creek Tributary	Flooding due to beaver dams	Channel maintenance	Removal of debris to be addressed by stream maintenance.
RIC3	Richton Park	Overbank flooding	North of Steger Road, west of Lakeshore Drive	Flooding on tributary upstream of Lake George	Local	Problem not located on a regional waterway. This is a local problem.
RIC6	Richton Park	Pavement flooding	Governors Highway S/O Sauk Trail	Overbank flooding	Regional	Construct detention facility, culvert improvements, channel improvements and earthen levee (Alternative BCEBG1-A5).
RIT2	Rich Township	Siltation and vegetation	Sauk Trail from Harlem Avenue to Western Avenue	Siltation and vegetation	Channel maintenance	Removal of debris to be addressed by stream maintenance.
RIT3	Rich Township	Debris in channel	Vollmer Road from Harlem Avenue to Western Avenue	Debris in channel	Channel maintenance	Removal of debris to be addressed by stream maintenance.
RIT4	Rich Township	Siltation	Flossmoor Road from Ridgeland Avenue to Governors Highway	Siltation	Channel maintenance	Removal of debris to be addressed by stream maintenance.
RIT6	Rich Township	Siltation and debris	Ridgeland Avenue from Steger Road to 183rd Street	Siltation and debris	Channel maintenance	Removal of debris to be addressed by stream maintenance.

3.1.1.6 Near Term Planned Projects

No near-term planned major flood control projects to be constructed by others were identified for the Butterfield Creek subwatershed.

3.1.2 Watershed Analysis

3.1.2.1 Hydrologic Model Development

3.1.2.1.1 Subbasin Delineation

The Butterfield Creek subwatershed was delineated based upon LiDAR topographic data developed by Cook County in 2003. There are 58 subbasins ranging in size from 0.015 to 2.20 square miles with an average size of 0.446 square miles.

3.1.2.1.2 Hydrologic Parameter Calculations

Curve numbers (CN) were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in **Section 1.3.2**, with lookup values for specific combinations of land use and soil data presented in **Appendix C**. An area-weighted average of the CN was generated for each subbasin.

Clark's unit hydrograph parameters were estimated using the method described in **Section 1.3.2**. **Appendix G** provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.1.2.2 Hydraulic Model Development

3.1.2.2.1 Field Data, Investigation, and Existing Model DataThe FEMA effective hydraulic model was developed by NRCS in the mid 1980s using WSP-2. The model data was over 20 years old and was not used in the DWP development.

A field reconnaissance was conducted in June 2007. Information was compiled on stream crossings, land use, and channel conditions. The collected hydraulic structure dimensions were compared to bridge/culvert dimensions data provided by Cook County Highway Department (provided data for only state/county highways). Based on the field reconnaissance data and hydraulic structures dimensions data, a field survey plan for Butterfield Creek was developed.

Field survey was performed under the protocol of FEMA's *Guidelines and Specifications for Flood Hazard Mapping partners, Appendix A: Guidance for Aerial Mapping and Surveying*. Field survey was performed in early 2008. Cross sections were generally surveyed between 500 and 1,000 feet apart. The actual spacing and location was determined based on the variability of the channel shape, roughness, and slope. To develop the model, 99 hydraulic structures throughout the subwatershed, including immediate upstream and downstream cross sections, were surveyed, as well as 98 additional cross sections along all the tributaries.

The Manning's n-values at each cross section were estimated using a combination of aerial photography and photographs from field survey and field reconnaissance. The horizontal extent of each type of land cover and the associated n-value for each cross section were manually entered into the HEC-RAS hydraulic model. All the n-values were manually adjusted using the HEC-RAS cross-sectional data editor.

The n-values were increased where buildings are located within the floodplain to account for conveyance loss. The n-values in these areas may range from 0.06 for areas with few buildings to 0.15 for fully developed areas. If significant blockage was caused by buildings in the flood fringe, the developed areas were modeled as ineffective flow. **Table 3.1.5** lists the channel and overbank ranges of n-values that were used for the subwatershed model.

Table 3.1.5: Channel and Overbank Associated Manning's n-Values[1]

Tributary	Range of Channel n-Values	Range of Overbank n-Values
BTCR	0.045 – 0.06	0.05 – 0.12
BCEB	0.045 – 0.06	0.05 – 0.12
BEBT	0.045 – 0.06	0.05 – 0.12
BETA	0.045 – 0.06	0.05 – 0.10
BCT1	0.045 – 0.06	0.05 – 0.08
BCT3	0.045 – 0.06	0.05 – 0.07
BCT4	0.045 – 0.06	0.05 – 0.08
UBCE	0.045 – 0.06	0.05 – 0.10
UBCW	0.045 – 0.06	0.05 – 0.10
UBEN	0.045 – 0.06	0.05 – 0.10

[1]**Source**: Open Channel Hydraulics, Chow 1959

3.1.2.2.2 Boundary ConditionsA downstream boundary condition was required within the Butterfield Creek hydraulic model at its confluence with Thorn Creek. The boundary condition was determined by extracting the flow output hydrograph from the HEC-RAS model and inputting it as an upstream flow for the Thorn Creek model. Once the Thorn Creek HEC-RAS model was run, the stage hydrograph at the confluence generated by the Thorn Creek model was used as the downstream boundary condition in the Butterfield Creek model. This allowed the modeling of any backwater effects that may be present due to the confluence of the two creeks.

3.1.2.3 Calibration and Verification A detailed calibration was performed for the Butterfield Creek subwatershed using historic gage records under the guidelines of Chapter 6 of the Cook County Stormwater Management Plan (CCSMP). Three historical storms (July 1996, April 2006 and September 2008) were found appropriate for calibration and verification. These historical storms were qualified and selected based on available stream gage data, precipitation amounts and records of flooding in the Butterfield Creek subwatershed.

For the above mentioned calibration storms, ISWS Cook County precipitation gages, NWS recording and non-recording gages, and CoCoRAHS precipitation amounts were used. Theissen polygons were developed for each storm based on the rain gages available for that storm. The gage weightings for the recording and non-recording gages were computed in ArcGIS for each subbasin. USGS 05536255 Butterfield Creek at Village of Flossmoor is the only stream gage in the Butterfield Creek subwatershed and was used for the calibration efforts. This gage is located at latitude 41°32'24" longitude 87°38'57" (NAD27), downstream of the Riegel Road crossing. The datum of the gage is 620.41 NGVD29 (620.12 NAVD88). Instantaneous flow data is available at this gage from August 18, 1989 through September 30, 2008.

Runoff hydrographs were developed using HEC-HMS and routed through the Butterfield Creek hydraulic model. The stages and flows produced for each calibration storm were compared to the observed stream gage data. During calibration of the Butterfield Creek subwatershed, the curve number, directly connected impervious area percentage, and lag time were adjusted so that the peak flow rate, hydrograph shape and timing, and total volume matched the observed hydrographs within the criteria specified in the CCSMP.

During calibration, the curve number and directly connected impervious percentage were reduced by 5% and 10%, respectively. The Clark's storage coefficient R was increased by +25%.

After the final adjustments to the HEC-HMS and HEC-RAS models, the flow and stage comparisons to the observed data were within the CCSMP's criteria. **Table 3.1.6** shows the comparison of the flows and stages for the three calibration storms. **Figures 3.1.2**, **3.1.3** and **3.1.4** show the calibration results for July 1996, April 2006 and September 2008, respectively.

Table 3.1.6: Butterfield Creek Subwatershed Calibration Results

	Observed		Modeled		CCSMP's Criteria[1]	
Storm Event	Flow (cfs)	Stage (ft)	Flow (cfs)	Stage (ft)	Percentage Difference in Peak Flow	Difference in Stage (ft)
July 1996	2,220	629.10	2,228	628.81	0%	-0.29
April 2006	2,640	629.59	1,711	627.9	-54%[2]	-1.69[2]
September 2008	2,020	628.57	2,064	628.56	2%	-0.01

[1]Flow within 30% and stage within 6 inches.
[2]April 2006 event did not meet the CCSMP criteria. The stream gauge was malfunctioning during this event and it appears that this rainfall event was not uniform across the Butterfield Creek watershed.

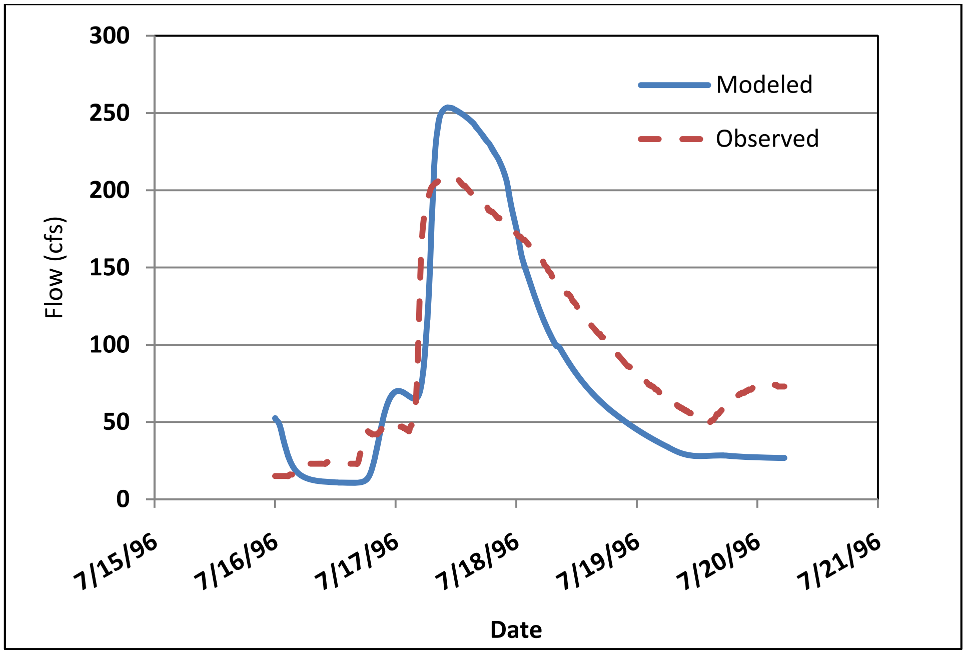


Figure 3.1.2: Butterfield Creek Subwatershed Calibration Results, July 1996 Storm Event

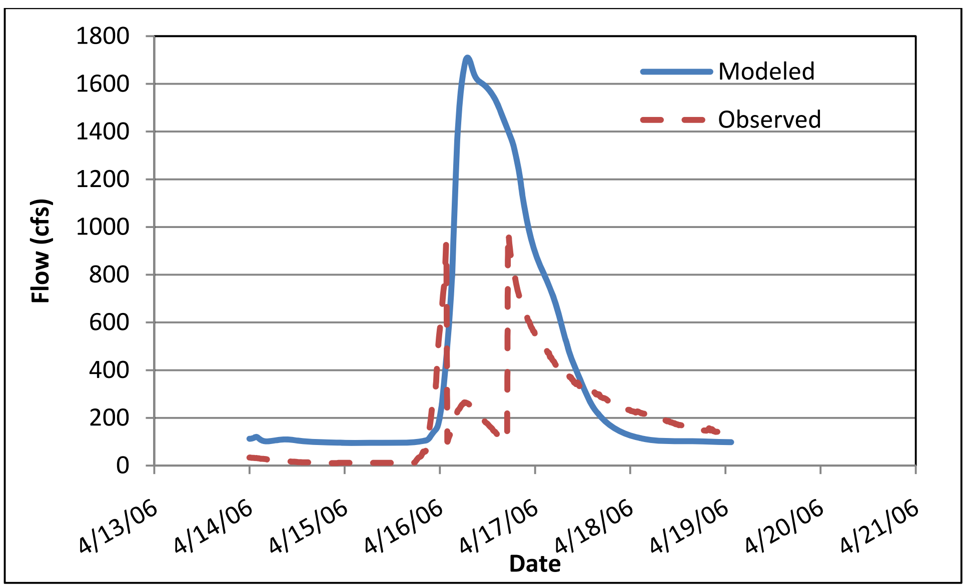


Figure 3.1.3: Butterfield Creek Subwatershed Calibration Results, April 2006 Storm Event

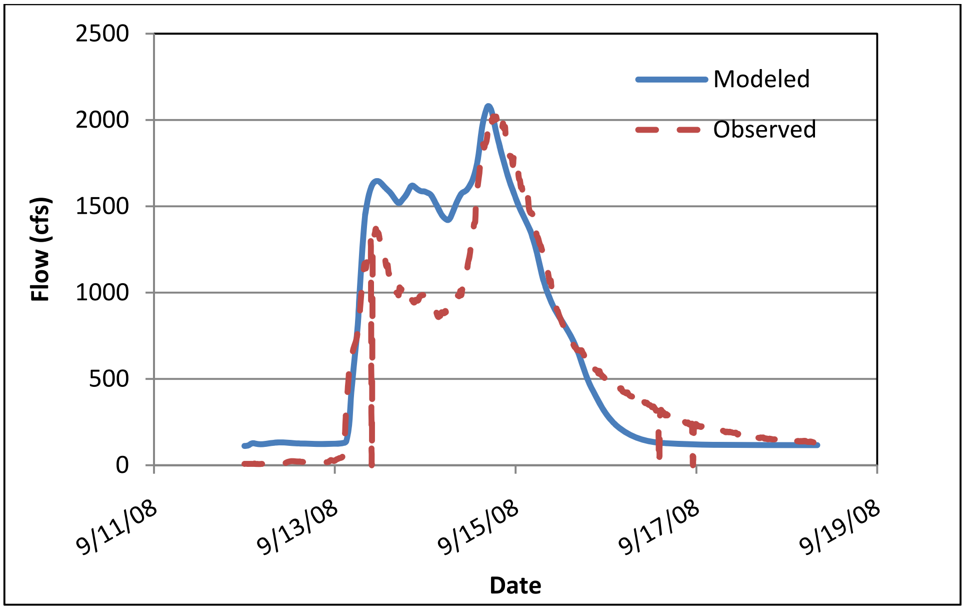


Figure 3.1.4: Butterfield Creek Subwatershed Calibration Results, September 2008 Storm Event

3.1.2.4 Existing Conditions Evaluation

3.1.2.4.1 Flood Inundation Areas A critical duration analysis was run for the Butterfield Creek subwatershed hydraulic model. The 100-year, 1-, 3-, 6-, 12-, 24-, and 48-hour storm events were run to determine the critical duration. The 48-hour storm event was found to be representative of the critical duration for BTCR, BCT1, UBCW, UBCE, and downstream parts of BCEB and BEBT. The 12-hour duration was found to be representative of the critical duration storm event for UBEN, UBES, BCT3, BCT4, BETA, and upstream parts of BCEB and BEBT.

Figure 3.1.1 shows inundation area produced for the 100-year critical duration storm event.

3.1.2.4.2 Hydraulic Profiles Hydraulic profiles for Butterfield Creek and its tributaries are shown in **Appendix H**. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100- and 500-year recurrence interval design storm events.

3.1.3 Development and Evaluation of Alternatives

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. **Table 3.1.7** summarizes problem areas identified through hydraulic modeling of the Butterfield Creek subwatershed.

Problem areas that were hydraulically interdependent or otherwise related were grouped for alternatives analysis. Each problem group is addressed in terms of combined damages and alternatives/solutions.

Table 3.1.7: Modeled Problem Definition for the Butterfield Creek Subwatershed

Problem ID	Group ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
BTCR1	BTCR-G1	Butterfield Creek Main Tributary, 203rd thru 206th Street, Unincorporated Cook County	50, 100	N/A	BTCRG1-A3
BTCR2	BTCR-G2	Butterfield Creek Main Tributary, Greenwood Drive and 207th Street, Olympia Fields	50, 100	N/A	BTCRG2-A1
BTCR3	BTCR-G3	Butterfield Creek Main Tributary, near Dartmouth Road and Dixie Highway, Flossmoor	50, 100	FLO2, FLO3	BTCRG3-A4
BTCR4	BTCR-G4	Isolated structures throughout Butterfield Creek subwatershed	50, 100	N/A	Floodproofing/ Acquisition
BCEB1	BCEB-G1	Butterfield Creek East Branch, Sauk Trail and Governors Highway, Matteson	10, 25, 50, 100	MAT6, MAT7, MAT8, RIC1, RIC6	BCEBG1-A5

Damage assessment, technology screening, alternative development and alternative selection were performed by problem grouping, since each group is independent of the other. Each problem group is evaluated in the following sections by problem group ID.

3.1.3.1 BTCR-G1 – Butterfield Creek Main Tributary Problem Group 1

3.1.3.1.1 Problem Definition

The BTCR-G1 problem area consists of overbank flooding between 203rd and 206th Streets. The extent of flooding is approximately 2,300 feet between 203rd Street and Keystone Avenue to 206th Street and Keeler Avenue. The overbank flooding is due to flow restriction within the 12-foot circular culvert at 206th Street. The flow backs up and inundates structures along the banks between 203rd Street thru 206th Street. Approximately 18 building structures are impacted by flooding, including the overtopping of two local roadway crossings. This area is shown as inundated on the FEMA DFIRM map.

In this problem area, 100-year flows of 850 cfs generally exceed the capacity of the channel and the culvert crossings on 204th and 205th Streets, and the 100-year flood elevation reaches 691.6 feet compared to a lowest damage elevation of 690.8 feet at 203rd Street.

3.1.3.1.2 Damage Assessment, BTCR-G1

Damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Butterfield Creek and its tributaries. These stages were used to calculate the depth of flooding and to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.1.8** lists the estimated damages for the problem group.

Table 3.1.8: Estimated Damages for Butterfield Creek Subwatershed, Problem Group BTCR-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
BTCR-G1	Property	$1,300,000	Structures at risk of flooding
	Transportation	$195,000	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.1.3.1.3 Technology Screening, BTCR-G1

Several combinations of technologies were analyzed to address the flooding problems associated with BTCR-G1. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.1.9** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.1.9: Evaluation of Flood Control Technologies for Butterfield Creek Subwatershed, Problem Group BTCR-G1

Flood Control Option	Feasibility
Detention Facilities	Feasible. Potential site for detention near west of 203rd Street and Keeler Avenue
Conveyance Improvement – Culvert/Bridge Replacement	Feasible. Increase opening at 206th Street
Conveyance Improvement – Channel Improvement	Not feasible. Limited right of way available
Conveyance Improvements – Diversion	Not feasible. No available outfall downstream
Flood Barriers, Levees/Floodwalls	Not feasible. Limited right of way available

3.1.3.1.4 Alternative Development

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of the DWP. **Table 3.1.10** summarizes flood control alternatives developed for Problem Group BTCR-G1.

Table 3.1.10: Flood Control Alternatives for Problem Group BTCR-G1

Alternative	Location	Description
BTCRG1-A1	206th Street	Upgrade existing crossing from 12-ft circular culvert to (2) 12-ft circular culverts. Due to the larger opening there will be higher stage increases downstream of 206th Street. This alternative cannot be implemented without compensatory storage.
BTCRG1-A2	West of 203rd Street and Keeler Avenue	Construct detention facility to detain the stage increases from the 206th Street culvert improvements.
BTCRG1-A3	206th Street, west of 203rd Street and Keeler Avenue, structures between 203rd Street and 206th Street	Upgrade existing crossing at 206th Street and construct detention facility west of 203rd Street and Keeler Avenue (combination of Alternatives BTCRG1-A1 and BTCRG1-A2). Additionally, non-structural solutions, such as floodproofing or acquisition, are recommended for three building structures where there will still be residual damages.

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the BTCR-G1 Problem Group.

3.1.3.1.5 Alternative Evaluation and Selection

Alternatives included in **Table 3.1.10** were evaluated to determine their effectiveness and produce the data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.1.12** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative for Problem Group BTCR-G1. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, thus costs were not calculated for these alternatives.

Alternative BTCRG1-A3 from **Table 3.1.10** provides the preferred alternative for Problem Group BTCR-G1. By increasing the opening area of the crossing with a twin, 12-foot circular culvert and the construction of the 65 acre-foot detention facility, the 100-year water surface elevation (WSEL) will be reduced to 690.4 feet at 203rd Street, which is 1.2 feet below the existing 100-year elevation.

Three properties are at risk of flooding under existing and recommended alternative conditions. Due to their locations, these properties' risk of flooding cannot be feasibly mitigated by structural measures. Such properties are candidates for protection using non-structural flood control measures, such as floodproofing or acquisition. These measures may be considered to address damages that are not fully addressed by capital projects recommended in the Little Calumet River DWP.

Table 3.1.11 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for BTCR-G1.

Table 3.1.11: Alternative Condition Flow & WSEL Comparison for Problem Group BTCR-G1

Location	Station	Existing Conditions		Alternative BTCRG1-A3	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Upstream of 204th Street	4819	691.46	808	690.09	739
Upstream of 205th Street	4076	691.33	828	689.41	766
Upstream of 206th Street	3350	691.17	850	688.64	793

3.1.3.1.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.1.12** lists the alternative analyzed in detail. The recommended alternative consists of replacement of the existing circular culvert crossing at 206th Street with a twin, 12-foot circular culvert and 65 acre-foot detention facility near 203rd and Keystone Avenue. **Figure 3.1.5** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.1.12: Butterfield Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group BTCR-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
BTCR-G1	BTCRG1-A3	Replace 206th Street crossing and construct detention facility	0.18	$1,495,000	$8,494,000	18 Structures	Positive	Unincorporated Cook County

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.1.3.2 BTCR-G2 – Butterfield Creek Problem Group 2

3.1.3.2.1 Problem Definition, BTCR-G2

The BTCR-G2 problem group consists of overbank flooding near Greenwood Drive and 207th Street in Olympia Fields. Near this problem area, the 100-year stage of 680.6 feet inundates approximately four building structures. This problem area was shown on the recent DFIRM floodplain maps. The flood protection elevation in this reach is 677.7 feet. Flood protection elevations were developed based on field reconnaissance of the area based on typical residential structures.

3.1.3.2.2 Damage Assessment, BTCR-G2

Damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Butterfield Creek and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.1.13** lists the estimated damages for the problem group.

Table 3.1.13: Estimated Damages for Butterfield Creek Subwatershed, Problem Group BTCR-G2

Problem Group ID	Damage Category	Estimated Damage ($)	Description
BTCR-G2	Property	$11,000	Structures at risk of flooding
	Transportation	$2,000	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.1.3.2.3 Technology Screening, BTCR-G2

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.1.14** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.1.14: Evaluation of Flood Control Technologies for the Butterfield Creek Subwatershed, Problem Group BTCR-G2

Flood Control Option	Feasibility
Detention Facilities	Feasible but not preferred given alternative
Conveyance Improvement – Culvert/Bridge Replacement	Feasible but not preferred given alternative
Conveyance Improvement – Channel Improvement	Feasible but not preferred given alternative
Conveyance Improvements – Diversion	Feasible but not preferred given alternative
Flood Barriers, Levees/Floodwalls	Feasible given that the problem is not due to high stages in the creek, but that a low overbank area exists

3.1.3.2.4 Alternative Development, BTCR-G2

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of the DWP. **Table 3.1.15** summarizes flood control alternatives developed for Problem Group BTCR-G2.

Table 3.1.15: Flood Control Alternatives for Problem Group BTCR-G2

Alternative	Location	Description
BTCRG2-A1	Greenwood Drive	Construct a 700 LF, 8-ft high earthen levee adjacent to the flooded properties along Greenwood Drive

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the BTCR-G2 Problem Group.

3.1.3.2.5 Alternative Evaluation and Selection, BTCR-G2

The alternative included in **Table 3.1.15** was evaluated to determine its effectiveness and produce data required for the countywide prioritization of watershed projects. The flood control alternative was modeled to evaluate its impact on water elevations and flood damages. **Table 3.1.17** provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative.

Alternative BTCRG2-A1 from **Table 3.1.15** is the preferred alternative for this Problem Group. An earthen levee was the only solution considered to be feasible, given that the cause of flooding is due to the low bank elevations adjacent to Greenwood Drive. A small earthen levee would protect homes while maintaining existing stages in the creek. A 700 linear-foot, average 8-foot high earthen levee adjacent to the flooded properties would prevent overbank flooding during the 100-year event. At an average height of 8-feet, the levee would provide approximately 3 feet of freeboard.

Table 3.1.16 provides a comparison of the modeled WSEL and modeled flow at the time of peak for BTCR-G2.

Table 3.1.16: Alternative Condition Flow & WSEL Comparison for Problem Group BTCR-G2

Location	Station	Existing Conditions		Alternative BTCRG2-A1	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Upstream of Olympian Way	42602	680.55	1,985	680.48[1]	1,973

[1]Levee provides protection.

3.1.3.2.6 Data Required for Countywide Prioritization of Watershed Projects, BTCR-G2

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.1.17** lists the alternative analyzed in detail. The recommended alternative consists of constructing an earthen levee adjacent to flooded properties. **Figure 3.1.6** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.1.17: Butterfield Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group BTCR-G2

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
BTCR-G2	BTCRG2-A1	Earthen levee	<0.01	$13,000	$9,556,000	4 Structures	No Impact	Olympia Fields

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.1.3.3 BTCR-G3 – Butterfield Creek Main Tributary Problem Group 3

3.1.3.3.1 Problem Definition, BTCR-G3

The BTCR-G3 problem area consists of overbank flooding in the area adjacent to Butterfield Creek Main Tributary from approximately Laurel Avenue to Dixie Avenue. In this reach, 100-year flows of 2,665 cfs exceed the capacity of the channel, and the critical water surface elevation is 638.6 feet at Laurel Avenue. There is flooding of approximately 12 building structures. This problem area was shown on the recent DFIRM floodplain maps. The flood protection elevation near the problem area is 637 feet at Laurel Avenue. Flood protection elevations were developed based on field reconnaissance of the area based on typical residential structures.

3.1.3.3.2 Damage Assessment, BTCR-G3

Damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Butterfield Creek and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.1.18** lists the estimated damages for the problem group.

Table 3.1.18: Estimated Damages for Butterfield Creek Subwatershed, Problem Group BTCR-G3

Problem Group ID	Damage Category	Estimated Damage ($)	Description
BTCR-G3	Property	$964,000	Structures at risk of flooding
	Transportation	$145,000	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.1.3.3.3 Technology Screening, BTCR-G3

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.1.19** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.1.19: Evaluation of Flood Control Technologies for Butterfield Creek Subwatershed, Problem Group BTCR-G3

Flood Control Option	Feasibility
Detention Facilities	Feasible and necessary to reduce stage increases from levee
Conveyance Improvement – Culvert/Bridge Replacement	Not feasible. Improvements to Dixie Highway will not reduce stages
Conveyance Improvement – Channel Improvement	Feasible and necessary to reduce stage increases from levee
Conveyance Improvements – Diversion	Feasible but not ideal given recommended alternative
Flood Barriers, Levees/Floodwalls	Feasible and necessary

3.1.3.3.4 Alternative Development, BTCR-G3

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.1.20** summarizes flood control alternatives developed for Problem Group BTCR-G3.

Table 3.1.20: Flood Control Alternatives for Problem Group BTCR-G3

Alternative	Location	Description
BTCRG3-A1	Laurel Avenue	Channel improvements for approximately 1,300 feet from downstream of Laurel Avenue crossing
BTCRG3-A2	Dixie Highway	Increasing the hydraulic capacity of the Dixie Highway will not reduce stages upstream, but included due to the proposed IDOT improvements to the Dixie Highway
BTCRG3-A3	Between Cambridge Avenue and Dixie Highway	Construct a 7-ft high, 3,100-ft long floodwall along left bank of BTCR from Cambridge Avenue to Dixie Avenue
BTCRG3-A4	Laurel Avenue, and between Cambridge Avenue and Dixie Highway	Channel improvements downstream of Laurel Avenue crossing, floodwall along creek from Cambridge Ave. to Dixie Highway (Combination of Alternatives BTCRG3-A1 and BTCRG3-A3)

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the BTCR-G3 Problem Group.

3.1.3.3.5 Alternative Evaluation and Selection, BTCR-G3

Alternatives included in **Table 3.1.20** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.1.22** provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed, as benefits were negligible, and thus costs were not calculated for these alternatives.

Alternative BCRG3-A4 from **Table 3.1.20** is the preferred alternative for this problem group. This problem area can be addressed by constructing a floodwall to prevent flooding of the overbank areas. Stages would remain the same, or decrease slightly, due to the 1,300-foot channel improvement.

Table 3.1.21 provides a comparison of the modeled WSEL and modeled flow at the time of peak for BTCR-G3.

Table 3.1.21: Alternative Condition Flow & WSEL Comparison for Problem Group BTCR-G3

Location	Station	Existing Conditions		Alternative BTCRG3-A4	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Downstream of Laurel Avenue	18608	641.45	2,610	641.03	2,645
Upstream of Chicago and Vincennes Road	15884	637.09	2,665	636.31[1]	2,693

[1]Levee provides protection.

3.1.3.3.6 Data Required for Countywide Prioritization of Watershed Projects, BTCR-G3

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.1.22** lists the alternative analyzed in detail. The recommended alternative consists of conveyance improvements including channel widening and deepening, replacing two roadway crossings, and providing overbank storage. **Figure 3.1.7** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.1.22: Butterfield Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group BTCR-G3

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
BTCR-G3	BTCRG3-A4	Levee and channel Improvements	0.04	$1,109,000	$29,876,000	12 Structures and 2 Roadways	No Impact	Flossmoor

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.1.3.4 BTCR-G4 – Butterfield Creek Problem Group 4

3.1.3.4.1 Problem Definition, BTCR-G4

The BTCR-G4 problem group consists of overbank flooding of isolated structures throughout the Butterfield Creek subwatershed. There are a total of five problem areas, each having fewer than four structures inundated. One isolated structure is inundated in BCEB near the intersection of Davis Avenue and Governors Highway. There are four building structures inundated in BTCR near the intersection of Crawford Avenue and Governors Highway in Matteson, two isolated structures inundated near Western Avenue and Brookwood Drive in Flossmoor, four building structures inundated near Kuechler Avenue and Flossmoor Road in Flossmoor, and one isolated structure near Riegel Road in Flossmoor.

3.1.3.4.2 Damage Assessment, BTCR-G4

Damages were not calculated since the proposed alternative for BTCR-G4 is a non-structural measure such as floodproofing or acquisition only.

3.1.3.4.3 Technology Screening, BTCR-G4

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.1.23** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.1.23: Evaluation of Flood Control Technologies for Butterfield Creek Subwatershed, Problem Group BTCR-G4

Flood Control Option	Feasibility
Detention Facilities	Not feasible for the isolated structures
Conveyance Improvement – Culvert/Bridge Replacement	Not feasible for the isolated structures
Conveyance Improvement – Channel Improvement	Not feasible for the isolated structures
Conveyance Improvements – Diversion	Not feasible for the isolated structures
Flood Barriers, Levees/Floodwalls	Not feasible for the isolated structures

3.1.3.4.4 Alternative Development, BTCR-G4

Flood Control Alternatives. No flood control alternatives were developed for isolated structures in the BTCR-G4 Problem Group.

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the BTCR-G4 Problem Group.

3.1.3.4.5 Alternative Evaluation and Selection, BTCR-G4

Since the building structures are isolated, located throughout the watershed, are relatively small in number, and their risk of flooding cannot be feasibly mitigated by structural measures, such structures are candidates for protection using non-structural flood control measures such as floodproofing or acquisition. The decision to acquire vs. floodproof should be taken on a case-by-case basis and be based on actual surveyed first floor elevations.

3.1.3.4.6 Data Required for Countywide Prioritization of Watershed Projects, BTCR-G4

None of the structural alternatives considered were effective in reducing flood damages for the 12 isolated residential structures; therefore, benefits and costs are not presented for these alternatives. No structural measures are recommended for Problem Group BTCR-G4.

3.1.3.5 BCEB-G1 – Butterfield Creek East Branch Problem Group 1

3.1.3.5.1 Problem Definition, BCEB-G1

The BCEB-G1 problem group consists of roadway overtopping at the intersection of Sauk Trail Road and Governors Highway and overbank flooding of approximately 3,200 feet along Governors Highway from Sauk Trail Road to the Metra railroad tracks in Matteson. The 100-year flow of 450 cfs exceeds the culvert capacity at Sauk Trail Road and the 100-year flow of 650 cfs exceeds the channel capacity of Butterfield Creek East Branch from downstream of Sauk Trail Road to the Metra railroad tracks.

There are a total of six building structures inundated, including the overtopping of two major roadways.

3.1.3.5.2 Damage Assessment, BCEB-G1

Damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Butterfield Creek and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.1.24** lists the estimated damages for the problem group.

Table 3.1.24: Estimated Damages for Butterfield Creek Subwatershed, Problem Group BCEB-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
BCEB-G1	Property	$315,000	Structures at risk of flooding
	Transportation	$200,000	Overtopping of Governors Highway and Sauk Trail Road
	Recreation	$0	

3.1.3.5.3 Technology Screening, BCEB-G1

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.1.25** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.1.25: Evaluation of Flood Control Technologies for Butterfield Creek Subwatershed, Problem Group BCEB-G1

Flood Control Option	Feasibility
Detention Facilities	Feasible. Provide detention for peak flows
Conveyance Improvement – Culvert/Bridge Replacement	Feasible. Increase capacity of Sauk Trail crossing
Conveyance Improvement – Channel Improvement	Feasible. Regrade profile and widen BCEB channel
Conveyance Improvements – Diversion	Not feasible. No outlet downstream
Flood Barriers, Levees/Floodwalls	Feasible, if done in conjunction with other flood control options

3.1.3.5.4 Alternative Development, BCEB-G1

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.1.26** summarizes flood control alternatives developed for Problem Group BCEB-G1.

Table 3.1.26: Flood Control Alternatives for Problem Group BCEB-G1

Alternative	Location	Description
BCEBG1-A1	1,000 feet south of Sauk Trail Road and Governors Highway	Construct a 130 ac-ft pumped detention facility at the upstream end of the reach to reduce stages and prevent increases from Sauk Trail Road crossing improvements. This will not solve the problems located downstream of Sauk Trail Road.
BCEBG1-A2	Sauk Trail Road and Governors Highway	Implement culvert improvements. Conveyance improvements alone do not reduce stages enough, but will aid in increasing the hydraulic capacity of the crossing.
BCEBG1-A3	Between Sauk Trail and Metra Railroad tracks	Regrade the BCEB channel to establish positive slope from Sauk Trail Road to the Metra railroad tracks. By increasing the conveyance capacity of BCEB, more water will be diverted from Sauk Trail Road, which will result in an increase of flows along the reach and have no positive impact on reducing flooding along the tributary.
BCEBG1-A4	Maple Avenue to Metra Railroad tracks	Construct a 1,700 LF earthen levee between Maple Avenue and the Metra railroad tracks to prevent overbank flooding. With detention and conveyance improvements alone, overbank flooding still occurs due to the restriction from the Metra railroad tracks. This must be done in conjunction with Alternatives 1, 2, and 3 to prevent any stage increases along or downstream of the levee.
BCEBG1-A5	Vicinity of Sauk Trail Road and Governors Highway; Maple Avenue to the Railroad tracks	Construct a detention facility at the upstream end of the creek, culvert improvements at Sauk Trail Road and Governors Highway, regrading of creek, and construction of an earthen levee (combination of Alternatives BCEBG1-A1, BCEBG1-A2, BCEBG1-A3 and BCEBG1-A4).

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the BCEB-G1 Problem Group.

3.1.3.5.5 Alternative Evaluation and Selection, BCEB-G1

Alternatives included in **Table 3.1.26** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.1.28** provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed, as benefits were negligible, and thus costs were not calculated for these alternatives.

Alternative BCEBG1-A5 from **Table 3.1.26** is the preferred alternative for this problem group. This combination was the only combination deemed feasible to address flooding in both problem areas. While detention alone alleviates the upstream problem, it does not adequately address the downstream problem. A levee alone, from Sauk Trail Road to the Metra railroad tracks will prevent overbank flooding downstream but will cause stage increases. Therefore, the feasible alternative is a combination of all four technologies. A 130 acre-foot storage reservoir (20 acre-foot surface area, 6.5 feet deep with a side channel spillway) is proposed at the upstream end of Sauk Trail Road. Sauk Trail Road culvert replacement from an existing 9.5-foot x 5.5-foot elliptical culvert to a 15-foot x 6-foot box culvert. Channel improvements between Sauk Trail Road and the Metra railroad tracks include channel widening and culvert improvements. An earthen levee that is 1,700 feet long, an average of 7 feet high and 25 feet wide is proposed parallel to Governors Highway from Maple Avenue to the Metra railroad tracks parallel to the creek.

Table 3.1.27 provides a comparison of the modeled WSEL and modeled flow at the time of peak for BCEB-G1.

Table 3.1.27: Alternative Condition Flow & WSEL Comparison for Problem Group BCEB-G1

Location	Station	Existing Conditions		Alternative BCEBG1-A5	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Upstream of Sauk Trail Road	15271	708.05	450	706.67	308
Upstream of Poplar Avenue	13559	706.19	585	705.03	440
Upstream of Maple Avenue	12984	706.17	646	704.96	446
Upstream of Railroad Tracks	11243	706.15	225	704.92	206

3.1.3.5.6 Data Required for Countywide Prioritization of Watershed Projects, BCEB-G1

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.1.28** lists the alternative analyzed in detail. The recommended alternative consists of construction a detention facility, Sauk Trail Road culvert improvements, channel and culvert improvements between Sauk Trail Road and the Metra railroad tracks and an earthen levee between Maple Avenue and the Metra railroad tracks along Governors Highway. **Figure 3.1.8** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.1.28: Butterfield Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group BCEB-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
BCEB-G1	BCEBG1-A5	Detention facility, culvert improvements, channel improvements, earthen levee	0.02	$515,000	$28,079,000	6 Structures and 2 Roadways	Positive	Matteson

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.1.4 Recommended Alternatives, Butterfield Creek Subwatershed

Table 3.1.29 summarizes the recommended alternatives for the Butterfield Creek subwatershed. The District will use data presented here to support prioritization of a countywide stormwater CIP.

Table 3.1.29: Butterfield Creek Project Alternative Matrix to Support District CIP Prioritization, All Problem Groups

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Structures & Roadways Protected	Water Quality Benefit	Involved Community
BTCR-G1	BTCRG1-A3	Replace 206th Street crossing and construct detention facility	0.18	$1,495,000	$8,494,000	18 Structures	Positive	Unincorporated. Cook County
BTCR-G2	BTCRG2-A1	Earthen levee	<0.01	$13,000	$9,556,000	4 Structures	No Impact	Olympia Fields
BTCR-G3	BTCRG3-A4	Levee and channel Improvements	0.04	$1,109,000	$29,876,000	12 Structures and 2 Roadways	No Impact	Flossmoor
BCEB-G1	BCEBG1-A5	Detention facility, culvert improvements, channel improvements, earthen levee	0.02	$515,000	$28,079,000	6 Structures and 2 Roadways	Positive	Matteson

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.2 Calumet Union Drainage Ditch

The Calumet Union Drainage Ditch (CUDD) subwatershed covers approximately 20 square miles and is located in the northern portion of the Little Calumet River watershed. **Table 3.2.1** lists the communities and the drainage areas contained within the CUDD subwatershed.

Table 3.2.1: Communities Draining to CUDD

Community	Tributary Area (mi^2)
Country Club Hills	3.39
East Hazel Crest	0.72
Flossmoor	1.08
Harvey	1.84
Hazel Crest	3.39
Homewood	3.48
Markham	2.96
Oak Forest	0.07
Phoenix	0.02
South Holland	2.11
Thornton	0.29
Unincorporated Cook County	1.19

Table 3.2.2 lists the land use breakdown by area within the CUDD subwatershed. **Figure 3.2.1** provides an overview of the tributary area of the subwatershed. Reported stormwater problem areas and proposed alternative projects are also shown on the figure, and are discussed in the following subsections.

There are 15 tributaries, including the CUDD main tributary, encompassing a study reach length of 31 miles, nearly 8 miles of which are enclosed conduits. The tributaries all discharge to the Little Calumet River via the CUDD main tributary, except for Dixie Creek, Park Creek, Belaire Creek, and the I-57 Drainage Ditch, which are diverted to the Little Calumet River via the Robey Street diversion conduit or directly through the I-57 Drainage Ditch.

Table 3.2.2: Land Use Distribution for CUDD

Land Use	Acres	%
Commercial/Industrial	2,339	18
Forest/Open Land	2,235	17
Institutional	630	5
Residential	6,472	49
Transportation/Utility	977	7
Water/Wetland	122	1
Agricultural	374	3

- Calumet Union Drainage Ditch (CUDD) – originates near 161st Street and Central Park Avenue in Markham, flows east across I-57 through Harvey, to the confluence with the Little Calumet River just east of State Street in South Holland. The majority of the subwatershed drains to CUDD, including the CUDD Southwest Branch, Cherry Creek, and Canadian Central tributaries.

- Calumet Union Drainage Ditch Southwest Branch (CUSW) – begins east of Cicero Avenue in Country Club Hills, continues northeast through Hazel Crest, crosses the Tri-State Tollway and ends at the confluence with CUDD east of I-294 in Markham. The Edward C. Howell Reservoir is located on the CUDD Southwest Branch approximately 2,000 feet upstream of its confluence with CUDD.

- Calumet Union Drainage Ditch Southwest Branch Tributary N (CUTN) – originates at Cicero Avenue and I-80 in Country Club Hills. It travels easterly, flowing mostly in an enclosed conduit running parallel to 175th Street and Country Club Hills Community Park, to its confluence with CUDD Southwest Branch near 175th Street and Crawford Avenue. The area between 175th Street and I-80 drains directly into the enclosed conduit via a storm sewer system.

- Calumet Union Drainage Ditch Southwest Branch Tributary S (CUTS) – begins north of 186th Avenue in Country Club Hills. It flows north to its confluence with CUDD Southwest Branch near 178th Street and Chestnut Avenue. The tributary is primarily enclosed in pipe through a residential development.

- Cherry Creek (CHCR) – originates at the confluence of Cherry Creek East Branch and Cherry Creek West Branch near 175th Street in Hazel Crest. It flows northeast, through the Calumet Country Club in Homewood and under the Tri-State Tollway. At 169th Street in Hazel Crest it enters a pipe and is conveyed approximately 5,000 feet until its confluence with CUDD under Dixie Highway in Markham.

- Cherry Creek East Branch (CHEB) – originates in the Coyote Run Golf Course in the Village of Flossmoor, and flows east past Homewood-Flossmoor High School. It continues northeast, roughly following Governors Highway through the Village of Homewood. It joins with Cherry Creek West Branch at 175th Street in Hazel Crest, where it becomes Cherry Creek.

- Cherry Creek East Branch Tributary (CHET) – begins near Flossmoor Road and Governors Highway in Flossmoor. It is a small roadside ditch which flows along Governors Highway to its confluence with Cherry Creek East Branch near Homewood-Flossmoor High School.

- Cherry Creek West Branch (CHWB) – originates in the detention area south of 183rd Street in the Village of Flossmoor. Flow is conveyed northeasterly, primarily through residential neighborhoods in Flossmoor and Hazel Crest, to its confluence with Cherry Creek East Branch at 175th Street, where it becomes Cherry Creek. There is a small offline detention pond downstream of Kedzie Avenue, and three inline ponds at 183rd Street with individual inline weirs for control structures.

- Cherry Creek West Branch East Fork (CHWE) – originates near 189th Street and Pulaski Road in Flossmoor. It flows northeasterly to its confluence with Cherry Creek West Branch West Fork in the Village of Hazel Crest, where it becomes Cherry Creek West Branch.

- Robey Street Diversion Conduit (RSDC) - redirects flow from CUDD and Dixie Creek north to the Little Calumet River at Ashland Avenue and Thornton Road. The conduit includes a 5-foot diameter pipe from CUDD to Dixie Creek and a 7.5-foot diameter pipe from Dixie Creek to the Little Calumet River. The conduit runs under the original Robey Street, which is currently an open space.

- Dixie Creek (DXCR) - begins as an enclosed conduit from Robey Street and 161st Street to Dixie Highway and ends as an open channel 1,500 feet southwest of the I-57/I-294 interchange. Depending on flow conditions, west of I-294 the creek flows to the I-57 Drainage Ditch, while east of I-294 the creek flows to the Robey Street Diversion. The tributary flows through both the Markham and Harvey communities.

- I-57 Drainage Ditch (I57D) – is an open channel running along I-57 from 157th Street to the Little Calumet River. It includes runoff from the east side of I-57, Park Creek, and portions of Dixie Creek depending on flow conditions. At the confluence with Dixie Creek, the channel enters a 10-foot diameter concrete conduit that discharges to the Little Calumet River at Ashland Avenue and Thornton Road.

- Park Creek (PKCR) – begins near Birch Road, at the border between the municipalities of Midlothian and Markham. It flows easterly towards Kedzie Avenue, under I-57, to its confluence with the I-57 Drainage Ditch in Markham.

- Belaire Creek (BLCR) – begins near 155th Street east of Kedzie Avenue in Markham. It flows easterly, through the Markham Prairie and under the Tri-State Tollway, and then turns northerly and flows to its confluence with Dixie Creek near Rockwell Street, at the border between the Cities of Markham and Harvey.

- Canadian Central Drainage Ditch (CCDD) – runs alongside the Canadian Central Rail Yard and Center Avenue in Harvey, between I-80 and US Highway 6 (159th Street). The ditch was never named since no FEMA study has been conducted. For this study, the ditch has been named "Canadian Central Drainage Ditch." Canadian Central is tributary to CUDD and conveys runoff from Harvey, East Hazel Crest, and Homewood.

- Unnamed Overland Flow Path - Although not a tributary, this area receives significant overbank flow from CUDD shortly upstream of Park Avenue at US Highway 6. The area is also a combined sewer area and is bounded to the northeast by the GTW Railroad Canadian National rail line. It includes Harvey, Posen, and Dixmoor.

There are two major regional flood control facilities within the Calumet Union Drainage Ditch subwatershed.

- Calumet Union Reservoir - The Calumet Union Reservoir is located on Cherry Creek approximately 10,000 feet upstream of CUDD. It provides flood control for Homewood, Hazel Crest, Markham, and Harvey and is operated by the MWRDGC. At an elevation of 629.0 feet, it stores approximately 420 acre feet.

- Edward C. Howell Reservoir - The Edward C. Howell Reservoir is located on CUDD Southwest Branch approximately 3,500 feet upstream of CUDD. The reservoir stores approximately 590 acre feet at elevation 617.0 feet, providing flood relief for Markham and Harvey.

3.2.1 Sources of Data

3.2.1.1 Previous Studies

One study was made available which pertained to the Calumet Union Drainage Ditch subwatershed.

- Little Calumet River Watershed Engineering Design Report (Revised), U.S. Department of Agriculture, Metropolitan Sanitary District of Greater Chicago and the Illinois Department of Conservation, January 1977.

During Phase A of the project, all the data, topography, precipitation, stream flow, land use and soils data needed for the development of the subwatershed model were collected.

3.2.1.2 Water Quality Data

There are no MWRDGC, IEPA or USGS water quality monitoring gages in the Calumet Union Drainage Ditch subwatershed. Per the IEPA's *2008 Integrated Water Quality Report*, which includes the Clean Water Act (CWA) 303(d) and the 305(d) lists, there are no impaired waterways within the subwatershed. No Total Maximum Daily Loads (TMDLs) have been established for CUDD or its tributaries.

NPDES point source discharges are listed in **Table 3.2.3.** In addition to the point source discharges listed in **Table 3.2.3**, municipalities discharging to CUDD or its tributaries are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems. Also as part of the Phase II Stormwater Permit Program, construction sites disturbing greater than 1 acre of land are required to get a construction permit.

Table 3.2.3: Point Source Dischargers in Calumet Union Drainage Ditch Area

Name	NPDES	Community	Receiving Waterway
Canadian NTL IL Central RR	IL0005193	Homewood	Calumet Union Drainage Ditch
Envirite of Illinois Inc.	IL0071285	Harvey	Calumet Union Drainage Ditch
Allied Tube and Conduit Corp.	IL0063649	Harvey	Calumet Union Drainage Ditch

Note: NPDES facilities were identified from the USEPA Water Discharge Permits Query Form at http://www.epa.gov/enviro/html/pcs/pcs_query_java.html.

3.2.1.3 Wetland and Riparian Areas

Figures 2.3.6 and **2.3.7** contain mapping of wetland and riparian areas in the Little Calumet River Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 147 acres of wetland areas in the CUDD subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.2.1.4 Floodplain Mapping

FEMA's 2006 effective models were not made available by the Illinois State Water Survey (ISWS) during the development of the subwatershed hydraulic model; however, the ISWS model of CUDD and CUDD Southwest Branch were made available.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.2.1.5 Stormwater Problem Data

Table 3.2.4 summarizes reported problem areas reviewed as a part of the DWP development. The problem area data was obtained primarily from Form B questionnaire response data provided by watershed communities to the District. There were 23 problem areas reported related to the CUDD subwatershed. Problems are classified in **Table 3.2.4** as regional or local. This classification is based on criteria described in **Section 2.2.1** of this report. All the listed regional problems were provided a resolution based on the alternative analysis.

Table 3.2.4: Community Response Data for Calumet Union Drainage Ditch Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
BRE1	Bremen Township	Siltation and scouring at culverts	175th Street from Oak Park to Argyle Avenue	Other (siltation)	Local	Culvert maintenance issue, local responsibility
BRE3	Bremen Township	Debris and siltation	167th Street from Kilbourn Avenue to Western Avenue	Debris at upstream end of culvert	Local	This is a local drainage issue; problem not located on a regional waterway
BRE8	Bremen Township	Debris and siltation; storm sewer flow restriction	Kedzie Avenue from 183rd Street to 135th Street	Other (debris, siltation, storm sewer restriction)	Local	This is a local storm sewer system problem; problem not located on a regional waterway
CCH1	East Hazel Crest	Pavement flooding	171st Street between Ashland Avenue and South Park Avenue	Pavement flooding that appears to have been addressed with the Cook County Highway Department's (CCHD) recent roadway and stormwater improvements	Local	Issue has been addressed by CCHD
CCH3	Chicago Heights	Pavement flooding - vegetation and dumping	Center Street/Illinois Central/Canadian National Railroad Ditch	Canadian Central tributary appears to have significant vegetation and may be prone to dumping	Local	Channel maintenance issue is local responsibility
COU1	Country Club Hills	Parking lots flooding	NE corner of Pulaski Road and 175th Street	Local drainage problems associated with the intersection. Modeling does show 175th overtops during the 100-year storm, but depths are less than 0.5 ft	Local	Local drainage issue
HAR1	Harvey	Basement and ponding	Entire village	Local drainage may be causing basement and street flooding. Modeling shows flooding due to CUDD overtopping during the 100-year event	Regional	Reservoir expansion and upsizing of conduit (Alternative CUDDG1-A8)

Table 3.2.4: Community Response Data for Calumet Union Drainage Ditch Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
HAR4	Harvey	Pavement flooding (IDOT)	US 6 between Park Avenue and Center Street	Local drainage problem at this underpass, although Highway 6 does overtop approx. 1,000 ft west	Local	Local drainage issue at underpass
HAR8	Harvey	Bank erosion and sedimentation	Lathrop Avenue and 161st Street	Siltation and vegetation in channel	Channel Maintenance	Removal of debris to be addressed by stream maintenance
HCT1	Hazel Crest	Siltation pond needs regular dredging	172nd Street and Palmer Avenue	Siltation in Pond #2 of the Cal-Union Reservoir	Facility Maintenance	Dredging of pond to be addressed by O&M
MRK1	Markham	Water in yard/ crawl space; 2-3 times per year. Significant erosion. Complaints received from residents during workshops	Arthur Terrace and Blackstone Avenue/ Lawndale Avenue	Overbank flooding from CUDD with additional basement flooding likely due to local drainage problems. Significant erosion	Regional	4-ft high floodwall with erosion protection, including culvert retrofit and channel rehabilitation (Alternative CUDDG3-A2)
MRK2	Markham	Overbank flooding	Dixie Highway and Western Avenue/ 159th Street and 156th Place (maybe 150th Place)	Local flooding due to local drainage problems, not overbank flooding from CUDD or Belaire Creek	Local	Not related to overbank flooding of regional waterway
MRK3	Markham	Overbank flooding, ponding	Dixie Highway and Park Avenue/167th and 161st Streets	Overbank flooding from CUDD with additional basement flooding likely due to local drainage problems. Construction of deep shaft has helped ease flooding	Regional	Reservoir expansion and upsizing of conduit (Alternative CUDDG1-A8)
MRK4	Markham	Overbank flooding, ponding	Lincoln Highway and Parkside Avenue/California and Lincoln Highway	Overbank flooding from Belaire Creek with additional basement flooding likely due to local drainage problems	Regional	Levee and pumped storage area (Alternative BLCRG1-A6)
MRK5	Markham	Storm sewer flow restriction	Lawndale Avenue and 167th Street	Storm sewer flow restriction	Local	Local storm sewer issue

Table 3.2.4: Community Response Data for Calumet Union Drainage Ditch Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
MRK6	Markham	Ponding	Oxford Drive and Richmond Avenue/ 2800 Circle Drive	Local storm sewer floods	Local	Local storm sewer issue
MRK7	Markham	Ponding	Magnolia Drive and Alta Road	Backyards flood approximately twice a year	Local	Local issue
MRK8	Markham	Yards flooding	155th Street and Lawndale Avenue	Ponding	Local	Not related to overbank flooding of regional waterway
MRK9	Markham	Basement flooding, ponding	West to Rockwell Avenue/162nd to 159th Streets	No problem has been observed since 2000; ponding due to overbank flow from CUDD	Regional	Construct 450 ac-ft detention basin with diversion culverts (Alternative CUDDG2-A1)
MRK10	Markham	Ponding, storm sewer flow restriction	154th to 155th Streets/Crawford Avenue to Hamlin Avenue	Yards flood 2-3 times a year	Local	Local storm sewer issue
MRK11	Markham	Pavement flooding	Route 6 at 6000 west (IDOT)	Pavement flooding	Local	Local issue
THO2	Thornton Township	Siltation and debris	171st Street from Robey Street to Halsted Street	Other (siltation, storm sewer flow restriction	Local	Maintenance issue
THO3	Thornton Township	Culvert flow restriction	Center Street from 175th Street to 159th Street	Debris at culvert opening	Local	Local maintenance issue

3.2.1.6 Near Term Planned Projects

No near-term planned major flood control projects have been identified. Two conveyance projects or stream maintenance projects have been identified: retrofit of the Country Club Lane crossing at Independence Park to reduce upstream stages, and maintenance along the Canadian Central Rail Yard.

3.2.2 Watershed Analysis

3.2.2.1 Hydrologic Model Development

3.2.2.1.1 Subbasin Delineation

The CUDD subwatershed was delineated according to the methods described in **Sections 1.3.2** and **2.3.2**. There are 63 subbasins ranging in size from 0.019 to 2.13 square miles with an average size of 0.393 square miles.

3.2.2.1.2 Hydrologic Parameter Calculations

Curve numbers (CN) and directly connected impervious percentages were estimated for each subbasin as described in **Section 1.3.2**. An area-weighted average of the CN was generated for each subbasin. Clark's unit hydrograph parameters were estimated using the method described in **Section 1.3.2**. A table summarizing the drainage area, final CN, directly connected impervious percentage and unit hydrograph parameters for each subbasin are shown in **Appendix G**.

3.2.2.2 Hydraulic Model Development

3.2.2.2.1 Field Data, Investigation, and Existing Model Data

During Phase A, any available existing models were collected and analyzed to determine if data could be used for developing the comprehensive model. Only existing models that were less than 10 years old were reviewed.

The FEMA effective hydraulic model for CUDD and the Calumet Union Drainage Ditch Southwest Branch was developed in January 2006 by the Illinois State Water Survey using HEC-2, and was made available for this study. The model met District criteria as identified in the CCSMP, and was used to support DWP development. Effective hydraulic models for the other tributaries were developed using the DWP field survey.

The HEC-2 model was reviewed to determine if any of the cross-sectional data and hydraulic structure information could be reused. If any information regarding location, date, and vertical datum was not available, the cross-sectional data was not used. For cross sections with this data available, the cross section was compared to the current channel conditions to ensure that the cross section was still representative of current conditions. The hydraulic structure dimensions were compared to 2007 field reconnaissance data and also to bridge/culvert dimension data provided by Cook County Highway Department (data provided for state/county highways only). Based on the existing model analysis, additional cross sections and hydraulic structures to be surveyed were determined. Any data used from the existing models was geo-referenced to represent true physical coordinates.

After review of existing models, field reconnaissance data, and hydraulic structure dimension data, a field survey plan was developed. Field survey was performed under the protocol of FEMA's *Guidelines and Specifications for Flood Hazard Mapping partners, Appendix A: Guidance for Aerial Mapping and Surveying.* Field surveying was performed in early 2008. Cross sections were generally surveyed between 500 to 1,000 feet apart. The actual spacing and location were determined based on the variability of the channel's shape, roughness, and slope. A total of 281 cross sections and 70 hydraulic structures were surveyed to develop the hydraulic model for the CUDD subwatershed. Additional cross sections were developed by interpolating the surveyed channel data and combining with contour data.

The Manning's n-values at each cross section were estimated using a combination of aerial photography and photographs from field survey and field reconnaissance. The horizontal extent of each type of land cover and the associated n-value for each cross section were manually entered into the HEC-RAS hydraulic model. All the n-values were manually adjusted using the HEC-RAS cross-sectional data editor.

The n-values were increased where buildings are located within the floodplain to account for conveyance loss. The n-values in these areas may range from 0.060 for areas with few buildings to 0.15 for fully developed areas. If significant blockage was caused by buildings in the flood fringe, the developed areas were modeled as ineffective flow. **Table 3.2.5** lists the channel and overbank ranges of n-values that were used for the subwatershed model.

Table 3.2.5: Channel and Overbank Associated Manning's n-Values[1]

Tributary	Range of Channel n-Values	Range of Overbank n-Values
CUDD	0.013 - 0.05	0.013 - 0.12
CUSW	0.015 - 0.05	0.015 - 0.12
CUTN	0.013 - 0.055	0.013 - 0.03
CUTS	0.013 - 0.05	0.03
CHCR	0.013 - 0.045	0.013 - 0.12
CHEB	0.013 - 0.116	0.015 - 0.12
CHET	0.045	0.10
CHWB	0.015 - 0.045	0.03 - 0.12
CHWE	0.05	0.045 - 0.12
DXCR	0.013 - 0.12	0.013 - 0.12
PKCR	0.045	0.12
I57D	0.045	0.12
BLCR	0.04 - 0.06	0.03 - 0.12
CCDD	0.035 - 0.045	0.035 - 0.4
RSDC	0.013	0.013

[1]**Source**: Open Channel Hydraulics, Chow 1959

3.2.2.2.2 Boundary Conditions

There are three downstream locations where boundary conditions were required to run the hydraulic model. Since CUDD upstream to Halsted Street was modeled within the Little Calumet River hydraulic model, the downstream boundary condition was not critical at the CUDD and Little Calumet River confluence. Normal depth was used as the downstream boundary condition for CUDD at the confluence with the Little Calumet River, the Robey Street Diversion Conduit at the Little Calumet River, and the I-57 Drainage Ditch at the Little Calumet River.

3.2.2.3 Calibration and Verification

A detailed calibration was not conducted on the CUDD subwatershed since historic gage records and high water marks were not available. Revisions to the hydrologic parameters were made based on the calibration results of the other subwatersheds. Five historic storms were modeled: August 2007, April 2007, April 2006, July 1996, and September 2008. An inspection of high water marks following the September

2008 storm event corresponded well to the 100-year model results along CUDD, Dixie Creek, and Belaire Creek.

For the historical storms, Illinois State Water Survey (ISWS) Cook County precipitation gages, National Weather Service (NWS) recording and non-recording gages, and Community Collaborative Rain, Hail & Snow Network (CoCoRAHS) precipitation amounts were used. Theissen polygons were developed for each storm based on the rain gages available for that storm. The gage weightings for the recording and non-recording gages were computed in ArcGIS for each subbasin.

Runoff hydrographs were developed using HEC-HMS and routed through the hydraulic model. Since a formal calibration of the subwatershed was not possible, changes made to the hydrology of the Midlothian Creek subwatershed were adopted for the CUDD subwatershed. The CN and directly connected impervious percentage were adjusted by -10% and -10%, respectively. The Clark's Unit Hydrograph storage coefficient R was increased by +25 percent.

The hydraulic model was verified by comparing the hydraulic model results with available high water marks for the September 2008 storm event. High water marks were surveyed in June 2009 using field photos taken after the event. **Table 3.2.6** shows the comparison of the model results to the surveyed high water marks.

Table 3.2.6: Calumet Union Drainage Ditch Subwatershed Verification Results

Storm Event	Location	Field Elevation (ft)	Model Elevation (ft)
Sep-08	Calumet Union Reach 1 RS 9663	605.25	605.49
Sep-08	Calumet Union Reach 1 RS 9768*	604.78	605.79
Sep-08	Calumet Union Reach 1 RS 9880*	604.17	605.82
Sep-08	Overbank area adjacent to Calumet Union Reach 2 RS 15702	607.56	608.01
Sep-08	Overbank area adjacent to Calumet Union Reach 2 RS 15702	607.78	608.01
Sep-08	Calumet Union Reach 3 RS 16367	608.25	608.03
Sep-08	Calumet Union Reach 3 RS 16505.7	607.98	608.10
Sep-08	Calumet Union Reach 3 RS 16552	608.66	608.10
Sep-08	Calumet Union Reach 3 RS 16676	608.20	608.13
Sep-08	Markham overbank area adjacent to Calumet Union Reach 2	607.96	607.32
Sep-08	Calumet Union SW Reach 1 RS 8321	627.07	627.59
Sep-08	Belaire Creek Reach 1 RS 5876	606.53	606.96

*Upstream high water mark is lower than downstream

Although gage data was not available, comparison to high water marks obtained during the September 2008 storm suggests the model is reasonably predicting stages along CUDD. Observed high water marks and modeled stages are within 0.51 feet. Two surveyed high water marks (see footnote) are inconsistent with the surveyed high water mark immediately downstream. If these two high water marks are discounted, modeled stages are within 0.35 feet of the surveyed high water marks.

3.2.2.4 Existing Conditions Evaluation

3.2.2.4.1 Flood Inundation Areas.

The existing conditions hydraulic model was run for the 2- through 500-year storm events. A critical duration analysis was performed for the subwatershed hydraulic model. The 100-year, 1-, 3-, 6-, 12-, 24-, and 48-hour storm events were run to determine the critical duration that produces the highest stages and flows. The 6-hour duration was found to be the representative critical duration for CUDD Southwest Branch Tributary N, CUDD Southwest Branch Tributary S, Cherry Creek East Branch Tributary, Cherry Creek West Branch East Fork, and portions of CUDD Southwest Branch, Cherry Creek East Branch, Cherry Creek West Branch, and the Canadian Central Drainage Ditch. The remainder of the reaches had a critical duration of 48 hours. **Figure 3.2.1** shows inundation area produced for the 100-year critical duration storm event.

3.2.2.4.2 Hydraulic Profiles

Hydraulic profiles for CUDD and its tributaries are shown in **Appendix H**. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100- and 500-year recurrence interval design storm events.

3.2.3 Development and Evaluation of Alternatives

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. **Table 3.2.7** summarizes problem areas identified through hydraulic modeling of the CUDD subwatershed.

Problem areas that were hydraulically interdependent or otherwise related were grouped for alternatives analysis. Each problem group is addressed in terms of combined damages and alternatives/solutions.

Table 3.2.7: Modeled Problem Definition for the Calumet Union Drainage Ditch Subwatershed

Problem ID	Group ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
CUDD1	CUDD-G1	Highway 6 and Park Avenue	10, 25, 50, & 100	HAR1	CUDDG1-A8
CUDD2	CUDD-G1	CUDD from Dixie Highway to Park Avenue	25, 50, & 100	MRK3	CUDDG1-A8
CUDD3	CUDD-G2	CUDD from Tri-State Tollway to Dixie Highway	10, 25, 50, & 100	MRK9	CUDDG2-A1
CUDD4	CUDD-G3	CUDD from Hamlin Avenue to Central Park	25, 50, & 100	MRK1	CUDDG3-A2

Table 3.2.7: Modeled Problem Definition for the Calumet Union Drainage Ditch Subwatershed

Problem ID	Group ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
CUDD5	CUDD-G3	CUDD from Sunset to Central Park	10, 25, 50, & 100	MRK1	CUDDG3-A2
CUSW1	CUSW-G1	CUDD Southwest from Holmes Avenue to Tri-State Tollway	50 & 100	None	CUSWG1-A1
CUSW2	CUSW-G2	CUDD Southwest at Kedzie Avenue	25, 50, & 100	None	CUSWG2-A2
CUTS1	CUTS-G1	CUDD SW Tributary South at Baker Avenue	100	None	CUTSG1-A1
CHCR1	CUDD-G1	Cherry Creek from Tri-State Tollway and I-80 interchange to Dixie Highway	50, & 100	None	CUDDG1-A8
CHEB1	CHEB-G1	Cherry Creek East Branch at Governors Highway	25, 50, & 100	None	CHEBG1-A4
CHEB2	CHEB-G2	Cherry Creek East Branch at Chayes Court	25, 50, & 100	None	Floodproofing/ acquisition
CHEB3	CHEB-G3	Cherry Creek East Branch at Governors Highway and the Homewood-Flossmoor High School	50, & 100	None	CHEBG3-A3
BLCR1	BLCR-G1	Belaire Creek from Albany Avenue to Afton Avenue	100	MRK4	BLCRG1-A6
PKCR1	PKCR-G1	Park Creek near 153rd Street	50, & 100	None	PKCRG1-A4
PKCR2	PKCR-G1	Park Creek from Kedzie Avenue to I-57	50, & 100	None	PKCRG1-A4

Damage assessment, technology screening, alternative development and alternative selection were performed by problem group, since each group is independent of the other. Each problem group is evaluated in the following sections by group ID.

3.2.3.1 CUDD-G1 – Calumet Union Drainage Ditch Problem Group 1

3.2.3.1.1 Problem Definition, CUDD-G1

The CUDD-G1 problem group consists of overbank flooding in Markham along CUDD from Dixie Highway to Vincennes Avenue. In this reach, 100-year flows ranging between 1,364 cfs at Dixie Highway to 1,608 cfs at Vincennes Avenue exceed the capacity of the channel. In addition, US Highway 6 upstream of Park Avenue overtops and flooding occurs north of US 6 within Harvey. The combined Markham and Harvey flooding include approximately 1,060 building structures. Flooding in

Markham was not shown on the recent DFIRM floodplain maps, since the current flood insurance study (FIS) maintains lower 100-year flow rates. The Harvey area is shown on the recent DFIRM floodplain maps; however, this is due to flooding from Dixie Creek and Dixie Highway, not CUDD. The flood protection elevation varies between 609.88 feet at Dixie Highway 601.37 feet at Vincennes Avenue.

An associated problem area consists of overbank flooding on Cherry Creek, between the Tri-State Tollway and Dixie Highway. In this reach, 100-year flows of 500 cfs generally exceed the capacity of the channel and the culvert crossings at 171st Street, Crane Avenue, 170th Street, and Head Avenue.

3.2.3.1.2 Damage Assessment, CUDD-G1

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for CUDD and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.2.8** lists the estimated damages for the problem group.

Table 3.2.8: Estimated Damages for Calumet Union Drainage Ditch Subwatershed, Problem Group CUDD-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
CUDD-G1	Property	$5,782,000	Structures at risk of flooding
	Transportation	$0	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.2.3.1.3 Technology Screening, CUDD-G1

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.2.9** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.2.9: Evaluation of Flood Control Technologies for CUDD Subwatershed, Problem Group CUDD-G1

Flood Control Option	Feasibility
Detention Facilities	Feasible and necessary
Conveyance Improvement – Culvert/Bridge Replacement	Not adequate to address flooding
Conveyance Improvement – Channel Improvement	Not adequate to address flooding
Conveyance Improvements – Diversion	Feasible and necessary
Flood Barriers, Levees/Floodwalls	Impractical given other technologies

3.2.3.1.4 Alternative Development

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.2.10** summarizes flood control alternatives developed for Problem Group CUDD-G1.

Table 3.2.10: Flood Control Alternatives for Problem Group CUDD-G1

Alternative	Location	Description
CUDDG1-A1	Edward C. Howell Reservoir	Expansion of the Edward C. Howell Reservoir
CUDDG1-A2	Calumet Union Reservoir	Expansion of the Calumet Union Reservoir
CUDDG1-A3	CUDD from Dixie Highway to Vincennes Avenue	Conveyance improvements by widening and deepening CUDD, retrofit structures through the Canadian Central Rail Yard
CUDDG1-A4	Robey Street Diversion Conduit	Replace the existing Robey Street Diversion Conduit with a higher conveyance diversion.
CUDDG1-A5	From Tri-State Tollway to Dixie Highway	Conveyance improvements to reduce flooding on Cherry Creek
CUDDG1-A6	Edward C. Howell and Calumet Union Reservoirs	Expansion of both reservoirs to their maximum capacity (combination of Alternatives CUDDG1-A1 and CUDDG1-A2). This did not reduce flows in CUDD enough to prevent overtopping. While the Calumet Union Reservoir expansion helped reduce flows significantly, expansion of the Edward C. Howell Reservoir did not. This alternative is not preferred
CUDDG1-A7	Calumet Union Reservoir and CUDD from Dixie Highway to Vincennes Avenue	Expansion of the Calumet Union Reservoir and conveyance improvements along CUDD (combination of Alternatives CUDDG1-A2 and CUDDG1-A3). Even with channel improvements, CUDD does not have enough capacity and this alternative is not preferred
CUDDG1-A8	Calumet Union Reservoir, Robey Street Diversion Conduit	Expansion of the Calumet Union Reservoir with improvements to the Robey Street Diversion Culvert (combination of Alternatives CUDDG1-A2 and CUDDG1-A4)

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the CUDD-G1 Problem Group.

3.2.3.1.5 Alternative Evaluation and Selection

Alternatives included in **Table 3.2.10** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.2.12** provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed, as benefits were negligible, and thus costs were not calculated for these alternatives.

Alternative CUDDG1-A8 from **Table 3.2.10** is the preferred alternative for this Problem Group. This improvement includes the expansion of the Calumet Union

Reservoir and the upgrading of the Robey Street Diversion Conduit. The Calumet Union Reservoir expansion project component includes the following items:

- Expansion of both Pool #4 and Pool #6 by increasing to their maximum capacities at 4:1 side slopes. This increases Pool #4 by 150 acre feet and Pool #6 by 235 acre feet.

- Construction of a new pool north of Pool #6.

- Raise the spillway on Pool #4 to 625 feet to provide more storage during the storm peak.

- If both pools are increased to their maximum depth, Pool #6 would have a lower invert than Pool #4. As a result, Pool #4 would need to be reconfigured to drain towards Pool #6, and a pump station would need to be constructed to dewater Pool #6.

- Construct a new pool to the north of Pool #6, between the Calumet Union Southwest Tributary and 171st Street at the Oak Hill Toll Park. At 13.4 acres and 55 feet deep, the pool would provide approximately 150 acre feet of storage.

- Add a diversion structure at 171st Street to divert flow from either Pool #6 or the forebay, and gravity pipes to drain the new pool into Pool #6.

The Robey Street Diversion Conduit improvement project component includes the removal of the existing 7.5-foot and 5-foot concrete pipe and construction of two (2) new 12-foot by 8-foot box culverts. The diversion would reduce flows and stages downstream by diverting flow north to the Little Calumet River.

Table 3.2.11 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for CUDD-G1.

Table 3.2.11: Alternative Condition Flow & WSEL Comparison for Problem Group CUDD-G1

Location	Station	Existing Conditions		Alternative CUDDG1-A8	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
80' downstream of 171st Street	Cherry Creek 1 7644.381	622.04	909	621.05	501
Wolcott Avenue	CUDD2 15702	608.37	624	603.89	40
Upstream of Highway 1	CUDD1 8542	605.31	1,202	603.17	591

3.2.3.1.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.2.12** lists the alternative analyzed in detail. The recommended alternative consists of expansion of and improvements to the Calumet Union Reservoir and upsizing the Robey Street Diversion Conduit. **Figure 3.2.2** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.2.12: CUDD Project Alternative Matrix to Support District CIP Prioritization for Problem Group CUDD-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
CUDD-G1	CUDDG1-A8	Reservoir expansion and upsizing of conduit	0.03	$5,782,000	$165,318,000	1,065 Structures	Positive	Markham, Harvey, Hazel Crest

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.2.3.2 CUDD-G2 – Calumet Union Drainage Ditch Problem Group 2

3.2.3.2.1 Problem Definition, CUDD-G2

The CUDD-G2 problem group consists of overbank flooding in Markham and Harvey as well as the unincorporated area between the Tri-State Tollway and Dixie Highway. In this reach, 100-year flows, ranging between 442 cfs at the Tri-State Tollway to 640 cfs at Dixie Highway, exceed the capacity of the channel. Flooding in this area impacts approximately 20 properties. This area is shown as flooding on the current FEMA DFIRMs. The flood protection elevation varies between 607.62 feet at Artesian Avenue and 607.0 feet upstream of Dixie Highway.

3.2.3.2.2 Damage Assessment, CUDD-G2

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for CUDD and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15 percent of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.2.13** lists the estimated damages for the problem group.

Table 3.2.13: Estimated Damages for CUDD Subwatershed, Problem Group CUDD-G2

Problem Group ID	Damage Category	Estimated Damage ($)	Description
CUDD-G2	Property	$3,789,000	Structures at risk of flooding
	Transportation	$668,560	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.2.3.2.3 Technology Screening, CUDD-G2

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.2.14** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.2.14: Evaluation of Flood Control Technologies for CUDD Subwatershed, Problem Group CUDD-G2

Flood Control Option	Feasibility
Detention Facilities	Feasible and necessary
Conveyance Improvement – Culvert/Bridge Replacement	Not adequate to address flooding
Conveyance Improvement – Channel Improvement	Not adequate to address flooding
Conveyance Improvements – Diversion	Feasible and necessary to divert to storage
Flood Barriers, Levees/Floodwalls	Not feasible due to stage increases downstream

3.2.3.2.4 Alternative Development, CUDD-G2

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.2.15** summarizes flood control alternatives developed for Problem Group CUDD-G2.

Table 3.2.15: Flood Control Alternatives for Problem Group CUDD-G2

Alternative	Location	Description
CUDDG2-A1	Edward C. Howell Reservoir	Create new storage pool adjacent to the Edward C. Howell Reservoir. The new storage pond would be approximately 450 ac-ft with a surface area of 18.5 ac and depth of 59 ft. The reservoir was purposely separated from the existing reservoir (as opposed to expanding the existing reservoir) to provide for separate operations for CUDD versus CUDD Southwest. During a detailed design, it may be possible to combine the existing and proposed pools after a more detailed analysis of the operations Construct diversion conduit from Tri-State Tollway to the new storage pool adjacent to the Edward C. Howell Reservoir. Includes construction of two (2) 1,500 LF, 12 ft by 3 ft culverts to divert flow from the Tollway to a new pumped storage reservoir

Table 3.2.15: Flood Control Alternatives for Problem Group CUDD-G2

Alternative	Location	Description
CUDDG2-A2	Various sections, CUDD	Construct levees and/or floodwalls to prevent overbank flooding. Traditional and set-back levees were both found to increase stages downstream. To not increase stages downstream, set-back levees would require significant acquisitions that were not considered feasible
CUDDG2-A3	Robey Street Diversion Conduit	Divert flood flows to the Robey Street Diversion Conduit. This resulted in increased stages along CUDD due to the Robey Street Diversion Conduit flowing over capacity

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the CUDD-G2 Problem Group.

3.2.3.2.5 Alternative Evaluation and Selection, CUDD-G2

Alternatives included in **Table 3.2.15** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.2.17** provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed, as benefits were negligible, and thus costs were not calculated for these alternatives.

Alternative CUDDG2-A1 from **Table 3.2.15** is the preferred alternative for this Problem Group. The CUDD-G2 alternative analysis focused on reducing stages at CUDD2, specifically between the Tri-State Tollway and Dixie Highway. A diversion at the Tri-State Tollway to a new pumped storage pond adjacent to the Edward C. Howell Reservoir prevents flooding in the problem area. This alternative does not necessarily corresponded to a significant reduction in flows, since lowering the stage results in flow reversals near the CUDD Southwest confluence. A significant amount of storage is required since a reduction in stage is needed over a long period.

Table 3.2.16 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for CUDD-G2.

Table 3.2.16: Alternative Condition Flow & WSEL Comparison for Problem Group CUDD-G2

Location	Station	Existing Conditions		Alternative CUDDG2-A1	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
300' u/s Artesian Ave	CUDD5 1475	608.77	342	607.62	191
u/s Dixie Hwy	CUDD4 16821	608.49	636	607.00	552

3.2.3.2.6 Data Required for Countywide Prioritization of Watershed Projects, CUDD-G2

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.2.17** lists the alternative analyzed in detail. The recommended alternative consists of the construction of a 450 acre-foot detention facility adjacent to the Edward C. Howell Reservoir, with a diversion conduit to divert flow from CUDD near the Tri-State Tollway. **Figure 3.2.3** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.2.17: CUDD Project Alternative Matrix to Support District CIP Prioritization for Problem Group CUDD-G2

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
CUDD-G2	CUDDG2-A1	Construct 450 ac-ft detention basin with diversion culverts	0.07	$3,377,000	$50,406,000	20 Structures	Positive	Markham, Harvey, Unincorporated Cook

Note: Net Benefits values do not include local benefits or non-economic benefits

3.2.3.3 CUDD-G3 – Calumet Union Drainage Ditch Problem Group 3

3.2.3.3.1 Problem Definition, CUDD-G3

The CUDD-G3 problem area consists of severe streambank erosion and overbank flooding in Markham between Springfield Avenue and Central Park. In this reach, 100-year flows are approximately 150 cfs. Flooding and erosion in this area impact approximately 60 properties. This area is not shown as flooding on the current FEMA DFIRMs since the FIS was only completed up to the culvert entrance at Central Park. The flood protection elevation is approximately 623 feet at Lawndale Avenue, where the majority of flooding occurs.

3.2.3.3.2 Damage Assessment, CUDD-G3

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for CUDD and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15 percent of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.2.18** lists the estimated damages for the problem group.

Table 3.2.18: Estimated Damages for CUDD Subwatershed, Problem Group CUDD-G3

Problem Group ID	Damage Category	Estimated Damage ($)	Description
CUDD-G3	Property	$972,458	Structures at risk of flooding and erosion
	Transportation	$171,610	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.2.3.3.3 Technology Screening, CUDD-G3

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.2.19** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.2.19: Evaluation of Flood Control Technologies for CUDD Subwatershed, Problem Group CUDD-G3

Flood Control Option	Feasibility
Detention Facilities	No space available
Conveyance Improvement – Culvert/Bridge Replacement	Would need to improve Central Park Avenue resulting in stage increases downstream
Conveyance Improvement – Channel Improvement	Not adequate to address flooding due to restriction at Central Avenue
Conveyance Improvements – Diversion	Not feasible due to downstream enclosed conduit
Flood Barriers, Levees/Floodwalls	Feasible and necessary

3.2.3.3.4 Alternative Development, CUDD-G3

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.2.20** summarizes flood control alternatives developed for Problem Group CUDD-G3.

Table 3.2.20: Flood Control Alternatives for Problem Group CUDD-G3

Alternative	Location	Description
CUDDG3-A1	Vicinity of Lawndale Avenue and Central Park Avenue	Increase capacity of channel in vicinity of area where overbank flooding occurs. Channel conveyance alone was not sufficient to prevent flooding between Lawndale Avenue and Central Park Avenue, mainly due to the restriction at Central Park Avenue. Improvement of the Central Park Avenue culvert will result in stage increases downstream
CUDDG3-A2	East of Hamlin Avenue to Central Park Avenue	Construct a 4-ft high floodwall from east of Hamlin Avenue to Central Park Avenue. Ideally, the floodwall could be constructed in combination with channel restoration and erosion protection to provide an aesthetic flood reduction structure. Performed in combination with streambank stabilization alternative (see **Table 3.2.21**)
CUDDG3-A3	Between Crawford Avenue and Central Avenue	Enclose CUDD in a culvert between Crawford Avenue and Central Avenue. This alternative will increase stages downstream

Streambank Stabilization Alternatives. **Table 3.2.21** summarizes streambank stabilization control alternatives developed for Problem Group CUDD-G3.

Table 3.2.21: Streambank Stabilization Alternatives for Problem Group CUDD-G3

Alternative	Location	Description
CUDDG3-A2	East of Hamlin Avenue to Central Park Avenue	Channel rehabilitation, culvert retrofits, and permanent erosion protection measures along the channel reach. Performed in combination with flood control alternative (see **Table 3.2.20**).

3.2.3.3.5 Alternative Evaluation and Selection, CUDD-G3

Alternatives included in **Tables 3.2.20** and **3.2.21** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.2.23** provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed, as benefits were negligible, and thus costs were not calculated for these alternatives.

Alternative CUDD-G3-A2 from **Table 3.2.20** and **Table 3.2.21** is the preferred alternative for this problem group. Alternative CUDD-G3-A2 focused on resolving the erosion and flooding problem between Sunset Avenue and Central Park Avenue in Markham. Significant erosion has occurred in the past few years, especially between Sunset Avenue and Hamlin Avenue. Erosion has resulted in damage to two homes' foundations, widening of the creek, and weakening of culvert headwalls. Without proper protection, erosion will continue at these locations and propagate downstream. Given that erosion protection between Sunset Avenue and Hamlin Avenue may result in accelerated erosion downstream, erosion protection has been proposed between Sunset Avenue and Central Park Avenue. Overbank flooding begins shortly downstream of Hamlin Avenue and continues to Central Park Avenue. The proposed alternative includes a 4-foot high concrete floodwall along both banks. This provides flood protection during the 100-year event. An earthen levee was considered impractical due to limited space.

Table 3.2.22 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for CUDD-G3.

Table 3.2.22: Alternative Condition Flow & WSEL Comparison for Problem Group CUDD-G3

Location	Station	Existing Conditions		Alternative CUDDG3-A2	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Upstream of Springfield	CUDD5 11934	633.22	153	631.36	124
Upstream of Hamlin	CUDD5 11406	630.49	168	630.08	169
Upstream of Lawndale Ave	CUDD5 10563	625.55	191	626.19[1]	160

[1]Levee provides protection.

3.2.3.3.6 Data Required for Countywide Prioritization of Watershed Projects, CUDD-G3

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.2.23** lists the alternative analyzed in detail. The recommended alternative consists of construction of a concrete floodwall from Hamlin Avenue to Central Park Avenue, and erosion protection between Sunset Avenue and Central Park Avenue. **Figure 3.2.4** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.2.23: CUDD Project Alternative Matrix to Support District CIP Prioritization for Problem Group CUDD-G3

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Water Quality Benefit	Involved Community
CUDD-G3	CUDDG3-A2	4 ft high floodwall with erosion protection, including culvert retrofit and channel rehabilitation	0.40	$1,144,000	$2,852,000	60 Structures	Positive	Markham

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.2.3.4 CUSW-G1 – Calumet Union Drainage Ditch Southwest Problem Group 1

3.2.3.4.1 Problem Definition, CUSW-G1

The CUSW-G1 problem area consists of roadway overtopping and overbank flooding from Holmes Avenue to the Tri-State Tollway. In this reach, 100-year flows of 1,130 cfs generally exceed the capacity of the channel and the culvert crossing on California Avenue. There is overtopping of two critical access roads and I-80. This problem area was not shown on the recent DFIRM floodplain maps. The flood protection elevation in this reach would be 629.0 feet at California Avenue. Flood protection elevations were developed based on the roadway elevation.

3.2.3.4.2 Damage Assessment, CUSW-G1

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for CUDD and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15 percent of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.2.24** lists the estimated damages for the problem group.

Table 3.2.24: Estimated Damages for CUDD Subwatershed, Problem Group CUSW-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
CUSW-G1	Property	$0	
	Transportation	$15,000	California Avenue overtopped for 0.06 days during the 100-year storm; Holmes Avenue overtopped less than 0.5 ft; I-80 overtopped for 0.14 days during the 100-year storm
	Recreation	$0	

3.2.3.4.3 Technology Screening, CUSW-G1

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.2.25** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.2.25: Evaluation of Flood Control Technologies for CUDD Subwatershed, Problem Group CUSW-G1

Flood Control Option	Feasibility
Detention Facilities	Unnecessary given alternative
Conveyance Improvement – Culvert/Bridge Replacement	Feasible to retrofit California Avenue
Conveyance Improvement – Channel Improvement	Unnecessary given alternative
Conveyance Improvements – Diversion	Unnecessary given alternative-
Flood Barriers, Levees/Floodwalls	Unnecessary given alternative

3.2.3.4.4 Alternative Development, CUSW-G1

Flood Control Alternatives. An alternative solution to regional flooding problems was developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.2.26** summarizes the flood control alternative developed for Problem Group CUSW-G1.

Table 3.2.26: Flood Control Alternatives for Problem Group CUSW-G1

Alternative	Location	Description
CUSWG1-A1	California Avenue	Retrofit the existing culvert with five (5) 10-ft x 6-ft (or equivalent) culverts. This reduces stages to 628.31 ft at California Avenue and 631.18 ft at Holmes Avenue upstream. Since the flood protection stage is 629 ft, this suggests that fewer or smaller culverts may be possible and should be assessed during a detailed design

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the CUSW-G1 Problem Group.

3.2.3.4.5 Alternative Evaluation and Selection, CUSW-G1

The alternative included in **Table 3.2.26** was evaluated to determine its effectiveness and produce data required for the countywide prioritization of watershed projects. The flood control alternative was modeled to evaluate its impact on water elevations and flood damages. **Table 3.2.28** provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative.

Alternative CUSWG1-A1 from **Table 3.2.26** is the preferred alternative for this problem group. By retrofitting the existing culvert with five (5) 10-foot x 6-foot (or equivalent) culverts, stages are reduced to 628.31 feet at California Avenue and 631.18 feet at Holmes Avenue upstream. This brings the maximum water surface elevation at California Avenue below the flood protection elevation of 629.0 feet.

Table 3.2.27 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for CUSW-G1.

Table 3.2.27: Alternative Condition Flow & WSEL Comparison for Problem Group CUSW-G1

Location	Station	Existing Conditions		Alternative CUSWG1-A1	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Upstream of California Avenue	CUSW 8321	630.58	1,080	628.13	1,130
Downstream of California Avenue	CUSW 8200	628.52	1,076	627.80	1,130
Upstream of Holmes Avenue	CUSW 9652	631.91	1,085	631.18	1,101
Downstream of Holmes Avenue	CUSW 9492	630.87	1,060	629.84	1,101

3.2.3.4.6 Data Required for Countywide Prioritization of Watershed Projects, CUSW-G1

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.2.28** lists the alternative analyzed in detail. The recommended alternative consists of the upgrading California Avenue crossing over CUDD Southwest Brach. **Figure 3.2.5** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.2.28: CUDD Project Alternative Matrix to Support District CIP Prioritization for Problem Group CUSW-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
CUSW-G1	CUSWG1-A1	Upgrade crossing	0.03	$15,000	$536,000	1 Roadway	No Impact	Hazel Crest

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.2.3.5 CUSW-G2 – Calumet Union Drainage Ditch Southwest Problem Group 2

3.2.3.5.1 Problem Definition, CUSW-G2

The CUSW-G2 problem group consists of roadway overtopping at Kedzie Avenue. The 100-year flow of 1,039 cfs exceeds the culvert capacity at Kedzie Avenue. The flood protection stage would be 636.0 feet.

3.2.3.5.2 Damage Assessment, CUSW-G2

Damages were defined following the protocol defined by the CCSMP. Critical duration analysis was performed to determine the highest flood stages for CUDD and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15 percent of the property damages, unless otherwise noted. Recreational damages were estimated based on depth and duration of flooding. **Table 3.2.29** lists the estimated damages for the problem group.

Table 3.2.29: Estimated Damages for CUDD Subwatershed, Problem Group CUSW-G2

Problem Group ID	Damage Category	Estimated Damage ($)	Description
CUSW-G2	Property	$0	
	Transportation	$6,000	Kedzie Avenue overtopped 0.12 days during the 100-year event
	Recreation	$0	

3.2.3.5.3 Technology Screening, CUSW-G2

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.2.30** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.2.30: Evaluation of Flood Control Technologies for CUDD Subwatershed, Problem Group CUSW-G2

Flood Control Option	Feasibility
Detention Facilities	Unnecessary given alternative
Conveyance Improvement – Culvert/Bridge Replacement	Feasible but not ideal given alternatives
Conveyance Improvement – Channel Improvement	Does not address the constriction at Kedzie Avenue
Conveyance Improvements – Diversion	Feasible
Flood Barriers, Levees/Floodwalls	Not feasible

3.2.3.5.4 Alternative Development, CUSW-G2

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.2.31** summarizes flood control alternatives developed for Problem Group CUSW-G2.

Table 3.2.31: Flood Control Alternatives for Problem Group CUSW-G2

Alternative	Location	Description
CUSWG2-A1	Kedzie Avenue	Replace existing crossing with a crossing with a larger hydraulic opening to increase conveyance capacity
CUSWG2-A2	Kedzie Avenue	Construct a diversion culvert parallel to Kedzie Avenue, 8 ft by 6 ft and 860 LF long to increase conveyance capacity

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the CUSW-G2 Problem Group.

3.2.3.5.5 Alternative Evaluation and Selection, CUSW-G2

Alternatives included in **Table 3.2.31** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.2.33** provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed, as benefits were negligible, and thus costs were not calculated for these alternatives.

Alternative CUSWG2-A2 from **Table 3.2.31** is the preferred alternative for this problem group. This alternative focused on reducing stages upstream of Kedzie Avenue and at I-80. To do so, stages need to be reduced to 636.0 feet upstream of Kedzie Avenue. This alternative was preferred to replacing the existing culvert because it prevents the need for modifications to Kedzie Avenue.

Table 3.2.32 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for CUSW-G2.

Table 3.2.32: Alternative Condition Flow & WSEL Comparison for Problem Group CUSW-G2

Location	Station	Existing Conditions		Alternative CUSWG2-A2	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Upstream of Kedzie Avenue	CUSW 11920	636.60	809	635.81	733
Downstream of Kedzie Avenue	CUSW 10993	633.31	807	633.02	733

3.2.3.5.6 Data Required for Countywide Prioritization of Watershed Projects, CUSW-G2

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.2.33** lists the alternative analyzed in detail. The recommended alternative consists of construction a diversion culvert parallel to Kedzie Avenue. **Figure 3.2.6** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.2.33: CUDD Project Alternative Matrix to Support District CIP Prioritization for Problem Group CUSW-G2

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
CUSW-G2	CUSWG2-A2	Additional culvert parallel to Kedzie Avenue	< 0.01	$6,000	$1,206,000	1 Roadway	No Impact	Hazel Crest

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.2.3.6 CUTS-G1 – CUDD Southwest Branch Tributary S Problem Group 1

3.2.3.6.1 Problem Definition, CUTS-G1

The CUTS-G1 problem group consists of overbank flooding in the area adjacent to the Calumet Union Drainage Ditch Southwest Branch Tributary S (CUTS) at the upstream end, generally corresponding to Baker Avenue from 186th Street to 185th Street. In this reach, 100-year flows of 45 cfs generally exceed the channel capacity, causing flows to back up into the low overbank area. There is flooding of approximately 10 building structures and overtopping of two roadway crossings, both of which are local roads. This problem area was shown on the recent DFIRM floodplain maps, but flooding was not as significant as suggested by the existing conditions hydraulic model developed for this study. The flood protection elevation in this reach would be 699.5 feet. Flood protection elevations were developed based on field reconnaissance of the area based on typical residential structures.

3.2.3.6.2 Damage Assessment, CUTS-G1

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for CUDD and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15 percent of the property damages, unless otherwise noted. Recreational damages were estimated based on depth and duration of flooding. **Table 3.2.34** lists the estimated damages for the problem group.

Table 3.2.34: Estimated Damages for CUDD Subwatershed, Problem Group CUTS-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
CUTS-G1	Property	$53,423	Structures at risk of flooding
	Transportation	$9,428	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.2.3.6.3 Technology Screening, CUTS-G1

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.2.35** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.2.35: Evaluation of Flood Control Technologies for CUDD Subwatershed, Problem Group CUTS-G1

Flood Control Option	Feasibility
Detention Facilities	Not feasible since reducing stages in the creek is not feasible. The creek is only 2 ft deep at the 100-year stage
Conveyance Improvement – Culvert/Bridge Replacement	Same as above
Conveyance Improvement – Channel Improvement	Same as above
Conveyance Improvements – Diversion	Same as above
Flood Barriers, Levees/Floodwalls	Feasible given that the problem is not that stages are too high in the creek, but that a low overbank area exists

3.2.3.6.4 Alternative Development, CUTS-G1

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.2.36** summarizes flood control alternatives developed for Problem Group CUTS-G1.

Table 3.2.36: Flood Control Alternatives for Problem Group CUTS-G1

Alternative	Location	Description
CUTSG1-A1	Baker Avenue	Construct a 945 LF, 4-ft high earthen levee adjacent to the flooded properties along Baker Avenue

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the CUTS-G1 Problem Group.

3.2.3.6.5 Alternative Evaluation and Selection, CUTS-G1

The alternative included in **Table 3.2.36** was evaluated to determine its effectiveness and produce data required for the countywide prioritization of watershed projects. The flood control alternative was modeled to evaluate its impact on water elevations and flood damages. **Table 3.2.38** provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative.

Alternative CUTSG1-A1 from **Table 3.2.36** is the preferred alternative for this problem group. A levee or floodwall was the only solution considered to be feasible, given that the cause of flooding is due to the low elevations adjacent to Baker Avenue. The 100-year depth in the creek is only 2 feet, which means any reduction in stage is not feasible. A small earthen levee would protect homes while maintaining a reasonable stage in the creek. A 945 linear-foot, 4-foot high earthen levee adjacent to the flooded properties would prevent overbank flooding during the 100-year event. At 4 feet high, the levee would provide approximately 3 feet of freeboard.

Table 3.2.37 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for CUTS-G1.

Table 3.2.37: Alternative Condition Flow & WSEL Comparison for Problem Group CUTS-G1

Location	Station	Existing Conditions		Alternative CUTSG1-A1	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
350' South of 185th Street	4747.33	700.0	45	700.0[1]	45

[1]Levee provides protection.

3.2.3.6.6 Data Required for Countywide Prioritization of Watershed Projects, CUTS-G1

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.2.38** lists the alternative analyzed in detail. The recommended alternative consists of constructing an earthen levee adjacent to flooded properties. **Figure 3.2.7** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.2.38: CUDD Project Alternative Matrix to Support District CIP Prioritization for Problem Group CUTS-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
CUTS-G1	CUTSG1-A1	Earthen levee	0.02	$63,000	$2,917,000	10 Structures, 2 Roadway	No Impact	Country Club Hills

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.2.3.7 CHEB-G1 – Cherry Creek East Branch Problem Group 1

3.2.3.7.1 Problem Definition, CHEB-G1

The CHEB-G1 problem group consists of overbank and roadway flooding along Cherry Creek East Branch, from near Governors Highway to approximately 500 feet upstream. In this reach, 100-year flows of 580 cfs generally exceed the capacity of the channel, flooding homes on the right bank and overtopping Governors Highway on the left bank. Governors Highway is also overtopped further upstream near 183rd Street. Along this reach, there is flooding of approximately 16 building structures and overtopping of 2 roadway crossings. This problem area was shown on the recent DFIRM floodplain maps. The flood protection elevation in this reach would be 635.36 feet. Flood protection elevations were developed based on field reconnaissance of the area based on typical residential structures.

3.2.3.7.2 Damage Assessment, CHEB-G1

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for CUDD and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15 percent of the property damages, unless otherwise noted. Recreational damages were estimated based on depth and duration of flooding. **Table 3.2.39** lists the estimated damages for the problem group.

Table 3.2.39: Estimated Damages for CUDD Subwatershed, Problem Group CHEB-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
CHEB-G1	Property	$144,614	Structures at risk of flooding
	Transportation	$25,520	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.2.3.7.3 Technology Screening, CHEB-G1

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.2.40** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.2.40: Evaluation of Flood Control Technologies for CUDD Subwatershed, Problem Group CHEB-G1

Flood Control Option	Feasibility
Detention Facilities	Inline storage was considered feasible as part of conveyance improvements, but a large pumped storage reservoir was considered infeasible due to size
Conveyance Improvement – Culvert/Bridge Replacement	Feasible given the need to reduce stages
Conveyance Improvement – Channel Improvement	Feasible given the need to reduce stages
Conveyance Improvements – Diversion	Infeasible given availability of other alternatives
Flood Barriers, Levees/Floodwalls	Infeasible given availability of other alternatives

3.2.3.7.4 Alternative Development, CHEB-G1

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.2.41** summarizes flood control alternatives developed for Problem Group CHEB-G1.

Table 3.2.41: Flood Control Alternatives for Problem Group CHEB-G1

Alternative	Location	Description
CHEBG1-A1	Hillcrest Park	Provide overbank storage in Hillcrest Park
CHEBG1-A2	Ravisloe Country Club to 175th Street	Channel improvements, including widening and deepening
CHEBG1-A3	Governors Highway and 175th Street crossings	Replace crossings with larger hydraulic openings
CHEBG1-A4	Hillcrest Park, Ravisloe Country Club to 175th Street, Governors Highway and 175th Street crossings	Provide overbank storage, channel improvements, and replace two crossings (combination of Alternatives CHEBG1-A1, CHEBG1-A2 and CHEBG1-A3)

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the CHEB-G1 Problem Group.

3.2.3.7.5 Alternative Evaluation and Selection, CHEB-G1

Alternatives included in **Table 3.2.41** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.2.43** provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed, as benefits were negligible, and thus costs were not calculated for these alternatives.

Alternative CHEBG1-A4 from **Table 3.2.41** is the preferred alternative for this problem group. This problem group can be addressed by improving the channel conveyance between the Ravisloe Golf Course and 175th Street, including culvert improvements, channel improvements, and storage at Hillcrest Park.

Table 3.2.42 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for CHEB-G1.

Table 3.2.42: Alternative Condition Flow & WSEL Comparison for Problem Group CHEB-G1

Location	Station	Existing Conditions		Alternative CHEBG1-A4	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
30' upstream of Governors Hwy	Cherry Creek East 1 1309.79	636.79	557	635.36	580

3.2.3.7.6 Data Required for Countywide Prioritization of Watershed Projects, CHEB-G1

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.2.43** lists the alternative analyzed in detail. The recommended alternative consists of conveyance improvements including channel widening and deepening, replacing two roadway crossings, and providing overbank storage. **Figure 3.2.8** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.2.43: CUDD Project Alternative Matrix to Support District CIP Prioritization for Problem Group CHEB-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
CHEB-G1	CHEBG1-A4	Channel improvements, replace two crossings, in-line storage	0.05	$170,000	$3,300,000	16 Structures, 2 Roadway	No Impact	Homewood, Hazel Crest

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.2.3.8 CHEB-G2 – Cherry Creek East Branch Problem Group 2

3.2.3.8.1 Problem Definition, CHEB-G2

The CHEB-G2 problem area consists of a single apartment building impacted by flooding at Chayes Court. This problem area was shown on the recent DFIRM floodplain maps. Flood protection elevations were developed based on field reconnaissance of the area based on typical residential structures.

3.2.3.8.2 Damage Assessment, CHEB-G2

Damages were not calculated since the proposed alternative for CHEB-G2 is non-structural floodproofing or acquisition only.

3.2.3.8.3 Technology Screening, CHEB-G2
Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.2.44** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.2.44: Evaluation of Flood Control Technologies for CUDD Subwatershed, Problem Group CHEB-G2

Flood Control Option	Feasibility
Detention Facilities	Unnecessary given non-structural alternative
Conveyance Improvement – Culvert/Bridge Replacement	Unnecessary given non-structural alternative
Conveyance Improvement – Channel Improvement	Unnecessary given non-structural alternative
Conveyance Improvements – Diversion	Unnecessary given non-structural alternative
Flood Barriers, Levees/Floodwalls	Unnecessary given non-structural alternative

3.2.3.8.4 Alternative Development, CHEB-G2
Flood Control Alternatives. No flood control alternatives were developed for the isolated structure.

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the CHEB-G2 Problem Group.

3.2.3.8.5 Alternative Evaluation and Selection, CHEB-G2
The preferred alternative for this problem is floodproofing or acquisition. For the single residential structure, although the flood stage is below the flood protection stage, the inundation area overlaps the structure. While floodproofing was generally not considered as primary solution for the DWP, in this case it is recommended.

3.2.3.9 CHEB-G3 – Cherry Creek East Branch Problem Group 3

3.2.3.9.1 Problem Definition, CHEB-G3
The CHEB-G3 problem area consists of roadway overtopping at Governors Highway and Braemar Road, as well as overbank flooding of homes along Braemar Road. Flood protection stages are approximately 668.2 feet at 60 feet upstream of Governor's Highway. There is flooding of approximately 9 building structures and overtopping of 2 roadway crossings, one of which is an arterial roadway. This problem area was shown on the recent DFIRM floodplain maps. Flood protection elevations were developed based on field reconnaissance of the area based on typical residential structures.

3.2.3.9.2 Damage Assessment, CHEB-G3
Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for CUDD and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building

structure were calculated and transportation damages were estimated at 15 percent of the property damages, unless otherwise noted. Recreational damages were estimated based on depth and duration of flooding. **Table 3.2.45** lists the estimated damages for the problem group.

Table 3.2.45: Estimated Damages for CUDD Subwatershed, Problem Group CHEB-G3

Problem Group ID	Damage Category	Estimated Damage ($)	Description
CHEB-G3	Property	$6,528,000	Structures at risk of flooding
	Transportation	$1,152,000	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.2.3.9.3 Technology Screening, CHEB-G3

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.2.46** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.2.46: Evaluation of Flood Control Technologies for CUDD Subwatershed, Problem Group CHEB-G3

Flood Control Option	Feasibility
Detention Facilities	Inline storage was considered infeasible due to size and land availability
Conveyance Improvement – Culvert/Bridge Replacement	Feasible
Conveyance Improvement – Channel Improvement	Feasible but would require permanent easements and one acquisition
Conveyance Improvements – Diversion	Not feasible due to hydraulics
Flood Barriers, Levees/Floodwalls	Not feasible due to space constraints and flooding of both overbanks

3.2.3.9.4 Alternative Development, CHEB-G3

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.2.47** summarizes flood control alternatives developed for Problem Group CHEB-G3.

Table 3.2.47: Flood Control Alternatives for Problem Group CHEB-G3

Alternative	Location	Description
CHEBG3-A1	Braemer Road and Governors Highway	Channel conveyance improvements; Replace Governors Highway crossing with (6) 8 ft x 4 ft culverts and the Braemer Road crossing with (4) 8 ft x 4 ft culverts (or equivalent)
CHEBG3-A2	Along channel from Homewood-Flossmoor HS to intersection of Braemer Road and Governors Highway	Channel improvements to widen and deepen the channel. This alternative would require 9 permanent easements and 1 acquisition
CHEBG3-A3	Braemer Road and Governors Highway crossings and along channel from Homewood-Flossmoor HS to Braemer Road/ Governors Highway intersection	Replace culverts at Braemer Road and Governors Highway; widen and deepen channel (combination of Alternatives CHEBG3-A1 and CHEBG3-A2)

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the CHEB-G3 Problem Group.

3.2.3.9.5 Alternative Evaluation and Selection, CHEB-G3

Alternatives included in **Table 3.2.47** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.2.49** provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed, as benefits were negligible, and thus costs were not calculated for these alternatives.

Alternative CHEBG3-A3 from **Table 3.2.47** is the preferred alternative for this problem group. The alternative analysis focused on reducing stages along Governors Highway and Braemer Road. The proposed alternative is to provide channel and culvert improvements. To obtain adequate capacity, these modifications may require acquisition of one property at Braemer Road and Governors Highway.

Table 3.2.48 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for CHEB-G3.

Table 3.2.48: Alternative Condition Flow & WSEL Comparison for Problem Group CHEB-G3

Location	Station	Existing Conditions		Alternative CHEBG3-A3	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
60’ upstream of Governors Hwy	Cherry Creek East 1a 10491.10	668.71	254	667.71	256

3.2.3.9.6 Data Required for Countywide Prioritization of Watershed Projects, CHEB-G3

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.2.49** lists the alternative analyzed in detail. The recommended alternative consists of conveyance improvements including channel widening and deepening, replacing two roadway crossings, and providing overbank storage. **Figure 3.2.10** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.2.49: CUDD Project Alternative Matrix to Support District CIP Prioritization for Problem Group CHEB-G3

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
CHEB-G3	CHEBG3-A3	Channel widening and culvert improvements	3.37	$7,680,000	$2,282,000	9 Structures, 2 Roadways	No Impact	Homewood

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.2.3.10 BLCR-G1 – Belaire Creek Problem Group 1

3.2.3.10.1 Problem Definition, BLCR-G1

The BLCR-G1 problem area consists of overbank flooding in the area adjacent to Belaire Creek from approximately Albany Avenue to Afton Avenue. In this reach, 100-year flows of 11 cfs exceed the capacity of the channel, since the channel is a small ditch with significant vegetation. There is flooding of approximately 15 building structures. This problem area was shown on the recent DFIRM floodplain maps. The flood protection elevation in this reach would be 606.32 feet. Flood protection elevations were developed based on field reconnaissance of the area based on typical residential structures.

3.2.3.10.2 Damage Assessment, BLCR-G1

Damages were defined following the protocol defined in the CCSMP. A critical duration analysis was performed to determine the highest flood stages for CUDD and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15 percent of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.2.50** lists the estimated damages for the problem group.

Table 3.2.50: Estimated Damages for CUDD Subwatershed, Problem Group BLCR-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
BLCR-G1	Property	$1,949,000	Structures at risk of flooding
	Transportation	$343,950	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.2.3.10.3 Technology Screening, BLCR-G1

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.2.51** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.2.51: Evaluation of Flood Control Technologies for CUDD Subwatershed, Problem Group BLCR-G1

Flood Control Option	Feasibility
Detention Facilities	Feasible and necessary to reduce stage increases from levee
Conveyance Improvement – Culvert/Bridge Replacement	Modification of the Tri-State Tollway crossing did not reduce stages significantly, and increased stages downstream
Conveyance Improvement – Channel Improvement	Not feasible due to sensitive nature of the Markham Prairie. In addition, channel improvements did not reduce stages enough to prevent flooding
Conveyance Improvements – Diversion	Feasible to reduce stages upstream of the Tollway, diverted to a pumped storage pond
Flood Barriers, Levees/Floodwalls	Feasible and necessary

3.2.3.10.4 Alternative Development, BLCR-G1

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.2.52** summarizes flood control alternatives developed for Problem Group BLCR-G1.

Table 3.2.52: Flood Control Alternatives for Problem Group BLCR-G1

Alternative	Location	Description
BLCRG1-A1	Upstream end of channel to I-294	Channel improvements from the upstream end to I-294. This does not reduce stages adequately, and channel improvements would disturb the Markham Prairie area
BLCRG1-A2	I-294 culvert crossing	Upgrade I-294 culvert crossing. This does not reduce stages adequately. When completed in conjunction with Alternative 1, stages would not be adequately reduced, and stages would increase downstream
BLCRG1-A3	Cherry Creek at upstream end of I-294	Construct a 4-ft high, 42-ft wide, 1,100-ft long earthen levee along Belaire Creek from Albany Avenue to Afton Avenue

Table 3.2.52: Flood Control Alternatives for Problem Group BLCR-G1

Alternative	Location	Description
BLCRG1-A4	Cherry Creek at upstream end of I-294	Construct a 10.5 acre surface area, 15-ft deep, 125 ac-ft pumped storage area located downstream of I-294 and a 700-ft long, double 10 ft by 3 ft diversion culvert from the channel to the pond. Diversion was considered from either side of the Tollway, but found to be more effective from the upstream side
BLCRG1-A5	Upstream end of channel to I-294, I-294 culvert crossing	Channel improvements and upgrade of I-294 culvert crossing (combination of Alternatives BLCRG1-A1 and BLCRG1-A2). This alternative did not reduce stages adequately and caused stage increases downstream. In addition, any channel modifications would disturb the Markham Prairie area
BLCRG1-A6	Cherry Creek at upstream end of I-294	Construct earthen levee along Belaire Creek along with a 125 ac-ft pumped storage area (combination of Alternatives BLCRG1-A3 and BLCRG1-A4)

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the BLCR-G1 Problem Group.

3.2.3.10.5 Alternative Evaluation and Selection, BLCR-G1

Alternatives included in **Table 3.2.52** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.2.54** provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed, as benefits were negligible, and thus costs were not calculated for these alternatives.

Alternative BLCRG1-A6 from **Table 3.2.52** is the preferred alternative for this problem group. This problem area can be addressed by constructing an earthen levee to prevent flooding of the overbank areas. A levee would require compensatory storage unless flood easements could be purchased.

Table 3.2.53 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for BLCR-G1.

Table 3.2.53: Alternative Condition Flow & WSEL Comparison for Problem Group BLCR-G1

Location	Station	Existing Conditions		Alternative BLCRG1-A6	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Albany Avenue	Belaire Creek 5777	607.50	12	606.91	26

3.2.3.10.6 Data Required for Countywide Prioritization of Watershed Projects, BLCR-G1

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.2.54** lists the alternative analyzed in detail. The recommended alternative consists of conveyance improvements including channel widening and deepening, replacing two roadway crossings, and providing overbank storage. **Figure 3.2.11** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.2.54: CUDD Project Alternative Matrix to Support District CIP Prioritization for Problem Group BLCR-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
BLCR-G1	BLCRG1-A6	Levee and pumped storage area	0.17	$2,293,000	$13,842,000	15 Structures	Positive	Markham

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.2.3.11 PKCR-G1 – Park Creek Problem Group 1

3.2.3.11.1 Problem Definition, PKCR-G1

The PKCR-G1 problem area consists of two areas of overbank flooding. The first is along Park Creek from Birch Road to Homan Avenue. In this reach, 100-year flows of 185 cfs generally exceed the capacity of the channel. This section has flooding of approximately 53 building structures. This problem area was shown on the recent DFIRM floodplain maps. The flood protection elevation in this reach would be 609.0 feet.

The second area is along Park Creek from Kedzie Avenue to I-57. In this reach, 100-year flows of 108 cfs generally exceed the capacity of the channel. This area has flooding of approximately 6 building structures. This problem area was shown on the recent DFIRM floodplain maps. The flood protection elevation in this reach would be 607.58 feet. Flood protection elevations were developed based on field reconnaissance of the area based on typical residential structures.

3.2.3.11.2 Damage Assessment, PKCR-G1

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for CUDD and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15 percent of the property damages, unless otherwise noted. Recreational damages were estimated based on depth and duration of flooding. **Table 3.2.55** lists the estimated damages for the problem group.

Table 3.2.55: Estimated Damages for CUDD Subwatershed, Problem Group PKCR-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
PKCR-G1	Property	$4,510,000	Structures at risk of flooding
	Transportation	$676,560	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.2.3.11.3 Technology Screening, PKCR-G1

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.2.56** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.2.56: Evaluation of Flood Control Technologies for CUDD Subwatershed, Problem Group PKCR-G1

Flood Control Option	Feasibility
Detention Facilities	Feasible and necessary to prevent flooding and stage increases from proposed levee
Conveyance Improvement – Culvert/Bridge Replacement	Feasible from Kedzie to I-57, in conjunction with other alternatives
Conveyance Improvement – Channel Improvement	Feasible from Kedzie to I-57, in conjunction with other alternatives
Conveyance Improvements – Diversion	Feasible at the upstream end of Park Creek
Flood Barriers, Levees/Floodwalls	Feasible if done in conjunction with other alternatives

3.2.3.11.4 Alternative Development, PKCR-G1

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.2.57** summarizes flood control alternatives developed for Problem Group PKCR-G1.

Table 3.2.57: Flood Control Alternatives for Problem Group PKCR-G1

Alternative	Location	Description
PKCRG1-A1	Upstream end of Park Creek	Construct a 200 ac-ft pumped detention facility at the upstream end of the reach to reduce stages and prevent increases from a levee
PKCRG1-A2	Park Creek from Kedzie to I-57	Implement channel and culvert improvements. Conveyance improvements alone do not reduce stages enough, but they are useful in minimizing stage increase due to a levee
PKCRG1-A3	Park Creek from Kedzie to I-57	Construct a 1,000 LF earthen levee between Kedzie Avenue and I-57 to prevent overbank flooding. With detention and conveyance improvements alone, overbank flooding still occurs. This must be done in conjunction with Alternatives 1 and 2 to prevent any stage increases along or downstream of the levee

Table 3.2.57: Flood Control Alternatives for Problem Group PKCR-G1

Alternative	Location	Description
PKCRG1-A4	Park Creek from Kedzie to I-57	Construct a 200 ac-ft pumped detention facility along with channel and culvert improvements and a 1,000 LF earthen levee (combination of Alternatives PKCRG1-A1, PKCRG1-A2 and PKCRG1-A3)

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the PKCR-G1 Problem Group.

3.2.3.11.5 Alternative Evaluation and Selection, PKCR-G1

Alternatives included in **Table 3.2.57** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.2.59** provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed, as benefits were negligible, and thus costs were not calculated for these alternatives.

Alternative PKCRG1-A4 from **Table 3.2.57** is the preferred alternative for this problem group. This project combination was the only combination deemed feasible to prevent flooding in both problem areas. While detention alone solves the upstream problem, it does not adequately address the downstream problem. A levee alone, from Kedzie Avenue to I-57, would prevent overbank flooding downstream, but cause stage increases as well. Therefore, the feasible alternative is a combination of all three technologies. An 11.5 acre surface area, 25-foot deep, 200 acre-foot pumped storage reservoir with a side channel spillway is proposed at the upstream end of Park Creek. Channel improvements between Kedzie Avenue and I-57 include channel widening and culvert improvements. A 1,000-foot-long, 3-foot-high and 34-foot-wide earthen levee is proposed parallel to the residential roadway paralleling the creek.

Table 3.2.58 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for PKCR-G1.

Table 3.2.58: Alternative Condition Flow & WSEL Comparison for Problem Group PKCR-G1

Location	Station	Existing Conditions		Alternative PKCRG1-A4	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Roesner Drive	Park Creek 3793	610.30	196	608.84	41
Between Kedzie Avenue and I-57	Park Creek 763.5	608.76	108	608.46	79

3.2.3.11.6 Data Required for Countywide Prioritization of Watershed Projects, PKCR-G1

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.2.59** lists the alternative analyzed in detail. The recommended alternative consists of conveyance improvements including channel widening and deepening, replacing two roadway crossings, and providing overbank storage. **Figure 3.2.12** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.2.59: CUDD Project Alternative Matrix to Support District CIP Prioritization for Problem Group PKCR-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
PKCR-G1	PKCRG1-A4	Detention facility upstream with conveyance improvements and levee downstream	0.26	$5,187,000	$20,327,000	53 structures	Positive	Markham

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.2.4 Recommended Alternatives, Calumet Union Drainage Ditch Subwatershed

Table 3.2.60 summarizes the recommended alternatives for the CUDD subwatershed. The District will use data presented here to support prioritization of a countywide stormwater CIP.

Table 3.2.60: CUDD Project Alternative Matrix to Support District CIP Prioritization, All Problem Groups

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Structures & Roadways Protected	Water Quality Benefit	Involved Community
CUDD-G1	CUDDG1-A8	Reservoir expansion and upsizing of conduit	0.03	$5,782,000	$165,318,000	1,065 Structures	Positive	Markham, Harvey, Hazel Crest
CUDD-G2	CUDDG2-A1	Construct 450 ac-ft detention basin with diversion culverts	0.07	$3,377,000	$50,406,000	20 Structures	Positive	Markham, Harvey, Unincorporated Cook
CUDD-G3	CUDDG3-A2	4-ft high floodwall with erosion protection, including culvert retrofit and channel rehabilitation	0.40	$1,144,000	$2,852,000	60 Structures	Positive	Markham
CUSW-G1	CUSWG1-A1	Upgrade 1 crossing	0.03	$15,000	$536,000	1 Roadway	No Impact	Hazel Crest

Table 3.2.60: CUDD Project Alternative Matrix to Support District CIP Prioritization, All Problem Groups

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Structures & Roadways Protected	Water Quality Benefit	Involved Community
CUSW-G2	CUSWG2-A2	Additional culvert parallel to Kedzie Avenue	<0.01	$6,000	$1,206,000	1 Roadway	No Impact	Hazel Crest
CUTS-G1	CUTSG1-A1	Earthen levee	0.02	$63,000	$2,917,000	10 Structures, 2 Roadways	No Impact	Country Club Hills
CHEB-G1	CHEBG1-A4	Channel improvements, replace two crossings, in-line storage	0.05	$170,000	$3,300,000	16 Structures, 2 Roadways	No Impact	Homewood, Hazel Crest
CHEB-G3	CHEBG3-A3	Channel widening and culvert improvements	3.37	$7,680,000	$2,282,000	9 Structures, 2 Roadways	No Impact	Homewood
BLCR-G1	BLCRG1-A6	Levee and pumped storage area	0.17	$2,293,000	$13,842,000	15 Structures	Positive	Markham
PKCR-G1	PKCRG1-A4	Detention facility upstream with conveyance improvements and levee downstream	0.26	$5,187,000	$20,327,000	53 Structures	Positive	Markham

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.3 Deer Creek

The Deer Creek subwatershed encompasses approximately 26 square miles (8.8 in Cook County and 17.5 in Will County) within the southern portion of the Little Calumet River watershed, with 9.6 square miles of drainage area in Cook County, and the remaining in Will County. Deer Creek joins Thorn Creek near the junction of Main Street and State Street in Glenwood. **Table 3.3.1** lists the communities and the drainage areas contained within the Deer Creek subwatershed.

Table 3.3.1: Communities Draining to Deer Creek within Cook County

Community	Tributary Area (mi^2)
Chicago Heights	1.10
Crete	<0.01
Ford Heights	1.04
Glenwood	0.04
Lynwood	<0.01
Sauk Village	0.14
South Chicago Heights	0.24
Steger	0.02
Unincorporated Cook County/ Forest Preserve	6.22

Table 3.3.2 lists the land use breakdown by area within the Deer Creek subwatershed. **Figure 3.3.1** provides an overview of the tributary area of the subwatershed. Reported stormwater problem areas and proposed alternative projects are also shown on the figure, and are discussed in the following subsections.

Within the Deer Creek subwatershed, a total of 15.1 stream miles were studied among the five tributaries: Deer Creek, Unnamed Tributary to Deer Creek, Third Creek, Tributary B, and Tributary B Unnamed Tributary.

Table 3.3.2: Land Use Distribution for Deer Creek Subwatershed within Cook County

Land Use	Acres	%
Agricultural	1,803	32
Commercial/Industrial	657	12
Forest/Open Land	1,314	23
Institutional	170	3
Residential	1,058	19
Transportation/Utility	268	4
Water/Wetland	371	6

- Deer Creek (DRCR) – originates in Will County and crosses the Cook County line at Steger Road, 1.5 miles west of Illinois Route 394 (Calumet Expressway) and flows to the confluence with Thorn Creek within the Cook County Forest Preserve, 0.25 miles southwest of the intersection of State Street and Main Street in Glenwood.

- Unnamed Tributary to Deer Creek (UTDC) – being less than 3,000 linear feet, flows entirely through property owned by Exelon, to its confluence with Deer Creek north of Sauk Trail Road and 0.25 miles west of Cottage Grove Avenue.

- Third Creek (TDCR) – extends from south of Joe Orr Road and flows northerly to its confluence with Deer Creek located southwest of the intersection of Cottage Grove Avenue and Glenwood-Dyer Road in Glenwood.

- Tributary B (DCTB) – originates in Will County and crosses the Cook County border at Steger Road, 1,500 feet west of Illinois Route 394. It reaches its confluence with Deer Creek just upstream of US Route 30 (Lincoln Highway) in Ford Heights. For approximately 3,200 feet at the downstream end of Tributary B, it flows along the north and east side of the Deer Creek Reservoir.

- Tributary B Unnamed Tributary (UTTB) – originates west of Cottage Grove Avenue, approximately 0.25 miles north of 229th Street in Steger. It extends less than 3,500 linear feet to its confluence with Tributary B, approximately 0.67 miles southwest of the intersection of Sauk Trail Road and Illinois Route 394.

The Deer Creek subwatershed contains one major detention facility, the Deer Creek Reservoir. The reservoir is located south of US 30 (Lincoln Highway) and west of Illinois Route 394 (Calumet Expressway) in Ford Heights. The reservoir was planned, designed, and constructed by the USACE Chicago District. The reservoir provides a total storage volume of 587 acre feet to a maximum stage of 639.0 feet.

3.3.1 Sources of Data

3.3.1.1 Previous Studies

Studies have been performed for the Deer Creek subwatershed with the purpose of assessing the stormwater flooding problems and evaluating structural solutions. Below is the list of studies that were identified for Deer Creek:

- *WSP-2 Study*, Illinois Department of Transportation, 1980.

- *Deer Creek Reservoir Study,* United States Army Corps of Engineers (USACE), 2006.

The USACE study was used to determine reservoir parameters for the Deer Creek Reservoir. No information from the IDOT was applicable to the development of the DWP.

During Phase A and B of DWP development, additional survey, topography, precipitation, stream flow, land use, and soils data needed for the development of the Deer Creek subwatershed model were identified and collected.

3.3.1.2 Water Quality Data

Water quality for the Deer Creek subwatershed is monitored by two agencies, the Illinois Environmental Protection Agency (IEPA) and the United States Geological Survey (USGS). IEPA monitors water quality at one location in the Deer Creek subwatershed as part of the Ambient Water Quality Monitoring Network (AWQMN). This water quality monitoring station (HBDC-02) is at the Cottage Grove Avenue crossing in Glenwood, Illinois. At the station, water samples are collected once every six weeks and analyzed for a minimum of 55 water quality parameters including pH, temperature, specific conductance, dissolved oxygen, suspended solids, nutrients, fecal coliform bacteria, and total and dissolved metals. Additional parameters specific to the station, watershed, or sub-network within the ambient network are also analyzed.

The USGS monitors water quality, including water temperature and instantaneous flow, at the USGS 05536235 gage located on Deer Creek at Joe Orr Road in Chicago Heights, Illinois. Several of the USGS stations identified for flow and stage recordings also have water quality measurements. Sporadic data recordings are taken at each of the sites, though they are typically recorded at least once a month. The period of record and type of data monitored vary from station to station.

IEPA's 2008 Integrated Water Quality Report, which includes the Clean Water Act (CWA) 303(d) and the 305(d) lists, identifies the main stem of Deer Creek as impaired for dissolved oxygen impairments, with a Stage 1 TMDL status being designated for Deer Creek for dissolved oxygen. In addition, total nitrogen, total phosphorous, and sedimentation/siltation are listed as "potential causes for stream impairment" even though there are no TMDL developed for these constituents.

NPDES point source discharges within the Deer Creek subwatershed are listed in **Table 3.3.3.** In addition to the point source discharges listed, municipalities discharging to Deer Creek or its tributaries are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement six minimum control measures for limiting runoff pollution to receiving systems. Also as part of the Phase II Stormwater Permit Program, construction sites disturbing greater than 1 acre of land are required to get a construction permit.

Table 3.3.3: Point Source Dischargers in Deer Creek Area

Name	NPDES	Community	Receiving Waterway
Mid-West Manufacturing Co.	IL0059421	Chicago Heights	State Street Ditch tributary to Thorn Creek
Chicago Heights Steel	IL0001678	Chicago Heights	State Street Ditch tributary to Thorn Creek
Innophos Inc.	IL0035220	Chicago Heights	State Street Ditch tributary to Thorn Creek

Note: NPDES facilities were identified from the USEPA Water Discharge Permits Query Form at http://www.epa.gov/enviro/html/pcs/pcs_query_java.html.

3.3.1.3 Wetland and Riparian Areas

Figures 2.3.6 and **2.3.7** contain mapping of wetland and riparian areas in the Little Calumet River Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 290 acres of wetland areas in the Deer Creek subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.3.1.4 Floodplain Mapping

The floodplain boundaries for the Deer Creek subwatershed were revised in 2008 as part of FEMA's Map Modernization program. Floodplain boundaries were revised based on the recent Cook County topographic data and an updated downstream boundary condition for the Deer Creek effective model. Deer Creek was mapped as Zone AE study (detailed).

The FEMA 2006 effective models were not available from the Illinois State Water Survey during the development of the Deer Creek subwatershed hydraulic model; however, other models were obtained from different agencies. A WSP-2 model from 1980 which includes Deer Creek, Tributary B, Unnamed Tributary to Tributary B and Third Creek was provided by IDOT, but was not considered usable since it was developed over ten years ago. A HEC-RAS model developed in 2008 by the USACE was made available and was used in hydraulic model development.

3.3.1.5 Stormwater Problem Data

Table 3.3.4 summarizes reported problem areas reviewed as a part of DWP development. The problem area data was obtained primarily from Form B questionnaire response data provided by watershed communities to the District. Problems are classified in **Table 3.3.4** as regional or local. This classification is based on criteria described in **Section 2.2.1** of this report.

Table 3.3.4: Community Response Data for Deer Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
BL02	Bloom Township	Storm sewer, other	Sauk Trail Road from Western Avenue to Torrence Avenue	Partially related to local storm sewer system; maintenance issue and overbank flooding near State Street	Regional	Channel improvements and maintenance (Alternative DRCRG2-A4)
BL06	Bloom Township	Siltation	Cottage Grove Avenue from Steger Road to 183rd Street	Siltation; stream is migrating	Channel maintenance	Removal of silt to be addressed by stream maintenance
CHT3	Chicago Heights	Pavement flooding	US 30 at Cottage Grove Avenue (IDOT)	Roadway flooding at US 30; properties flooded north of US 30	Regional	Channel improvements, floodwall, additional storage (Alternative DRCRG1-A5)
FHT1	Ford Heights	New reservoir not in service	Woodlawn Avenue and 17th Street	Residences south of US 30 flooded	Regional	Channel improvements, floodwall, additional storage (Alternative DRCRG1-A5)

Table 3.3.4: Community Response Data for Deer Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
GLW3	Glenwood	Channel restriction	Deer Creek/Thorn Creek confluence	Prone to beaver dams	Channel maintenance	Removal of debris to be addressed by stream maintenance
STE1	Steger	Pavement flooding	State Street at 227th Place (IDOT)	Flooding of residential properties, overtopping of Sauk Trail	Regional	Channel improvements and maintenance (Alternative DRCRG2-A4)

3.3.1.6 Near Term Planned Projects

No near-term planned major flood control projects to be constructed by others were identified for the Deer Creek subwatershed.

3.3.2 Watershed Analysis

3.3.2.1 Hydrologic Model Development

3.3.2.1.1 Subbasin Delineation

The Deer Creek subwatershed was delineated according to the methods described in **Sections 1.3.2** and **2.3.2**. There are 34 subbasins ranging in size from 0.049 to 8.43 square miles with an average size of 0.793 square miles.

Hydrologic Parameter Calculations. Curve numbers (CN) and directly connected impervious percentages were estimated for each subbasin as described in **Section 1.3.2**. An area-weighted average of the CN was generated for each subbasin. The Clark's unit hydrograph parameters were estimated using the method described in **Section 1.3.2**. Appendix G provides a summary of the hydrologic parameters used for the subbasins in each subwatershed.

3.3.2.2 Hydraulic Model Development

3.3.2.2.1 Field Data, Investigation, and Existing Model Data.

The FEMA effective hydraulic models were not available for use in developing the hydraulic model for the Deer Creek subwatershed. A WSP-2 model from 1980 which includes Deer Creek, Tributary B, Unnamed Tributary to Tributary B and Third Creek was provided by IDOT, but was not considered usable since it was developed over ten years ago. A HEC-RAS model from 2008 by the USACE was made available, and was created for a Deer Creek Reservoir Letter of Map Change (LOMC# 08-05-2074P-170054).

The USACE HEC-RAS model was reviewed to determine which portions of the geometry could be used in DWP development. The entire portion of the model that defined the geometry of the Deer Creek Reservoir, including storage cells, storage volumes, connections between storage areas, and connections to Deer Creek and Tributary B were used. However, the channel geometry for Deer Creek or Tributary B as defined in the USACE HEC-RAS model was not used since the number and density of the cross sections provided did not meet the modeling requirements for use in the DWP.

After a review of existing models, field reconnaissance data and hydraulic structures dimensions data, a field survey plan for Deer Creek was developed. Field survey was performed under the protocol of FEMA's *Guidelines and Specifications for Flood Hazard Mapping partners, Appendix A: Guidance for Aerial Mapping and Surveying.* Field survey was performed in early 2008. Cross sections were generally surveyed between 500 to 1,000 feet apart. The actual spacing and location was determined based on the variability of the channel's shape, roughness, and slope. A total of 32 cross sections and 36 hydraulic structures were surveyed to develop the hydraulic model for the Deer Creek subwatershed.

The Manning's n-values at each cross section were estimated using a combination of aerial photography and photographs from field survey and field reconnaissance. The horizontal extent of each type of land cover and the associated n-value for each cross section were manually entered in to the HEC-RAS hydraulic model. The initial n-values were used as a model starting point and were adjusted within the provided ranges during calibration. All the n-values were manually adjusted using the HEC-RAS cross-sectional data editor.

The n-values were increased where buildings are located within the floodplain to account for conveyance loss. The n-values in these areas may range from 0.06 for areas with few buildings to 0.15 for fully developed areas. If significant blockage is caused by buildings in the flood fringe, the developed areas were modeled as ineffective flow. **Table 3.3.5** is the list of channel and overbank ranges of n-values that were used for the Deer Creek subwatershed model.

Table 3.3.5: Channel and Overbank Associated Manning's n-Values[1]

Tributary	Range of Channel n-Values	Range of Overbank n-Values
DRCR	0.045 - 0.07	0.05 - 0.15
UTDC	0.055	0.08
DCTB	0.055 - 0.06	0.06 - 0.075
UTTB	0.055 - 0.06	0.07 - 0.1
TDCR	0.06 - 0.065	0.05 - 0.1

[1]**Source**: Open Channel Hydraulics, Chow 1959

3.3.2.2.2 Boundary Conditions.

The Deer Creek hydraulic model requires one boundary condition at its downstream end, at the confluence with Thorn Creek. FEMA's Cook County FIS 100-year elevation of 618.0 feet was used as a boundary condition at this location.

3.3.2.3 Calibration and Verification

A detailed calibration was performed for the Deer Creek subwatershed using historic gage records under the guidelines of Chapter 6 of the Cook County Stormwater Management Plan (CCSMP). Three historical storms, April 2006, April 2007 and September 2008, were evaluated based on the stream gage flows, precipitation amounts and records of flooding in the Deer Creek subwatershed, and were found to be applicable for calibration and verification.

For the calibration storms, Illinois State Water Survey (ISWS) Cook County precipitation gages, National Weather Service (NWS) recording and non-recording gages, and Community Collaborative Rain, Hail & Snow Network (CoCoRAHS) precipitation amounts were used. Theissen polygons were developed for each storm based on the rain gages available for that storm. The gage weightings for the recording and non-recording gages were computed in ArcGIS for each subbasin.

There is one active stream gage in the Deer Creek subwatershed. USGS Gage 05536235 on Deer Creek near Chicago Heights, Illinois, located where Deer Creek passes under US 30, is at latitude 41°31'15" longitude 87°35'25" (NAD27). The datum of the gage is 615.95 feet NGVD29 (615.65 feet NAVD88). Instantaneous flow data is available at this gage from 09/01/1986 through the present.

Runoff hydrographs were developed using HEC-HMS and routed through the Deer Creek hydraulic model. The stages and flows produced for each calibration storm were compared to the observed stream gage data. During calibration of the Deer Creek subwatershed model, the curve number, directly connected impervious area percentage, and lag times were adjusted so that the peak flow rate, hydrograph shape and timing, and total volume matched the observed hydrographs within the CCSMP's criteria.

During calibration, the curve number and directly connected impervious percentage were reduced by 5% and 10%, respectively. The Clark's storage coefficient R was increased by 25%.

After the final adjustments to the HEC-HMS and HEC-RAS models, the modeled flows and stages were compared to the observed data to determine if they were within the CCSMP's criteria. **Table 3.3.6** shows the comparison of the flows for all three calibration storms. **Figures 3.3.2**, **3.3.3**, and **3.3.4** show the calibration results for the April 2006, April 2007 and September 2008 storm events, respectively. The modeled flow is within 30% of the observed flow, which is within CCSMP's criteria. The modeled stage is within 0.5 feet of the observed stage for the September 2008 event and within 0.75 feet of the observed stage for the other two events. Since the CCSMP's criteria for calibration is 0.5 feet for stage and 30% for flow, the April 2006 and April 2007 storm events are slightly outside of this range.

Table 3.3.6: Deer Creek Subwatershed Calibration Results

	Observed		Modeled		CCSMP's Criteria[1]	
Storm Event	**Flow (cfs)**	**Stage (ft)**	**Flow (cfs)**	**Stage (ft)**	**Percentage Difference in Peak Flow**	**Difference in Stage (ft)**
Apr-06	873	627.80	789	627.04	-10%	-0.75
Apr-07	402	625.79	290	625.09	-28%	-0.69
Sep-08	1,320	628.24	1,542	628.06	17%	-0.18

[1]Flow within 30% and stage within 6 inches.

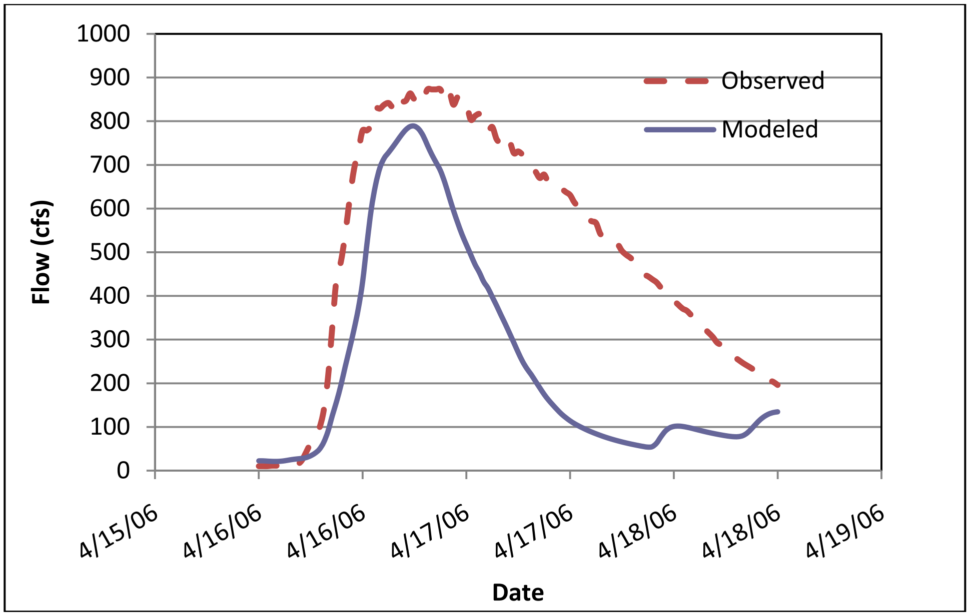


Figure 3.3.2: Deer Creek Calibration Results, April 2006 Storm Event

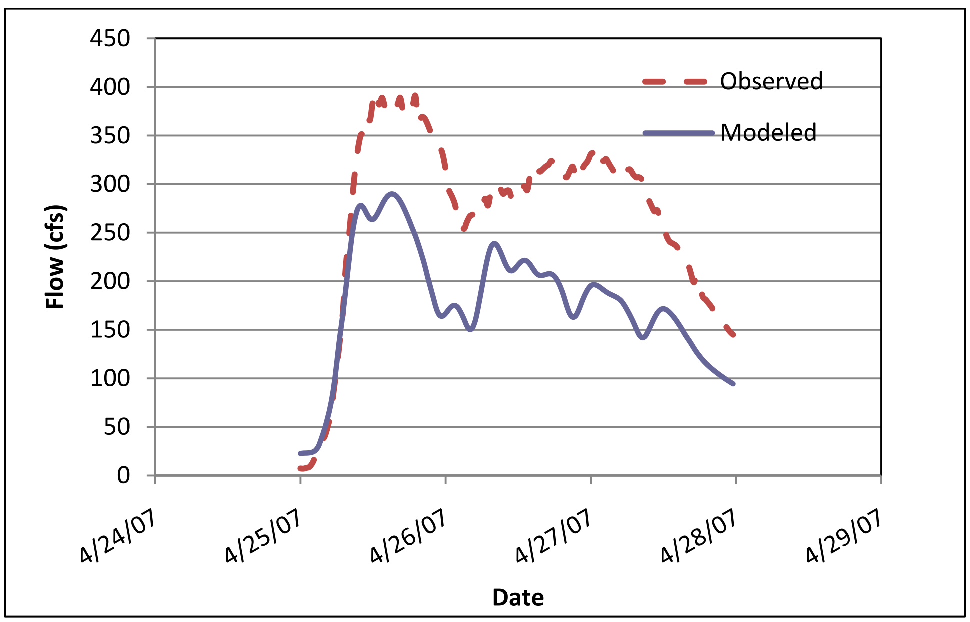


Figure 3.3.3: Deer Creek Calibration Results, April 2007 Storm Event

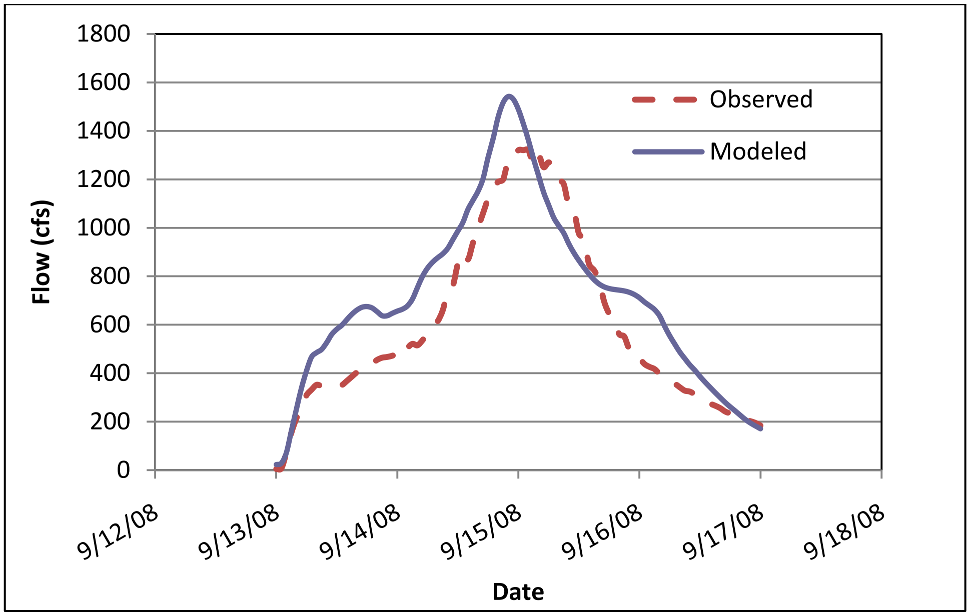


Figure 3.3.4: Deer Creek Calibration Results, September 2008 Storm Event

Although the April 2006 and April 2007 storm events do not meet the CCSMP's criteria, the model is considered well calibrated. Since the stages are seen to be generally on the low side, raising the Manning's n-values was initially considered, but more research was performed to understand this discrepancy, as follows.

Figure 3.3.5 depicts the rating curve with the three simulated events (black squares) as well as all events measured by the USGS since 1995. The USGS measurements have been further broken down into those for which the field notes stated "Heavy Debris", and those for which the field notes stated "Clear or Medium Debris".

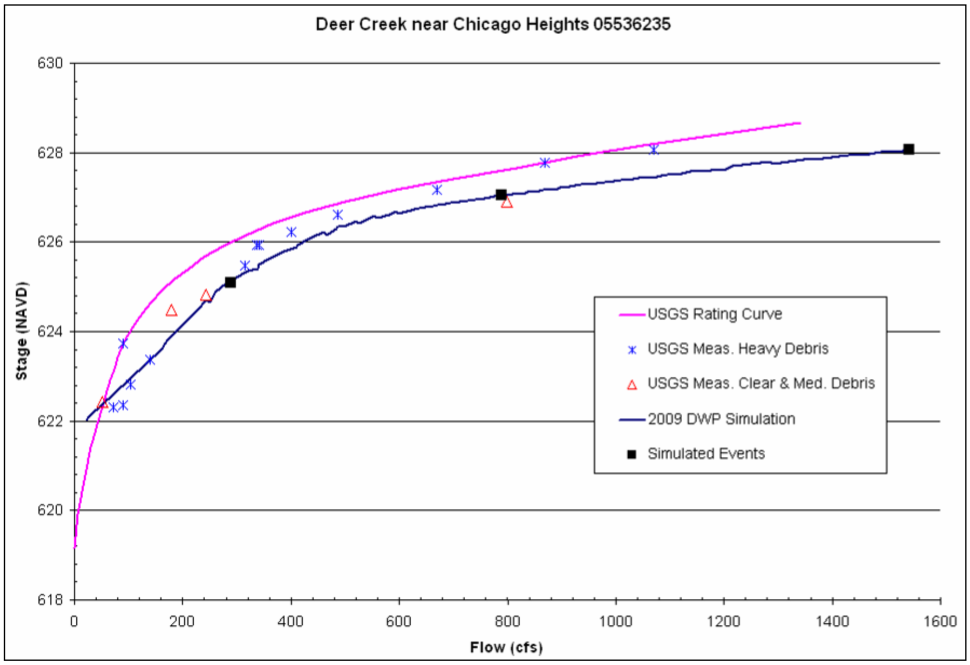


Figure 3.3.5: USGS Rating Curve vs. Simulated Events, Deer Creek Gage

Although the three simulated events are slightly outside the limits for stage as required by the CCSMP, the three USGS measurements that were noted either "Clear" or "Medium" debris lie very close to the simulated rating curve. The modeled event of April 2006 lies almost directly over one of the USGS "Clear or Medium" measurements (Dated January 8, 2008 with flow = 799 cfs and stage = 626.91 feet). This measurement's flow is within 10 cfs of the simulated event and has a stage within 0.13 feet of the simulated event.

Figure 3.3.5 includes the USGS station rating curve. The term "Observed" in **Table 3.3.6** refers to the stage that the USGS gage automatically measured via a pressure transducer. The stage value was correlated to a flow value based on the USGS station rating curve. Thus, in order to obtain a well calibrated model based solely on the USGS data output from a stream gage, a simulated rating curve is required that matches well with the USGS station rating curve.

In **Figure 3.3.5**, the rating curve developed by the model (2009 DWP simulation) matches well with the three "Clear or Medium" USGS measurements. It is likely that if a rating curve was developed solely on "Clear or Medium" measurements, that rating curve would agree almost exactly with the modeled rating curve. Because of this, the HEC-RAS model for this subwatershed is considered well calibrated to conditions in the channel that can be described as either "Clear" or "Medium" debris. The option of including debris in the model during the final calibration was considered as it is well documented and would also raise the stages in Table 3.3.6 to within the CCSMP's criteria; however, this was deemed to be an unacceptable option.

3.3.2.4 Existing Conditions Evaluation

3.3.2.4.1 Flood Inundation Areas.

A critical duration analysis was performed for the Deer Creek subwatershed hydraulic model. The 100-year, 1-, 3-, 6-, 12-, 24-, 48- and 72-hour storm events were run to determine the critical duration. The 6-hour duration was found to be the critical duration for Tributary B upstream of Sauk Trail. The 12-hour duration was found to be the critical duration for Deer Creek upstream of the EJ&E Railroad tracks. The 48-hour duration was found to be the critical duration for the remainder of the reaches. **Figure 3.3.1** shows inundation area produced for the 100-year critical duration storm event.

3.3.2.4.2 Hydraulic Profiles.

Hydraulic profiles for Deer Creek and its tributaries are shown in Appendix H. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500 year recurrence interval design storm events.

3.3.3 Development and Evaluation of Alternatives

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. **Table 3.3.7** summarizes problem areas identified through hydraulic modeling of the Deer Creek subwatershed.

Problem areas that were hydraulically interdependent or otherwise related were grouped for alternatives analysis. Each project group is addressed in terms of combined damages and alternatives/solutions.

Table 3.3.7: Modeled Problem Definition for the Deer Creek Subwatershed

Problem ID	Group ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
DRCR1	DRCR-G1	North of US 30, Ford Heights	5, 10, 25, 50 & 100	CHT3	DRCRG1-A5
DRCR2	DRCR-G2	South of Sauk Trail Road, Steger	10, 25, 50, & 100	BL02, STE1	DRCRG2-A4

Damage assessment, technology screening, alternative development and alternative selection were performed by problem grouping, since each group is independent of the other. Each problem grouping is evaluated in the following sections by group ID.

3.3.3.1 DRCR-G1 – Deer Creek Problem Group 1

3.3.3.1.1 Problem Definition, DRCR-G1

The DRCR-G1 problem area consists of overbank flooding along Deer Creek in the Village of Ford Heights, between US Route 30 and 8th Street. North of US 30 is a dense residential neighborhood, with approximately 270 structures subject to flooding. South of US 30, approximately 24 residential structures in the vicinity of 14th Place and one business on US Route 30 are subject to flooding during the 100-year storm event.

3.3.3.1.2 Damage Assessment, DRCR-G1

Damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Deer Creek and its tributaries. These stages were used to calculate the depth of flooding and to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.3.8** lists the estimated damages for the problem group.

Table 3.3.8: Estimated Damages for Deer Creek Subwatershed, Problem Group DRCR-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
DRCR-G1	Property	$3,305,000	Structures at risk of flooding
	Transportation	$496,000	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.3.3.1.3 Technology Screening, DRCR-G1

Several combinations of technologies were analyzed to address the flooding problems associated with DRCR-G1. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.3.9** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem grouping.

Table 3.3.9: Evaluation of Flood Control Technologies for Deer Creek Subwatershed, Problem Group DRCR-G1

Flood Control Option	Feasibility
Detention Facilities	Feasible. Potential to increase size of Deer Creek reservoir
Conveyance Improvement – Culvert/Bridge Replacement	Feasible. Enhance hydraulic capacity at crossing at Joe Orr Road by modifying or removing bridge
Conveyance Improvement – Channel Improvement	Feasible. May result in need for compensatory storage
Conveyance Improvements – Diversion	Not feasible
Flood Barriers, Levees/Floodwalls	Feasible. May result in need for compensatory storage

3.3.3.1.4 Alternative Development, DRCR-G1

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.3.10** summarizes flood control alternatives developed for Problem Group DRCR-G1.

Table 3.3.10: Flood Control Alternatives for Problem Grouping DRCR-G1

Alternative	Location	Description
DRCRG1-A1	Deer Creek north of US 30	Increase channel capacity of adjacent reach. This requires compensatory storage
DRCRG1-A2	Joe Orr Road	Modification or removal of crossing at Joe Orr Road. This alternative does not provide the needed reduction in stage
DRCRG1-A3	Deer Creek Reservoir	Increase storage volume of Deer Creek Reservoir to provide 24 ac-ft of compensatory storage
DRCRG1-A4	Along Deer Creek, from US 30 to 15th Street	Construct a floodwall to protect residential and commercial properties
DRCRG1-A5	Deer Creek north of US 30, Deer Creek reservoir, Deer Creek from US 30 to 15th Street	Increase channel capacity of reach, increase storage volume of reservoir and construct floodwall (combination of Alternatives DRCRG1-A1, DRCRG1-A3 and DRCRG1-A4)

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the DRCR-G1 Problem Group.

3.3.3.1.5 Alternative Evaluation and Selection, DRCR-G1

Alternatives included in **Table 3.3.10** were evaluated to determine their effectiveness and produce the data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.3.12** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative for Problem Group DRCR-G1. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, thus costs were not calculated for these alternatives.

Alternative DRCRG1-A5 from **Table 3.3.10** is the preferred alternative for Problem Group DRCR-G1. The preferred alternative includes channel capacity improvements along Deer Creek north of US Route 30 with compensatory storage provided upstream in the Deer Creek Reservoir. A floodwall would be constructed from US 30 to 16th Street. Since the land in the vicinity of Deer Creek Drive and 14th Place is a local low spot and collects overflows from the surrounding area, building a floodwall along Deer Creek to reduce the overflow from the creek into the residential neighborhood will alleviate flooding.

Table 3.3.11 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for DRCR-G1.

Table 3.3.11: Alternative Condition Flow & WSEL Comparison for Problem Group DRCR-G1

Location	Station	Existing Conditions		Alternative DRCRG1-A5	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
USACE Reservoir Access Road	23099	637.17	1726	634.40	1461
US Highway 30	22545	635.80	2470	2454	634.13

3.3.3.1.6 Data Required for Countywide Prioritization of Watershed Projects, DRCR-G1

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.3.12** lists the alternative analyzed in detail. The recommended alternative consists of channel capacity improvements along Deer Creek and compensatory storage in the Deer Creek Reservoir. **Figure 3.3.6** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.3.12: Deer Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Grouping DRCR-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
DRCR-G1	DRCRG1-A5	Conveyance Improvement, Storage	0.49	$3,801,000	$8,331,000	270 Structures	No Impact	Ford Heights

3.3.3.2 DRCR-G2 – Deer Creek Problem Group 2

3.3.3.2.1 Problem Definition, DRCR-G2

The DRCR-G2 problem area consists of overbank flooding along Deer Creek south of Sauk Trail Road in Steger. Approximately 2 structures, including residences and a church, are flooded.

3.3.3.2.2 Damage Assessment, DRCR-G2

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Deer Creek and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.3.13** lists the estimated damages for the problem group.

Table 3.3.13: Estimated Damages for Deer Creek Subwatershed, Problem Group DRCR-G2

Problem Group ID	Damage Category	Estimated Damage ($)	Description
DRCR-G2	Property	$58,000	Structures at risk of flooding
	Transportation	$9,000	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.3.3.2.3 Technology Screening, DRCR-G2

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.3.14** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem grouping.

Table 3.3.14: Evaluation of Flood Control Technologies for Deer Creek Subwatershed, Problem Group DRCR-G2

Flood Control Option	Feasibility
Detention Facilities	Not needed given alternative
Conveyance Improvement – Culvert/Bridge Replacement	Feasible at Sauk Trail Road
Conveyance Improvement – Channel Improvement	Feasible north of Sauk Trail Road
Conveyance Improvements – Diversion	Not needed given alternative
Flood Barriers, Levees/Floodwalls	Not needed given alternative

3.3.3.2.4 Alternative Development, DRCR-G2

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.3.15** summarizes flood control alternatives developed for Problem Group DRCR-G2.

Table 3.3.15: Flood Control Alternatives for Problem Grouping DRCR-G2

Alternative	Location	Description
DRCRG2-A1	Sauk Trail Road	Improve conveyance capacity by unblocking debris at crossing
DRCRG2-A2	Upstream of Sauk Trail Road	Increase channel conveyance; widen to 50 ft with 3:1 side slopes for 1,800 LF
DRCRG2-A3	Sauk Trail Road	Remove crossing. This alternative does not provide required reduction in stages
DRCRG2-A4	Vicinity of Sauk Trail Road	Unblock debris from crossing and increase channel conveyance (combination of Alternatives DRCRG2-A1 and DRCRG2-A2)

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the DRCR-G2 Problem Group.

3.3.3.2.5 Alternative Evaluation and Selection, DRCR-G2

Alternatives included in **Table 3.3.15** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.3.17** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, thus costs were not calculated for these alternatives.

Alternative DRCRG2-A4 from **Table 3.3.15** is the preferred alternative for this Problem Group. The existing culvert under Sauk Trail Road is partially blocked, and maintenance is required to unblock the culvert. However, even with the culvert able to convey its full capacity, the peak water surface elevation is not reduced enough to remove the structures from the inundation area. Conveyance improvements in the channel from Sauk Trail Road to 1,800 feet upstream consisting of widening the channel to a 50-foot width with 3:1 side slopes are recommended to increase the capacity of the channel.

Table 3.3.16 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for DRCR-G2.

Table 3.3.16: Alternative Condition Flow & WSEL Comparison for Problem Group DRCR-G2

Location	Station	Existing Conditions		Alternative DRCRG2-A4	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
300 feet upstream of Sauk Trail Road	35977	656.14	1940	655.91	1931

3.3.3.2.6 Data Required for Countywide Prioritization of Watershed Projects, DRCR-G2

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.3.17** lists the alternative analyzed in detail. The recommended alternative consists of maintenance at the Sauk Trail Road culvert crossing and 1,800 linear feet of channel conveyance improvements. **Figure 3.3.7** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.3.17: Deer Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Grouping DRCR-G2

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
DRCR-G2	DRCRG2-A4	Maintenance at culvert crossing, channel widening	< 0.01	$55,000	$14,312,000	2 Structures	No Impact	Steger

3.3.4 Recommended Alternatives, Deer Creek Subwatershed

Table 3.3.18 summarizes the recommended alternatives for the Deer Creek subwatershed. The District will use data presented here to support prioritization of a countywide stormwater CIP.

Table 3.3.18: Deer Creek Project Alternative Matrix to Support District CIP Prioritization, All Problem Groups

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
DRCR-G1	DRCRG1-A5	Conveyance improvement, storage, floodwall	0.49	$3,801,000	$8,331,000	270 Structures	No Impact	Ford Heights
DRCR-G2	DRCRG2-A4	Maintenance at culvert crossing, channel widening	< 0.01	$55,000	$14,312,000	2 Structures	No Impact	Steger

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.4 Midlothian Creek

The Midlothian Creek subwatershed encompasses approximately 21 square miles (20.57 in Cook County and 0.09 in Will County) within the Little Calumet River watershed. There are seven tributaries within the subwatershed, including Midlothian Creek, totaling over 23 stream miles. **Table 3.4.1** lists the communities that lie within the subwatershed and the associated drainage area for each community contained within the subwatershed.

Table 3.4.1: Communities Draining to Midlothian Creek Subwatershed Within Cook County

Community	Tributary Area (mi^2)
Blue Island	0.64
Country Club Hills	0.50
Cook County Forest Preserve/ Unincorporated Cook County	4.79
Crestwood	0.72
Midlothian	1.88
Oak Forest	3.25
Orland Hills	0.20
Orland Park	0.93
Posen	0.97
Robbins	1.15
Tinley Park	5.53

Table 3.4.2 lists the land use breakdown by area within the Midlothian Creek subwatershed. **Figure 3.4.1** provides an overview of the tributary area of the subwatershed. Reported stormwater problem areas and proposed alternative projects are also shown on the figure, and are discussed in the following subsections.

Table 3.4.2: Land Use Distribution for Midlothian Creek Subwatershed Within Cook County

Land Use	Acres	%
Commercial/Industrial	1,364	10.4
Forest/Open Land	2,507	19.1
Institutional	590	4.5
Residential	7,720	58.7
Transportation/Utility	285	2.1
Water/Wetland	216	1.6
Agricultural	484	3.6

Within the Midlothian Creek subwatershed, a total of 23 stream miles were studied among the seven tributaries: Midlothian Creek, Midlothian Creek Western Branch, Midlothian Creek Western Tributary, 76th Avenue Ditch, Filsen Park Ditch, Twin Lakes Tributary, and Natalie Creek.

- Midlothian Creek Western Branch (MCWB) – extends from the intersection of Long Avenue and 163rd Street to the confluence with the Midlothian Creek main tributary.

- Midlothian Creek Western Tributary (MCWT) – headwaters start near the intersection of 88th Avenue and 168th Street with the channel extending to the confluence with the Midlothian Creek main tributary.

- 76th Avenue Ditch (76DT) – extends from the intersection of 159th Street and 77th Avenue to the confluence with the Midlothian Creek main tributary.

- Filsen Park Ditch (FPDT) – headwaters start near north of Harlem Avenue and 166th Street (extended) with the channel extending to the confluence with the 76th Avenue Ditch tributary.

- Twin Lakes Tributary (TLTY) – extends from the Dan Ryan expressway to the confluence with the Twin Lakes Reservoir.

- Natalie Creek (NTCR) – extends from the intersection of 159th Street and Central Avenue to the confluence with the Natalie Creek Diversion Conduit at Pulaski Road.

- Midlothian Creek Main Tributary (MTCR) – headwaters start near west of 84th Avenue and 175th Street extending to the confluence with the Little Calumet River.

- All of the tributaries drain to Midlothian Creek Main Tributary except for the Natalie Creek tributary in the northwest portion of the subwatershed which drains to the Calumet-Sag Channel through the Natalie Creek Diversion Conduit. Midlothian Creek Main Tributary splits at 137th Street and Kedzie Avenue; one split flows through the Midlothian Creek Diversion conduit which drains to the Calumet-Sag Channel, and the other split flows into the Little Calumet River.

The Midlothian Creek subwatershed contains five major flood control facilities: Fernway Detention Basin, Tinley Park Reservoir, Twin Lakes Reservoir, Midlothian Creek Diversion Conduit and Natalie Creek Diversion Conduit, all of which are located on the Midlothian Creek main tributary except for the Natalie Creek Diversion Conduit, which is on Natalie Creek.

- Fernway Detention Basin (Pond G) – Pond G is in Tinley Park, southwest of 171st Street and 80th Avenue. Construction of the pond was completed in the late 1990s by Illinois Department of Natural Resources, Office of Water Resources. It provides a total storage volume of 110 acre-feet.

- Tinley Park Reservoir (Structure 32) - Tinley Park Reservoir, also called Structure 32, is in Tinley Park northeast of the intersection of 80th Avenue and 170th Street. This reservoir provides a storage volume of 616 acre-feet and was built by the District and the Tinley Park District in 1989, and is now maintained by the District. It was constructed to provide flood relief to Tinley Park, Orland Park and Oak Forest.

- Twin Lakes Reservoir (Midlothian) - The Illinois Department of Natural Resources, Office of Water Resources (IDNR-OWR) constructed Midlothian Reservoir in 1974 to provide 950 acre-feet of storage, attenuating the flood stages to the downstream areas of Oak Forest and Midlothian. The storage facility is in an unincorporated area of Cook County between 163rd Street and 167th Street, northwest of the intersection of 167th and Cicero Avenue.

- Midlothian Creek Diversion Conduit - The Midlothian Creek Diversion Conduit diverts flow from Midlothian Creek Main Tributary to the Calumet-

Sag Channel. It was constructed in 1980 by the Cook County Highway Department in the Village of Robbins, near the intersection of 137th Street and Kedzie Avenue. The diversion conduit is a 12-foot x 7.5-foot box culvert approximately 1,200 feet in length that runs along Kedzie Avenue.

- Natalie Creek Diversion Conduit – The Natalie Creek Diversion Conduit conveys flows from Natalie Creek to the Calumet-Sag Channel. The inlet to the conduit is at 146th Street and Pulaski Road. Two 96- and 48- inch conduits run along Pulaski Road for a total length of 9,200 feet and connect to a 102-inch pipe for 700 feet before discharging into the Calumet-Sag Channel.

3.4.1 Sources of Data

3.4.1.1 Previous Studies

Previous studies have been performed for the Midlothian Creek subwatershed for assessing stormwater flooding problems and developing solutions. Below is a list of studies that were identified for the Midlothian Creek subwatershed:

- Interim Review Report of Little Calumet River, U.S. Army Corps of Engineers, December 1973

- *Little Calumet River Watershed Engineering Design Report (Revised),* U.S. Department of Agriculture, Metropolitan Sanitary District of Greater Chicago and the Illinois Department of Conservation, January 1977

- Little Calumet River Watershed Tinley Park Retention Reservoir Design Folder Contract #77.237.AF

- Natalie Creek Flood Damage Reduction Study, U.S. Army Corps of Engineers, August 2004

The above studies were used to supplement the development of the Midlothian Creek hydraulic model developed for this DWP. During Phase A of DWP development, additional survey, topography, precipitation, stream flow, land use and soils data needed for the development of the Midlothian Creek subwatershed model were identified and collected.

3.4.1.2 Water Quality Data

Water quality for the Midlothian Creek subwatershed is monitored by two agencies: the Illinois Environmental Protection Agency (IEPA) and the United States Geological Survey (USGS). IEPA monitors water quality at one location in the Midlothian Creek subwatershed as part of the Ambient Water Quality Monitoring Network (AWQMN). This water quality monitoring station (HBA-01) is at the Dixie Highway crossing in the Village of Blue Island. USGS monitors water quality at the USGS 5536340 gage located near 151st Street and Kilbourn Avenue in Oak Forest.

The IEPA's *2008 Integrated Water Quality Report*, which includes the Clean Water Act (CWA) 303(d) and the 305(d) lists, does not identify Midlothian Creek tributaries as having water quality impairments. No Total Maximum Daily Loads (TMDLs) have been developed for Midlothian Creek tributaries.

There are no National Pollutant Discharge Elimination System (NPDES) permits issued by IEPA for discharge into Midlothian Creek tributaries. Municipalities discharging to Midlothian Creek or its tributaries are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement six minimum control measures for limiting runoff pollution to receiving systems. Also as part of the Phase II Stormwater Permit Program, construction sites disturbing greater than 1 acre of land are required to get a construction permit.

3.4.1.3 Wetland and Riparian Areas

Figures 2.3.6 and **2.3.7** contain mapping of wetland and riparian areas in the Little Calumet River Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 216 acres of wetland areas in the Midlothian Creek subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.4.1.4 Floodplain Mapping

The floodplain boundaries for the Midlothian Creek subwatershed were revised in 2008 as part of the FEMA's Map Modernization program. Floodplain boundaries were revised based on the recent Cook County topographic data and an updated downstream boundary condition for the Midlothian Creek effective model. The entire Midlothian Creek subwatershed was mapped as Zone AE study (detailed) except for the Twin Lakes Tributary which was mapped as Zone A (approximate) study.

Appendix A contains a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.4.1.5 Stormwater Problem Data

Table 3.4.3 summarizes reported problem areas reviewed as a part of DWP development. The problem area data was obtained primarily from Form B questionnaire response data provided by watershed communities to the District. Problems are classified in **Table 3.4.3** as regional or local. This classification is based on a process described in Section 2.2.1 of this report.

3.4.1.6 Near-Term Planned Projects

No near-term planned major flood control projects have been identified for the Midlothian Creek subwatershed; however, there is minor local conveyance improvement projects and stream maintenance that takes place throughout the subwatershed.

Table 3.4.3: Community Response Data for Midlothian Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
BLI1	Blue Island	Flooding, culvert blockages	Western Avenue and 139th Street	Stream maintenance	Channel maintenance	Removal of debris to be addressed by stream maintenance
BRE2	Bremen Township	Debris at culvert	167th Street from Harlem Avenue to Cicero Avenue	Stream maintenance	Channel maintenance	Removal of debris to be addressed by stream maintenance
BRE6	Bremen Township	Debris and siltation	Central Avenue from 183rd Street to Midlothian Turnpike	Stream maintenance	Channel maintenance	Removal of debris to be addressed by stream maintenance
BRE7	Bremen Township	Debris and siltation	Ridgeland Avenue from 147th Street to 135th Street	Stream maintenance	Channel maintenance	Removal of debris to be addressed by stream maintenance
MID1	Midlothian	Flooding at intersection and houses	149th Street and Kilpatrick Avenue	Natalie Creek overbank flooding	Regional	Detention pond, diversion conduit and culvert improvements (Alternative NTCRG1-A4)
MID2	Midlothian	Natalie Creek flooding	149th Street and Kenton Avenue	Natalie Creek overbank flooding	Regional	Detention pond, diversion conduit and culvert improvements (Alternative NTCRG1-A4)
MID3	Midlothian	Natalie Creek flooding	147th Street and Kolmar Avenue	Natalie Creek overbank flooding	Regional	Detention pond, diversion conduit and culvert improvements (Alternative NTCRG1-A4)
MID4	Midlothian	Street flooding	147th Street and Kilbourn Avenue	Natalie Creek overbank flooding	Regional	Detention pond, diversion conduit and culvert improvements (Alternative NTCRG1-A4)
MID5	Midlothian	Flooding due to culvert size	146th Street and Keeler Avenue	Natalie Creek overbank flooding	Regional	Detention pond, diversion conduit and culvert improvements (Alternative NTCRG1-A4)
MID6	Midlothian	Street and basement flooding	146th Street and Karlov Avenue	Natalie Creek overbank flooding	Regional	Detention pond, diversion conduit and culvert improvements (Alternative NTCRG1-A4)

Table 3.4.3: Community Response Data for Midlothian Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
MID7	Midlothian	Flooding due to culvert size	146th Street and Keystone Avenue	Natalie Creek overbank flooding	Regional	Detention pond, diversion conduit and culvert improvements (Alternative NTCRG1-A4)
MID9	Midlothian	Pavement flooding	IL 50 at 151st Street	Natalie Creek overbank flooding	Regional	Detention pond, diversion conduit and culvert improvements (Alternative NTCRG1-A4)
MID10	Midlothian	Pavement flooding	US 6 at Crawford Avenue to Cicero Avenue	Overbank flooding	Regional	Detention pond, diversion conduit and culvert improvements (Alternative NTCRG1-A4)
MID11	Midlothian	Pavement flooding	IL 83 at Kostner Avenue (W/O)	Natalie Creek overbank flooding	Regional	Detention pond, diversion conduit and culvert improvements (Alternative NTCRG1-A4)
MID12	Midlothian	Restriction from intersection to drainage ditch system	151st Street and Kilbourn Avenue	Natalie Creek overbank flooding	Regional	Detention pond, diversion conduit and culvert improvements (Alternative NTCRG1-A4)
MID13	Midlothian	Lack of proper grade to Calumet Union Drainage Ditch	153rd Street and Lawndale Avenue	Storm sewer flow restriction	Local	Problem not located on a regional waterway. This is a local storm sewer system problem
OKF2	Oak Forest	Natalie Creek flooding	Natalie Creek, 159th Street to 151st Street	Overbank flooding	Regional	Detention pond, diversion conduit and culvert improvements (Alternative NTCRG1-A4)
OKF3	Oak Forest	Pavement flooding	IL 50 at 158th Street (Metra viaduct)	Pavement flooding	Local	Local drainage issue related to flooding of an underpass
OKF4	Oak Forest	Pavement flooding	US 6 at Central Avenue to Oak Park Avenue	Pavement flooding	Local	Pavement flooding related to local drainage system
OKF5	Oak Forest	Overgrowth, falling trees, culvert need maintenance	North of 155th Street and Long Avenue	Culverts need maintenance	Channel maintenance	Removal of debris to be addressed by stream maintenance
ORH2	Orland Hills	Street flooding	88th Court Detention Pond (near 167th Street and 88th Avenue)	Pavement flooding from a local detention basin	Local	Local drainage issue related to local detention facility

Table 3.4.3: Community Response Data for Midlothian Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
ORP5	Orland Park	Stream and culvert blockages	167th Street and 88th Avenue	Stream maintenance on Midlothian Creek	Channel maintenance	Removal of debris to be addressed by stream maintenance
ORT2	Orland Township	Debris and siltation	80th Avenue from 183rd Street to 151st Street	Stream maintenance on Midlothian Creek	Channel maintenance	Removal of debris to be addressed by stream maintenance
ROB1	Village of Robbins	Shallow flooding, few first floors flooded	137th Street and 139th Street from Kedzie Avenue 3 blocks east	Overbank flooding	Regional	Channel improvements (Alternative MTCRG6-A1)
ROB2	Village of Robbins	Flooding, culvert blockage and erosion	Kedzie Avenue and 139th Street	Overbank flooding	Regional	Channel improvements (Alternative MTCRG6-A1)
TIN1	Tinley Park	Erosion on 2.7 mile of Midlothian Creek	Midlothian Creek (near Central Avenue and 167th Street)	Erosion on 2.7 miles of Midlothian Creek	Local	Local drainage issue, structure are not within 30 ft from the active erosion
TIN2	Tinley Park	Inadequate drainage	Oak Park Avenue and 167th Street	Ponding and basement flooding	Local	Local drainage issue pertaining to local conveyance system.
TIN3	Tinley Park	Pavement flooding	Route 43 at 159th Street to 165th Street	Pavement flooding	Local	Local drainage issue pertaining to local storm sewer system
TIN4	Tinley Park	Pavement flooding	Route 43 at 175th Street railroad underpass	Pavement flooding	Local	Local drainage issue pertaining to roadway underpass drainage
TIN5	Tinley Park	Pavement flooding	US 6 at IL 43 (Harlem Avenue)	Pavement flooding	Local	Local drainage issue related to local storm sewer system
TIN6	Tinley Park	Pavement flooding	IL 43 at Rock Island railroad	Pavement flooding	Local	Local drainage issue related to local storm drainage system
TIN7	Tinley Park	Ponding	Ridgeland Avenue and 167th Street	Ponding	Local	Local drainage issue related to local conveyance system
TIN8	Tinley Park	Ponding	Oak Park Avenue on the west, 179th Street to the North, 183rd Street to the south and 1/4 mi east of Ridgeland Avenue	Ponding	Local	Local drainage issue related to local storm sewer system

Table 3.4.3: Community Response Data for Midlothian Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
TIN9	Tinley Park	Streambank erosion	17251 66th Court	Streambank erosion	Regional	Stabilization of stream banks (Alternative MTCRG2-A1)
TIN10	Tinley Park	Streambank erosion	17147 South Oak Park Avenue	Streambank erosion	Regional	Stabilization of stream banks (Alternative MTCRG2-A1)

3.4.2 Watershed Analysis

3.4.2.1 Hydrologic Model Development

3.4.2.1.1 Subbasin DelineationThe Midlothian Creek subwatershed was delineated based upon LiDAR topographic data developed by Cook County in 2003. There are 47 subbasins ranging in size from 0.051 to 1.31 square miles with an average size of 0.397 square miles.

3.4.2.1.2 Hydrologic Parameter CalculationsCurve numbers (CN) were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in **Appendix C**. An area-weighted average of the CN was generated for each subbasin.

Clark's unit hydrograph parameters were estimated using the method described in Section 1.3.2. **Appendix G** provides a summary of the hydrologic parameters used for the subbasins in each subwatershed.

3.4.2.2 Hydraulic Model Development

3.4.2.2.1 Field Data, Investigation, and Existing Model DataDuring Phase A, the available existing models for the Midlothian Creek subwatershed were collected and analyzed to determine if any model data could be used for developing the comprehensive model for Midlothian Creek. Only existing models that were less than 10 years old were reviewed.

The FEMA effective hydraulic model was developed by IDNR-OWR in the early 1990s using HEC-2 and was updated in 2001 by Patrick Engineering. Also, an FEQ model was developed by IDNR-OWR in the late 1990s, which extends between 171st Street below Harlem Avenue to the Midlothian Creek Diversion Conduit. The 76th Avenue Ditch model was updated by Robinson Engineering and submitted to FEMA in 2004. All the models met the criteria identified in the CCSMP and were used to support the development of the hydraulic model.

The models listed above were reviewed to determine if any of the cross-sectional data and hydraulic structure information could be reused. If any information regarding location, date, and vertical datum was not available, the cross-sectional data was not used. For cross sections with this data available, the cross section was compared to the current channel conditions to ensure that the cross section was still representative of current conditions. The hydraulic structure dimensions were compared to 2007 field reconnaissance data and also to bridge/culvert dimensions data provided by Cook County Highway Department (provided data for only state/county highways). Based on the existing model analysis additional cross sections and hydraulic structures to be surveyed were determined. Any data used from the existing models were geo-referenced to represent true physical coordinates.

After review of existing models, field reconnaissance data and hydraulic structures dimensions data, a field survey plan for Midlothian Creek was developed. Field survey was performed under the protocol of FEMA's *Guidelines and Specifications for Flood Hazard Mapping partners, Appendix A: Guidance for Aerial Mapping and Surveying.* Field survey was performed in early 2008. Cross sections were generally surveyed between 500 and 1,000 feet apart. The actual spacing and location was determined based on the variability of the channel shape and roughness and slope of the channel. To supplement the model, 56 hydraulic structures throughout the subwatershed, including immediate upstream and downstream cross sections, were surveyed, as well as 66 additional cross sections along Midlothian Creek Main Tributary, Midlothian Creek Western Branch, Midlothian Creek Western Tributary, Twin Lakes Tributary, Filsen Park Ditch, and Natalie Creek.

The Manning's n-values at each cross section were estimated using a combination of aerial photography and photographs from field survey and field reconnaissance. The horizontal extent of each type of land cover and the associated n-value for each cross section were manually entered into the HEC-RAS hydraulic model. All the n-values were manually adjusted using the HEC-RAS cross-sectional data editor. The n-values were increased where buildings are located within the floodplain to account for conveyance loss. The n-values in these areas may range from 0.06 for areas with few buildings to 0.15 for fully developed areas. If significant blockage was caused by buildings in the flood fringe, the developed areas were modeled as ineffective flow. **Table 3.4.4** lists the channel and overbank ranges of n-values that were used for the subwatershed model.

Table 3.4.4: Channel and Overbank Associated Manning's n-Values[1]

Tributary	Range of Channel n-Values	Range of Overbank n-Values
MCWB	0.03 – 0.06	0.05 – 0.10
MCWT	0.03 – 0.06	0.05 – 0.10
76DT	0.03 – 0.05	0.05 – 0.12
FPDT	0.03 – 0.06	0.05 – 0.10
TLTY	0.03 – 0.06	0.05 – 0.10
NTCR	0.04 – 0.06	0.05 – 0.12
MTCR	0.03 – 0.06	0.05 – 0.12

[1]**Source**: Open Channel Hydraulics, Chow 1959

3.4.2.2.2 Boundary Conditions

There were three downstream locations where boundary conditions were required to run the hydraulic model: the confluence of Midlothian Creek with Little Calumet River, the confluence of the Midlothian Creek Diversion Conduit with the Calumet-Sag Channel, and the confluence of the Natalie Creek Diversion Conduit with the Calumet-Sag Channel. Normal depth was used as the downstream boundary condition for the Midlothian Creek confluence with the Little Calumet River and FEMA's Cook County FIS 100-year elevations were used as boundary conditions at the remaining two locations.

3.4.2.3 Calibration and VerificationA detailed calibration was performed for the Midlothian Creek subwatershed using historic gage records under the guidelines of the Cook County Stormwater Management Plan (CCSMP). Three historical storms: July 1996, April 2006 and September 2008 were evaluated based on the stream gage flows, precipitation totals and records of flooding in the Midlothian Creek subwatershed and were found to be acceptable for calibration and verification.

For the calibration storms, Illinois State Water Survey (ISWS) Cook County precipitation gages, National Weather Service (NWS) recording and non-recording gages, and Community Collaborative Rain, Hail & Snow Network (CoCoRAHS) precipitation amounts were used. Theissen polygons were developed for each storm based on the rain gages available for that storm. The gage weightings for the recording and non-recording gages were computed in ArcGIS for each subbasin. USGS Gage 05536340 on Midlothian Creek at Oak Forest, Illinois (the only stream gage in the Midlothian Creek subwatershed) was used for calibration. This gage is at latitude 41°36′51″ longitude 87°43′46″ (NAD27), on the downstream side of the Kilbourn Avenue Crossing, near the intersection of Kilbourn Avenue and 151st Street. The datum of the gage is 620.41 feet NGVD29 (620.12 NAVD88). Instantaneous data is available at this gage from 5/1/1989 through 9/30/2007.

Runoff hydrographs were developed using HEC-HMS and routed through the Midlothian Creek hydraulic model. The stages and flows produced for each calibration storm were compared to the observed stream gage data. During calibration of the Midlothian Creek subwatershed model, the CN, directly connected impervious area percentage, and storage coefficient were adjusted so that the peak flow rate, hydrograph shape and timing, and total volume matched the observed hydrographs within the CCSMP's criteria.

During calibration, the CN and directly connected impervious percentage were reduced by -10% and -10%, respectively. The Clark's storage coefficient R was increased by 25%. After the final adjustments to the HEC-HMS and HEC-RAS models, the flow and stage comparisons to the observed data were within the CCSMP's criteria. **Table 3.4.5** shows the comparison of the flows and stages for all calibration storms. **Figures 3.4.2**, **3.4.3** and **3.4.4** show the calibration results for the July 1996, April 2006, and September 2008, respectively.

Table 3.4.5: Midlothian Creek Subwatershed Calibration Results

	Observed		Modeled		CCSMP's Criteria[1]	
Storm Event	Flow (cfs)	Stage (ft)	Flow (cfs)	Stage (ft)	Percentage Difference in Peak Flow	Difference in Stage (ft)
July 1996	473	626.27	446	626.37	-6%	0.1
April 2006	126	622.65	128	622.80	1%	0.1
September 2008	325	625.24	383	625.49	15%	0.3

[1]Flow within 30% and stage within 6 inches.

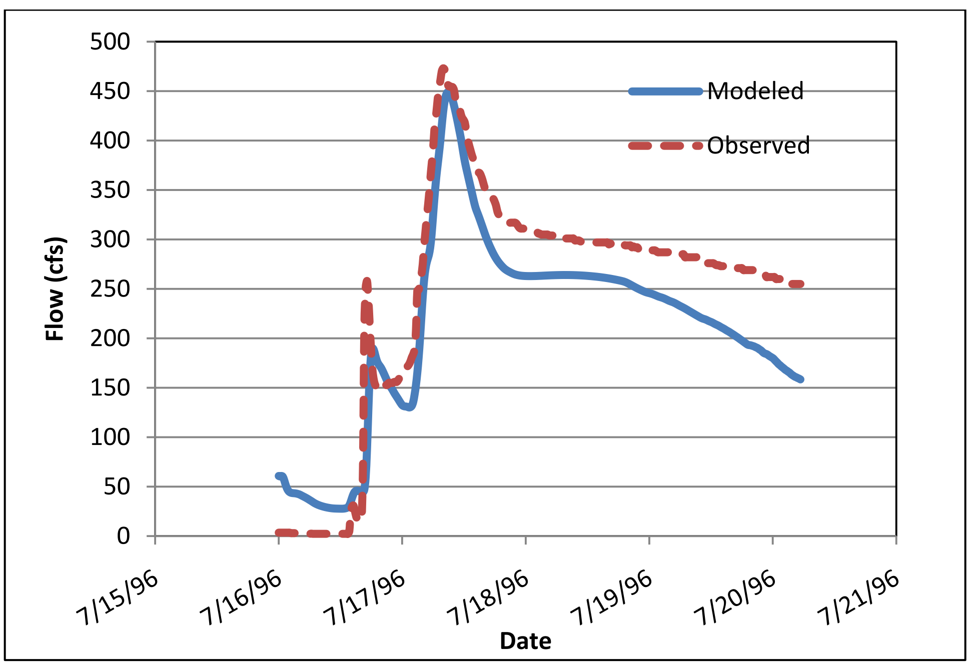


Figure 3.4.2: Midlothian Creek Subwatershed Calibration Results, July 1996 Storm Event

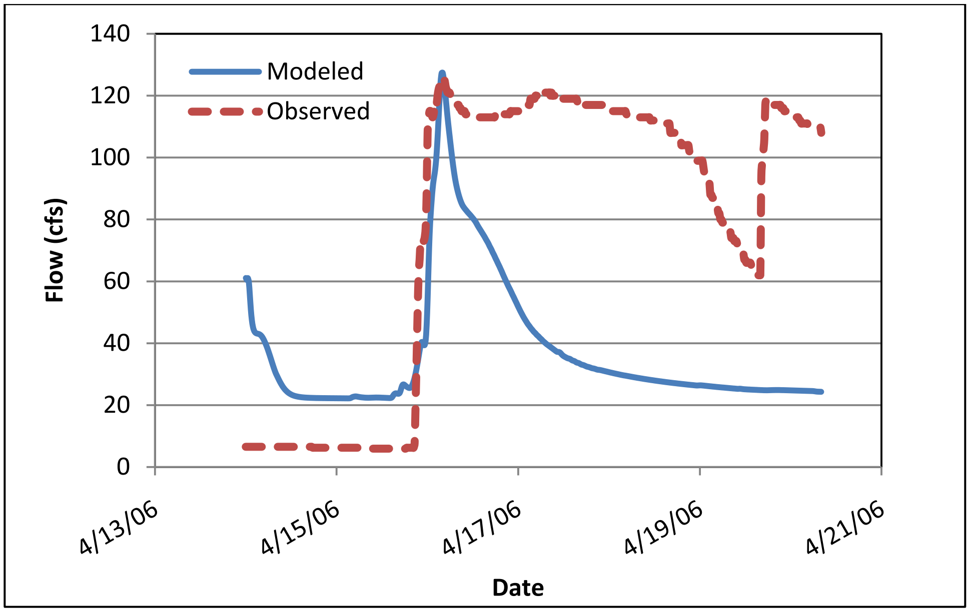


Figure 3.4.3: Midlothian Creek Subwatershed Calibration Results, April 2006 Storm Event

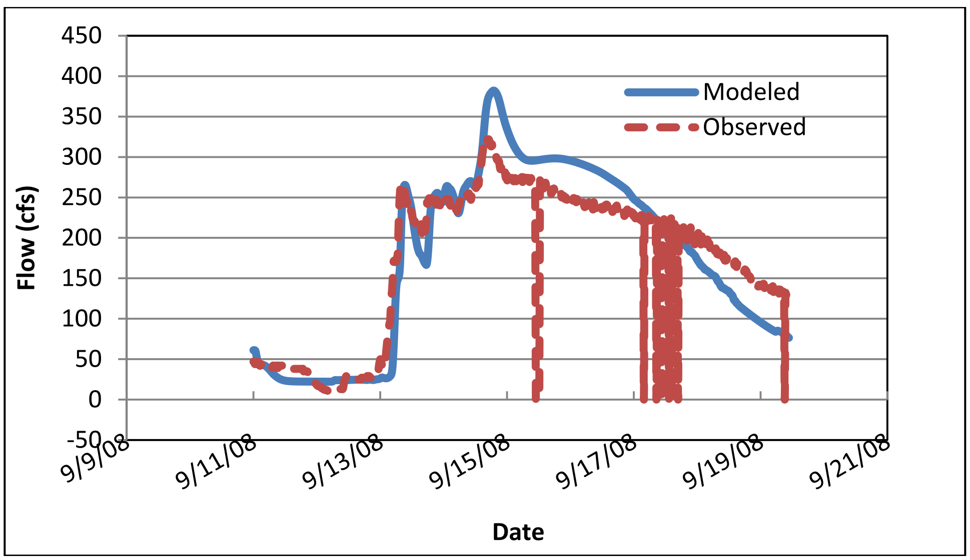


Figure 3.4.4: Midlothian Creek Subwatershed Calibration Results, September 2008 Storm Event

The receding limbs for April 2006 storm event do not correlate between the observed and modeled hydrographs; this may be due to operation of the reservoir pump stations. In the Midlothian Creek subwatershed model, the reservoir pump stations are not simulated and this excess volume shown in the observed graph may be due to the draining of the flood control facilities.

3.4.2.4 Existing Conditions Evaluation

3.4.2.4.1 Flood Inundation AreasA critical duration analysis was run for the Midlothian Creek subwatershed hydraulic model. The 100-year, 1-, 3-, 6-, 12-, 24- and

48-hour storm events were run to determine the critical duration. The 48-hour storm event was found to be the critical duration for the majority of the watershed, including all reaches downstream of the Tinley Park and Twin Lakes Reservoirs. The 12-hour duration was found to be the critical duration storm event for three of the tributaries, 76th Avenue Ditch, Twin Lakes Tributary and Midlothian Western Tributary. **Figure 3.4.1** shows inundation area produced for the 100-year critical duration storm event.

*3.4.2.4.2 Hydraulic Profiles*Hydraulic profiles for Midlothian Creek and its tributaries are shown in **Appendix H**. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100- and 500-year recurrence interval design storm events.

3.4.3 Development and Evaluation of Alternatives

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. **Table 3.4.6** summarizes problem areas identified through hydraulic modeling of the Midlothian Creek subwatershed.

Problem areas that were hydraulically interdependent or otherwise related were grouped for alternatives analysis. Each problem group is addressed in terms of combined damages and alternatives/solutions.

Table 3.4.6: Modeled Problem Definition for the Midlothian Creek Subwatershed

Problem ID	Group ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
MTCR1	MTCR-G1	Midlothian Creek, subdivision east of the Tinley Park Reservoir, Tinley Park	100	n/a	MTCRG1-A1
MTCR2	MTCR-G2	17147 South Oak Park Avenue, Tinley Park	n/a	TIN10	MTCRG2-A1
MTCR3	MTCR-G2	17251 66th Court, Tinley Park	n/a	TIN9	MTCRG2-A1
MTCR4	MTCR-G3	Midlothian Creek, near 160th Street and Forest Avenue, Oak Forest	100	n/a	MTCRG3-A4
MTCR5	MTCR-G3	Midlothian Creek, 159th Street and Cicero Avenue, Oak Forest	100	n/a	MTCRG3-A4
MTCR6	MTCR-G4	Midlothian Creek, Metra railroad tracks to Waverly Avenue, Oak Forest	2, 5, 10, 25, 50, & 100	n/a	MTCRG4-A4
MTCR7	MTCR-G4	Midlothian Creek, near 155th Street and Kilpatrick Avenue, Oak Forest	2, 5, 10, 25, 50, & 100	n/a	MTCRG4-A4
MTCR8	MTCR-G5	Midlothian Creek, Kenton Avenue to Pulaski along the creek, Oak Forest	100	n/a	MTCRG5-A4
MTCR9	MTCR-G6	Midlothian Creek, 137th Street and Kedzie Avenue, Blue Island	2, 5, 10, 25, 50, & 100	ROB1 & ROB2	MTCRG6-A1
MTCR10	MTCR-G7	Isolated structures near Twin Lakes Tributary, Oak Forest	100	n/a	Floodproofing/ acquisition
NTCR1	NTCR-G1	Natalie Creek, Laramie Avenue to 159th Street, Oak Forest	2, 5, 10, 25, 50, & 100	OKF2	NTCRG1-A4

Table 3.4.6: Modeled Problem Definition for the Midlothian Creek Subwatershed

Problem ID	Group ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
NTCR2	NTCR-G1	Natalie Creek, 149th Street to Keystone Avenue, Midlothian	2, 5, 10, 25, 50, & 100	MID1 thru MID7, and MID9 thru MID12	NTCRG1-A4

Damage assessment, technology screening, alternative development and alternative selection were performed by problem group, since each group is independent of the other. Each problem group is evaluated in the following sections by Problem Group ID.

3.4.3.1 MTCR-G1 – Midlothian Creek Problem Group 1

3.4.3.1.1 Problem Definition, MTCR-G1

The MTCR-G1 problem group consists of overflowing of the Tinley Park Reservoir, resulting in flooding near Dorothy Lane and Overhill Avenue in Tinley Park. At Tinley Park Reservoir, the 100-year stage of 693.4 feet inundates approximately 25 building structures. This problem area was shown on the recent DFIRM floodplain maps. The flood protection elevation near this problem area would be 690.4 feet. Flood protection elevations were developed based on field reconnaissance of the area based on typical residential structures.

3.4.3.1.2 Damage Assessment, MTCR-G1

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Midlothian Creek and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15 percent of the property damages, unless otherwise noted. Recreational damages were estimated based on depth and duration of flooding. **Table 3.4.7** lists the estimated damages for the problem group.

Table 3.4.7: Estimated Damages for MTCR Subwatershed, Problem Group MTCR-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
MTCR-G1	Property	$117,000	Structures at risk of flooding
	Transportation	$18,000	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.4.3.1.3 Technology Screening, MTCR-G1

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.4.8**

summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.4.8: Evaluation of Flood Control Technologies for MTCR Subwatershed, Problem Group MTCR-G1

Flood Control Option	Feasibility
Detention Facilities	Feasible but not preferred given alternative
Conveyance Improvement – Culvert/Bridge Replacement	Feasible but not preferred given alternative
Conveyance Improvement – Channel Improvement	Feasible but not preferred given alternative
Conveyance Improvements – Diversion	Feasible but not preferred given alternative
Flood Barriers, Levees/Floodwalls	Feasible given that the problem is not due to high stages in the reservoir, but that a low ground area exists

3.4.3.1.4 Alternative Development, MTCR-G1

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in Section 1.4 of this report. **Table 3.4.9** summarizes flood control alternatives developed for Problem Group MTCR-G1.

Table 3.4.9: Flood Control Alternatives for Problem Group MTCR-G1

Alternative	Location	Description
MTCRG1-A1	Overhill Avenue and Dorothy Lane	Construct a 700 LF, 4-ft high earthen levee adjacent to the flooded properties along Overhill Avenue and Oleander Avenue

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the MTCR-G1 Problem Group.

3.4.3.1.5 Alternative Evaluation and Selection, MTCR-G1

The alternative in **Table 3.4.9** was evaluated to determine its effectiveness and produce data required for the countywide prioritization of watershed projects. The flood control alternative was modeled to evaluate its impact on water elevations and flood damages. **Table 3.4.11** provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative.

Alternative MTCRG1-A1 in **Table 3.4.9** is the preferred alternative for this problem group. An earthen levee was the only solution considered to be feasible, given that the flooding is due to the low ground elevation adjacent to Overhill Avenue. An earthen levee would protect homes while maintaining a reasonable stage in the reservoir. A 1,600 linear-foot, 4-foot-high earthen levee adjacent to the flooded properties would prevent overbank flooding during the 100-year event. At 4 feet high, the levee would provide approximately 3 feet of freeboard. This alternative also includes interior drainage for the drainage area behind the levee.

Table 3.4.10 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for MTCR-G1.

Table 3.4.10: Alternative Condition Flow & WSEL Comparison for Problem Group MTCR-G1

Location	Station	Existing Conditions		Alternative MTCRG1-A1	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Tinley Park Reservoir	SA 288	693.40	1,087	693.40[1]	1,087

[1]Levee provides protection.

3.4.3.1.6 Data Required for Countywide Prioritization of Watershed Projects, MTCR-G1

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.4.11** lists the alternative analyzed in detail. The recommended alternative consists of constructing an earthen levee adjacent to flooded properties. **Figure 3.4.5** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.4.11: Midlothian Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group MTCR-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
MTCR-G1	MTCRG1-A1	Earthen levee and Interior drainage	0.08	$134,000	$1,710,000	25 Structures	No Impact	Tinley Park

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.4.3.2 MTCR-G2 – Midlothian Creek Problem Group 2

3.4.3.2.1 Problem Definition, MTCR-G2

The MTCR-G2 problem group consists of stream bank erosion at two locations in Tinley Park. One problem area is located near Oak Park Avenue and 172nd Street and the second location is near Hickory Street and 66th Court. A total of 4 building structures and one parking lot are within the 30 feet from an actively eroding creek segment.

3.4.3.2.2 Damage Assessment, MTCR-G2

Damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. The District's Stormwater Planning Database Tool was used to estimate the damages. Erosion damages for each building structure were calculated. There are no transportation or recreational damages at this location. **Table 3.4.12** lists the estimated damages for the problem group.

Table 3.4.12: Estimated Damages for MTCR Subwatershed, Problem Group MTCR-G2

Problem Group ID	Damage Category	Estimated Damage ($)	Description
MTCR-G2	Property	$1,110,000	Structures at risk of flooding
	Transportation	$0	
	Recreation	$0	

3.4.3.2.3 Technology Screening, MTCR-G2

Streambank stabilization technologies from Chapter 6 of the CCSMP were considered as potential solutions for the problem area. Several combinations of technologies were analyzed to address the problems at this location.

3.4.3.2.4 Alternative Development, MTCR-G2

Flood Control Alternatives. No flood control alternatives were developed for the MTCR-G2 Problem Group.

Streambank Stabilization Alternatives. Table 3.4.13 summarizes streambank stabilization alternatives developed for Problem Group MTCR-G2.

Table 3.4.13: Streambank Stabilization Alternatives for Problem Group MTCR-G2

Alternative	Location	Description
MTCRG2-A1	Oak Park Avenue and 172nd Street; Hickory Street and 66th Court	Stabilize using hard armoring or other acceptable technology to prevent erosion problems that threaten structures at Oak Park Avenue and 172nd Street and Hickory Street and 66th Court

3.4.3.2.5 Alternative Evaluation and Selection, MTCR-G2

The alternative in **Table 3.4.13** was evaluated to determine its effectiveness and produce data required for the countywide prioritization of watershed projects. **Table 3.4.15** provides a summary of the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant data for the alternative. A preliminary conceptual level analysis was performed for these erosion problem areas due to limited available data.

Alternative MTCRG2-A1 from **Table 3.4.13** is the proposed alternative for this problem group. The proposed alternative will provide hard armoring of the banks were erosion is occurring. For the location at Oak Park Avenue and 172nd Street, 300 feet of hard armoring of both banks is proposed from Oak Park Avenue to 67th Court. At Hickory Street and 66th Court, 300 feet of hard armoring is proposed along the both banks adjacent to three townhomes. For both locations, traditional approaches to armoring using concrete walls have been conceptually developed to determine project cost estimates. As an alternative to using concrete, there are other hard-armoring erosion protection techniques available to stabilize creek banks that may give a more natural appearance.

Table 3.4.14 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for MTCR-G2.

Table 3.4.14: Alternative Condition Flow & WSEL Comparison for Problem Group MTCR-G2

Location	Station	Existing Conditions		Alternative MTCRG2-A1	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Midlothian and Oak Park Avenue	52452	688.80	549.46	688.80[1]	549.46
Footpath northeast of 67th Avenue and 172nd Street	51584	686.80	550.67	686.80[1]	550.67

[1]Streambank stabilization provides protection.

3.4.3.2.6 Data Required for Countywide Prioritization of Watershed Projects, MTCR-G2

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.4.15** lists the alternative analyzed in detail. The recommended alternative consists of streambank stabilization. **Figure 3.4.6** shows the location of the recommended alternative.

Table 3.4.15: Midlothian Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group MTCR-G2

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
MTCR-G2	MTCRG2-A1	Stream bank stabilization near Oak park Avenue and 172nd Street and also near Hickory Street and 66th Court	0.71	$1,110,000	$1,569,000	4 Structures	No Impact	Tinley Park

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.4.3.3 MTCR-G3 – Midlothian Creek Problem Group 3

3.4.3.3.1 Problem Definition

The MTCR-G3 problem area consists of overbank flooding at two locations: 160th Street and Forest Avenue, and 159th Street and Cicero Avenue. The flooding is due to the restriction from the 159th and 160th Street culvert crossings. The 100-year flow (518 cfs) exceeds the capacity of the existing culverts. The existing culvert crossing consists of two (2), 6-foot circular culverts at 160th Street and one 6.3-foot circular culvert at 159th Street. MTCR-G3 consists of approximately 23 building structures and overtopping of one local and one arterial roadway crossing. This area is also inundated on the FEMA DFIRM map.

3.4.3.3.2 Damage Assessment, MTCR-G3

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Midlothian Creek and its tributaries. These stages were used to calculate the depth of flooding and to estimate damages at each flooding problem area. The District's Stormwater

Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15 percent of the property damages, unless otherwise noted. Recreational damages were estimated based on depth and duration of flooding. **Table 3.4.16** lists the estimated damages for the problem group.

Table 3.4.16: Estimated Damages for Midlothian Creek Subwatershed, Problem Group MTCR-G3

Problem Group ID	Damage Category	Estimated Damage ($)	Description
MTCR-G3	Property	$32,000	Structures at risk of flooding
	Transportation	$4,800	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.4.3.3.3 Technology Screening, MTCR-G3

Several combinations of technologies were analyzed to address the flooding problems associated with MTCR-G3. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.4.17** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.4.17: Evaluation of Flood Control Technologies for Midlothian Creek Subwatershed, Problem Group MTCR-G3

Flood Control Option	Feasibility
Detention Facilities	Not feasible. Limited space available
Conveyance Improvement – Culvert/Bridge Replacement	Feasible. Increase openings at 160th Street and 159th Street
Conveyance Improvement – Channel Improvement	Not feasible. Limited right-of-way available for regrading the channel
Conveyance Improvements – Diversion	Not feasible. No available outfall downstream
Flood Barriers, Levees/Floodwalls	Not feasible. Limited right-of-way available

3.4.3.3.4 Alternative Development, MTCR-G3

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in Section 1.4 of this report. **Table 3.4.18** summarizes flood control alternatives developed for Problem Group MTCR-G3.

Table 3.4.18: Flood Control Alternatives for Problem Group MTCR-G3

Alternative	Location	Description
MTCRG3-A1	160th Street	Upgrade existing crossing from 2, 6-ft circular culverts to a twin, 9-ft x 6-ft elliptical culvert
MTCRG3-A2	159th Street	Upgrade existing crossing from 6.3-ft circular culvert, to 13-ft x 6.5-ft elliptical culvert
MTCRG3-A3	160th Street and Oak Avenue	Minor channel improvements needed for regrading the channel to return grade to a positive slope

Table 3.4.18: Flood Control Alternatives for Problem Group MTCR-G3

Alternative	Location	Description
MTCRG3-A4	159th Street, 160th Street and Oak Avenue	Upgrade culverts at 159th and 160th Streets; channel improvements (combination of Alternatives MTCRG3-A1, MTCRG3-A2 and MTCRG3-A3)

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the MTCR-G3 Problem Group.

3.4.3.3.5 Alternative Evaluation and Selection

Alternatives included in **Table 3.4.18** were evaluated to determine their effectiveness and produce the data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.4.20** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative for Problem Group MTCR-G3. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, thus costs were not calculated for these alternatives.

Alternative MTCRG3-A4 from **Table 3.4.18** is the preferred alternative for Problem Group MTCR-G3. By increasing the opening area of the 160th Street crossing with a twin 9-foot x 6-foot elliptical culvert, the 100-year water surface elevation will be reduced to 644.02 feet which is approximately 2 feet below the ground elevation and 5.81 feet below the existing 100-year elevation. The 100-year elevation at 159th Street is reduced to 640.73, which is 5.40 feet below the 100-year elevation. With the preferred alternative, the 23 building structures and the roadways will be protected from flooding.

Table 3.4.19 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for MTCR-G3.

Table 3.4.19: Alternative Condition Flow & WSEL Comparison for Problem Group MTCR-G3

Location	Station	Existing Conditions		Alternative MTCRG3-A4	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Upstream of 160th Street Culvert	30545	649.83	518.12	644.90	534.61
Upstream of 159th Street Culvert	29591	646.13	518.09	643.22	534.58

3.4.3.3.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.4.20** lists the alternative analyzed in detail. **Figure 3.4.7** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.4.20: Midlothian Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group MTCR-G3

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
MTCR-G3	MTCRG3-A4	Replace crossings, channel improvements	0.01	$37,000	$3,455,000	23 Structures, 2 Roadways	No Impact	Oak Forest

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.4.3.4 MTCR-G4 – Midlothian Creek Problem Group 4

3.4.3.4.1 Problem Definition

The MTCR-G4 problem area consists of overbank flooding at two locations: building structures between Waverly Avenue and the Metra railroad tracks, and upstream and downstream of 155th Street and Kilpatrick Avenue. The flooding is due to the restriction from the 155th Street crossing and also the low grade along the banks. The 100-year flow (495 cfs) exceeds the capacity of the existing crossing at 155th Street. The existing bridge crossing at 155th Street has an opening of 16.5 feet wide and 6 feet high. MTCR-G4 consists of flooding of approximately 12 building structures and overtopping of two local roadway crossings. This area is also inundated on the FEMA DFIRM map.

3.4.3.4.2 Damage Assessment, MTCR-G4

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Midlothian Creek and its tributaries. These stages were used to calculate the depth of flooding and to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15 percent of the property damages, unless otherwise noted. Recreational damages were estimated based on depth and duration of flooding. **Table 3.4.21** lists the estimated damages for the problem group.

Table 3.4.21: Estimated Damages for Midlothian Creek Subwatershed, Problem Group MTCR-G4

Problem Group ID	Damage Category	Estimated Damage ($)	Description
MTCR-G4	Property	$995,000	Structures at risk of flooding
	Transportation	$149,000	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.4.3.4.3 Technology Screening, MTCR-G4

Several combinations of technologies were analyzed to address the flooding problems associated with MTCR-G4. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.4.22** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.4.22: Evaluation of Flood Control Technologies for Midlothian Creek Subwatershed, Problem Group MTCR-G4

Flood Control Option	Feasibility
Detention Facilities	Not feasible. Limited space available
Conveyance Improvement – Culvert/Bridge Replacement	Feasible. Increase openings at 155th Street
Conveyance Improvement – Channel Improvement	Not feasible. Limited right-of-way available
Conveyance Improvements – Diversion	Not feasible. No available outfall downstream
Flood Barriers, Levees/Floodwalls	Feasible. Need a floodwall due to the limited right-of-way available

3.4.3.4.4 Alternative Development

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in Section 1.4 of this report. **Table 3.4.23** summarizes flood control alternatives developed for Problem Group MTCR-G4.

Table 3.4.23: Flood Control Alternatives for Problem Group MTCR-G4

Alternative	Location	Description
MTCRG4-A1	155th Street and Kilpatrick Avenue	Upgrade both the existing 155th crossing16.5 ft x 6 ft and Kilpatrick Avenue crossing 26 ft x 5.2 ft to one crossing (3) – 12-ft x 6-ft box culvert
MTCRG4-A2	Upstream of Waverly Avenue	Construct a 350 LF, 3-ft high floodwall adjacent to the flooded properties along both the banks from Metra railroad tracks to Waverly Avenue
MTCRG4-A3	Downstream of Kilpatrick Avenue	Construct a 700 LF, average 7-ft high floodwall adjacent to the flooded properties along the north bank of the channel from downstream of Kilpatrick Avenue
MTCRG4-A4	Vicinity of 155th Street, Kilpatrick Avenue and Waverly Avenue	Upgrade crossing at Kilpatrick Avenue, construct floodwall from Metra railroad tracks to Waverly Avenue, and construct floodwall near Kilpatrick Avenue (combination of Alternatives MTCRG4-A1, MTCRG4-A2 and MTCRG4-A3)

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the MTCR-G4 Problem Group.

3.4.3.4.5 Alternative Evaluation and Selection

Alternatives included in **Table 3.4.23** were evaluated to determine their effectiveness and produce the data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.4.25** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant data for the preferred alternative for Problem Group MTCR-G4. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, thus costs were not calculated for these alternatives.

Alternative MTCRG4-A4 from **Table 3.4.23** provides the preferred alternative for Problem Group MTCR-G4. By increasing the opening area of the 155th Street and Kilpatrick Avenue crossings and combining the culverts into one (3) 12-foot x 6-foot box culvert, the 100-year water surface elevation will be reduced to 633.52 feet which is approximately 1.4 feet below the existing 100-year elevation at the upstream of the 155th Street crossing, which is 1.2 feet below the lowest elevation on the road. The floodwall near Waverly and Kilpatrick Avenues provides 3 feet of freeboard to the building structures. With the preferred alternative, the 12 building structures and the roadways will be removed from the flooding.

Table 3.4.24 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for MTCR-G4.

Table 3.4.24: Alternative Condition Flow & WSEL Comparison for Problem Group MTCR-G4

Location	Station	Existing Conditions		Alternative MTCRG4-A4	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Downstream of Railroad Tracks	26901	636.36	495.31	636.19	505.54
Upstream of Waverly Avenue	26528	635.79	495.10	635.08	505.43
Upstream of 155th Street Culvert	25892	635.28	495.05	634.07	505.38

3.4.3.4.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.4.25** lists the alternative analyzed in detail. **Figure 3.4.8** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.4.25: Midlothian Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group MTCR-G4

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
MTCR-G4	MTCRG4-A4	Replace crossings and construct floodwall	0.04	$1,143,000	$27,700,000	12 Structures, 2 Roadways	No Impact	Oak Forest

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.4.3.5 MTCR-G5 – Midlothian Creek Problem Group 5

3.4.3.5.1 Problem Definition, MTCR-G5

The MTCR-G5 problem group consists of overbank flooding along the left bank of Midlothian Creek from Kenton Avenue to Pulaski Road. The flooding is due to inadequate capacity of the channel and the low ground elevation along the left bank. The 100-year flow (525 cfs) exceeds the capacity of the channel at many locations. MTCR-G5 consists of approximately 25 inundated building structures near Kenton Avenue, 151st Street and upstream of Pulaski Road.

3.4.3.5.2 Damage Assessment, MTCR-G5

Damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Midlothian Creek and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15 percent of the property damages, unless otherwise noted. Recreational damages were estimated based on depth and duration of flooding. **Table 3.4.26** lists the estimated damages for the problem group.

Table 3.4.26: Estimated Damages for MTCR Subwatershed, Problem Group MTCR-G5

Problem Group ID	Damage Category	Estimated Damage ($)	Description
MTCR-G5	Property	$50,000	Structures at risk of flooding
	Transportation	$7,500	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.4.3.5.3 Technology Screening, MTCR-G5

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.4.27** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.4.27: Evaluation of Flood Control Technologies for MTCR Subwatershed, Problem Group MTCR-G5

Flood Control Option	Feasibility
Detention Facilities	Feasible. Needed to reduce the stage increases from earthen embankment or channel improvements
Conveyance Improvement – Culvert/Bridge Replacement	Feasible, but not preferred given alternative
Conveyance Improvement – Channel Improvement	Feasible. Needed to reduce the stages
Conveyance Improvements – Diversion	Feasible, but not preferred given alternative
Flood Barriers, Levees/Floodwalls	Feasible, given that the problem is low ground on the left bank

3.4.3.5.4 Alternative Development, MTCR-G5

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in Section 1.4 of this report. **Table 3.4.28** summarizes flood control alternatives developed for Problem Group MTCR-G5.

Table 3.4.28: Flood Control Alternatives for Problem Group MTCR-G5

Alternative	Location	Description
MTCRG5-A1	Kilbourn Avenue and Waverly Avenue	Construct a 25 ac-ft pumped detention facility at downstream of Kilbourn and Waverly crossings to prevent the stage increases from the channel improvements. Not adequate storage to solve all the downstream problems
MTCRG5-A2	From 151st Street to Pulaski Road	Approximately 5900 LF of earth work, including channel improvements, earthen berm along the left bank and a floodwall near upstream of Pulaski Road. This alternative Increases stages downstream
MTCRG5-A3	From Kenton Avenue to Kilbourn Avenue	Widen the cross sections to increase the hydraulic capacity of the channel. This alternative did effectively reduce water surface elevations in the flooding problem area between Kenton and Kilbourn Avenues and was not providing any benefits to the downstream problem areas
MTCRG5-A4	Kilbourn Avenue and Waverly Avenue, 151st Street to Pulaski Road, and Kenton Avenue to Kilbourn Avenue	Construct 25 ac-ft pumped detention facility downstream of Kilbourn Avenue and Waverly Avenue, earthwork including channel improvements and floodwall, and widened cross section width (combination of Alternatives MTCRG5-A1, MTCRG5-A2 and MTCRG5-A3)

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the MTCR-G5 Problem Group.

3.4.3.5.5 Alternative Evaluation and Selection, MTCR-G5

The alternatives included in **Table 3.4.28** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. The flood control alternatives were modeled to evaluate their impacts on water elevations and flood damages. **Table 3.4.30** provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative.

Alternative MTCRG5-A4 from **Table 3.4.28** is the preferred alternative for Problem Group MTCR-G5. With the 5,900 linear feet of channel improvements and the earthen berm, the building structures between 151st Street and Pulaski Road are protected during the 100-year event. Due to the limited availability of the right-of-way, a 100 linear-foot floodwall on the upstream side of Pulaski Road is needed to control the flooding. A 25 acre-foot pumped detention facility downstream of Kilbourn Avenue and Waverly Avenue is needed to control the stage increases from the channel improvements. With the preferred alternative, the 25 building structures will be protected from flooding.

Table 3.4.29 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for MTCR-G5.

Table 3.4.29: Alternative Condition Flow & WSEL Comparison for Problem Group MTCR-G5

Location	Station	Existing Conditions		Alternative MTCRG5-A4	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Upstream of Waverly Avenue	23028	626.24	517	625.70	521
Upstream of Pulaski Road	18642	618.82	616	620.38[1]	616

[1]Levee provides protection.

3.4.3.5.6 Data Required for Countywide Prioritization of Watershed Projects, MTCR-G5

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.4.30** lists the alternative analyzed in detail. The recommended alternative consists constructing an earthen levee adjacent to flooded properties. **Figure 3.4.9** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.4.30: Midlothian Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group MTCR-G5

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
MTCR-G5	MTCRG5-A4	Detention Pond and Earthen Levee	< 0.01	$58,000	$21,000,000	25 Structures	No Impact	Tinley Park

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.4.3.6 MTCR-G6– Midlothian Creek Problem Group 6

3.4.3.6.1 Problem Definition, MTCR-G6

The MTCR-G6 problem group consists of overbank flooding downstream of 139th and 137th Streets along Kedzie Avenue in the Village of Robbins. The flooding is due to the low ground elevation on the right overbank and causes inundation of approximately 25 properties. The 100-year flow (810 cfs) exceeds the capacity of the channel at this location and the critical elevation is 598.6 feet. This problem area was shown on the recent DFIRM floodplain maps. The flood protection elevation near this problem area would be 597.5 feet. Flood protection elevations were developed based on field reconnaissance of the area based on typical residential structures.

3.4.3.6.2 Damage Assessment, MTCR-G6

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Midlothian Creek and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15 percent of the property damages, unless otherwise noted. Recreational damages were estimated based on depth and duration of flooding. **Table 3.4.31** lists the estimated damages for the problem group.

Table 3.4.31: Estimated Damages for MTCR Subwatershed, Problem Group MTCR-G6

Problem Group ID	Damage Category	Estimated Damage ($)	Description
MTCR-G6	Property	$96,000	Structures at risk of flooding
	Transportation	$14,500	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.4.3.6.3 Technology Screening, MTCR-G6

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.4.32** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.4.32: Evaluation of Flood Control Technologies for MTCR Subwatershed, Problem Group MTCR-G6

Flood Control Option	Feasibility
Detention Facilities	Feasible but not ideal preferred alternative
Conveyance Improvement – Culvert/Bridge Replacement	Feasible but not preferred given alternative
Conveyance Improvement – Channel Improvement	Feasible. Needed to lower the peak stages
Conveyance Improvements – Diversion	Not feasible. There is already a diversion conduit near this problem location
Flood Barriers, Levees/Floodwalls	Feasible. There may be some stage increases downstream

3.4.3.6.4 Alternative Development, MTCR-G6

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in Section 1.4 of this report. **Table 3.4.33** summarizes flood control alternatives developed for Problem Group MTCR-G6.

Table 3.4.33: Flood Control Alternatives for Problem Group MTCR-G6

Alternative	Location	Description
MTCRG6-A1	Between 139th and 137th Streets	Widen the channel to increase the hydraulic capacity of the channel. This alternative effectively reduces water surface elevations in the flooding problem area

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the MTCR-G6Problem Group.

3.4.3.6.5 Alternative Evaluation and Selection, MTCR-G6

The alternative included in **Table 3.4.33** was evaluated to determine its effectiveness and produce data required for the countywide prioritization of watershed projects. The flood control alternative was modeled to evaluate its impact on water elevations and flood damages. **Table 3.4.35** provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative.

Alternative MTCRG6-A1 from **Table 3.4.33** is the preferred alternative for this problem group. 1,200 linear feet of channel improvements is recommended including widening of the channel from 22 feet to 39 feet and lowering the bottom of the channel by 0.5 foot. The 100-year water surface elevation will be reduced to 596.8 feet which is approximately 1.8 feet below the existing 100-year elevation near the problem area. With the preferred alternative, the channel flow will be contained within the banks and 25 building structures will be protected from flooding.

Table 3.4.34 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for MTCR-G6.

Table 3.4.34: Alternative Condition Flow & WSEL Comparison for Problem Group MTCR-G6

Location	Station	Existing Conditions		Alternative MTCRG6-A1	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Upstream of 139th Street	9889	599.15	809	597.85	810
Downstream of 139th Street	9547	598.95	809	597.49	810
Upstream of 137th Street	8447	595.32	947	595.32	951

3.4.3.6.6 Data Required for Countywide Prioritization of Watershed Projects, MTCR-G6

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.4.35** lists the alternative analyzed in detail. The recommended alternative consists of approximately 1,200 linear feet of channel improvements. **Figure 3.4.10** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.4.35: Midlothian Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group MTCR-G6

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
MTCR-G6	MTCRG6-A1	Channel improvements	0.23	$110,000	$479,000	25 Structures	No Impact	Robbins

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.4.3.7 MTCR-G7– Midlothian Creek Problem Group 7

3.4.3.7.1 Problem Definition, MTCR-G7

The MTCR-G7 problem group consists of overbank flooding of two isolated structures along the Twin Lakes Tributary in Oak Forest. One building structure is a commercial building located near southwest corner of 167th Street and Cicero Avenue, and the other building structure is a residential structure located approximately 2,000 feet upstream of the 167th Street culvert.

3.4.3.7.2 Damage Assessment, MTCR-G7

Damages were not calculated since the proposed alternative for MTCR-G7 is a non-structural measure such as floodproofing or acquisition only.

3.4.3.7.3 Technology Screening, MTCR-G7

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.4.36** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.4.36: Evaluation of Flood Control Technologies for Midlothian Creek Subwatershed, Problem Group MTCR-G7

Flood Control Option	Feasibility
Detention Facilities	Not feasible for the isolated structures
Conveyance Improvement – Culvert/Bridge Replacement	Not feasible for the isolated structures
Conveyance Improvement – Channel Improvement	Not feasible for the isolated structures
Conveyance Improvements – Diversion	Not feasible for the isolated structures
Flood Barriers, Levees/Floodwalls	Not feasible for the isolated structures

3.4.3.7.4 Alternative Development, MTCR-G7

Flood Control Alternatives. No flood control alternatives were developed for isolated structures.

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the MTCR-G7 Problem Group.

3.4.3.7.5 Alternative Evaluation and Selection, MTCR-G7

Since the building structures are isolated, relatively small in number, and their risk of flooding cannot be feasibly mitigated by structural measures, the structures are candidates for protection using non-structural flood control measures such as floodproofing or acquisition. The decision to acquire vs. floodproof should be taken on a case-by-case basis and be based on actual surveyed first floor elevations.

3.4.3.7.6 Data Required for Countywide Prioritization of Watershed Projects, MTCR-G7

None of the structural alternatives considered was effective in reducing flood damages for the two isolated building structures; therefore, benefits and costs are not presented for this alternative. No structural measures are recommended for Problem Group MTCR-G7.

3.4.3.8 NTCR-G1 – Natalie Creek Problem Group 1

3.4.3.8.1 Problem Definition, NTCR-G1

The NTCR-G1 problem group consists of overbank flooding in Oak Forest and Midlothian along Natalie Creek from Laramie Avenue to Keystone Avenue. In this reach, 100-year flows ranging between 410 cfs at Lavergne Avenue, 515 cfs at 149th and Kilpatrick Avenue and 280 cfs at Keystone Avenue exceed the capacity of the channel. The combined Oak Forest and Midlothian flooding includes approximately 130 building structures. These problem areas are shown on the recent DFIRM floodplain maps. The flood protection elevation varies between 645.8 feet at Laramie Avenue to 613.0 feet at Karlov Avenue.

3.4.3.8.2 Damage Assessment, NTCR-G1

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Natalie Creek and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's

Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15 percent of the property damages, unless otherwise noted. Recreational damages were estimated based on depth and duration of flooding. **Table 3.4.37** lists the estimated damages for the problem group.

Table 3.4.37: Estimated Damages for Calumet Union Drainage Ditch Subwatershed, Problem Group NTCR-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
NTCR-G1	Property	$12,790,000	Structures at risk of flooding
	Transportation	$1,920,000	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.4.3.8.3 Technology Screening, NTCR-G1
Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.4.38** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.4.38: Evaluation of Flood Control Technologies for MTCR Subwatershed, Problem Group NTCR-G1

Flood Control Option	Feasibility
Detention Facilities	Feasible and necessary
Conveyance Improvement – Culvert/Bridge Replacement	Not adequate to address flooding, but needed at few locations
Conveyance Improvement – Channel Improvement	Not adequate to address flooding
Conveyance Improvements – Diversion	Feasible and necessary
Flood Barriers, Levees/Floodwalls	Impractical given other technologies

3.4.3.8.4 Alternative Development, NTCR-G1
Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in Section 1.4 of the DWP. **Table 3.4.39** summarizes flood control alternatives developed for Problem Group NTCR-G1.

Table 3.4.39: Flood Control Alternatives for Problem Group NTCR-G1

Alternative	Location	Description
NTCRG1-A1	153rd Street and Leclaire	New detention facility to detain the peak flows
NTCRG1-A2	149th Street and Kilpatrick Diversion Conduit	Construct new diversion conduit to divert peak flows
NTCRG1-A3	Between Laramie and Karlov Avenue	Culvert improvements to increase hydraulic capacity
NTCRG1-A4	153rd Street and Leclaire, 159th Street and Kilpatrick Avenue and Laramie to Karlov Avenue	New detention facility, new diversion conduit and culvert improvements (combination of Alternatives NTCRG1-A1, NTCRG1-A2, and NTCRG1-A3)

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the NTCR-G1 Problem Group.

3.4.3.8.5 Alternative Evaluation and Selection

Alternatives included in **Table 3.4.39** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.4.41** provides a summary of the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed, as benefits were negligible, and thus costs were not calculated for these alternatives.

Alternative NTCRG1-A4 from **Table 3.4.39** consists of the preferred alternative for this problem group. The project components for this alternative include:

- A new pumped detention facility (190 acre-feet) at Leclaire Avenue and 153rd Street with a control structure at Lavergne Avenue

- Culvert improvements to increase the hydraulic capacity of Leclaire Avenue. Increase the existing opening from a twin - 7-foot x 4.6-foot box culvert to a twin - 10-foot x 5-foot box culvert

- A new 6,600 linear-foot diversion conduit (6-foot x 4-foot) from 149th Street and Kilpatrick along 149th Street up to Keystone Avenue and north on Keystone Avenue up to the existing diversion conduit on Natalie Creek near Pulaski Road

- Culvert improvements to increase the hydraulic capacity of Karlov Avenue. Increase the existing opening from (3) 4-foot x 2.83-foot culverts to one box culvert of 14-foot x 3.5-foot

- Construct an enclosed 270 linear-foot concrete lined channel from Keystone Avenue to Pulaski Road to tie the new diversion conduit with the existing diversion conduit

- Construct a 600 linear-foot floodwall upstream of Leclaire Avenue to protect the inundated properties along both the banks

With the above project components, the modeled peak flow at Lavergne Avenue is reduced from 410 cfs to 167 cfs, at Kilpatrick Avenue the peak flow is reduced from 514 cfs to 77 cfs, and at Keystone Avenue the peak flow is reduced from 278 cfs to 188 cfs. Approximately 130 properties are protected from flooding and a non-structural measure such as floodproofing or acquisition is recommended for five properties that would be subject to flooding should the recommended alternative be implemented.

Table 3.4.40 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for NTCR-G1.

Table 3.4.40: Alternative Condition Flow & WSEL Comparison for Problem Group NTCR-G1

Location	Station	Existing Conditions		Alternative NTCRG1-A4	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Downstream of Lavergne Avenue	17646	640.52	410	639.27	210
Upstream of 151st Street	16239	638.99	435	636.74	242
Upstream of 149th Street	14538	633.64	514	631.73	84
Upstream of Kenton Avenue	13666	630.75	462	628.53	98
Upstream of Karlov Avenue	9225	614.31	291	613.48	186
Upstream of Keystone Avenue	8972	614.07	279	612.93	190

3.4.3.8.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.4.41** lists the alternative analyzed in detail. The recommended alternative consists of a new reservoir in Oak Forest, a new diversion conduit in Midlothian and culvert improvements along Natalie Creek. **Figure 3.4.11** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.4.41: Midlothian Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group NTCR-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Water Quality Benefit	Involved Community
NTCR-G1	NTCRG1-A4	New detention facility, new diversion conduit and culvert improvements	0.24	$14,700,000	$61,940,000	132 Structures	No Impact	Oak Forest and Midlothian

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.4.4 Recommended Alternatives, Midlothian Creek Subwatershed

Table 3.4.42 summarizes the recommended alternatives for the Midlothian Creek subwatershed. The District will use data presented here to support prioritization of a countywide stormwater CIP.

Table 3.4.42: Midlothian Creek Project Alternative Matrix to Support District CIP Prioritization, All Problem Groups

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Structures & Roadways Protected	Water Quality Benefit	Involved Community
MTCR-G1	MTCRG1-A1	Earthen levee and Interior drainage	0.08	$134,000	$1,710,000	25 Structures	No Impact	Tinley Park
MTCR-G2	MTCRG2-A1	Stream bank stabilization at Oak Park Avenue and 172nd Street and also at Hickory Street and 66th Court	0.71	$1,110,000	$1,569,000	4 Structures	No Impact	Tinley Park
MTCR-G3	MTCRG3-A4	Replace crossings	0.01	$37,000	$3,455,000	23 Structures, 2 Roadways	No Impact	Oak Forest
MTCR-G4	MTCRG4-A4	Replace crossings and construct floodwall	0.04	$1,143,000	$27,700,000	12 Structures, 2 Roadways	No Impact	Oak Forest
MTCR-G5	MTCRG5-A4	Detention pond and earthen levee	< 0.01	$58,000	$21,000,000	25 Structures	No Impact	Tinley Park
MTCR-G6	MTCRG6-A1	Channel Improvements	0.23	$110,000	$479,000	25 Structures	No Impact	Robbins
NTCR-G1	NTCRG1-A4	New detention facility, new diversion conduit and culvert improvements	0.24	$14,700,000	$61,940,000	132 Structures	No Impact	Oak Forest and Midlothian

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.5 North Creek

The North Creek subwatershed encompasses approximately 23 square miles (19.46 in Cook County, 1.33 in Will County and 2.16 in Lake County) within the Little Calumet River watershed. There are seven tributaries within the subwatershed, including North Creek, totaling over 23 stream miles. **Table 3.5.1** lists the communities that lie within the subwatershed and the associated drainage area for each community contained within the subwatershed.

Table 3.5.1: Communities Draining to North Creek Subwatershed Within Cook County

Community	Tributary Area (mi^2)
Crete	<0.01
Ford Heights	<0.01
Glenwood	0.65
Lansing	1.95
Lynwood	4.29
Sauk Village	2.47
Unincorporated Cook County	10.09

Table 3.5.2 lists the land use breakdown by area within the North Creek subwatershed. **Figure 3.5.1** provides an overview of the tributary area of the subwatershed. Reported stormwater problem areas and proposed alternative projects are also shown on the figure, and are discussed in the following subsections.

Table 3.5.2: Land Use Distribution for North Creek Subwatershed Within Cook County

Land Use	Acres	%
Commercial/Industrial	635	5
Forest/Open Land	3,477	28
Institutional	197	2
Residential	3,504	28
Transportation/Utility	588	5
Water/Wetland	252	2
Agricultural	3,783	30

Within the North Creek subwatershed, a total of 23.4 stream miles were studied among the seven tributaries: North Creek, Lansing Ditch, Lansing Ditch Tributary A, Lansing Ditch East Tributary, Lansing Ditch Torrence Tributary, Lansing Ditch West Tributary, and Lansing Ditch Lynwood Tributary.

- Lansing Ditch (NCLD) – The tributary extends from upstream of 225th Street in Sauk Village to the confluence with North Creek north of 189th Street and Burnham Avenue in Lansing.

- Lansing Ditch East Tributary (LDET) – The tributary extends from 231st Street/Steger Road to the confluence with Lansing Ditch just upstream of Sauk Trail Road in Sauk Village.

- Lansing Ditch Tributary A (LDTA) – The tributary extends from 223rd Street west of Burnham Avenue to the confluence with Lansing Ditch downstream of Sauk Trail Road.

- Lansing Ditch West Tributary (LDWT) – The tributary extends from approximately 1,000 feet west of Torrence Avenue to the confluence with Lansing Ditch downstream of Sauk Trail Road.

- Lansing Ditch Torrence Tributary (LDTT) – The tributary extends from the southeast quadrant of Lincoln Highway/US 30 and Torrence Avenue to the confluence with Lansing Ditch just downstream of the EJ&E Railroad tracks.

A 6.5′x4′ diversion culvert is located on Lansing Ditch just downstream of the confluence of Lansing Ditch and Lansing Ditch Torrence Tributary. The purpose of the culvert is to allow low flows to pass through, but to divert higher flows to the Woodland Reservoir. Backflow generated by the culvert will flow in the reverse direction along Torrence Tributary to a weir located approximately 1,000 feet upstream of the confluence with Lansing Ditch, with a spillway entering into Woodland Reservoir.

- Lansing Ditch Lynwood Tributary (LDLT) – The tributary begins at a flow split from Lansing Ditch located just downstream of 202nd Street near the Lansing Municipal Airport in Lynwood. A weir was originally constructed at this flow split to divert low flows down Lynwood Tributary, but this weir is damaged and is no longer functional. Lynwood Tributary ends at the confluence with North Creek near Torrence Avenue in Unincorporated Cook County.

- North Creek (NOCR) – North Creek extends from just east of Wentworth Avenue in Lansing to its confluence with Thorn Creek in Thornton.

The North Creek subwatershed contains one major detention facility, the Dr. Mary Woodland Reservoir, as well as other smaller detention areas, both natural and manmade.

- Dr. Mary Woodland Reservoir – The largest storage reservoir in the North Creek subwatershed is the Dr. Mary Woodland Reservoir, located south of Lincoln Highway and east of Torrence Avenue in Lynwood. This reservoir, also known as the Lynwood Reservoir, was built in 1988 and provides approximately 1,089 acre-feet of storage. The facility serves to detain flow generated upstream of the confluence of Lansing Ditch and Lansing Ditch–Torrence Tributary. The basis of design was to provide enough detention during the 100-year frequency storm to keep flows within the banks of Lansing Ditch downstream of the reservoir.

- Sandpit 2 – Sandpit 2 is located adjacent to Lansing Ditch, north of Sauk Trail Road and south of the EJ&E railroad tracks. The Sandpit 2 area was once used for mining, but is now Cook County Forest Preserve property and functions as a pond. There is no controlled inlet to the pond, but it receives overbank flows at the 25-year storm frequency and greater from Lansing Ditch and Lansing Ditch–Tributary A.

- Lansing Country Club Reservoir – A reservoir is located in the Lansing Country Club, at the upstream end of North Creek east of Wentworth Avenue and south of 186th Street. It was assumed that all flows originating upstream of

Wentworth Avenue are routed through the reservoir. The reservoir outlets just downstream of an access road running along the pond near the Illinois-Indiana border.

3.5.1 Sources of Data

3.5.1.1 Previous Studies

Previous documents were made available pertaining to the Dr. Mary Woodland Reservoir, as listed below:

- Design Folder, Little Calumet Watershed, Lynwood Reservoir, Project 77-236-AF, Cook County, Illinois, Volume I, undated, by PRC Consoer Townsend.

- *Supplemental Hydrologic and Hydraulic Analysis (Three Pond Reservoir), Lynwood Retention Reservoir,* February 1984, for the Metropolitan Sanitary District of Greater Chicago, by PRC Consoer Townsend.

The above studies were used to supplement the HEC-RAS hydraulic model with respect to the modeling of the Mary Woodland Reservoir. During Phase A of the project, additional survey, topography, precipitation, stream flow, land use and soils data needed for the development of the North Creek subwatershed model were identified and collected.

3.5.1.2 Water Quality Data

Water quality data for the North Creek subwatershed is collected by the Illinois Environmental Protection Agency (IEPA). IEPA has assessed water quality at one monitoring station in the North Creek subwatershed as part of the Ambient Water Quality Monitoring Network (AWQMN). This water quality monitoring station (HBDA-01) is within the Sweet Woods Forest Preserve, part of the Forest Preserve District of Cook County.

IEPA's 2008 Integrated Water Quality Report, which includes the Clean Water Act (CWA) 303(d) and the 305(d) lists, identifies reach IL_HBDA-01 (North Creek) as impaired for Aquatic Life designated uses, with potential causes being sedimentation/siltation and the chemicals aldrin and hexachlorobenzene. Additionally, Stage 1 Total Maximum Daily Load (TMDL) analysis has been developed for North Creek reach IL_HBDA-01 for dissolved oxygen.

NPDES point source discharges within the North Creek subwatershed are listed in **Table 3.5.3**. In addition to the point source discharges listed, municipalities discharging to North Creek or its tributaries are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement six minimum control measures for limiting runoff pollution to receiving systems. Also as part of the Phase II Stormwater Permit Program, construction sites disturbing greater than 1 acre of land are required to get a construction permit.

Table 3.5.3: Point Source Dischargers in North Creek Area

Name	NPDES	Community	Receiving Waterway
Paradise MHP–Chicago Heights	IL0026794	Chicago Heights	Lansing Ditch
Einoder Sand Pit	IL0062502	Chicago Heights	Lansing Ditch

Note: NPDES facilities were identified from the USEPA Water Discharge Permits Query Form at http://www.epa.gov/enviro/html/pcs/pcs_query_java.html.

3.5.1.3 Wetland and Riparian Areas

Figures 2.3.6 and **2.3.7** contain mapping of wetland and riparian areas in the Little Calumet River Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 772 acres of wetland areas in the North Creek subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.5.1.4 Floodplain Mapping

The effective FEMA FIS, published in August 2008, uses hydrologic models which were developed by IDNR-OWR in the late 1990s using HEC-1. The hydraulic model was also developed by IDNR-OWR in the late 1990s using HEC-RAS, FEQ and HEC-2. The North Creek detailed study was revised in 2008 from the confluence with Thorn Creek to Lansing Ditch Lynwood Tributary. The HEC-RAS model was not available for review. An FEQ model encompassing North Creek from Wentworth Avenue to the confluence with Lansing Ditch Lynwood Tributary, Lansing Ditch, Lansing Ditch Tributary A, Lansing Ditch West Tributary, Lansing Ditch East Tributary, Lansing Ditch Lynwood Tributary and Lansing Ditch Torrence Tributary was available.

As part of the FEMA Map Modernization Program, the ISWS prepared DFIRMs for Cook County, including the North Creek subwatershed, effective August 2008. **Appendix A** includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.5.1.5 Stormwater Problem Data

Table 3.5.4 summarizes reported problem areas reviewed as a part of the DWP development. The problem area data was obtained primarily from Form B questionnaire response data provided by watershed communities to the District. Problems are classified in **Table 3.5.4** as regional or local. This classification is based on a process described in **Section 2.2.1** of this report.

Table 3.5.4: Community Response Data for North Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
BL01	Bloom Township	Storm sewer flow restriction, other	Steger Road from Wallace Avenue to Indiana State Line	Beaver dams, siltation causing restriction	Local	Primarily outside of North Creek watershed; portion within watershed is a local storm sewer system problem
BL02	Bloom Township	Storm sewer flow restriction	Sauk Trail Road from Western Avenue to Torrence Avenue	Siltation of culvert causing restriction	Local	Local drainage problem not located on a regional waterway
BL04	Bloom Township	Storm sewer flow restriction	Glenwood Lansing Road from Glenwood Dyer Road to Indiana State Line	Undersized trunk storm sewer; siltation and vegetation	Local	Problem not located on a regional waterway. This is a local storm sewer system problem
BL07	Bloom Township	Siltation	Stony Island Avenue from Joe Orr Road to 183rd Street	Silt debris accumulating under bridge	Local	Local drainage problem not located on a regional waterway
BL08	Bloom Township	Storm sewer flow restriction	Torrence Avenue from Steger Road to Sauk Trail Road	Undersized storm sewer, high water level at outfall; siltation and vegetation	Local	Problem not located on a regional waterway. This is a local storm sewer problem. Addressing item BL09 (Alternative LDETG1-A4) may alleviate some flow restriction near Sauk Trail Road
BL09	Bloom Township	Overbank flooding	West side of Torrence Avenue, south of Katz Corner Road	Flooding due to roadway overtopping of Katz Corner and backflow to Torrence Avenue	Regional	Increase hydraulic opening of Torrence Avenue and Katz Corner Road crossings (Alternative LDETG1-A4)

Table 3.5.4: Community Response Data for North Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
CCH5	Lansing	Overbank flooding	Wentworth Avenue at North Creek	Surcharging of culvert conveying North Creek under subdivision west of Wentworth Avenue due to backflow from North Creek/Lansing Ditch confluence	Regional	Disconnect local system from North Creek conveyance culvert; detain local flows until water level in North Creek subsides (Alternative NOCRG1-A6)
GLW1	Glenwood	Overbank flooding	187th Street/193rd Street/193rd Place/194th Street/Minerva Avenue	Flooding within local subdivision; located on local tributary to North Creek	Local	Problem not located on a regional waterway; this is a local stormwater conveyance problem
GLW4	Glenwood	Bank erosion & sedimentation, storm sewer restriction, water quality, wetland/ riparian areas at risk	Cottage Grove and Glenwood Lansing Road	Local channel and storm sewer system backups	Local	Flooding issue not located on a regional waterway; this is a local problem
LAN1	Lansing	Overbank flooding	South of 188th Street and Torrence Avenue to North of 188th Place and Park Avenue	Overbank flooding in topographically flat area causes overtopping of local roads and flooding on residential properties	Regional	Overtopping of local roadways is a local issue. Sufficient land was not available to address flooded properties in this area. Such properties are candidates for protection using non-structural measures, such as floodproofing or acquisition
LAN2	Lansing	Basement flooding	Between Wildwood Avenue and Greenbay Avenue, and North Creek and 190th Street	Basement backups caused by high water level at outfall for local sewer system	Local	This is a local storm sewer system problem

Table 3.5.4: Community Response Data for North Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
LAN3	Lansing	Basement flooding	South Manor to Otto Street, and Burnham Avenue to Wentworth Avenue	Basement backups caused by high water level at outfall for local sewer system and water entering homes via overland flooding.	Local	Problem not located on a regional waterway; this is a local storm sewer system problem.
LAN6	Lansing	Bank erosion and sedimentation	Torrence Avenue to Stony Island	Beaver dams, debris in culverts along North Creek	Channel Maintenance	Removal of debris to be addressed by stream maintenance
LYN1	Lynwood	Overbank flooding, ponding, storm sewer restriction, bank erosion and sedimentation	202nd Street and 203rd Street/ Burnham Avenue	Widespread flooding due to overbank flooding of Lansing Ditch and Lynwood Tributary, undersized hydraulic openings of crossings	Regional	Construct regional detention facility and increase hydraulic opening of undersized hydraulic structures (Alternative NCLDG1-A7)
LYN2	Lynwood	Overbank flooding of local detention facility, basement flooding, ponding, storm sewer restriction, bank erosion and sedimentation at pond.	Joe Orr Road and Bluestem Parkway	Flooding due to local storm sewer system backups and local detention pond performance	Local	Problem not located on a regional waterway; this is a local storm sewer system problem
LYN3	Lynwood	Overbank flooding, basement flooding, ponding, storm sewer restriction, bank erosion and sedimentation	Lincoln Lansing Drainage Ditch and Lake Lynwood	Lack of channel conveyance capacity and undersized hydraulic strictures at crossings causing overbank flooding	Regional	Construct regional detention facility and increase hydraulic opening of undersized hydraulic structures (Alternative NCLDG1-A7)
LYN5	Lynwood	Silt, sedimentation	Near Glenwood Lansing Road and Burnham Avenue	Sedimentation at cross culvert under roadway	Local	Local authority responsible for maintenance of culvert

Table 3.5.4: Community Response Data for North Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
SKV1	Sauk Village	Pavement flooding	Route 30 at Torrence Avenue	Pavement flooding of IDOT roadway due to undersized culvert	Local	Roadway flooding issue not located on a regional waterway (less than 0.5 acre drainage area); this is a local problem
SKV2	Sauk Village	Overbank flooding	Torrence Avenue and 223rd Street/ Katz Corner Road	Pavement flooding due to undersized culvert	Regional	Increase hydraulic opening of crossing under Katz Corner Road (Alternative LDETG1-A4)

3.5.1.6 Near Term Planned Projects

On North Creek, Cook County Highway Department has a scheduled project for Wentworth Avenue in Lansing which includes upgrading the existing 4-foot by 4-foot box culvert conveying North Creek under Wentworth Avenue to a 6-foot by 4-foot box culvert. This is consistent with the recommendation in this report to replace and upgrade the culvert to a 6-foot by 4-foot box, as discussed in more detail in the recommendations section.

On Lansing Ditch, the Lansing Municipal Airport is completing a Stormwater Master Plan, prepared by Crawford, Murphy and Tilly, Inc., which details development plans for the property bound by Glenwood Lansing Road on the north, Burnham Avenue on the west, Lansing Ditch on the east, and Lansing Ditch Lynwood Tributary on the south. The preliminary recommendation includes compensatory storage of over 400 acre-feet for Lansing Ditch in the existing farm field southeast of the confluence of Lansing Ditch and Lansing Ditch Lynwood Tributary. This is consistent with the recommendation made in the alternatives analysis section of this report for the placement of a detention facility.

3.5.2 Watershed Analysis

3.5.2.1 Hydrologic Model Development

3.5.2.1.1 Subbasin Delineation. The North Creek subwatershed was delineated based upon LiDAR topographic data developed by Cook County in 2003. There are 38 subbasins ranging in size from 0.005 to 2.81 square miles with an average size of 0.587 square miles.

Hydrologic Parameter Calculations. Curve numbers (CN) were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in **Section 1.3.2**, with lookup values for specific combinations of land use and soil data presented in **Appendix C**. An area-weighted average of the CN was generated for each subbasin.

Clark's unit hydrograph parameters were estimated using the method described in **Section 1.3.2**. **Appendix G** provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.5.2.2 Hydraulic Model Development

3.5.2.2.1 Field Data, Investigation, and Existing Model Data The FEMA effective hydraulic model was developed by IDNR-OWR in the late 1990s using HEC-2 and FEQ. A HEC-RAS model was also developed, but was not available for review. The FEQ model encompassing North Creek (from Wentworth Avenue to the confluence with Lansing Ditch Lynwood Tributary), Lansing Ditch, Lansing Ditch Tributary A, Lansing Ditch West Tributary, Lansing Ditch East Tributary, Lansing Ditch Lynwood Tributary and Lansing Ditch Torrence Tributary met District criteria as identified in Section 6.3.3.2 of the CCSMP and was therefore used to support DWP development.

Where available, the HEC-2/FEQ cross section and hydraulic structure information were used, with the Cook County 2-foot contours used in the overbanks. A field reconnaissance was conducted in June 2007. Information was compiled on stream crossings, land use, and channel conditions. Stream crossing data was compared to the data entered into the models. To supplement the model, 54 hydraulic structures throughout the subwatershed, including immediate upstream and downstream cross sections, were surveyed, as well as 21 additional cross sections along North Creek, Torrence Tributary, and Lansing Ditch.

The Manning's n-value at each cross section was estimated using a combination of aerial photography and photographs from field survey and field reconnaissance. The horizontal extent of each type of land cover and the associated n-value for each cross section were manually entered in to the HEC-RAS hydraulic model. The initial n-values were used as a model starting point and were adjusted within the provided ranges during calibration. All the n-values were manually adjusted using the HEC-RAS cross-sectional data editor.

The n-values were increased where buildings are located within the floodplain to account for conveyance loss. The n-values in these areas may range from 0.060 for areas with few buildings to 0.15 for fully developed areas. If significant blockage is caused by buildings in the flood fringe, the developed areas were modeled as ineffective flow. **Table 3.5.5** lists the channel and overbank ranges of n-values that were used for the North Creek subwatershed model.

Table 3.5.5: Channel and Overbank Associated Manning's n-Values[1]

Tributary	Range of Channel n-Values	Range of Overbank n-Values
NOCR	0.05 – 0.06	0.08 – 0.15
NCLD	0.06 – 0.07	0.08 – 0.12
LDET	0.05	0.08 – 0.10
LDTA	0.065	0.08 – 0.12
LDWT	0.06	0.08 – 0.10
LDTT	0.06	0.08 – 0.10
LDLT	0.06 – 0.08	0.08 – 0.12

[1]**Source**: Open Channel Hydraulics, Chow 1959

3.5.2.2.2 Boundary Conditions A downstream boundary condition was required within the North Creek hydraulic model at its confluence with Thorn Creek. The boundary condition was determined by extracting the flow output hydrograph from the HEC-RAS model and inputting it as an upstream flow for the Thorn Creek model. Once the Thorn Creek HEC-RAS model was run, the stage hydrograph at the confluence generated by the Thorn Creek model was used as the downstream boundary condition in the North Creek model. This allowed the modeling of any backwater effects that may be present due to the confluence of the two creeks.

3.5.2.3 Calibration and Verification A detailed calibration was performed for the North Creek subwatershed using historic gage records under the guidelines of Chapter 6 of Cook County Stormwater Management Plan. Three historical storms: July 1996, April 2006 and September 2008, were evaluated based on the stream gage flows, precipitation totals and records of flooding in the North Creek subwatershed and were found to be applicable for calibration and verification.

For the calibration storms, Illinois State Water Survey (ISWS) Cook County precipitation gages, National Weather Service (NWS) recording and non-recording gages, and Community Collaborative Rain, Hail & Snow Network (CoCoRAHS) precipitation amounts were used. Theissen polygons were developed for each storm based on the rain gages available for that storm. The gage weightings for the recording and non-recording gages were computed in ArcGIS for each subbasin. USGS Gage 05536265 on Lansing Ditch near Lansing, IL (the only stream gage in the North Creek subwatershed) was used for calibration. This gage is at latitude 41°31′42″ longitude 87°31′45″ (NAD27), on the upstream side of the 204th Street crossing, just upstream of the Lansing Ditch and Lansing Ditch Lynwood Tributary flow split. The datum of the gage is 607.16 feet NGVD29 (606.84 NAVD88). Stage data is available at this gage from 5/1/1989 through 9/30/2007.

Runoff hydrographs were developed using HEC-HMS and routed through the North Creek hydraulic model. The stages and flows produced for each calibration storm were compared to the observed stream gage data. During calibration of the North Creek subwatershed model, the curve number, directly connected impervious area percentage, and lag times were adjusted so that the peak flow rate, hydrograph shape and timing, and total volume matched the observed hydrographs within the CCSMP's criteria.

During calibration, the curve number and directly connected impervious percentage were adjusted by -5% and -10%, respectively. The Clark's storage coefficient R was increased by +25%.

After the final adjustments to the HEC-HMS and HEC-RAS models, the flow and stage comparisons to the observed data were within the CCSMP's criteria. **Table 3.5.6** shows the comparison of the flows and stages for all calibration storms. **Figures 3.5.2** and **3.5.3** show the calibration results for the July 1996 and April 2006, respectively.

Table 3.5.6: North Creek Subwatershed Calibration Results

	Observed		Modeled		CCSMP's Criteria[1]	
Storm Event	Flow	Stage	Flow	Stage	Percentage Difference in Peak Flow	Difference in Stage (feet)
Jul-96	208	616.4	254	616.0	22.0%	0.4
Apr-06	202	616.0	258	616.0	27.7%	0.0
Sep-08	unknown[2]	616.4[3]	252	615.9	unknown[2]	0.5

[1]Flow within 30% and stage within 6 inches.
[2]Flow data not available for September 2008 storm event.
[3]Only peak stage available for September 2008 event.

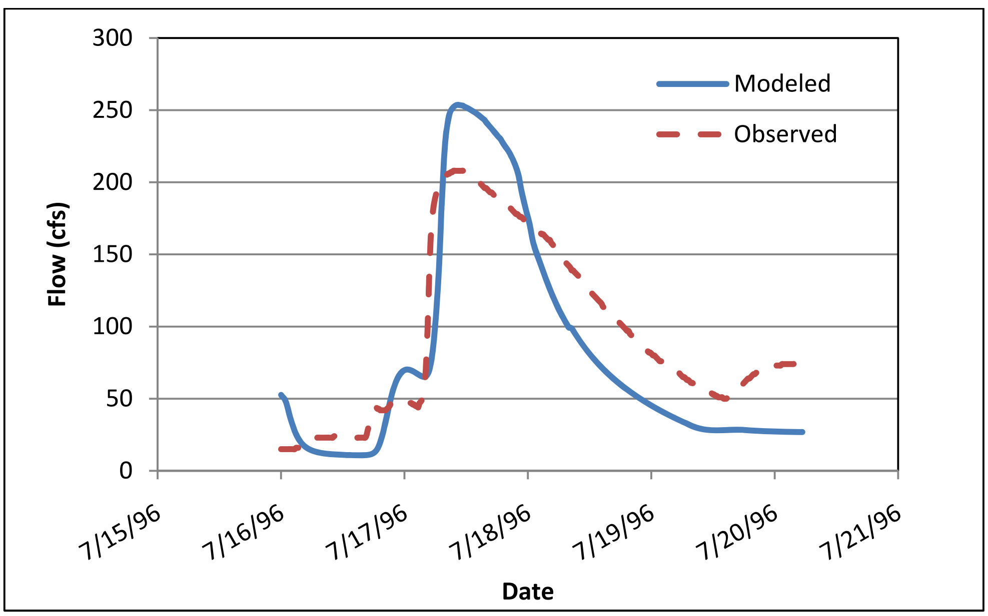


Figure 3.5.2: North Creek Subwatershed Calibration Results, July 1996 Storm Event

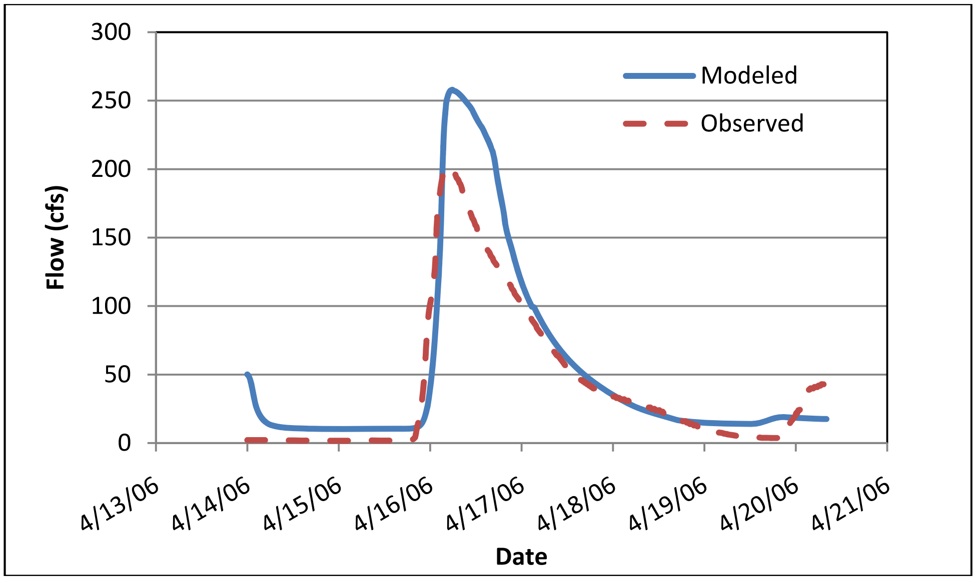


Figure 3.5.3: North Creek Subwatershed Calibration Results, April 2006 Storm Event

The hydraulic model was verified by comparing the hydraulic model results with available high water marks for the September 2008 storm event. High water marks were provided by the Illinois Department of Natural Resources (IDNR)**. Table 3.5.7** shows the comparison of the model results to the surveyed high water marks.

Table 3.5.7: Calumet Union Drainage Ditch Subwatershed Verification Results

Storm Event	Location	Field Elevation (feet)	Model Elevation (feet)
Sep-08	Gage 2 - North Creek at Oakwood Avenue (u/s)	609.99	610.07
Sep-08	Gage 3 - Lansing Ditch, Burnham Avenue at 189th Street (u/s)	610.90	610.87
Sep-08	Gage 6 - Lansing Ditch at Lynwood Gage (u/s)	616.43	615.89
Sep-08	Gage 7 - Lansing Ditch, trailer park d/s of US 30 at bridge crossing (d/s)	622.73	623.25
Sep-08	Gage 9 - Lansing Ditch at Sauk Trail Road (d/s)	631.86	631.78

At all locations, the modeled elevation is within 0.5 feet of the observed high water elevation, which is within the MWRDGC's criteria.

3.5.2.4 Existing Conditions Evaluation

3.5.2.4.1 Flood Inundation Areas The existing conditions hydraulic model was run for the 2- through 500-year storm events. A critical duration analysis was performed for the North Creek subwatershed hydraulic model. The 100-year, 1-, 3-, 6-, 12-, 24-, 48- and 72-hour storm events were run to determine the critical duration. The 48-hour storm event was found to be representative of the critical duration downstream of the Mary Woodland Reservoir, Lansing Ditch–Torrence Tributary, and Lansing Ditch Tributary A. The 12-hour duration was found to be representative of the critical duration storm event for Lansing Ditch upstream of the reservoir, Lansing Ditch East Tributary, and Lansing Ditch West Tributary.

Figure 3.5.1 shows inundation area produced for the 100-year critical duration storm event.

*3.5.2.4.2 **Hydraulic Profiles*** Hydraulic profiles for North Creek and its tributaries are shown in **Appendix H**. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100- and 500-year recurrence interval design storm events.

3.5.3 Development and Evaluation of Alternatives

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. **Table 3.5.8** summarizes problem areas identified through hydraulic modeling of the North Creek subwatershed.

Problem areas that were hydraulically interdependent or otherwise related were grouped for alternatives analysis. Each project group is addressed in terms of combined damages and alternatives/solutions.

Table 3.5.8: Modeled Problem Definition for the North Creek Subwatershed

Problem ID	Group ID	Location	Recurrence Interval (year) of Flooding	Associated Form B	Resolution in DWP
LDET1	LDET-G1	Lansing Ditch East Tributary, Katz Corner Road west of Plum Grove Road, Sauk Village	50,100	BL09, SKV2	LDETG1-A4
NCLD1	NCLD-G1	Lansing Ditch, East of 202nd Street and Burnham Avenue, near Lansing Municipal Airport	10, 25, 50, 100	LYN1	NCLDG1-A7
NCLD2	NCLD-G1	Lansing Ditch Lynwood Tributary, along tributary and Lake Lynwood	50, 100	LYN3	NCLDG1-A7
NCLD3	NCLD-G2	Lansing Ditch, near Bridge Street and Valerie Drive, Chicago Heights	50, 100	n/a	NCLDG2-A7
NCLD4	NCLD-G3	Lansing Ditch, Torrence Avenue and 223rd Street/Sauk Trail Road, Sauk Village	50, 100	n/a	NCLDG3-A4
NOCR1	NOCR-G1	North Creek, Wentworth Avenue to Grand Trunk Railroad, Lansing	2, 5, 10, 25, 50, 100	CCH5	NOCRG1-A6
NOCR2	NOCR-G2	North Creek, North of 188th Street between Oakwood Avenue and Burnham Avenue, Lansing	25, 50, 100	LAN1	Floodproofing/ Acquisition

Damage assessment, technology screening, alternative development and alternative selection were performed by problem grouping, since each group is independent of the other. Each problem group is evaluated in the following sections by problem group ID.

3.5.3.1 LDET-G1 – Lansing Ditch East Tributary Problem Group 1

3.5.3.1.1 Problem Definition

The LDET-G1 problem area consists of overbank flooding in the vicinity of the Katz Corner Road crossing. The location of flooding is from approximately 150 feet upstream of the Katz Corner Road crossing to just downstream. The 50-year flow (466 cfs) and the 100-year flow (590 cfs) exceed the capacity of the existing culverts. The existing culvert crossing consists of two (2), 6-foot span/5.5-foot rise conspan arches and one 5-foot span/3-foot rise conspan arch.

LDET-G1 includes flooding of one structure and overtopping of one arterial roadway crossing. This area is also inundated on the FEMA DFIRM map. The roadway can be overtopped at an approximate elevation 636 feet; the roadway flooding does not occur directly above the culvert, but at the low spot in the road, approximately 175 feet west of the crossing. The 50-year water surface elevation is 636.3 feet, and the 100-year water surface elevation is 637.3 feet.

3.5.3.1.2 Damage Assessment, LDET-G1

Damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. Critical duration analysis was performed to determine the highest flood stages for North Creek and its tributaries. These stages were used to calculate the depth of flooding and to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.5.9** lists the estimated damages for the problem group.

Table 3.5.9: Estimated Damages for North Creek Subwatershed, Problem Group LDET-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
LDET-G1	Property	$99,570	Structures at risk of flooding
	Transportation	$14,935	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.5.3.1.3 Technology Screening, LDET-G1

Several combinations of technologies were analyzed to address the flooding problems associated with LDET-G1. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table**

3.5.10 summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.5.10: Evaluation of Flood Control Technologies for North Creek Subwatershed, Problem Group LDET-G1

Flood Control Option	Feasibility
Detention Facilities	No. Limited space is available
Conveyance Improvement – Culvert/Bridge Replacement	Yes. Increase the opening at Sauk Trail Road
Conveyance Improvement – Channel Improvement	No. Limited ROW is available
Conveyance Improvements – Diversion	No. No available outfall is downstream
Flood Barriers, Levees/Floodwalls	Yes. May require detention

3.5.3.1.4 Alternative Development

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.5.11** summarizes flood control alternatives developed for Problem Group LDET-G1.

Table 3.5.11: Flood Control Alternatives for Problem Group LDET-G1

Alternative	Location	Description
LDETG1-A1	Individual Residences	Construct a floodwall to protect property. While this is beneficial to the property, it does not address the roadway flooding problem
LDETG1-A2	Katz Corner Road	Upgrade existing crossing from 2, 6-ft span/5.5-ft rise con/span arches and one 5-ft span/3-ft rise con/span arch, to a twin, 10-ft by 7-ft box culvert
LDETG1-A3	Katz Corner Road	Remove debris from upstream side of culvert
LDETG1-A4	Katz Corner Road	Upgrade existing culvert and remove debris (combination of LDETG1-A2 and LDETG1-A3)

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the LDET-G1 Problem Group.

3.5.3.1.5 Alternative Evaluation and Selection

Alternatives included in **Table 3.5.11** were evaluated to determine their effectiveness and produce the data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.5.13** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative for Problem Group LDET-G1. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, thus costs were not calculated for these alternatives.

Alternative LDETG1-A4 from **Table 3.5.11** provides the preferred alternative for Problem Group LDET-G1. By increasing the opening area of the crossing with a twin, 10-foot by 7-foot box culvert, the 100-year water surface elevation will be reduced to

636.2 feet, which is 0.1 feet above the natural water surface elevation and 1.1 feet below the existing 100-year elevation.

Table 3.5.12 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for LDET-G1.

Table 3.5.12: Alternative Condition Flow & WSEL Comparison for Problem Group LDET-G1

Location	Station	Existing Conditions		Alternative LDETG1-A4	
		Max WSEL (feet)	Max Flow (cfs)	Max WSEL (feet)	Max Flow (cfs)
Upstream of Sauk Trail Road	ET1 2971.89	637.57	582	636.48	586

3.5.3.1.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.5.13** lists the alternative analyzed in detail. The recommended alternative consists of replacement of the existing con/span culvert crossing at Katz Corner Road with a double, 10-foot by 7-foot box culvert. **Figure 3.5.4** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.5.13: North Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group LDET-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
LDET-G1	LDETG1-A4	Replace crossing	0.29	$82,000	$287,000	9 Structures, 1 Roadway	No impact	Sauk Village

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.5.3.2 NCLD-G1 – Lansing Ditch Problem Group 1

3.5.3.2.1 Problem Definition, NCLD-G1

The NCLD-G1 problem area consists of overbank flooding along both banks of Lansing Ditch approximately 2,700 feet south of 202nd Street, as well as into the Lansing Municipal Airport property north of 202nd Street. Flooding also occurs along Lansing Ditch Lynwood Tributary over both banks from the flow split with Lansing Ditch west to Burnham Avenue as well as from Ash Lane downstream to approximately the private entrance downstream of 201st Street.

The storm sewer for the Lake Lynwood subdivision outlets to Lynwood Tributary at 201st Street. This storm sewer is directly connected to Lake Lynwood; the storm sewer from the neighborhood is routed to the lake, and the lake's outflow is through the hydraulic connection to Lynwood Tributary. The outfall pipe is near the bottom of the Lynwood Tributary cross section, so the sewer can only drain by pressure flow when the ditch flow line is above the pipe crown elevation. Since the tributary does not have a positive slope throughout the whole reach, it commonly has a high water surface elevation, even during smaller storm events, which may cause reduced outflow capacity of the pipe. This contributes to the sewer backing up through the subdivision, and result in intermittent areas of flooding throughout the subdivision. Since this problem is associated with the subdivision's drainage system, it is considered a local problem and no alternatives have been provided herein. However, overbank flooding of Lynwood Tributary is considered a regional problem, and any alternatives which lower the stage of the tributary will have a positive effect on the subdivision's drainage system.

Along Lansing Ditch, there are two residential structures flooded, and the Lansing Municipal Airport floods, including overtopping of the runways. Along Lynwood Tributary, 57 residential structures are flooded, the majority within the Lake Lynwood subdivision. Ten local streets and one arterial, Burnham Avenue, flood. This area is also inundated on the FEMA DFIRM map, although the DFIRMs show a smaller inundation area in the portion of the watershed bound by Lansing Ditch on the south and Torrence Avenue on the west.

3.5.3.2.2 Damage Assessment, NCLD-G1

Damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. Critical duration analysis was performed to determine the highest flood stages for North Creek and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.5.14** lists the estimated damages for the problem group.

Table 3.5.14: Estimated Damages for North Creek Subwatershed, Problem Group NCLD-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
NCLD-G1	Property	$2,056,000	Structures at risk of flooding
	Transportation	$308,500	Assumed as 15% of property damage due to flooding; flooding on arterial roadways less than 0.5 feet.
	Recreation	$0	

3.5.3.2.3 Technology Screening, NCLD-G1

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.5.15** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.5.15: Evaluation of Flood Control Technologies for North Creek Subbasin, Problem Group NCLD-G1

Flood Control Option	Feasibility
Detention Facilities	Yes. Potential site for detention in farm fields or increase Mary Woodland Reservoir
Conveyance Improvement – Culvert/Bridge Replacement	Yes. Increase hydraulic capacity of crossings along Lynwood Tributary
Conveyance Improvement – Channel Improvement	Yes. Regrade profile and/or widen cross section along Lynwood Tributary
Conveyance Improvements – Diversion	No. Lynwood Tributary already acts as diversion for Lansing Ditch
Flood Barriers, Levees/Floodwalls	Yes, but will not reduce roadway overtopping

3.5.3.2.4 Alternative Development, NCLD-G1

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.5.16** summarizes flood control alternatives developed for Problem Group NCLD-G1.

Table 3.5.16: Flood Control Alternatives for Problem Group NCLD-G1

Alternative	Location	Description
NCLDG1-A1	Mary Woodland Reservoir	Increase the volume of the existing regional detention facility. Increasing the size of this reservoir had no noticeable effect on downstream peak flows. The reservoir is properly sized to detain the 100-year flow; it is the additional flow from the downstream subbasins that cause the peak flow rates which contribute to flooding
NCLDG1-A2	Lynwood Tributary from Burnham Avenue to North Creek	Regrade Lynwood Tributary to establish positive slope from Burnham Avenue to the confluence with North Creek. Lynwood Tributary was initially constructed to divert water from Lansing Ditch and bypass it to North Creek. By increasing the conveyance capacity of Lynwood Tributary, more water would be diverted from Lansing Ditch, which would result in an increase of flows along the reach and have no positive impact on reducing flooding along the Tributary
NCLDG1-A3	Various sections, Lansing Ditch and Lynwood Tributary	Widen the cross sections to increase the hydraulic capacity of the channels. This alternative did not effectively reduce water surface elevations in the flooding problem area
NCLDG1-A4	Various sections, Lansing Ditch and Lynwood Tributary	Construct levees or floodwalls to restrict the flows to the channels. This alternative did not effectively reduce water surface elevations in the flooding problem area
NCLDG1-A5	Crossings at 198th Street and private drives immediately upstream and downstream of 198th Street	Upgrade opening of culverts to increase hydraulic capacity. Increase private drive upstream of 198th Street from an 11-ft by 6-ft arch to a triple 7-ft by 6.5-ft box culvert; the 198th Street crossing from a triple, 7-ft by 5-ft box culvert to a double, 8-ft by 8.5-ft box culvert, and the crossing downstream of 198th Street from a bridge with a 14-ft span and approximately 7-ft high opening to a double 8-ft by 8.5 ft box culvert

Table 3.5.16: Flood Control Alternatives for Problem Group NCLD-G1

Alternative	Location	Description
NCLDG1-A6	Flow split at Lansing Ditch and Lynwood Tributary, southwest quadrant	Construct detention facility to detain flows above the carrying capacity of Lansing Ditch and Lynwood Tributary. This facility would be in the same location as the one being recommended by Crawford, Murphy & Tilly's stormwater master plan for the airport, but would provide more storage to address impacts further downstream of the airport property. Approximately 700 ac-ft of detention volume is required, which equals an area approximately 1,200 feet by 1,700 feet and 15.5 feet deep (elevation 600.0 to 615.5 feet). A weir would be located on both Lansing Ditch and Lynwood Tributary to divert flows to the pond, with a pump station needed to pump flows out
NCLDG1-A7	Flow split at Lansing Ditch and Lynwood Tributary; crossings on Lynwood Tributary at 198th Street and private drives	Construct detention facility at Lansing Ditch/Lynwood Tributary flow split and upgrade opening of culverts on Lynwood Tributary (combination of alternatives NCLDG1-A5 and NCLDG1-A6)

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the NCLD-G1 Problem Group.

3.5.3.2.5 Alternative Evaluation and Selection, NCLD-G1

Alternatives included in **Table 3.5.16** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.5.18** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, thus costs were not calculated for these alternatives.

Alternative NCLDG1-A7 from **Table 3.5.16** provides the preferred alternative for this problem group. The crossings at 198th Street and at the private drives immediately upstream and downstream of 198th Street have a considerably smaller opening area than the other culverts along Lansing Ditch, and also have low crown elevations. This causes water in the channel to back up and overtop the banks and the roadways. Upgrading the culverts will reduce head on the culverts and decrease the maximum water surface elevation. This must be done in conjunction with upstream detention. A 700 acre-foot detention facility located near the flow split of Lansing Ditch and Lynwood Tributary will reduce peak flow rates through both reaches and decrease instances of flooding.

The Lansing Municipal Airport has plans to expand on the parcel of land north of Lynwood Tributary, so this area was not considered for placement of the detention facility. Additionally, Joe Orr Road is proposed to be expanded, so the area south of 204th Street was not considered available. Due to FAA regulations regarding the placement of open water near runways, the land south of the airport runway on the east side on Lansing Ditch was not considered. Distances from the runway will still need to be considered with the current placement, but it is not prohibitive to its construction. A pipeline runs along 204th Street, further limiting the expansion south of the pond.

Table 3.5.17 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for NCLD-G1.

Table 3.5.17: Alternative Condition Flow & WSEL Comparison for Problem Group NCLD-G1

Location	Station	Existing Conditions		Alternative NCLDG1-A7	
		Max WSEL (feet)	Max Flow (cfs)	Max WSEL (feet)	Max Flow (cfs)
Lansing Ditch, 204th Street (upstream)	LD5 12732	618.63	378	615.96	102
Lansing Ditch, 201st Street (upstream of flow diversion)	LD5 11401	616.46	308	614.85	108
Lynwood Tributary, Burnham Avenue (upstream)	LT1 11652	615.73	172	614.67	81
Lynwood Tributary, 201st Street (upstream)	LT1 5658	614.56	280	613.44	239
Lynwood Tributary, 198th Street (upstream)	LT1 3861	612.90	341	612.49	315

3.5.3.2.6 Data Required for Countywide Prioritization of Watershed Projects, NCLD-G1

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.5.18** lists the alternative analyzed in detail. The recommended alternative consists of the construction of a 700 acre-foot detention facility at the flow split of Lansing Ditch with Lynwood Tributary, as well as the upgrading of the crossings at 198th Street, the private drive upstream of 198th Street, and the private drive downstream of 198th Street. **Figure 3.5.5** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.5.18: North Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group NCLD-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
NCLD-G	NCLDG1-A7	Upgrade 3 crossings, construct 700 ac-ft detention basin	0.03	$2,364,000	$69,500,000	49 Structures, 10 Roadways	Positive	Lansing, Lynwood

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.5.3.3 NCLD-G2 – Lansing Ditch Problem Group 2

3.5.3.3.1 Problem Definition, NCLD-G2

The NCLD-G2 problem area consists of overbank flooding near Bridge Street and associated street flooding in the mobile home park located east of Glenwood Dyer Road in Bloom Township. Overbank flooding occurs just downstream of Glenwood Dyer Road through the Bridge Street crossing to approximately 650 feet downstream of the Bridge Street crossing.

When Bridge Street is flooded, a portion of the mobile home park east of the Bridge Street/Valerie Drive intersection has no access. Bridge Street overtops during the 100-year storm, and the 2- through 100-year storm events have water surface elevations above the crown of the cross-road culverts. Approximately 40 mobile homes are within the 100-year inundation area. Bridge Street and six other side streets also fall within the inundation area. Portions of the channel banks are below the overtopping elevation of Bridge Street, so some flooding will occur even if Bridge Street is not overtopped. The inundation mapping in this portion of the reach encompasses a slightly smaller area than the FEMA DFIRM.

The restriction at the Bridge Street crossing caused by the low crown elevation of the culverts and the relatively small opening area contributes to the flooding in the area. This area was not reported to the District on a Form B report, but was indicated as a flooding concern during community workshops.

3.5.3.3.2 Damage Assessment, NCLD-G2

Damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. Critical duration analysis was performed to determine the highest flood stages for North Creek and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.5.19** lists the estimated damages for the problem group.

Table 3.5.19: Estimated Damages for North Creek Subwatershed, Problem Group NCLD-G2

Problem Group ID	Damage Category	Estimated Damage ($)	Description
NCLD-G2	Property	$1,039	Structures at risk of flooding
	Transportation	$150	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.5.3.3.3 Technology Screening, NCLD-G2

Several combinations of technologies were analyzed to eliminate the flooding problems at this location. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table**

3.5.20 summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.5.20: Evaluation of Flood Control Technologies for North Creek Subwatershed, Problem Group NCLD-G2

Flood Control Option	Feasibility
Detention Facilities	Yes. Increase the volume of Mary Woodland Reservoir
Conveyance Improvement – Culvert/Bridge Replacement	Yes. Increase the hydraulic capacity of crossing at Bridge Street
Conveyance Improvement – Channel Improvement	Yes. Widen the cross section along Lansing Ditch
Conveyance Improvements – Diversion	No. There is no available outfall for diversion
Flood Barriers, Levees/Floodwalls	Yes. This will not reduce roadway overtopping

3.5.3.3.4 Alternative Development, NCLD-G2

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.5.21** summarizes flood control alternatives developed for Problem Group NCLD-G2.

Table 3.5.21: Flood Control Alternatives for Problem Group NCLD-G2

Alternative	Location	Description
NCLDG2-A1	Mary Woodland Reservoir	Increase the volume of the existing regional detention facility. Increasing the size of this reservoir had no noticeable effect on downstream peak flows. The reservoir is properly sized to detain the 100-year flow; it is the additional flow from the downstream subbasins that cause the peak flow rates which contribute to flooding
NCLDG2-A2	Lansing Ditch near Bridge Street and Geneva Drive	Widen the cross section of Lansing Ditch to provide a greater hydraulic capacity in the reach. Widening the cross section of the reach within the available open space along the ditch does not provide the required capacity to reduce peak water surface elevation
NCLDG2-A3	Lansing Ditch near Bridge Street and Geneva Drive	Construct a floodwall to keep the flows within the channel. Constructing a floodwall will protect some of the properties, but will increase the peak water surface elevation at the point where the bridge overtops
NCLDG2-A4	Lansing Ditch, Bridge Street crossing	Upsize the crossing at Bridge Street. Upgrade the existing Bridge Street crossing from two, 6.2-ft W x 3.4-ft H con/span arches to two, 7-ft W x 5-ft H culvert
NCLDG2-A5	Lansing Ditch, Linda Lane (Geneva Drive) crossing	Upsize the crossing at Linda Lane. Backwater from this crossing contributes to the decreased capacity of the Bridge Street crossing. Replace the existing Linda Lane crossing, an 11 foot width bridge opening with a depth of approximately 6 ft; with a 19-ft span crossing with the low chord raised one ft
NCLDG2-A6	Throughout Mobile Home Park	Relocate mobile homes situated on vulnerable sites. A number of mobile homes are located directly adjacent to the banks of Lansing Ditch. These homes should be relocated to different pads within the mobile home park. A flood easement is recommended in the area of the pads remaining in the inundation area

Table 3.5.21: Flood Control Alternatives for Problem Group NCLD-G2

Alternative	Location	Description
NCLDG2-A7	Lansing Ditch – Bridge Street and Linda Lane crossings; various sites throughout Mobile Home Park	Upsize crossings at Bridge Street and Linda Lane, and relocate mobile homes situated on sites which remain vulnerable (combination of alternatives NCLDG2-A4, NCLDG2-A5 and NCLDG2-A6)

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the NCLD-G2 Problem Group.

3.5.3.3.5 Alternative Evaluation and Selection, NCLD-G2

Alternatives included in **Table 3.5.21** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.5.23** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, thus costs were not calculated for these alternatives.

Alternative NCLDG2-A7 from **Table 3.5.21** provides the preferred alternative for this problem group. Under this recommendation, the 100-year water surface elevation at Bridge Street is 623.8 feet, and the overtopping elevation of the roadway is 623.9 feet. Ideally, a minimum one foot of freeboard would be provided; however this would require the roadway to be raised a minimum of two feet, which would require considerable roadway reconstruction. Since Bridge Street is not a major arterial, rather a residential side street, and it is recommended for upgrading for the purpose of eliminating a point where access is cut off, the current recommendation is considered adequate.

Table 3.5.22 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for NCLD-G2.

Table 3.5.22: Alternative Condition Flow & WSEL Comparison for Problem Group NCLD-G2

Location	Station	Existing Conditions		Alternative NCLDG2-A7	
		Max WSEL (feet)	Max Flow (cfs)	Max WSEL (feet)	Max Flow (cfs)
Bridge Street	LD5 19460	623.89	171	623.76	176
Geneva Drive	LD5 18262	623.47	228	623.27	235

3.5.3.3.6 Data Required for Countywide Prioritization of Watershed Projects, NCLD-G2

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.5.23** lists the alternative analyzed in detail. The recommended alternative consists of upgrading the Bridge Street and Linda Lane crossings and relocating mobile homes located close to the banks of Lansing Ditch to other parcels within the mobile home park. **Figure 3.5.6** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.5.23: North Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group NCLD-G2

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Water Quality Benefit	Involved Community
NCLD-G2	NCLDG2-A7	Upgrade 2 crossings, relocate mobile homes	< 0.01	$1,000	$357,000	2 Structures, 1 Roadway	No Impact	Bloom Township

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.5.3.4 NCLD-G3 – Lansing Ditch Problem Group 3

3.5.3.4.1 Problem Definition, NCLD-G3

The NCLD-G3 problem area consists of overbank flooding near the Torrence Avenue crossing south of Sauk Trail Road in Sauk Village. The roadway overtops for the 100-year storm and causes backwater for the 25- and 50-year events. Also, the structure immediately downstream of the Torrence Avenue crossing at Sauk Trail Road causes backwater for the 50- and 100-year events, though this crossing is not overtopped.

A commercial center on the southeast quadrant of Torrence Avenue and Sauk Trail Road is within the 100-year inundation area, as are two residential structures. Torrence Avenue and one residential side street are also in the inundation area. This area is in the 100-year floodplain per the FEMA DFIRM.

The roadway topping elevation on Torrence Avenue is 653.1 feet, and the 100-year water surface elevation at the crossing is 635.2 feet. The channel bank elevation upstream of Torrence Avenue is approximately 634.0 feet on the right bank and 635.0 feet on the left bank, causing the channel to overtop before the roadway. Downstream of the crossing, the left channel bank is at an approximate elevation of 632.0 feet and the right channel bank is 634.0 feet. The commercial center along the left bank has a first floor elevation of 634.0 feet, the same as the 100-year water surface elevation.

3.5.3.4.2 Damage Assessment, NCLD-G3

Damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. Critical duration analysis was performed to determine the highest flood stages for North Creek and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.5.24** lists the estimated damages for the problem group.

Table 3.5.24: Estimated Damages for North Creek Subwatershed, Problem Group NCLD-G3

Problem Group ID	Damage Category	Estimated Damage ($)	Description
NCLD-G3	Property	$1,524,000	Structures at risk of flooding
	Transportation	$228,570	Assumed as 15% of property damage due to flooding; flooding of arterial routes less than 0.5 ft depth
	Recreation	$0	

3.5.3.4.3 Technology Screening, NCLD-G3

Several combinations of technologies were analyzed to eliminate the flooding problems at this location. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.5.25** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.5.25: Evaluation of Flood Control Technologies for North Creek Subwatershed, Problem Group NCLD-G3

Flood Control Option	Feasibility
Detention Facilities	No. Limited space available
Conveyance Improvement – Culvert/Bridge Replacement	Yes. Increase hydraulic capacity of crossing at Sauk Trail and Torrence Avenue
Conveyance Improvement – Channel Improvement	No. Limited ROW available
Conveyance Improvements – Diversion	No. No available outfall for diversion
Flood Barriers, Levees/Floodwalls	Yes, but will not reduce roadway overtopping

3.5.3.4.4 Alternative Development, NCLD-G3

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.5.26** summarizes flood control alternatives developed for Problem Group NCLD-G3.

Table 3.5.26: Flood Control Alternatives for Problem Group NCLD-G3

Alternative	Location	Description
NCLDG3-A1	Lansing Ditch upstream of Torrence Avenue	Construct a floodwall to keep flood waters in the channel. This is not recommended as it will increase the stage at the Torrence Avenue crossing
NCLDG3-A2	Torrence Avenue crossing	Increase the opening area of the Torrence Avenue crossing from a 10-ft width by 5-ft height box culvert to two, 8.6-ft width by 6-ft height box culverts
NCLDG3-A3	Sauk Trail Road crossing	Increase the opening area of the Sauk Trail Road crossing from a bridge with a 20-ft width and an average depth of 8.5 ft to a span of 29 ft. Increasing the opening area at Torrence Avenue will require the opening area at Sauk Trail Road to be increased as well

Table 3.5.26: Flood Control Alternatives for Problem Group NCLD-G3

Alternative	Location	Description
NCLDG3-A4	Torrence Avenue and Sauk Trail Road crossings	Increase opening area of Torrence Avenue and Sauk Trail Road crossings (combination of alternatives NCLDG3-A3 and NCLDG3-A4)

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the NCLD-G3 Problem Group.

3.5.3.4.5 Alternative Evaluation and Selection, NCLD-G3

Alternatives included in **Table 3.5.26** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.5.28** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, and thus costs were not calculated for these alternatives.

Alternative NCLDG3-A4 from **Table 3.5.26** provides the preferred alternative for this problem group. Under this recommendation, the 100-year water surface elevation at Torrence Avenue decreases from 635.2 feet under existing conditions to 634.3 feet; the overtopping elevation of the roadway is 635.1 feet. The 100-year water surface elevation at the Sauk Trail Road crossing decreases from 633.3 feet to 632.9 feet.

Table 3.5.27 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for NCLD-G3.

Table 3.5.27: Alternative Condition Flow & WSEL Comparison for Problem Group NCLD-G3

Location	Station	Existing Conditions		Alternative NCLDG3-A4	
		Max WSEL (feet)	Max Flow (cfs)	Max WSEL (feet)	Max Flow (cfs)
Upstream of Torrence	LD1 31000	635.23	395	634.34	395
Downstream of Torrence, upstream of confluence with Lansing Ditch East Tributary	LD1 30054	633.83	396	633.61	396
Upstream of Sauk Trail Road	LD2 29664	633.28	1,049	632.90	1,060

3.5.3.4.6 Data Required for Countywide Prioritization of Watershed Projects, NCLD-G3

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.5.28** lists the alternative analyzed in detail. The recommended alternative consists of upgrading the Torrence Avenue and Sauk Trail Road crossings over Lansing Ditch. **Figure 3.5.7** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.5.28: North Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group NCLD-G3

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
NCLD-G3	NCLDG3-A4	Upgrade two crossings	< 0.01	$10,000	$2,180,000	12 Structures, 1 Roadway	No Impact	Sauk Village

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.5.3.5 NOCR-G1 – North Creek Problem Group 1

3.5.3.5.1 Problem Definition, NOCR-G1

The NOCR-G1 problem area consists of flooding through a residential subdivision. North Creek enters a series of culverts at Wentworth Avenue in Lansing. Flow is conveyed in pipe for approximately 1,000 feet, then passes under a railroad crossing, and daylights downstream of the railroad. North Creek flows as open channel for 325 feet, where it enters a culvert at Louise Drive, and daylights 850 feet downstream near the confluence with Lansing Ditch.

Flow in North Creek downstream of Wentworth Avenue surcharges into the residential streets, causing flooding. The low point elevation is 609.4 feet on Sherman Street. Water will surcharge onto the street for the 10-year (water surface elevation 609.5 feet) through 100-year (water surface elevation 610.9 feet) storm events. Additionally, for the 2- and 5-year events, roadway flooding still occurs because the sewer system which directly connects to North Creek has limited capacity, and stormwater which cannot enter the conveyance system instead ponds in the street.

The inundation area along North Creek between the railroad tracks and Wentworth Avenue, which is contained in a culvert, does not appear on the FEMA DFIRM map. However, this area experiences flooding which was confirmed at community workshops and during a field visit to the site after the September 2008 storm event. 56 residential properties are within the 100-year inundation area along North Creek between the railroad and Wentworth Avenue, as well as four residential streets. Upstream of Wentworth Avenue, the Lansing Country Club golf course and two commercial properties adjacent to the golf club are within the inundation area. Downstream of the railroad tracks, 21 residential properties are within the inundation area, as well as three residential streets.

Once North Creek enters the culvert at Wentworth Avenue, it passes through a series of different sized culverts until its outfall. These culverts are aging and the exact sizes are unknown. Also, the upstream reach of North Creek receives considerable backwater from the confluence of North Creek and Lansing Ditch. Flows from the upstream reach of North Creek (North Creek Reach 1) cannot subside until the downstream reach (North Creek Reach 2) has receded.

3.5.3.5.2 Damage Assessment, NOCR-G1

Damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. Critical duration analysis was performed to determine the highest flood stages for North Creek and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.5.29** lists the estimated damages for the problem group.

Table 3.5.29: Estimated Damages for North Creek Subwatershed, Problem Group NOCR-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
NOCR-G1	Property	$607,000	Structures at risk of flooding
	Transportation	$91,000	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.5.3.5.3 Technology Screening, NOCR-G1

Several combinations of technologies were analyzed to eliminate the flooding problems at this location. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.5.30** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.5.30: Evaluation of Flood Control Technologies for North Creek Subwatershed, Problem Group NOCR-G1

Flood Control Option	Feasibility
Detention Facilities	Yes. Potential for detention site upstream of Wentworth Avenue
Conveyance Improvement – Culvert/Bridge Replacement	Yes. Increase open area of culvert from Wentworth to Railroad
Conveyance Improvement – Channel Improvement	Yes. Increase capacity of downstream reach
Conveyance Improvements – Diversion	No. Too much infrastructure in way of constructing diversion culvert, little to no fall available
Flood Barriers, Levees/Floodwalls	No. Channel contained in culvert

3.5.3.5.4 Alternative Development, NOCR-G1

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.5.31** summarizes flood control alternatives developed for Problem Group NOCR-G1.

Table 3.5.31: Flood Control Alternatives for Problem Group NOCR-G1

Alternative	Location	Description
NOCRG1-A1	Ponds on Lansing Country Club property	Increase the detention volume of the in-line ponds upstream of Wentworth Avenue on the Lansing Country Club property to reduce the peak flows downstream. This option does not have benefits because the flooding is from the downstream head on the system, not the peak flows coming from upstream
NOCRG1-A2	Culvert from Wentworth Avenue to Grand Trunk Railroad	Replace the culvert from Wentworth to the Grand Trunk Railroad tracks to increase the carrying capacity of North Creek. While the culvert does need to be slightly increased in size and replaced due to age (see NOCRG1-A4), significantly increasing the size of the culvert will not resolve the flooding problem. Hydraulic modeling of the system indicates that the source of the flooding is from water backing up from the North Creek/Lansing Ditch confluence. Because of this high downstream head, water originating upstream of the confluence cannot drain out until the downstream water surface elevation has subsided
NOCRG1-A3	North Creek from confluence with Lansing Ditch to Torrence Avenue	Increase the capacity of North Creek downstream of the North Creek/Lansing Ditch junction to reduce created head upstream. To reduce the backflow into the upstream portion of North Creek, the creek would need to be re-graded from the junction with Lansing Ditch, through Erfert Park, and through a portion of the Cook County Forest Preserve; even with this effort, the problem would not be fully corrected
NOCRG1-A4	Culvert from Wentworth Avenue to Grand Trunk Railroad	Replace the aging culvert from conveying North Creek from Wentworth Avenue to the Grand Trunk Railroad tracks. The existing culvert system, which consists of a combination of culvert sizes, should be replaced with a 4-ft by 6-ft culvert
NOCRG1-A5	Upstream of Wentworth Avenue	This is a locally-funded and constructed option. Separate the storm sewer system in the residential neighborhood so it does not directly connect to the culvert conveying North Creek, and route the system to the proposed detention basin. Substantial roadway and residential property flooding occurs because the North Creek culvert surcharges in the residential streets through the inlet structures, and the flows originating in the subdivision cannot enter the conveyance system and add additional ponding volume on the streets and yards. A new storm sewer system should be constructed to convey flows from Sherman, William, and Bernadine Streets east, across Wentworth Avenue, to a proposed detention facility adjacent to the Lansing Country Club. The storm sewer cannot be connected to the north, because this is a combined sewer area, and it cannot be conveyed west, because significant infrastructure would be required to cross the railroad and ultimately discharge to North Creek in the Forest Preserve property Construct a 12 ac-ft detention basin to detain the volume from a new storm sewer until the downstream head in North Creek subsides to a point where the Creek can receive additional flow volume. The volume of the basin is designed to detain the entire 100-year flow volume from the residential subdivision. The flow would outlet, via pump station, to North Creek upstream of Wentworth Avenue when the water surface elevation in the creek has subsided

Table 3.5.31: Flood Control Alternatives for Problem Group NOCR-G1

Alternative	Location	Description
NOCRG1-A6	Vicinity of Wentworth Avenue to Railroad Tracks.	Replace the aging culvert from Wentworth Avenue to the railroad tracks with a single, 4-ft by 6-ft box culvert. This will not have any substantial benefits towards decreasing peak flood stages in the problem area, but will decrease the chance of future problems due to failing infrastructure. To fully address the problem, a locally-funded and constructed project must be undertaken to separate the local storm sewer from the North Creek conveyance culvert. This alternative is a combination of alternatives NOCRG1-A4 and NOCRG1-A5.

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the NOCR-G1 Problem Group.

3.5.3.5.5 Alternative Evaluation and Selection, NOCR-G1

Alternatives included in **Table 3.5.31** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.5.33** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, thus costs were not calculated for these alternatives.

Alternative NOCRG1-A6 from **Table 3.5.31** provides the preferred alternative for this problem group. A portion of the project must be undertaken by the local agency to achieve this solution. Work must be performed by the local agency on the local storm sewer system to disconnect it from the culvert conveying North Creek and reconnect it upstream at a proposed detention facility. Under this recommendation, the 100-year water surface elevation along North Creek upstream of Burnham Avenue is not significantly increased; however, temporarily disconnecting the local system from the creek reduces the backflow volume into the reach and prevents the surcharging of North Creek through the storm sewer system. Because of the age and combination of sizes of the culverts conveying North Creek from Wentworth Avenue to the railroad tracks, it is recommended that the District replace this culvert at the same time a local project is performed to increase the integrity of the system.

Table 3.5.32 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for NOCR-G1.

Table 3.5.32: Alternative Condition Flow & WSEL Comparison for Problem Group NOCR-G1

Location	Station	Existing Conditions		Alternative NOCRG1-A6	
		Max WSEL (feet)	Max Flow (cfs)	Max WSEL (feet)	Max Flow (cfs)
Upstream of Wentworth Avenue	NC1 38538	610.96	26	610.88	24
Downstream of Railroad Crossing	NC1	610.73	26	610.66	24

3.5.3.5.6 Data Required for Countywide Prioritization of Watershed Projects, NOCR-G1

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.5.33** lists the alternative analyzed in detail. The recommended alternative consists of replacing the culvert conveying North Creek from Wentworth Avenue to the Grand Trunk Railroad with a 6-foot by 4-foot culvert and constructing a 12 acre-foot detention basin for temporary storage. Local efforts would require disconnecting the local storm sewer and routing it to the proposed detention facility. The costs for the entire project, not just the District's portion, were calculated in order to get the alternative's B/C ratio. **Figure 3.5.8** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.5.33: North Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group NOCR-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
NOCR-G1	NOCRG1-A6	Replace culvert, construct detention facility	0.05	$388,000	$7,126,000	14 Structures, 4 Roadways	Positive	Lansing

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.5.3.6 NOCR-G2 – North Creek Problem Group 2

3.5.3.6.1 Problem Definition, NOCR-G2

The NOCR-G2 problem area consists of overbank flooding of North Creek from the Grand Trunk Western Railroad tracks on the north to 188th Street on the south, and from Oakwood Avenue to Burnham Avenue. Erfert Park, located between Chicago Avenue and Burnham Avenue along North Creek, is able to contain the majority of the inundation area east of Chicago Avenue, but residential properties along the border of the park also experience flooding. Chicago Avenue is inundated for the 25-year and above storm event, and Oakwood Avenue is inundated for the 50-year and above event.

Along Chicago Avenue and Oakwood Avenue, residences have been built in low-lying areas near the creek and are frequently subject to flooding. A typical first floor elevation of the residences in the inundation area is approximately 609.7 feet, which is lower than the 50-year (609.9 feet) and 100-year (610.2 feet) water surface elevations.

Chicago Avenue has an overtopping elevation of 609.3 feet, and overtops for the 25-year storm (water surface elevation 609.5 feet) and above. Oakwood Avenue has an overtopping elevation of 609.5 feet, and overtops for the 50-year storm event (water surface elevation 609.9 feet) and above.

The topography of the overbank area along Reach 2 of North Creek is flat, with little relief through the residential neighborhoods. North Creek has a shallow slope of only 0.08% from the crossing at Burnham Avenue to 850 feet downstream of Oakwood Avenue. The Creek has a negative bed slope for a length of almost a half a mile. This causes the carrying capacity of the creek to be limited. The low carrying capacity of the creek channel combined with the large tributary area to the reach contributes to the overbank flooding experienced along the reach.

3.5.3.6.2 Damage Assessment, NOCR-G2

Damages were not calculated since the proposed alternative for BTCR-G4 is a non-structural measure such as floodproofing or acquisition only.

3.5.3.6.3 Technology Screening, NOCR-G2

Several combinations of technologies were analyzed to eliminate the flooding problems at this location. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.5.34** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.5.34: Evaluation of Flood Control Technologies for North Creek Subwatershed, Problem Group NOCR-G2

Flood Control Option	Feasibility
Detention Facilities	Yes. There is a potential site in Erfert Park
Conveyance Improvement – Culvert/Bridge Replacement	Yes. Increase the opening areas of Oakwood and Chicago Avenue crossings
Conveyance Improvement – Channel Improvement	Yes. Widen the floodplain downstream of Chicago Avenue
Conveyance Improvements – Diversion	No. There is too much infrastructure in way of constructing diversion culvert, little to no fall available
Flood Barriers, Levees/Floodwalls	Yes

3.5.3.6.4 Alternative Development, NOCR-G2

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.5.35** summarizes flood control alternatives developed for Problem Group NOCR-G2.

Table 3.5.35: Flood Control Alternatives for Problem Group NOCR-G2

Alternative	Location	Description
NOCRG2-A1	Erfert Park, Lansing	Provide detention in Erfert Park. Due to the large flow volume that would need to be detained, this option is not feasible
NOCRG2-A2	North Creek from Burnham Avenue to downstream of Oakwood Avenue	Regrade North Creek. The option was explored to regrade North Creek to provide a consistent positive slope and widen the creek with the addition of a floodplain shelf. Extensive regrading would be required, and in order to provide a creek with sufficient width for the floodplain shelf, two of the most severely flooded structures would need to be acquired, and the water surface elevation would still be above that required to provide necessary benefit
NOCRG2-A3	Chicago Avenue and Oakwood Avenue crossings	Increase the hydraulic openings of the Chicago Avenue and Oakwood Avenue crossings. These crossings are low and are flooded by as much as two feet during the 100-year storm event. Increasing the opening area will not provide a positive benefit
NOCRG2-A4	North Creek from Burnham Avenue to downstream of Oakwood Avenue	Construct floodwalls along North Creek. Overtopping will still occur at Chicago Avenue and Oakwood Avenue, and thus floodwaters will still be able to reach the homes which are flooded. Compensatory storage would need to be provided to mitigate the increase in flood elevations; this would need to be done downstream within the Forest Preserve property

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the NOCR-G2 Problem Group.

3.5.3.6.5 Alternative Evaluation and Selection, NOCR-G2

Alternatives included in **Table 3.5.35** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. None of the alternatives analyzed feasibly produced the required significant changes in inundation areas, thus benefits and costs were not calculated for this problem group.

Five properties are at risk of flooding in the 100-year event. At least two of the properties are repetitively flooded, and are located in low spots along the channel. Since the properties receiving structure damages were built in naturally low-lying areas and are relatively small in number, they are candidates for protection using non-structural flood control measures, such as floodproofing or acquisition. The decision to acquire vs. floodproof should be taken on a case-by-case basis and be based on actual surveyed first floor elevations. For the homes along the north side of 188th Place, inundation mapping suggests that it is only the yards of these properties that are inundated and not the structures. This solution does not address the local street and basement flooding in the residential neighborhood south of 188th Place, as this is a local issue. The overtopping of Oakwood Avenue and Chicago Avenue are not addressed, since these roadways do not constrict the 100-year flow of North Creek and are local roadways which have alternative routes that residents can take to exit their neighborhoods. **Figure 3.5.9** shows the location of the properties at risk of flooding.

3.5.4 Recommended Alternatives, North Creek Subwatershed

Table 3.5.36 summarizes the recommended alternatives for the North Creek subwatershed. The District will use data presented here to support prioritization of a countywide stormwater CIP.

Table 3.5.36: North Creek Project Alternative Matrix to Support District CIP Prioritization, All Problem Groups

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
LDET-G1	LDETG1-A4	Replace crossing	0.29	$82,000	$287,000	9 Structures, 1 Roadway	No impact	Sauk Village
NCLD-G1	NCLDG1-A7	Upgrade 3 crossings, construct 700 ac-ft detention basin	0.03	$2,364,000	$69,500,000	49 Structures, 10 Roadways	Positive	Lansing, Lynwood
NCLD-G2	NCLDG2-A7	Upgrade 2 crossings, relocate mobile homes	< 0.01	$1,000	$357,000	2 Structures, 1 Roadway	No impact	Bloom Township
NCLD-G3	NCLDG3-A4	Upgrade two crossings	< 0.01	$10,000	$2,180,000	12 Structures, 1 Roadway	No impact	Sauk Village
NOCR-G1	NOCRG1-A6	Replace culvert, construct detention facility	0.05	$388,000	$7,126,000	14 Structures, 4 Roadways	Positive	Lansing

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.6 Plum Creek

The Plum Creek subwatershed encompasses approximately 54 square miles (1.07 in Cook County, 33.03 in Will County and 19.82 in Lake County, Indiana) within the southeastern portion of the Little Calumet River watershed. There are two tributaries within the subwatershed, including Plum Creek, totaling over 23 stream miles. **Table 3.6.1** lists the communities that lie within the subwatershed and the associated drainage area for each community contained within the subwatershed.

Table 3.6.1: Communities Draining to Plum Creek Subwatershed Within Cook County

Community	Tributary Area (mi^2)
Sauk Village	0.08
Unincorporated Cook County	0.99

Table 3.6.2 lists the land use breakdown by area within the Plum Creek subwatershed. **Figure 3.6.1** provides an overview of the tributary area of the subwatershed. Reported stormwater problem areas and proposed alternative projects are also shown on the figure, and are discussed in the following subsections.

Table 3.6.2: Land Use Distribution for Plum Creek Subwatershed within Cook County

Land Use	Acres	%
Forest/Open Land	581	86.58
Institutional	1	0.14
Residential	54	8.04
Water/Wetland	35	5.21

The majority of the Plum Creek subwatershed lies within Will County, Illinois and Lake County, Indiana, with only 3 river miles within the Cook County limits.

- Plum Creek (PLCR) – Plum Creek, named Hart Ditch in Indiana, originates south of Church Road and east of Western Avenue in Unincorporated Will County. The creek flows northeasterly and crosses into Unincorporated Cook County at Steger Road (231st Street) east of Burnham Avenue. The creek continues approximately 3 miles northeast through the Plum Creek Forest Preserve, and crosses into Indiana near Forest Park Drive in Dyer, Indiana. The creek continues as Hart Ditch for approximately 6 miles to its confluence with the Little Calumet River, approximately 0.5 miles southwest of Interstate 80 and US Route 41 in Munster, Indiana.

- Cady Marsh Ditch (CADY) – Cady Marsh Ditch is contained entirely in the State of Indiana. It originates north of 45th Avenue and east of Cleveland Street in Gary, Indiana. It flows westerly to its confluence with Plum Creek, west of US Route 41 and south of Ridge Road in Munster, Indiana. There is a flow diversion culvert along Cady Marsh Ditch located at Arborgast Avenue near Lawndale Drive in Griffith, Indiana. This culvert diverts flow from Cady Marsh Ditch north through a 6-foot diameter culvert under Arborgast Avenue to the Little Calumet River approximately 1.5 miles north of Cady Marsh Ditch.

No major flood control facilities are located within the Plum Creek subwatershed.

3.6.1 Sources of Data

3.6.1.1 Previous Studies

Previous studies were made available pertaining to the Plum Creek subwatershed for use in assessing stormwater flooding problems and designing structural solutions.

- *WSP-2 Study,* Illinois Department of Transportation (IDOT), 1980.
- *Hart Ditch Hydraulic Study*, Indiana Department of Natural Resources (DNR), 2002.

No information from IDOT was applicable to the development of the DWP. The Indiana DNR study was used during the development of the hydraulic model for Plum Creek.

3.6.1.2 Water Quality Data

Water quality for the Plum Creek subwatershed within Illinois is monitored by the Illinois Environmental Protection Agency (IEPA). IEPA monitors water quality at one location in the Plum Creek subwatershed as part of the Ambient Water Quality Monitoring Network (AWQMN). This water quality monitoring station (HBE-01) is at the Steger Road crossing, five miles east of Steger at the Will County/Cook County boundary.

IEPA's *2008 Integrated Water Quality Report*, which includes the Clean Water Act (CWA) 303(d) and the 305(d) lists, does not identify Plum Creek tributaries as impaired. No Total Maximum Daily Loads (TMDLs) have been established for Plum Creek tributaries.

No National Pollutant Discharge Elimination System (NPDES) permits have been issued by IEPA for discharges into Plum Creek. Government entities discharging to Plum Creek or its tributaries are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement six minimum control measures for limiting runoff pollution to receiving systems. Also as part of the Phase II Stormwater Permit Program, construction sites disturbing greater than 1 acre of land are required to obtain a construction permit.

3.6.1.3 Wetland and Riparian Areas

Figures 2.3.6 and **2.3.7** contain wetland and riparian area mapping in the Little Calumet River Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 35 acres of wetland areas in the Illinois portion of the Plum Creek subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.6.1.4 Floodplain Mapping

The floodplain boundaries for the Plum Creek subwatershed were revised in 2008 as part of FEMA's Map Modernization program. Floodplain boundaries were revised solely based on recent Cook County topographic data. The entire length of Plum Creek in Cook County is mapped as Zone AE.

FEMA's 2006 effective model for Plum Creek was not made available during the development of the Plum Creek subwatershed hydraulic model. A UNET model for Cady Marsh Ditch was available for use from the USCOE. **Appendix A** includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.6.1.5 Stormwater Problem Data

Table 3.6.3 summarizes reported problem areas reviewed as a part of DWP development. The problem area data was obtained primarily from questionnaire response data (Form B) provided by watershed communities to the District. Only problem areas located within Cook County were included. Problems are classified in **Table 3.6.3** as regional or local. This classification is based on criteria described in **Section 2.2.1** of this report.

Table 3.6.3: Community Response Data for Plum Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
CCH2	Cook County Highway Department	Overbank flooding	Steger Road between Burnham Avenue and Indiana border	Overbank flooding of Plum Creek at Steger Road	Local	Local drainage issue, roadway flooding less than 0.5 ft
LYN4	Lynwood	Bank erosion and sedimentation	Lincoln Highway and Sauk Trail	Heavy sedimentation	Channel maintenance	Removal of debris to be addressed by stream maintenance

3.6.1.6 Near Term Planned Projects

There are no near-term planned projects within the Illinois portion of the Plum Creek watershed.

3.6.2 Watershed Analysis

3.6.2.1 Hydrologic Model Development

3.6.2.1.1 Subbasin Delineation

The Plum Creek subwatershed was delineated according to the methods described in **Sections 1.3.2** and **2.3.2**. There are 23 subbasins ranging in size from 0.021 to 10.3 square miles with an average size of 3.07 square miles.

3.6.2.1.2 Hydrologic Parameter Calculations

Curve numbers (CN) and directly connected impervious percentages were estimated for each subbasin as described in **Section 1.3.2**. An area-weighted average of the CN was generated for each subbasin. Clark's unit hydrograph parameters were estimated using the method described in **Section 1.3.2**. **Appendix G** provides a summary of the hydrologic parameters used for the subbasins in each subwatershed.

3.6.2.2 Hydraulic Model Development

3.6.2.2.1 Field Data, Investigation, and Existing Model Data

The FEMA effective hydraulic model for Plum Creek was not available for use in developing the hydraulic model. A WSP-2 model from 1980, which includes the portion of Plum Creek in Illinois was provided by IDOT, but was not considered usable since it was developed over ten years ago.

A HEC-RAS model from 2002 covering the Indiana portion of Plum Creek was provided by the Indiana DNR. The model was reviewed to determine which portions met the CCSMP's criteria and could be used. The portion of the model covering Plum Creek downstream of 213th Street in Dyer, Indiana was found to be within District standards and was used in the hydraulic model development for the subwatershed.

The UNET model provided by the USCOE for Cady Marsh Ditch was used in its entirety to develop the HEC-RAS model for Cady Marsh Ditch. Since Cady Marsh Ditch falls entirely within Indiana and the tributary was modeled only to represent the boundary condition at Plum Creek (Hart Ditch), no additional cross sections or structures were surveyed.

After a review of existing models, field reconnaissance data and hydraulic structures dimensions data, a field survey plan for Plum Creek was developed. Field survey was performed under the protocol of FEMA's *Guidelines and Specifications for Flood Hazard Mapping partners, Appendix A: Guidance for Aerial Mapping and Surveying*. Field survey was performed in early 2008. Cross sections were generally surveyed between 500 to 1,000 feet apart. The actual spacing and location was determined based on the variability of the channel's shape, roughness, and slope. A total of 4 cross sections and 8 hydraulic structures were surveyed to develop the hydraulic model for the Plum Creek subwatershed.

The Manning's n-values at each cross section were estimated using a combination of aerial photography and photographs from field survey and field reconnaissance. The horizontal extent of each type of land cover and the associated n-value for each cross section were manually entered in to the HEC-RAS hydraulic model. The initial n-values were used as a model starting point and were adjusted within the provided ranges during calibration. All the n-values were manually adjusted using the HEC-RAS cross-sectional data editor.

The n-values were increased where buildings are located within the floodplain to account for conveyance loss. The n-values in these areas may range from 0.060 for areas with few buildings to 0.15 for fully developed areas. If significant blockage is caused by buildings in the flood fringe, the developed areas were modeled as ineffective flow. **Table 3.6.4** lists channel and overbank ranges of n-values that were used for the Plum Creek subwatershed model.

Table 3.6.4: Channel and Overbank Associated Manning's n-Values[1]

Tributary	Range of Channel n-Values	Range of Overbank n-Values
PLCR	0.03 - 0.15	0.06 - 0.15
CADY	0.045	0.09 - 0.10

[1]**Source**: Open Channel Hydraulics, Chow 1959

Boundary Conditions. The Plum Creek hydraulic model required one boundary condition at the downstream confluence with the Little Calumet River. Since the downstream end of Plum Creek is relatively steep and is reasonably free of backwater effects, normal depth was used as the downstream boundary condition.

3.6.2.3 Calibration and Verification

A detailed calibration was performed for the Plum Creek subwatershed using historic gage records under the guidelines of the Cook County Stormwater Management Plan (CCSMP). Three historical storms, April 2006, April 2007 and September 2008, were evaluated based on the stream gage flows, precipitation totals and records of flooding in the Plum Creek subwatershed and were found to be applicable for calibration and verification.

For the calibration storms, Illinois State Water Survey (ISWS) Cook County precipitation gages, National Weather Service (NWS) recording and non-recording gages, and Community Collaborative Rain, Hail & Snow Network (CoCoRAHS) precipitation depths were used. Theissen polygons were developed for each storm based on the rain gages available for that storm. The gage weightings for the recording and non-recording gages were computed in ArcGIS for each subbasin.

There are two USGS gages located in the Plum Creek subwatershed. USGS Gage 05536179, located on Plum Creek (Hart Ditch) at 213th Street in Dyer, Indiana, was used for calibration. This gage is at latitude 41°30′28″ longitude 87°30′36″ (NAD27). The datum of the gage is 607.38 feet NGVD29. Stage data is available at this gage from 9/19/1989 through present.

The second USGS gage, USGS Gage 05536190, is located on Plum Creek (Hart Ditch) at Hawthorne Drive in Munster, Indiana. The gage is located approximately 0.5 miles from the confluence with the Little Calumet River. Because of the proximity of the gage to the downstream boundary condition, it was not used for calibration for the Plum Creek subwatershed; however, it was used for calibration in the Little Calumet subwatershed (see **Section 3.8**).

Runoff hydrographs were developed using HEC-HMS and routed through the Plum Creek hydraulic model. The stages and flows produced for each calibration storm were compared to the observed stream gage data. During calibration of the Plum Creek subwatershed model, the curve number, directly connected impervious area percentage, and lag times were adjusted so that the peak flow rate, hydrograph shape and timing, and total volume matched the observed hydrographs within the CCSMP's criteria. During calibration, the Clark's storage coefficient R was increased by 25 percent.

After the final adjustments to the HEC-HMS and HEC-RAS models, the flow and stage from the model were compared to the observed data and the CCSMP's criteria. **Table 3.6.5** shows the comparison of the flows and stages for all calibration storms. **Figures 3.6.2**, **3.6.3** and **3.6.4** show the calibration results for the April 2006, April 2007 and September 2008 storms, respectively. The April 2006 event is not within the CCSMP's criteria. Upon further research, it appears that this event's rainfall was not uniform within the Plum Creek subwatershed.

Table 3.6.5: Plum Creek Subwatershed Calibration Results

Storm Event	Observed		Modeled		CCSMP's Criteria[1]	
	Flow (cfs)	Stage (ft)	Flow (cfs)	Stage (ft)	Percentage Difference in Peak Flow	Difference in Stage (ft)
April-2006	1,430	617.57	730	617.76	-49%	0.19
April-2007[2]	712	unknown	565	614.59	-21%	unknown
Sept-2008	3,110	623.56	3,088	623.32	-1%	-0.24

[1]Flow within 30% and stage within 6 inches.
[2]Stage data not available for April 2007 storm event.

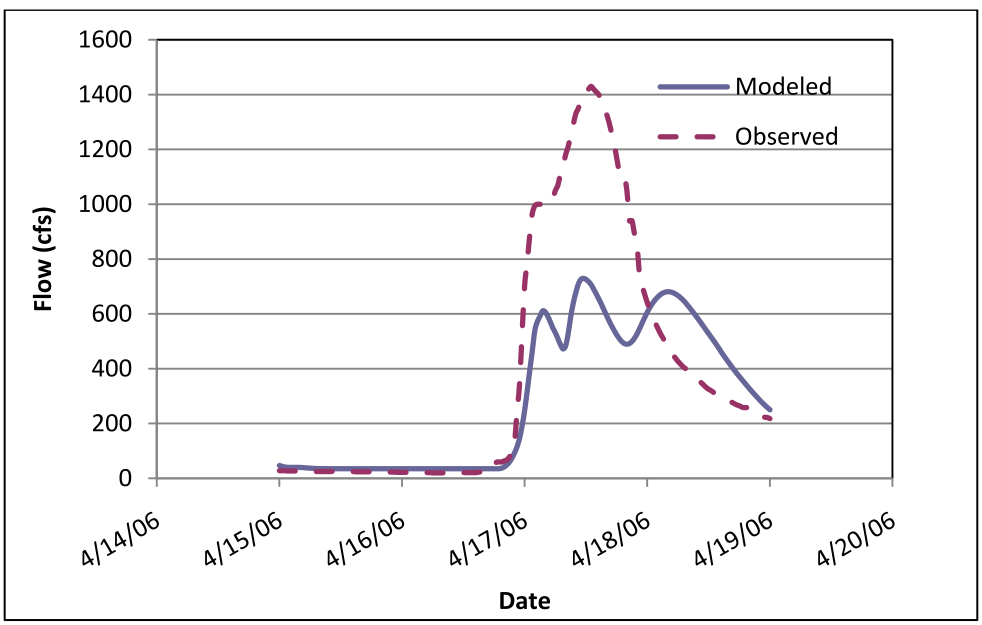


Figure 3.6.2: Plum Creek Subwatershed Calibration Results, April 2006 Storm Event

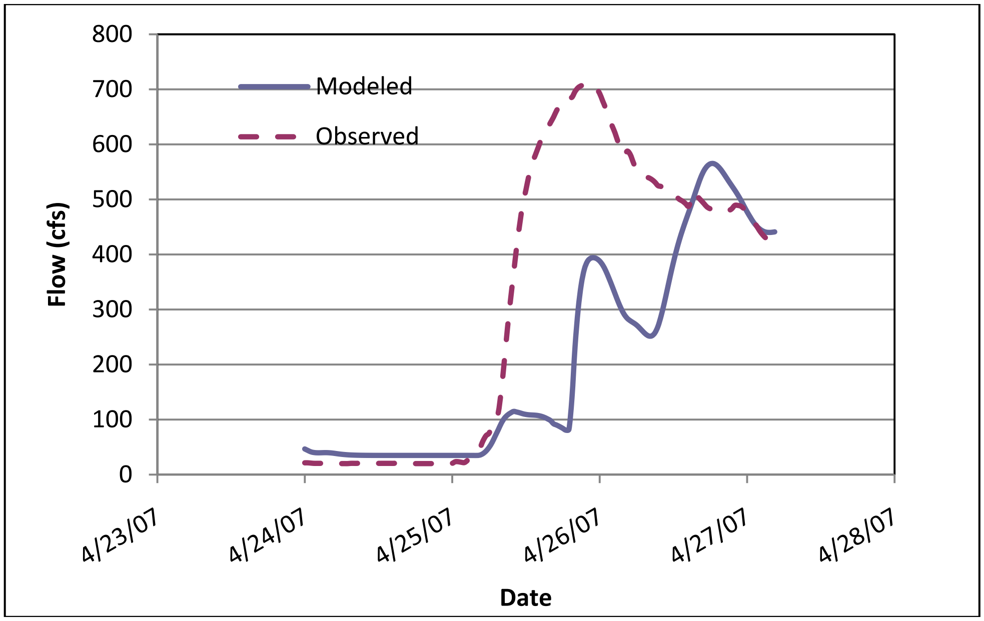


Figure 3.6.3: Plum Creek Subwatershed Calibration Results, April 2007 Storm Event

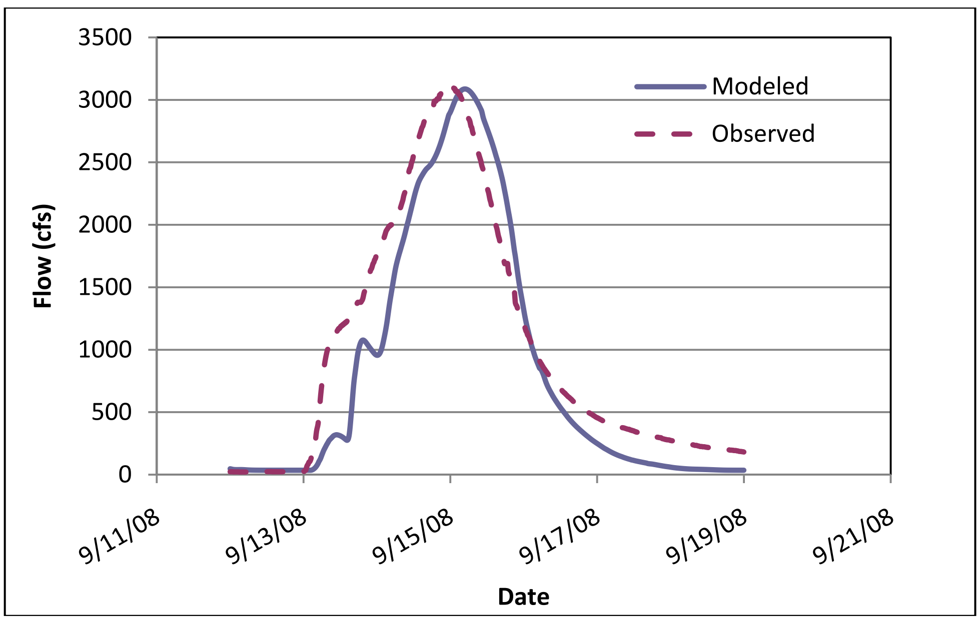


Figure 3.6.4: Plum Creek Subwatershed Calibration Results, September 2008 Storm Event

3.6.2.4 Existing Conditions Evaluation

3.6.2.4.1 Flood Inundation Areas

A critical duration analysis was performed for the Plum Creek subwatershed hydraulic model. The 100-year, 1-, 3-, 6-, 12-, 24-, 48- and 72-hour storm events were run to determine the critical duration. The 48-hour storm event was found to be the critical duration for the Plum Creek subwatershed.

Figure 3.6.1 shows the inundation area produced for the 100-year critical duration storm event.

3.6.2.4.2 Hydraulic Profiles

Hydraulic profiles for Plum Creek and its tributary are shown in **Appendix H**. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100- and 500-year recurrence interval design storm events.

3.6.3 Development and Evaluation of Alternatives

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. **Table 3.6.6** summarizes problem areas identified through hydraulic modeling of the Plum Creek subwatershed.

Problem areas that were hydraulically interdependent or otherwise related were grouped for alternatives analysis. Each project group is addressed in terms of combined damages and alternatives/solutions.

Table 3.6.6: Modeled Problem Definition for the Plum Creek Subwatershed

Problem ID	Group ID	Location	Recurrence Interval (year) of Flooding	Associated Form B	Resolution in DWP
PLCR1	PLCR-G1	St. Margaret Mercy Hospital, Illinois/Indiana state line	25, 50 & 100	N/A	PLCRG1-A1

Damage assessment, technology screening, alternative development and alternative selection were performed by problem grouping, since each group is independent of the other. Each problem grouping is evaluated in the following sections by Group ID.

3.6.3.1 PLCR-G1 – Plum Creek Problem Group 1

3.6.3.1.1 Problem Definition

The PLCR-G1 problem area consists of overbank flooding along Plum Creek near the Steger Illinois-Indiana border, near St. Margaret Mercy Hospital. The hospital is a regional hospital serving Northwest Indiana and the Southeast Chicago metropolitan area. Flood damages to the hospital from the August 24, 2007 storm event caused flooding of the hospital and evacuation of over 60 patients. Approximately $20 million in damages occurred, with extensive clean-up causing portions of the hospital to remain closed for over two months. There was a floodwall constructed around the area after the storm event, and while this floodwall does provide some benefit, it was not constructed to FEMA standards.

3.6.3.1.2 Damage Assessment, PLCR-G1

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Plum Creek and its tributary. These stages were used to calculate the depth of flooding and to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15 percent of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.6.7** lists the estimated damages for the problem group.

Table 3.6.7: Estimated Damages for Plum Creek Subwatershed, Problem Group PLCR-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
PLCR-G1	Property	$2,418,000	Structures at risk of flooding
	Transportation	$363,000	Assumed as 15 percent of property damage due to flooding
	Recreation	$0	

3.6.3.1.3 Technology Screening, PLCR-G1

Several combinations of technologies were analyzed to address the flooding problems associated with PLCR-G1. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problem. **Table 3.6.8** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.6.8: Evaluation of Flood Control Technologies for Plum Creek Subwatershed, Problem Group PLCR-G1

Flood Control Option	Feasibility
Detention Facilities	Feasible upstream of Steger Road
Conveyance Improvement – Culvert/Bridge Replacement	Feasible in reach, but with limited benefit
Conveyance Improvement – Channel Improvement	Feasible in reach, but with limited benefit
Conveyance Improvements – Diversion	Not feasible, since no available outfall
Flood Barriers, Levees/Floodwalls	Feasible and necessary

3.6.3.1.4 Alternative Development

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.6.9** summarizes flood control alternatives developed for Problem Group PLCR-G1.

Table 3.6.9: Flood Control Alternatives for Problem Grouping PLCR-G1

Alternative	Location	Description
PLCRG1-A1	St. Margaret Mercy Hospital	Construct floodwall around the property with compensatory storage
PLCRG1-A2	Upstream of Steger Road	Construct a 1,250 ac-ft reservoir with weir inlet and gravity outlet on Longwood Golf Course property in Will County. Solution would provide benefits to Dyer, Indiana as well as the Hospital
PLCRG1-A3	Plum Creek within Cook County	Channel improvements to increase capacity of channel. This does not provided benefits to the Hospital, located at the downstream end of the Cook County portion of the creek. It may be beneficial to increase channel capacity of the creek downstream of the Hospital, but this section of the creek lies in Indiana and is outside Cook County
PLCRG1-A4	Structures downstream of Hospital	Increase channel capacity by increasing hydraulic opening of structures along Plum Creek downstream of the hospital. This alternative may provide benefits, but this section of the creek lies in Indiana and is outside Cook County

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the PLCR-G1 Problem Group.

3.6.3.1.5 Alternative Evaluation and Selection

Alternatives included in **Table 3.6.9** were evaluated to determine their effectiveness and produce the data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. It should be noted that when calculating benefits for the alternatives in the Plum Creek subwatershed, only benefits within the Illinois portion of the watershed and benefits to Illinois population that relies on St. Margaret Mercy Hospital were included in the analysis of flood control alternatives. There are benefits with the identified flood control alternatives in Indiana, but these benefits were not included in the calculation of the B/C ratio.

Table 3.6.11 provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative for Problem Group PLCR-G1. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, thus costs were not calculated for these alternatives.

PLCRG1-A1 from **Table 3.6.9** is the preferred alternative for Problem Group PLCR-G1. The preferred alternative includes the construction of a floodwall along the north bank of Plum Creek around St. Margaret Mercy Hospital at an elevation of 640.0 feet and built to FEMA standards. The compensatory storage for the floodwall would be provided just upstream of the floodwall and within the property limits of the Hospital. This alternative will take the Hospital out of the 100-year floodplain.

Table 3.6.10 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for PLCR-G1.

Table 3.6.10: Alternative Condition Flow & WSEL Comparison for Problem Group PLCR-G1

Location	Station	Existing Conditions		Alternative PLCRG1-A1	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Southwest corner of Hart Street and Lincoln Highway	32200	635.08	3558	635.08	3558[1]

[1] Levee provides protection

3.6.3.1.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.6.11** lists the alternative analyzed in detail. The recommended alternative consists of the construction of floodwall along the left bank of Plum Creek and corresponding compensatory storage. **Figure 3.6.5** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.6.11: Plum Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group PLCR-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
PLCR-G1	PLCRG1-A1	Floodwall with Comp Storage	0.73	$2,781,000	$3,803,000	1 Structure	No Impact	Will County, Dyer, Indiana

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.6.4 Recommended Alternatives, Plum Creek Subwatershed

Table 3.6.12 summarizes the recommended alternatives for the Plum Creek subwatershed. The District will use data presented here to support prioritization of a countywide stormwater CIP.

Table 3.6.12: Plum Creek Project Alternative Matrix to Support District CIP Prioritization, All Problem Groups

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
PLCR-G1	PLCRG1-A1	Floodwall with Comp Storage	0.73	$2,781,000	$3,803,000	1 Structure	No Impact	Will County, Dyer, Indiana

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.7 Thorn Creek

The Thorn Creek subwatershed encompasses approximately 32 square miles (22.86 in Cook County and 8.92 in Will County) within the Little Calumet River watershed. There are eight tributaries including Thorn Creek, totaling over 26 stream miles. **Table 3.7.1** lists the communities and the drainage areas contained within the Thorn Creek subwatershed.

Table 3.7.1: Communities Draining to Thorn Creek Subwatershed Within Cook County

Community	Tributary Area (mi^2)
Calumet City	<0.01
Chicago Heights	7.03
East Hazel Crest	0.05
Flossmoor	0.07
Glenwood	0.96
Homewood	0.17
Lansing	0.26
Matteson	0.28
Olympia Fields	0.07
Park Forest	3.40
Richton Park	0.35
South Chicago Heights	1.31
South Holland	0.99
Steger	0.61
Thornton	2.10
Unincorporated Cook County	5.22
University Park	<0.01

Table 3.7.2 lists the land use breakdown by area within the Thorn Creek subwatershed. **Figure 3.7.1** provides an overview of the tributary area of the subwatershed. Reported stormwater problem areas and proposed alternative projects are also shown on the figure, and are discussed in the following subsections.

Within the Thorn Creek subwatershed, a total of 26.6 stream miles were studied among the eight tributaries.

Table 3.7.2: Land Use Distribution for Thorn Creek Subwatershed Within Cook County

Land Use	Acres	%
Commercial/Industrial	2,995	20
Forest/Open Land	4,848	33
Institutional	772	5
Residential	5,038	34
Transportation/Utility	467	3
Water/Wetland	179	1

- Thorn Creek (THCR) – extends from near Steger Road and Western Avenue at the boundary between Cook and Will counties in Park Forest to the confluence with the Little Calumet River 0.5 miles north of 170th Street in South Holland.

- Thorn Creek Tributary A (TCTA) – extends from the intersection of 33rd Street between Lewis Avenue and Loverock Avenue in Steger to the confluence with Thorn Creek, near the intersection of Joe Orr Road and the Union Pacific Railroad, about 2,000 feet west of State Street in Chicago Heights.

- Thorn Creek Tributary A of A (TCAA) – extends from Sauk Trail Road east of Western Avenue in South Chicago Heights and flows northerly to 26th Street in Chicago Heights.

- Thorn Creek Tributary B (TCTB) – extends from north of the US Route 30 (Lincoln Highway) and Wilson Avenue intersection in Chicago Heights to the confluence with Thorn Creek east of Edgewood Avenue and 13th Street.

- Thorn Creek Tributary A of B (TCAB) – extends from 10th Street and Damico Drive in Chicago Heights, through the Chicago Heights Country Club, to the confluence with Thorn Creek Tributary B near the intersection of Irving Boulevard and Franklin Avenue.

- Thorn Creek Tributary C (TCTC) – extends from Coolidge Street and Glengate Avenue in Chicago Heights to the confluence with Thorn Creek near the Chicago Heights Park District Golf Course.

- Thorn Creek Tributary D (TCTD) – extends from the Rich East High School Pond in Park Forest near East Rocket Circle Drive and West Rocket Circle Drive, to the confluence with Thorn Creek near Beacon Boulevard and Campbell Avenue in Chicago Heights.

- Thorn Creek Tributary E (TCTE) – extends from 34th Street (Steger Road), 700 feet east of Western Avenue, to the confluence with Thorn Creek.

The Thorn Creek subwatershed contains two major detention facilities, the Thornton Transitional Reservoir and Sauk Trail Lake.

- Thornton Transitional Reservoir – The Thornton Transitional Reservoir is located in the West Lobe of Thornton Quarry, southeast of I-294/I-80 and Halsted (US 1). The reservoir has capacity for 9,600 acre-feet from non-Tunnel and Reservoir Plan (TARP) flows. The transitional reservoir came online in 2003. Floodwaters from Thorn Creek flow through a diversion inlet structure, drop 230 feet down a 24-foot diameter shaft, and flow through an 8,000-foot long, 22-foot diameter tunnel into the reservoir. After the storm passes, the reservoir is drained through an 8-foot diameter tunnel for pumping to the Calumet Water Reclamation Plant for treatment and eventual discharge to the Little Calumet River.

- Sauk Trail Lake – Sauk Trail Lake Dam, also known as Sauk Trail Lake, is of earthen construction. Sauk Trail Lake is on Thorn Creek in Cook County and is used for recreation purposes. Its capacity is 376 acre-feet (height is 18 feet, length is 355 feet), with normal storage of 122 acre-feet. Construction was completed in 1923. It is owned by the Forest Preserve District of Cook County.

3.7.1 Sources of Data

3.7.1.1 Previous Studies

Studies have been performed for the Thorn Creek subwatershed for assessing stormwater flooding problems and evaluating structural solutions. Below is the list of studies that were identified for Thorn Creek:

- *Interim Review Report of Little Calumet River*, U.S. Army Corps of Engineers, December 1973

- *Little Calumet River Watershed Engineering Design Report (Revised)*, U.S. Department of Agriculture, Metropolitan Sanitary District of Greater Chicago and the Illinois Department of Conservation, January 1977

During Phase A and B of DWP development, additional survey, topography, precipitation, stream flow, land use and soils data needed for the development of the Thorn Creek subwatershed model were identified and collected.

3.7.1.2 Water Quality Data

Water quality for the Thorn Creek subwatershed is monitored by the Metropolitan Reclamation District of Greater Chicago (the District), Illinois Environmental Protection Agency (IEPA) and the United States Geological Survey (USGS). The District is responsible for monitoring the water quality of streams and canals within its jurisdiction, and has one water quality monitoring station, Station 54, located on Thorn Creek at Joe Orr Road. Detailed annual water quality summaries of all the water quality data collected have been published by the District for the years 1970 through 2007, except for the year 1971.

IEPA monitors water quality at six locations in the Thorn Creek subwatershed as a part of the Ambient Water Quality Monitoring Network (AWQMN) in Cook County. **Table 3.7.3** lists the locations of the six gages.

Table 3.7.3: IEPA Water Quality Monitoring Stations in the Thorn Creek Subwatershed

Station ID	Waterbody	Location
HBDD-01	Thorn Creek Tributary B	Joe Orr Road, Chicago Heights
HBDD-02	Thorn Creek Tributary B	0.5 MI NE Chicago Heights
HBD-01	Thorn Creek	167th Street NE, S Holland
HBD-02	Thorn Creek	Vincennes Avenue, Glenwood
HBD-03	Thorn Creek	Dixie Highway, Chicago Heights
HBD-04	Thorn Creek	Dixie Highway, Chicago Heights

Source: EPA STORET (Storage and Retrieval) database.

At each station, water samples are collected once every six weeks and analyzed for a minimum of 55 water quality parameters including pH, temperature, specific conductance, dissolved oxygen, suspended solids, nutrients, fecal coliform bacteria, and total and dissolved metals. Additional parameters specific to the station, watershed, or sub network within the ambient network are also analyzed.

The USGS operates three water quality monitoring stations in the Thorn Creek subwatershed. Several of the USGS stations identified for flow and stage recordings also have water quality measurements. Sporadic data recordings are taken at each of the sites, though they are typically recorded at least once a month. The period of record and type of data monitored vary from station to station. **Table 3.7.4** lists additional details for the gages.

Table 3.7.4: USGS Water Quality Monitoring Stations in the Thorn Creek Subwatershed

Station ID	Waterbody	Location
5536210	Thorn Creek	Chicago Heights
5536215	Thorn Creek	Glenwood
5536275	Thorn Creek	Thornton

Source: http://waterdata.usgs.gov/usa/nwis/qw

IEPA's *2008 Integrated Water Quality Report*, which includes the Clean Water Act (CWA) 303(d) and the 305(d) lists six segments within the Thorn Creek subwatershed as impaired. **Table 3.7.5** lists the 303(d) listed impaired waters.

Table 3.7.5: IEPA Use Support Categorization and 303(d) Impairments in the Thorn Creek Subwatershed

IEPA Segment ID	Waterbody	Impaired Designated Use	Potential Cause	Potential Source
IL_HBD-03	Thorn Creek	Aquatic Life	Dissolved Oxygen	Dam or Impoundment, Impacts from Hydrostructure Flow Regulation/Modification
IL_ HBD-05	Thorn Creek	Aquatic Life	Total Dissolved Solids	Urban Runoff/Storm Sewers
IL_HBD-06	Thorn Creek	Aquatic Life	Aldrin, Dieldrin, Hexachlorobenzene, Nitrogen (Total), Dissolved Oxygen, Phosphorous (Total) and Silver	Contaminated Sediments, Municipal Point Source Discharges and Urban Runoff/ Storm Sewers
		Primary Contact Recreation	Fecal Coliform	Municipal Point Source Discharges, Urban Runoff/ Storm Sewers
IL_HBD-04	Thorn Creek	Aquatic Life	Aldrin, Chlordane, DDT, Endrin, Fluoride, Polychlorinated biphenyls Dieldrin, Total Suspended Solids, Zinc, Hexachlorobenzene, Nitrogen (Total), Dissolved Oxygen, Phosphorous (Total) and Silver	Contaminated Sediments, Municipal Point Source Discharges and Urban Runoff/ Storm Sewers and Channelization
		Primary Contact Recreation	Fecal Coliform	Source Unknown

Table 3.7.5: IEPA Use Support Categorization and 303(d) Impairments in the Thorn Creek Subwatershed

IEPA Segment ID	Waterbody	Impaired Designated Use	Potential Cause	Potential Source
IL_HBD-02	Thorn Creek	Aquatic Life	Aldrin, Chlordane, DDT, Endrin, Fluoride, Polychlorinated biphenyls, Dieldrin, Total Suspended Solids, Zinc, Hexachlorobenzene, Nitrogen (Total), Dissolved Oxygen, Phosphorous (Total) and Silver	Contaminated Sediments, Municipal Point Source Discharges and Urban Runoff/ Storm Sewers
		Primary Contact Recreation	Fecal Coliform	Urban Runoff/Storm Sewers
IL_RH1	Sauk Trail (Thorn Creek)	Aesthetic Quality	Phosphorus (Total) & Total Suspended Solids	Urban Runoff/Storm Sewers, Site Clearance (Land Development and Redevelopment), Impacts from Hydrostructure Flow Regulation/modification, Crop Production (Crop Land or Dry Land), Runoff from Forest/Grassland/Parkland
		Aquatic Life	Dissolved Oxygen, Phosphorous (Total), Polychlorinated biphenyls, Sedimentation/Siltation and Total Suspended Solids	Runoff from Forest/Grassland/ Parkland, Urban Runoff/Storm Sewers, Site Clearance (Land Development or Redevelopment), Impacts from Hydrostructure Flow Regulation/modification, Crop Production (Crop Land or Dry Land)

Total Maximum Daily Loads (TMDL) have been developed for the Thorn Creek subwatershed. **Table 3.7.6** lists the water segments in the Thorn Creek subwatershed and the impairment addressed.

Table 3.7.6: IEPA TMDL Status in the Thorn Creek Subwatershed

Station ID	Waterbody	Impairment Addressed	TMDL Status
IL_HBD-02	Thorn Creek	Dissolved Oxygen, Fecal Coliform, Fluoride, Silver and Zinc	Stage 1
IL_HBD-03	Thorn Creek	Dissolved Oxygen	Stage 1
IL_HBD-04	Thorn Creek	Thornton Dissolved Oxygen, Fecal Coliform, Fluoride, Silver and Zinc	Stage 1
IL_HBD-06	Thorn Creek	Dissolved Oxygen, Fecal Coliform and Silver	Stage 1
IL_RHI	Sauk Trail (Thorn Creek)	Dissolved Oxygen	Stage 1

Source: http://www.epa.state.il.us/water/tmdl/303-appendix/2008/appendix-a6-status.pdf

NPDES point source discharges within the Thorn Creek subwatershed are listed in **Table 3.7.7.** In addition to the point source discharges listed, municipalities discharging to Thorn Creek or its tributaries are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement six minimum control measures for limiting runoff pollution to receiving systems. Also as part of the Phase II Stormwater Permit Program, construction sites disturbing greater than 1 acre of land are required to get a construction permit.

Table 3.7.7: Point Source Dischargers in Thorn Creek Area

Name	NPDES	Community	Receiving Waterway
Park Forest Excess Flow Facility	IL0047562	Park Forest	Unnamed Ditch to Thorn Creek
Hanson Material Service Yd 41	IL0001937	Thornton	Thorn Creek

Note: NPDES facilities were identified from the USEPA Water Discharge Permits Query Form at http://www.epa.gov/enviro/html/pcs/pcs_query_java.html.

3.7.1.3 Wetland and Riparian Areas

Figures 2.3.6 and **2.3.7** contain mapping of wetland and riparian areas in the Little Calumet River Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 784 acres of wetland areas in the Thorn Creek subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.7.1.4 Floodplain Mapping

All the tributary names used in this study were adopted from FEMA's Cook County Flood Insurance Study, August 2008, except for Thorn Creek Tributary A of A, Thorn Creek Tributary D and Thorn Creek Tributary E. Tributary A of A was shown in the FEMA mapping but was not officially named; therefore it was named for the DWP. FEMA had classified Thorn Creek Tributary D as Zone X, meaning the 1% interval flood had an average depth of less than 1 foot or the drainage area was less than 1 square mile. However, the DWP determined that flooded areas had significant depths and the drainage area was in excess 1 square mile; therefore, Thorn Creek Tributary D was added to the study. Thorn Creek Tributary E was modeled by FEMA as a backwater, but was included in the DWP since it has a drainage area over 1 square mile and has a defined channel.

FEMA's 2006 effective models were not made available during the development of the Thorn Creek subwatershed hydraulic model; however, various models were collected from MG2A/Land Resources Management Group, IDNR-OWR, and USACOE.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels (effective date August 2008) with inundation areas developed for the DWP.

3.7.1.5 Stormwater Problem Data

Table 3.7.8 summarizes reported problem areas reviewed as a part of DWP development. The problem area data was obtained primarily from questionnaire response data (Form B) provided by watershed communities to the District. Problems are classified in **Table 3.7.8** as regional or local. This classification is based on a process described in **Section 2.2.1** of this report.

3.7.1.6 Near Term Planned Projects

No near-term planned major flood control projects have been identified for the Thorn Creek subwatershed.

Table 3.7.8: Community Response Data for Thorn Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
BL03	Bloom Township	72" CMP at Stewart Avenue, at Third Creek. Significant vegetation present. Slight drifting of creek	26th Street from East End Avenue to State Street	Culvert and channel blockage	Local	Contact Small Streams Maintenance Program
BL05	Bloom Township	Structure number 016-3224, a 2-10' by 6' box culvert north of 22nd Street, at Third Creek. Box culvert is silted and migrating north	State Street from Sauk Trail to Main Street	Problem may be due to overland flooding	Local	Local drainage problem since problem likely due to overland flow
CHT2	Chicago Heights	Small ditch floods from the culvert below the railroad tracks, likely caused by a blockage, 3 homes with basement flooding. Includes commercial properties	26th Street, Chicago Road	Problem is due to local drainage issues	Local	Problem is not on a regional waterway. This is a local problem
CHT7	Chicago Heights	Overbank flooding	Halsted and Main Street	Problem is due to local drainage issues	Local	Problem is not on a regional waterway
CHT5	Chicago Heights	Roadway pavement flooding	Route 30 at Halsted Street	Problem is due to local drainage issues	Local	Problem is not on a regional waterway
CHT6	Chicago Heights	Roadway pavement flooding	US Route 30 at State and East End Avenue	Problem is due to local drainage issues	Local	Problem is not on a regional waterway
CHT8	Chicago Heights	Ponding, water quality and bank erosion and sedimentation	12th Street and Halsted	Problem is due to local drainage issues	Local	Problem is not on a regional waterway
CHT1	Chicago Heights	Overbank flooding, basement flooding	Miller Avenue (Chicago, Route 1) to Jackson -- Railroad tracks	Problem is due to local drainage issues	Local	Problem is not on a regional waterway

Table 3.7.8: Community Response Data for Thorn Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
GLW2	Glenwood	Overbanking of Thorn Creek and Butterfield Creek due to high rain volumes, stream obstruction, and non-operation of MWRD diversion chamber	187^{th} Street and Glenwood-Chicago Heights Road	Low lying residential area and Boy's school is inundated from overbank flooding from Thorn and Butterfield Creek	Regional	Conveyance Improvement, Levees, Flow Diversion and Storage (Alternative THCRG1-A16)
LAN7	Lansing	Tri-state Expressway flooding, beaver dams and erosion	Lake Wampum Forest Preserve	Erosion along the banks of Forest Preserve lake. Appeared that problem had been resolved, during field inspection	Local	Problem previously resolved
OLY6	Olympia Fields	The Inlet capacity within the intersection does not appear to have adequate capacity to accept the runoff during moderate to heavy rainfall events and the intersection tends to pond water	Western Avenue and US Route 30 (Lincoln Highway)	Problem is due to local drainage issues	Local	Problem is not on a regional waterway. This is a local storm sewer issue
OLY11	Olympia Fields	Pavement flooding	US Route 30 at Western Avenue	Problem is due to local drainage issues. Appears to the same problem as OLY6	Local	Problem is not on a regional waterway. This is a local storm sewer issue
PAR1	Park Forest	During large rain events, drainageway becomes flooded and ponds. Water levels rise into backyards of the residents that reside adjacent to this drainageway	East Rocket Circle/West Rocket Circle (near Lakewood Boulevard/ Orchard Drive)	Residential ponding from Thorn Creek Tributary D due to under-sized culverts	Regional	Create offline storage facility, upstream conveyance Improvements (Alternative TCTDG1-A9)

Table 3.7.8: Community Response Data for Thorn Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
PAR2	Park Forest	Stormwater flow restriction at twin culvert pipes crossing under Western Avenue Pipes are restricted by tree branches, vegetation, sediment, and debris to approximately 90-95% of pipe cross-sectional area	Western Avenue/EJ&E Railroad (South Street)	Local drainage obstructions	Local	Local maintenance issue
PAR3	Park Forest	Pavement flooding	26th Street at Euclid Avenue to Western Avenue	Major road/dam outlet is overtopping	Regional	Conveyance improvement, levees, flow diversion and storage (Alternative THCRG1-A16)
PAR4	Park Forest	Pavement flooding	Western Avenue at Route 30 to 26th Parkway	Problem is due to local drainage issues	Local	Local drainage issue not on regional waterway
RIC5	Richton Park	Flooding occurs at two locations along this tributary. The flooding takes place primarily with rain events of 1" or more	Tributary crossing with Central Park Avenue, north	Undersized culverts in ditch in an area of less than 1 square mile	Local	Problem area not located on regional waterway
SHO3	South Holland	Pavement flooding	I-94 at 170th Street	Overtopping of major roadway	Regional	Problem previously resolved; no action required
SHO2	South Holland	Pavement flooding	I-94 at 159th Street (to I-80)	Flooding of highway. Residents stated that problem no longer exists since Thornton Transitional Quarry came online. No flooding shown in model	Regional	Problem previously resolved; no action required
TRN1	Thornton	Flooding of ground and lower levels of commercial building	400 East Margaret Street (Brownell)	Overbank flooding from Thorn Creek in Tributary in low-lying area on river bank	Regional	Risk of flooding could not be mitigated by structural measures. Property is a candidate for protection using non-structural measures such as floodproofing or acquisition

3.7.2 Watershed Analysis

3.7.2.1 Hydrologic Model Development

Subbasin Delineation. The Thorn Creek subwatershed was delineated based upon LiDAR topographic data developed by Cook County in 2003. There are 48 subbasins ranging in size from 0.018 to 4.22 square miles with an average size of 0.644 square miles.

Hydrologic Parameter Calculations. Curve numbers (CN) were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in **Section 1.3.2**, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

Clark's unit hydrograph parameters were estimated using the method described in **Section 1.3.2**. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.7.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. The FEMA effective hydraulic models were not available for use in developing the hydraulic model for the Thorn Creek subwatershed. Three models from other sources were made available. The MG2A/Land Resources Management Group model for Thorn Creek Tributary A (2007), IDNR-OWR model for Thorn Creek Tributary B (2000) and USACOE model for Thorn Creek Main Stem (2007) were used in the development of the hydraulic model for Thorn Creek and its tributaries. The models were reviewed to determine if any of the cross-sectional data and hydraulic structure information could be reused. If any information regarding location, date, and vertical datum was not available, the cross-sectional data was not used. Cross sections were compared to the current channel conditions to ensure that they were still representative of current conditions. The hydraulic structure dimensions were compared to 2007 field reconnaissance data and also to bridge/culvert dimensions data provided by Cook County Highway Department (data provided only state/county highways). Based on the existing model analysis additional cross sections and hydraulic structures to be surveyed were determined. Any data used from the existing models were geo-referenced to represent true physical coordinates.

After review of existing models, field reconnaissance data and hydraulic structures dimensions data, a field survey plan for Thorn Creek was developed. Field survey was performed under the protocol of FEMA's *Guidelines and Specifications for Flood Hazard Mapping partners, Appendix A: Guidance for Aerial Mapping and Surveying*. Field survey was performed in early 2008. Cross sections were generally surveyed between 500 to 1,000 feet apart. The actual spacing and location was determined based on the variability of the channel's shape, roughness, and slope. A total of 66 cross sections and 57 hydraulic structures were surveyed to develop the hydraulic model for Thorn

Creek. Additional cross sections were developed by interpolating the surveyed channel data and combining with contour data.

The Manning's n-value at each cross section was estimated using a combination of aerial photography and photographs from field survey and field reconnaissance. The horizontal extent of each type of land cover and the associated n-value for each cross section were manually entered in to the HEC-RAS hydraulic model. The initial n-values were used as a model starting point and were adjusted within the provided ranges during calibration. All the n-values were manually adjusted using the HEC-RAS cross-sectional data editor.

The n-values were increased where buildings are located within the floodplain to account for conveyance loss. The n-values in these areas may range from 0.060 for areas with few buildings to 0.20 for fully developed areas. If significant blockage is caused by buildings in the flood fringe, the developed areas were modeled as ineffective flow. **Table 3.7.9** lists the channel and overbank ranges of n-values that were used for the Thorn Creek subwatershed model.

Table 3.7.9: Channel and Overbank Associated Manning's n-Values[1]

Tributary	Range of Channel n-Values	Range of Overbank n-Values
THCR	0.037-0.08	0.057-0.21
TCTA	0.013-0.075	0.037-0.15
TCAA	0.062	0.062
TCTB	0.037-0.062	0.037-0.162
TCAB	0.013-0.056	0.037-0.10
TCTC	0.013-0.068	0.013-0.10
TCTD	0.03-.125	.037-0.15
TCTE	0.56-0.62	0.15

[1]**Source**: Open Channel Hydraulics, Chow 1959

Boundary Conditions. There is a single location where a stage boundary condition was required to run the Thorn Creek hydraulic model, located at the confluence of Thorn Creek with the Little Calumet River. Normal depth was used.

3.7.2.3 Calibration and Verification

A detailed calibration was performed for the Thorn Creek subwatershed using historic gage records under the guidelines of the Cook County Stormwater Management Plan (CCSMP). Three historical storms, April 2006, April 2007, and September 2008, were evaluated based on the stream gage flows, precipitation amounts and records of flooding in the Thorn Creek subwatershed and were found to be applicable for calibration and verification.

For the calibration storms, Illinois State Water Survey (ISWS) Cook County precipitation gages, National Weather Service (NWS) recording and non-recording gages, and Community Collaborative Rain, Hail & Snow Network (CoCoRAHS) precipitation amounts were used. Theissen polygons were developed for each storm based on the rain gages available for that storm. The gage weightings for the recording and non-recording gages were computed in ArcGIS for each subbasin.

There are two active stream gages in the Thorn Creek subwatershed. Gage 05536275 on Thorn Creek at Thornton is at latitude 41°34'06", longitude 87°36'28" (NAD27). The datum of the gage is 586.43 feet NGVD29 (586.15 NAVD88). Instantaneous flow data is available at this gage from 09/01/1986 through 9/30/2007. USGS Gage 05536215 on Thorn Creek at Glenwood is located at latitude 41°31'49", longitude 87°37'20" (NAD27), on the right bank 20 feet downstream from the Cook County Forest Preserve bike trail, 1 mile upstream of Deer Creek. The datum of the gage is 610.97 feet NGVD29 (610.66 NAVD88). Instantaneous flow data is available at this gage from 10/01/1993 through 9/30/2005.

Runoff hydrographs were developed using HEC-HMS and routed through the Thorn Creek hydraulic model. The stages and flows produced for each calibration storm were compared to the observed stream gage data. During calibration of the Thorn Creek subwatershed model, the curve number, directly connected impervious area percentage, and lag times were adjusted so that the peak flow rate, hydrograph shape and timing, and total volume matched the observed hydrographs within the District's criteria.

During calibration, the curve number and directly connected impervious percentage were reduced by 5% and 10%, respectively. The Clark's storage coefficient R was increased by 25%.

After the final adjustments to the HEC-HMS and HEC-RAS models, the flow and stage comparisons to the observed data were within the CCSMP's criteria. **Table 3.7.10** and **Table 3.7.11** show the comparison of the flows and stages for all calibration storms. **Figures 3.7.2**, **3.7.3**, **3.7.4** and **3.7.5** show the calibration results for the April 2006, April 2007 and September 2008 storm events.

Table 3.7.10: Thorn Creek Subwatershed Calibration Results, Thorn Creek at Thornton

Storm Event	Observed		Modeled		CCSMP's Criteria[1]	
	Flow (cfs)	Stage	Flow (cfs)	Stage	Percentage Difference in Peak Flow	Difference in Stage (ft)
Apr-06	5540	600.19	5056	600.16	-9%	-0.03
Apr-07	1810	596.57	1773	597.04	-2%	0.47
Sep-08	5860	601.76	7398	602.04	26%	0.28

[1]Flow within 30% and stage within 6 inches.

Table 3.7.11: Thorn Creek Subwatershed Calibration Results, Thorn Creek at Glenwood

Storm Event	Observed		Modeled		CCSMP's Criteria[1]	
	Flow (cfs)	Stage	Flow (cfs)	Stage	Percentage Difference in Peak Flow	Difference in Stage (ft)
Apr-06	2540	621.94	2774	623.07	9%	1.13
Apr-07	926	619.99	848	620.18	-8%	0.19
Sep-08[2]	N/A	N/A	3330	623.48	N/A	N/A

[1]Flow within 30% and stage within 6 inches.
[2]Flow and stage data for September 2008 event not available at Glenwood gage.

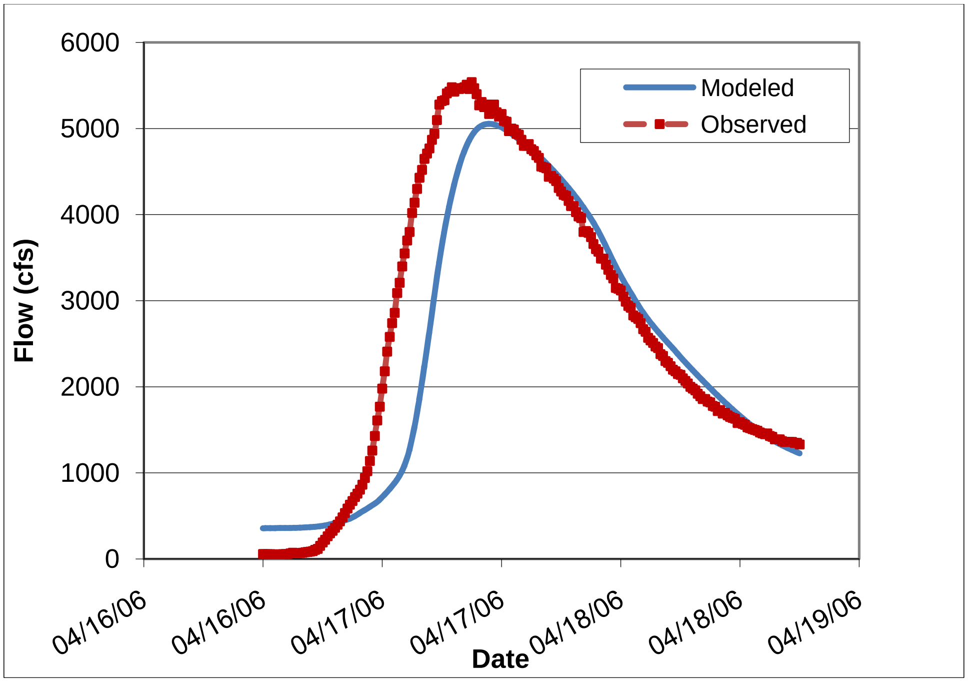


Figure 3.7.2: Thorn Creek at Thornton Calibration Results, April 2006 Storm Event

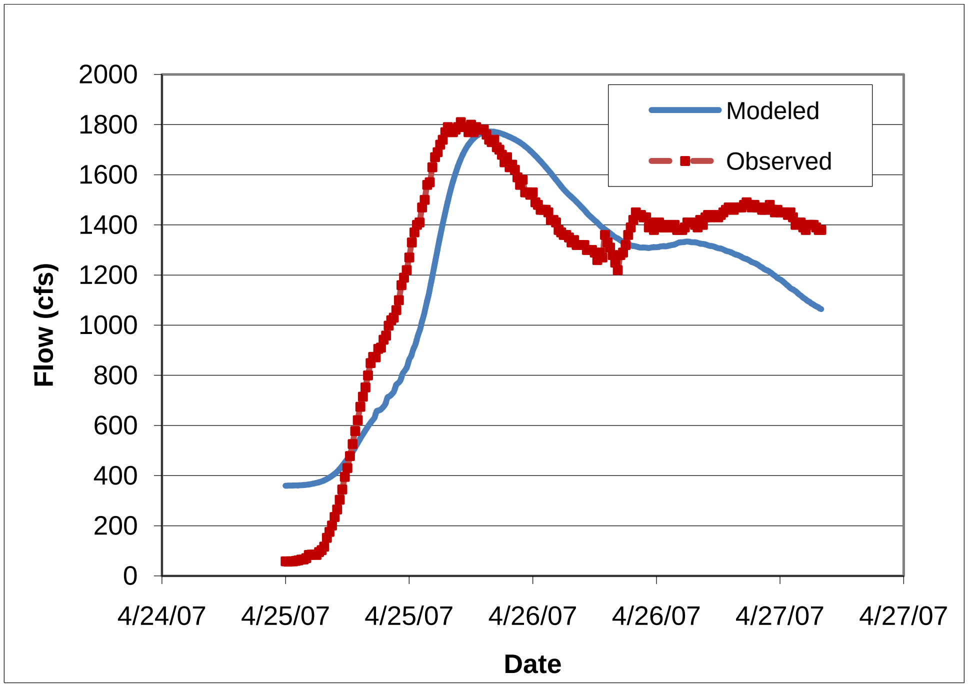


Figure 3.7.3: Thorn Creek at Thornton Calibration Results, April 2007 Storm Event

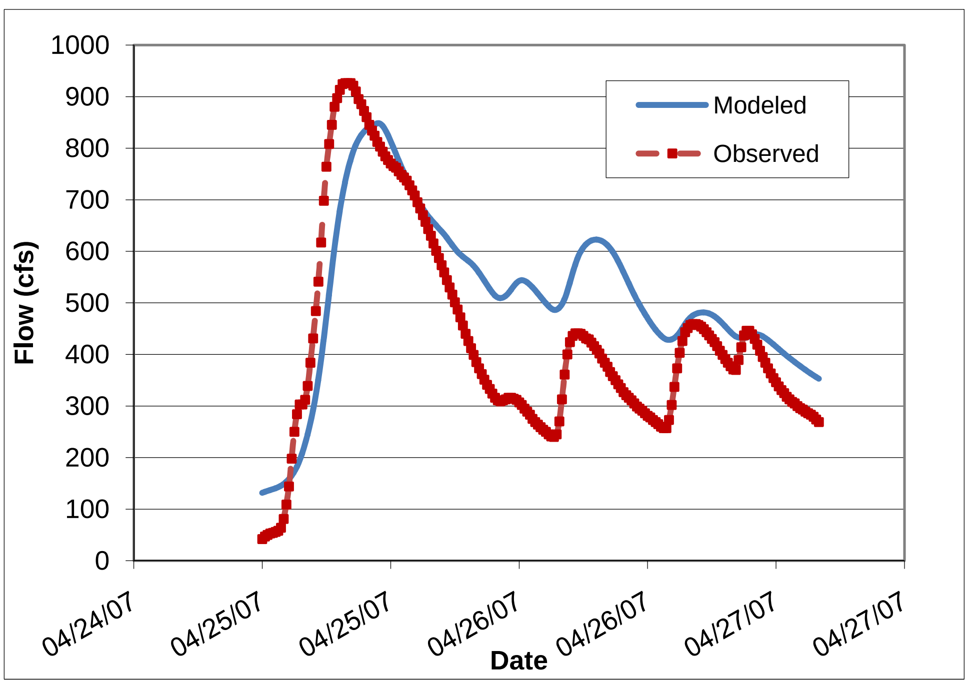


Figure 3.7.4: Thorn Creek at Glenwood Calibration Results, April 2007 Storm Event

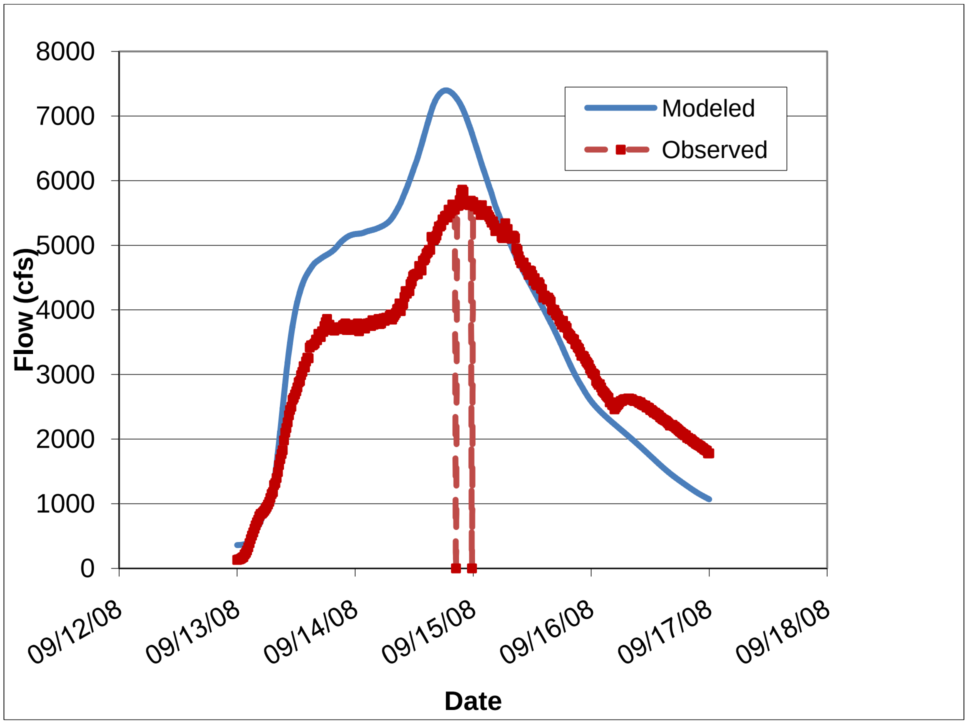


Figure 3.7.5: Thorn Creek at Thornton Calibration Results, September 2008 Storm Event

3.7.2.4 Existing Conditions Evaluation

Flood Inundation Areas. A critical duration analysis was performed for the Thorn Creek subwatershed hydraulic model. The 100-year, 1-, 3-, 6-, 12-, 24- and 48-hour storm events were run to determine the critical duration. The 6-hour storm event was found to be the critical duration event for Thorn Creek Tributary A of B, and a portion of Thorn Creek Tributary B and Thorn Creek Tributary D. The 48-hour storm event was found to be the representative critical duration for the remainder of the reaches.

Figure 3.5.1 shows inundation area produced for the 100-year critical duration storm event.

Hydraulic Profiles. Hydraulic profiles for Thorn Creek and its tributaries are shown in Appendix H. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100- and 500-year recurrence interval design storm events.

3.7.3 Development and Evaluation of Alternatives

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. **Table 3.7.12** summarizes problem areas identified through hydraulic modeling of the Thorn Creek subwatershed.

Problem areas that were hydraulically interdependent or otherwise related were grouped for alternatives analysis. Each problem group is addressed in terms of combined damages and alternatives/solutions.

Table 3.7.12: Modeled Problem Definition for the Thorn Creek Subwatershed

Problem ID	Group ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
THCR1	THCR-G1	West side of Thorn Creek from Chicago Heights-Glenwood Road to the abandoned B & O Railroad	5, 10, 25, 50 & 100	GLW2	THCRG1-A16
THCR2	THCR-G1	West side of Thorn Creek at Park Side and Union Avenues	5, 10, 25, 50 & 100	None	THCRG1-A16
THCR3	THCR-G1	Thorn Creek at 26th Street	5, 10, 25, 50 & 100	PAR3	THCRG1-A16
TCTB1	THCR-G1	Irving Blvd and Franklin Avenue to IL 1, 1000ft southwest of Halsted Street, Chicago Heights	5, 10, 25, 50 & 100	None	THCRG1-A16
THCR4	THCR-G2	Thorn Creek at Sauk Trail Road	50 & 100	None	THCRG2-A1
TCTA1	TCTA-G1	26th Street & Stewart to State Street & 22nd Street, Chicago Heights	2, 5, 10, 25, 50 & 100	None	TCTAG1-A8
TCTA2	TCTA-G1	Arnold Street from 15th Street to 12th Street (extended), Chicago Heights	2, 5, 10, 25, 50 & 100	None	TCTAG1-A8
TCTA3	TCTA-G1	32nd Street & Phillips Avenue to 33rd Street & Lewis Avenue, Steger	2, 5, 10, 25, 50 & 100	None	TCTAG1-A8
TCTB2	TCTB-G1	Lincoln Highway and Wilson Avenue to Irving Blvd and Franklin Avenue, Chicago Heights	50 & 100	None	TCTBG1-A1
TCTD1	TCTD-G1	Station Drive & Front Street, 216th Street & Oak Street, Charles Street and 218th Street, Park Forest and Matteson	2, 5, 10, 25, 50 & 100	None	TCTDG1-A9
TCTD2	TCTD-G1	E and W Rocket Circle Drive to Lakewood Blvd, Park Forest	2, 5, 10, 25, 50 & 100	PAR1	TCTDG1-A9

Damage assessment, technology screening, alternative development and alternative selection were done by problem grouping, since each group is independent of the other. Each problem group is evaluated in the following sections by Group ID.

3.7.3.1 THCR-G1 – Thorn Creek Problem Group 1

3.7.3.1.1 Problem Definition

The THCR-G1 problem area consists of flooding from four related areas. The first problem area (THCR1) consists of overbank flooding in Glenwood along the west side of Thorn Creek from Chicago Heights-Glenwood Road to the abandoned B & O Railroad. In this reach, 100-year flows ranging between 8,025 cfs at Chicago Heights-Glenwood Road to 7,872 cfs at the abandoned B&O Railroad exceeds the capacity of the channel. The flooding in Glenwood includes 3 structures within Glenwood School for Boys and approximately 45 structures west of Arquilla Park. The Glenwood area is shown on the recent DFIRM floodplain maps with flooding to a lesser extent. The flood protection elevation is approximately at 613 feet NGVD.

The second problem area (THCR2) consists of overbank flooding in Chicago Heights along the west side of Thorn Creek near the intersection of Parkside Avenue and Union Avenue. In this reach, the 100-year flow is approximately 2,890 cfs at Halsted

Street, exceeding the capacity of the channel. The flooding in Chicago Heights includes 8 structures within the adjacent subdivision. The Chicago Heights area is shown on the recent DFIRM floodplain maps with flooding, but to a slightly lesser extent. The flood protection elevation is approximately 635 feet NGVD.

The third problem area (THCR3) consists of overtopping of 26th Street at the outlet of Sauk Lake at the border of Chicago Heights and South Chicago Heights. In this reach, 100 year flows at are approximately 1,830 cfs. Flooding at this location impacts traffic along 26th Street, a major roadway, but does not impact any properties. This area is shown as flooded on the current FEMA DFIRMs. The flood protection elevation is approximately 681 feet, 1 foot below the current top of the road.

The forth problem area (TCTB1) is located on Thorn Creek Tributary B, and consists of overbank flooding in Chicago Heights along the creek from Irving Boulevard and Franklin Avenue to IL Rte. 1, 1,000 feet southwest of Halsted Street, in Chicago Heights. In this reach, 100-year flows range from 463 cfs at the 10th Street culvert to 704 cfs at the intersection of Parkside Avenue and Peoria Street. The flooding in Chicago Heights is shown on the recent DFIRM floodplain maps with flooding to a lesser extent. The flood protection elevation is approximately 655 feet NGVD at the upstream, to 637.42 NGVD at the downstream. Flood protection elevations at all the problem areas were developed based on field reconnaissance of the area based on typical residential structures.

3.7.3.1.2 Damage Assessment, THCR-G1

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Thorn Creek and its tributaries. These stages were used to calculate the depth of flooding and to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.7.13** lists the estimated damages for the problem group.

Table 3.7.13: Estimated Damages for Thorn Creek Subwatershed, Problem Group THCR-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
THCR-G1	Property	$1,167,000	Structures at risk of flooding.
	Transportation	$175,000	Assumed as 15% of property damage due to flooding.
	Recreation	$0	

3.7.3.1.3 Technology Screening, THCR-G1

Several combinations of technologies were analyzed to address the flooding problems associated with THCR-G1. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.7.14**

summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.7.14: Evaluation of Flood Control Technologies for Thorn Creek Subwatershed, Problem Group THCR-G1

Flood Control Option	Feasibility
Detention Facilities	Feasible and necessary at Sauk Lake/THCR3 for downstream stage reduction. Infeasible in THTB1 due to lack of available space. Infeasible at downstream THCR1 & THCR2 due to extremely large storage requirements
Conveyance Improvement – Culvert/ Bridge Replacement	Feasible and necessary at Sauk Lake/THCR3 to prevent Dam overtopping. Feasible and necessary in TCTB1 to decrease stages
Conveyance Improvement – Channel Improvement	Feasible and necessary in TCTB1, due to space restrictions. Infeasible at downstream THCR1 & THCR2 due to extremely large flows
Conveyance Improvements – Diversion	Feasible and necessary in THTB1 due to limited channel capacity and space restriction. Infeasible at downstream THCR1 & THCR2 due to extremely large flows. Infeasible at Sauk Lake/THCR3 due to unavailable diversion routes
Flood Barriers, Levees/Floodwalls	Feasible and necessary in THCR1 & THCR2 due to limited channel capacity and space restrictions. Infeasible in THTB1 due to lack of available space. Not a suitable solution in THCR3 to prevent dam overtopping

3.7.3.1.4 Alternative Development, THCR-G1

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.7.15** summarizes flood control alternatives developed for Problem Group THCR-G1.

Table 3.7.15: Flood Control Alternatives for Problem Group THCR-G1

Alternative	Location	Description
THCRG1-A1	Sauk Lake	Expand Sauk Lake to decrease downstream flows, control the 100-year flood and to prevent overtopping of 26th Street
THCRG1-A2	Sauk Lake	Provide compensatory storage by modifying the outlet of the Sauk Lake Dam. Simulations of a modified Sauk Lake Dam indicate that downstream stages could be decreased by controlling the 100-year flood (i.e., not allowing 100-year flows to overtop the outlet dam, as occurs under baseline conditions)
THCRG1-A3	Sauk Lake Dam	Adjust the outlet configuration of Sauk Lake Dam to prevent the Dam from overtopping while at the same time decreasing downstream elevations to provide compensatory storage for the Alternative 1 & 2 levees and for the diversion flow from Thorn Creek Tributary A to Thorn Creek

Table 3.7.15: Flood Control Alternatives for Problem Group THCR-G1

Alternative	Location	Description
THCRG1-A4	Forest Preserve	Divert high flows from Thorn Creek to an offline reservoir. This alternative results in an extremely large storage volume requirement due to the large and persistent flows in the main reach. The only feasible area which could provide the required offline storage volume is in Forest Preserve District of Cook County property, and was found to be infeasible
THCRG1-A5	Thornton Composite Reservoir	Adjust operations of the Reservoir. Delaying the opening of the inlet gates to Thornton Composite Reservoir was simulated but did not significantly decrease stages, and resulted in stage increases in the Little Calumet River
THCRG1-A6	Various along Thorn Creek	Increase channel capacity by widening and/or regrading. This was considered infeasible due to the large increase in capacity required to significantly decrease the stages of the existing flows. Increasing channel carrying capacity would also be likely to increase downstream stages and require a large volume of compensatory storage
THCRG1-A7	Various crossings along Thorn Creek	Increase hydraulic openings of bridges and culverts along Thorn Creek. This was considered infeasible due to the large increase in capacity required to significantly decrease the stages of the existing flows. Increasing the hydraulic opening would also be likely to increase downstream stages and require a large volume of compensatory storage
THCRG1-A8	Thorn Creek, Chicago Heights-Glenwood Road to B&O RR tracks	Construct a levee to protect building structures. This alternative results in stage increases of greater than 0.04 ft, so compensatory storage is required
THCRG1-A9	Thorn Creek, Parkside Avenue to Union Avenue	Construct a levee to protect building structures. This alternative results in stage increases of greater than 0.04 ft, so compensatory storage is required
THCRG1-A10	Thorn Creek Tributary B	Construct a levee to protect building structures. This was found infeasible since the levee would have to extend over a long stretch of residential area with numerous road crossings. There is no feasible location to provide compensatory storage
THCRG1-A11	Thorn Creek Tributary B, u/s of Parkside Avenue to confluence	Increase channel capacity by flattening the slope and widening the cross section of Thorn Creek Tributary B from Parkside Avenue to the confluence with Thorn Creek
THCRG1-A12	Thorn Creek Tributary B at Parkside Avenue & IL 1	Increase hydraulic openings of the crossings on Thorn Creek Tributary B at Parkside Avenue and IL Rte. 1
THCRG1-A13	Thorn Creek Tributary B	Add a diversion to Thorn Creek Tributary B with an outlet to Thorn Creek
THCRG1-A14	Length of Thorn Creek Tributary B	Provide a diversion culvert along the length of the creek to discharge further downstream to increase channel conveyance. This option does not sufficiently reduce stages
THCRG1-A15	Thorn Creek Tributary B	Divert flow into THCR. This alternative decreases downstream stages, and compensatory storage is required
THCRG1-A16	Sauk Lake Dam, Thorn Creek, Thorn Creek Tributary B	Adjust the outlet configuration of Sauk Lake Dam, levee construction, increase channel capacity, increase hydraulic openings of crossings, and divert flow into Thorn Creek Reach 7 (combination of Alternatives THCRG1-A3, THCRG1-A8, THCRG1-A9, THCRG1-A11, THCRG1-A12, and THCRG1-A15)

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the THCR-G1 Problem Group.

3.7.3.1.5 Alternative Evaluation and Selection, THCR-G1

Alternatives included in **Table 3.7.15** were evaluated to determine their effectiveness and produce the data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.7.17** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative for Problem Group THCR-G1. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, thus costs were not calculated for these alternatives.

Alternative THCRG1-A16 from **Table 3.7.15** is the preferred alternative for Problem Group THCR-G1. The preferred alternative includes channel capacity improvements along Thorn Creek Tributary B, levees along Thorn Creek, a diversion structure on Thorn Creek Tributary B and modifying the Sauk Lake Dam to provide compensatory storage. Modifying Sauk Lake Dam by raising the dam spillway elevation to 685.60 feet and adding an additional 5.5-foot by 2.25-foot box culvert to the existing five (5) box culvert configuration results in the 100-year water surface elevation to increase 2.38 feet, which results in 118 acre-feet of additional storage and a decrease in outflow of 582 cfs.

Raising 187th Street in Village of Glenwood to act as a levee at 621.44 feet NGVD (i.e., 3 feet above the 100-year flood stage) should prevent flooding to Glenwood School for Boys. 187th Street would maintain this elevation to south of Butterfield Creek to past Arquilla Park to the north. An additional floodwall at NGVD 621.44 feet would continue north of 187th Street and protect residences west of Arquilla Park from flooding. Chicago Heights Glenwood Road would also be raised 1 foot above the 100 year flood elevation to 619.44 feet NGVD. The bridge opening under Chicago Heights Glenwood Road would likely need to be increased from its current single span formation to allow a similar flow rate to pass through the opening, since it would no longer have overtopping flows. The bike path (former rail road tracks) would also potentially be removed to allow increased conveyance in this area. The recommended alternative also included the following project components:

- Construct a 1,200 linear-foot earthen berm along Thorn Creek next to Parkside Avenue and Union Avenue with a height varying from 1.4 to 6.4 feet.
- Construct a flow diversion from the upstream portion of Thorn Creek Tributary B that follows the existing roads and discharges into Thorn Creek Reach 7.
- Replace the culverts at Thorn Creek Tributary B under Parkside Avenue and IL Rte. 1 with larger box culverts.

- Flatten the slope and widen the cross section of Thorn Creek Tributary B from upstream of Parkside Avenue to the confluence with Thorn Creek.

Table 3.7.16 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for THCR-G1.

Table 3.7.16: Alternative Condition Flow & WSEL Comparison for Problem Group THCR-G1

Location	Station	Existing Conditions		Alternative THCRG1-A16	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Sauk Lake	SA 211	682.22	689	684.60	630
Halsted Avenue, downstream of Tributary B	Thorn Creek 60185	638.67	2,893	638.00	2,514
Bike Path/Foot Bridge downstream of Halsted Avenue	Thorn Creek 59507	637.00	2,897	636.70[1]	2,524
Downstream of confluence with Thorn Creek Tributary A	Thorn Creek 55515	629.21	3,526	628.81	3,049
Vincennes Avenue	Thorn Creek 37973	617.31	7,975	616.68[1]	7,405
10th St culvert, downstream face	Thorn Cr Tributary B 4839	650.95	463	649.86	492
Parkside Avenue at Peoria Street	Thorn Cr Tributary B 626	641.21	704	638.05	432

[1] Levee provides protection

3.7.3.1.6 Data Required for Countywide Prioritization of Watershed Projects, THCR-G1

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.7.17** lists the alternative analyzed in detail. The recommended alternative consists of channel capacity improvements along Thorn Creek Tributary B, levees along Thorn Creek, a diversion structure on Thorn Creek Tributary B and modifying Sauk Lake Dam to provide compensatory storage. **Figure 3.7.6** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.7.17: Thorn Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group THCR-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
THCR-G1	THCRG1-A16	Conveyance Improvement, Levees, Flow Diversion and Storage	0.02	$717,000	$37,660,000	51 Structures, 3 Roadways	No Impact	Chicago Heights, Glenwood, South Chicago Heights

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.7.3.2 THCR-G2 – Thorn Creek Problem Group 2

3.7.3.2.1 Problem Definition, THCR-G2

The THCR-G2 problem area consists of overtopping of Sauk Trail Road within the Forest Preserve District of Cook County property, adjacent to Park Forest. In this reach, 100-year flows are at approximately 1,620 cfs. Flooding at this location impacts traffic along Sauk Trail Road, a major County route, but does not impact any properties. This area is shown as flooded on the current FEMA DFIRMs. The flood protection elevation is approximately 681.74, 1 foot below the current top of the road. Flood protection elevations were developed based on field reconnaissance of the area and the elevation of the existing road.

3.7.3.2.2 Damage Assessment, THCR-G2

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Thorn Creek and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.7.18** lists the estimated damages for the problem group.

Table 3.7.18: Estimated Damages for Thorn Creek Subwatershed, Problem Group THCR-G2

Problem Group ID	Damage Category	Estimated Damage ($)	Description
THCR-G2	Property	$0	
	Transportation	$1,600,000	Overtopping of Sauk Trail Road
	Recreation	$0	

3.7.3.2.3 Technology Screening, THCR-G2

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.7.19** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.7.19: Evaluation of Flood Control Technologies for Thorn Creek Subbasin, Problem Group THCR-G2

Flood Control Option	Feasibility
Detention Facilities	Unnecessary given alternative
Conveyance Improvement – Culvert/Bridge Replacement	Feasible to adjust Sauk Trail Road grading and bridge opening
Conveyance Improvement – Channel Improvement	Unnecessary given alternative
Conveyance Improvements – Diversion	Unnecessary given alternative
Flood Barriers, Levees/Floodwalls	Unnecessary given alternative

3.7.3.2.4 Alternative Development, THCR-G2

Flood Control Alternatives. An alternative solution to regional flooding problems was developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.7.20** summarizes flood control alternative developed for Problem Group THCR-G2.

Table 3.7.20: Flood Control Alternatives for Problem Group THCR-G2

Alternative	Location	Description
THCRG2-A1	Sauk Trail Road	Increase elevation of Sauk Trail Road and adjust bridge opening to prevent overtopping. Increase bridge low chord increase 3.4 ft to elevation 682.7 ft NGVD

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the THCR-G2 Problem Group.

3.7.3.2.5 Alternative Evaluation and Selection, THCR-G2

The alternative included in **Table 3.7.20** was evaluated to determine its effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.7.22** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative.

Alternative THCRG2-A1 from **Table 3.7.20** is the preferred alternative for this problem group. The top of road elevation is to be raised to NGVD 686.67 feet to prevent overtopping during the 100-year event. The bridge opening is to be increased by raising the low chord 3.4 feet to elevation 682.7 feet NGVD.

Table 3.7.21 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for THCR-G2.

Table 3.7.21: Alternative Condition Flow & WSEL Comparison for Problem Group THCR-G2

Location	Station	Existing Conditions		Alternative THCRG2-A1	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Sauk Lake Road, upstream face	Thorn Cr 80864	686.87	1,621	685.67	1,753

3.7.3.2.6 Data Required for Countywide Prioritization of Watershed Projects, THCR-G2

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.7.22** lists the alternative analyzed in detail. The recommended alternative consists of the retrofitting the existing Sauk Trail Road crossing at Thorn Creek by raising the roadway profile and increasing the low chord elevation of the bridge structure. **Figure 3.7.7** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.7.22: Thorn Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group THCR-G2

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
THCR-G2	THCRG2-A1	Modify and retrofit bridge	0.63	$1,600,000	$2,543,000	1 Roadway	No Impact	Cook County FPD

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.7.3.3 TCTA-G1 – Thorn Creek Tributary A Problem Group 1

3.7.3.3.1 Problem Definition, TCTA-G1

The TCTA-G1 problem group consists of a combination of three problem areas. The first problem area (TCTA1) consists of overland flooding in Chicago Heights due to insufficient capacity in the existing 6 inch diameter enclosed conduit underneath a residential subdivision from 26th Street and Stewart Avenue to the proximity of the State Street and 22nd Street intersection. In this reach, 100-year flows range from 508 cfs near 26th Street to 275 cfs near the State Street and 22nd Street intersection, and exceed the capacity of the existing culvert. The flooding in Chicago Heights includes approximately 50 homes in the subdivision. This Chicago Heights subdivision is not shown in the recent DFIRM floodplain maps because it was not modeled. The flood protection elevation is approximately 678.91 feet NGVD at 26th Street and 671.79 feet NGVD near 22nd Street.

The second problem area (TCTA2) consists of flooding caused by overflow from the enclosed culvert located from 26th Street and Stewart Avenue to near the State Street and 22nd Street intersection in Chicago Heights. Flooding in this area runs overland, parallel to Stewart Avenue, and eventually returns to Thorn Creek Tributary A at State Street. In this reach, 100-year overflow occurs over approximately 24 hours with a peak flow of 290 cfs, inundating the area with approximately 1 foot of water. The flooding in Chicago Heights includes 10 structures along the overland flow path. This area is not shown in the recent DFIRM floodplain maps because it was not modeled. The flood protection elevation varies between 657.66 feet NGVD to 635 feet NGVD near State Street.

The third problem area (TCTA3) consists of flooding caused by high stages from Thorn Creek Tributary B, which back up into the upstream residential area in the Village of Steger from 32nd Street and Phillips Avenue to 33rd Street and Lewis Avenue. In this reach, the 100-year peak flow of 552 cfs occurs with a peak elevation of 699.15 feet NGVD, inundating the area with 1 to 3 feet of water. The flood protection elevation is approximately 698 feet, 1 foot below the high point over which flooding occurs. For all problem areas, flood protection elevations were developed based on field reconnaissance of the area and the elevation of the existing roadways.

3.7.3.3.2 Damage Assessment, TCTA-G1

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Thorn Creek and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.7.23** lists the estimated damages for the problem group.

Table 3.7.23: Estimated Damages for Thorn Creek Subwatershed, Problem Group TCTA-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
TCTA-G1	Property	$1,230,000	Structures at risk of flooding.
	Transportation	$184,000	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.7.3.3.3 Technology Screening, TCTA-G1

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.7.24** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.7.24: Evaluation of Flood Control Technologies for Thorn Creek Subwatershed, Problem Group TCTA-G1

Flood Control Option	Feasibility
Detention Facilities	Feasible and necessary to account for stage increases
Conveyance Improvement – Culvert/Bridge Replacement	Feasible and necessary to upgrade existing long enclosed culvert between 26th St and 22nd Street
Conveyance Improvement – Channel Improvement	Feasible but not necessary
Conveyance Improvements – Diversion	Feasible but with potential drawbacks
Flood Barriers, Levees/Floodwalls	Unnecessary given alternative

3.7.3.3.4 Alternative Development, TCTA-G1

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.7.25** summarizes flood control alternatives developed for Problem Group TCTA-G1.

Table 3.7.25: Flood Control Alternatives for Problem Group TCTA-G1

Alternative	Location	Description
TCTAG1-A1	26th Street & Stewart Avenue to State Street & 22nd Street	Upsize existing 6-ft diameter culvert
TCTAG1-A2	Thorn Creek Tributary B, upstream reach	Conveyance improvements by removing two minor culverts under restrictive footpaths and replacing with non-obstructive footbridges
TCTAG1-A3	Upstream of 26th Street	Construct 540 ac-ft of offline storage facility upstream of the enclosed culvert to reduce the current peak flow of 508 cfs to 120 cfs, the approximate capacity of the current 6-ft diameter culvert. Based on meetings with local officials, there is not a site available that could provide this storage volume
TCTAG1-A4	Upstream of 26th Street & downstream of 22nd Street	Construct 180 ac-ft offline storage facility upstream of culvert and 660 ac-ft storage facility downstream of culvert to reduce flow volumes
TCTAG1-A5	Various along Thorn Creek Tributary A	Increasing channel conveyance along Thorn Creek Tributary A. Re-grading and/or widening the creek does not have a benefit unless the undersized culvert is also addressed
TCTAG1-A6	Various along Thorn Creek Tributary A	Construct a levee along Thorn Creek Tributary A. Using a levee would not be feasible due to the residential nature of the streets and area surrounding the long enclosed culvert

Table 3.7.25: Flood Control Alternatives for Problem Group TCTA-G1

Alternative	Location	Description
TCTAG1-A7	26th Street	Divert peak flows from Thorn Creek Tributary A to Sauk Lake by constructing a 7,700 LF box culvert underneath 26th Street. This would require adjustments to the dam outlet structure at Sauk Lake. While potentially effective, this alternative was not pursued because the cost of the culvert would be prohibitive
TCTAG1-A8	26th Street & Stewart Avenue to State Street & 22nd Street, Thorn Creek Tributary B upstream reach, Upstream of 26th Street & downstream of 22nd Street	Upsize culvert, conveyance improvements, and offline storage facility (combination of Alternatives TCTAG1-A1, TCTAG1-A2 and TCTAG1-A4)

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the TCTA-G1 Problem Group.

3.7.3.3.5 Alternative Evaluation and Selection, TCTA-G1

Alternatives included in **Table 3.7.25** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.7.27** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, thus costs were not calculated for these alternatives.

Alternative TCTAG1-A8 from **Table 3.7.25** provides the preferred alternative for this problem group. To relieve flooding in this problem area two objectives must be met: 1) prevent overtopping of the enclosed culvert from 26th Street and Stewart Avenue to State Street and 22nd Street; and 2) decrease the stage at the upstream reach of Thorn Creek Tributary B to prevent flows from backing up into the upstream residential area.

The preferred alternative has several recommended components, listed below.

- Replace the 6-foot diameter enclosed culvert between 26th Street and Stewart Avenue to 22nd Street near State Street with two (2) 9-foot by 6-foot box culverts.

- Construct offline detention upstream and downstream of this culvert. The upstream detention area would hold approximately 180 acre-feet of storage. The downstream detention area would contain approximately 660 acre-feet. Both storage facilities would require pumping to drain the facilities after a storm. Neither facility is directly adjacent to the stream and would therefore require inlet pipes of significant lengths, 1,300 feet and 1,700 feet for the upstream and downstream detention facilities respectively. This would allow all flow to be contained within the proposed double box culvert. The inlet water surface elevation should be no higher than approximately 676 feet NGVD to prevent surcharging of the long enclosed box culvert.

- Remove two culverts in the upstream reach of Thorn Creek Tributary B. The first culvert appears to be within a power company right-of-way and consists of a small circular culvert and a large box culvert. It is located 550 feet north and 450 feet east of the intersection of 30th Street and Holeman Avenue in Chicago Heights. The second culvert is a 5-foot by 2-foot elliptical culvert approximately 180 feet west of the intersection of Loverock Avenue and 32nd Street that appears to serve as a crossing for pedestrians. Both culverts would be removed and replaced by non-obstructive foot bridges.

Table 3.7.26 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for TCTA-G1.

Table 3.7.26: Alternative Condition Flow & WSEL Comparison for Problem Group TCTA-G1

		Existing Conditions		Alternative TCTAG1-A8	
Location	**Station**	**Max WSEL (ft)**	**Max Flow (cfs)**	**Max WSEL (ft)**	**Max Flow (cfs)**
State Street	Thorn Creek Tributary A 15378	665.30	275	663.93	184
RR 800 ft upstream of 26th Street	Thorn Creek Tributary A 20296	687.80	508	678.33	413
DS Face Loverock Avenue	Thorn Creek Tributary A 27528	699.15	553	697.40	553

3.7.3.3.6 Data Required for Countywide Prioritization of Watershed Projects, TCTA-G1

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.7.27** lists the alternative analyzed in detail. The recommended alternative consists of upgrading the diameter of the culvert conveying the creek, providing upstream and downstream compensatory storage, and removing restrictive culvert crossings. **Figure 3.7.8** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.7.27: Thorn Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group TCTA-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
TCTA-G1	TCTAG1-A8	Upgrade crossings, offline detention, upsize culvert	0.02	$1,415,000	$89,000,000	51 Structures	Positive	Chicago Heights, South Chicago Heights, Steger

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.7.3.4 TCTB-G1 – Thorn Creek Tributary B Problem Group 1

3.7.3.4.1 Problem Definition, TCTB-G1

The TCTB-G1 problem area consists of overbank flooding in Chicago Heights from Lincoln Highway and Wilson Avenue to Irving Boulevard and Franklin Avenue. In this reach, the 100-year flow ranges from approximately 193 cfs at Lincoln Highway to 238 cfs at Irving Boulevard. The potential flooding in Chicago Heights includes about 40 structures within a residential subdivision. The problem area is shown on the recent DFIRM floodplain maps with flooding to a similar extent. The flood protection elevation is approximately at 664 feet NGVD at the upstream, and 659.2 feet in the downstream. Flood protection elevations were developed based on field reconnaissance of the area based on typical residential structures.

3.7.3.4.2 Damage Assessment, TCTB-G1

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Thorn Creek and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.7.28** lists the estimated damages for the problem group.

Table 3.7.28: Estimated Damages for Thorn Creek Subwatershed, Problem Group TCTB-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
TCTB-G1	Property	$6,800	Structures at risk of flooding
	Transportation	$1,200	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.7.3.4.3 Technology Screening, TCTB-G1

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.7.29** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.7.29: Evaluation of Flood Control Technologies for Thorn Creek Subwatershed, Problem Group TCTB-G1

Flood Control Option	Feasibility
Detention Facilities	Not feasible due to limited space
Conveyance Improvement – Culvert/Bridge Replacement	Feasible but limited
Conveyance Improvement – Channel Improvement	Feasible and necessary
Conveyance Improvements – Diversion	Feasible but undesirable
Flood Barriers, Levees/Floodwalls	Not feasible due to space restrictions

3.7.3.4.4 Alternative Development, TCTB-G1

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.7.30** summarizes flood control alternatives developed for Problem Group TCTB-G1.

Table 3.7.30: Flood Control Alternatives for Problem Group TCTB-G1

Alternative	Location	Description
TCTBG1-A1	Various along Thorn Creek Tributary B	Replace restricting culverts. This is a feasible option, although most culverts do not have much potential for significant expansion
TCTBG1-A2	Thorn Creek Tributary B	Divert flow to the downstream reach. Additional flow to this reach was undesirable since it already experiences flooding.
TCTBG1-A3	Various along Thorn Creek Tributary B	Decreasing stages by increasing culvert flow capacities was deemed feasible though most culverts did not have much potential for significant expansion
TCTBG1-A4	Various along Thorn Creek Tributary B	Conveyance improvements by widening the channel and decreasing the channel roughness. This alternative has the potential to produce reasonable stage decreases. This could be achieved by creating a wider, concrete-lined trapezoidal channel, although other design alternatives may be possible

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the TCTB-G1 Problem Group.

3.7.3.4.5 Alternative Evaluation and Selection, TCTB-G1

Alternatives included in **Table 3.7.30** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.7.32** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed, as benefits were negligible, and thus costs were not calculated for these alternatives.

Alternative TCTBG1-A1 from **Table 3.7.30** is the preferred alternative for this problem group. In this problem area, flooding occurs from a lack of channel capacity in a heavily residential area, and a lack of space is the limiting factor. The preferred alternative involves widening the existing channel along Thorn Creek Tributary B and decreasing its roughness. The new channel would have a trapezoidal cross section with a wider bottom width. The overall channel slope would remain the same. The roughness could potentially be reduced by using a concrete lining, although alternate designs could be conceived in the detailed design phase. Overall, this design decreases stages by 0.2 to 1.7 feet throughout this reach.

Table 3.7.31 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for TCTB-G1.

Table 3.7.31: Alternative Condition Flow & WSEL Comparison for Problem Group TCTB-G1

Location	Station	Existing Conditions		Alternative TCTBG1-A1	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Wilson Ave US Face	Thorn Creek Tributary B 8865	664.11	193	662.48	193
Irving Blvd and Franklin Ave	Thorn Creek Tributary B 5822	654.21	236	652.62	238

[1] Levee provides protection

3.7.3.4.6 Data Required for Countywide Prioritization of Watershed Projects, CTB-G1

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.7.32** lists the alternative analyzed in detail. The recommended alternative consists of widening the existing channel and decreasing the channel roughness. **Figure 3.7.9** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.7.32: Thorn Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group TCTB-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
TCTB-G1	TCTBG1-A1	Channel conveyance improvements	< 0.01	$8,000	$6,900,000	4 Structures, 3 Roadways	No Impact	Chicago Heights

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.7.3.5 TCTD-G1 – Thorn Creek Tributary D Problem Group 1

3.7.3.5.1 Problem Definition, TCTD-G1

The TCTD-G1 problem group consists of two problem areas. The first problem area (TCTD1) consists of overbank flooding in Park Forest and Matteson upstream of Thorn Creek Tributary D along Station Drive and Front Street, 216th Street and Oak Street, and Charles Street and 218th Street (Storage Area 212). In this reach, the 100-year peak flow is 507 cfs. No profile is available for the storage area; the elevation in the storage area is 704.60 feet NGVD. The potential flooding in Park Forest and Matteson includes about 78 structures within the adjacent residential and industrial areas. Flooding in Park Forest and Matteson is shown on the recent DFIRM floodplain maps only in Central Park. The large public park at the downstream end of the reach is marked as Zone X, indicating the drainage area for the reach should be less than 1 square mile. The revised hydrology indicates that the drainage area at this location is greater than 1 square mile. The flood protection elevation is approximately 700.3 feet NGVD for the entire area.

The second problem area (TCTD2) consists of ponding in Park Forest in the reach adjacent to East and West Rocket Circle Drive to Lakewood Boulevard. In this reach, the 100-year peak flow is approximately 236 cfs at the pedestrian walkway near West Rocket Circle Drive and 277 cfs at the upstream face of Lakewood Boulevard. The potential flooding in Park Forest includes approximately 28 residences within the adjacent subdivision. The Park Forest area is shown on the recent DFIRM floodplain maps marked as Zone X, likely meaning this area has less than 1 square mile of drainage area. Revised hydrology indicates a drainage area of greater than 1 square mile. The flood protection elevation is approximately 703.7 feet NGVD. Flood protection elevations for both problem areas were developed based on field reconnaissance of the area based on typical residential structures.

3.7.3.5.2 Damage Assessment, TCTD-G1

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Thorn Creek and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.7.33** lists the damages caused from the problem group.

Table 3.7.33: Estimated Damages for Thorn Creek Subwatershed, Problem Group TCTD-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
TCTD-G1	Property	$4,900,000	Structures at risk of flooding
	Transportation	$740,000	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.7.3.5.3 Technology Screening, TCTD-G1

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.7.34** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.7.34: Evaluation of Flood Control Technologies for Thorn Creek Subwatershed, Problem Group TCTD-G1

Flood Control Option	Feasibility
Detention Facilities	Feasible
Conveyance Improvement – Culvert/Bridge Replacement	Feasible
Conveyance Improvement – Channel Improvement	Feasible but not necessary
Conveyance Improvements – Diversion	Not feasible
Flood Barriers, Levees/Floodwalls	Not feasible due to space restrictions

3.7.3.5.4 Alternative Development, TCTD-G1

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.7.35** summarizes flood control alternatives developed for Problem Group TCTD-G1.

Table 3.7.35: Flood Control Alternatives for Problem Group TCTD-G1

Alternative	Location	Description
TCTDG1-A1	Thorn Creek Tributary D	Divert flow to downstream reach. Any flow diversion results in increased downstream stages. There is no possibility for downstream offline storage due to space restrictions
TCTDG1-A2	Culvert from Krotiak Road to Westwood Drive	Restore culvert conveying Thorn Creek Tributary D to its original, open channel condition. This increases downstream stages, requiring offline storage, which is not available
TCTDG1-A3	Thorn Creek Tributary D	Divert flow to Sauk Lake along the power line right-of-way. This option would significantly increase outflows from Sauk Lake and cause downstream stage increases in Thorn Creek

Table 3.7.35: Flood Control Alternatives for Problem Group TCTD-G1

Alternative	Location	Description
TCTDG1-A4	Central Park, Park Forest	Create a 530 ac-ft offline storage area in the upstream reach of Thorn Creek Tributary D. Central Park in Park Forest has a large enough footprint to construct the detention facility
TCTDG1-A5	Lakewood Blvd. between East Rocket Circle and Orchard Drive	Construct levees to alleviate flooding to businesses and backyards of residences. Offline storage in the area would be required to compensate for increases in downstream stages
TCTDG1-A6	Lakewood Boulevard	Divert flow to downstream reach. This would result in increases in downstream stages, with no possibility for downstream offline storage due to space restrictions
TCTDG1-A7	Lakewood Boulevard Culvert	Upgrade existing double, 3.5-ft diameter culvert to a single, 10-ft by 5-ft box culvert
TCTDG1-A8	East of Gold Street and East Rocket Circle	Remove an existing 5-ft diameter corrugated metal pipe sidewalk crossing and replace with an unobtrusive foot bridge
TCTDG1-A9	Central Park, Lakewood Boulevard culvert, east of Gold Street and East Rocket Circle	530 ac-ft offline storage facility, upgrade culvert crossings (combination of Alternatives TCTDG1-A4, TCTDG1-A7 and TCTDG1-A8)

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the TCTD-G1 Problem Group.

3.7.3.5.5 Alternative Evaluation and Selection, TCTD-G1

Alternatives included in **Table 3.7.35** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.7.37** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, thus costs were not calculated for these alternatives.

Alternative TCTDG1-A9 from **Table 3.7.35** provides the preferred alternative for this problem group. This alternative consists of an offline storage basin and upgrading or replacing two crossings. The offline storage could be located within Park Forest's Central Park. A storage basin could hold approximately 530 acre-feet and be 11 feet deep, with a footprint of approximately 56 acres. A pumped outlet would be required. The potential exists to retrofit the park to maintain some of its existing recreational uses. This storage area will reduce peak stages to 702.5 feet NGVD, below the existing stages of 706 feet NGVD, although not achieving the optimal no-damage elevation of 700.3 feet NGVD.

The preferred alternative also includes conveyance improvements within the upstream portion of Thorn Creek Tributary D. The culvert underneath Lakewood Boulevard could be upgraded from double, 3.5-ft diameter culverts to a single, 10-foot by 5-foot box culvert. A restrictive sidewalk crossing located 200 feet east of Gold

Street and East Rocket Circle could be removed and replaced by a non-obstructive foot bridge. This would decrease stages in this reach by 1.8 feet, to below the flood protection stage of 705.8 feet NGVD.

Table 3.7.36 provides a comparison of the modeled WSEL and modeled flow at the time of peak for TCTD-G1.

Table 3.7.36: Alternative Condition Flow & WSEL Comparison for Problem Group TCTD-G1

Location	Station	Existing Conditions		Alternative TCTDG1-A9	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Area US of Central Park	SA 212	704.60	507	702.37	141
Upstream face of Lakewood Blvd	Thorn Cr Tributary D 5822	706.74	236	704.96	238

3.7.3.5.6 Data Required for Countywide Prioritization of Watershed Projects, TCTD-G1

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.7.37** lists the alternative analyzed in detail. The recommended alternative consists of providing 530 acre-feet of offline storage and upgrading or replacing two crossings. **Figure 3.7.10** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.7.37: Thorn Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group TCTD-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
TCTD-G1	TCTDG1-A9	Central Park offline storage, upstream conveyance Improvements	0.08	$5,500,000	$65,442,000	22 structures, 1 roadway	Positive	Park Forest

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.7.4 Recommended Alternatives, Thorn Creek Subwatershed

Table 3.7.38 summarizes the recommended alternatives for the Thorn Creek subwatershed. The District will use data presented here to support prioritization of a countywide stormwater CIP.

Table 3.7.38: Thorn Creek Project Alternative Matrix to Support District CIP Prioritization, All Problem Groups

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
THCR-G1	THCRG1-A16	Conveyance improvement, levees, flow diversion and storage	0.02	$717,000	$37,660,000	51 Structures, 3 Roadways	No impact	Chicago Heights, Glenwood, South Chicago Heights
THCR-G2	THCRG2-A1	Modify and retrofit bridge	0.63	$1,600,000	$2,543,000	1 Roadway	No impact	Cook County FPD
TCTA-G1	TCTAG1-A8	Upgrade crossings, offline detention, upsize culvert	0.02	$1,415,000	$89,000,000	51 Structures	Positive	Chicago Heights, South Chicago Heights, Steger
TCTB-G1	TCTBG1-A1	Channel conveyance improvements	<0.01	$8,000	$6,900,000	4 Structures, 3 Roadways	No impact	Chicago Heights
TCTD-G1	TCTDG1-A9	Central Park offline storage, upstream conveyance Improvements	0.08	$5,500,000	$65,442,000	22 Structures, 1 Roadway	Positive	Park Forest

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.8 Little Calumet River

The Little Calumet River subwatershed encompasses approximately 33 square miles (27.66 in Cook County and 4.86 in Lake County, Indiana) within the northwestern portion of the Little Calumet River watershed. **Table 3.8.1** lists the communities that lie within the subwatershed and the associated drainage area for each community contained within the subwatershed.

Table 3.8.1: Communities Draining to Little Calumet River Subwatershed Within Cook County

Community	Tributary Area (mi^2)
Blue Island	0.30
Calumet City	2.44
Calumet Park	<0.01
Country Club Hills	0.02
Dixmoor	1.24
Dolton	2.40
Harvey	4.35
Lansing	4.35
Markham	2.26
Midlothian	0.51
Oak Forest	0.44
Phoenix	0.44
Posen	0.17
Riverdale	1.95
South Holland	4.20
Unincorporated Cook County/ Forest Preserve	2.59

Table 3.8.2 lists the land use breakdown by area within the Little Calumet River subwatershed. **Figure 3.8.1** provides an overview of the tributary area of the subwatershed. Reported stormwater problem areas and proposed alternative projects are also shown on the figure, and are discussed in the following subsections.

Within the Little Calumet River subwatershed, a total of 13.8 stream miles were studied among two tributaries, the Little Calumet River main stem and an Unnamed Tributary to the Little Calumet River. The remaining tributaries to the Little Calumet River were studied as separate subwatersheds (See **Sections 3.1** through **3.7**).

Table 3.8.2: Land Use Distribution for Little Calumet River Subwatershed Within Cook County

Land Use	Acres	%
Commercial/Industrial	2,466	13.9
Forest/Open Land	4,279	24.1
Institutional	1,023	5.8
Residential	8,137	46
Transportation/Utility	1,396	7.9
Water/Wetland	262	1.5
Agricultural	126	0.7

- Little Calumet River (LCRW) – The Little Calumet River originates in Indiana near Hart Ditch (Plum Creek) at a flow divide, which varies in location depending on flow conditions and precipitation distribution across the watershed. At the flow divide, a portion of the Little Calumet River flows easterly and becomes Burns Ditch at the confluence with Deep River, ultimately discharging into Lake Michigan. This occurs entirely within the State of Indiana. The easterly flowing portion of the Little Calumet River, although included in the hydrologic and hydraulic models created for the DWP, was not studied further as part of the DWP.

- The westerly flowing portion continues west towards the Illinois State Line through Calumet City and Lansing. The River then turns north and flows through South Holland, turns west through Dolton, and then northwest through Riverdale and Dixmoor. The Little Calumet River meets its confluence with the Calumet-Sag Channel in Unincorporated Cook County, near Joe Louis the Champ Golf Course between Ashland Avenue and Halstead Street.

- An unnamed Tributary to the Little Calumet River (ULCR) originates in South Holland near the intersection of 165th Street and Cottage Grove Avenue and flows easterly, underneath the Bishop Ford Expressway, to its confluence with the Little Calumet River south of 159th Street in South Holland.

Within the Little Calumet River subwatershed, one major detention facility has an effect on flows, the Thornton Transitional Reservoir.

- Thornton Transitional Reservoir – The reservoir is located off of Thorn Creek and has a diversion structure 17,000 linear feet upstream of the confluence of Thorn Creek with the Little Calumet River. The existing Thornton Transitional Reservoir holds approximately 11,000 acre-feet in its current configuration. The Thornton Transitional Reservoir, which is estimated to be completed in 2013, will use the same diversion structure on Thorn Creek and will allow 9,600 acre-feet of water to be diverted from Thorn Creek, affecting flows and stages in Thorn Creek and the Little Calumet River.

3.8.1 Sources of Data

3.8.1.1 Previous Studies

Two previous studies were made available pertaining to the Little Calumet River:

- Interim Review Report of Little Calumet River, U.S. Army Corps of Engineers, December 1973

- Little Calumet River Watershed Engineering Design Report (Revised), U.S. Department of Agriculture, Metropolitan Sanitary District of Greater Chicago and the Illinois Department of Conservation, January 1977

During Phase A and Phase B of DWP development, additional survey, topography, precipitation, stream flow, land use and soils data needed for the development of the Little Calumet River subwatershed model were identified and collected.

3.8.1.2 Water Quality Data

Water quality for the Little Calumet River subwatershed is monitored by the Metropolitan Reclamation District of Greater Chicago (the District), Illinois Environmental Protection Agency (IEPA) and the United States Geological Survey (USGS). The District is responsible for monitoring the water quality of the streams and canals within its jurisdiction, and has three water quality monitoring stations on the Little Calumet River: Station 52, at Wentworth Avenue and the Little Calumet

River; Station 57, at Ashland Avenue and the Little Calumet River; and Station 97, at 170th Street and Thorn Creek. Annual water quality summaries have been published by the District from 1970 through the present for Stations 52 and 57, and from 2001 through the present for Station 97.

IEPA monitors water quality data at five locations in the Little Calumet River subwatershed as a part of the Ambient Water Quality Monitoring Network (AWQMN) in Cook County. **Table 3.8.3** lists the locations of the five water quality monitoring stations.

Table 3.8.3: IEPA Water Quality Monitoring Stations in the Little Calumet River Subwatershed

Station ID	Waterbody	Location
HA-06	Little Calumet River	I-94, Dolton
HB-03	Little Calumet River	South US Route 6 Torrence Avenue
HB-02	Little Calumet River	South Wentworth Avenue
HB-04	Little Calumet River	South US Route 6 and 159th Street, South Holland
HB-05	Little Calumet River	South IL Route 83, Harvey

Source: EPA STORET (Storage and Retrieval) database.

At each station, samples are collected once every six-weeks and analyzed for a minimum of 55 water quality parameters including pH, temperature, specific conductance, dissolved oxygen, suspended solids, nutrients, fecal coliform bacteria, and total and dissolved metals. Additional parameters specific to the station, watershed, or sub network within the ambient network are also analyzed.

The USGS operates two water quality monitoring stations in the Little Calumet River subwatershed as shown in **Table 3.8.4**. Sporadic data recordings are taken at each of the sites, though they are typically recorded at least once a month. The period of record and type of data monitored vary.

Table 3.8.4: USGS Water Quality Monitoring Stations in the Little Calumet River Subwatershed

Station ID	Waterbody	Location
5536290	Little Calumet River	South Holland
5536325	Little Calumet River	Harvey

Source: http://waterdata.usgs.gov/usa/nwis/qw

IEPA's *2008 Integrated Water Quality Report*, which includes the Clean Water Act (CWA) 303(d) and the 305(d) list, lists two segments within the Little Calumet River subwatershed as impaired. **Table 3.8.5** lists the 303(d) listed impairments. No Total Maximum Daily Loads (TMDL) has been developed for the Little Calumet River subwatershed.

Table 3.8.5: IEPA Use Support Categorization and 303(d) Impairments in the Little Calumet River Watershed

IEPA Segment ID	Waterbody	Impaired Designated Use	Potential Cause	Potential Source
IL_HB-42	Little Calumet River	Aquatic Life	Fluoride, Nitrogen (Total), Oxygen, Dissolved, Phosphorus (Total), Sedimentation/Siltation, Silver, Total Dissolved Solids and Total Suspended Solids	Urban Runoff/Storm Sewers, Combined Sewer Overflows
		Fish Consumption	Mercury	Source Unknown
		Primary Contact Recreation	Fecal Coliform	Urban Runoff/Storm Sewers, Combined Sewer Overflows
IL_ HB-01	Little Calumet River	Aquatic Life	Fluoride, Nitrogen (Total), Oxygen, Dissolved, Phosphorus (Total), Sedimentation/Siltation, Silver, Oil and Grease, and Hexachlorobenzene	Contaminated Sediments, Municipal Point Source Discharges, Urban Runoff/Storm Sewers and Combined Sewer Overflows
		Fish Consumption	Mercury	Source Unknown
		Primary Contact Recreation	Fecal Coliform	Urban Runoff/Storm Sewers, Combined Sewer Overflows

NPDES point source discharges within the Little Calumet River subwatershed are listed in **Table 3.8.6**. In addition to the point source discharges listed, municipalities discharging to the Little Calumet River or its tributaries are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement six minimum control measures for limiting runoff pollution to receiving systems. Also as part of the Phase II Stormwater Permit Program, construction sites disturbing greater than 1 acre of land are required to get a construction permit.

Table 3.8.6: Point Source Discharges in the Little Calumet River Subwatershed

Name	NPDES	Community	Receiving Waterway
PHOENIX CSOs	IL0072834	Phoenix	Little Calumet River
INDIANA HARBOR BELT RAILROAD	IL0062863	Riverdale	Little Calumet River
RIVERDALE INDUSTRIES, INC	IL0068926	Riverdale	Little Calumet River via storm sewer

Note: NPDES facilities were identified from the USEPA Water Discharge Permits Query Form at http://www.epa.gov/enviro/html/pcs/pcs_query_java.html.

3.8.1.3 Wetland and Riparian Areas

Figures 2.3.6 and **2.3.7** contain mapping of wetland and riparian areas in the Little Calumet River Watershed. Wetland areas were identified using National Wetlands

Inventory (NWI) mapping. NWI data includes roughly 549 acres of wetland areas in the Little Calumet River subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.8.1.4 Floodplain Mapping

The floodplain boundaries for the subwatershed were revised in 2008 as part of the FEMA's Map Modernization Program. Floodplain boundaries were revised based on the recent Cook County topographic data.

FEMA's 2006 effective models were not available during the development of the subwatershed hydraulic model; however the US Army Corps of Engineers Little Calumet River model was available. **Appendix A** includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.8.1.5 Stormwater Problem Data

Table 3.8.7 summarizes reported problem areas reviewed as a part of DWP development. The problem area data was obtained primarily from Form B questionnaire response data provided by watershed communities to the District. Problems are classified in **Table 3.8.7** as regional or local. This classification is based on the criteria described in **Section 2.2.1** of this report.

3.8.1.6 Near Term Planned Projects

Currently planned projects in the Little Calumet River subwatershed include the conversion from the existing Thornton Transitional Reservoir, currently providing 11,000 acre-feet of storage, to the Thornton Composite Reservoir which will provide 9,600 acre-feet of storage.

In Indiana, upgraded levees are currently under construction as well as a control structure just west of the Little Calumet River's confluence with Hart Ditch. According to USACE, the Little Calumet River flood control project in Indiana has no adverse impact on flood conditions in Illinois. Some features of the project that reduces the flood impacts in Illinois are:

- Cady Marsh Ditch Diversion Tunnel – This 10 foot diameter tunnel diverts flood waters 3 miles farther east of the hart Ditch flow split, thus reducing the flows to the west.

- The Hart Ditch Control Structure – The Hart Ditch Control Structure is a 14 foot wide channel construction located just west of the Hart Ditch flow split that will reduce flows to the west.

- Channel Improvements – Most of the bridge openings east of the Hart Ditch confluence within the project limits have been increased. This also reduces flows to the west.

Table 3.8.7: Community Response Data for Little Calumet River Subwatershed

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
BLI1	Blue Island	Flooding due to culvert blockages	Western Avenue and 139th Street	Stream maintenance	Channel maintenance	Removal of debris to be addressed by stream maintenance
CAC4	Calumet City	Pavement flooding	US 6 from I-94 to Torrence Avenue	Pavement flooding	Local	Pavement flooding related to local drainage system
CAC6	Calumet City	Bank erosion and sedimentation	160th Street and Torrence	Bank erosion and sedimentation near a culvert	Local	Local authority responsible for maintenance of culvert
CAC7	Calumet City	Water quality, wetland/riparian areas at risk	River Oaks Drive and Wentworth Avenue	Appears to be a local issue. No problem observed in the field	Local	Problem not located on a regional waterway
DIX1	Dixmoor	Pavement flooding	Wood Street at Thornton Road	Low spot along roadway causing conveyance problems	Local	Pavement flooding related to local drainage system
DOL3	Dolton	Roadway ponding	144th Street from Indiana Avenue to Jackson Street	Excessive roadway ponding occurs on 144th Street from Indiana Avenue to Jackson Street during large rain events	Local	Problem not located on a regional waterway. This is a local conveyance issue
DOL4	Dolton	Roadway p	Between State Street and Indiana from 146th Street to Village	Excessive roadway ponding occurs between Main Street and 146th Street from Ingleside to Dante Avenue during large events	Local	Problem not located on a regional waterway. This is a local conveyance issue
DOL5	Dolton	Pavement flooding	Indiana Avenue at 146th Street to 147th Street	Pavement flooding of IDOT roadway due to undersized culvert	Local	Pavement flooding related to local drainage system

Table 3.8.7: Community Response Data for Little Calumet River Subwatershed

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
HAR2	Harvey	Pavement flooding	US 1 at 151st Street	Pavement flooding of IDOT roadway due to undersized culvert	Local	Although this is a local problem, it will be benefited from the Reservoir expansion and upsizing of conduit (Alternative CUDDG1-A8)
HAR3	Harvey	Pavement flooding	US 6 at Park Avenue (River Oaks golf course)	Overbank pavement flooding of golf course property	Local	Problem not located on a regional waterway. This is a local drainage issue
HAR5	Harvey	Pavement flooding	IL 83 at Clinton Street	Pavement flooding of IDOT roadway due to undersized culvert	Local	Although this problem is local, it will be benefited from the proposed reservoir and diversion conduit expansion (Alternative CUDDG1-A8)
HAR6	Harvey	Pavement flooding	IL 83 east of US 1	Pavement flooding of IDOT roadway due to undersized culvert	Local	Although this problem is local, it will be benefited from the proposed reservoir and diversion conduit expansion (Alternative CUDDG1-A8)
HAR7	Harvey	Pavement flooding	Rt.83 at Illinois Central Railroad	Pavement flooding of IDOT roadway due to undersized culvert	Local	Although this problem is local, it will be benefited from the proposed reservoir and diversion conduit expansion (Alternative CUDDG1-A8)

Table 3.8.7: Community Response Data for Little Calumet River Subwatershed

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
LAN4	Lansing	Pavement flooding	Burnham Avenue at 170th Street (at river)	Road is overtopped by Little Calumet River	Regional	Sufficient land was not available to address all flooding in this area. Properties at risk of flooding in this area are candidates for protection using non-structural measures, such as floodproofing or acquisition
LAN5	Lansing	Pavement flooding	I-80 at Torrence Avenue	Pavement flooding of IDOT roadway due to undersized culvert	Local	Problem not located on a regional waterway. This is a local conveyance issue
RVD1	Riverdale	Pavement flooding	Ashland Avenue at near 138th Street	Pavement flooding of IDOT roadway due to undersized culvert	Local	Problem not located on a regional waterway. This is a local conveyance issue
RVD2	Riverdale	Pavement flooding	Ashland Avenue at North Crossing	Pavement flooding of IDOT roadway due to undersized culvert	Local	Problem not located on a regional waterway. This is a local conveyance issue
RVD3	Riverdale	Pavement flooding	Ashland Avenue at South Crossing	Pavement flooding of IDOT roadway due to undersized culvert	Local	Problem not located on a regional waterway. This is a local conveyance issue
SHO1	South Holland	Overbank flooding	Little Calumet River throughout South Holland	Ponding and flooding adjacent to the Little Calumet River in South Holland	Regional	Construction of levees in various locations along Little Calumet River through South Holland (Alternative LCRWG2-A1, LCRWG3-A1, LCRWG4-A1, LCRWG5-A1, LCRWG6-A1, LCRWG7-A1, and LCRWG8-A5)

Table 3.8.7: Community Response Data for Little Calumet River Subwatershed

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
THO1	Thornton Township	Bank erosion and sedimentation	Thornton Road from Dixie Highway (Chatham) to Wood Street	Stretch of creek bank has rip-rap and appears to be at least partially addressed	Local	Problem is not located on a regional waterway. This is a local drainage issue.

3.8.2 Watershed Analysis

3.8.2.1 Hydrologic Model Development

3.8.2.1.1 Subbasin Delineation The portion of the Little Calumet River subwatershed in Illinois and Indiana that was not included in other tributary subwatersheds was delineated according to the methods described in **Sections 1.3.2** and **2.3.2**. There are 120 subbasins ranging in size from 0.019 to 17.8 square miles with an average size of 3.21 square miles.

3.8.2.1.2 Hydrologic Parameter Calculations
Curve numbers (CN) were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in **Section 1.3.2**, with lookup values for specific combinations of land use and soil data presented in **Appendix C**. An area-weighted average of the CN was generated for each subbasin.

Clark's unit hydrograph parameters were estimated using the method described in **Section 1.3.2**. **Appendix G** provides a summary of the hydrologic parameters used for the subbasins in each subwatershed.

3.8.2.2 Hydraulic Model Development

3.8.2.2.1 Field Data, Investigation, and Existing Model Data During Phase A, available existing models were collected and analyzed to determine if data could be used for developing the comprehensive model. Only existing models that were less than 10 years old were reviewed.

Three HEC-RAS models were available for use in the development of the Little Calumet River subwatershed hydraulic model: a model of the Little Calumet River (east and west portions), Deep River, Burns Ditch, and Thorn Creek developed by the ISWS in 2006; a model of the Little Calumet River (east and west portions), Deep River, Burns Ditch, and Thorn Creek developed by the USACE in 2005; and a model of the Little Calumet River (east and west portions), Deep River, Burns Ditch, and Thorn Creek (with Thornton Composite Reservoir) developed by the USACE in 2008.

The available models were reviewed to determine if any of the cross–sectional data and hydraulic structure information could be used. If any information regarding location, date, and vertical datum was not available, the cross-sectional data was not used. Cross sections with available data were compared to the current channel conditions to ensure that the cross section was still representative of current conditions. The hydraulic structure dimensions were compared to 2007 field reconnaissance data and also to bridge/culvert dimensions data provided by Cook County Highway Department (data provided for state/county highways only). Based on the existing model analysis, the location of additional cross sections and hydraulic structures to be surveyed was determined. Any data used from the existing models were geo-referenced to represent true physical coordinates.

After review of existing models, field reconnaissance data, and hydraulic structure dimension data, a field survey plan was developed. Field survey was performed under the protocol of FEMA's *Guidelines and Specifications for Flood Hazard Mapping partners, Appendix A: Guidance for Aerial Mapping and Surveying*. Field survey was performed in early 2008. Cross sections were generally surveyed between 500 to 1,000 feet apart. The actual spacing and location was determined based on the variability of the channel shape and roughness and slope of the channel. A total of 27 cross sections and 11 hydraulic structures were surveyed to develop the hydraulic model for the Little Calumet River subwatershed. Additional cross sections were developed by interpolating the surveyed channel data and combining with contour data.

The Manning's n-value at each cross section was estimated using a combination of aerial photography and photographs from field survey and field reconnaissance. The horizontal extent of each type of land cover and the associated n-value for each cross section were manually entered in to the HEC-RAS hydraulic model. The initial n-values were used as a model starting point and were adjusted within the provided ranges during calibration. All the n-values were manually adjusted using the HEC-RAS cross-sectional data editor.

The n-values were increased where buildings are located within the floodplain to account for conveyance loss. The n-values in these areas may range from 0.060 for areas with few buildings to 0.22 for fully developed areas. If significant blockage is caused by buildings in the flood fringe, the developed areas were modeled as ineffective flow. **Table 3.8.8** lists the channel and overbank ranges of n-values that were used for the Little Calumet River subwatershed model.

Table 3.8.8: Channel and Overbank Associated Manning's n-Values[1]

Tributary	Range of Channel n-Values	Range of Overbank n-Values
LCRW	0.038 - 0.076	0.095 - 0.22
ULCR	0.045 - 0.12	0.045 - 0.119

[1]**Source**: Open Channel Hydraulics, Chow 1959

3.8.2.2.2 Boundary Conditions There are two downstream locations were boundary conditions were required to run the hydraulic model. Since the stage of the Calumet-Sag Channel is highly variable, the stage was obtained from the USACE – Chicago District 's *Chicagoland Underflow Plan McCook Reservoir, Illinois (November 1999)* as the modeled 1% chance exceedance event near the confluence of the Little Calumet River and the Calumet-Sag Channel. Since Lake Michigan is relatively independent of local rainfall events, the historic average water surface elevation was used. Below are the boundary conditions used.

Boundary Conditions

Location	Elevation (ft)
Little Calumet River confluence with Calumet-Sag Channel	584.7
Burns Ditch Confluence with Lake Michigan	579.0

3.8.2.3 Calibration and Verification A detailed calibration was performed for the Little Calumet River subwatershed using historic gage records under the guidelines of the Cook County Stormwater Management Plan (CCSMP). Three historic storm events in April 2006, April 2007 and September 2008 were evaluated based on the stream gage flows, precipitation totals and records of flooding in the Little Calumet River subwatershed and were found to be applicable for calibration and verification.

For the calibration storms, Illinois State Water Survey (ISWS) Cook County precipitation gages, National Weather Service (NWS) recording and non-recording gages, and Community Collaborative Rain, Hail & Snow Network (CoCoRAHS) precipitation amounts were used. Theissen polygons were developed for each storm based on the rain gages available for that storm. The gage weightings for the recording and non-recording gages were computed in ArcGIS for each subbasin.

There are two stream gages on the Little Calumet River. USGS Gage 05536290, Little Calumet River at South Holland, is at latitude 41°36′25″ longitude 87°35′52″ (NAD27). The datum of the gage is 575.00 ft NGVD29 (574.72 NAVD88). Instantaneous flow data is available at this gage from 10/1/1990 through 9/30/2008. The second stream gage, USGS Gage 05536195, Little Calumet River at Munster, IN is at latitude 41°34'38" longitude 87°31'17" (NAD27). The datum of the gage is 580.72 ft NGVD29 (580.44 NAVD88). Instantaneous flow data is available at this gage from 10/01/1987 through 9/30/2008.

Runoff hydrographs were developed using HEC-HMS and routed through the Little Calumet River hydraulic model. The stages and flows produced for each calibration storm were compared to the observed stream gage data. During calibration of the Little Calumet River subwatershed model, the curve number, directly connected impervious area percentage, and Clark's storage coefficient were adjusted so that the peak flow rate, hydrograph shape and timing, and total volume matched the observed hydrographs within the District's criteria. During calibration, the Clark's storage coefficient R was increased by 25%.

The hydraulic model was verified by comparing the model results with available high water marks from the September 2008 storm event. High water marks were surveyed in June 2009 using field photos taken after the event**.** **Table 3.8.9** shows the comparison of the modeled and observed stages for the September 2008 storm event.

Table 3.8.9: Little Calumet River Subwatershed Verification Results

Storm Event	Location	Field Elevation (ft)	Model Elevation (ft)	Difference in Stage (ft)
Sep-08	Little Calumet W Reach 5 RS 87401	597.16	597.01	0.15
Sep-08	Little Calumet W Reach 5 RS 86195	597.15	596.99	0.16
Sep-08	Little Calumet W Reach 5 RS 78426	596.81	596.87	-0.06
Sep-08	Little Calumet W Reach 5 RS 72121	596.13	596.00	0.13
Sep-08	Little Calumet W Reach 5 RS 67516	595.65	595.65*	0.00
Sep-08	Little Calumet W Reach 5 RS 67399	594.31	593.98	0.33
Sep-08	Little Calumet W Reach 5 RS 63229	594.72	593.94	0.78
Sep-08	Little Calumet W Reach 5 RS 54871	600.52	600.54	-0.02
Sep-08	Little Calumet W Reach 3 RS 43997	600.67	600.21	0.46
Sep-08	Calumet Union Reach 1 RS 1978	598.92	598.45	0.47
Sep-08	Calumet Union Reach 1 RS 1650.42	597.76	597.29	0.47

*Average of 3 observed high water marks

After the final adjustments to the HEC-HMS and HEC-RAS models, the flow and stage comparisons to the observed data were within the District's criteria. **Table 3.8.10** and **Table 3.8.11** show the comparison of the flows and stages for all calibration storms at the South Holland and Munster gages, respectively. **Figures 3.8.2, 3.8.3, 3.8.4 and 3.8.5** show the calibration results for the April 2006 and April 2007 storm events at the South Holland and Munster gage.

Table 3.8.10: Little Calumet River at South Holland Gage Calibration Results

Storm Event	Observed		Modeled		District's Criteria[1]	
	Flow	Stage	Flow	Stage	Percentage Difference in Peak Flow	Difference in Stage
Apr-06	2,600	591.33	1,676	590.21	-36%	-1.12
Apr-07	1,580	588.30	1,208	589.18	-24%	0.88
Sep-08	3,930	594.60	4,228	594.82	8%	0.22

[1]Flow within 30% and stage within 6 inches.

Table 3.8.11: Little Calumet River at Munster, IN Gage Calibration Results

Storm Event	Observed		Modeled		District's Criteria[1]	
	Flow	Stage	Flow	Stage	Percentage Difference in Peak Flow	Difference in Stage
Apr-06	781	N/A	669	593.81	-14%	N/A
Apr-07	596	N/A	394	592.05	-34%	N/A
Sep-08	1,553	597.45	1,604	597.3	3%	-0.15

[1]Flow within 30% and stage within 6 inches.

The April 2006 storm at South Holland and the April 2007 storm at Munster, Indiana didn't meet the CCSMP criteria. This is likely due to the spatial distribution of the storm and missing coverage by some of the rain gages.

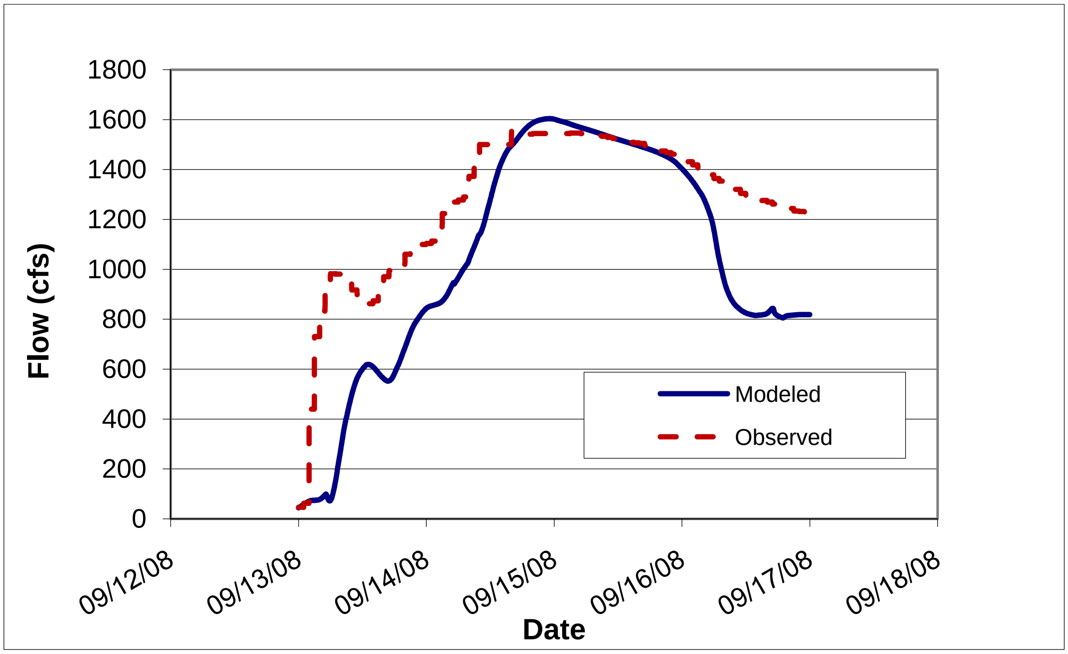


Figure 3.8.2: Little Calumet River Subwatershed at South Holland Gage Calibration Results, April 2006 Storm Event

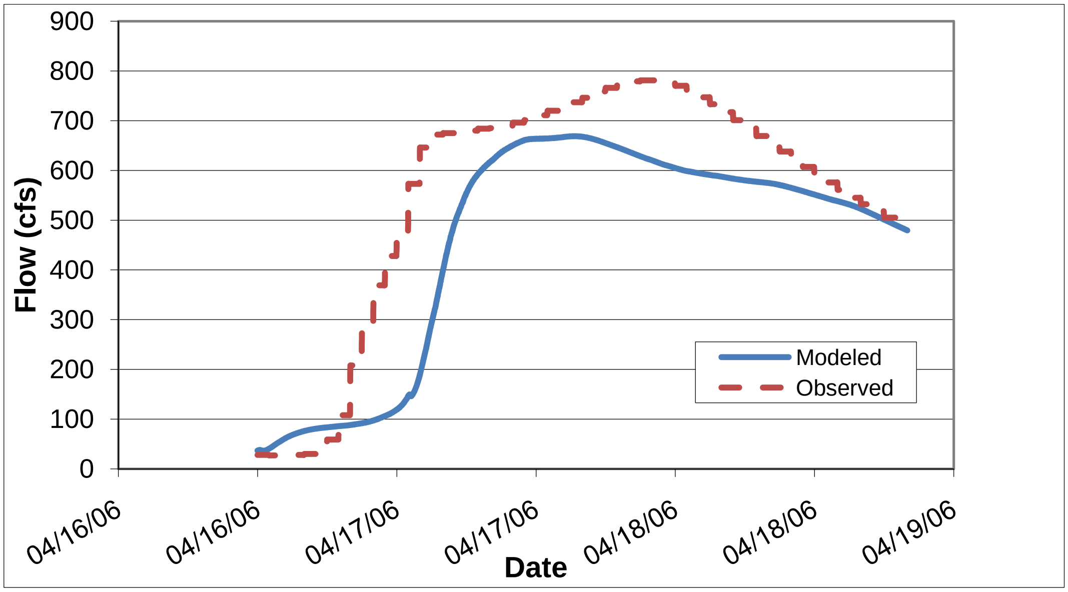


Figure 3.8.3: Little Calumet River Subwatershed at Munster Gage Calibration Results, April 2006 Storm Event

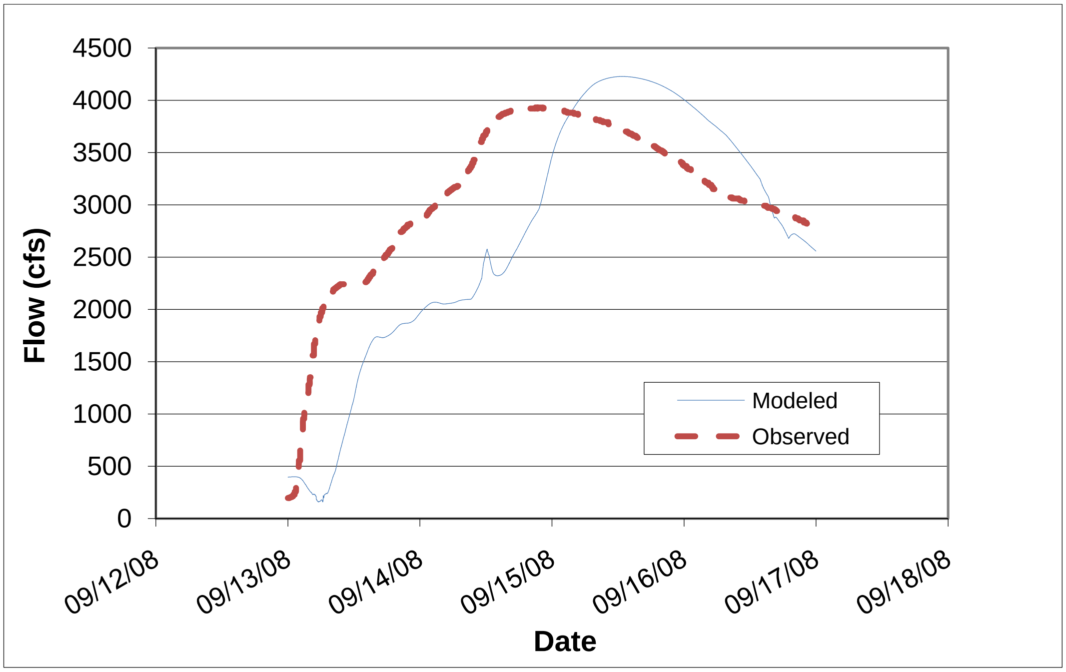


Figure 3.8.4: Little Calumet River Subwatershed at South Holland Gage Calibration Results, September 2008 Storm Event

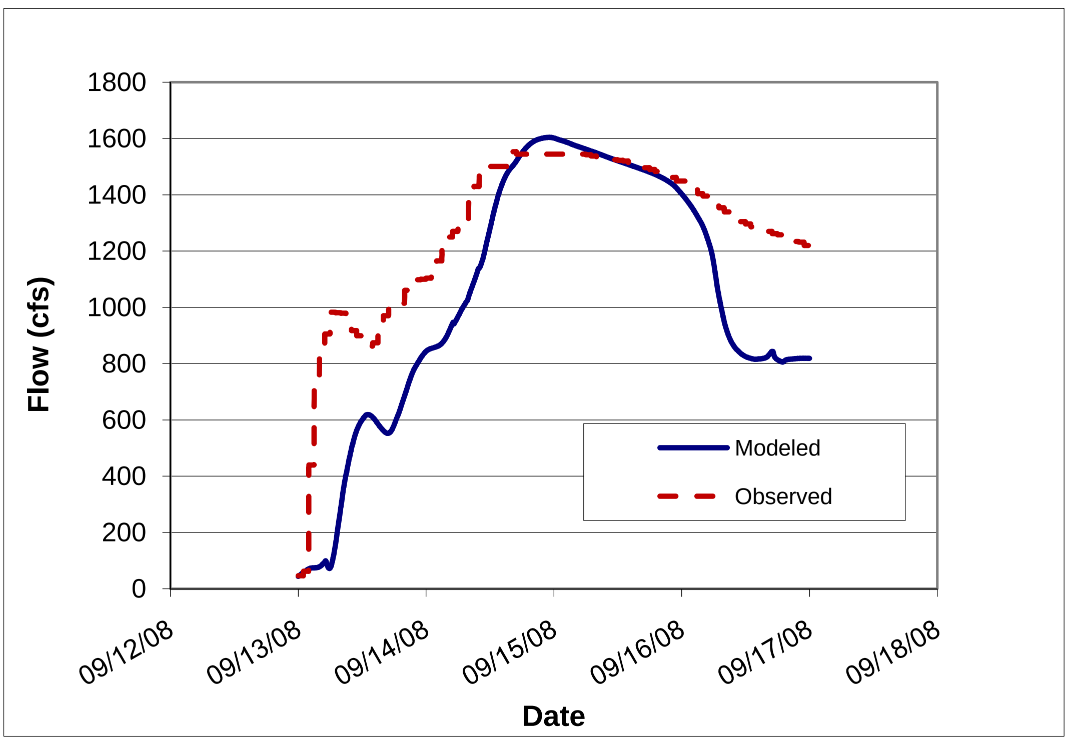


Figure 3.8.5: Little Calumet River Subwatershed at Munster Gage Calibration Results, September 2008 Storm Event

3.8.2.4 Existing Conditions Evaluation

Flood Inundation Areas. A critical duration analysis was performed for the Little Calumet River subwatershed hydraulic model. The 100-year, 1-, 3-, 6-, 12-, 24- and 48-hour storm events were run to determine the critical duration. The 48-hour storm event was found to be the critical duration for the Little Calumet River and the Unnamed Tributary to the Little Calumet River.

Figure 3.8.1 shows the inundation area produced for the 100-year critical duration storm event.

Hydraulic Profiles. Hydraulic profiles for the Little Calumet River and the Unnamed Tributary to the Little Calumet River are shown in **Appendix H**. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100- and 500-year recurrence interval design storm events.

3.8.3 Development and Evaluation of Alternatives

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. **Table 3.8.12** summarizes problem areas identified through hydraulic modeling of the Little Calumet River subwatershed.

Problem areas that were hydraulically interdependent or otherwise related were grouped for alternatives analysis. Each problem group is addressed in terms of combined damages and alternatives/solutions.

Table 3.8.12: Modeled Problem Definition for the Little Calumet River Subwatershed

Problem ID	Group ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
LCRW1	LCRW-G1	Upstream of Sibley Blvd., near 147th Street and Riverside Drive, Harvey	25, 50 & 100	None	LCRWG1-A3
LCRW2	LCRW-G2	At CUDD Confluence. 158th Place and 159th Street, east of State Street/Indiana Avenue, South Holland	10, 25, 50 & 100	SHO1	LCRWG2-A1
LCRW3	LCRW-G3	158th Street, east of Chicago Road, South Holland	50 & 100	SHO1	LCRWG3-A1
LCRW4	LCRW-G4	Riverview Drive between Parkside Avenue and School Street, South Holland	100	SHO1	LCRWG4-A1
LCRW5	LCRW-G5	Along 158th Street near the intersection with Church Street, South Holland	2, 5, 10, 25, 50 & 100	SHO1	LCRWG5-A1
LCRW6	LCRW-G6	N Riverview Drive/Blouin Drive, from Ingleside Avenue to Dobson Avenue, Dolton	25, 50 & 100	None	LCRWG6-A1
LCRW7	LCRW-G7	158th Street from Kenwood Avenue to Dobson Avenue, South Holland	50 & 100	SHO1	LCRWG7-A1

Table 3.8.12: Modeled Problem Definition for the Little Calumet River Subwatershed

Problem ID	Group ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
LCRW8	LCRW-G8	158th Street from Greenwood Road to Madison Avenue, South Holland	5, 10, 25, 50 & 100	SHO1	LCRWG8-A5
LCRW9	LCRW-G9	Area adjacent to 163rd Street from Balmoral Drive to Stateline Road, Calumet City and Lansing	2, 5, 10, 25, 50 & 100	LAN4	Floodproofing/ Acquisition

Damage assessment, technology screening, alternative development and alternative selection were performed by problem grouping, since each group is independent of the other. Each problem group is evaluated in the following sections by problem group ID.

3.8.3.1 LCRW-G1 – Little Calumet River Problem Group 1

3.8.3.1.1 Problem Definition, LCRW-G1

The LCRW-G1 problem area consists of overbank flooding upstream of Sibley Boulevard, near 147th Street and Riverside Drive in Harvey. In this reach, the 100-year flow of 4,138 cfs at Sibley Boulevard exceeds the capacity of the channel. The flooding impacts 4 structures. The area is shown on the recent DFIRM floodplain maps with flooding to a similar extent.

3.8.3.1.2 Damage Assessment, LCRW-G1

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for the Little Calumet River. These stages were used to calculate the depth of flooding and to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. **Table 3.8.13** lists the estimated damages for the problem group.

Table 3.8.13: Estimated Damages for Little Calumet River Subwatershed, Problem Group LCRW-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
LCRW-G1	Property	$13,978	Structures at risk of flooding.
	Transportation	$2,096	Assumed 15% of the property damages
	Recreation	$0	

3.8.3.1.3 Technology Screening, LCRW-G1

Several combinations of technologies were analyzed to address flooding problems associated with LCRW-G1. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.8.14**

summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.8.14: Evaluation of Flood Control Technologies for Little Calumet River Subwatershed, Problem Group LCRW-G1

Flood Control Option	Feasibility
Detention Facilities	Infeasible due to large and sustained stream flows from the Little Calumet River and lack of available storage area for such large volumes
Conveyance Improvement – Culvert/Bridge Replacement	Infeasible due to resultant downstream increases in stage without available compensatory storage
Conveyance Improvement – Channel Improvement	Infeasible due to resultant downstream increases in stage without available compensatory storage
Conveyance Improvements – Diversion	Infeasible due to resultant downstream increases in stage without available compensatory storage and lack of available alternate receiving waters for such a discharge
Flood Barriers, Levees/Floodwalls	Feasible and necessary

3.8.3.1.4 Alternative Development

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.8.15** summarizes flood control alternatives developed for Problem Group LCRW-G1.

Table 3.8.15: Flood Control Alternatives for Problem Group LCRW-G1

Alternative	Location	Description
LCRWG1-A1	Forest Preserve District	Construct detention basin to reduce peak flows. Due to the very large volume which would be required, massive excavation and removal of acres of recreational forest preserve would be required and was not considered feasible
LCRWG1-A2	Thornton Composite Reservoir	Adjust operations of reservoir. The current operational scheme was found to be close to optimal in preventing stage increases in the Little Calumet River. The Little Calumet River experiences two instances of peak stages during the 48-hour storm event. Any adjustment in reservoir operation was predicted to increase one of the peak stages above its current level. Any changes to the operations of the Thornton Composite Reservoir were therefore considered infeasible
LCRWG1-A3	Vicinity of Sibley Boulevard	Construct a levee/floodwall in form of a concrete wall with length of 600 LF and height between 6 to 13 ft

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for Problem Group LCRW-G1.

3.8.3.1.5 Alternative Evaluation and Selection

Alternatives included in **Table 3.8.15** were evaluated to determine their effectiveness and produce the data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.8.17** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative for Problem Group LCRW-G1. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, thus costs were not calculated for these alternatives.

Alternative LCRWG1-A3 from **Table 3.8.15** provides the preferred alternative for Problem Group LCRW-G1. A floodwall could be constructed upstream of Sibley Boulevard to protect residences near 147th Street and Riverside Drive in Harvey. The wall would be approximately 600 linear feet of concrete varying between 8 to 13 feet in height with a maximum elevation of 695.6 feet NAVD. Adding a levee to protect the building structures was shown to have a negligible effect on baseline stages (i.e., stage increases were not greater than 0.04 feet) therefore would not require compensatory storage.

Table 3.8.16 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for LCRW-G1.

Table 3.8.16: Alternative Condition Flow & WSEL Comparison for Problem Group LCRW-G1

Location	Station	Existing Conditions		Alternative LCRWG1-A3	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Upstream face of Sibley Blvd	LCRW 22905	592.6	4,057	592.6	3,982

3.8.3.1.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.8.17** lists the alternative analyzed in detail. The recommended alternative consists of the construction of a 600 linear-foot concrete floodwall near Sibley Boulevard in Harvey. **Figure 3.8.6** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.8.17: Little Calumet River Project Alternative Matrix to Support District CIP Prioritization for Problem Group LCRW-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
LCRW-G1	LCRWG1-A3	Levee/ floodwall	< 0.01	$16,000	$3,412,000	4 structures	No Impact	Harvey

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.8.3.2 LCRW-G2 – Little Calumet River Problem Group 2

3.8.3.2.1 Problem Definition, LCRW-G2

The LCRW-G2 problem area consists of overbank flooding in the area of the Calumet Union Drainage Ditch confluence with the Little Calumet River, near 158th Place and 159th Street in South Holland, east of State Street/Indiana Avenue on the left bank of the Little Calumet River. The 100-year peak flow is 1,441 cfs at the footbridge just upstream of the Calumet Union confluence, which exceeds the capacity of the channel. The flooding impacts 6 structures. The area is shown on the recent DFIRM floodplain maps with flooding to a slightly lesser extent.

3.8.3.2.2 Damage Assessment, LCRW-G2

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for the Little Calumet River and its tributary. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. **Table 3.8.18** lists the estimated damages for the problem group.

Table 3.8.18: Estimated Damages for Little Calumet River Subwatershed, Problem Group LCRW-G2

Problem Group ID	Damage Category	Estimated Damage ($)	Description
LCRW-G2	Property	$128,915	Structures at risk of flooding.
	Transportation	$19,336	Assumed 15% of the property damages
	Recreation	$0	

3.8.3.2.3 Technology Screening, LCRW-G2

Several combinations of technologies were analyzed to address flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.8.19** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.8.19: Evaluation of Flood Control Technologies for Little Calumet River Subwatershed, Problem Group LCRW-G2

Flood Control Option	Feasibility
Detention Facilities	Infeasible due to large and sustained stream flows from the Little Calumet River and Calumet Union Drainage Ditch and lack of available storage area for such large volumes
Conveyance Improvement – Culvert/Bridge Replacement	Infeasible due to resultant downstream increases in stage without available compensatory storage
Conveyance Improvement – Channel Improvement	Infeasible due to resultant downstream increases in stage without available compensatory storage
Conveyance Improvements – Diversion	Infeasible due to resultant downstream increases in stage without available compensatory storage and lack of available alternate receiving waters for such a discharge
Flood Barriers, Levees/Floodwalls	Feasible and necessary

3.8.3.2.4 Alternative Development, LCRW-G2

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.8.20** summarizes flood control alternatives developed for Problem Group LCRW-G2.

Table 3.8.20: Flood Control Alternatives for Problem Group LCRW-G2

Alternative	Location	Description
LCRWG2-A1	Little Calumet River and Calumet Union Drainage Ditch confluence	Construct 1,900 LF levee/floodwall near 158th Place/159th Street in South Holland
LCRWG2-A2	Forest Preserve District	Construct detention facility. Due to the very large volume which would be required, massive excavation and removal of acres of recreational forest preserve would be required and was not considered feasible
LCRWG2-A3	Thornton Transitional Reservoir	Adjust operations of reservoir. The current operational scheme was found to be close to optimal in preventing stage increases in the Little Calumet River. The Little Calumet River experiences two instances of peak stages during the 48-hour storm event. Any adjustment in reservoir operation was predicted to increase one of the peak stages above its current level. Any changes to the operations of the Thornton Composite Reservoir were therefore considered infeasible

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for Problem Group LCRW-G2.

3.8.3.2.5 Alternative Evaluation and Selection, LCRW-G2

Alternatives included in **Table 3.8.20** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.8.22** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, thus costs were not calculated for these alternatives.

Alternative LCRWG2-A1 from **Table 3.8.20** provides the preferred alternative for this problem group. The preferred alternative consists of construction of a 1,900 linear-foot concrete levee/floodwall and earthen berm that that varies from 4 to 14 ft in height and has a maximum elevation of 697.3 feet NAVD. This levee/floodwall would protect residences on 158th Place and 159th Street, east of State Street/Indiana Avenue in South Holland.

Table 3.8.21 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for LCRW-G2.

Table 3.8.21: Alternative Condition Flow & WSEL Comparison for Problem Group LCRW-G2

Location	Station	Existing Conditions		Alternative LCRWG2-A1	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Upstream of the Foot Bridge at the confluence of CUDD with LCRW	CUDD 258	594.0	1,436	594.0	1,441

3.8.3.2.6 Data Required for Countywide Prioritization of Watershed Projects, LCRW-G2

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.8.22** lists the alternative analyzed in detail. The recommended alternative consists of the construction of a 1,900 linear-foot levee/floodwall near 158th Place and 159th Street. **Figure 3.8.7** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.8.22: Little Calumet River Project Alternative Matrix to Support District CIP Prioritization for Problem Group LCRW-G2

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
LCRW-G2	LCRWG2-A1	Construct levee	0.03	$148,000	$5,752,000	6 structures	No impact	South Holland

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.8.3.3 LCRW-G3 – Little Calumet River Problem Group 3

3.8.3.3.1 Problem Definition, LCRW-G3

The LCRW-G3 problem area consists of overbank flooding in the area near 158th Street east of Chicago Road (Park Avenue) in South Holland, on the north bank of the Little Calumet River. The 100-year peak flow rate is 3,156 cfs, which exceeds the capacity of the channel. The flooding impacts 2 structures. The area is shown on the recent DFIRM floodplain maps with flooding to a slightly lesser extent.

3.8.3.3.2 Damage Assessment, LCRW-G3

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Little Calumet River and its tributary. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. **Table 3.8.23** lists the damages caused from the problem group.

Table 3.8.23: Estimated Damages for Little Calumet River Subwatershed, Problem Group LCRW-G3

Problem Group ID	Damage Category	Estimated Damage ($)	Description
LCRW-G3	Property	$3,296	Structures at risk of flooding.
	Transportation	$500	Assumed 15% of the property damages
	Recreation	$0	

3.8.3.3.3 Technology Screening, LCRW-G3

Several combinations of technologies were analyzed to address flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.8.24** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.8.24: Evaluation of Flood Control Technologies for Little Calumet River Subwatershed, Problem Group LCRW-G3

Flood Control Option	Feasibility
Detention Facilities	Infeasible due to large and sustained stream flows from the Little Calumet River and lack of available storage area for such large volumes
Conveyance Improvement – Culvert/Bridge Replacement	Infeasible due to resultant downstream increases in stage without available compensatory storage
Conveyance Improvement – Channel Improvement	Infeasible due to resultant downstream increases in stage without available compensatory storage
Conveyance Improvements – Diversion	Infeasible due to resultant downstream increases in stage without available compensatory storage and due to lack of available alternate receiving waters for such a discharge
Flood Barriers, Levees/Floodwalls	Feasible and necessary

3.8.3.3.4 Alternative Development, LCRW-G3

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.8.25** summarizes flood control alternatives developed for Problem Group LCRW-G3.

Table 3.8.25: Flood Control Alternatives for Problem Group LCRW-G3

Alternative	Location	Description
LCRWG3-A1	158th Street and Chicago Road	Construct 850 LF levee/floodwall near 158th Street and Chicago Road (Park Avenue) in South Holland
LCRWG3-A2	Forest Preserve District	Construct detention facility. Due to the very large volume which would be required, massive excavation and removal of acres of recreational forest preserve would be required and was not considered feasible

Table 3.8.25: Flood Control Alternatives for Problem Group LCRW-G3

Alternative	Location	Description
LCRWG3-A3	Thornton Transitional Reservoir	Adjust operations of reservoir. The current operational scheme was found to be close to optimal in preventing stage increases in the Little Calumet River. The Little Calumet River experiences two instances of peak stages during the 48-hour storm event. Any adjustment in reservoir operation was predicted to increase one of the peak stages above its current level. Any changes to the operations of the Thornton Composite Reservoir were therefore considered infeasible

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the LCRW-G3 Problem Group.

3.8.3.3.5 Alternative Evaluation and Selection, LCRW-G3

Alternatives included in **Table 3.8.25** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.8.27** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, thus costs were not calculated for these alternatives.

Alternative LCRWG3-A1 from **Table 3.8.25** provides the preferred alternative for this problem group. Under this recommendation, an 850 linear-foot concrete levee/floodwall that varies in height from 3 to 10 feet in height and has a maximum elevation of NAVD 597.6 ft could be constructed in the vicinity of 158th Street and Chicago Road in South Holland to protect the nearby residences. Adding a levee to protect the building structures was shown to have a negligible effect on baseline stages (i.e., stage increases were not greater than 0.04 feet) therefore would not require compensatory storage.

Table 3.8.26 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for LCRW-G3.

Table 3.8.26: Alternative Condition Flow & WSEL Comparison for Problem Group LCRW-G3

Location	Station	Existing Conditions		Alternative LCRWG3-A1	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
850 ft Upstream of South Park Avenue	LCRW 35148	594.2	3,809	594.2	3,805

3.8.3.3.6 Data Required for Countywide Prioritization of Watershed Projects, LCRW-G3

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.8.27** lists the alternative analyzed in detail. The recommended alternative consists of the construction of an 850 linear-foot floodwall near 158th Street and

Chicago Avenue in South Holland. **Figure 3.8.8** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.8.27: Little Calumet River Project Alternative Matrix to Support District CIP Prioritization for Problem Group LCRW-G3

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Water Quality Benefit	Involved Community
LCRW-G3	LCRWG3-A1	Construct levee	< 0.01	$4,000	$4,332,000	2 structures	No Impact	South Holland

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.8.3.4 LCRW-G4 – Little Calumet River Problem Group 4

3.8.3.4.1 Problem Definition, LCRW-G4

The LCRW-G4 problem area consists of overbank flooding on Riverview Drive between Parkside Avenue and School Street in South Holland, on the south bank of the Little Calumet River. The 100-year peak flow rate is 3,156 cfs in the vicinity of the problem area and exceeds the capacity of the channel. The flooding impacts 1 structure. The area is shown on the recent DFIRM floodplain maps with flooding to a slightly lesser extent.

3.8.3.4.2 Damage Assessment, LCRW-G4

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for the Little Calumet River and its tributary. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. **Table 3.8.28** lists the estimated damages for the problem group.

Table 3.8.28: Estimated Damages Little Calumet River Subwatershed, Problem Group LCRW-G4

Problem Group ID	Damage Category	Estimated Damage ($)	Description
LCRW-G4	Property	$2,882	Structures at risk of flooding.
	Transportation	$430	Assumed 15% of the property damages
	Recreation	$0	

3.8.3.4.3 Technology Screening, LCRW-G4

Several combinations of technologies were analyzed to address flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.8.29** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.8.29: Evaluation of Flood Control Technologies for Little Calumet River Subwatershed, Problem Group LCRW-G4

Flood Control Option	Feasibility
Detention Facilities	Infeasible due to large and sustained stream flows from the Little Calumet River and lack of available storage area for such large volumes
Conveyance Improvement – Culvert/Bridge Replacement	Infeasible due to resultant downstream increases in stage without available compensatory storage
Conveyance Improvement – Channel Improvement	Infeasible due to resultant downstream increases in stage without available compensatory storage
Conveyance Improvements – Diversion	Infeasible due to resultant downstream increases in stage without available compensatory storage; also Infeasible due to lack of available alternate receiving waters for such a discharge
Flood Barriers, Levees/Floodwalls	Feasible and necessary

3.8.3.4.4 Alternative Development, LCRW-G4

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.8.30** summarizes flood control alternatives developed for Problem Group LCRW-G4.

Table 3.8.30: Flood Control Alternatives for Problem Group LCRW-G4

Alternative	Location	Description
LCRWG4-A1	Riverside Street & Parkside Avenue	Construct 825 LF levee/floodwall near Riverside Street and Parkside Avenue in South Holland
LCRWG4-A2	Forest Preserve District	Construct detention facility. Due to the very large volume which would be required, massive excavation and removal of acres of recreational forest preserve would be required and was not considered feasible
LCRWG4-A3	Thornton Transitional Reservoir	Adjust operations of reservoir. The current operational scheme was found to be close to optimal in preventing stage increases in the Little Calumet River. The Little Calumet River experiences two instances of peak stages during the 48-hour storm event. Any adjustment in reservoir operation was predicted to increase one of the peak stages above its current level. Any changes to the operations of the Thornton Composite Reservoir were therefore considered infeasible

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for Problem Group LCRW-G4.

3.8.3.4.5 Alternative Evaluation and Selection, LCRW-G4

Alternatives included in **Table 3.8.30** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.8.32** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed, as benefits were negligible, and thus costs were not calculated for these alternatives.

Alternative LCRWG4-A1 from **Table 3.8.30** provides the preferred alternative for this problem group. Under this recommendation, an 825 linear-foot concrete wall that that varies in height from 4 to 8.5 ft with a maximum elevation of 597.6 feet NAVD could be constructed along the south bank of the Little Calumet River near Parkside Avenue and School Street to protect residences on Riverside Street.

Table 3.8.31 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for LCRW-G4.

Table 3.8.31: Alternative Condition Flow & WSEL Comparison for Problem Group LCRW-G4

Location	Station	Existing Conditions		Alternative LCRWG4-A1	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
1000 ft Upstream of South Park Avenue	LCRW 35298	594.2	3,810	594.2	3,805

3.8.3.4.6 Data Required for Countywide Prioritization of Watershed Projects, LCRW-G4

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.8.32** lists the alternative analyzed in detail. The recommended alternative consists of constructing an 825 linear-foot concrete levee/floodwall along the South bank of the Little Calumet River near Parkside Avenue and School Street in South Holland. **Figure 3.8.9** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.8.32: Little Calumet River Project Alternative Matrix to Support District CIP Prioritization for Problem Group LCRW-G4

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
LCRW-G4	LCRWG4-A1	Construct 825 LF levee	< 0.01	$3,000	$3,427,000	1 structure	No Impact	South Holland

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.8.3.5 LCRW-G5 – Little Calumet River Problem Group 5

3.8.3.5.1 Problem Definition, LCRW-G5

The LCRW-G5 problem area consists of overbank flooding along 158th Street near the intersection of 158th Street and Church Drive in South Holland, on the north bank of the Little Calumet River. In this reach, the 100-year peak flow rate of 2,979 cfs exceeds the capacity of the channel. The flooding impacts 6 structures. The problem area is shown on the recent DFIRM floodplain maps with flooding to a slightly lesser extent.

3.8.3.5.2 Damage Assessment, LCRW-G5

Damages were defined following the protocol defined in of the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Little Calumet River and its tributary. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. **Table 3.8.33** lists the estimated damages for the problem group.

Table 3.8.33: Estimated Damages for Little Calumet River Subwatershed, Problem Group LCRW-G5

Problem Group ID	Damage Category	Estimated Damage ($)	Description
LCRW-G5	Property	$2,169,000	Structures at risk of flooding
	Transportation	$325,500	Assumed 15% of the property damages
	Recreation	$0	

3.8.3.5.3 Technology Screening, LCRW-G5

Several combinations of technologies were analyzed to address flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.8.34** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.8.34: Evaluation of Flood Control Technologies for Little Calumet River Subwatershed, Problem Group LCRW-G5

Flood Control Option	Feasibility
Detention Facilities	Infeasible due to large and sustained stream flows from the Little Calumet River and lack of available storage area for such large volumes
Conveyance Improvement – Culvert/Bridge Replacement	Infeasible due to resultant downstream increases in stage without available compensatory storage
Conveyance Improvement – Channel Improvement	Infeasible due to resultant downstream increases in stage without available compensatory storage
Conveyance Improvements – Diversion	Infeasible due to resultant downstream increases in stage without available compensatory storage; also infeasible due to lack of available alternate receiving waters for such a discharge
Flood Barriers, Levees/Floodwalls	Feasible and necessary

3.8.3.5.4 Alternative Development, LCRW-G5

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.8.35** summarizes flood control alternatives developed for Problem Group LCRW-G5.

Table 3.8.35: Flood Control Alternatives for Problem Group LCRW-G5

Alternative	Location	Description
LCRWG5-A1	158th Street and Church Drive	Construct 930 LF levee/floodwall near 158th Street and Church Drive in South Holland
LCRWG5-A2	Forest Preserve District	Construct detention facility. Due to the very large volume which would be required, massive excavation and removal of acres of recreational forest preserve would be required and was not considered feasible
LCRWG5-A3	Thornton Transitional Reservoir	Adjust operations of reservoir. The current operational scheme was found to be close to optimal in preventing stage increases in the Little Calumet River. The Little Calumet River experiences two instances of peak stages during the 48-hour storm event. Any adjustment in reservoir operation was predicted to increase one of the peak stages above its current level. Any changes to the operations of the Thornton Composite Reservoir were therefore considered infeasible

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for Problem Group LCRW-G5.

3.8.3.5.5 Alternative Evaluation and Selection, LCRW-G5

Alternatives included in **Table 3.8.35** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.8.37** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, thus costs were not calculated for these alternatives.

Alternative LCRWG5-A1 from **Table 3.8.35** provides the preferred alternative for this problem group. Under this recommendation, a 930 linear-foot concrete wall and earthen berm that that varies in height from 3 to 8 feet and has a maximum elevation of 597.3 feet NAVD could be constructed along the north bank of the Little Calumet River near 158th Street and Church Drive in South Holland to protect residences along 158th Street. Adding a levee to protect the building structures has a negligible effect on baseline stages (i.e., stage increases were not greater than 0.04 feet) therefore would not require compensatory storage.

Table 3.8.36 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for LCRW-G5.

Table 3.8.36: Alternative Condition Flow & WSEL Comparison for Problem Group LCRW-G5

Location	Station	Existing Conditions		Alternative LCRWG5-A1	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
600 ft Downstream of Cottage Grove Boulevard	LCRW 36294	594.3	3,813	594.3	3,807

3.8.3.5.6 Data Required for Countywide Prioritization of Watershed Projects, LCRW-G5

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.8.37** lists the alternative analyzed in detail. The recommended alternative consists of constructing a 930 linear-foot concrete levee/floodwall and earthen berm near 158th Street and Church Drive in South Holland. **Figure 3.8.10** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.8.37: Little Calumet River Project Alternative Matrix to Support District CIP Prioritization for Problem Group LCRW-G5

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
LCRW-G5	LCRWG5-A1	Construct 930 LF levee/berm	2.21	$2,494,000	$1,126,000	6 structures	No impact	South Holland

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.8.3.6 LCRW-G6 – Little Calumet River Problem Group 6

3.8.3.6.1 Problem Definition, LCRW-G6

The LCRW-G6 problem area consists of overbank flooding on Blouin Drive from Ingleside Avenue east to Dobson Avenue in Dolton, on the north bank of the Little Calumet River. The 100-year peak flow rate is 2,998 cfs, which exceeds the capacity of the channel. The flooding impacts 2 structures. The problem area is shown on the recent DFIRM floodplain maps with flooding to a slightly lesser extent.

3.8.3.6.2 Damage Assessment, LCRW-G6

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for the Little Calumet River and its tributary. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. **Table 3.8.38** lists the estimated damages for the problem group.

Table 3.8.38: Estimated Damages for Little Calumet River Subwatershed, Problem Group LCRW-G6

Problem Group ID	Damage Category	Estimated Damage ($)	Description
LCRW-G6	Property	$52,420	Structures at risk of flooding.
	Transportation	$7,860	Assumed 15% of the property damages
	Recreation	$0	

3.8.3.6.3 Technology Screening, LCRW-G6

Several combinations of technologies were analyzed to address flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.8.39** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.8.39: Evaluation of Flood Control Technologies for Little Calumet River Subwatershed, Problem Group LCRW-G6

Flood Control Option	Feasibility
Detention Facilities	Infeasible due to large and sustained stream flows from the Little Calumet River and lack of available storage area for such large volumes
Conveyance Improvement – Culvert/Bridge Replacement	Infeasible due to resultant downstream increases in stage without available compensatory storage
Conveyance Improvement – Channel Improvement	Infeasible due to resultant downstream increases in stage without available compensatory storage
Conveyance Improvements – Diversion	Infeasible due to resultant downstream increases in stage without available compensatory storage; also infeasible due to lack of available alternate receiving waters for such a discharge
Flood Barriers, Levees/Floodwalls	Feasible and necessary

3.8.3.6.4 Alternative Development, LCRW-G6

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.8.40** summarizes flood control alternatives developed for Problem Group LCRW-G6.

Table 3.8.40: Flood Control Alternatives for Problem Group LCRW-G6

Alternative	Location	Description
LCRWG6-A1	Blouin Drive from Ingleside Avenue east to Dobson Avenue	Construct 1,285 LF levee/floodwall near Blouin Drive in Dolton
LCRWG6-A2	Forest Preserve District	Construct detention facility. Due to the very large volume which would be required, massive excavation and removal of acres of recreational forest preserve would be required and was not considered feasible
LCRWG6-A3	Thornton Transitional Reservoir	Adjust operations of reservoir. The current operational scheme was found to be close to optimal in preventing stage increases in the Little Calumet River. The Little Calumet River experiences two instances of peak stages during the 48-hour storm event. Any adjustment in reservoir operation was predicted to increase one of the peak stages above its current level. Any changes to the operations of the Thornton Composite Reservoir were therefore considered infeasible

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for Problem Group LCRW-G6.

3.8.3.6.5 Alternative Evaluation and Selection, LCRW-G6

Alternatives included in **Table 3.8.40** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.8.42** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, thus costs were not calculated for these alternatives.

Alternative LCRWG6-A1 from **Table 3.8.40** is the preferred alternative for this problem group. The preferred alternative consists of the construction of a 1,285 linear-foot concrete levee/floodwall that that varies in height from 3 to 5 feet with a maximum elevation of 597.6 feet NAVD along the north bank of the Little Calumet River parallel to Blouin Drive near Ingleside Avenue and Dobson Avenue in Dolton. This levee protects residences along Blouin Drive. Adding a levee to protect the building structures has a negligible effect on baseline stages (i.e., stage increases were not greater than 0.04 feet) therefore would not require compensatory storage.

Table 3.8.41 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for LCRW-G6.

Table 3.8.41: Alternative Condition Flow & WSEL Comparison for Problem Group LCRW-G6

Location	Station	Existing Conditions		Alternative LCRWG6-A1	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
2500 ft Downstream of the Bishop Ford Freeway	LCRW 38893	594.5	3,825	594.6	3,819

3.8.3.6.6 Data Required for Countywide Prioritization of Watershed Projects, LCRW-G6

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.8.42** lists the alternative analyzed in detail. The recommended alternative consists of the construction of a 1,285 linear-foot concrete wall along the north bank of the Little Calumet River near Blouin Drive in Dolton. **Figure 3.8.11** shows the location of the recommended alternative.

Table 3.8.42: Little Calumet River Project Alternative Matrix to Support District CIP Prioritization for Problem Group LCRW-G6

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
LCRW-G6	LCRWG6-A1	Construct 1,285 LF levee	0.03	$60,000	$2,401,000	2 structures	No Impact	Dolton

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.8.3.7 LCRW-G7 – Little Calumet River Problem Group 7

3.8.3.7.1 Problem Definition, LCRW-G7

The LCRW-G7 problem area consists of overbank flooding along 158th Street from Kenwood Avenue east to Dorchester Avenue in South Holland, on the north bank of the Little Calumet River. The 100-year peak flow rate of 2,534 cfs exceeds the capacity of the channel. The flooding impacts 2 structures. The area is shown on the recent DFIRM floodplain maps with flooding to a lesser extent.

3.8.3.7.2 Damage Assessment, LCRW-G7

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for the Little Calumet River and its tributary. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. **Table 3.8.43** lists the estimated damages for the problem group.

Table 3.8.43: Estimated Damages for Little Calumet River Subwatershed, Problem Group LCRW-G7

Problem Group ID	Damage Category	Estimated Damage ($)	Description
LCRW-G7	Property	$18,000	Structures at risk of flooding
	Transportation	$2,700	Assumed 15% of the property damages
	Recreation	$0	

3.8.3.7.3 Technology Screening, LCRW-G7

Several combinations of technologies were analyzed to address flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.8.44** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.8.44: Evaluation of Flood Control Technologies for Little Calumet River Subwatershed, Problem Group LCRW-G7

Flood Control Option	Feasibility
Detention Facilities	Infeasible due to large and sustained stream flows from the Little Calumet River and lack of available storage area for such large volumes
Conveyance Improvement – Culvert/Bridge Replacement	Infeasible due to resultant downstream increases in stage without available compensatory storage
Conveyance Improvement – Channel Improvement	Infeasible due to resultant downstream increases in stage without available compensatory storage
Conveyance Improvements – Diversion	Infeasible due to resultant downstream increases in stage without available compensatory storage; also infeasible due to lack of available alternate receiving waters for such a discharge
Flood Barriers, Levees/Floodwalls	Feasible and necessary

3.8.3.7.4 Alternative Development, LCRW-G7

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.8.45** summarizes flood control alternatives developed for Problem Group LCRW-G7.

Table 3.8.45: Flood Control Alternatives for Problem Group LCRW-G7

Alternative	Location	Description
LCRWG7-A1	Kenwood Avenue to Dorchester Avenue	Construct 785 LF levee/floodwall along Little Calumet River near Kenwood Avenue and Dorchester Avenue in South Holland
LCRWG7-A2	Forest Preserve District	Construct detention facility. Due to the very large volume which would be required, massive excavation and removal of acres of recreational forest preserve would be required and was not considered feasible
LCRWG7-A3	Thornton Transitional Reservoir	Adjust operations of reservoir. The current operational scheme was found to be close to optimal in preventing stage increases in the Little Calumet River. The Little Calumet River experiences two instances of peak stages during the 48-hour storm event. Any adjustment in reservoir operation was predicted to increase one of the peak stages above its current level. Any changes to the operations of the Thornton Composite Reservoir were therefore considered infeasible

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for Problem Group LCRW-G7.

3.8.3.7.5 Alternative Evaluation and Selection, LCRW-G7

Alternatives included in **Table 3.8.45** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.8.47** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, thus costs were not calculated for these alternatives.

Alternative LCRWG7-A1 from **Table 3.8.45** is the preferred alternative for this problem group. The preferred alternative consists of the construction of a 785 linear-foot earthen berm, that that varies in height from 5 to 5.5 ft with a maximum elevation of 597.8 ft NAVD along the north bank of the Little Calumet River parallel to 158th Street from Kenwood Avenue to Dorchester Avenue in South Holland. This levee protects residences along 158th Street. Adding a levee to protect the building structures has a negligible effect on baseline stages (i.e., stage increases were not greater than 0.04 feet) therefore would not require compensatory storage.

Table 3.8.46 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for LCRW-G7.

Table 3.8.46: Alternative Condition Flow & WSEL Comparison for Problem Group LCRW-G7

Location	Station	Existing Conditions		Alternative LCRWG7-A1	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
700 ft Downstream of the Bishop Ford Freeway	LCRW 40671	594.8	2,563	594.8	2,565

3.8.3.7.6 Data Required for Countywide Prioritization of Watershed Projects, LCRW-G7

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.8.47** lists the alternative analyzed in detail. The recommended alternative consists of the construction of a 785 linear-foot earthen berm, along the north bank of the Little Calumet River near 158th Street in South Holland. **Figure 3.8.12** shows the location of the recommended alternative.

Table 3.8.47: Little Calumet River Project Alternative Matrix to Support District CIP Prioritization for Problem Group LCRW-G7

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
LCRW-G7	LCRWG7-A1	Construct 785 LF levee	0.01	$21,000	$3,040,000	2 structures	No Impact	South Holland

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.8.3.8 LCRW-G8 – Little Calumet River Problem Group 8

3.8.3.8.1 Problem Definition, LCRW-G8

The LCRW-G8 problem area consists of overbank flooding on 158th Street from Greenwood Road to Madison Avenue in Dolton. The 100-year peak flow rate of 3,805 cfs exceeds the capacity of the channel. The flooding impacts 8 structures. The area is shown on the recent DFIRM floodplain maps with flooding to a similar extent.

3.8.3.8.2 Damage Assessment, LCRW-G8

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for the Little Calumet River and its tributary. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. **Table 3.8.48** lists the estimated damages for the problem group.

Table 3.8.48: Estimated Damages for Little Calumet River Subwatershed, Problem Group LCRW-G8

Problem Group ID	Damage Category	Estimated Damage ($)	Description
LCRW-G8	Property	$610,500	Structures at risk of flooding
	Transportation	$91,600	Assumed 15% of the property damages
	Recreation	$0	

3.8.3.8.3 Technology Screening, LCRW-G8

Several combinations of technologies were analyzed to address flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.8.49** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.8.49: Evaluation of Flood Control Technologies for Little Calumet River Subwatershed, Problem Group LCRW-G8

Flood Control Option	Feasibility
Detention Facilities	Infeasible due to large and sustained stream flows from the Little Calumet River and lack of available storage area for such large volumes
Conveyance Improvement – Culvert/Bridge Replacement	Infeasible due to resultant downstream increases in stage without available compensatory storage
Conveyance Improvement – Channel Improvement	Infeasible due to resultant downstream increases in stage without available compensatory storage
Conveyance Improvements – Diversion	Infeasible due to resultant downstream increases in stage without available compensatory storage; also infeasible due to lack of available alternate receiving waters for such a discharge
Flood Barriers, Levees/Floodwalls	Feasible and necessary

3.8.3.8.4 Alternative Development, LCRW-G8

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.8.50** summarizes flood control alternatives developed for Problem Group LCRW-G8.

Table 3.8.50: Flood Control Alternatives for Problem Group LCRW-G8

Alternative	Location	Description
LCRWG8-A1	Near Greenwood Road and 158th Street	Add backflow protection to existing culvert
LCRWG8-A2	Greenwood Road to Madison Avenue	Modify existing berm to act as a levee/floodwall parallel to 158th Street near Greenwood Road and Madison Avenue in Dolton
LCRWG8-A3	Forest Preserve District	Construct detention facility. Due to the very large volume which would be required, massive excavation and removal of acres of recreational forest preserve would be required and was not considered feasible

Table 3.8.50: Flood Control Alternatives for Problem Group LCRW-G8

Alternative	Location	Description
LCRWG8-A4	Thornton Transitional Reservoir	Adjust operations of reservoir. The current operational scheme was found to be close to optimal in preventing stage increases in the Little Calumet River. The Little Calumet River experiences two instances of peak stages during the 48-hour storm event. Any adjustment in reservoir operation was predicted to increase one of the peak stages above its current level. Any changes to the operations of the Thornton Composite Reservoir were therefore considered infeasible
LCRWG8-A5	Near Greenwood Road and 158th Street and Greenwood Road to Madison Avenue	Add backflow protection to existing culvert and modify existing berm to act as a levee/floodwall parallel to 158th Street near Greenwood Road and Madison Avenue in Dolton (combination of LCRWG8-A1 & LCRWG8-A2)

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for Problem Group LCRW-G8.

3.8.3.8.5 Alternative Evaluation and Selection, LCRW-G8

Alternatives included in **Table 3.8.50** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.8.52** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, thus costs were not calculated for these alternatives.

Alternative LCRWG8-A5 from **Table 3.8.50** is the preferred alternative for this problem group. The preferred alternative consists of the modification of an existing earthen berm to upgrade it to a levee that varies in height from 3.5 to 6 ft with a maximum elevation of 597.8 ft NAVD parallel to 158th Street from Greenwood Road to Madison Avenue in Dolton. The addition of a backflow protector on the existing culvert under the footpath will reduce the impact of backflow from the Little Calumet River.

Table 3.8.51 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for LCRW-G8.

Table 3.8.51: Alternative Condition Flow & WSEL Comparison for Problem Group LCRW-G8

Location	Station	Existing Conditions		Alternative LCRWG8-A1	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
700 ft Downstream of the Bishop Ford Freeway	LCRW 41528	594.8	3,880	594.8	3851

3.8.3.8.6 Data Required for Countywide Prioritization of Watershed Projects, LCRW-G8

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.8.52** lists the alternative analyzed in detail. The recommended alternative consists of the construction of a 785 linear-foot earthen berm, along the Little Calumet River near 158th Street in South Holland. **Figure 3.8.13** shows the location of the recommended alternative.

Table 3.8.52: Little Calumet River Project Alternative Matrix to Support District CIP Prioritization for Problem Group LCRW-G8

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
LCRW-G8	LCRWG8-A5	Convert existing berm into levee and add backflow protection to existing culvert	0.30	$702,000	$2,373,000	8 structures	No Impact	South Holland

3.8.3.9 LCRW-G9 – Little Calumet River Problem Group 9

3.8.3.9.1 Problem Definition, LCRW-G9

The LCRW-G9 problem area consists of a large area of overbank flooding at State Line Road (extended) in Lansing on the east to Balmoral Avenue and 163rd Street in Calumet City on the west, on both the north and south banks of the Little Calumet River. The 100-year peak flow rate varies from 1,464 cfs at State Line Road (extended) to 1,534 cfs near Balmoral Avenue and 163rd Street, and exceeds the capacity of the channel. The flooding impacts approximately 880 structures. The inundated area is shown on the recent DFIRM floodplain maps with flooding to a somewhat lesser extent.

3.8.3.9.2 Damage Assessment, LCRW-G9

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for the Little Calumet River and its tributaries. These stages were used to calculate the depth of flooding and then to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15% of the property damages, unless otherwise noted. **Table 3.8.53** lists the estimated damages for the problem group.

Table 3.8.53: Estimated Damages for Little Calumet River Subwatershed, Problem Group LCRW-G9

Problem Group ID	Damage Category	Estimated Damage ($)	Description
LCRW-G9	Property	$11,476,000	Structures at risk of flooding
	Transportation	$1,721,000	Assumed 15% of the property damages
	Recreation	$0	

3.8.3.9.3 Technology Screening, LCRW-G9

Several combinations of technologies were analyzed to address flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.8.54** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.8.54: Evaluation of Flood Control Technologies for Little Calumet River Subwatershed, Problem Group LCRW-G9

Flood Control Option	Feasibility
Detention Facilities	Due to the large extent of flooding, would only be feasible if a suitable site were available with sufficient storage volumes
Conveyance Improvement – Culvert/Bridge Replacement	Feasible if used in a setback levee option
Conveyance Improvement – Channel Improvement	Feasible for a setback levee option
Conveyance Improvements – Diversion	Due to the large extent of flooding, would be feasible if a suitable site or receiving water were available
Flood Barriers, Levees/Floodwalls	Would be feasible if sufficient space and easements
Flooding Easements	Feasible when compensatory storage is not an option to prevent stage increases

3.8.3.9.4 Alternative Development, LCRW-G9

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.8.55** summarizes flood control alternatives developed for Problem Group LCRW-G9.

Table 3.8.55: Flood Control Alternatives for Problem Group LCRW-G9

Alternative	Location	Description
LCRWG9-A1	Various locations along banks of Little Calumet River	Construct levees/floodwalls to protect residences inundated from the main reach of the Little Calumet River. Option would result in stage increases and require compensatory storage or purchase of flooding easements
LCRWG9-A2	Various locations along banks of Little Calumet River	Construct setback levees by placing levees at a set distance from the channel and purchasing any properties between the proposed levee and the channel bank. The area between the channel and the levee could be smoothed or deepened to better serve as an effective flow area
LCRWG9-A3	Various locations along banks of Little Calumet River	Upgrade existing levees to provide a higher level of protection. Option would result in stage increases and require compensatory storage or purchase of flooding easements
LCRWG9-A4	Forest Preserve Property	Construct detention facility to decrease flood stages below damage levels by decreasing flows through diversion to an offline storage area or for use as compensatory storage
LCRWG9-A5	Various locations along banks of Little Calumet River	Retrofit restrictive culverts to provide increased hydraulic capacity

Table 3.8.55: Flood Control Alternatives for Problem Group LCRW-G9

Alternative	Location	Description
LCRWG9-A6	Various locations along banks of Little Calumet River	Widen and/or regrade channel to increase hydraulic capacity
LCRWG9-A7	Various locations along banks of Little Calumet River	Purchase flooding easements when flooding cannot be avoided in an area; option is only feasible when stage increases are minor
LCRWG9-A8	Modifications to operation of the Thornton Composite Reservoir	Any adjustments in operations to Thornton Composite Reservoir will increase peak stages above existing conditions. Changes to the operations of the Thornton Composite Reservoir were therefore considered infeasible
LCRWG9-A9	Various locations along banks of Little Calumet River	Construct levees/floodwalls to protect residences inundated from the main reach of the Little Calumet River and construct 500 ac-ft detention facility in forest preserve property (Combination of LCRWG9-A1 & LCRWG9-A4)
LCRWG9-A10	Various locations along banks of Little Calumet River	Construct levees/floodwalls to protect residences inundated from the main reach of the Little Calumet River and construct 2,600 ac-ft detention facility in forest preserve property (Combination of LCRWG9-A1 & LCRWG9-A4)

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for Problem Group LCRW-G9.

3.8.3.9.5 Alternative Evaluation and Selection, LCRW-G9

Alternatives included in **Table 3.8.55** were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. **Table 3.8.57** provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, thus costs were not calculated for these alternatives.

The alternatives listed in **Table 3.8.55** are considered infeasible for this area due to the lack of sufficient available area for the large storage volumes necessary for storage alternatives to be feasible, the lack of resulting benefits and necessary easements associated with levee alternatives, and the inability to control additional flows resulting from storage and levee solutions, resulting in increased flood stages.

Providing a storage alternative would require a large scale storage area similar in magnitude to the existing Thornton Composite Reservoir. Within the main stem of the Little Calumet River, flows are very large and sustain a peak stage for many hours. A potentially feasible storage alternative would be to use a large tract of land belonging to the Forest Preserve District (FPD). This would require massive excavation and removal of acres of recreational forest preserve and trees. This option would likely face public protest, and protests from the FPD and environmental advocates, further reducing the feasibility. Similarly, diverting flows to a further downstream reach or to the Calumet-Sag Channel, for instance, was considered but would require a very large compensatory storage area. Altering current channel geometry and existing structures would require large scale storage to prevent increases in stage in other portions of the Little Calumet River and was considered infeasible.

An option to adjust the operations of the Thornton Composite Reservoir was found to be infeasible since the current operational scheme was shown to be close to optimal in preventing stage increases in the Little Calumet River. It should be noted that the Little Calumet experiences two periods of peak stages during the 48-hour storm. Any adjustment in operations was shown to increase one or the other peak stage above its current level. Changes to the operations of the Thornton Composite Reservoir were therefore considered infeasible.

Erecting a levee/floodwall between the channel bank and the closest residential property would prevent most residential flooding in the problem group. However floodwalls would likely result in unacceptable increases (greater that 0.04 ft) in river stages upstream and/or downstream of the levee structures. Such increases would need to be mitigated by diverting flows from the channel to an offline storage area, which would need to be large, and infeasible as described above. Currently, open space for a significant offline storage area is not available except for Forest Preserve Property. A second way to deal with these increased stages would be to purchase flood easements from individual property owners which would allow flooding to increase by the property owner's permission.

A second option involving floodwalls would be to create set-back levees. This involves placing levees at a set distance from the channel and purchasing any properties that happen to be between the proposed levee and the channel bank. The area between the channel and the levee can also be smoothed or deepened and better serve as an effective flow area without structures impeding the flow. Set-back levees therefore have the advantage of potentially requiring less compensatory storage and/or less purchase of flood easements.

The following potential levee component combinations were considered:

1. Project Component Combination 1 – Erect Levees to Prevent Ponding and Divert Flows to an Offsite Detention Location to Prevent Stage Increases Outside of the Levee Protection Area.

The two proposed levees and the three existing levees at problem area LCRW9, on both sides of the river, have a total length of 19,780 ft with heights varying between 3 and 8.57 feet, set 3 feet above the 100-year flood elevation. This levee system includes upgrades to existing levees which are already in place in order that the levee system would be certifiable by FEMA (i.e., 3 feet above the 100-year flood elevation, and tied back to 3 feet above the 100-year flood elevation).

The two proposed levees are located at:

- Between Balmoral Ave/163rd Street and 169th Street/State-Line Rd, Calumet City, IL (10,550 feet)

- Between Chicago Ave/170th Street to near 175th Street and State-Line, Lansing, IL (9,230 feet)

The levees vary between concrete walls and earthen berms. The three existing levees would also be upgraded to a height of 3 feet above the 100 year flood stage, thus forming a protective barrier when combined with the proposed levee system. This levee system protects approximately 880 residences west of State Line Road in Lansing and Calumet City. This system also requires interior drainage to prevent flooding behind the floodwalls.

To prevent increases in stages due to the creation of this new levee system, this combination requires offline storage of between 500 and 2,600 acre-feet, according to the approximate volume of flooding removed from the floodplain, and the results of hydraulic modeling, respectively. Estimates were made for both the offline storage areas. The construction of a 500 acre-feet, 33 feet deep storage area assumes a 1 mile diversion tunnel and has an approximate footprint of 22 acres. The construction of a 2,600 acre-feet, 33 feet deep storage area assumes a 2.4 mile diversion tunnel and has an approximate footprint of 92 acres.

The 2,600 acre-feet represents the volume currently needed to be diverted to prevent increased levee stages upstream and downstream of the levee improvements. This was based on opening gates of the diversion tunnel at a water surface elevation of 595.80 feet NAVD and closing gates at a water surface elevation of 595.55 feet NAVD. Some combination of optimization of the gate operation scheme, relocation of the diversion tunnel, or inclusion of a control structure may result in a lower compensatory storage volume between 500 and 2,600 acre-feet.

Project Component Combination 2 – Erect Levees to Prevent Ponding in Problem Area LCRW9 and Purchase Flooding Easements where Stage Increases Occur Outside of the Levee System

This combination assumes the same levee configuration as combination #1, but excludes offline storage. Due to the potential difficulty in obtaining offline storage area with the storage capacity required for combination #1, this combination implements the purchase of flood easements which allow increases in stages outside the levees through a negotiated contract with any properties affected by such flooding.

1. Project Component Combination 3 – Erection of Set-back Levees to Prevent Ponding in Problem Area LCRW9, with Floodproofing or Property Acquisition and Purchase of Flooding Easements where Stage Increases Occur Outside of the Levee System.

This combination assumes levees to be setback 600 ft from the bank of the channel with buyouts of properties between the channel bank and set-back levee. Levees would be located as described in Combination #1 above, except 600 feet from the current channel bank. Existing levees would be upgraded but remain in their current locations. While the additional setback distance would decrease increases in stages outside the levee system, hydraulic modeling indicates that the purchase of flood easements would still be necessary due to increased stages to outside the levee system.

The estimated total cost and benefit/cost ratio of levee solutions were analyzed, and as shown in **Table 3.8.57**. These costs, relatively limited resulting benefits, increased resulting flows and stages, limited available land, and necessary purchase of easements limit the feasibility of implementing these levee solutions.

This analysis suggests that the properties at risk of flooding during the 100-year event are candidates for protection using non-structural flood control measures, such as floodproofing or acquisition. These measures may be considered to address damages that are not fully addressed by capital projects recommended in the Little Calumet River DWP.

Table 3.8.56 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for LCRW-G9.

Table 3.8.56: Alternative Condition Flow & WSEL Comparison for Problem Group LCRW-G9

Location	Station	Existing Conditions		Alternative LCRWG9-A10	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Downstream Face of Hohman Avenue	LCRW 72150	597.2	1,696	596.6	1,801
Upstream Face of Wentworth Avenue	LCRW 67516	596.7	1,462	595.6	1,184
Downstream Face of Wentworth Avenue	LCRW 67399	596.7	1,462	595.4	1,184
1,000 ft downstream of Wentworth Avenue	LCRW 66253	596.7	1,388	595.4	1,155
Downstream Face of Burnham Avenue	LCRW 63309	596.6	1,477	595.3	1,063
Upstream of Pennsylvania Railroad/Bike Trail	LCRW 58194	596.2	1,534	595.2	1,242

3.8.3.9.6 Data Required for Countywide Prioritization of Watershed Projects, LCRW-G9

None of the structural measures analyzed were considered feasible for implementation. Therefore data for prioritization of recommended capital improvement projects is not provided. **Table 3.8.57** lists the alternative analyzed in detail. The recommended alternative consists of acquiring or floodproofing the impacted structures. **Figure 3.8.14** shows the general location of the recommended alternative.

Table 3.8.57: Little Calumet River Project Alternative Matrix to Support District CIP Prioritization for Problem Group LCRW-G9

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Recommended	Involved Community
LCRW-G9	LCRWG9-A9*	2 proposed levees, modifications to 3 existing levees and 500 ac-ft of storage area on forest preserve land*	0.08	$13,197,000	$162,975,000	880	Positive	No	Lansing, Calumet City
LCRW-G9	LCRWG9-A10	2 proposed levees, modifications to 3 existing levees and 2,600 ac-ft of storage area on forest preserve land	0.03	$13,197,000	$441,967,000	880	Positive	No	Lansing, Calumet City

Note: Net Benefits values do not include local benefits or non-economic benefits.

*This alternative would need a control structure upstream of problem area LCRW9 to limit the higher flows coming from the Little Calumet River. The total project cost does not include a control structure.

3.8.4 Recommended Alternatives, Little Calumet River Subwatershed

Table 3.8.58 summarizes the recommended alternatives for the Little Calumet River subwatershed. The District will use data presented here to support prioritization of a countywide stormwater CIP.

Table 3.8.58: Little Calumet River Project Alternative Matrix to Support District CIP Prioritization, All Problem Groups

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
LCRW-G1	LCRWG1-A3	Levee/ floodwall	< 0.01	$16,000	$3,412,000	4 structures	No Impact	Harvey
LCRW-G2	LCRWG2-A1	Construct levee	0.03	$148,000	$5,752,000	6 structures	No impact	South Holland
LCRW-G3	LCRWG3-A1	Construct levee	< 0.01	$4,000	$4,332,000	2 structures	No Impact	South Holland
LCRW-G4	LCRWG4-A1	Construct 825 LF levee	< 0.01	$3,000	$3,427,000	1 structure	No Impact	South Holland
LCRW-G5	LCRWG5-A1	Construct 930 LF levee/berm	2.21	$2,494,000	$1,126,000	6 structures	No impact	South Holland
LCRW-G6	LCRWG6-A1	Construct 1,285 LF levee	0.03	$60,000	$2,401,000	2 structures	No Impact	Dolton
LCRW-G7	LCRWG7-A1	Construct 785 LF levee	0.01	$21,000	$3,040,000	2 structures	No Impact	South Holland
LCRW-G8	LCRWG8-A5	Convert existing berm into levee and add backflow protection to existing culvert	0.30	$702,000	$2,373,000	8 structures	No Impact	South Holland

Note: Net Benefits values do not include local benefits or non-economic benefits.

Section 4
Watershed Action Plan

This section summarizes the recommendations for watershed improvements developed through the Little Calumet River Detailed Watershed Plan (DWP) process. The recommendations and supporting information will be considered by the District's Board of Commissioners in their prioritization of a countywide Stormwater Capital Improvement Program (CIP). The recommendations within the DWP consist of maintenance activities (Section 4.1) and recommended capital improvements (Section 4.2).

4.1 Watershed Maintenance Activities

Review of reported stormwater problem data indicated that certain types of maintenance activities would be helpful in preventing stormwater problems. The District, through its maintenance activities, has been actively removing blockages such as tree limbs and woody debris from channels throughout Cook County. Local communities have reported benefits from these maintenance activities. It is recommended that the District's maintenance activities be continued to address ongoing future maintenance needs. Most structures in the watershed are in need of minor debris clearing, and should be periodically inspected to maintain hydraulic capacity.

Sedimentation is a dynamic process that is affected by soil protective measures taken in upland tributary areas as well as dynamic streambank conditions. The District's Watershed Management Ordinance will define standard practices for erosion protection on construction sites. Best management practices in upland areas should be paired with stream maintenance measures to reduce sediment delivered to waterways to reduce the need for extensive dredging programs.

Improvement projects recommended in the Little Calumet River DWP, including detention basins, channel diversions, etc., will require ongoing maintenance if constructed. Costs associated with maintenance over a 50-year life-cycle period were included in the cost estimates presented in this DWP. It is recommended that the District develop maintenance plans for capital improvements, and where applicable, execute agreements with local governments to delegate certain maintenance responsibilities. Maintenance agreements could follow current District practice, where the District is responsible for operation and maintenance of structural, electrical, and mechanical facilities, and grounds are the responsibility of partnering organizations.

Table 4.1 lists problem area locations where stream maintenance activities should be prioritized, as maintenance is the only improvement necessary to prevent flooding (no structural improvements needed).

Table 4.1: Summary of Problem Areas where Debris Removal or Other Maintenance is Recommended

Problem Area ID	Tributary	Location	Type of Maintenance Activity Required
BLI1	Midlothian Creek	Western Avenue and 139th Street	Remove debris and clear channel
BRE2	Midlothian Creek	167th Street from Harlem Avenue to Cicero Avenue	Remove debris and clear channel
BRE6	Midlothian Creek	Central Avenue from 183rd Street to Midlothian Turnpike	Remove debris and clear channel
BRE7	Midlothian Creek	Ridgeland Avenue from 147th Street to 135th Street	Remove debris and clear channel
PAR2	Thorn Creek	Western Avenue/ EJ&E Railroad (South Street)	Remove debris and clear channel
MAT2	Butterfield Creek	Cicero Avenue to Vollmer Avenue	Remove debris and clear channel
MAT3	Butterfield Creek	US 30 and Ridgeland Avenue	Remove debris and clear channel
MAT4	Butterfield Creek	Lindenwood Avenue to Rose Lane	Remove debris and clear channel
MAT5	Butterfield Creek	1/2 mile south of US 30 / Kostner Avenue	Remove debris and clear channel
OKF5	Midlothian Creek	North of 155th Street and Long Avenue	Remove debris and clear channel
ORP5	Midlothian Creek	167th Street and 88th Avenue	Remove debris and clear channel
ORT2	Midlothian Creek	80th Avenue from 183rd Street to 151st Street	Remove debris and clear channel
RIT2	Butterfield Creek	Sauk Trail Road from Harlem Avenue to Western Avenue	Remove debris and clear channel
RIT3	Butterfield Creek	Vollmer Road from Harlem Avenue to Western Avenue	Remove debris and clear channel
RIT4	Butterfield Creek	Flossmoor Road from Ridgeland Avenue to Governors Highway	Remove debris and clear channel
RIT6	Butterfield Creek	Ridgeland Avenue from Steger Road to 183rd Street	Remove debris and clear channel

4.2 Recommended Capital Improvements

Table 4.2 lists the recommended capital improvements for the Little Calumet River Watershed (prioritization matrix). The District will use data presented here to support prioritization of a countywide stormwater CIP.

Table 4.2: Little Calumet River Watershed Prioritization Matrix

ID	Subwatershed	B/C Ratio	Total Benefits ($)	Total Project Cost ($)	Probable Construction Cost ($)	Relative Damage Averted 25% 50% 75%	Acreage Removed from Inundation Area (ac)	Wetland or Riparian Areas Impacted (ac)	Cumulative Structures & Roadways Protected	Implementation Time (months)*	Water Quality Benefit	Community Involvement
BTCR-G1	Butterfield Creek	0.18	$1,495,000	$8,494,000	$6,363,000		18	-	18 Structures	12	Positive	Unincorporated Cook County
BTCR-G2	Butterfield Creek	<0.01	$13,000	$9,556,000	$5,567,000		15	-	4 Structures	6	No Impact	Olympia Fields
BTCR-G3	Butterfield Creek	0.04	$1,109,000	$29,876,000	$17,572,000		6	-	12 Structures, 2 Roadways	18	No Impact	Flossmoor
BCEB-G1	Butterfield Creek East Branch	0.02	$515,000	$28,079,000	$19,462,000		88	-	6 Structures, 2 Roadways	18	Positive	Matteson
BLCR-G1	Cal-Union Drainage Ditch	0.17	$2,293,000	$13,842,000	$10,600,000		9	-	15 Structures	24	Positive	Markham
CHEB-G1	Cal-Union Drainage Ditch	0.05	$170,000	$3,300,000	$2,140,000		15	-	16 Structures, 2 Roadways	12	No Impact	Homewood, Hazel Crest
CHEB-G3	Cal-Union Drainage Ditch	3.37	$7,680,000	$2,282,000	$849,000		6	-	9 Structures, 2 Roadways	12	No Impact	Homewood
CUDD-G1	Cal-Union Drainage Ditch	0.03	$5,782,000	$165,318,000	$119,593,000		750	-	1,065 Structures	36	Positive	Markham, Harvey, Hazel Crest
CUDD-G2	Cal-Union Drainage Ditch	0.07	$3,377,000	$50,406,000	$39,733,000		98	-	20 Structures	30	Positive	Markham, Harvey, Unincorporated
CUDD-G3	Cal-Union Drainage Ditch	0.40	$1,144,000	$2,852,000	$1,537,000		44	-	60 Structures	12	Positive	Markham
CUSW-G1	Cal-Union Drainage Ditch	0.03	$15,000	$536,000	$328,000		22	-	1 Roadway	6	No Impact	Hazel Crest
CUSW-G2	Cal-Union Drainage Ditch	<0.01	$6,000	$1,206,000	$735,000		2	-	1 Roadway	12	No Impact	Hazel Crest
CUTS-G1	Cal-Union Drainage Ditch	0.02	$63,000	$2,917,000	$1,666,000		3	-	10 Structures, 2 Roadways	6	No Impact	Country Club Hills
PKCR-G1	Cal-Union Drainage Ditch	0.26	$5,187,000	$20,327,000	$15,819,000		15	-	53 Structures	24	Positive	Markham
DRCR-G1	Deer Creek	0.49	$3,801,000	$8,331,000	$6,881,000		198	-	270 Structures	12	No Impact	Ford Heights
DRCR-G2	Deer Creek	< 0.01	$55,000	$14,312,000	$10,671,000		14	-	2 Structures	6	No Impact	Steger
LCRW-G1	Little Calumet River	< 0.01	$16,000	$3,412,000	$1,925,000		1	-	4 Structures	6	No Impact	Harvey
LCRW-G2	Little Calumet River	0.03	$148,000	$5,752,000	$3,102,000		4	-	6 Structures	6	No Impact	South Holland
LCRW-G3	Little Calumet River	< 0.01	$4,000	$4,332,000	$2,151,000		2	-	2 Structures	6	No Impact	South Holland
LCRW-G4	Little Calumet River	< 0.01	$3,000	$3,427,000	$1,913,000		2	-	1 Structure	6	No Impact	South Holland
LCRW-G5	Little Calumet River	2.21	$2,494,000	$1,126,000	$480,000		2	-	6 Structures	6	No Impact	South Holland
LCRW-G6	Little Calumet River	0.03	$60,000	$2,401,000	$644,000		2	-	2 Structures	6	No Impact	Dolton
LCRW-G7	Little Calumet River	0.01	$21,000	$3,040,000	$1,518,000		2	-	2 Structures	6	No Impact	South Holland

Table 4.2: Little Calumet River Watershed Prioritization Matrix

ID	Subwatershed	B/C Ratio	Total Benefits ($)	Total Project Cost ($)	Probable Construction Cost ($)	Relative Damage Averted 25% 50% 75%	Acreage Removed from Inundation Area (ac)	Wetland or Riparian Areas Impacted (ac)	Cumulative Structures & Roadways Protected	Implementation Time (months)*	Water Quality Benefit	Community Involvement
LCRW-G8	Little Calumet River	0.30	$702,000	$2,373,000	$1,389,000		14	-	8 Structures	6	No Impact	South Holland
MTCR-G1	Midlothian Creek	0.08	$134,000	$1,710,000	$1,118,000		11	-	25 Structures	6	No Impact	Tinley Park
MTCR-G2	Midlothian Creek	0.71	$1,110,000	$1,569,000	$926,000		-	-	4 Structures	6	No Impact	Tinley Park
MTCR-G3	Midlothian Creek	0.01	$37,000	$3,455,000	$1,814,000		25	-	23 Structures, 2 Roadways	12	No Impact	Oak Forest
MTCR-G4	Midlothian Creek	0.04	$1,143,000	$27,700,000	$15,996,000		8	-	12 Structures, 2 Roadways	18	No Impact	Oak Forest
MTCR-G5	Midlothian Creek	< 0.01	$58,000	$21,000,000	$12,673,000		9	-	25 Structures	12	No Impact	Oak Forest
MTCR-G6	Midlothian Creek	0.23	$110,000	$479,000	$400,000		33	-	25 Structures	6	No Impact	Robbins
NTCR-G1	Natalie Creek	0.24	$14,700,000	$61,940,000	$42,390,000		136	-	132 Structures	30	No impact	Oak Forest and Midlothian
LDET-G1	North Creek	0.29	$82,000	$287,000	$191,000		3	-	9 Structures, 1 Roadway	6	No Impact	Sauk Village
NCLD-G1	North Creek	0.03	$2,364,000	$69,500,000	$52,247,000		594	-	49 Structures, 10 Roadways	36	Positive	Lansing, Lynwood
NCLD-G2	North Creek	< 0.01	$1,000	$357,000	$201,000		5	-	2 Structures, 1 Roadway	6	No Impact	Bloom Township
NCLD-G3	North Creek	< 0.01	$10,000	$2,180,000	$1,201,000		7	-	12 Structures, 1 Roadway	6	No Impact	Sauk Village
NOCR-G1	North Creek	0.05	$388,000	$7,126,000	$4,605,000		55	-	14 Structures, 4 Roadways	12	Positive	Lansing
PLCR-G1	Plum Creek	0.73	$2,781,000	$3,803,000	$2,540,000		20	-	1 Structure	6	No Impact	Will County, Dyer, IN
TCTA-G1	Thorn Creek	0.02	$1,415,000	$89,000,000	$65,426,000		61	-	51 Structures	24	Positive	Chicago Heights, South Chicago
TCTB-G1	Thorn Creek	< 0.01	$8,000	$6,900,000	$3,825,000		3	-	4 Structures, 3 Roadways	6	No Impact	Chicago Heights
TCTD-G1	Thorn Creek	0.08	$5,500,000	$65,442,000	$48,905,000		50	-	22 Structures, 1 Roadway	30	Positive	Park Forest
THCR-G1	Thorn Creek	0.02	$717,000	$37,660,000	$25,880,000		68	-	51 Structures, 3 Roadways	24	No Impact	Chicago Heights, Glenwood, South
THCR-G2	Thorn Creek	0.63	$1,600,000	$2,543,000	$1,878,000		3	-	1 Roadway	6	No Impact	Cook County FPD

Property Damage Erosion Transportation Recreation

4.3 Implementation Plan

Alternatives listed in **Table 4.2** can be constructed independently. However in many cases, benefits associated with constructing several alternatives in a subwatershed will exceed the sum of the benefits of the individual alternatives. The data presented in **Table 4.2**, along with non-economic factors, will allow the District to prioritize its CIP and implement projects. A number of alternatives in **Table 4.2** require the acquisition of land that currently may be unavailable. Upon selecting an alternative for implementation, the District will identify and evaluate land acquisition needs and procedures.

Section 5
Summary and Conclusions

Stormwater problems in the Little Calumet River Watershed, whether identified by stakeholders or identified by modeling of intercommunity waterways, indicate a need for regional stormwater management solutions throughout the Little Calumet River Watershed. The Little Calumet River Detailed Watershed Plan (DWP) was developed in coordination with the Little Calumet River Watershed Planning Council (WPC), with a focus on integrating community knowledge of stormwater problems and ideas for feasible solutions into the District's regional stormwater plan. All stormwater problem data received from stakeholders was recorded in a database, and classified as local or regional according to the criteria defined in Section 1.

Hydrologic and hydraulic models were developed to estimate flow and stage along regional waterways and assess the frequency and depth of flooding problems for a range of modeled recurrence intervals. Inundation mapping was developed for the 100-year modeled storm event, identifying areas estimated to be at risk of flooding. Modeled water depths and inundation mapping were used to help estimate damages due to flooding within each tributary.

Stormwater improvements were developed to address regional problems throughout the watershed. Appropriate tributary-specific technologies were screened considering their applicability for addressing problem areas, constructability in the area required, and regulatory feasibility. H&H models were modified to represent possible future conditions. Damage estimates for proposed alternatives were performed to evaluate an alternative's effectiveness at reducing regional stormwater damages. The difference in damages between existing and alternative conditions was quantified as an alternative's benefit. In addition to numeric benefits, several other criteria were noted for each alternative, such as the number of structures protected, water-quality benefit, and wetland/riparian areas affected. Conceptual level cost estimates were developed to estimate the construction and maintenance cost of proposed alternatives over a 50-year period. Estimated benefits were divided by conceptual costs to develop B/C ratios.

The distribution of benefits resulting from the recommended alternatives is relatively uneven throughout the Little Calumet River Watershed due to the wide range and severity of flooding problems among communities and individual tributaries. Predicted benefits are greatest for Cal-Union Drainage Ditch, and Midlothian Creek subwatersheds due to relatively large numbers of impacted structures (hundreds) as well as multiple roadways.

Stormwater problems, whether identified by stakeholders or identified by modeling of intercommunity waterways, indicate a need for regional stormwater management solutions throughout the Little Calumet River Watershed. The alternatives recommended within this plan substantially address damages within the predicted 100-year inundation areas. For the majority of alternatives, flood stages are predicted to address damages. Some residual flooding areas remain, for which floodproofing or acquisition may be considered. The maintenance activities, stream bank stabilization, conveyance improvement, and flood storage alternatives recommended in this plan will provide benefits to the Little Calumet River Watershed as the District implements its regional stormwater plan.

Appendix A
DWP Inundation Area and FEMA Floodplain Comparison

Introduction

As part of the Little Calumet River DWP development, inundation mapping was produced based on hydrologic and hydraulic modeling. **Tables A1 and A2** below provide a comparison of the inundation area created for this DWP to that of the effective FEMA floodplain mapping, revised August 19, 2008, as part of the FEMA Map Modernization Program. Only detailed study Zone AE and limited detail study Zone A special flood hazard areas (SFHA) are included in the comparison.

Caution should be exercised when evaluating the numbers in **Table A1** and **A2**, as differences in inundation area may result from differences in the extent of detailed hydraulic modeling performed between the District's DWP development process and the FEMA program. The relative impact of the differences is described below. The greatest reasons for any difference that will likely result in higher flood stages for DWP inundation areas are: the change to Bulletin 70 rainfall data; detailed critical duration analysis; including Tunnel and Reservoir Plan (TARP) areas; and using historic storm calibration versus calibrating to a discharge frequency curve. These detailed model development differences will tend to raise predicted stages throughout the watershed. Other modeling differences have resulted in more minor inundation area differences, more local in nature, resulting in higher or lower predicted stages.

Hydrologic Modeling Methodology

Hydrologic modeling methodologies utilized for the District's DWPs are different than those performed for DFIRM mapping, thus estimated peak flow rates may be significantly different. DFIRM hydrology was primarily based on regression equations and older hydrologic models (HEC-1, TR-20, etc.) while this DWP utilized a more current hydrologic model (HEC-HMS). Consequently, different approaches to channel and reservoir routing may have been taken, which may result in peak magnitude and timing differences.

The parameters used for each hydrologic model may also be different. This DWP computed NRCS Curve Numbers based on the latest CMAP land use maps and NRCS soil maps. Hydrologic methods utilized by the FEMA DFIRM process likely referenced older land use and soil data. Additionally, different methodologies may have been used to calculate subbasin times of concentration.

This DWP utilized current ISWS Bulletin 70 rainfall data while previous hydrologic studies used for DFIRM mapping may have used older Technical Paper-40 rainfall data. Bulletin 70 rainfall data generally yields higher rainfall depths than Technical Paper-40. For example, Technical Paper-40 specifies a 100-year, 24-hour duration rainfall depth of approximately 5.7 inches, while Bulletin 70 specifies a corresponding rainfall depth of approximately 7.6 inches. Additionally, this DWP utilizes depth-area adjustments, which may not have been utilized for DFIRM mapping. Also, detailed critical duration analysis was performed to identify the critical duration storms in each subwatershed.

Subbasin delineation is likely different between this DWP and the DFIRM mapping, as this DWP utilized the latest Cook County LiDAR data for topographic information to support subbasin delineation.

Tunnel and Reservoir Plan (TARP) subareas were incorporated into the DWP modeling, including the impact of diverting flow and filling the tunnels. Some of the earlier modeling of the Little Calumet River used for DFIRM mapping did not include the TARP areas as contributing runoff to the watershed. Within earlier modeling, the proposed TARP Thornton Reservoir was sized to contain the largest volume computed during continuous modeling performed for TARP. The currently proposed TARP Thornton Reservoir is much smaller than the original proposed volume, and the combined sewer area will contribute runoff to the Little Calumet River watershed during larger events.

Hydraulic Modeling Methodology

Hydraulic modeling methodologies utilized for this DWP are different than those performed for DFIRM mapping, thus their associated flood surface profiles may be different. Steady-state hydraulic modeling was generally performed in support of DFIRM mapping. This DWP utilized dynamic unsteady flow simulation. The difference in approaches between steady and unsteady hydraulic modeling may contribute to discrepancies between flood surface profiles.

Channel cross sections in the hydraulic models differ between this DWP and previous modeling. The differences may contribute to discrepancies between flood surface profiles. Cross sections developed under this DWP were generally obtained from rigorous field survey. In a few cases, recent hydraulic models were available and modified under this DWP. If recent hydraulic models were used, several cross sections were verified with field surveying. Hydraulic models produced in support of DFIRM mapping may have used different cross-sectional data, which may reflect outdated channel geometries. Likewise, bridge section geometries may also vary from previous modeling.

Hydraulic model calibration differences may also contribute to discrepancies in flood surface profiles between this DWP and DFIRM mapping. This DWP was calibrated to recent storm events that have occurred since the development of DFIRM modeling. The calibration differences may contribute to discrepancies between flood surface profiles.

DWP and FEMA Floodplain Area Comparison

Table A1 below depicts the floodplain area within each subwatershed as determined by the Little Calumet River DWP and DFIRM mapping (for both FEMA Zone AE, and FEMA Zone A).

Table A1: Comparison of DWP Inundation Area and FEMA Floodplain by Subwatershed

Subwatershed	DWP Floodplain Area (acres)	FEMA Zone AE Area (acres)	FEMA Zone A Area (acres)
Butterfield Creek	1,267.5	1,556.0	135.1
Calumet Union Drainage Ditch	910.8	478.4	135.0
Deer Creek	1,305.0	1,267.1	1.2
Hart Ditch	13.4	7.8	
Little Calumet River	1,505.0	1,136.7	76.9
Midlothian Creek	762.9	833.6	151.7
North Creek	2,134.7	2,233.8	42.4
Plum Creek	239.3	238.4	
Thorn Creek	1,546.2	1,132.8	174.7
Totals	**9,683.9**	**8,884.6**	**717.0**

1. Subwatersheds with no DWP mapping were not included in the table. Some FEMA Zone A does exist in these locations.

2. The floodplain area comparisons are within the Cook County

Table A2 depicts the floodplain area within each community within the Little Calumet River watershed as determined by the Little Calumet River DWP and DFIRM mapping (for both FEMA Zone AE, and FEMA Zone A).

Table A2: Comparison of DWP Inundation Area and FEMA Floodplain by Community

Community	DWP Floodplain Area (acres)	FEMA Zone AE Area (acres)	FEMA Zone A Area (acres)
Blue Island	36.1	62.5	5.1
Calumet City	309.8	261.6	
Calumet Park	0.3	0.7	
Chicago Heights	337.4	193.8	82.1
Country Club Hills	32.8	88.8	60.1
Crestwood	0.1		
Crete			0.1
Dixmoor	80.3	15.6	7.4
Dolton	24.9	21.1	17.8
East Hazel Crest	0.6		14.4
Flossmoor	138.0	191.6	3.1
Ford Heights	284.4	261.4	
Glenwood	189.8	178.5	1.1

Table A2: Comparison of DWP Inundation Area and FEMA Floodplain by Community

Community	DWP Floodplain Area (acres)	FEMA Zone AE Area (acres)	FEMA Zone A Area (acres)
Harvey	548.7	193.3	
Hazel Crest	159.7	104.7	75.7
Homewood	135.2	115.5	0.0
Lansing	459.8	345.7	
Lynwood	862.7	1024.1	42.4
Markham	350.4	185.1	8.1
Matteson	476.6	559.7	55.6
Midlothian	136.8	116.0	
Oak Forest	236.5	234.2	15.8
Olympia Fields	91.5	92.2	28.5
Orland Hills	4.6		10.4
Orland Park	9.1	1.2	
Park Forest	162.8	9.0	
Phoenix	0.4	0.2	
Posen	12.4		91.8
Richton Park	83.7	125.3	9.8
Riverdale	23.0	23.2	
Robbins	39.9	99.5	
Sauk Village	137.8	173.9	
South Chicago Height	28.2	13.5	19.3
South Holland	527.1	492.3	
Steger	23.7		24.2
Thornton	31.6	29.0	5.9
Tinley Park	215.8	212.1	8.1
UNINCORP	3483.5	3454.3	130.2
University Park	7.9	4.9	
Totals	**9,683.9**	**8,884.6**	**717.0**

CHAPTER 6
WATERSHED PLANNING

Acronyms used in Chapter 6:

AA_B	Average Annual Benefits
AA_C	Average Annual Costs
AA_D	Average Annual Damages
ABM	Articulated Block Mat
BC	Benefit-to-Cost
CCSMP	Cook County Stormwater Management Plan
CDSA	Critical Duration Storm Analysis
CIP	Capital Improvement Program
CMAP	Chicago Metropolitan Agency for Planning
CUDD	Calumet Union Drainage District
DTM	Digital Terrain Model
DWP	Detailed Watershed Plan
FDA	Flood Damage Assessment
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
GIS	Geographic Information Systems
HEC	Hydrologic Engineering Center
H&H	Hydrologic and Hydraulic
HSPF	Hydrologic Simulation Program-Fortran
IDNR-OWR	Illinois Department of Natural Resources - Office of Water Resources
IDNR-SWS	Illinois Department of Natural Resources – State Water Survey
IDOT	Illinois Department of Transportation
IEMA	Illinois Emergency Management Agency
IEPA	Illinois Environmental Protection Agency
LCSMC	Lake County Stormwater Management Commission
NB	Net Benefits
NCDC	National Climactic Data Center
NRCS	Natural Resource Conservation Service
NWI	National Wetland Inventory
O&M	Operation and Maintenance
PV	Present Value
PV_B	Present Value of Benefits
PV_C	Present Value of Costs
RAS	River Analysis System
SCS	Soil Conservation Service
UAA	User Attainability Analysis
UDV	Unit Day Value
UNET	Unsteady NETwork Model
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WPC	Watershed Planning Council

CHAPTER 6
WATERSHED PLANNING

6.1 Introduction

A standardized approach to watershed planning is required throughout Cook County to coordinate the District's efforts to implement its Cook County Stormwater Management Plan (CCSMP). Detailed Watershed Plans (DWPs) will be developed for all major watersheds and will serve as standardized documents to help guide the District as it develops a Capital Improvement Program (CIP). Previous planning efforts have been conducted by various organizations, and will be used in the development of DWPs where applicable. This chapter provides guidance for merging findings from previous flood remediation efforts in Cook County with new data and evaluations done to develop effective and consistent DWPs.

6.2 Status of Watershed Planning in Cook County

Local, state, and federal agencies have conducted comprehensive stormwater planning (Table 6.1) efforts as a part of their watershed planning programs for the following watersheds within Cook County: the North Branch of the Chicago River, Lower Des Plaines Tributaries, Calumet-Sag Channel, Little Calumet River, Poplar Creek and Upper Salt Creek. Where possible, previous planning information should be included and built upon in developing DWPs to take advantage of earlier efforts.

6.3 Planning Methodology

6.3.1 Organization of Detailed Watershed Plans

DWPs will serve as the supporting documentation to the District's Stormwater Management CIP. The watershed planning methodologies and standards described herein will be used to develop a DWP for each major watershed in Cook County. The objective is to supply the District with information on existing conditions, stormwater problems, alternative improvements considered to address stormwater problems, and other relevant information necessary to prioritize projects on a countywide level. Table 6.2 is a standard outline of the content to be provided within DWPs.

6.3.2 Data Collection and Review

The initial step in DWP development is the collection and review of existing data. Data that will be collected and reviewed include stormwater problem data, existing watershed studies and models, monitoring data, geographic information systems (GIS) data and other sources of useful watershed mapping.

6.3.3 Use of Existing Data for Detailed Watershed Studies

The DWP report will include a summary of existing watershed data and information. As a part of DWP development, the District will collect and review watershed data from member communities, Watershed Planning Councils (WPCs), applicable state and federal agencies, available complaint records, and other relevant watershed stakeholders. Relevant stormwater data will be compiled within the DWP report. The following subsections provide means of summarizing data regarding stormwater problems (detailed in Section 6.3.3.1) and available studies that have compiled some of the existing stormwater data (detailed in Section 6.3.3.2).

Table 6.1 Summary of Watershed Planning In Cook County

Agency	Description of Watershed Planning
Illinois Department of Natural Resources, Office of Water Resources (IDNR-OWR)	At the request of local governments, IDNR-OWR performs flood control studies to identify flooding problems, analyze alternative solutions, and determine the economic feasibility of those solutions. Plans developed by IDNR-OWR focus on structural flood control measures, but nonstructural flood mitigation alternatives are also examined. IDNR-OWR administers other funding assistance. It has a small-projects program that is often used to address local drainage problems and can fund flood related improvements up to $100,000. A less rigorous quantification of benefits is allowed under this program. Its flood mitigation program administers funds for the acquisition of flood-prone structures and flood mitigation planning. IDNR-OWR is involved in assisting FEMA with the map modernization for Cook County, as explained further in Section 2.5.1.
Illinois Environmental Protection Agency (IEPA)	IEPA collects water quality and biological data on streams and lakes throughout the state. The data are reported in the biannual *Illinois Water Quality Report,* which documents the level to which water bodies are supporting their designated uses (such as swimming, aquatic life). IEPA also maintains the Illinois Water Quality Management Plan, which offers recommendations for stormwater, soil erosion and sediment control, and stream and wetland best management practices (BMPs). IEPA also provides grants annually for implementation of nonpoint source control plans and demonstration projects. These projects can include BMPs to curtail urban runoff and also instream activities to reduce erosion, sedimentation, and degradation of water quality, as detailed in Section 319 of the Clean Water Act. On the preventive side, activities such as ordinance implementation and workshops on stormwater BMPs have been funded by IEPA. The IEPA Illinois Clean Lakes Program provides annual grants for lake remediation projects where there is a realistic opportunity for restoration and protection for high quality lakes. IEPA encourages a watershed approach in addressing lake remediation and protection.
Federal Emergency Management Agency (FEMA)	FEMA has several flood hazard mitigation funding programs, administered by the Illinois Emergency Management Agency (IEMA) and described in Section 2.5.8. Some FEMA regulatory floodplain maps for Cook County are inadequate. They do not include water surface elevations or they are out of date because of significant land use and other topographic changes. FEMA has initiated a Flood Insurance Rate Map (FIRM) Modernization Program, which compiles hydrologic and hydraulic (H&H) modeling data for selected map panels in Cook County. IDNR-OWR serves as a local sponsor for this project. The data will be included in a countywide modernization of floodplain maps.
Chicago Metropolitan Agency for Planning (CMAP)	CMAP has historically performed watershed planning, including the Area Wide Water Quality Management Plan developed for all the major watersheds in northeastern Illinois under Section 208 of the Clean Water Act. CMAP assists local governments in developing watershed planning. CMAP has produced a watershed inventory (http://www.nipc.org/environment/sustainable/water/watershed/) that includes a list of watershed plans from various sources and active watershed groups.
IDNR, State Water Survey (IDNR-SWS)	IDNR-SWS runs research centers that gather and maintain scientific data resources used in watershed planning. IDNR-SWS is also involved in planning activities for FEMA map modernization.
U.S. Army Corps of Engineers (USACE)	USACE administers a program for cost-sharing funding for the study, design, and construction of flood control projects. These projects generally are limited to structural flood control measures. If a reconnaissance level study shows that a project is likely to be cost-effective, USACE proceeds with a project analysis, which must be funded locally by 50% matching funds. For approved projects, USACE funds up to

Table 6.1 Summary of Watershed Planning In Cook County

Agency	Description of Watershed Planning
	65% of design and construction costs; the remaining costs are funded by a local or nonfederal sponsor. Sponsors must furnish all required lands, easements, rights-of-way and utility relocations, and also operate and maintain the completed project in perpetuity. Cost-sharing agreements must be negotiated individually with USACE on a project-by-project basis. USACE also provides design services for floodproofing of residences as part of an overall flood control project. This work and most USACE studies are performed with in-house staff.
U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS)	NRCS has planned, designed, and constructed flood control facilities to address overbank flooding in the Chicago metropolitan region with local sponsors, including the District. It also has performed floodplain management studies and updated floodplain mapping for local governments. In an effort partially funded by Section 319 of the Clean Water Act under the IEPA's direction, NRCS developed the *Illinois Urban Manual,* a technical reference for developers, planners, engineers, government officials and others involved in land use planning, building site development, and natural resource conservation. Applicable in rural, urban, and developing areas, the manual includes BMPs for soil erosion and sediment control, stormwater management, and special area protection. The manual was updated in 2002.
The District	The District designed and constructed the Tunnel And Reservoir Plan to address combined sewer overflow in the combined sewer areas of Cook County. The District has also been involved in many federal and state flood control projects, serving as the local sponsor or providing other forms of cost-sharing.
Municipalities and Townships	Most stormwater planning within a municipality is performed by the municipality itself or completed under its direction. Planning assistance on larger waterways may be initiated by state and federal agencies. Capital improvement projects that address local drainage problems are typically implemented by municipalities. Many communities within Cook County have ongoing stormwater planning efforts that could contribute to the development of DWPs.
Soil and Water Conservation Districts (SWCD)	Cook County has two Soil and Water Conservation Districts (SWCDs); the North Cook County Soil and Water Conservation District and the Will-South Cook Soil and Water Conservation District. The purpose of the SWCDs is to provide information, education and guidance on the conservation and wise use of natural resources.
Lake County Stormwater Management Commission (LCSMC)	SMC conducted a watershed assessment in conjunction with the Friends of the Chicago River. The watershed assessment pertains to the North Branch of the Chicago River within Cook County.
U.S. Geological Survey (USGS)	Through a cooperative program, in which the District participates, the USGS (Illinois Water Science Center) maintains a stream gauging network and publishes an annual report containing daily streamflow data and water quality information for selected sites around the state. The USGS administers funding for site-specific hydrologic and water quality data collection and analysis. Additionally, the USGS provides streamflow, stream elevations, and precipitation data in real-time at http://il.water.usgs.gov/nwis-w/IL/. Some mapping efforts may be fundable through the USGS. USGS funds up to 50% of a project's in-house labor and expenses. On this reimbursable basis, USGS provides technical assistance in developing watershed models and other hydrologic and water quality related assistance. In the past, the USGS has researched and completed studies on emerging technologies in the water resources field.
U.S. Environmental Protection Agency (USEPA)	USEPA provides grants for water quality related planning and demonstration projects under Section 319(h) and 104(b)(3) of the Clean Water Act, as discussed under IEPA's roles and resources in Section 2.5.7. USEPA routinely holds national conferences on stormwater-related topics.

Table 6.2 DWP Standard Outline

1. Executive Summary
2. Introduction
    - 2.1 Scope and Approach
    - 2.2 Goals and Objectives
    - 2.3 Jurisdictional Responsibilities
    - 2.4 Organization of Detailed Watershed Study
    - 2.5 Summary of Problem Areas
    - 2.6 Coordination with Watershed Planning Councils
3. Watershed Characteristics
    - 3.1 General Watershed Description
    - 3.2 Sources of Data
        - 3.2.1 Previous Studies
        - 3.2.2 Floodplain Mapping
        - 3.2.3 Wetland and Riparian Areas Data
            - 3.2.3.1 Wetland Areas
            - 3.2.3.2 Riparian Areas
        - 3.2.4 Water Quality Data
            - 3.2.4.1 Monitoring Data
            - 3.2.4.2 National Pollutant Discharge Elimination System (NPDES) Permits
            - 3.2.4.3 Impaired Waterways
            - 3.2.4.4 Nonpoint-Source Pollution
            - 3.2.4.5 Total Maximum Daily Load (TMDLs)
        - 3.2.5 Stormwater Problem Data
            - 3.2.5.1 Problem Data
            - 3.2.5.2 Watershed Planning Council Coordination
        - 3.2.6 Watershed Analysis Data
            - 3.2.6.1 Monitoring Data
            - 3.2.6.2 Sub-watershed Delineation
            - 3.2.6.3 Drainage Network
            - 3.2.6.4 Topography and Benchmarks
            - 3.2.6.5 Soil Classifications
            - 3.2.6.6 Land use
            - 3.2.6.7 Anticipated Development
        - 3.2.7 Model Selection
4. Watershed Analysis
    - 4.1 Hydrologic Model Development
        - 4.1.1 Sub-area Delineation
        - 4.1.2 Hydrologic Parameter Measurements and Calibration
        - 4.1.3 Model Setup and Unit Numbering
    - 4.2 Hydraulic Model Development
        - 4.2.1 Field Data, Investigation and Existing Modeling Data
        - 4.2.2 Physical Modeling Assumptions and Computational Settings
        - 4.2.3 Model Setup and Unit Numbering
    - 4.3 Calibration and Verification
        - 4.3.1 Gauge Data
        - 4.3.2 Modifications to Model Input Data
        - 4.3.3 Calibration Results
    - 4.4 Existing Conditions Evaluation
        - 4.4.1 Floodplain Delineation
        - 4.4.2 Hydraulic Profiles

Table 6.2 DWP Standard Outline

	4.5	Future Conditions Evaluation	
5.	Development and Evaluation of Alternatives		
	5.1	Problem Definition and Damage Assessment	
		5.1.1	Flood Damage Curves
		5.1.2	Erosion Damage Curves
	5.2	Technology Screening	
	5.3	Alternative Development	
		5.3.1	Flood Control Alternatives
		5.3.2	Erosion Control Alternatives
		5.3.3	Water Quality Improvement Alternatives
		5.3.4	Natural Resources and Environment Improvement Alternatives
		5.3.5	Alternative Cost Development Data
	5.4	Alternative Evaluation and Selection	
		5.4.1	Data Required for Countywide Prioritization of Watershed Projects
6.	Action Plan		
	6.1	Recommended Improvements	
	6.2	Implementation Plan	
7.	Summary and Conclusions		

6.3.3.1 Stormwater Problem Data

DWPs will include a comprehensive summary of stormwater problem data within a standardized table. Table 6.3 summarizes the typical fields required within the DWP watershed problem summary table. The watershed problem summary table will include relevant stormwater problem data compiled as part of DWP development, and recommendations on the use of stormwater problem data. Table 6.4 provides descriptions of standard problem categories to be used as a part of the watershed problem summary table. Additional problem categories may arise and will be considered by the District as necessary during the watershed planning process, however problem categories will generally be consistent with those listed in Table 6.4.

Table 6.3 Structure of Watershed Problem Summary Table for DWPs

Table Field	Description
Problem Category	*Refer to Table 6.4 for list of categories.*
Source of Information	Sources of problem information such as member communities, published reports, state and federal agencies, watershed stakeholders, complaints.
Date	Date upon which data were compiled or published.
Project Planned or Underway	In some cases, efforts are planned or underway to address the problem. Identify this in the table as a consideration on the path forward.
Resolution or Action Required	Describe how the data will be acted upon. Describe resolution or planned resolution of problem.

Table 6.4 Problem Category Description

Problem Category	Description
Intercommunity (regional) flooding	Flooding problems that affect more than one community.
Intracommunity (local) flooding	Flooding problems within a community that affect only part of a single community.
Streambank erosion on inter-community waterways	Streambank erosion along regional waterways that threatens a structure or human health and safety.
Streambank erosion on intra-community (local) waterways	Streambank erosion along local waterways that threatens a structure or human health and safety.
Stream maintenance problems	Debris jams, system failure, restrictions on waterways, etc.
Water quality problems	Observed water quality problems such as odor, spill-related pollution, aesthetically objectionable debris (such as toilet waste), etc.
Environmental degradation issues	Wetland or riparian impacts observed by watershed stakeholders.

6.3.3.2 Existing Watershed Studies

Several local, state, and federal agencies have completed watershed studies and modeling for watersheds within Cook County. Studies and the models used to support them may contain data useful to the development of DWPs. Table 6.5 summarizes some known watershed studies developed by agencies such as IDNR-OWR, USACE, IEPA, or the Illinois Department of Transportation (IDOT). These studies and others will be reviewed as a part of DWP development.

Watershed modeling has been performed for many of the studies listed in Table 6.5. The models may be useful for the development of DWPs or other watershed planning activities to be coordinated by watershed stakeholder groups. Table 6.6 summarizes some of the existing models that were identified for watersheds within Cook County.

IDNR-OWR and IDNR-SWS personnel have identified several other models that have been developed for Cook County watersheds. Many of the models include data that are not fully documented to allow for a complete evaluation of their applicability to DWP development. As a part of developing each DWP, the District will review and discuss the usefulness of existing watershed models for supporting the definition of problem areas, the development and evaluation of improvement projects and possible floodplain mapping revisions. Table 6.7 lists key criteria to be considered in defining the scope of DWP modeling activities.

Table 6.5 Existing Watershed Studies Identified

Watershed	Subwatershed	Title of Study	Agencies	Date	Summary
Calumet-Sag	Stony Creek	Stony Creek, Oak Lawn, Illinois Detailed Project Report	USACE	October 2001	Completed USACE's planning process for a project to reduce overbank flooding along Stony Creek in Oak Lawn. The recommended plan consists of flow diversion, removal of a small weir, and channel clearing downstream.
Calumet-Sag	(Report addresses tributaries)	Calumet-Sag Watershed Floodwater Management Plan Environmental Assessment	The District, NRCS, IDOT (Division of Water Resources)	June 1979	The study estimates floodwater damage in the watershed due to urbanization. It addresses erosion problems, lack of open space and recreational facilities, wetlands, and channel maintenance. Although somewhat dated, the report may be most useful in providing relevant background information.
Chicago River	Chicago River and Waterway System	Draft Use Attainability Analysis (UAA)	IEPA	November 2004	The UAA will help the IEPA understand the changing circumstances of the Chicago River and Waterway System in order to better set water quality standards for the system.
Des Plaines River	Upper Des Plaines River	Final Feasibility Report and Environmental Impact Statement	USACE	June 1999	Evaluated feasibility of, and federal interest in, implementation of a flood damage reduction plan for the Upper Des Plaines watershed located within Lake and Cook Counties. Recommended a plan consisting of the construction of two levee units, expansion of two reservoirs, construction of one lateral storage area, and modification of one earthen dam to add flood storage.
Des Plaines River	Salt Creek TMDLs	Total Maximum Daily Loads for Salt Creek, Illinois	IEPA	October 2004	Describes methods and procedures used to develop chloride and dissolved oxygen TMDLs for Salt Creek. The focus of the report is on water quality, but it contains rainfall, hydrologic, hydraulic, and stream flow information. Salt Creek and its watershed span both Cook and DuPage counties.
Des Plaines River	Farmers/Prairie Creek	Farmers/Prairie Creek Preliminary Strategic Planning Study	IDNR-OWR	October 2005	Studied alternatives for relieving flooding on Farmers/Prairie Creek, a tributary to the Des Plaines River with a watershed in areas of Des Plaines, Park Ridge, Niles, Glenview, and unincorporated Maine Township.
Des Plaines River	Addison Creek	Addison Creek Flood Control Study	IDOT (Division of Water Resources)	1993	Studied existing conditions and alternatives for relieving flooding on Addison Creek, a tributary of Lower Salt Creek. The affected area for the study includes Bellwood, Bensenville, Broadview, Elmhurst, Hillside, Maywood, Melrose Park, North Lake, North Riverside, Stone Park, and Westchester.

Table 6.5 Existing Watershed Studies Identified

Watershed	Subwatershed	Title of Study	Agencies	Date	Summary
Des Plaines River	(Report addresses tributaries)	Des Plaines River Watershed Floodwater Management Plan Environmental Assessment	The District, NRCS, IDOT (Division of Water Resources)	January 1976	The purpose of the study was to reduce flood damage, reduce erosion and sedimentation, protect wildlife habitat, improve water quality, enhance fisheries, provide additional recreation sites and open space. The study includes Lower Salt Creek, located primarily in DuPage County. Recommended flood control facilities, some of which have since been built, are described, as are anticipated impacts. The report contains useful background information.
Little Calumet River	(Report addresses tributaries)	Little Calumet River Watershed Floodwater Management Plan and Environmental Assessment	The District, NRCS, U.S. Forest Service, Illinois Department of Conservation	May 1975	The purpose of the study was to reduce flood damages, provide increased water based recreation, and provide watershed protection and environmental enhancement. Background information may be useful.
Little Calumet River	(Report addresses tributaries)	Little Calumet River Watershed Plan and Environmental Impact Statement	The District, Will-South Cook SWCD, Calumet-Union Drainage District (CUDD), Cook County Board of Commissioners, Villages, Park Districts, IDNR-OWR, NRCS, U.S. Forest Service	November 1978	This study was developed to achieve goals similar to those of the May 1975 study. Planned projects and their impacts are described. Some of the projects have been implemented. Discussion of project impacts is included. Background information is potentially useful.
Lower Des Plaines Tributaries	(Report addresses tributaries)	Lower Des Plaines Tributaries Final Watershed Plan – EIS	The District, SWCDs, NRCS, U.S. Forest Service, Municipalities	September 1987	The purpose of the study was to solve flooding and associated erosion and sedimentation problems, and to address the shortage of water-based recreation. Structural and nonstructural improvement measures are recommended, several of which have been built. Background information may be useful.
North Branch Chicago River	(Report addresses tributaries)	North Branch Chicago River Floodwater Management Plan	The District, NRCS, IDNR-OWR	October 1974	The purpose of the study was to reduce flood damages, provide increased recreational uses, and provide watershed protection and environmental enhancement. The southern limit of the study is Touhy Ave. Alternatives are suggested, including construction of flood control reservoirs that have now been built. The report may be most useful in providing relevant background information.

Table 6.5 Existing Watershed Studies Identified

Watershed	Subwatershed	Title of Study	Agencies	Date	Summary
North Branch Chicago River	(Report addresses tributaries)	North Branch Chicago River Open Space (Green Infrastructure) Plan	LCSMC, Friends of the Chicago River, IDNR-OWR	June 2005	Identifies high quality natural resources recommended for preservation, and open lands suitable for watershed improvement projects. Study is based on analysis of individual parcels. Includes listing of funding sources for land preservation and restoration.
Poplar Creek	(Report addresses tributaries)	Poplar Creek Watershed Floodwater Management Plan Environmental Assessment	The District, NRCS, IDOT (Division of Water Resources)	May 1976	The study estimates floodwater damage in the watershed due to urbanization. It addresses erosion problems, lack of open space and recreational facilities, wetlands, and channel maintenance. Some flood control measures are recommended. Although somewhat dated, the report may be most useful in providing relevant background information.
Upper Salt Creek	(Report addresses tributaries)	Upper Salt Creek Watershed Floodwater Management Plan	The District, North Cook SWCD, Forest Preserve District of Cook County, Villages, Park Districts, IDOT (Division of Water Resources)	May 1973	The purpose of the study was to reduce flood damages and create water related recreation facilities. Five flood control facilities, one multipurpose facility, and channel improvements were recommended and have been implemented. The report contains useful background information.

Table 6.6 Existing Modeling Data For Watersheds Within Cook County

Watershed	Subwatershed	Model Description
Chicago River	Chicago River and Chicago Waterway System	Unsteady flow and water quality model of entire 76-mile navigable waterway system, developed by Marquette University. More information is available at http://www.chicagoareawaterways.org/ Unsteady NETwork Model (UNET) and Hydrologic Simulation Program-Fortran (HSPF) model developed by the USACE.
Des Plaines River	Des Plaines River	Hydrologic Engineering Center-1 (HEC) and HEC-River Analysis System (RAS)
Des Plaines River	Farmers/Prairie Creek	HEC-1 and HEC-RAS
Chicago River	North Branch	HEC-1 and HEC-2
Chicago River	Middle Fork and West Fork	HEC-1 and HEC-2
Little Calumet River	Little Calumet River	HEC-1 and Unsteady-RAS; Illinois Department of Natural Resources-State Water Survey (IDNR-SWS) is updating
Little Calumet River	Stony Creek	HEC-1 and UNET

Table 6.7 Existing Model Use Criteria for DWPs

Category	Criteria for Use in DWPs
Date developed	Model must have been developed reflecting current conditions or have been updated to reflect current conditions unless otherwise accepted by the District to be used for DWPs.
Regulatory acceptance	Model must be the current regulatory model for watershed or otherwise accepted by the District to be used as a part of DWPs.
Data development requirements	Documentation of H&H model data are available and show that the data were developed to be consistent with District and IDNR-OWR minimum standards.
Calibration requirements	Must have been calibrated to a network of rainfall and stream monitoring gauges. Calibration must be documented and show that minimum District standards were met. Alternatively, radar derived precipitation could be used as approved by the District. Exceptions to the calibration requirement must be approved by the District.
Consistency with District modeling application requirements	Must have been developed using a modeling application that meets the District's minimum requirements, or is otherwise approved by the District.

Existing Monitoring Data. Rainfall, stream flow (and stage), and water quality data are available for all the major watersheds within Cook County. Some of the data may be used to support DWP modeling evaluations. Table 6.8 summarizes sources of existing monitoring data. In addition to the data listed, the District collects monitoring data that will be reviewed and utilized as appropriate as a part of DWP development.

Descriptions of USGS stream flowmeters and National Climactic Data Center (NCDC) rain gauge data are provided in Appendixes C and D, respectively.

Geographic Information Systems Data. Several sources of GIS data exist and are available to support watershed planning activities that will occur as a part of DWP development. One primary source of GIS data is Cook County. GIS data from Cook County will be obtained and used as appropriate as a part of DWP development. Section 6.4 identifies several Cook County GIS data sets to be used in DWP development.

Table 6.8 Sources of Existing Monitoring Data

Data	Owning Agency	Description
USGS Stream Flow Data	USGS	USGS stream flow data are available at http://waterdata.usgs.gov/nwis/sw. Appendix C contains a comprehensive list of gauge locations.
IDNR-OWR Stage Data	IDNR-OWR	The IDNR-OWR maintains a network of stage gauges that may have data useful for model calibration.
Rain Gauge Data	IDNR-SWS, NCDC, and USGS	The Cook County Precipitation Network is a dense rain gauge network that the IDNR-SWS has operated in Cook County since the fall of 1989 to provide accurate precipitation data for use in simulating runoff for Lake Michigan diversion accounting. The network consists of 25 rain gauges throughout Cook County, approximately every 5 to 7 miles and representative of the various watersheds within the county. The data are available in digital format at hourly increments from 1989 through 2000, and at 10-minute increments from 2001 to the present. There are 74 locations of rainfall gauges for which data are available within Cook County through the NCDC. Some gauges are no longer active, but past data are available. The time increments of the data vary from gauge to gauge. Table B-1 in Appendix D lists all gauges and information related to the type of data available. Information about obtaining data from all these gauges and associated fees can be found at the NCDC website: http://www.ncdc.noaa.gov. The USGS operates and publishes data from approximately 42 rain gauges in northeastern Illinois, of which 6 are located in Cook County. This data, almost all available in real-time, together with data from other agency rain gauges can be found at http://il.waterdata.usgs.gov/nwis/current/?type=precip&group-key=NONE.
Water Quality Monitoring Data	IEPA	Available from the IEPA Ambient Water Quality Monitoring Network of 213 monitoring sites. More information is available at: http://www.epa.state.il.us/water/surface-water/river-stream-mon.html

6.4 Watershed Data Development

New data developed for DWPs must meet the District standards and specifications described in Table 6.9.

Table 6.9 Watershed Data Development Standards And Specifications

Data Type	Standards Documentation	Summary
GIS Data	District GIS Data Development Standards	Data developed to support DWPs will be consistent with latest available District GIS Standards and Specifications.
Survey Data	District Vertical Datum	Survey data will be developed using the NAD 1983 coordinate system with the Chicago City Datum (CCD) for vertical coordinates (579.48 feet above 1925 mean sea level). DWPs will contain a survey standards document subject to District review prior to initiating any field surveys. If necessary, the District may allow changes to these standards in order to be consistent with unique conditions in watersheds such as those that have upstream or downstream boundary condition models that have been developed in a different coordinate system.
Survey Data	FEMA Guidelines	Survey standards will be consistent with FEMA's *Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix A, "Guidance for Aerial Mapping and Surveying*," available at WWW.FEMA.GOV/FHM/DL_CGS.SHTML
DWP Data	Cook County Stormwater Management Plan	All data developed to support DWPs will be consistent with standards provided as a part of this document, or other scoping documents provided by the District.

6.4.1 Watershed Analysis and Floodplain Mapping

The District has developed the following goals for watershed analysis and floodplain mapping that will be applied to the development of DWPs. It is understood that meeting some of these goals may not be possible as a part of DWP development. These goals will be considered and applied wherever the District deems applicable:

- H&H analyses must be consistent with IDNR-OWR and FEMA map revision requirements.
- Hydrology for watershed plans will be determined by a hydrologic model that, where necessary, considers online and offline storage, infiltration, interflow, depressional storage, overland flow, nonuniform rainfall distribution, evapotranspiration, and soil moisture. The output from the hydrologic model must be compatible with the hydraulic model.
- Hydrologic analyses may require cooperative plans for water bodies that cross the District's corporate boundaries, such as the North Branch Chicago River, Little Calumet River, Des Plaines River, Poplar Creek, and Upper Salt Creek.
- Hydraulic conditions for the major watershed plans will be determined by a model that can, at a minimum, analyze the effects of floodplain encroachment, online and offline storage, diversions, channel improvements, bridges, culverts, dams, weirs, and other impediments to flow. The input to the hydraulic model will be compatible with the output from the hydrologic model. Fully dynamic models will be used when channel conditions are extremely flat (for example, slope is less than 5 feet per 1,000) and subject to backwater conditions that make it difficult to approximate storage accurately.

6.4.2 Watershed Modeling

The object of a DWP is to support the development and documentation of a countywide CIP. Understanding stormwater problems and evaluating scenarios to correct them requires the use of models and other watershed analysis tools. The following includes standards for application selection, data development, and calibration of H&H models.

Several steps are involved in applying models to the development of DWPs. First, a model of existing conditions is developed to support calibration and an understanding of existing problems. Second, a baseline conditions model is developed to reflect the conditions expected to be current when the District begins to implement the countywide CIP. This may include modifications to the existing conditions model that reflect projects that are under way and near completion. Finally, the model is modified to evaluate the effectiveness of alternative improvement projects. The guidance provided in Section 6.4.2 applies to all these steps.

6.4.2.1 Screening Considerations

Several H&H modeling applications in the public and private domain are accepted by FEMA and IDNR-OWR to determine floodplain and floodway areas for the National Flood Insurance Program. The applications are summarized in Tables 6.10 and 6.11. Table 6.12 summarizes considerations in the selection of H&H modeling applications. For DWPs, the District will specify the most appropriate H&H modeling application based on the considerations listed in Table 6.12 and specific watershed modeling requirements. In some cases, it may be acceptable to use two or more separate H&H modeling applications within the same DWP.

6.4.2.2 Hydrologic Model Data Development

Hydrologic model data developed as a part of a DWP will be consistent with minimum District standards. District standards have been developed to be consistent with the countywide stormwater management program needs and wherever possible with IDNR-OWR preferences.

Subarea Delineations. Subarea Delineations will be performed using the best available topographic mapping to a level necessary to accurately simulate hydrologic conditions within the watershed. The best available topographic data are those developed by Cook County. Cook County GIS photogrammetry data includes a digital, geospatial GIS file that depicts (through the use of a digital terrain model (DTM), and modeled by a triangulated irregular network) a general surface description for Cook County with a 300-foot buffer beyond the county boundary. The data have been made available to the District and will be used to support Subarea Delineations.

Table 6.10 Hydrologic Models Accepted by FEMA for the National Flood Insurance Program

Type	Program	Developer	Public Domain?
Single event	HEC-1 4.0.1 and upa (May 1991)	USACE	Yes
	HEC-HMS 1.1 and up (March 1998)	USACE	Yes
	MIKE 11 UHM	DHI Water and Environment	No
	PondPack v.8	Haestad Methods, Inc.	No
	SWMM (RUNOFF) 4.30 (May 1994), and 4.31 (January 1997)	USEPA and Oregon State University	Yes

Table 6.10 Hydrologic Models Accepted by FEMA for the National Flood Insurance Program

Type	Program	Developer	Public Domain?
	SWMM 5 Version 5.0.005 (May 2005)	USEPA	Yes
	TR-20 (February 1992)	USDA NRCS	Yes
	TR-20 Win 1.00.002 (Jan. 2005)	USDA NRCS	Yes
	TR-55 (June 1986)	USDA NRCS	Yes
	WinTR-55 1.0.08, (Jan. 2005)	USDA NRCS	Yes
	XP-SWMM 8.52 and up	XP Software	No
Continuous event	DR3M	USGS	Yes
	HSPF 10.10 and up	USEPA, USGS	Yes
	MIKE 11 RR	DHI Water and Environment	No
	PRMS Version 2.1	USGS	Yes
Interior drainage	HEC-IFH 1.03 and up	USACE	Yes

[a]Enhancement of these programs in editing and graphical presentation can be obtained from several private companies.

Note: FEMA periodically updates its list of approved hydrologic models.

Table 6.11 Hydraulic Modeling Applications Accepted by FEMA for the National Flood Insurance Program

Type	Program	Developer	Public Domain?
One-dimensional steady flow models	Culvert Master v.2.0	Haestad Methods, Inc.	No
	HEC-2 4.6.2a(May 1991)	USACE	Yes
	HEC-RAS 3.1.1 and up	USACE	Yes
	HY8 4.1 and up (November 1992)	U.S. Department of Transportation, Federal Highway Administration	Yes
	PondPack v.8	Haestad Methods, Inc.	No
	QUICK-2 1.0 and up (January 1995)	FEMA	Yes
	StormCAD v.4 and v.5	Haestad Methods, Inc.	No
	WSPGW 12.96 (October 2000)	Los Angeles Flood Control District and Joseph E. Bonadiman & Associates, Inc.	No
	WSPRO (June 1988 and up)	USGS, Federal Highway Administration	Yes
	XP-SWMM 8.52 and up	XP Software	No

Table 6.11 Hydraulic Modeling Applications Accepted by FEMA for the National Flood Insurance Program

Type	Program	Developer	Public Domain?
One-dimensional unsteady flow models	FEQ 9.98 and FEQUTL 5.46 (2005, both), FEQ 8.92 and FEQUTL 4.68 (1999, both)	Delbert D. Franz of Linsley, Kraeger Associates; and Charles S. Melching, USGS	Yes
	FLDWAV (November 1998)	National Weather Service	Yes
	FLO-2D v. 2003.6 (July 2003) and 2004.10 (November 2004)	Jimmy S. O'Brien	No
	HEC-RAS 3.1.1 and up	USACE	Yes
	ICPR 2.20 (October 2000) and 3.02 (November 2002)	Streamline Technologies, Inc.	No
	MIKE 11 HD	DHI Water and Environment	No
	Storm Water Management Model (SWMM) 4.30 and 4.31	USEPA and Oregon State University	Yes
	SWMM 5.0.005 (May 2005)	USEPA	Yes
	UNET 4.0	USACE	Yes
	XP-SWMM 8.52 and up	XP Software	No
Two-dimensional steady/unsteady flow models	FESWMS 2DH 1.1 and up	USGS	Yes
	FLO-2D v. 2003.6 (July 2003) and 2004.10 (November 2004)	Jimmy S. O'Brien	No
	MIKE Flood HD 2002 D and 2004	DHI Water and Environment	No
	TABS RMA2 v.4.3 RMA4 v4.5	USACE	Yes
Floodway analysis	PSUPRO	Pennsylvania State University/USACE/FEMA	Yes
	SFD	USACE/FEMA	Yes

[a] Enhancement of these programs in editing and graphical presentation can be obtained from several private companies.

Note: FEMA periodically updates its list of approved hydraulic models.

Table 6.12 H&H Modeling Application Selection Considerations

Consideration	Description
Familiarity to regulatory community	FEMA requirements for modeling to support regulatory floodplain mapping do not exclude the use of many models, but it is clear that many are more acceptable to regulatory review staff than others. The familiarity of regulatory staff at IDNR-OWR and FEMA will be considered as a part of specific H&H modeling application selection.
User base for consistent type of projects	It is common for modelers to look to a broader community of users for advice and support as a part of modeling projects. For example, a SWMM users' e-mail group is commonly used to troubleshoot problems with the application and draw upon the experience of a broad group of users. SWMM users commonly are focused on the application of SWMM to sewer system evaluations. Similar user groups exist for Hydrologic Engineering Center (HEC) modeling applications. Local, regional, and national training seminars and conferences focus on some applications more than others. The existence of an active user base will be considered in the selection of a modeling application.
History of use on floodplain mapping projects	This will be considered as part of the modeling application selection to project ease of permitting for any regulatory activities. The use of an application for projects similar to those faced by the District likely will lead to tools and support programs developed by others that will benefit the District. HEC is the most commonly used national tool for supporting flood control programs similar to the District.
Number of options for simulating open channel hydraulics	Having several options for modeling open channel hydraulics allows for a more accurate representation of field conditions. HEC applications have extensive bridge and culvert crossing options that allow users to develop confidence in results through the application of alternative hydraulic simulation approaches.
Consistency with data developed for existing regulatory models	It may be important to integrate new modeling with existing models. The ability of model output to be used between models may be important. Conversations with IDNR-OWR and experience in the area confirms that HEC software is the most commonly applied modeling application for flood control projects and regulatory floodplain mapping. This is an important consideration in the selection of any modeling application for the District's Stormwater Management Program.
Ability to perform fully dynamic unsteady flow analysis	This may be an important feature that could affect the model results and magnitude of flood control projects identified as a part of this program. Because of the flat terrain of Cook County and surrounding areas, the regulatory floodplains and floodways contain significant storage volumes. Traditional modeling applications use approaches that simulate this storage in a simplified and typically conservative manner. Fully dynamic unsteady flow modeling applications allow for a more explicit simulation of this storage that often leads to results showing more accurate lower floodway elevations.
Availability of vendor provided proprietary interface applications that enhance usability of product	Some models include proprietary modules to increase the functionality of the model. This may be useful as modeling exercises become more complex.
GIS interface capabilities	An important component of watershed modeling will be to integrate the application with GIS software. Most modeling applications listed in Tables 6.10 and 6.11 have GIS interfaces that have been developed to support data development and visualization.

Subarea boundaries will be developed as closed polygons with attribute data that at a minimum include their watershed designation, model name, total area and source of data used for delineation and any other fields specified by the District. Subarea delineation data will be in a format compatible with the District's stormwater GIS. The overall watershed delineation developed as a part of DWPs will be used as the District's official watershed delineation for administrative as well as technical purposes.

Rainfall Data. Observed and design event rainfall data may be used to support H&H modeling performed as a part of a DWP. Observed rainfall data are used as a part of hydrologic model data calibration. Two approaches are typically used to define observed rainfall data. These are the use of rain gauge data or rainfall data developed using radar technology. Both approaches are acceptable and will be used where appropriate as a part of DWPs developed by the District. Table 6.13 specifies how observed rainfall data will be used. Design event rainfall data are used to define flood damages, evaluate alternative improvement projects, and recommend capital improvements. Observed and design event rainfall data developed and used as a part of a DWP will be organized in a database format. Fields required in the table where rainfall data are stored will include year, month, day, hour, minute, and depth (inches).

GIS applications will be used to determine influence areas for rainfall data. For rain gauges, GIS applications will be used to develop Theissen polygon areas that can be intersected with subarea delineations to assign rainfall data for hydrologic modeling. Theissen polygon areas will be created in a GIS format consistent with District standards. If radar derived rainfall data are used, influence areas of rainfall data sets will be provided to the District in a GIS format consistent with District standards.

Table 6.13 Observed Rainfall Data Utilization Criteria

Source of Observed Rainfall Data	Criteria for Application
Rain gauges	Rain gauges that log rainfall data on a 10- to 15-minute increment will be used to support hydrologic model data calibration during storms where spatial distribution of rainfall appears to be adequately captured by the rain gauge network in place. The Cook County Precipitation Network operated by IDNR-SWS records data at 10-minute increments at 25 rain gauges (see Table 6.8). Research was developed to determine the appropriate minimum spacing and coverage requirements, which determined the locations of the rain gauges.
Radar-derived rainfall data	Radar derived rainfall data may be used in large watersheds where the rain gauge network in place is unlikely to sufficiently define the spatial distribution of rainfall occurring over the watershed. The District will review the existing and proposed rain gauge network and historic spatial rainfall distribution patterns to provide justification for the use of radar derived rainfall data.

Design Event Rainfall Data. Design event rainfall data are used as a part of the H&H modeling that is performed to support the identification of flooding problem areas, flood damage curves and the development and evaluation of alternative improvement projects. The standard source of rainfall depth and distribution data for H&H model evaluations will be the sectional frequency distribution of rainfall for given recurrence intervals as listed in Bulletin 70 or Bulletin 71 with Huff Distribution or the data most recently adopted by IDNR-OWR for use in hydrologic modeling. Bulletin 71 provides guidance on which Huff distribution will be used (1st, 2nd, 3rd, or 4th quartiles) with storms of various durations.

To determine the critical or most extreme duration storm for each recurrence interval storm considered as a part of DWP development, a critical duration analysis will be conducted. To be consistent with IDNR-OWR requirements, the critical duration analysis must include at least the simulations of 1-, 3-, 6-, 12- and 24-hour duration storms.

Infiltration Rates and Capacities. The most common method used to determine loss rates and runoff volumes in Cook County has been the Soil Conservation Service (SCS) Curve Number method. The method is acceptable for the hydrologic modeling that is performed as part of a DWP. Other methods may be used when appropriate at the discretion of the District. When using the SCS Curve Number method, the modeler will follow guidance contained in Urban Hydrology for Small Watersheds (USDA NRCS, TR-55, June 1986) or as approved by the District.

Runoff and Overland Flow Parameters (Existing and Future). Impervious area coverage, aerial photography, topographic mapping, soils groups mapping and other soils data, land use mapping, and other land use data all will be used to determine watershed areas, flow paths, slopes, lengths, time of concentration, and any other parameters necessary to support developing stormwater runoff hydrographs consistent with the guidance within USDA NRCS TR-55 or as approved by the District.

Unit Hydrograph/Routing. Unit hydrographs acceptable for routing runoff include SCS dimensionless, Clark, or Snyder. A user-specified unit hydrograph may be used for a watershed if enough quality data are available for it to be properly derived from observed rainfall and runoff.

6.4.2.3 Hydraulic Model Data Development

Channel Cross Section Data. Channel cross sections used within hydraulic modeling applications will be obtained through field surveys that meet survey standards described in Table 6.9. Field survey efforts will include the determination of the appropriate Manning's roughness parameters based on observations of characteristics that include surface roughness, vegetation, channel size, channel shape, channel alignment, and obstructions. If observed water surface profile information is available in the form of gauge data, calibration of Manning's "n" values is possible and desirable.

Open Channel Hydraulics by V. T. Chow (McGraw-Hill 1959; reissued 1988) contains excellent guidance for determining Manning's "n" values for a wide range of rivers and streams. The USGS Illinois Water Science Center has computed Manning's "n" values at many representative urban and rural sites in Illinois, available at http://il.water.usgs.gov/proj/nvalues/. Figure E-1 in Appendix E is an example of the type of form to be used to document Manning's "n" values in the field. Separate Manning's "n" values are generally appropriate to be used for the channel and the overbanks. The typical channel cross section template form in Figure E-2 in Appendix E is an example of the type of form that will be used to gather cross-sectional data during a survey.

Bridge and Culvert Crossings. Bridges and culverts generally will be modeled as existing. For the baseline conditions model, bridge or culvert replacement projects that are under construction or in the late stages of the planning process and unlikely to be revised may be modeled as proposed. The model must account for bridge deck, piers, abutments, and embankment side slopes.

Storage Areas. Storage areas that are simulated as a part of hydraulic modeling will be represented with stage-area or stage-volume relationships developed from best available topographic information and discharge rating curves developed according to hydraulic properties of the controlling device.

Downstream Boundary Conditions. Downstream boundary conditions for hydraulic analysis will be based on known water surface elevations when available. If the water surface elevation is unknown at the downstream end of the study reach, normal depth will be used at a location further downstream so as not to have influence on the profile. To test whether the starting cross section is sufficiently downstream for a given discharge, the distance is varied until the water elevation at the project boundary does not change appreciably, which indicates that the profile will not be affected by the starting elevation.

6.4.2.4 Steady State vs. Unsteady Flow Analysis
If there is reason to believe that a steady-state model would inadequately represent actual hydraulic conditions, such as extremely flat slopes (Froude number < 0.1) or flow restrictions that may cause significant storage within the channel or situations with reverse flow, then unsteady-state modeling will be considered and used where necessary.

6.4.2.5 Critical Duration Storm Analysis
A critical duration storm analysis (CDSA) will be performed and documented as a part of design event simulations performed to develop flood damage curves. A CDSA is performed for each problem area to identify the duration storm that produces the critical water surface elevation and level of damage. CDSA involves running a range of duration storm events for a given recurrence interval to determine which duration storm is critical. Generally, this duration is somewhere near the time of concentration of the watershed tributary to a given point. The IDNR-OWR generally requires a CDSA as a part of the regulatory map revision process.

6.4.2.6 Model Calibration and Verification
Calibration must be performed in developing defensible H&H models representative of actual conditions. High water marks, historic floods, or other stream gauge data will be used to compare with model results and adjust model parameters, typically the roughness coefficients. The final calibrated model must not contain model parameters outside their "reasonable" bounds, although it may be permitted when performing model sensitivity analyses. If enough data exist, the model will be validated by comparing calibrated model results to a set of data that was not included in the calibration.

H&H model data will be calibrated to a point where the runoff volume and stream flow rates are within roughly 30 percent of the data recorded at stream gauges. Water surface elevations will match within 6 inches. In some cases, where rain gauge data are used to support calibration, it is not possible to adjust H&H model data with confidence when the spatial distribution of rainfall appears to be inadequately captured and reflected in the model.

6.4.3 Floodplain Mapping
To ensure that H&H modeling performed as a part of a DWP can be utilized for future FEMA FIRM remapping efforts, the District will require that all modeling performed be consistent with current IDNR-OWR and FEMA standards. Both agencies have published standards that will be followed: *Floodplain Map Revision Manual* (March 1996) published by IDNR-OWR and *Guidelines and Specifications for Flood Hazard Mapping Partners* published by FEMA, available at http://www.fema.gov/fhm/gs_main.shtm. It is not a specific goal of the DWPs to replace or revise the current FEMA FIRM maps. However, if a substantial error in

the current regulatory maps is identified during a DWP, the District may consider requesting a map revision from FEMA. As the CIP progresses, a decision will be made as to whether the District or the benefiting local government entity will pursue map revisions necessary to reflect the implementation of future flood control projects.

6.5 Problem Area Identification

Stormwater problem areas will be identified through stakeholder involvement, such as WPC meetings, discussion with other agencies, and logs of complaints. They will also be identified and confirmed as a part of the DWP. DWP reports will summarize relevant and known stormwater problem areas and also watershed analyses to confirm the magnitude of flooding problems.

6.5.1 Flooding Problem Areas

Flooding problems are defined as flooding of residential, commercial, industrial and public buildings, or transportation facilities that are critical to the economy and emergency services. H&H models will be the primary method for evaluating flooding problem areas. H&H models will be used to define water surface elevations for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms. These elevations will be compared with top of foundation and first floor elevations for properties within the floodplain to develop flood damage curves. The methodology for developing flood damage curves and data required to support them are described in Section 6.6.

In some instances flooding may result from non-riverine sources, such as depressions in the ground surface that are inundated by the water table. The majority of such depressional flooding instances are expected to be confined to a single community, and therefore will not be addressed in a DWP. However, cases where depressional inundation results in inter-community flooding will be addressed with the DWP, in conjunction with the District, on a case by case basis.

6.5.2 Erosion Problem Areas

Erosion problems are defined as streambank erosion along waterways that could result in property damage or a risk to human health and safety. As part of a DWP, the District will require an evaluation of streambank conditions to generally identify areas where erosion appears to meet these criteria. Special attention will be paid to areas where the District or other stakeholders have received complaints about erosion problems that are threatening structures or posing a risk to human health and safety. The District will visit the erosion problem areas identified and document existing conditions to support the evaluation of alternatives. Site visits will include the collection of survey data that is necessary to prepare conceptual level plans and cost estimates for alternative improvement scenarios.

6.5.3 Maintenance Problem Areas

Maintenance problems are defined as restrictions on drainage caused by accumulation of debris. They will be identified through field visits by District staff or through stakeholder identification. Further information on maintenance can be found in Section 5.4. Efforts to identify the agencies responsible for maintenance within the watershed will be undertaken in the DWPs.

6.5.4 Water Quality Problem Areas

Water quality problem areas are identified in the IEPA's 303d Report. As discussed in Chapter 4, the report provides a comprehensive summary of waterways within the state of Illinois where water quality standards or listing criteria are not met. Water quality benefits provided by projects planned as a part of DWPs will be shown in qualitative terms as a part of the documentation of improvement projects identified. During development of the draft CCSMP, the District went to great lengths to identify methods accepted by other agencies, such as the USACE and the IDNR-OWR, for determining the economic value of ecosystem impacts and water quality improvement to no avail. Therefore, until an acceptable method is identified and approved by the District, the water quality improvement and ecosystem impact facets of a project will be considered as non-economic factors.

6.5.5 Wetlands, Floodplains, and Riparian Environment at Risk

Wetland, floodplain, and riparian areas will be identified as a part of a DWP. Wetland areas are identified on National Wetland Inventory (NWI) mapping. GIS data for NWI mapping are available on the Web (http://www.fws.gov/nwi/) for download and incorporation into DWPs. Floodplain areas are delineated for many of the Cook County regional waterways and will be summarized as a part of a DWP.

Riparian zones generally are not delineated for Cook County waterways and will be defined as a part of a DWP. Wherever possible, a desktop evaluation of aerial photography or other available field data will be the method for identifying riparian zones. Riparian zones generally are defined as the interfaces between terrestrial and aquatic ecosystems. For the purpose of DWP development, riparian areas will be defined as any vegetated area adjacent to a waterbody that is occasionally inundated by floodwaters resulting in periodic hydric soil conditions. The frequency of inundation impacts the nutrient loads of riparian areas, as well as the soil conditions and plant community composition. The 10-yr delineated floodplain will be used to characterize inundation. For stream reaches where flood frequency data is not available, riparian delineation will attempt to capture the functional relationship between periodic inundation and species diversity in the floodplain.

6.6 Estimates of Existing Damage

Estimating existing damages is the first step in defining the extent of problem areas. Damage estimates defined as a part of a DWP will focus on the economic damages caused by flooding and streambank erosion. Economic damages are estimated by summing damages from four categories:

- Property damage resulting from flooding (residential and commercial)
- Streambank erosion damage
- Transportation damage
- Recreation damage

The following subsections provide guidance on the economic valuation of damages and benefits that will be included as a part of DWP development.

6.6.1 Property Damage

Property damage caused by flooding includes structural damage to buildings (residential, commercial, industrial, and public) and loss of building contents (equipment, furnishings, raw materials, and inventory). The extent of property damage depends on the severity of the flood. For riverine flooding typical of Cook County, severity is dictated primarily by flooding levels and by high flow velocities and the duration of flooding. A floodplain inventory is necessary to understand the assets that are at risk. H&H modeling is used to define water surface elevations for several storm events of varying probability of occurrence and to understand the impact on properties within the floodplain.

Table 6.14 summarizes data requirements for this analysis and suggested data sources. Several public domain applications are available to support the development of average annual damages (AA_D) curves using the data listed in Table 6.14 and consistent with the USACE's National Economic Development (NED) methodology.

Table 6.14 Property Damage Calculations

Data Requirement	Source
Flood stage elevations for 2-, 5-, 10-, 25-, 50-, and 100-year storms.	H&H modeling based on guidance contained in Section 6.4. For DWPs, flood stage elevation (floodplain boundaries) will be developed consistent with GIS standards and specifications provided by the District.
Surveyed property and structure Locations	Based on surveys performed during DWP development or acceptable estimates based on topographic data and visual inspections.
Zero-damage elevations for each structure	Based on surveys performed during DWP development or acceptable estimates based on topographic data and visual inspections.
Assessed value of each asset	Cook County tax parcel data.
Valuation of contents of structures	Recommended assumptions: For residential structures, contents are 50% of the replacement value of the structure. For commercial, industrial, or public facilities, contents are 90% of the replacement value of the structure. More specific information can be substituted, if it can be easily obtained through interviews or additional data gathering.

In general, based on the flood stage calculated using H&H models, damages are calculated for six storm events: 2-, 5-, 10-, 25-, 50-, and 100-year. Once the damages are calculated, a damage curve is developed by plotting the value of damages versus the exceedance probability. The AA_D value, which can be determined by calculating the area under the damage curve, is essentially the sum of all the damages weighted by their probability of occurrence.

Appendix F contains a more detailed description of the NED methodology for determining property damages including the development of damage curves and performing benefit-to-cost (BC) analysis.

6.6.2 Streambank Erosion Damage

Streambank erosion damage will be calculated in a manner similar to property damage calculations. Surveys performed by the District will determine where streambank erosion is likely to cause property damage. In such cases, the valuation of the structure and the contents of structures deemed to be at imminent risk will be included. Therefore, frequency determinations are unnecessary, and evaluations will focus on effectiveness for the full range of expected flows, particularly bank full-flow ranges. Only actual property damage to structures will be included in the damage calculation. Loss of land will not be considered.

6.6.3 Transportation Damage

The following damages in the transportation category will be quantified for the purposes of damage assessment:

- Physical damages to roads, bridges, traffic signal installations, and sewers
- Emergency response costs
- Traffic delay or disruption

Transportation damages will be calculated using the following tiered approach:

Tier 1—If avoided transportation damages are not expected to be a significant component of the project, then a 15 percent markup of total property damage should be used to account for indirect damages. This methodology is consistent with the IDNR-OWR's common approach to damage assessment, which includes physical damages, emergency response costs, and traffic delays or disruptions, and is intended to cover such costs as public works staff time, lost wages for residents, and other associated damages.

Tier 2—If the traffic delay component of the project is expected to be more significant, then a more detailed traffic delay analysis will be performed and included as an addition to the 15 percent markup. The methodology used for this analysis will be site-specific and will be approved by the District.

Tier 3—If historic information obtained during DWP preparation shows that flooding in the area has been known to cause significant transportation damage, then project-specific transportation damage curves will be developed in place of the 15 percent markup. An example of this may be that bridges in a particular project area are of high value and vulnerable to flood damages; therefore, the 15 percent markup would not be high enough to account for the damage expected to these bridges. These project-specific damages will be calculated using the formula

$$D_x = F_x Q_x$$

where:

D_x = the monetary damages derived from a particular flood event; e.g., damages for a 2-year flood

F_x = multiplication factor incorporating cost; e.g., cost of project-specific bridge replacement

Q_x = the quantity of the particular facility affected by the flood event; e.g., number of bridges affected by the flood

Specific cost factors and inputs to be used to calculate damages for each transportation cost component will be developed using historic information. As with property damages, transportation damages will be calculated for each flooding event, developed into a damage curve, and then converted into an AA_D. The AA_D is determined by calculating the area under the damage curve. Appendix F contains a detailed explanation of this procedure.

6.6.4 Recreation Damages and Benefits

Recreation damages are incurred through the loss of the use of parks, forest preserves, or other recreational facilities. Recreation benefits can accrue from damages avoided and by the creation of recreation areas as part of a flood control project. Several methods have been developed to calculate recreational damage/benefit. The unit day value (UDV) method will be used for recreational damage or benefit calculation as a part of DWPs. The UDV method relies on annually published studies by the USACE that estimate dollar damages per day ($ person-day) that are accrued based on a point rating. The point rating system includes five criteria related to: available activities, facilities, relative scarcity, ease of access, and aesthetics. Appendix G contains USACE's 2006 published study, which is updated annually. The general formula for calculating damages is:

$$D_x = F_x V_x L_x$$

where:

D_x = the monetary damages derived from a particular flood
F_x = multiplication factor incorporating the UDV
V_x = the average number of daily visitors to a recreational facility
L_x = Length of impact in days

Unless site-specific information can be readily developed, the values contained in Appendix H (Table H-1) will be used to calculate recreational damages or benefits. This table will be evaluated annually to determine if updates are required.

Similar to property and transportation damages, recreation damages must be calculated for each flood event, developed into a damage curve, and then converted into an AA_D for recreation facilities. The AA_D can be determined by calculating the area under the damage curve. Appendix F contains a detailed explanation of the procedure.

6.6.5 Final Calculation

Once damages are calculated for each flood event, a damage curve will be developed for the sum of all damages from each category, and then converted into an overall AA_D. The AA_D can be determined by calculating the area under the damage curve. Appendix F contains a more detailed explanation of this procedure. Table 6.15 summarizes the valuation of damages and benefits proposed in the sections above.

Table 6.15 Summary Recommendation for Economic Valuation

Type of Damage and Benefit	Description	Valuation Method
Property Damage from Flooding		
Residential property —structural damage	Avoided structural damage to residences.	Follow USACE NED guidance. Use HEC-Flood Damage Assessment (FDA) or IDNR-OWR's damages model. Property valuation will be based on assessed value obtained from Cook County tax records.
Residential property—contents	Avoided damage to contents within residences.	Assume 50% of structural damage to account for residential contents.
Industrial commercial property—structural damage	Avoided structural damage to industrial/commercial property.	Follow USACE NED guidance. Use HEC-FDA software or IDNR-OWR's damages. Research individual building types through interviews and other data collection.
Industrial/ commercial property—contents	Avoided damage to contents within industrial/commercial property.	Assume 90% of structural damage unless information can be obtained through interviews and other data collection.

Table 6.15 Summary Recommendation for Economic Valuation

Type of Damage and Benefit	Description	Valuation Method
Streambank Erosion Damage		
Erosion damage	Damages from erosion.	Similar to structural damage, except include damage in areas where erosion is the cause of structural damage rather than flooding. Only structural damage will be included in the valuation, loss of land will not be considered.
Transportation Damage		
Transportation—physical damage and emergency response costs	Physical damage to roads, bridges, and utilities, as well as damages resulting from police, fire and emergency rescue costs.	Assume 15% of property damages (structural plus contents) for indirect transportation damages (this includes both physical damage and emergency response costs).
Transportation damage—operation and delay costs	Damage from additional vehicle operation, and loss of productivity.	Operational delay is considered when the flood elevation reaches 0.5 foot above the low roadway elevation. If significant, estimate damages based on estimated cost of delay.
Transportation damage—vehicles	Damage to vehicles.	Not included for District transportation damage calculations. Assume most vehicles will be removed from flooded areas before damage can occur.
Other damages—income loss	Damage from lost wages of workers that cannot be transferred out of a flooded area.	Not included. Assume that work can be transferred out of the flooded area. (*Note:* The likelihood of an event extreme enough to cause income loss is small.)
Other damages — relocation costs	Damages from additional living expenses of residences required to temporarily relocate.	Not included for District transportation damage calculations. Assume that living expenses are small relative to property damage.
Recreation Damage and Benefit		
Parks and forest preserves	Damage incurred from the loss of use of parks, forest preserves, or other recreation areas. Benefits accrued from the development of new recreation areas created by an alternative will be valued (see Section 6.6.4)	USACE Economics Guidance Memorandum, 07-03 dated November 20, 2006, unit day values for recreation, fiscal year 2007, which estimates $/person-recreation day. This calculation can be used to calculate damages in recreation areas as well as benefit from recreation area created.
Wetland and Riparian Areas		
Wetlands and riparian habitat	Existing damage to wetlands and riparian habitats will not be included in the baseline damages valuation. Damage caused by an alternative will be mitigated and included in the overall cost of an alternative. Benefit from additional wetlands or riparian habitat created by an alternative will be valued (see Section 6.7.3.1).	Not included in damage calculation. For benefit calculations use the market rate of wetlands and riparian habitat from a wetland bank in the appropriate watershed.
Water Quality		
Water quality	Damages from impaired water quality, both ecological and regulatory.	Not included until an acceptable method is developed.

6.7 Alternative Development and Evaluation

Once problem areas are defined (Section 6.5) and damages quantified (Section 6.6), then alternatives to reduce the damages associated with the problems will be developed and evaluated. Several alternatives will be developed and evaluated for each problem area. For flooding problem areas, alternatives will provide a varying level of protection. In other words, some alternatives will address lower recurrence interval storms such as the 15-year storm, and others will address higher recurrence interval storms such as the 100-year storm. Once alternatives are developed, they will be evaluated based on their BC ratio or net benefit.

The enacting legislation, Public Act 93-1049, in which authority was granted to the District for the responsibilities of stormwater management for Cook County, stipulates that BC analysis is required during deliberations for capital project selection. However, the District's Board of Commissioners is not required to select projects solely on BC analysis. They may also decide to consider noneconomic criteria in the selection of alternatives for each problem areas. Information about noneconomic criteria will be summarized for each project so that it can be included as a consideration in the countywide prioritization of stormwater improvement projects. The ultimate decision for funding of any capital project is at the discretion of the District's Board of Commissioners.

Section 6.7 is generally organized according to the steps to be followed as a part of alternative development and evaluation. Alternative development and evaluation will be performed as a part of DWPs. Table 6.16 summarizes the general steps for development and evaluation of alternatives.

Table 6.16 Summary of Alternative Development Sections

CCSMP Section Number	Alternative Development and Evaluation Step	General Overview
6.5	Define problem areas	Use guidance in Section 6.5 to identify and define the magnitude of problem areas.
6.7.1	Identify alternatives	Use technology guidance provided in Section 6.7.1 and information on watershed to identify alternatives that can help resolve problems in problem areas.
6.7.2	Evaluate alternatives	Evaluate alternatives for effectiveness addressing problem areas. This will primarily focus on the evaluation of the effectiveness of flood control alternatives using H&H modeling consistent with protocol established in Section 6.4. Streambank erosion control alternatives will focus on bank-full conditions.
6.7.3	Estimate conceptual cost of alternatives	Use unit costs, markups, and other guidance provided by the District to estimate the conceptual cost of alternatives.
6.7.3	Evaluate cost-effectiveness of alternatives	Use the damages defined in Section 6.6 and the conceptual cost estimates to determine the BC ratio for each alternative. Use the BC ratio to determine whether alternatives address problem areas cost-effectively.
6.8	Summarize recommended projects for each problem area and define noneconomic criteria	Develop lists of projects recommended throughout the watershed for each problem area. Alternatives that have the highest BC ratio (net benefit) generally will be recommended for each problem area. Also summarize noneconomic data for each problem area to be used as a part of District's countywide prioritization of improvement projects.

6.7.1 Technology Guidance and Alternative Identification

Many acceptable technologies can be used alone or in combination to form project alternatives to remediate existing stormwater problems. Where opportunities exist, projects funded by the District will incorporate BMPs that provide secondary water quality benefits. Section 6.7.1 provides guidance on the use of technologies in developing alternatives to remediate flooding and erosion problems.

6.7.1.1 Flood Control Technologies

As described in Section 6.5, flooding problems occur when flood waters reach structures, transportation facilities, utilities, critical facilities, or recreation areas. Damages arise from the effects on the facilities and their contents, as well as the consequences of loss of service. Table 6.17 contains descriptions of technologies that can remediate flooding problems and also general guidance on their use for the development of alternatives. The technologies will be used as appropriate for the development of flood control alternatives as a part of a DWP.

Technologies listed in Table 6.17 are summarized in terms of their ability to remediate flooding problems. It is assumed that these technologies would be implemented along with a regulatory program that requires measures to prevent future flooding problems. Without measures to prevent future flooding problems, such as site discharge restrictions, the technologies may not prove as effective in the future as when they originally were designed and implemented.

Table 6.17 Summary of Flood Control Options

Flood Control Option	Description
Detention/Retention	
Detention facilities	Impoundments to temporarily store stormwater. This centralized technology includes wet basins, stormwater wetlands, regional facilities, and flood control reservoirs.
Retention facilities (Wet basins)	Impoundments to permanently store stormwater and remove it through infiltration and evaporation. Retention facilities generally have an outfall to the receiving waterway that is located at an elevation above the permanent pool.
Underground detention	A specialized form of storage where stormwater is detained in underground facilities such as vaults or tunnels.
Bioretention	Decentralized microbasins distributed throughout a site or watershed to control runoff close to where it is generated. Runoff is detained in the bioretention facilities and infiltrated into the soil and removed through evapotranspiration.
Conveyance Improvement	
Culvert/bridge re-placement	Enhancement of the hydraulic capacity of culverts or bridges serving as stream crossings through size increase, roughness reduction, and removal of obstacles (for example, piers).
Channel improvement	Enhancement of the hydraulic capacity of channels by enlarging cross sections (for example, floodplain enhancement), reducing roughness (for example, lining), or channel realignment.
Flood Barriers	
Levees	Earth embankments built along rivers and streams to keep flood waters within the channel.
Floodwalls	Vertical walls typically made of concrete or other hard materials built along rivers and streams to keep flood waters within the channel.
Relocation	
Buyouts	Acquisition and demolition of properties in the floodplain to eliminate flood damages.
Building relocation	Relocation of buildings (typically houses) to higher ground to remove them from the floodplain. This technology requires purchasing new land and transporting buildings to new locations.
Elevation	Modification of a structure's foundation to elevate the building above a given flood level. Typically applied to houses.
Floodproofing	
Dry floodproofing	Installation of impermeable barriers and flood gates along the perimeter of a building to keep flood waters out. Typically deployed around commercial and industrial build-ings that cannot be elevated or relocated.
Wet floodproofing	Implementation of measures that do not prevent water from entering a building but minimize damages; for example, utility relocation and installation of water resistant materials.

Note that sometimes applications of flood control technologies to address problems in one location may aggravate problems in another location (for example, conveyance improve-ments reduce flooding upstream but may worsen conditions downstream). Therefore, the potential applications of flood control technologies to address problems will not be analyzed in isolation. No alternative recommended as a part of a DWP may create negative impacts within the watershed or outside of the watershed, including areas lying outside of Cook County.

6.7.1.2 Erosion Control Technologies

As described in Section 6.5, streambank erosion can result in property damage or a risk to human health and safety. Damages arise from the effects on the facilities and their contents, as well as the consequences of loss of service. A description of appropriate technologies that can remediate existing streambank erosion problems and general guidance on their utilization for the development of alternatives, is presented in Table 6.18.

Table 6.18 Streambank Erosion Control Options

Control Option	Description
Natural (vegetated or bioengineered) stabilization	The stabilization and protection of eroding overland flow areas or streambanks with selected vegetation using bioengineering techniques. The practice applies to natural or excavated channels where the streambanks are susceptible to erosion from the action of water, ice, or debris and the problem can be solved using vegetation. Vegetative stabilization is generally applicable where bankfull flow velocity does not exceed 5 ft/sec and soils are more erosion resistant, such as clayey soils. Combinations of the stabilization methods listed below and others may be used.
Vegetating by sodding, seeding or planting	Establishing permanent vegetative cover to stabilize disturbed or exposed areas. Required in open areas to prevent erosion and provide runoff control. This stabilization method often includes the use of geotextile materials to provide stability until the vegetation is established and able to resist scour and shear forces.
Vegetated armoring (joint planting)	The insertion of live stakes, trees, shrubs and other vegetation in the openings or joints between rocks in a riprap or articulated block mat (ABM). The object is to reinforce riprap or ABM by establishing roots into the soil. Drainage may also be improved through extracting soil moisture.
Vegetated cellular grid (erosion blanket)	Lattice-like network of structural material installed with planted vegetation to facilitate the establishment of the vegetation, but not strong enough to armor the slope. Typically involves the use of coconut or plastic mesh fiber (erosion blanket) that may disintegrate over time after the vegetation is established.
Reinforced grass systems	Similar to the vegetated cellular grid, but the structural coverage is designed to be permanent. The technology can include the use of mats, meshes, interlocking concrete blocks, or the use of geocells containing fill material.
Live cribwall	Installation of a regular framework of logs, timbers, rock, and woody cuttings to protect an eroding channel bank with structural components consisting of live wood.
Structural stabilization	Stabilization of eroding streambanks or other areas by use of designed structural measures. Structural stabilization is generally applicable where flow velocities exceed 5 ft/sec or where vegetative streambank protection is inappropriate.
Riprap	A section of rock placed in the channel or on the channel banks to prevent erosion. Riprap typically is underlain by a sand and geotextile base to provide a foundation for the rock, and to prevent scour behind the rock.
Interlocking concrete	Interlocking concrete may include A-Jacks®, ABM, or similar structural controls that form a grid or matrix to protect the channel from erosion. A-Jacks armor units may be assembled into a continuous, flexible matrix that provides channel toe protection against high velocity flow. The matrix of A-Jacks can be backfilled with topsoil and vegetated to increase system stability and to provide in-stream habitat. ABM can be used with or without joint planting with vegetation. ABM is available in several sizes and configurations from several manufacturers. The size and configuration of the ABM is determined by the shear forces and site conditions of the channel.

Table 6.18 Streambank Erosion Control Options

Control Option	Description
Gabions	Gabions are wire mesh baskets filled with river stone of specific size to meet the shear forces in a channel. The gabions are used more often in urban areas where space is not available for other stabilization techniques. Gabions can provide stability when designed and installed correctly.
Grade Control	Grade control measures may be used to prevent stream incision into the channel bed or upstream nickpoint migration. Grade control measures involve some means of stabilizing the channel bed at a desired elevation with natural materials such as rocks or logs, or in some situations concrete. Rock vortex weirs, rock cross vanes, and log drops are means of grade control that impede channel incision and often result in scour pools developing downstream of the grade control measure.
Concrete channels	A constructed concrete channel designed to convey flow at a high velocity (greater than 5 ft/sec) where other stabilization methods cannot be used. May be suitable in situations where downstream areas can handle the increase in peak flows and there is limited space available for conveyance.
Outlet stabilization	Prevent streambank erosion from excessive discharge velocities where stormwater flows out of a pipe. Outlet stabilization may include any method discussed above.

USDA NRCS and IEPA. *Illinois Urban Manual.* 2002

Sometimes applications of streambank erosion control technologies to address problems in one location may aggravate problems in another location (for example, lining a channel in one location may exacerbate streambank erosion at another location). Therefore, application of streambank erosion or grade control technologies to address problems must not be analyzed in isolation. As stated previously, no alternative recommended as a part of a DWP may create negative impacts in the watershed or outside of the watershed including areas outside of Cook County.

Bioengineering techniques for stabilizing water body shorelines provide more natural solutions than hard armoring. Hard armoring, which protects the bank with concrete, riprap, or other nonnatural materials, is sometimes necessary when a bioengineered solution will not provide the necessary level of protection or cannot withstand flow velocities. In preparing a DWP, consideration will be made to allow only the minimum necessary amount of hard armoring. The DWP will consider the use of bioengineering techniques where appropriate. A combination of treatments will likely be suggested to maximize durability.

6.7.2 Alternative Evaluation

Alternatives developed to address flooding will be evaluated using H&H modeling consistent with methodologies described in Section 6.4. Modeling will determine the avoided damages or benefit for each alternative. The avoided damage or benefit will be used to calculate the BC ratio for each alternative.

Frequency determinations are unnecessary in evaluating alternatives developed to address erosions problems. Evaluations will focus on effectiveness for the full range of expected flows, particularly the bank full flow ranges. Costs will be considered, but not using the multistorm approach applied for flood damages.

6.7.3 Evaluating Cost Effectiveness of Alternatives

BC ratio is determined by calculating the benefit of a project in terms of avoided damages or benefit added, and the construction and operation and maintenance (O&M) costs associated with a project. Section 6.6 provides a description of the process to be followed to determine the benefit or damages for problem areas. Benefits are then divided by the cost to obtain an indicator of the cost effectiveness of each project. Net benefit can also be calculated by subtracting the cost from the benefit.

6.7.3.1 Benefit Calculation

In economic terms, benefit is the dollar value of the damages avoided because of implementation of an alternative (flood control project, soil stabilization project, buyouts). Benefits are calculated by determining damages without a project minus damages with a project; that is, damages avoided. Benefits can include the added value of recreation facilities, wetlands, or riparian areas. As explained in Appendix F, benefits can be expressed as a present value, PV_B, or can be annualized to obtain the average annual benefits AA_B.

Recreation Areas. If the project creates recreation areas, the value will be included as a benefit to the project using the economic valuation method described in Section 6.6.4. Recreation benefit, once created, can be assumed to accrue annually over the life of the project.

Wetlands and Riparian Areas. If the project creates wetlands or riparian areas, their value will be included as an economic benefit of the project. The value of wetlands and riparian areas is calculated based on the market rate of wetlands in the watershed. Appendix H provides the 2006 market rate for wetlands by watershed (Table H-2). The values are variable and will be confirmed annually.

6.7.3.2 Costing Assumptions

Project costs involve all expenditures necessary for implementation. For traditional flood control projects such as levees or reservoirs, they include study, design, land acquisition, construction, and O&M costs. For a residential buyout, there is a one-time cost to purchase structures in the floodplain, including demolition of the structures, restoration of the land, relocation and closing costs. Floodproofing costs may be represented by one-time costs of utility relocation and the occasional complete replacement of flood shields.

Flood protection projects provide benefits throughout a defined period of time that depends on the useful life of a project. A levee may have a useful life of 50 years, whereas relocation of a house outside the floodplain is a permanent solution. Every year that the project performs its functions, it provides benefits and, in principle, requires some expenditure, although most of the cost is incurred during construction. Therefore, the concept of annualizing is applied to compare these unevenly distributed benefits and costs.

Annualizing benefits and costs is a basic concept of engineering economics that accounts for the time value of money. To calculate the annual payment, benefits accrued and the costs incurred every year are discounted using compound interest procedures. The typical discount rate is set by the federal government and is also used by IDNR-OWR. Recently it has varied between 3 and 7 percent. In 2005, the value used by IDNR-OWR for discounting was 5.375 percent. The District will validate the discount rate annually. If the life expectancy of facilities is less than the period for which benefits are calculated, then replacement costs must be incorporated to account for the total cost of facilities for the entire time period.

Standard engineering economics textbooks provide formulas for converting a present value or a future value into a uniform series of "payments." For example, a capital expenditure can be converted into an annual payment using the formula

$$AAc = PV \frac{i(1+i)^n}{(1+i)^n - 1}$$

where:

AAc = annual cost
n = useful life of the project in years
PV = total cost or benefit in the present
i = discount rate

To calculate costs accurately, it is necessary to have an assumption of the life expectancy of a project. Table 6.19 lists the standard assumptions to be used to estimate project life for purposes of alternative evaluation.

Table 6.19 Life Expectancy and O&M Requirements for Alternative Evaluation

Project	Life Expectancy (yr)	Inspection and Routine O&M (yr)	Additional O&M (YR)
Flood Control Projects			
Detention pond	50	Every 2-3	Every 10
Underground detention	50	Every 2-3	Every 5
Levee with detention	100	Every 3	Every 15
Channel enlargement with detention	50	Every 2-3	Every 5
Floodproofing	20	Every 1	Every 2
Buyouts	Permanent		
Detention pond	50	Every 2-3	Every 10
Underground detention	50	Every 2-3	Every 5
Soil Stabilization Projects			
Natural stabilization	30	Every 1	Every 2
Riprap	30	Every 2-3	Every 5
Reno gabions	30	Every 1	Every 5
Basket gabions	30	Every 1	Every 5
Sloped vertical concrete wall	30	Every 2-3	Every 5
Rectangular concrete channel	50	Every 2-3	Every 5
Trapezoidal concrete channel	50	Every 2-3	Every 5

6.7.3.3 Unit Costs for Alternative Development

The District will develop a current list of unit costs to use as part of alternative cost estimation. Unit cost items will be developed by the District and evaluated annually to determine if updates are required. In addition to the list of unit costs, the District will also establish consistent markups for items such as mobilization, engineering, and contingencies. Unless a customized or site-specific approach to include these costs is approved by the District, standard unit cost items and markups will be used for DWP alternative development to provide for consistency during the countywide prioritization of projects.

6.7.3.4 Calculating Benefit-to-Cost Ratio

Once the average annual benefits (AA_B) and average annual cost (AA_C) have been estimated, the BC ratio is computed using the formula:

$$BC = \frac{AA_B}{AA_C}$$

where:

AA_B = the average annual benefit
AA_C = the average annual costs

Note that the BC ratio can also be computed using benefits and costs expressed as present values:

$$BC = \frac{PV_B}{PV_C}$$

where:

PV_B = the present value of the benefits
PV_C = the present value of the costs

The BC ratio will be used to evaluate whether a project is cost-effective. If the BC ratio is greater than one, the project benefits exceed the costs and the project can be considered cost-effective. Other factors may be considered that would favor a project that did not have a BC ratio greater than one.

Similarly, the net benefits of the project are equal to:

$$NB = PV_B - PV_C$$

If the net benefits are positive, the project is cost-effective and the BC ratio greater than one.

6.7.4 Alternative Selection for Problem Area

As stated previously, the District is required to consider the BC ratio when selecting projects for implementation. In addition the District will consider noneconomic criteria in selecting alternatives. All projects which meet the District's absolute requirements for capital project funding will be prioritized on a countywide basis, with final decision for funding made at the discretion of the District's Board of Commissioners.

6.8 Summary of Recommended Alternatives

Recommended projects will be summarized to describe the economic and noneconomic data to be used as a part of the District's countywide prioritization of improvements. The economic data will focus on the BC ratio defined for each problem area, consistent with the documentation provided in Sections 6.6 and 6.7. Noneconomic data to be developed for each project are summarized in Section 6.8.1.

Exhibit 6.1 depicts the documentation that will be prepared as a part of each DWP to support the countywide prioritization of projects. Only alternatives that meet the District's minimum criteria for funding (see Chapter 1) will be developed and evaluated. For each project that meets the minimum criteria, a BC analysis will be developed, as will information on the development of noneconomic data. That information will be summarized in a manner consistent with what is shown in Exhibit 6.1 for incorporation into the District's countywide prioritization of improvement projects. Note that all costs and net benefits shown in Exhibit 6.1 shall be expressed as present values.

6.8.1 Other Noneconomic Evaluation Criteria

In addition to the BC ratio, the following information will be compiled for the District to use as a part of the countywide prioritization of projects:

- Total cost to the District
- Area (in acres) removed from the floodplain
- Number of structures protected
- Probability that funding will be provided by outside agencies (identify funding source, and percent of project to be funded, if known)
- Implementation time (in months)
- Water quality benefit, based on the qualitative scale described in Section 6.8.2
- Cook County communities involved
- Wetland or riparian area protected (ac)

6.8.2 Water Quality Benefit

To determine the water quality benefit of a flood control or erosion control project, the following questions must be addressed:

- Does the project contribute to the implementation of a TMDL established for the watershed?
- Does the project improve water quality concerns identified as a part of an NPDES Phase II Stormwater Permit?
- Does the project improve water quality related to a pollutant or pollution identified in the state's 303(d) Report?
- Does the project have an effect on habitat?

Once these questions are addressed, water quality benefit will be evaluated qualitatively using the scale in Table 6.20.

Table 6.20 Water Quality Benefit Evaluation Scale

Rating	Description
No Impact	No notable impact on water quality.
Slightly Positive	Project partly addresses or affects an NPDES Phase II Stormwater Permit, a TMDL established for the watershed, violations in water quality standards or listing criteria, or habitat.
Positive	Project fully addresses or impacts an NPDES Phase II Stormwater Permit, a TMDL established for the watershed, violations in water quality standards or listing criteria, or habitat.

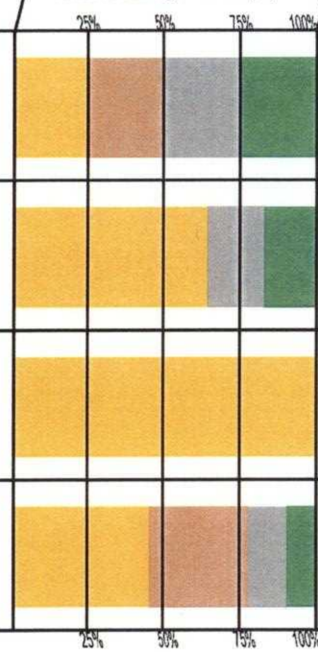
6.9 Implementation Plan

Each DWP will include an implementation plan that identifies issues critical to implementation of watershed recommendations. The recommendations will include stormwater improvement projects to address watershed problems, data management needs and responsibilities, special coordination requirements identified as a part of DWP development, scheduled updates to DWPs, and any other issues identified as critical to the District.

Exhibit 6-1 Example CIP Prioritization Matrix

Metropolitan Water Reclamation District of Greater Chicago
Example Prioritization Matrix

	B/C Ratio	Total Benefits ($)	Total Project Cost ($)	Total Cost To MWRDGC ($)	Relative Damage Averted (%)	Area Removed from Floodplain (ac)	Wetland or Riparian Area Protected (ac)	Number of Structures Protected	Possibility of Funding Provided by Outside Agencies	Implementation Time (months)	Water Quality Benefit	Communities Involved
Project A	1.25	5.0 M	4.0 M	3.2 M		5.0	40	6	Very Likely	6	Positive	Oak Park Berwyn Cicero
Project B	2.5	7.5 M	3.0 M	3.0 M		2.6	8	10	Not Likely	28	Slightly Positive	Park Ridge Des Plaines Mount Prospect
Project C	1.2	12.0 M	10.0 M	7.8 M		13.0	0	50	Somewhat Likely	3	No Impact	Oak Lawn Chicago Ridge
Project D	1.0	15.0 M	15.0 M	14.0 M		3.9	15	25	Not Likely	24	Slightly Postive	Buffalo Grove Wheeling Des Plaines Mount Prospect Prospect Heights



Property Damage | Erosion | Transportation | Recreation

Note: This prioritization matrix may be expanded to include additional non-economic criteria. All values are hypothetical and for demonstration purposes only.

Appendix C
Little Calumet River Watershed Curve Number Calculation

Introduction

SCS hydrology uses the empirical curve number (CN) parameter as a part of calculating runoff volumes based on landscape characteristics such as soil type, land cover, imperviousness, and land-use development. Areas characterized by saturated or poorly infiltrating soils, or impervious development, have higher CN values, converting a greater portion of rainfall volume into runoff. The principle data sources used to develop CN values for the Little Calumet River (LCR) watershed are the Natural Resource Conversation Service (NRCS) soil data for Cook County and the 2001 Northeast Illinois Planning Commission (NIPC) land-use mapping for Cook County. The below subsections discusses the procedure used to develop a CN grid for use in hydrologic modeling for the LCR watershed and the assumptions inherent in this procedure.

Approach

CN values are dependent on a number of factors, including the soil infiltration characteristics and condition, as well as land cover characteristics such as directly connected impervious area and cover type. Therefore both soil data and land-use data are required to estimate CN. The best available soil and land-use data for Cook County are the NRCS soil data and NIPC land-use data. **Table C1** lists curve numbers based on combinations of land-use data and soil data for small urban watersheds.

Table C1: Curve Number Generation for Small Urban Watersheds

Cover description: Cover type and hydrologic condition	Average percent impervious area [2/]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3/]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4/]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5/]		77	86	91	94

Table excerpted from Technical Release 55, Urban Hydrology for Small Watersheds, June 1986

A slightly modified version of this table will be used for curve number generation in the LCR DWP, shown in **Table C2**. Both the NRCS soil data and the land use data require preprocessing before generating curve numbers using the lookup table.

Table C2: Modified Curve Number Generation for LCR DWP

Description	Average % Impervious	Curve Number by Hydrologic Soil Group: A	B	C	D	Typical Land Uses
Residential (High Density)	65	77	85	90	92	Multi-family, Apartments, Condos, Trailer Parks
Residential (Med. Density)	30	57	72	81	86	Single-Family, Lot Size ¼ to 1 acre
Residential (Low Density)	15	48	66	78	83	Single-Family, Lot Size 1 acre and Greater
Commercial	85	89	92	94	95	Strip Commercial, Shopping Centers, Convenience Stores
Industrial	72	81	88	91	93	Light Industrial, Schools, Prisons, Treatment Plants

Table C2: Modified Curve Number Generation for LCR DWP

Description	Average % Impervious	Curve Number by Hydrologic Soil Group				Typical Land Uses
		A	B	C	D	
Disturbed / Transitional	5	76	85	89	91	Gravel Parking, Quarries, Land Under Development
Agricultural	5	67	77	83	87	Cultivated Land, Row crops, Broadcast Legumes
Open Land – Good	5	39	61	74	80	Parks, Golf Courses, Greenways, Grazed Pasture
Meadow	5	30	58	71	78	Hay Fields, Tall Grass, Ungrazed Pasture
Woods (Thick Cover)	5	30	55	70	77	Forest Litter and Brush adequately cover soil
Woods (Thin Cover)	5	43	65	76	82	Light Woods, Woods-Grass combination, Tree Farms
Impervious	95	98	98	98	98	Paved Parking, Shopping Malls, Major Roadways
Water	100	100	100	100	100	Water Bodies, Lakes, Ponds, Wetlands

Data from http://gis2.esri.com/library/userconf/proc00/professional/papers/PAP657/p657.htm
Data is for average antecedent moisture condition II- dormant season (5-day) rainfall averaging from 0.5 to 1.1 inches and growing season rainfall from 1.4 to 2.1 inches

NRCS Soil data

NRCS soil data representative of 2005 conditions was obtained for Cook and Will Counties in Illinois and Lake, Porter, and La Porte Counties in Indiana. There are several unmapped areas which include the City of Chicago and some portions of nearby communities that consist primarily of urban land forms. These urban land forms were assumed to be Hydrologic Soil Group C.

The NRCS soil data includes hydrologic soil group, representing the minimum infiltration rate of the soil after wetting. **Table C3** summarizes the hydrologic soil groups.

Table C3: Hydrologic Soil Groups

Hydrologic Soil Group	Description	Texture	Infiltration Rates (in/hr)
A	Low runoff potential and high infiltration rates even when wetted	Sand, loamy sand, or sandy loam	> 0.30
B	Moderate infiltration rates when wetted	Silt loam or loam	0.15 – 0.30
C	Low infiltration rates when wetted	Sandy clay loam	0.05 – 0.15
D	High runoff potential and very low infiltration when wetted	Clay loam, silty clay loam, sandy clay, silty clay, or clay clay, or clay	0 – 0.05

All data from Technical Release 55, Urban Hydrology for Small Watersheds, June 1986

Soil groups with drainage characteristics impacted by a high water table are indicated with a '/D' designation, where the letter preceding the slash indicates the hydrologic group of the soil under drained conditions. Thus an 'A/D' indicates that the soil has characteristics of the A soil group if drained but the D soil group if not. 'A/D', 'B/D', or 'C/D', occur throughout the LCR watershed and represent approximately 7 percent of the total drainage area. Because of the difficulty of establishing the extent of drainage of these soils for each mapped soil polygon, it was assumed that 50 percent (by area) of the soil types are drained.

NIPC Land Use Data

A 2001 land use inventory for the Chicago metropolitan area was received from CMAP in GIS format. The data was used to characterize existing conditions land use within the Little Calumet River Watershed. The data include 49 land use classifications, grouped into seven general categories for summarizing land use within the DWP.

Generation of CN

Table C4 describes the input data used to develop the CN values throughout the watershed.

Table C4: Description of Curve Number Input Data

Variable Used to Determine CN	Approach for Definition of Variable for Little Calumet River Watershed Hydrologic Modeling
Ground cover (Illinois)	Chicago Metropolitan Agency for Planning (CMAP) 2001 land use inventory (v.1.2 2006) was used to define land use. A lookup table was developed to link CMAP categories to CN values and soil types.
Ground cover (Indiana)	USGS 2001 Land Cover was used to define land use. A lookup table was developed to link USGS categories to CN values and soil types.
Soil type	The Natural Resources Conservation Service (NRCS) publishes county soil surveys that include a hydrologic classification of A, B, C, or D. If a soil group's infiltration capacity is affected by a high water table, it is classified as, for instance, "A/D," meaning the drained soil has "A" infiltration characteristics, undrained "D." It was assumed that half of these soil groups (by area) are drained.
Antecedent moisture condition	Antecedent Moisture Conditions (AMC) reflects the initial soil storage capacity available for rainfall. For areas within Northeastern Illinois, it is typical to assume an AMC of II.

The subbasin curve numbers were determined based on existing land use and soil types. The NRCS soil maps were imported into ArcGIS. The NIPC 2001 land use and USGS 2001 land cover data were imported into ArcGIS. The USGS raster data was converted to a polygon file. The soil type polygons and land use polygons were intersected in ArcGIS to end up with polygons with consistent land use and soil type in each polygon. Based on the land use and soil type in these polygons, a curve number was assigned to each polygon. The land use/soil type/curve number assignment was based on *TR-55: Urban Hydrology for Small Watersheds* (U.S. Department of Agriculture [USDA], 1986). These polygons were then converted to raster grid with 25-foot grid cells identical to the locations of the DEM grid cells. The Spatial Analyst extension was then used to calculate the average curve number for each subbasin.

For each subbasin, the Directly Connected Impervious percentage was estimated. This estimate was based on the total impervious area within the subbasin. Directly Connected Impervious areas are impervious areas that drain directly to the waterway via sewers or other lined channels where infiltration will not occur before the runoff from the impervious area reaches the stream. The directly connected impervious percentage for each land use type varied from 20 to 50% of the total impervious percentage. **Table C5** shows the curve number and directly connected impervious by land use type.

Table C5: Curve Number and Directly Connected Impervious by Land Use Type

NIPC 2001 Land Use Code	Land Use Description	A	B	C	D	A/D	B/D	C/D	%DCIA
11	Open Water	100	100	100	100	100	100	100	0
21	Developed, Open Space	37	58	70	76	57	67	73	0
22	Developed, Low Intensity	51	67	76	81	66	74	78	5
23	Developed, Medium Intensity	58	71	79	83	70	77	81	7

Table C5: Curve Number and Directly Connected Impervious by Land Use Type

NIPC 2001 Land Use Code	Land Use Description	A	B	C	D	A/D	B/D	C/D	%DCIA
24	Developed, High Intensity	78	84	87	88	83	86	88	37
31	Barren Land	72	81	85	86	79	84	86	0
41	Deciduous Forest	29	52	67	73	51	63	70	0
42	Evergreen Forest	29	52	67	73	51	63	70	0
43	Mixed Forest	29	52	67	73	51	63	70	0
52	Shrub/Scrub	29	46	62	69	49	57	66	0
71	Grassland	37	58	70	76	57	67	73	0
81	Pasture/Hay	29	55	67	74	51	65	71	0
82	Cultivated Crops	64	74	81	85	74	79	83	0
90	Woody Wetlands	46	64	73	79	62	71	76	0
95	Emergent Wetlands	65	75	82	85	75	80	83	0
1110	1110 RES/SF	54	68	77	82	68	75	80	6
1120	1120 RES/FARM	46	63	74	79	63	71	77	3
1130	1130 RES/MF	54	68	77	82	68	75	80	6
1140	1140 RES/MOBILE HM	73	81	86	87	81	85	86	13
1211	1211 MALL	85	87	89	90	87	89	90	40
1212	1212 RETAIL CNTR	85	87	89	90	87	89	90	40
1221	1221 OFFICE CMPS	85	87	89	90	87	89	90	40
1222	1222 SINGL OFFICE	85	87	89	90	87	89	90	40
1223	1223 BUS. PARK	85	87	89	90	87	89	90	40
1231	1231 URB MX W/PRKNG	85	87	89	90	87	89	90	40
1232	1232 URB MX NO PRKNG	77	84	86	88	83	86	87	35
1240	1240 CULT/ENT	85	87	89	90	87	89	90	40
1250	1250 HOTEL/MOTEL	85	87	89	90	87	89	90	40
1310	1310 MEDICAL	77	84	86	88	83	86	87	35
1320	1320 EDUCATION	77	84	86	88	83	86	87	35
1330	1330 GOVT	85	87	89	90	87	89	90	40
1340	1340 PRISON	77	84	86	88	83	86	87	35
1350	1350 RELIGOUS	85	87	89	90	87	89	90	40
1360	1360 CEMETERY	37	58	70	76	57	67	73	0
1370	1370 INST/OTHER	46	63	74	79	63	71	77	3
1410	1410 MINERAL EXT	72	81	85	86	80	84	86	0
1420	1420 MANUF/PROC	77	84	86	88	83	86	87	35
1430	1430 WAREH/DIST/WHOL	77	84	86	88	83	86	87	35
1440	1440 INDUST PK	77	84	86	88	83	86	87	35
1511	1511 INTERSTATE/TOLL	79	85	87	89	84	86	88	0
1512	1512 OTHER ROADWY	79	85	87	89	84	86	88	35
1520	1520 OTH LINEAR TRAN	72	81	85	86	80	84	86	0

Table C5: Curve Number and Directly Connected Impervious by Land Use Type

NIPC 2001 Land Use Code	Land Use Description	A	B	C	D	A/D	B/D	C/D	%DCIA
1530	1530 AIR TRANSPORT	66	76	82	85	75	80	84	0
1540	1540 INDEP AUTO PRK	85	87	89	90	87	89	90	40
1550	1550 COMMUNICATION	64	73	79	83	73	78	81	0
1560	1560 UTILITIES/WASTE	72	81	85	86	80	84	86	0
2100	2100 CROP/GRAIN/GRAZ	64	73	79	83	73	78	81	0
2200	2200 NRSRY/GRNHS/ORC	64	73	79	83	73	78	81	0
2300	2300 AG/OTHER	64	73	79	83	73	78	81	0
3100	3100 OPENSP REC	37	58	70	76	57	67	73	0
3200	3200 GOLF COURSE	37	58	70	76	57	67	73	0
3300	3300 OPENSP CONS	37	58	70	76	57	67	73	0
3400	3400 OPENSP PRIVATE	37	58	70	76	57	67	73	0
3500	3500 OPENSP LINEAR	37	58	70	76	57	67	73	0
3600	3600 OPENSP OTHER	37	58	70	76	57	67	73	0
4110	4110 VAC FOR/GRASS	37	58	70	76	57	67	73	0
4120	4120 WETLAND	29	55	67	74	51	65	71	0
4210	4210 CONST RES	72	81	85	86	80	84	86	0
4220	4220 CONST NONRES	72	81	85	86	80	84	86	0
4300	4300 OTHER VACANT	37	58	70	76	57	67	73	0
5100	5100 RIVERS/CANALS	100	100	100	100	100	100	100	0
5200	5200 LAKE/RES/LAGOON	100	100	100	100	100	100	100	0
5300	5300 LAKE MICHIGAN	100	100	100	100	100	100	100	0
9999	9999 OUT OF REGION	100	100	100	100	100	100	100	0

Appendix D

LITTLE CALUMET RIVER WATERSHED SURVEY POINTS

Little Calumet River DWP

December, 2009

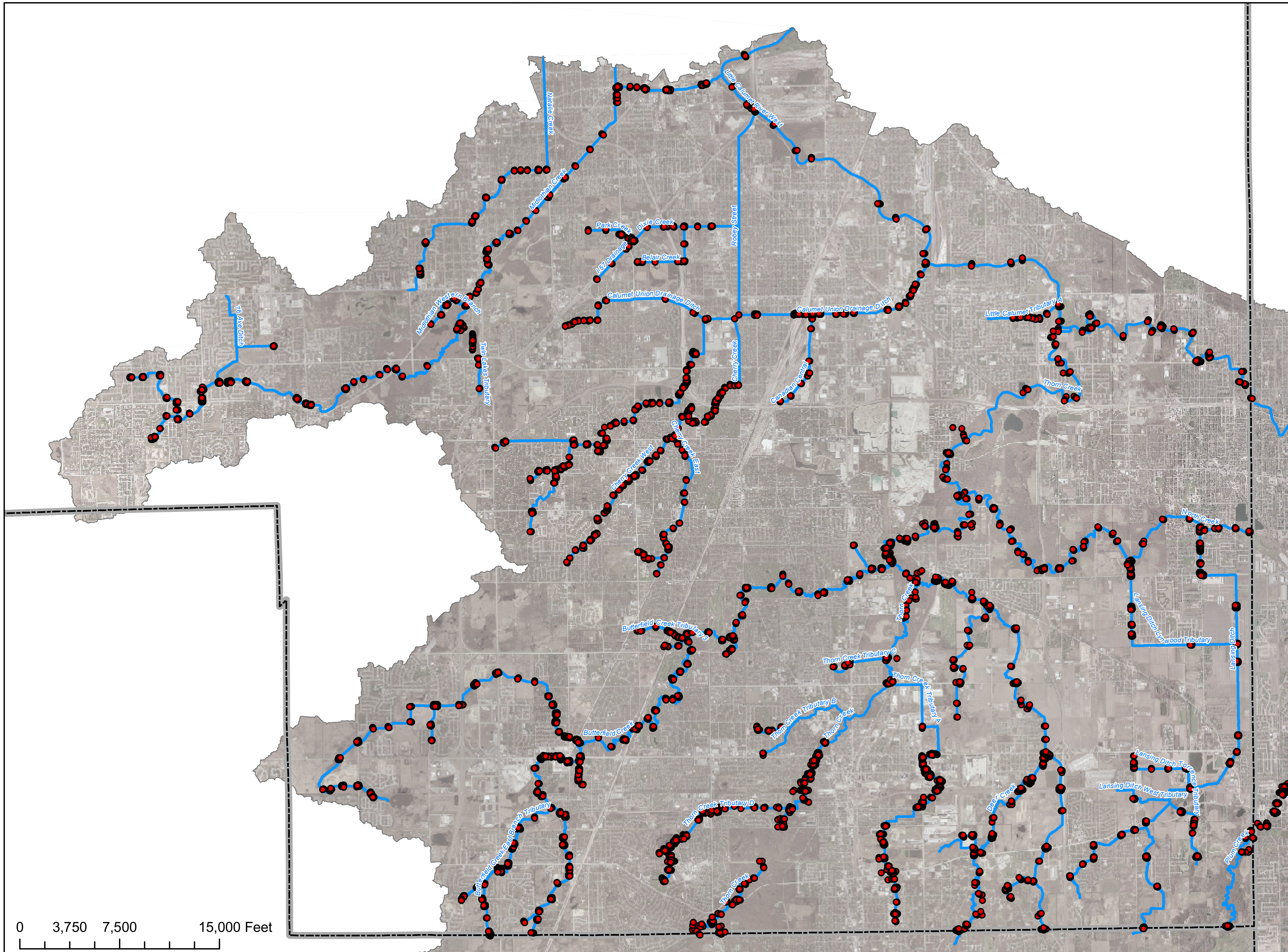
LEGEND

- Survey Points
- County Boundary

N

1 inch = 7,500 feet

CDM



CERTIFICATION OF COMPLIANCE

Project Name:	Little Calumet River Detailed
Statement/Agreement Date:	Agreement dated June 1, 2009 between Camp Dresser & McKee, Inc. (CDM) and Environmental Design International, inc.
Certification Date:	November 11, 2009

Tasks/Activities Covered by This Certification (Check All That Apply)

☐	**Entire Project**
☒	**Survey**
☐	**Topographic Data Development**
☐	**Hydrologic and/or Hydraulic Analyses**
☐	**Coastal Flood Hazard Analyses**
☐	**Floodplain Mapping**
☐	**Other (Specify):**

This is to certify that the work summarized above was completed in accordance with the statement/agreement cited above and all amendments thereto, together with all such modifications, either written or oral, as directed by CDM, as such modifications affect the statement/agreement, and that all such work has been accomplished to meet accuracy guidelines contained in *Guidelines and Specifications for Flood Hazard Mapping Partners* cited in the survey scope of work document, and in accordance with sound and accepted engineering practices within the contract provisions for respective phases of the work. A discussion between CDM and NGS regarding NOAA NGS-58 occurred prior to the initiation of field surveys for this project. The discussion is documented in an internal technical memo (attached) which describes the survey procedures to be followed for this project. NGS stated that NOAA NGS 58 is a guideline, and that more recent developments in GPS technology permit the use of other techniques to achieve the same results; therefore, by signing this document the project surveyor agrees that complying with the survey procedures outlined in the technical memo will meet or exceed the final accuracy results specified in the FEMA guidelines and further confirm that their field surveyors have complied with the procedures outlined in the technical memo.

Name:	Donald G. Groesser
Title:	Professional Land Surveyor
Firm/Agency Represented:	Environmental Design International, inc.
Registration No.:	035-03273
Signature:	11/11/2009

DONALD G. GROESSER 3273 PROFESSIONAL LAND SURVEYOR STATE OF ILLINOIS CHICAGO, ILLINOIS

This form must be signed, stamped, and dated by the surveyor in responsible charge from the firm contracted to perform the work who is registered as a Professional Land Surveyor in the State of Illinois.

CERTIFICATION OF COMPLIANCE

Project Name:	Little Calumet River Detailed Watershed Plan
Statement/Agreement Date:	Technical Memorandum guidelines August 10, 2007
Certification Date:	October 29, 2009

Tasks/Activities Covered by This Certification (Check all that apply)

☐	Entire Project
☑	Survey
☐	Topographic Data Development
☐	Hydrologic and/or Hydraulic Analyses
☐	Coastal Flood Hazard Analyses
☐	Floodplain Mapping
☐	Other (Specify)

This is to certify the work summarized above was completed in accordance with the statement/agreement cited above and all amendments thereto, together with all such modifications, either written or oral, as directed by CDM, as such modifications affect the statement/agreement, and that all such work has been accomplished to meet accuracy guidelines contained in *Guidelines and Specifications for Flood Hazard Mapping Partners* cited in the survey scope of work document, and in accordance with sound and accepted engineering practices within the contract provisions for respective phases of the work. A discussion between CDM and NGS regarding NOAA NGS-58 occurred prior to the initiation of field surveys for this project. The discussion is documented in an internal technical memo (attached) which describes the survey procedures to be followed for this project. NGS state that BOAA NGS 58 is a guideline, and that more recent developments in GPS technology permit the use of other techniques to achieve the same results; therefore, by signing this document the project surveyor agrees that complying with the survey procedures outlined in the technical memo will meet or exceed the final accuracy results specified in the FEMA guidelines and further confirm that their field surveyors have compiled with the procedures outlined in the technical memo.

Name:	Tom Baumgartner
Title:	Professional Land Surveyor
Firm/Agency Represented:	Terra Engineering, Ltd.
Registration No.:	35-3142
Signature:	

PROFESSIONAL LAND SURVEYOR
THOMAS E. BAUMGARTNER
35-3142
CHICAGO
STATE OF ILLINOIS

This form must be signed, stamped, and dated by the surveyor in responsible charge form the firm contracted to perform the work who is registered as a Professional Land Surveyor in the State of Illinois.

Appendix F - Depth Damage Curves

TABLE 1.
Residential, One Story with Basement.

Structure			Content		
Depth	Mean of Damage	Standard Deviation of Damage	Depth	Mean of Damage	Standard Deviation of Damage
-8	0%	0	-8	0.10%	1.6
-7	0.70%	1.34	-7	0.80%	1.16
-6	0.80%	1.06	-6	2.10%	0.92
-5	2.40%	0.94	-5	3.70%	0.81
-4	5.20%	0.91	-4	5.70%	0.78
-3	9.00%	0.88	-3	8.00%	0.76
-2	13.80%	0.85	-2	10.50%	0.74
-1	19.40%	0.83	-1	13.20%	0.72
0	25.50%	0.85	0	16.00%	0.74
1	32.00%	0.96	1	18.90%	0.83
2	38.70%	1.14	2	21.80%	0.98
3	45.50%	1.37	3	24.70%	1.17
4	52.20%	1.63	4	27.40%	1.39
5	58.60%	1.89	5	30.00%	1.6
6	64.50%	2.14	6	32.40%	1.81
7	69.80%	2.35	7	34.50%	1.99
8	74.20%	2.52	8	36.30%	2.13
9	77.70%	2.66	9	37.70%	2.25
10	80.10%	2.77	10	38.60%	2.35
11	81.10%	2.88	11	39.10%	2.45
12	81.10%	2.88	12	39.10%	2.45
13	81.10%	2.88	13	39.10%	2.45
14	81.10%	2.88	14	39.10%	2.45
15	81.10%	2.88	15	39.10%	2.45

TABLE 1.
Residential, One Story with Basement.

Structure			Content		
16	81.10%	2.88	16	39.10%	2.45

TABLE 2.
Residential, Two or More Stories, With Basement

Structure			Content		
Depth	Mean of Damage	Standard Deviation of Damage	Depth	Mean of Damage	Standard Deviation of Damage
-8	1.70%	2.7	-8	0%	0
-7	1.70%	2.7	-7	1.00%	2.27
-6	1.90%	2.11	-6	2.30%	1.76
-5	2.90%	1.8	-5	3.70%	1.49
-4	4.70%	1.66	-4	5.20%	1.37
-3	7.20%	1.56	-3	6.80%	1.29
-2	10.20%	1.47	-2	8.40%	1.21
-1	13.90%	1.37	-1	10.10%	1.13
0	17.90%	1.32	0	11.90%	1.09
1	22.30%	1.35	1	13.80%	1.11
2	27.00%	1.5	2	15.70%	1.23
3	31.90%	1.75	3	17.70%	1.43
4	36.90%	2.04	4	19.80%	1.67
5	41.90%	2.34	5	22.00%	1.92
6	46.90%	2.63	6	24.30%	2.15
7	51.80%	2.89	7	26.70%	2.36
8	56.40%	3.13	8	29.10%	2.56
9	60.80%	3.38	9	31.70%	2.76
10	64.80%	3.71	10	34.40%	3.04
11	68.40%	4.22	11	37.20%	3.46
12	71.40%	5.02	12	40.00%	4.12
13	73.70%	6.19	13	43.00%	5.08
14	75.40%	7.79	14	46.10%	6.39
15	76.40%	9.84	15	49.30%	8.08
16	76.40%	12.36	16	52.60%	10.15

TABLE 3.
Residential, Split Level, With Basement

Structure			Content		
Depth	Mean of Damage	Standard Deviation of Damage	Depth	Mean of Damage	Standard Deviation of Damage
-8			-8	0.60%	2.09
-7			-7	0.70%	1.49
-6	2.50%	1.80%	-6	1.40%	1.14
-5	3.10%	1.60%	-5	2.40%	1.01
-4	4.70%	1.50%	-4	3.80%	1
-3	7.20%	1.60%	-3	5.40%	1.02
-2	10.40%	1.60%	-2	7.30%	1.03
-1	14.20%	1.60%	-1	9.40%	1.04
0	18.50%	1.60%	0	11.60%	1.06
1	23.20%	1.70%	1	13.80%	1.12
2	28.20%	1.90%	2	16.10%	1.23
3	33.40%	2.10%	3	18.20%	1.38
4	38.60%	2.40%	4	20.20%	1.57
5	43.80%	2.60%	5	22.10%	1.76
6	48.80%	2.90%	6	23.60%	1.95
7	53.50%	3.20%	7	24.90%	2.13
8	57.80%	3.40%	8	25.80%	2.28
9	61.60%	3.60%	9	26.30%	2.44
10	64.80%	3.90%	10	26.30%	2.44
11	67.20%	4.20%	11	26.30%	2.44
12	68.80%	4.80%	12	26.30%	2.44
13	69.30%	5.70%	13	26.30%	2.44
14	69.30%	5.70%	14	26.30%	2.44
15	69.30%	5.70%	15	26.30%	2.44
16	69.30%	5.70%	16	26.30%	2.44

TABLE 4.
Residential, One Story, No Basement

Structure			Content		
Depth	Mean of Damage	Standard Deviation of Damage	Depth	Mean of Damage	Standard Deviation of Damage
-2	0%	0%	-2	0%	0%
-1	2.50%	2.70%	-1	2.40%	2.10%
0	13.40%	2.00%	0	8.10%	1.50%
1	23.30%	1.60%	1	13.30%	1.20%
2	32.10%	1.60%	2	17.90%	1.20%
3	40.10%	1.80%	3	22.00%	1.40%
4	47.10%	1.90%	4	25.70%	1.50%
5	53.20%	2.00%	5	28.80%	1.60%
6	58.60%	2.10%	6	31.50%	1.60%
7	63.20%	2.20%	7	33.80%	1.70%
8	67.20%	2.30%	8	35.70%	1.80%
9	70.50%	2.40%	9	37.20%	1.90%
10	73.20%	2.70%	10	38.40%	2.10%
11	75.40%	3.00%	11	39.20%	2.30%
12	77.20%	3.30%	12	39.70%	2.60%
13	78.50%	3.70%	13	40.00%	2.90%
14	79.50%	4.10%	14	40.00%	3.20%
15	80.20%	4.50%	15	40.00%	3.50%
16	80.70%	4.90%	16	40.00%	3.80%

TABLE 5.
Residential, Two of More Stories, No Basement

Structure			Content		
Depth	Mean of Damage	Standard Deviation of Damage	Depth	Mean of Damage	Standard Deviation of Damage
-2	0%	0%	-2	0%	0%
-1	3.00%	4.10%	-1	1.00%	3.50%
0	9.30%	3.40%	0	5.00%	2.90%
1	15.20%	3.00%	1	8.70%	2.60%
2	20.90%	2.80%	2	12.20%	2.50%
3	26.30%	2.90%	3	15.50%	2.50%
4	31.40%	3.20%	4	18.50%	2.70%
5	36.20%	3.40%	5	21.30%	3.00%
6	40.70%	3.70%	6	23.90%	3.20%
7	44.90%	3.90%	7	26.30%	3.30%
8	48.80%	4.00%	8	28.40%	3.40%
9	52.40%	4.10%	9	30.30%	3.50%
10	55.70%	4.20%	10	32.00%	3.50%
11	58.70%	4.20%	11	33.40%	3.50%
12	61.40%	4.20%	12	34.70%	3.50%
13	63.80%	4.20%	13	35.60%	3.50%
14	65.90%	4.30%	14	36.40%	3.60%
15	67.70%	4.60%	15	36.90%	3.80%
16	69.20%	5.00%	16	37.20%	4.20%

TABLE 6.
Residential, Split Level, No basement

Structure			Content		
Depth	Mean of Damage	Standard Deviation of Damage	Depth	Mean of Damage	Standard Deviation of Damage
-2	0%	0%	-2	0%	0%
-1	6.40%	2.90%	-1	2.20%	2.20%
0	7.20%	2.10%	0	2.90%	1.50%
1	9.40%	1.90%	1	4.70%	1.20%
2	12.90%	1.90%	2	7.50%	1.30%
3	17.40%	2.00%	3	11.10%	1.40%
4	22.80%	2.20%	4	15.30%	1.50%
5	28.90%	2.40%	5	20.10%	1.60%
6	35.50%	2.70%	6	25.20%	1.80%
7	42.30%	3.20%	7	30.50%	2.10%
8	49.20%	3.80%	8	35.70%	2.50%
9	56.10%	4.50%	9	40.90%	3.00%
10	62.60%	5.30%	10	45.80%	3.50%
11	68.60%	6.00%	11	50.20%	4.10%
12	73.90%	6.70%	12	54.10%	4.60%
13	78.40%	7.40%	13	57.20%	5.00%
14	81.70%	7.90%	14	59.40%	5.40%
15	83.80%	8.30%	15	60.50%	5.70%
16	84.40%	8.70%	16	60.50%	6.00%

TABLE 7.
Non-residential, Commercial and Industry

Structure		Contents	
Depth	Combined Commercial Industrial	Depth	Combined Commercial Industrial
-8		-8	
-7		-7	
-6		-6	
-5		-5	
-4	0.00%	-4	0.00%
-3	0.00%	-3	0.00%
-2	0.00%	-2	0.00%
-1	0.00%	-1	0.00%
0	0.68%	0	2.75%
1	10.21%	1	19.50%
2	14.21%	2	33.73%
3	17.46%	3	45.16%
4	20.92%	4	55.26%
5	24.02%	5	62.08%
6	27.35%	6	66.93%
7	30.50%	7	70.34%
8	33.72%	8	73.19%
9	36.89%	9	75.46%
10	39.86%	10	77.21%
11	43.52%	11	79.60%
12	46.85%	12	81.10%
13	49.45%	13	82.40%
14	51.85%	14	83.64%
15	54.31%	15	84.28%
16	56.53%	16	84.82%

Note: This curve was created by USACE, Galveston District

References:

Economic Guidance Memorandum (EGM) 04-01, Generic Depth-Damage Relationships for Residential Structures with Basements.

United States Army Corp of Engineers, Galveston District, HAZUS application.

CECW-PG 10 October 2003

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Economic Guidance Memorandum (EGM) 04-01, Generic Depth-Damage Relationships for Residential Structures with Basements.

1. Purpose. The purpose of this memorandum is to release, and provide guidance for the use of, generic depth-damage curves for use in U.S. Army Corps of Engineers flood damage reduction studies.

2. Background. Proper planning and evaluation of flood damage reduction projects require knowledge of actual damage caused to various types of properties. The primary purpose of the Flood Damage Data Collection Program is to meet that requirement by providing Corps district offices with standardized relationships for estimating flood damage and other costs of flooding, based on actual losses from flood events. Under this program, data have been collected from major flooding that occurred in various parts of the United States from 1996 through 2001. Damage data collected are based on comprehensive accounting of losses from flood victims' records. The generic functions developed and provided in this EGM represent a substantive improvement over other generalized depth-damage functions such as the Flood Insurance Administration (FIA) Rate Reviews.

3. Results. Generic damage functions are attached for one-story homes with basement, two or more story homes with basement, and split-level homes with basement. Generic damage functions for similar structures without basements were published in 2000 and are included as enclosure 1 for ready reference.

a. Regression analysis was used to create the damage functions. While several independent variables, such as flood duration and flood warning lead-time, were examined in building the models, the models that were most efficient in explaining the percent damage to structure and contents were quadratic and cubic forms with depth as the only independent variable.

b. Content damage was modeled with the dependent variable being content damage as a percentage of structure value. This differs from the previous technique of first developing content valuations and then content damage relationships as a function of content valuations. The generic content damage models are statistically significant and their use eliminates the need to establish content-to-structure ratios through surveys.

c. While the data collected include information on all aspects of National Economic Development (NED) losses, only results and recommendations related to the structure and content damages for homes with basements are included in this EGM.

Direct costs for cleanup expenses, unpaid hours for cleanup and repair, emergency damage prevention actions, and other flood-related costs are not included in these damage functions. Information on other residential flood costs, beyond those included in these damage functions will found the summary report, discussed in paragraph 5. These costs should be developed using site-specific historical information.

4. Application. The following paragraphs provide information on the application of the generic curves within the HEC-FDA damage calculation program.

a. The economic section of HEC-FDA divides the quantification of flood damages into a direct method and an indirect method. The direct method allows the user to directly enter a stage-damage relationship for any structure. This approach is commonly used for large or unique properties such as industrial or pubic buildings. The indirect method quantifies the stage-damage relationship for a group of structures that have significant commonality. Typically damage to residential structures is calculated using the indirect method. The procedures described in the following paragraphs apply only when using the indirect method to determine the stage-damage relationship.

b. The traditional approach to quantifying damage to contents by the indirect method relies on three pieces of information: 1) structure value; 2) content-to-structure value ratio; and 3) the content depth-damage relationship. The content-to-structure value ratio and content depth-damage relationship are unique to the structure occupancy type to which a structure is assigned. The content depth-damage relationship provides the estimate of content flood damage as a percentage of content value. Thus, to calculate a content stage-damage function for an individual structure, the structure value for an individual structure is first multiplied by the content-to-structure value ratio to provide an estimate of the content value. This content value is then multiplied by each percent damage value of the content depth-damage relationship.

c. The new content depth-damage functions provided herein are different from those used by the Corps in the past in one important aspect. The new functions calculate content damage as a percent of structure value rather than content value. Using these functions within HEC-FDA requires care in specifying a content-to-structure value ratio. To understand the requirements for using the new content depth-damage functions requires a basic understanding of how HEC-FDA calculates content damage.

(1). To calculate damages by the indirect method, each structure must be assigned to a structure occupancy type. For each structure occupancy type a content-to-structure value ratio and content depth-damage relationship are defined. These data for calculating content damage within HEC-FDA is entered on the “Study Structure Occupancy Type” screen. As long as a content value is not entered for a structure in the Structure Inventory Data, HEC-FDA calculates the content stage-damage by first calculating content using the structure value multiplied by the content-to-structure value ratio.

In some instances, however, analysts develop unique estimates of content values for a structure, which are entered for the individual structure on the Structure Inventory Data screen. For each structure that has a content value entered, calculating a content value by using the content-to-structure value ratio is ignored and the user entered content value is used to calculate content damage.

(2). The new content depth-damage functions do not require this intermediate step of calculating content values. Therefore, the content-to-structure value ratio for each structure occupancy type using the new content depth-damage relationships must be set to one hundred percent (100). This forces the content depth-damage function to be multiplied by the structure value as required. Also, the "Error Associated with Content/Structure Value" on the "Study Structure Occupancy Type" screen should be left blank. This implies that the error in content-to-structure value ratio is part of the new content depth-damage relationship.

(3). Because entering a content value on the Structure Inventory Data window overrides the content-to-structure value ratio, the new content depth-damage relationships should not be used for structures that have separately entered content values.

(4). Questions concerning the use of the generic curves within the HEC-FDA model can be addressed to Dr. David Moser, Institute of Water Resources (IWR), (703) 428-8066.

5. <u>Report</u>. A report summarizing the data collection effort and analyses performed to derive these curves will shortly be available on the IWR website. More information may be obtained by contacting the program's principal investigator, Stuart Davis, (703) 428-7086.

6. <u>Waiver to Policy</u>. These curves are developed for nation-wide applicability in flood damage reduction studies. When using these curves, the requirement to develop site-specific depth-damage curves contained in ER 1105-2-100, E-19q.(2) is waived. Additionally, the requirement to develop content valuations and content-to-structure ratios based on site-specific or comparable floodplain information, ER 1005-2-100, E-19q.(1)(a), is also waived. Note these waivers currently apply only to single-family homes with and without basements for which generic curves have been published, and not other categories of flood inundation damages for which no generic curves exist. Feasibility reports must state the generic curves are being used in the flood damage analysis for residential structures with and/or without basements. Use of these curves is optional and analysts should always endeavor to use the best available information to accurately quantify the damages and benefits in inundation reduction studies.

7. Point of Contact. Administrators of the Flood Damage Data Collection Program continue to collect and analyze flood-related damages to both residential and commercial properties. The HQUSACE program monitor is Lillian Almodovar, (202) 761-4233, who can address any questions concerning the program.

FOR THE COMMANDER:

/s/

Encl

WILLIAM R. DAWSON, P.E.
Chief, Planning and Policy Division
Directorate of Civil Works

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DAMAGE FUNCTIONS
FOR SINGLE FAMILY RESIDENTIAL
STRUCTURES WITH BASEMENTS

Structure Depth-Damage

Table 1 Structure One Story, With Basement		
Depth	Mean of Damage	Standard Deviation of Damage
-8	0%	0
-7	0.7%	1.34
-6	0.8%	1.06
-5	2.4%	0.94
-4	5.2%	0.91
-3	9.0%	0.88
-2	13.8%	0.85
-1	19.4%	0.83
0	25.5%	0.85
1	32.0%	0.96
2	38.7%	1.14
3	45.5%	1.37
4	52.2%	1.63
5	58.6%	1.89
6	64.5%	2.14
7	69.8%	2.35
8	74.2%	2.52
9	77.7%	2.66
10	80.1%	2.77
11	81.1%	2.88
12	81.1%	2.88
13	81.1%	2.88
14	81.1%	2.88
15	81.1%	2.88
16	81.1%	2.88

Table 2
Structure
Two or More Stories, With Basement

Depth	Mean of Damage	Standard Deviation of Damage
-8	1.7%	2.70
-7	1.7%	2.70
-6	1.9%	2.11
-5	2.9%	1.80
-4	4.7%	1.66
-3	7.2%	1.56
-2	10.2%	1.47
-1	13.9%	1.37
0	17.9%	1.32
1	22.3%	1.35
2	27.0%	1.50
3	31.9%	1.75
4	36.9%	2.04
5	41.9%	2.34
6	46.9%	2.63
7	51.8%	2.89
8	56.4%	3.13
9	60.8%	3.38
10	64.8%	3.71
11	68.4%	4.22
12	71.4%	5.02
13	73.7%	6.19
14	75.4%	7.79
15	76.4%	9.84
16	76.4%	12.36

Table 3 Structure Split Level, With Basement		
Depth	Mean of Damage	Standard Deviation of Damage
-8		
-7		
-6	2.5%	1.8%
-5	3.1%	1.6%
-4	4.7%	1.5%
-3	7.2%	1.6%
-2	10.4%	1.6%
-1	14.2%	1.6%
0	18.5%	1.6%
1	23.2%	1.7%
2	28.2%	1.9%
3	33.4%	2.1%
4	38.6%	2.4%
5	43.8%	2.6%
6	48.8%	2.9%
7	53.5%	3.2%
8	57.8%	3.4%
9	61.6%	3.6%
10	64.8%	3.9%
11	67.2%	4.2%
12	68.8%	4.8%
13	69.3%	5.7%
14	69.3%	5.7%
15	69.3%	5.7%
16	69.3%	5.7%

Content Depth-Damage

Table 4 Content One Story, With Basement		
Depth	Mean of Damage	Standard Deviation of Damage
-8	0.1%	1.60
-7	0.8%	1.16
-6	2.1%	0.92
-5	3.7%	0.81
-4	5.7%	0.78
-3	8.0%	0.76
-2	10.5%	0.74
-1	13.2%	0.72
0	16.0%	0.74
1	18.9%	0.83
2	21.8%	0.98
3	24.7%	1.17
4	27.4%	1.39
5	30.0%	1.60
6	32.4%	1.81
7	34.5%	1.99
8	36.3%	2.13
9	37.7%	2.25
10	38.6%	2.35
11	39.1%	2.45
12	39.1%	2.45
13	39.1%	2.45
14	39.1%	2.45
15	39.1%	2.45
16	39.1%	2.45

Table 5
Content
Two or More Stories-With Basement

Depth	Mean of Damage	Standard Deviation of Damage
-8	0%	0
-7	1.0%	2.27
-6	2.3%	1.76
-5	3.7%	1.49
-4	5.2%	1.37
-3	6.8%	1.29
-2	8.4%	1.21
-1	10.1%	1.13
0	11.9%	1.09
1	13.8%	1.11
2	15.7%	1.23
3	17.7%	1.43
4	19.8%	1.67
5	22.0%	1.92
6	24.3%	2.15
7	26.7%	2.36
8	29.1%	2.56
9	31.7%	2.76
10	34.4%	3.04
11	37.2%	3.46
12	40.0%	4.12
13	43.0%	5.08
14	46.1%	6.39
15	49.3%	8.08
16	52.6%	10.15

Table 6 Content Split-Level-With Basement		
Depth	Mean of Damage	Standard Deviation of Damage
-8	0.6%	2.09
-7	0.7%	1.49
-6	1.4%	1.14
-5	2.4%	1.01
-4	3.8%	1.00
-3	5.4%	1.02
-2	7.3%	1.03
-1	9.4%	1.04
0	11.6%	1.06
1	13.8%	1.12
2	16.1%	1.23
3	18.2%	1.38
4	20.2%	1.57
5	22.1%	1.76
6	23.6%	1.95
7	24.9%	2.13
8	25.8%	2.28
9	26.3%	2.44
10	26.3%	2.44
11	26.3%	2.44
12	26.3%	2.44
13	26.3%	2.44
14	26.3%	2.44
15	26.3%	2.44
16	26.3%	2.44

ENCLOSURE
DAMAGE FUNCTIONS
FOR SINGLE FAMILY RESIDENTIAL

STRUCTURES WITHOUT BASEMENTS

Structure One Story, No Basement		
Depth	**Mean of Damage**	**Standard Deviation of Damage**
-2	0%	0%
-1	2.5%	2.7%
0	13.4%	2.0%
1	23.3%	1.6%
2	32.1%	1.6%
3	40.1%	1.8%
4	47.1%	1.9%
5	53.2%	2.0%
6	58.6%	2.1%
7	63.2%	2.2%
8	67.2%	2.3%
9	70.5%	2.4%
10	73.2%	2.7%
11	75.4%	3.0%
12	77.2%	3.3%
13	78.5%	3.7%
14	79.5%	4.1%
15	80.2%	4.5%
16	80.7%	4.9%

Structure Two or More Stories-No Basement		
Depth	**Mean of Damage**	**Standard Deviation of Damage**
-2	0%	0%
-1	3.0%	4.1%
0	9.3%	3.4%
1	15.2%	3.0%
2	20.9%	2.8%
3	26.3%	2.9%
4	31.4%	3.2%
5	36.2%	3.4%
6	40.7%	3.7%
7	44.9%	3.9%
8	48.8%	4.0%
9	52.4%	4.1%
10	55.7%	4.2%
11	58.7%	4.2%
12	61.4%	4.2%
13	63.8%	4.2%
14	65.9%	4.3%
15	67.7%	4.6%
16	69.2%	5.0%

Structure Split-Level-No Basement		
Depth	**Mean of Damage**	**Standard Deviation of Damage**
-2	0%	0%
-1	6.4%	2.9%
0	7.2%	2.1%
1	9.4%	1.9%
2	12.9%	1.9%
3	17.4%	2.0%
4	22.8%	2.2%
5	28.9%	2.4%
6	35.5%	2.7%
7	42.3%	3.2%
8	49.2%	3.8%
9	56.1%	4.5%
10	62.6%	5.3%
11	68.6%	6.0%
12	73.9%	6.7%
13	78.4%	7.4%
14	81.7%	7.9%
15	83.8%	8.3%
16	84.4%	8.7%

Content One Story, No Basement		
Depth	Mean of Damage	Standard Deviation of Damage
-2	0%	0%
-1	2.4%	2.1%
0	8.1%	1.5%
1	13.3%	1.2%
2	17.9%	1.2%
3	22.0%	1.4%
4	25.7%	1.5%
5	28.8%	1.6%
6	31.5%	1.6%
7	33.8%	1.7%
8	35.7%	1.8%
9	37.2%	1.9%
10	38.4%	2.1%
11	39.2%	2.3%
12	39.7%	2.6%
13	40.0%	2.9%
14	40.0%	3.2%
15	40.0%	3.5%
16	40.0%	3.8%

Content Two or More Stories-No Basement		
Depth	**Mean of Damage**	**Standard Deviation of Damage**
-2	0%	0%
-1	1.0%	3.5%
0	5.0%	2.9%
1	8.7%	2.6%
2	12.2%	2.5%
3	15.5%	2.5%
4	18.5%	2.7%
5	21.3%	3.0%
6	23.9%	3.2%
7	26.3%	3.3%
8	28.4%	3.4%
9	30.3%	3.5%
10	32.0%	3.5%
11	33.4%	3.5%
12	34.7%	3.5%
13	35.6%	3.5%
14	36.4%	3.6%
15	36.9%	3.8%
16	37.2%	4.2%

Content Split-Level-No Basement		
Depth	Mean of Damage	Standard Deviation of Damage
-2	0%	0%
-1	2.2%	2.2%
0	2.9%	1.5%
1	4.7%	1.2%
2	7.5%	1.3%
3	11.1%	1.4%
4	15.3%	1.5%
5	20.1%	1.6%
6	25.2%	1.8%
7	30.5%	2.1%
8	35.7%	2.5%
9	40.9%	3.0%
10	45.8%	3.5%
11	50.2%	4.1%
12	54.1%	4.6%
13	57.2%	5.0%
14	59.4%	5.4%
15	60.5%	5.7%
16	60.5%	6.0%

Appendix F
HMS Model Parameters

Subwatershed	Subbasin	Area (sq.mi.)	Final Clarks Tc	Final Clarks R	Final CN	Final DCI (%)
Butterfield Creek	BC-01	1.006	2.71	5.08	76.0	3.31
Butterfield Creek	BC-02	0.837	2.61	4.90	75.5	2.46
Butterfield Creek	BC-03	0.604	1.19	2.23	74.4	0.07
Butterfield Creek	BC-04	1.652	2.13	3.99	71.2	2.68
Butterfield Creek	BC-05	0.507	1.45	2.72	72.2	5.40
Butterfield Creek	BC-06	1.777	2.42	4.54	69.3	0.83
Butterfield Creek	BC-07	2.196	3.86	7.24	71.7	5.51
Butterfield Creek	BC-08	0.521	1.23	2.30	73.7	6.05
Butterfield Creek	BC-09	0.235	0.76	1.42	76.3	6.94
Butterfield Creek	BC-10	0.329	1.13	2.12	78.6	13.35
Butterfield Creek	BC-11	1.090	1.58	2.97	72.5	4.77
Butterfield Creek	BC-12	0.593	0.82	1.54	70.4	1.95
Butterfield Creek	BC-13	0.120	0.68	1.27	69.7	2.99
Butterfield Creek	BC-14	0.429	1.46	2.74	73.5	6.87
Butterfield Creek	BC-15	0.155	1.27	2.38	66.1	0.95
Butterfield Creek	BC-16	0.606	1.10	2.06	70.5	3.93
Butterfield Creek	BC-17	0.670	0.94	1.75	70.0	4.74
Butterfield Creek	BC-18	0.085	0.93	1.75	65.6	4.33
Butterfield Creek	BC-19	0.178	0.67	1.25	72.0	7.47
Butterfield Creek	BC-20	0.900	1.38	2.59	72.5	10.79
Butterfield Creek	BC-21	0.294	1.28	2.41	72.1	9.04
Butterfield Creek	BC-22	0.101	0.65	1.22	71.1	11.21
Butterfield Creek	BC-EB-01	0.409	1.53	2.87	77.7	1.27
Butterfield Creek	BC-EB-02	0.086	0.51	0.95	74.8	4.22
Butterfield Creek	BC-EB-03	0.191	1.12	2.10	68.9	1.22
Butterfield Creek	BC-EB-04	0.769	1.65	3.09	74.7	10.49
Butterfield Creek	BC-EB-05	0.263	0.89	1.66	71.1	4.03
Butterfield Creek	BC-EB-06	0.151	1.50	2.82	72.1	4.63
Butterfield Creek	BC-EB-07	1.537	2.63	4.94	76.8	15.74
Butterfield Creek	BC-EB-08	0.118	0.89	1.67	84.4	33.06
Butterfield Creek	BC-EB-09	0.039	0.37	0.69	81.6	27.32
Butterfield Creek	BC-EB-10	0.088	0.48	0.89	76.3	10.40
Butterfield Creek	BC-EB-TA-01	0.130	0.78	1.47	75.6	1.98
Butterfield Creek	BC-EB-TA-02	0.037	0.87	1.63	71.6	5.34
Butterfield Creek	BC-EB-TR-01	0.273	0.82	1.53	79.2	4.46
Butterfield Creek	BC-EB-TR-02	0.666	1.53	2.87	75.7	1.53
Butterfield Creek	BC-EB-TR-03	0.067	0.58	1.09	74.7	10.55
Butterfield Creek	BC-EB-TR-04	0.116	0.66	1.23	75.4	6.07
Butterfield Creek	BC-EB-TR-05	0.165	1.24	2.32	72.6	7.82
Butterfield Creek	BC-EB-TR-06	0.859	1.97	3.69	73.7	6.07
Butterfield Creek	BC-EB-TR-07	0.250	1.24	2.33	69.9	2.33
Butterfield Creek	BC-EB-UTL-01	0.168	1.66	3.11	78.2	10.11

Subwatershed	Subbasin	Area (sq.mi.)	Final Clarks Tc	Final Clarks R	Final CN	Final DCI (%)
Butterfield Creek	BC-EB-UTL-02	0.222	1.07	2.00	74.0	8.85
Butterfield Creek	BC-EB-UTS-01	0.443	0.91	1.71	77.8	4.20
Butterfield Creek	BC-EB-UTS-02	0.034	1.11	2.09	73.4	3.84
Butterfield Creek	BC-T1-01	0.607	1.38	2.59	73.5	7.27
Butterfield Creek	BC-T1-02	0.088	0.86	1.62	72.2	4.83
Butterfield Creek	BC-T3-01	0.317	0.85	1.58	75.0	8.44
Butterfield Creek	BC-T3-02	0.096	0.61	1.14	73.8	7.03
Butterfield Creek	BC-T3-03	0.386	1.19	2.23	74.1	7.70
Butterfield Creek	BC-T3-04	0.015	0.57	1.06	72.2	5.40
Butterfield Creek	BC-T4-01	0.140	0.79	1.48	78.8	17.76
Butterfield Creek	BC-T4-02	0.122	0.78	1.46	75.8	7.63
Butterfield Creek	BC-T4-03	0.049	0.55	1.04	74.1	5.70
Butterfield Creek	BC-UTC-01	0.369	2.33	4.36	75.5	9.23
Butterfield Creek	BC-UTC-02	0.365	1.21	2.27	73.5	3.38
Butterfield Creek	BC-UTH-01	1.237	2.00	3.74	69.8	6.02
Butterfield Creek	BC-UTH-02	0.091	0.86	1.61	65.1	11.39
Cady Marsh Ditch	CM-01	0.681	2.12	3.98	49.9	5.01
Cady Marsh Ditch	CM-02	1.561	2.50	4.70	44.9	3.06
Cady Marsh Ditch	CM-03	2.544	3.65	6.84	45.8	2.85
Cady Marsh Ditch	CM-04	3.579	5.48	10.27	58.0	5.97
Cady Marsh Ditch	CM-05	0.492	3.19	5.98	52.0	7.79
Cady Marsh Ditch	CM-06	0.273	1.13	2.11	49.8	5.47
Cady Marsh Ditch	CM-SD-01	7.121	5.17	9.69	59.4	5.74
Cal Union Drainage Ditch	CU-01	0.374	1.22	2.29	73.3	17.68
Cal Union Drainage Ditch	CU-02	0.209	0.82	1.55	65.0	6.65
Cal Union Drainage Ditch	CU-03	0.055	1.06	1.99	61.8	11.98
Cal Union Drainage Ditch	CU-04	2.126	3.07	5.76	67.0	8.71
Cal Union Drainage Ditch	CU-05	0.415	1.21	2.26	66.2	4.06
Cal Union Drainage Ditch	CU-06	0.214	1.66	3.11	71.3	14.91
Cal Union Drainage Ditch	CU-07	0.295	1.91	3.58	70.2	11.14
Cal Union Drainage Ditch	CU-08	0.405	1.85	3.46	76.5	0.01
Cal Union Drainage Ditch	CU-09	0.138	1.47	2.75	71.0	12.40
Cal Union Drainage Ditch	CU-10	0.642	2.36	4.42	71.1	17.95
Cal Union Drainage Ditch	CU-11	0.360	2.17	4.06	74.1	24.22
Cal Union Drainage Ditch	CU-12	0.504	2.41	4.53	70.8	12.84
Cal Union Drainage Ditch	CU-13	0.399	1.84	3.46	71.1	13.72
Cal Union Drainage Ditch	CU-14	0.413	1.81	3.40	72.2	17.84
Cal Union Drainage Ditch	CU-BC-01	0.128	1.65	3.10	60.6	4.65
Cal Union Drainage Ditch	CU-BC-02	0.399	2.12	3.97	59.2	2.50
Cal Union Drainage Ditch	CU-BC-03	0.286	2.05	3.85	65.2	6.71
Cal Union Drainage Ditch	CU-CC-01	0.299	0.99	1.85	66.5	5.92
Cal Union Drainage Ditch	CU-CC-02	1.271	2.48	4.66	67.0	7.10
Cal Union Drainage Ditch	CU-CC-03	0.222	1.73	3.25	63.5	5.55
Cal Union Drainage Ditch	CU-CC-04	0.588	2.27	4.25	67.1	13.06
Cal Union Drainage Ditch	CU-CE-01	0.367	1.16	2.18	68.6	3.14
Cal Union Drainage Ditch	CU-CE-02	0.019	0.38	0.71	78.7	31.32

Subwatershed	Subbasin	Area (sq.mi.)	Final Clarks Tc	Final Clarks R	Final CN	Final DCI (%)
Cal Union Drainage Ditch	CU-CE-03	0.080	0.61	1.15	73.2	19.46
Cal Union Drainage Ditch	CU-CE-04	0.024	0.36	0.68	78.1	25.75
Cal Union Drainage Ditch	CU-CE-05	0.019	0.62	1.16	72.6	12.48
Cal Union Drainage Ditch	CU-CE-06	0.334	1.06	1.99	71.1	9.88
Cal Union Drainage Ditch	CU-CE-07	0.920	1.69	3.17	68.5	6.03
Cal Union Drainage Ditch	CU-CE-08	0.030	0.31	0.57	67.4	4.64
Cal Union Drainage Ditch	CU-CET-01	0.276	0.93	1.74	71.9	10.25
Cal Union Drainage Ditch	CU-CET-02	0.075	1.66	3.11	72.7	14.60
Cal Union Drainage Ditch	CU-CN-01	1.869	3.17	5.94	70.6	10.74
Cal Union Drainage Ditch	CU-CN-02	0.108	1.83	3.44	75.5	8.41
Cal Union Drainage Ditch	CU-CN-04	0.937	2.41	4.52	72.1	20.45
Cal Union Drainage Ditch	CU-CW-01	0.183	0.87	1.64	71.4	6.06
Cal Union Drainage Ditch	CU-CW-02	0.476	1.31	2.45	71.3	5.81
Cal Union Drainage Ditch	CU-CW-03	0.034	0.25	0.47	76.7	14.32
Cal Union Drainage Ditch	CU-CW-04	0.299	0.62	1.17	71.1	10.85
Cal Union Drainage Ditch	CU-CW-05	0.300	0.92	1.72	70.5	10.01
Cal Union Drainage Ditch	CU-CW-06	0.152	0.74	1.39	68.6	5.49
Cal Union Drainage Ditch	CU-CWT-01	0.162	0.95	1.78	69.6	5.41
Cal Union Drainage Ditch	CU-CWT-02	0.346	0.74	1.38	72.1	7.50
Cal Union Drainage Ditch	CU-DC-01	0.198	2.36	4.43	60.5	1.72
Cal Union Drainage Ditch	CU-DC-02	0.048	0.91	1.71	65.8	0.52
Cal Union Drainage Ditch	CU-I57-01	1.354	1.95	3.66	69.6	9.40
Cal Union Drainage Ditch	CU-I57-02	0.112	1.39	2.60	62.5	2.26
Cal Union Drainage Ditch	CU-PC-01	0.401	2.14	4.01	60.4	5.03
Cal Union Drainage Ditch	CU-PC-02	0.236	2.00	3.76	61.0	2.62
Cal Union Drainage Ditch	CU-PC-03	1.458	3.10	5.81	62.7	3.71
Cal Union Drainage Ditch	CU-SW-01	0.626	1.06	1.99	71.6	5.59
Cal Union Drainage Ditch	CU-SW-02	0.175	1.19	2.24	70.8	9.86
Cal Union Drainage Ditch	CU-SW-03	0.177	0.85	1.60	69.7	6.42
Cal Union Drainage Ditch	CU-SW-04	0.113	0.64	1.21	69.3	6.13
Cal Union Drainage Ditch	CU-SW-05	0.227	0.66	1.24	69.3	5.96
Cal Union Drainage Ditch	CU-SW-06	0.590	1.07	2.01	70.2	9.59
Cal Union Drainage Ditch	CU-SW-07	0.434	1.45	2.71	66.7	6.01
Cal Union Drainage Ditch	CU-SW-08	0.289	1.52	2.84	67.8	4.84
Cal Union Drainage Ditch	CU-SW-09	0.111	1.51	2.84	63.6	8.35
Cal Union Drainage Ditch	CU-SWN-01	0.372	0.80	1.50	71.2	2.64
Cal Union Drainage Ditch	CU-SWN-02	0.043	0.57	1.07	70.2	2.26
Cal Union Drainage Ditch	CU-SWN-03	0.454	1.59	2.97	69.2	6.18
Cal Union Drainage Ditch	CU-SWS-02	0.179	0.71	1.33	71.4	6.07
Cal Union Drainage Ditch	CU-SWS-03	0.397	1.13	2.12	72.5	10.92
Deer Creek	DC-01	5.052	3.56	6.68	73.4	1.19
Deer Creek	DC-02	2.209	2.76	5.18	72.1	4.12
Deer Creek	DC-03	8.427	3.47	6.51	72.7	3.09
Deer Creek	DC-04	0.428	0.56	1.05	71.5	3.85
Deer Creek	DC-05	0.599	1.30	2.43	70.7	3.65
Deer Creek	DC-06	0.150	0.45	0.84	75.4	11.82

Subwatershed	Subbasin	Area (sq.mi.)	Final Clarks Tc	Final Clarks R	Final CN	Final DCI (%)
Deer Creek	DC-07	0.281	0.92	1.72	72.6	7.56
Deer Creek	DC-08	0.154	1.02	1.92	72.4	2.85
Deer Creek	DC-09	0.178	1.21	2.27	73.3	6.33
Deer Creek	DC-10	0.288	1.34	2.51	78.8	16.53
Deer Creek	DC-11	0.049	0.95	1.78	72.2	1.79
Deer Creek	DC-12	0.083	1.47	2.76	71.4	4.23
Deer Creek	DC-13	0.437	1.51	2.84	75.1	12.81
Deer Creek	DC-14	0.335	3.09	5.79	74.2	1.47
Deer Creek	DC-15	0.784	3.69	6.93	75.0	3.68
Deer Creek	DC-16	0.283	1.81	3.40	74.8	0.87
Deer Creek	DC-17	0.334	3.94	7.39	71.5	2.41
Deer Creek	DC-18	0.291	1.71	3.21	66.8	0.53
Deer Creek	DC-19	0.174	1.63	3.05	68.4	0.52
Deer Creek	DC-MT-01	0.626	0.91	1.70	72.0	5.28
Deer Creek	DC-T1-01	0.240	0.79	1.48	71.5	11.00
Deer Creek	DC-T1-02	0.233	1.14	2.13	72.0	2.67
Deer Creek	DC-T1-03	0.334	1.37	2.57	73.3	7.60
Deer Creek	DC-TB-01	0.750	0.83	1.55	73.6	4.43
Deer Creek	DC-TB-02	0.340	0.89	1.67	72.8	2.57
Deer Creek	DC-TB-03	0.380	1.19	2.23	75.9	7.65
Deer Creek	DC-TB-04	0.509	1.48	2.78	73.9	1.98
Deer Creek	DC-TB-05	0.105	1.14	2.14	78.5	7.71
Deer Creek	DC-TB-T1-01	0.417	1.04	1.96	70.4	3.11
Deer Creek	DC-TB-T1-02	0.257	1.05	1.96	72.1	4.48
Deer Creek	DC-TC-01	0.589	2.85	5.34	72.1	5.47
Deer Creek	DC-TC-02	0.585	8.02	15.04	71.6	4.00
Deer Creek	DC-TC-03	0.450	5.31	9.96	74.3	10.46
Deer Creek	DC-TC-04	0.612	3.71	6.95	71.1	3.51
Hart Ditch	HD-01	1.106	3.14	5.89	75.8	5.42
Hart Ditch	HD-02	0.402	2.65	4.98	80.0	5.03
Hart Ditch	HD-03	3.954	6.87	12.88	70.1	5.23
Hart Ditch	HD-04	0.138	2.05	3.85	47.6	4.28
Hart Ditch	HD-05	0.021	5.13	9.62	61.0	1.85
Hart Ditch	HD-DD-01	9.738	4.03	7.55	67.2	4.18
Hart Ditch	HD-SD-01	1.637	7.51	14.08	52.6	8.03
Little Calumet River	LC-DR-01	4.817	3.56	6.67	71.1	2.44
Little Calumet River	LC-DR-02	5.541	4.37	8.20	64.5	2.16
Little Calumet River	LC-DR-03	3.532	8.06	15.12	49.2	2.29
Little Calumet River	LC-DR-04	3.326	2.38	4.46	73.3	2.88
Little Calumet River	LC-DR-05	13.227	14.08	26.40	69.9	3.09
Little Calumet River	LC-DR-06	4.482	2.94	5.51	75.5	6.54
Little Calumet River	LC-DR-07	4.219	3.80	7.12	73.2	4.43
Little Calumet River	LC-DR-08	4.192	5.47	10.26	77.1	0.37
Little Calumet River	LC-DR-09	4.926	4.45	8.35	67.9	0.58
Little Calumet River	LC-DR-10	14.294	10.45	19.59	72.8	3.42
Little Calumet River	LC-DR-11	3.049	5.05	9.48	72.9	1.98

Subwatershed	Subbasin	Area (sq.mi.)	Final Clarks Tc	Final Clarks R	Final CN	Final DCI (%)
Little Calumet River	LC-DR-12	2.062	3.67	6.89	77.5	0.47
Little Calumet River	LC-DR-13	12.747	27.87	52.26	73.2	0.35
Little Calumet River	LC-DR-14	4.144	5.19	9.74	75.4	0.60
Little Calumet River	LC-DR-15	4.655	2.64	4.94	73.9	1.25
Little Calumet River	LC-DR-16	15.203	5.24	9.82	68.5	0.43
Little Calumet River	LC-DR-17	6.480	6.31	11.83	68.5	0.46
Little Calumet River	LC-DR-18	5.736	3.61	6.76	74.1	4.28
Little Calumet River	LC-DR-19	1.163	2.82	5.29	70.3	0.67
Little Calumet River	LC-DR-20	14.944	3.63	6.81	71.1	0.88
Little Calumet River	LC-DR-21	6.199	7.47	14.01	73.1	2.40
Little Calumet River	LC-DR-22	11.123	12.00	22.51	62.4	3.38
Little Calumet River	LC-E-01	1.109	2.64	4.96	68.7	5.20
Little Calumet River	LC-E-02	0.223	1.07	2.00	56.9	4.78
Little Calumet River	LC-E-03	2.479	2.49	4.66	62.6	2.74
Little Calumet River	LC-E-04	0.799	2.16	4.05	78.2	0.30
Little Calumet River	LC-E-05	0.395	1.63	3.05	73.3	0.77
Little Calumet River	LC-E-06	0.153	1.25	2.34	81.7	2.31
Little Calumet River	LC-E-07	4.244	3.64	6.83	61.7	4.68
Little Calumet River	LC-E-08	0.139	1.15	2.17	75.1	4.34
Little Calumet River	LC-E-09	5.995	10.11	18.96	63.3	4.32
Little Calumet River	LC-E-10	9.460	7.59	14.22	64.3	3.10
Little Calumet River	LC-E-11	3.228	3.63	6.81	54.9	3.35
Little Calumet River	LC-E-12	3.073	4.37	8.19	50.2	5.02
Little Calumet River	LC-EA-01	8.915	3.38	6.33	61.1	0.27
Little Calumet River	LC-EA-02	3.737	1.90	3.56	61.5	0.34
Little Calumet River	LC-EA-03	5.375	1.90	3.56	62.8	0.32
Little Calumet River	LC-EA-04	10.513	13.22	24.79	68.5	0.83
Little Calumet River	LC-EA-05	15.175	3.75	7.04	68.3	0.48
Little Calumet River	LC-EA-06	5.114	2.30	4.31	65.5	0.80
Little Calumet River	LC-EA-07	0.801	1.10	2.05	68.4	2.24
Little Calumet River	LC-EA-08	17.776	4.71	8.83	63.2	0.79
Little Calumet River	LC-EA-09	2.060	2.92	5.48	69.5	2.98
Little Calumet River	LC-EA-10	7.074	7.40	13.87	68.6	5.11
Little Calumet River	LC-EA-11	1.427	0.97	1.82	58.3	4.05
Little Calumet River	LC-EID-01	1.331	3.98	7.46	66.1	7.20
Little Calumet River	LC-EID-02	0.421	1.45	2.72	58.4	4.35
Little Calumet River	LC-EID-03	0.188	4.14	7.77	74.9	4.92
Little Calumet River	LC-EID-04	2.146	6.93	12.99	67.4	7.13
Little Calumet River	LC-EID-05	1.057	2.08	3.90	69.1	7.84
Little Calumet River	LC-EID-06	0.226	1.38	2.58	70.2	4.28
Little Calumet River	LC-EID-07	0.526	1.37	2.57	72.9	2.83
Little Calumet River	LC-EID-08	0.580	2.14	4.00	66.0	8.78
Little Calumet River	LC-EID-09	1.878	5.14	9.63	58.8	4.69
Little Calumet River	LC-EID-10	1.105	2.68	5.03	56.0	3.07
Little Calumet River	LC-EID-11	0.827	2.24	4.20	62.6	4.05
Little Calumet River	LC-EID-12	0.755	1.27	2.38	64.1	5.49

Subwatershed	Subbasin	Area (sq.mi.)	Final Clarks Tc	Final Clarks R	Final CN	Final DCI (%)
Little Calumet River	LC-EID-13	0.197	6.19	11.60	77.2	15.16
Little Calumet River	LC-EID-14	0.289	26.64	49.95	61.7	1.20
Little Calumet River	LC-EID-15	1.459	1.67	3.12	60.6	6.54
Little Calumet River	LC-EID-16	1.377	2.77	5.20	57.2	6.02
Little Calumet River	LC-SC-01	7.949	4.51	8.46	70.8	4.60
Little Calumet River	LC-SC-02	10.281	5.48	10.27	64.1	0.51
Little Calumet River	LC-SC-03	9.406	2.25	4.22	67.9	2.45
Little Calumet River	LC-SC-04	12.317	3.71	6.95	67.0	0.55
Little Calumet River	LC-SC-05	11.833	2.16	4.05	67.9	0.68
Little Calumet River	LC-SC-06	14.168	3.76	7.04	70.8	0.81
Little Calumet River	LC-SC-07	13.694	5.63	10.56	67.8	2.39
Little Calumet River	LC-SC-08	1.458	1.78	3.34	59.6	2.11
Little Calumet River	LC-TA-01	0.700	2.87	5.38	78.1	10.55
Little Calumet River	LC-TA-02	0.613	2.74	5.13	78.8	10.40
Little Calumet River	LC-W-01	0.093	2.28	4.27	71.5	3.09
Little Calumet River	LC-W-02	0.229	2.92	5.47	76.1	6.81
Little Calumet River	LC-W-03	0.216	4.26	7.99	75.4	5.54
Little Calumet River	LC-W-04	0.068	1.19	2.24	82.3	26.93
Little Calumet River	LC-W-05	0.096	1.04	1.94	76.5	12.14
Little Calumet River	LC-W-06	0.213	2.79	5.23	77.5	10.96
Little Calumet River	LC-W-07	2.410	4.58	8.59	73.2	15.07
Little Calumet River	LC-W-08	0.146	0.88	1.64	73.0	3.23
Little Calumet River	LC-W-09	1.166	3.13	5.86	66.5	4.59
Little Calumet River	LC-W-10	0.832	3.04	5.71	79.0	11.08
Little Calumet River	LC-W-11	0.404	2.05	3.85	78.0	8.04
Little Calumet River	LC-W-12	0.082	2.00	3.75	84.8	4.33
Little Calumet River	LC-W-13	0.037	27.75	52.03	80.0	0.00
Little Calumet River	LC-W-14	0.074	1.89	3.54	80.7	0.99
Little Calumet River	LC-W-15	0.063	5.88	11.03	84.6	0.51
Little Calumet River	LC-WCSO-01	2.718	2.58	4.84	74.2	12.12
Little Calumet River	LC-WCSO-02	0.499	1.63	3.05	77.9	10.21
Little Calumet River	LC-WCSO-03	0.286	1.45	2.71	71.4	9.58
Little Calumet River	LC-WCSO-04	0.168	1.27	2.37	78.9	11.82
Little Calumet River	LC-WCSO-05	0.113	1.19	2.23	80.4	21.70
Little Calumet River	LC-WCSO-06	1.546	2.66	4.98	79.9	12.70
Little Calumet River	LC-WCSO-07	0.019	0.91	1.70	75.9	5.49
Little Calumet River	LC-WCSO-08	0.418	1.97	3.69	82.2	20.44
Little Calumet River	LC-WCSO-09	0.188	1.49	2.79	77.5	4.28
Little Calumet River	LC-WCSO-10	0.553	1.80	3.38	80.6	6.37
Little Calumet River	LC-WCSO-11	0.051	0.84	1.58	78.3	2.37
Little Calumet River	LC-WCSO-12	0.538	1.61	3.02	78.6	10.96
Little Calumet River	LC-WCSO-13	0.153	1.18	2.22	79.9	17.11
Little Calumet River	LC-WCSO-14	0.068	0.79	1.48	76.4	6.21
Little Calumet River	LC-WCSO-15	0.095	0.82	1.53	82.1	25.26
Little Calumet River	LC-WCSO-16	0.378	1.46	2.73	77.9	8.88
Little Calumet River	LC-WCSO-17	0.042	1.03	1.92	77.0	6.00

Subwatershed	Subbasin	Area (sq.mi.)	Final Clarks Tc	Final Clarks R	Final CN	Final DCI (%)
Little Calumet River	LC-WCSO-18	0.055	0.91	1.71	84.2	21.25
Little Calumet River	LC-WCSO-19	0.891	1.90	3.57	77.7	7.00
Little Calumet River	LC-WCSO-20	1.051	2.14	4.02	81.2	15.65
Little Calumet River	LC-WCSO-21	0.741	1.88	3.53	79.2	12.89
Little Calumet River	LC-WCSO-22	1.883	2.10	3.94	77.4	9.77
Little Calumet River	LC-WCSO-23	1.388	2.15	4.03	79.3	9.54
Little Calumet River	LC-WCSO-24	1.476	2.05	3.84	79.4	6.16
Little Calumet River	LC-WCSO-25	1.061	1.89	3.54	79.3	12.74
Little Calumet River	LC-WCSO-26	1.024	1.86	3.48	79.1	11.58
Little Calumet River	LC-WCSO-27	0.498	1.55	2.91	73.9	6.22
Little Calumet River	LC-WID-01	0.228	0.79	1.48	62.8	4.74
Little Calumet River	LC-WID-02	1.205	5.70	10.69	57.3	5.35
Little Calumet River	LC-WID-03	0.990	2.82	5.29	70.3	7.15
Little Calumet River	LC-WID-04	0.785	3.46	6.48	61.8	7.99
Little Calumet River	LC-WID-05	0.822	5.69	10.66	65.2	6.54
Little Calumet River	LC-WID-06	0.578	2.86	5.36	64.7	6.51
Little Calumet River	LC-WID-07	0.521	3.43	6.42	63.3	5.02
Midlothian Creek	MC-01	0.951	2.28	4.28	72.1	2.40
Midlothian Creek	MC-02	0.051	0.43	0.81	71.0	11.05
Midlothian Creek	MC-03	0.223	1.29	2.42	71.0	8.65
Midlothian Creek	MC-04	0.847	1.75	3.27	68.7	5.31
Midlothian Creek	MC-05	0.075	0.57	1.07	73.5	16.99
Midlothian Creek	MC-06	0.199	0.89	1.67	69.3	7.28
Midlothian Creek	MC-07	0.535	2.77	5.19	69.5	5.88
Midlothian Creek	MC-08	0.221	1.17	2.19	69.7	10.35
Midlothian Creek	MC-09	0.146	0.98	1.84	72.4	12.15
Midlothian Creek	MC-10	0.896	3.09	5.80	69.1	7.14
Midlothian Creek	MC-11	0.306	0.74	1.38	65.3	2.03
Midlothian Creek	MC-12	0.118	0.70	1.32	62.6	0.38
Midlothian Creek	MC-13	0.310	0.98	1.84	63.5	0.68
Midlothian Creek	MC-14	0.282	0.91	1.70	69.7	0.43
Midlothian Creek	MC-15	0.098	0.62	1.16	65.0	2.58
Midlothian Creek	MC-16	0.128	0.44	0.83	70.8	10.89
Midlothian Creek	MC-17	0.250	0.76	1.43	69.2	14.46
Midlothian Creek	MC-18	0.437	1.46	2.75	71.1	9.92
Midlothian Creek	MC-19	0.463	1.73	3.24	69.0	7.02
Midlothian Creek	MC-20	0.056	1.36	2.56	79.0	26.43
Midlothian Creek	MC-21	0.168	1.14	2.13	69.3	3.70
Midlothian Creek	MC-22	0.408	3.16	5.92	69.9	7.56
Midlothian Creek	MC-23	0.293	3.48	6.52	70.8	7.03
Midlothian Creek	MC-24	1.314	4.69	8.80	69.9	7.90
Midlothian Creek	MC-76A-01	0.735	3.76	7.06	69.5	7.88
Midlothian Creek	MC-76A-02	0.870	2.80	5.26	73.2	16.25
Midlothian Creek	MC-76A-03	0.397	1.86	3.48	67.6	5.68
Midlothian Creek	MC-FP-01	0.636	1.25	2.34	71.9	13.12
Midlothian Creek	MC-FP-02	0.304	1.36	2.54	67.5	13.12

Subwatershed	Subbasin	Area (sq.mi.)	Final Clarks Tc	Final Clarks R	Final CN	Final DCI (%)
Midlothian Creek	MC-NC-01	0.941	1.06	1.99	66.2	4.73
Midlothian Creek	MC-NC-02	0.385	1.15	2.15	68.4	8.26
Midlothian Creek	MC-NC-03	0.881	1.77	3.31	70.3	9.87
Midlothian Creek	MC-NC-04	0.284	1.31	2.45	69.0	6.70
Midlothian Creek	MC-NC-05	0.147	1.02	1.92	69.0	7.22
Midlothian Creek	MC-NC-06	0.117	0.68	1.28	71.2	10.83
Midlothian Creek	MC-NC-07	0.216	1.60	3.01	70.6	9.70
Midlothian Creek	MC-NC-08	0.251	4.67	8.75	69.3	7.08
Midlothian Creek	MC-TL-01	1.079	1.34	2.52	68.9	4.47
Midlothian Creek	MC-TL-02	0.448	1.07	2.01	68.2	5.56
Midlothian Creek	MC-UT-01	0.672	1.49	2.79	69.7	5.65
Midlothian Creek	MC-WB-01	0.407	0.86	1.62	66.0	2.66
Midlothian Creek	MC-WB-02	0.156	1.66	3.12	68.1	6.26
Midlothian Creek	MC-WT-01	0.494	1.10	2.06	71.4	9.33
Midlothian Creek	MC-WT-02	0.071	0.49	0.93	72.7	5.20
Midlothian Creek	MC-WT-03	0.190	2.14	4.01	69.3	4.70
Midlothian Creek	MC-WT-04	0.118	0.96	1.80	70.8	4.09
Midlothian Creek	MC-WT-05	0.080	0.79	1.48	70.4	8.80
North Creek	NC-01	0.193	1.30	2.45	74.3	5.69
North Creek	NC-02	0.205	3.65	6.84	59.2	6.58
North Creek	NC-03	0.152	5.07	9.51	67.9	5.68
North Creek	NC-04	0.321	1.66	3.10	69.2	5.09
North Creek	NC-05	0.274	2.68	5.03	71.4	5.11
North Creek	NC-06	0.369	2.36	4.43	66.8	2.40
North Creek	NC-07	2.807	3.51	6.58	66.5	4.33
North Creek	NC-08	0.858	1.78	3.35	69.2	5.83
North Creek	NC-09	0.677	2.83	5.31	57.5	2.27
North Creek	NC-10	0.367	4.30	8.06	62.9	0.29
North Creek	NC-11	0.387	1.56	2.93	57.4	0.00
North Creek	NC-LD-01	0.341	0.48	0.90	71.4	0.56
North Creek	NC-LD-02	0.432	1.10	2.05	72.5	5.55
North Creek	NC-LD-03	0.489	1.51	2.84	75.2	9.72
North Creek	NC-LD-04	0.146	1.74	3.26	69.3	1.22
North Creek	NC-LD-05	0.005	0.62	1.17	72.0	0.00
North Creek	NC-LD-06	0.287	2.45	4.59	67.9	4.60
North Creek	NC-LD-07	0.417	2.67	5.00	76.5	12.94
North Creek	NC-LD-08	0.296	2.94	5.52	78.1	10.93
North Creek	NC-LD-09	1.469	5.60	10.50	74.8	2.90
North Creek	NC-LD-10	1.804	2.99	5.61	75.2	3.74
North Creek	NC-LD-11	0.655	7.98	14.95	72.1	8.75
North Creek	NC-LD-East-01	1.232	1.24	2.32	72.4	0.98
North Creek	NC-LD-East-02	0.214	0.75	1.41	68.3	1.33
North Creek	NC-LD-East-03	0.145	1.06	1.98	67.3	0.03
North Creek	NC-LD-East-04	0.434	1.05	1.96	70.9	3.22
North Creek	NC-LD-East-05	0.445	1.55	2.90	73.2	4.44
North Creek	NC-LD-Lyn-02	0.172	2.10	3.95	73.4	0.81

Subwatershed	Subbasin	Area (sq.mi.)	Final Clarks Tc	Final Clarks R	Final CN	Final DCI (%)
North Creek	NC-LD-Lyn-03	1.117	3.72	6.98	70.6	3.14
North Creek	NC-LD-Lyn-04	1.301	4.45	8.34	73.9	5.95
North Creek	NC-LD-Torr-01	1.948	2.98	5.58	73.9	3.51
North Creek	NC-LD-Torr-02	0.630	5.00	9.38	75.6	3.17
North Creek	NC-LD-Torr-03	0.209	2.96	5.55	80.8	4.20
North Creek	NC-LD-TribA-01	0.339	0.87	1.64	66.3	0.54
North Creek	NC-LD-TribA-02	0.364	1.38	2.59	68.0	2.99
North Creek	NC-LD-TribA-03	0.105	0.68	1.27	67.5	3.07
North Creek	NC-LD-West-01	0.518	1.86	3.49	73.7	6.38
North Creek	NC-LD-West-02	0.168	1.17	2.19	74.1	4.40
Plum Creek	PC-01	10.285	6.05	11.35	78.7	0.68
Plum Creek	PC-02	4.817	2.93	5.49	75.8	5.54
Plum Creek	PC-03	4.439	3.55	6.66	75.1	1.33
Plum Creek	PC-04	2.043	2.44	4.58	76.5	0.74
Plum Creek	PC-05	4.286	4.27	8.00	72.9	1.26
Plum Creek	PC-06	4.580	2.72	5.10	76.3	2.21
Plum Creek	PC-07	1.899	1.44	2.69	75.7	3.58
Plum Creek	PC-08	3.519	7.77	14.57	71.9	1.92
Plum Creek	PC-09	1.524	2.85	5.35	71.0	1.98
Thorn Creek	TC-01	4.224	3.14	5.88	77.1	7.38
Thorn Creek	TC-02	2.364	1.75	3.29	71.8	3.42
Thorn Creek	TC-03	0.120	0.42	0.79	71.0	3.21
Thorn Creek	TC-04	1.498	1.36	2.54	68.7	2.82
Thorn Creek	TC-05	0.506	1.43	2.68	68.6	0.19
Thorn Creek	TC-06	0.410	0.99	1.86	69.9	3.48
Thorn Creek	TC-07	0.380	0.83	1.56	71.2	6.99
Thorn Creek	TC-08	1.128	1.82	3.41	75.2	12.29
Thorn Creek	TC-09	0.339	1.29	2.42	71.4	6.87
Thorn Creek	TC-10	0.107	2.01	3.76	65.5	0.54
Thorn Creek	TC-11	0.201	1.12	2.10	66.2	0.74
Thorn Creek	TC-12	0.557	3.30	6.19	67.8	4.40
Thorn Creek	TC-13	0.201	0.63	1.18	61.9	1.82
Thorn Creek	TC-14	1.414	1.80	3.37	67.1	6.27
Thorn Creek	TC-15	0.455	1.88	3.53	66.5	1.04
Thorn Creek	TC-16	0.501	1.33	2.50	70.7	7.74
Thorn Creek	TC-17	0.541	1.25	2.34	59.9	1.49
Thorn Creek	TC-18	1.002	1.76	3.30	69.8	3.18
Thorn Creek	TC-19	0.792	1.39	2.61	71.9	7.66
Thorn Creek	TC-20	0.458	2.09	3.93	74.2	7.77
Thorn Creek	TC-TA-01	2.091	2.14	4.01	73.6	8.82
Thorn Creek	TC-TA-02	0.475	1.16	2.17	76.3	13.95
Thorn Creek	TC-TA-03	0.277	1.28	2.40	73.6	13.85
Thorn Creek	TC-TA-04	0.018	0.10	0.19	70.2	6.71
Thorn Creek	TC-TA-05	0.137	0.44	0.82	68.8	1.60
Thorn Creek	TC-TA-06	0.529	1.60	3.00	73.4	8.23
Thorn Creek	TC-TA-07	0.139	1.01	1.90	77.7	7.75

Subwatershed	Subbasin	Area (sq.mi.)	Final Clarks Tc	Final Clarks R	Final CN	Final DCI (%)
Thorn Creek	TC-TA-08	1.572	1.47	2.75	76.0	15.75
Thorn Creek	TC-TA-09	0.500	4.06	7.61	78.3	21.34
Thorn Creek	TC-TB-01	0.461	1.32	2.48	79.1	20.67
Thorn Creek	TC-TB-02	0.068	0.68	1.28	70.0	3.76
Thorn Creek	TC-TB-03	0.039	0.26	0.49	72.6	6.52
Thorn Creek	TC-TB-04	0.491	1.05	1.97	73.8	8.69
Thorn Creek	TC-TB-05	0.110	0.81	1.52	74.1	7.54
Thorn Creek	TC-TB-06	0.960	1.62	3.04	75.9	14.78
Thorn Creek	TC-TC-01	0.485	2.19	4.11	74.6	10.22
Thorn Creek	TC-TC-02	0.152	0.87	1.64	72.5	9.70
Thorn Creek	TC-TC-03	0.287	1.51	2.83	71.3	7.95
Thorn Creek	TC-TD-01	1.461	1.91	3.58	73.2	5.72
Thorn Creek	TC-TD-02	0.105	0.66	1.23	64.3	2.41
Thorn Creek	TC-TD-03	0.117	0.84	1.57	70.0	5.26
Thorn Creek	TC-TD-04	0.257	1.22	2.28	77.5	12.93
Thorn Creek	TC-TD-05	0.315	1.34	2.52	76.7	19.36
Thorn Creek	TC-TD-06	0.104	2.04	3.83	69.5	2.83
Thorn Creek	TC-TD-TA-01	1.008	2.43	4.56	76.7	5.68
Thorn Creek	TC-TD-TA-02	0.353	1.28	2.40	79.8	19.11
Thorn Creek	TC-TE-01	1.153	1.36	2.55	68.7	2.77
Thorn Creek	TC-TE-02	0.031	0.31	0.58	67.7	1.36

Subwatershed	Subbasin	Area (sq.mi.)	Final Clarks Tc	Final Clarks R	Final CN	Final DCI (%)
Butterfield Creek	BC-01	1.006	2.71	5.08	76.0	3.31
Butterfield Creek	BC-02	0.837	2.61	4.90	75.5	2.46
Butterfield Creek	BC-03	0.604	1.19	2.23	74.4	0.07
Butterfield Creek	BC-04	1.652	2.13	3.99	71.2	2.68
Butterfield Creek	BC-05	0.507	1.45	2.72	72.2	5.40
Butterfield Creek	BC-06	1.777	2.42	4.54	69.3	0.83
Butterfield Creek	BC-07	2.196	3.86	7.24	71.7	5.51
Butterfield Creek	BC-08	0.521	1.23	2.30	73.7	6.05
Butterfield Creek	BC-09	0.235	0.76	1.42	76.3	6.94
Butterfield Creek	BC-10	0.329	1.13	2.12	78.6	13.35
Butterfield Creek	BC-11	1.090	1.58	2.97	72.5	4.77
Butterfield Creek	BC-12	0.593	0.82	1.54	70.4	1.95
Butterfield Creek	BC-13	0.120	0.68	1.27	69.7	2.99
Butterfield Creek	BC-14	0.429	1.46	2.74	73.5	6.87
Butterfield Creek	BC-15	0.155	1.27	2.38	66.1	0.95
Butterfield Creek	BC-16	0.606	1.10	2.06	70.5	3.93
Butterfield Creek	BC-17	0.670	0.94	1.75	70.0	4.74
Butterfield Creek	BC-18	0.085	0.93	1.75	65.6	4.33
Butterfield Creek	BC-19	0.178	0.67	1.25	72.0	7.47
Butterfield Creek	BC-20	0.900	1.38	2.59	72.5	10.79
Butterfield Creek	BC-21	0.294	1.28	2.41	72.1	9.04
Butterfield Creek	BC-22	0.101	0.65	1.22	71.1	11.21
Butterfield Creek	BC-EB-01	0.409	1.53	2.87	77.7	1.27
Butterfield Creek	BC-EB-02	0.086	0.51	0.95	74.8	4.22
Butterfield Creek	BC-EB-03	0.191	1.12	2.10	68.9	1.22
Butterfield Creek	BC-EB-04	0.769	1.65	3.09	74.7	10.49
Butterfield Creek	BC-EB-05	0.263	0.89	1.66	71.1	4.03
Butterfield Creek	BC-EB-06	0.151	1.50	2.82	72.1	4.63
Butterfield Creek	BC-EB-07	1.537	2.63	4.94	76.8	15.74
Butterfield Creek	BC-EB-08	0.118	0.89	1.67	84.4	33.06
Butterfield Creek	BC-EB-09	0.039	0.37	0.69	81.6	27.32
Butterfield Creek	BC-EB-10	0.088	0.48	0.89	76.3	10.40
Butterfield Creek	BC-EB-TA-01	0.130	0.78	1.47	75.6	1.98
Butterfield Creek	BC-EB-TA-02	0.037	0.87	1.63	71.6	5.34
Butterfield Creek	BC-EB-TR-01	0.273	0.82	1.53	79.2	4.46
Butterfield Creek	BC-EB-TR-02	0.666	1.53	2.87	75.7	1.53
Butterfield Creek	BC-EB-TR-03	0.067	0.58	1.09	74.7	10.55
Butterfield Creek	BC-EB-TR-04	0.116	0.66	1.23	75.4	6.07
Butterfield Creek	BC-EB-TR-05	0.165	1.24	2.32	72.6	7.82
Butterfield Creek	BC-EB-TR-06	0.859	1.97	3.69	73.7	6.07
Butterfield Creek	BC-EB-TR-07	0.250	1.24	2.33	69.9	2.33
Butterfield Creek	BC-EB-UTL-01	0.168	1.66	3.11	78.2	10.11
Butterfield Creek	BC-EB-UTL-02	0.222	1.07	2.00	74.0	8.85
Butterfield Creek	BC-EB-UTS-01	0.443	0.91	1.71	77.8	4.20
Butterfield Creek	BC-EB-UTS-02	0.034	1.11	2.09	73.4	3.84
Butterfield Creek	BC-T1-01	0.607	1.38	2.59	73.5	7.27
Butterfield Creek	BC-T1-02	0.088	0.86	1.62	72.2	4.83
Butterfield Creek	BC-T3-01	0.317	0.85	1.58	75.0	8.44
Butterfield Creek	BC-T3-02	0.096	0.61	1.14	73.8	7.03
Butterfield Creek	BC-T3-03	0.386	1.19	2.23	74.1	7.70
Butterfield Creek	BC-T3-04	0.015	0.57	1.06	72.2	5.40
Butterfield Creek	BC-T4-01	0.140	0.79	1.48	78.8	17.76
Butterfield Creek	BC-T4-02	0.122	0.78	1.46	75.8	7.63
Butterfield Creek	BC-T4-03	0.049	0.55	1.04	74.1	5.70
Butterfield Creek	BC-UTC-01	0.369	2.33	4.36	75.5	9.23
Butterfield Creek	BC-UTC-02	0.365	1.21	2.27	73.5	3.38
Butterfield Creek	BC-UTH-01	1.237	2.00	3.74	69.8	6.02

Butterfield Creek	BC-UTH-02	0.091	0.86	1.61	65.1	11.39
Cady Marsh Ditch	CM-01	0.681	2.12	3.98	49.9	5.01
Cady Marsh Ditch	CM-02	1.561	2.50	4.70	44.9	3.06
Cady Marsh Ditch	CM-03	2.544	3.65	6.84	45.8	2.85
Cady Marsh Ditch	CM-04	3.579	5.48	10.27	58.0	5.97
Cady Marsh Ditch	CM-05	0.492	3.19	5.98	52.0	7.79
Cady Marsh Ditch	CM-06	0.273	1.13	2.11	49.8	5.47
Cady Marsh Ditch	CM-SD-01	7.121	5.17	9.69	59.4	5.74
Cal Union Drainage Ditch	CU-01	0.374	1.22	2.29	73.3	17.68
Cal Union Drainage Ditch	CU-02	0.209	0.82	1.55	65.0	6.65
Cal Union Drainage Ditch	CU-03	0.055	1.06	1.99	61.8	11.98
Cal Union Drainage Ditch	CU-04	2.126	3.07	5.76	67.0	8.71
Cal Union Drainage Ditch	CU-05	0.415	1.21	2.26	66.2	4.06
Cal Union Drainage Ditch	CU-06	0.214	1.66	3.11	71.3	14.91
Cal Union Drainage Ditch	CU-07	0.295	1.91	3.58	70.2	11.14
Cal Union Drainage Ditch	CU-08	0.405	1.85	3.46	76.5	0.01
Cal Union Drainage Ditch	CU-09	0.138	1.47	2.75	71.0	12.40
Cal Union Drainage Ditch	CU-10	0.642	2.36	4.42	71.1	17.95
Cal Union Drainage Ditch	CU-11	0.360	2.17	4.06	74.1	24.22
Cal Union Drainage Ditch	CU-12	0.504	2.41	4.53	70.8	12.84
Cal Union Drainage Ditch	CU-13	0.399	1.84	3.46	71.1	13.72
Cal Union Drainage Ditch	CU-14	0.413	1.81	3.40	72.2	17.84
Cal Union Drainage Ditch	CU-BC-01	0.128	1.65	3.10	60.6	4.65
Cal Union Drainage Ditch	CU-BC-02	0.399	2.12	3.97	59.2	2.50
Cal Union Drainage Ditch	CU-BC-03	0.286	2.05	3.85	65.2	6.71
Cal Union Drainage Ditch	CU-CC-01	0.299	0.99	1.85	66.5	5.92
Cal Union Drainage Ditch	CU-CC-02	1.271	2.48	4.66	67.0	7.10
Cal Union Drainage Ditch	CU-CC-03	0.222	1.73	3.25	63.5	5.55
Cal Union Drainage Ditch	CU-CC-04	0.588	2.27	4.25	67.1	13.06
Cal Union Drainage Ditch	CU-CE-01	0.367	1.16	2.18	68.6	3.14
Cal Union Drainage Ditch	CU-CE-02	0.019	0.38	0.71	78.7	31.32
Cal Union Drainage Ditch	CU-CE-03	0.080	0.61	1.15	73.2	19.46
Cal Union Drainage Ditch	CU-CE-04	0.024	0.36	0.68	78.1	25.75
Cal Union Drainage Ditch	CU-CE-05	0.019	0.62	1.16	72.6	12.48
Cal Union Drainage Ditch	CU-CE-06	0.334	1.06	1.99	71.1	9.88
Cal Union Drainage Ditch	CU-CE-07	0.920	1.69	3.17	68.5	6.03
Cal Union Drainage Ditch	CU-CE-08	0.030	0.31	0.57	67.4	4.64
Cal Union Drainage Ditch	CU-CET-01	0.276	0.93	1.74	71.9	10.25
Cal Union Drainage Ditch	CU-CET-02	0.075	1.66	3.11	72.7	14.60
Cal Union Drainage Ditch	CU-CN-01	1.869	3.17	5.94	70.6	10.74
Cal Union Drainage Ditch	CU-CN-02	0.108	1.83	3.44	75.5	8.41
Cal Union Drainage Ditch	CU-CN-04	0.937	2.41	4.52	72.1	20.45
Cal Union Drainage Ditch	CU-CW-01	0.183	0.87	1.64	71.4	6.06
Cal Union Drainage Ditch	CU-CW-02	0.476	1.31	2.45	71.3	5.81
Cal Union Drainage Ditch	CU-CW-03	0.034	0.25	0.47	76.7	14.32
Cal Union Drainage Ditch	CU-CW-04	0.299	0.62	1.17	71.1	10.85
Cal Union Drainage Ditch	CU-CW-05	0.300	0.92	1.72	70.5	10.01
Cal Union Drainage Ditch	CU-CW-06	0.152	0.74	1.39	68.6	5.49
Cal Union Drainage Ditch	CU-CWT-01	0.162	0.95	1.78	69.6	5.41
Cal Union Drainage Ditch	CU-CWT-02	0.346	0.74	1.38	72.1	7.50
Cal Union Drainage Ditch	CU-DC-01	0.198	2.36	4.43	60.5	1.72
Cal Union Drainage Ditch	CU-DC-02	0.048	0.91	1.71	65.8	0.52
Cal Union Drainage Ditch	CU-I57-01	1.354	1.95	3.66	69.6	9.40
Cal Union Drainage Ditch	CU-I57-02	0.112	1.39	2.60	62.5	2.26
Cal Union Drainage Ditch	CU-PC-01	0.401	2.14	4.01	60.4	5.03
Cal Union Drainage Ditch	CU-PC-02	0.236	2.00	3.76	61.0	2.62
Cal Union Drainage Ditch	CU-PC-03	1.458	3.10	5.81	62.7	3.71
Cal Union Drainage Ditch	CU-SW-01	0.626	1.06	1.99	71.6	5.59

Cal Union Drainage Ditch	CU-SW-02	0.175	1.19	2.24	70.8	9.86
Cal Union Drainage Ditch	CU-SW-03	0.177	0.85	1.60	69.7	6.42
Cal Union Drainage Ditch	CU-SW-04	0.113	0.64	1.21	69.3	6.13
Cal Union Drainage Ditch	CU-SW-05	0.227	0.66	1.24	69.3	5.96
Cal Union Drainage Ditch	CU-SW-06	0.590	1.07	2.01	70.2	9.59
Cal Union Drainage Ditch	CU-SW-07	0.434	1.45	2.71	66.7	6.01
Cal Union Drainage Ditch	CU-SW-08	0.289	1.52	2.84	67.8	4.84
Cal Union Drainage Ditch	CU-SW-09	0.111	1.51	2.84	63.6	8.35
Cal Union Drainage Ditch	CU-SWN-01	0.372	0.80	1.50	71.2	2.64
Cal Union Drainage Ditch	CU-SWN-02	0.043	0.57	1.07	70.2	2.26
Cal Union Drainage Ditch	CU-SWN-03	0.454	1.59	2.97	69.2	6.18
Cal Union Drainage Ditch	CU-SWS-02	0.179	0.71	1.33	71.4	6.07
Cal Union Drainage Ditch	CU-SWS-03	0.397	1.13	2.12	72.5	10.92
Deer Creek	DC-01	5.052	3.56	6.68	73.4	1.19
Deer Creek	DC-02	2.209	2.76	5.18	72.1	4.12
Deer Creek	DC-03	8.427	3.47	6.51	72.7	3.09
Deer Creek	DC-04	0.428	0.56	1.05	71.5	3.85
Deer Creek	DC-05	0.599	1.30	2.43	70.7	3.65
Deer Creek	DC-06	0.150	0.45	0.84	75.4	11.82
Deer Creek	DC-07	0.281	0.92	1.72	72.6	7.56
Deer Creek	DC-08	0.154	1.02	1.92	72.4	2.85
Deer Creek	DC-09	0.178	1.21	2.27	73.3	6.33
Deer Creek	DC-10	0.288	1.34	2.51	78.8	16.53
Deer Creek	DC-11	0.049	0.95	1.78	72.2	1.79
Deer Creek	DC-12	0.083	1.47	2.76	71.4	4.23
Deer Creek	DC-13	0.437	1.51	2.84	75.1	12.81
Deer Creek	DC-14	0.335	3.09	5.79	74.2	1.47
Deer Creek	DC-15	0.784	3.69	6.93	75.0	3.68
Deer Creek	DC-16	0.283	1.81	3.40	74.8	0.87
Deer Creek	DC-17	0.334	3.94	7.39	71.5	2.41
Deer Creek	DC-18	0.291	1.71	3.21	66.8	0.53
Deer Creek	DC-19	0.174	1.63	3.05	68.4	0.52
Deer Creek	DC-MT-01	0.626	0.91	1.70	72.0	5.28
Deer Creek	DC-T1-01	0.240	0.79	1.48	71.5	11.00
Deer Creek	DC-T1-02	0.233	1.14	2.13	72.0	2.67
Deer Creek	DC-T1-03	0.334	1.37	2.57	73.3	7.60
Deer Creek	DC-TB-01	0.750	0.83	1.55	73.6	4.43
Deer Creek	DC-TB-02	0.340	0.89	1.67	72.8	2.57
Deer Creek	DC-TB-03	0.380	1.19	2.23	75.9	7.65
Deer Creek	DC-TB-04	0.509	1.48	2.78	73.9	1.98
Deer Creek	DC-TB-05	0.105	1.14	2.14	78.5	7.71
Deer Creek	DC-TB-T1-01	0.417	1.04	1.96	70.4	3.11
Deer Creek	DC-TB-T1-02	0.257	1.05	1.96	72.1	4.48
Deer Creek	DC-TC-01	0.589	2.85	5.34	72.1	5.47
Deer Creek	DC-TC-02	0.585	8.02	15.04	71.6	4.00
Deer Creek	DC-TC-03	0.450	5.31	9.96	74.3	10.46
Deer Creek	DC-TC-04	0.612	3.71	6.95	71.1	3.51
Hart Ditch	HD-01	1.106	3.14	5.89	75.8	5.42
Hart Ditch	HD-02	0.402	2.65	4.98	80.0	5.03
Hart Ditch	HD-03	3.954	6.87	12.88	70.1	5.23
Hart Ditch	HD-04	0.138	2.05	3.85	47.6	4.28
Hart Ditch	HD-05	0.021	5.13	9.62	61.0	1.85
Hart Ditch	HD-DD-01	9.738	4.03	7.55	67.2	4.18
Hart Ditch	HD-SD-01	1.637	7.51	14.08	52.6	8.03
Little Calumet River	LC-DR-01	4.817	3.56	6.67	71.1	2.44
Little Calumet River	LC-DR-02	5.541	4.37	8.20	64.5	2.16
Little Calumet River	LC-DR-03	3.532	8.06	15.12	49.2	2.29
Little Calumet River	LC-DR-04	3.326	2.38	4.46	73.3	2.88

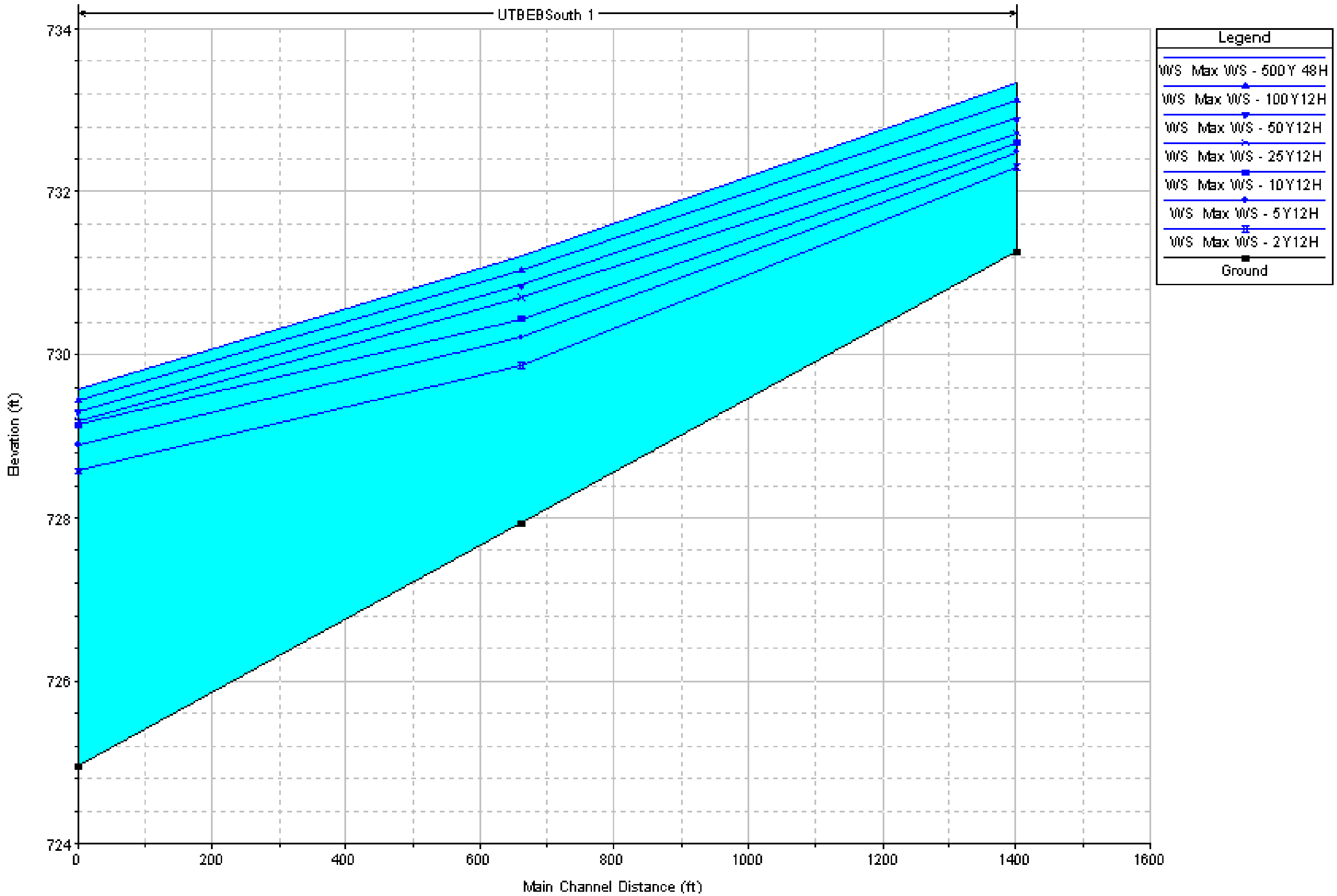
Little Calumet River	LC-DR-05	13.227	14.08	26.40	69.9	3.09
Little Calumet River	LC-DR-06	4.482	2.94	5.51	75.5	6.54
Little Calumet River	LC-DR-07	4.219	3.80	7.12	73.2	4.43
Little Calumet River	LC-DR-08	4.192	5.47	10.26	77.1	0.37
Little Calumet River	LC-DR-09	4.926	4.45	8.35	67.9	0.58
Little Calumet River	LC-DR-10	14.294	10.45	19.59	72.8	3.42
Little Calumet River	LC-DR-11	3.049	5.05	9.48	72.9	1.98
Little Calumet River	LC-DR-12	2.062	3.67	6.89	77.5	0.47
Little Calumet River	LC-DR-13	12.747	27.87	52.26	73.2	0.35
Little Calumet River	LC-DR-14	4.144	5.19	9.74	75.4	0.60
Little Calumet River	LC-DR-15	4.655	2.64	4.94	73.9	1.25
Little Calumet River	LC-DR-16	15.203	5.24	9.82	68.5	0.43
Little Calumet River	LC-DR-17	6.480	6.31	11.83	68.5	0.46
Little Calumet River	LC-DR-18	5.736	3.61	6.76	74.1	4.28
Little Calumet River	LC-DR-19	1.163	2.82	5.29	70.3	0.67
Little Calumet River	LC-DR-20	14.944	3.63	6.81	71.1	0.88
Little Calumet River	LC-DR-21	6.199	7.47	14.01	73.1	2.40
Little Calumet River	LC-DR-22	11.123	12.00	22.51	62.4	3.38
Little Calumet River	LC-E-01	1.109	2.64	4.96	68.7	5.20
Little Calumet River	LC-E-02	0.223	1.07	2.00	56.9	4.78
Little Calumet River	LC-E-03	2.479	2.49	4.66	62.6	2.74
Little Calumet River	LC-E-04	0.799	2.16	4.05	78.2	0.30
Little Calumet River	LC-E-05	0.395	1.63	3.05	73.3	0.77
Little Calumet River	LC-E-06	0.153	1.25	2.34	81.7	2.31
Little Calumet River	LC-E-07	4.244	3.64	6.83	61.7	4.68
Little Calumet River	LC-E-08	0.139	1.15	2.17	75.1	4.34
Little Calumet River	LC-E-09	5.995	10.11	18.96	63.3	4.32
Little Calumet River	LC-E-10	9.460	7.59	14.22	64.3	3.10
Little Calumet River	LC-E-11	3.228	3.63	6.81	54.9	3.35
Little Calumet River	LC-E-12	3.073	4.37	8.19	50.2	5.02
Little Calumet River	LC-EA-01	8.915	3.38	6.33	61.1	0.27
Little Calumet River	LC-EA-02	3.737	1.90	3.56	61.5	0.34
Little Calumet River	LC-EA-03	5.375	1.90	3.56	62.8	0.32
Little Calumet River	LC-EA-04	10.513	13.22	24.79	68.5	0.83
Little Calumet River	LC-EA-05	15.175	3.75	7.04	68.3	0.48
Little Calumet River	LC-EA-06	5.114	2.30	4.31	65.5	0.80
Little Calumet River	LC-EA-07	0.801	1.10	2.05	68.4	2.24
Little Calumet River	LC-EA-08	17.776	4.71	8.83	63.2	0.79
Little Calumet River	LC-EA-09	2.060	2.92	5.48	69.5	2.98
Little Calumet River	LC-EA-10	7.074	7.40	13.87	68.6	5.11
Little Calumet River	LC-EA-11	1.427	0.97	1.82	58.3	4.05
Little Calumet River	LC-EID-01	1.331	3.98	7.46	66.1	7.20
Little Calumet River	LC-EID-02	0.421	1.45	2.72	58.4	4.35
Little Calumet River	LC-EID-03	0.188	4.14	7.77	74.9	4.92
Little Calumet River	LC-EID-04	2.146	6.93	12.99	67.4	7.13
Little Calumet River	LC-EID-05	1.057	2.08	3.90	69.1	7.84
Little Calumet River	LC-EID-06	0.226	1.38	2.58	70.2	4.28
Little Calumet River	LC-EID-07	0.526	1.37	2.57	72.9	2.83
Little Calumet River	LC-EID-08	0.580	2.14	4.00	66.0	8.78
Little Calumet River	LC-EID-09	1.878	5.14	9.63	58.8	4.69
Little Calumet River	LC-EID-10	1.105	2.68	5.03	56.0	3.07
Little Calumet River	LC-EID-11	0.827	2.24	4.20	62.6	4.05
Little Calumet River	LC-EID-12	0.755	1.27	2.38	64.1	5.49
Little Calumet River	LC-EID-13	0.197	6.19	11.60	77.2	15.16
Little Calumet River	LC-EID-14	0.289	26.64	49.95	61.7	1.20
Little Calumet River	LC-EID-15	1.459	1.67	3.12	60.6	6.54
Little Calumet River	LC-EID-16	1.377	2.77	5.20	57.2	6.02
Little Calumet River	LC-SC-01	7.949	4.51	8.46	70.8	4.60

Little Calumet River	LC-SC-02	10.281	5.48	10.27	64.1	0.51
Little Calumet River	LC-SC-03	9.406	2.25	4.22	67.9	2.45
Little Calumet River	LC-SC-04	12.317	3.71	6.95	67.0	0.55
Little Calumet River	LC-SC-05	11.833	2.16	4.05	67.9	0.68
Little Calumet River	LC-SC-06	14.168	3.76	7.04	70.8	0.81
Little Calumet River	LC-SC-07	13.694	5.63	10.56	67.8	2.39
Little Calumet River	LC-SC-08	1.458	1.78	3.34	59.6	2.11
Little Calumet River	LC-TA-01	0.700	2.87	5.38	78.1	10.55
Little Calumet River	LC-TA-02	0.613	2.74	5.13	78.8	10.40
Little Calumet River	LC-W-01	0.093	2.28	4.27	71.5	3.09
Little Calumet River	LC-W-02	0.229	2.92	5.47	76.1	6.81
Little Calumet River	LC-W-03	0.216	4.26	7.99	75.4	5.54
Little Calumet River	LC-W-04	0.068	1.19	2.24	82.3	26.93
Little Calumet River	LC-W-05	0.096	1.04	1.94	76.5	12.14
Little Calumet River	LC-W-06	0.213	2.79	5.23	77.5	10.96
Little Calumet River	LC-W-07	2.410	4.58	8.59	73.2	15.07
Little Calumet River	LC-W-08	0.146	0.88	1.64	73.0	3.23
Little Calumet River	LC-W-09	1.166	3.13	5.86	66.5	4.59
Little Calumet River	LC-W-10	0.832	3.04	5.71	79.0	11.08
Little Calumet River	LC-W-11	0.404	2.05	3.85	78.0	8.04
Little Calumet River	LC-W-12	0.082	2.00	3.75	84.8	4.33
Little Calumet River	LC-W-13	0.037	27.75	52.03	80.0	0.00
Little Calumet River	LC-W-14	0.074	1.89	3.54	80.7	0.99
Little Calumet River	LC-W-15	0.063	5.88	11.03	84.6	0.51
Little Calumet River	LC-WCSO-01	2.718	2.58	4.84	74.2	12.12
Little Calumet River	LC-WCSO-02	0.499	1.63	3.05	77.9	10.21
Little Calumet River	LC-WCSO-03	0.286	1.45	2.71	71.4	9.58
Little Calumet River	LC-WCSO-04	0.168	1.27	2.37	78.9	11.82
Little Calumet River	LC-WCSO-05	0.113	1.19	2.23	80.4	21.70
Little Calumet River	LC-WCSO-06	1.546	2.66	4.98	79.9	12.70
Little Calumet River	LC-WCSO-07	0.019	0.91	1.70	75.9	5.49
Little Calumet River	LC-WCSO-08	0.418	1.97	3.69	82.2	20.44
Little Calumet River	LC-WCSO-09	0.188	1.49	2.79	77.5	4.28
Little Calumet River	LC-WCSO-10	0.553	1.80	3.38	80.6	6.37
Little Calumet River	LC-WCSO-11	0.051	0.84	1.58	78.3	2.37
Little Calumet River	LC-WCSO-12	0.538	1.61	3.02	78.6	10.96
Little Calumet River	LC-WCSO-13	0.153	1.18	2.22	79.9	17.11
Little Calumet River	LC-WCSO-14	0.068	0.79	1.48	76.4	6.21
Little Calumet River	LC-WCSO-15	0.095	0.82	1.53	82.1	25.26
Little Calumet River	LC-WCSO-16	0.378	1.46	2.73	77.9	8.88
Little Calumet River	LC-WCSO-17	0.042	1.03	1.92	77.0	6.00
Little Calumet River	LC-WCSO-18	0.055	0.91	1.71	84.2	21.25
Little Calumet River	LC-WCSO-19	0.891	1.90	3.57	77.7	7.00
Little Calumet River	LC-WCSO-20	1.051	2.14	4.02	81.2	15.65
Little Calumet River	LC-WCSO-21	0.741	1.88	3.53	79.2	12.89
Little Calumet River	LC-WCSO-22	1.883	2.10	3.94	77.4	9.77
Little Calumet River	LC-WCSO-23	1.388	2.15	4.03	79.3	9.54
Little Calumet River	LC-WCSO-24	1.476	2.05	3.84	79.4	6.16
Little Calumet River	LC-WCSO-25	1.061	1.89	3.54	79.3	12.74
Little Calumet River	LC-WCSO-26	1.024	1.86	3.48	79.1	11.58
Little Calumet River	LC-WCSO-27	0.498	1.55	2.91	73.9	6.22
Little Calumet River	LC-WID-01	0.228	0.79	1.48	62.8	4.74
Little Calumet River	LC-WID-02	1.205	5.70	10.69	57.3	5.35
Little Calumet River	LC-WID-03	0.990	2.82	5.29	70.3	7.15
Little Calumet River	LC-WID-04	0.785	3.46	6.48	61.8	7.99
Little Calumet River	LC-WID-05	0.822	5.69	10.66	65.2	6.54
Little Calumet River	LC-WID-06	0.578	2.86	5.36	64.7	6.51
Little Calumet River	LC-WID-07	0.521	3.43	6.42	63.3	5.02

Midlothian Creek	MC-01	0.951	2.28	4.28	72.1	2.40
Midlothian Creek	MC-02	0.051	0.43	0.81	71.0	11.05
Midlothian Creek	MC-03	0.223	1.29	2.42	71.0	8.65
Midlothian Creek	MC-04	0.847	1.75	3.27	68.7	5.31
Midlothian Creek	MC-05	0.075	0.57	1.07	73.5	16.99
Midlothian Creek	MC-06	0.199	0.89	1.67	69.3	7.28
Midlothian Creek	MC-07	0.535	2.77	5.19	69.5	5.88
Midlothian Creek	MC-08	0.221	1.17	2.19	69.7	10.35
Midlothian Creek	MC-09	0.146	0.98	1.84	72.4	12.15
Midlothian Creek	MC-10	0.896	3.09	5.80	69.1	7.14
Midlothian Creek	MC-11	0.306	0.74	1.38	65.3	2.03
Midlothian Creek	MC-12	0.118	0.70	1.32	62.6	0.38
Midlothian Creek	MC-13	0.310	0.98	1.84	63.5	0.68
Midlothian Creek	MC-14	0.282	0.91	1.70	69.7	0.43
Midlothian Creek	MC-15	0.098	0.62	1.16	65.0	2.58
Midlothian Creek	MC-16	0.128	0.44	0.83	70.8	10.89
Midlothian Creek	MC-17	0.250	0.76	1.43	69.2	14.46
Midlothian Creek	MC-18	0.437	1.46	2.75	71.1	9.92
Midlothian Creek	MC-19	0.463	1.73	3.24	69.0	7.02
Midlothian Creek	MC-20	0.056	1.36	2.56	79.0	26.43
Midlothian Creek	MC-21	0.168	1.14	2.13	69.3	3.70
Midlothian Creek	MC-22	0.408	3.16	5.92	69.9	7.56
Midlothian Creek	MC-23	0.293	3.48	6.52	70.8	7.03
Midlothian Creek	MC-24	1.314	4.69	8.80	69.9	7.90
Midlothian Creek	MC-76A-01	0.735	3.76	7.06	69.5	7.88
Midlothian Creek	MC-76A-02	0.870	2.80	5.26	73.2	16.25
Midlothian Creek	MC-76A-03	0.397	1.86	3.48	67.6	5.68
Midlothian Creek	MC-FP-01	0.636	1.25	2.34	71.9	13.12
Midlothian Creek	MC-FP-02	0.304	1.36	2.54	67.5	13.12
Midlothian Creek	MC-NC-01	0.941	1.06	1.99	66.2	4.73
Midlothian Creek	MC-NC-02	0.385	1.15	2.15	68.4	8.26
Midlothian Creek	MC-NC-03	0.881	1.77	3.31	70.3	9.87
Midlothian Creek	MC-NC-04	0.284	1.31	2.45	69.0	6.70
Midlothian Creek	MC-NC-05	0.147	1.02	1.92	69.0	7.22
Midlothian Creek	MC-NC-06	0.117	0.68	1.28	71.2	10.83
Midlothian Creek	MC-NC-07	0.216	1.60	3.01	70.6	9.70
Midlothian Creek	MC-NC-08	0.251	4.67	8.75	69.3	7.08
Midlothian Creek	MC-TL-01	1.079	1.34	2.52	68.9	4.47
Midlothian Creek	MC-TL-02	0.448	1.07	2.01	68.2	5.56
Midlothian Creek	MC-UT-01	0.672	1.49	2.79	69.7	5.65
Midlothian Creek	MC-WB-01	0.407	0.86	1.62	66.0	2.66
Midlothian Creek	MC-WB-02	0.156	1.66	3.12	68.1	6.26
Midlothian Creek	MC-WT-01	0.494	1.10	2.06	71.4	9.33
Midlothian Creek	MC-WT-02	0.071	0.49	0.93	72.7	5.20
Midlothian Creek	MC-WT-03	0.190	2.14	4.01	69.3	4.70
Midlothian Creek	MC-WT-04	0.118	0.96	1.80	70.8	4.09
Midlothian Creek	MC-WT-05	0.080	0.79	1.48	70.4	8.80
North Creek	NC-01	0.193	1.30	2.45	74.3	5.69
North Creek	NC-02	0.205	3.65	6.84	59.2	6.58
North Creek	NC-03	0.152	5.07	9.51	67.9	5.68
North Creek	NC-04	0.321	1.66	3.10	69.2	5.09
North Creek	NC-05	0.274	2.68	5.03	71.4	5.11
North Creek	NC-06	0.369	2.36	4.43	66.8	2.40
North Creek	NC-07	2.807	3.51	6.58	66.5	4.33
North Creek	NC-08	0.858	1.78	3.35	69.2	5.83
North Creek	NC-09	0.677	2.83	5.31	57.5	2.27
North Creek	NC-10	0.367	4.30	8.06	62.9	0.29
North Creek	NC-11	0.387	1.56	2.93	57.4	0.00

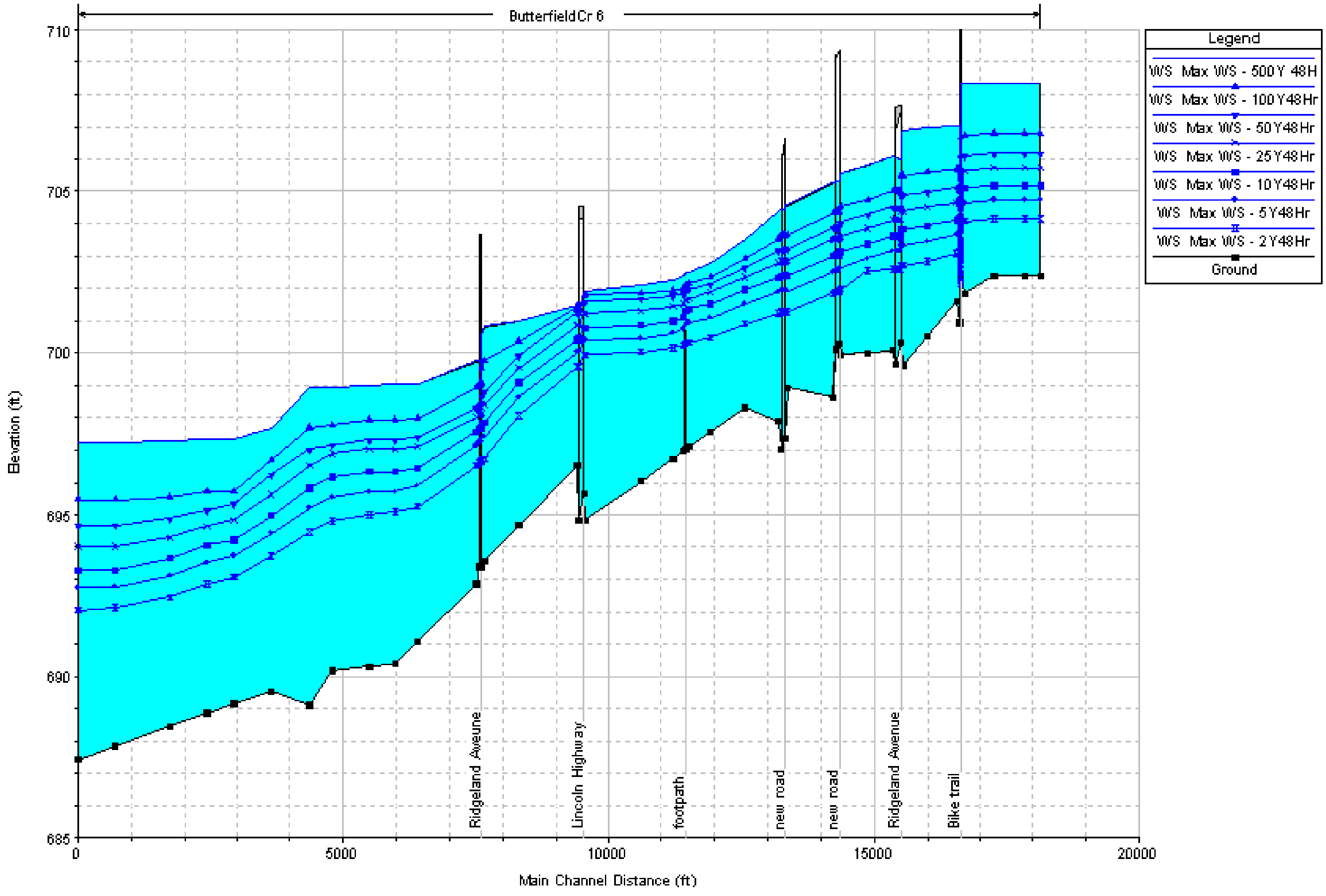
North Creek	NC-LD-01	0.341	0.48	0.90	71.4	0.56
North Creek	NC-LD-02	0.432	1.10	2.05	72.5	5.55
North Creek	NC-LD-03	0.489	1.51	2.84	75.2	9.72
North Creek	NC-LD-04	0.146	1.74	3.26	69.3	1.22
North Creek	NC-LD-05	0.005	0.62	1.17	72.0	0.00
North Creek	NC-LD-06	0.287	2.45	4.59	67.9	4.60
North Creek	NC-LD-07	0.417	2.67	5.00	76.5	12.94
North Creek	NC-LD-08	0.296	2.94	5.52	78.1	10.93
North Creek	NC-LD-09	1.469	5.60	10.50	74.8	2.90
North Creek	NC-LD-10	1.804	2.99	5.61	75.2	3.74
North Creek	NC-LD-11	0.655	7.98	14.95	72.1	8.75
North Creek	NC-LD-East-01	1.232	1.24	2.32	72.4	0.98
North Creek	NC-LD-East-02	0.214	0.75	1.41	68.3	1.33
North Creek	NC-LD-East-03	0.145	1.06	1.98	67.3	0.03
North Creek	NC-LD-East-04	0.434	1.05	1.96	70.9	3.22
North Creek	NC-LD-East-05	0.445	1.55	2.90	73.2	4.44
North Creek	NC-LD-Lyn-02	0.172	2.10	3.95	73.4	0.81
North Creek	NC-LD-Lyn-03	1.117	3.72	6.98	70.6	3.14
North Creek	NC-LD-Lyn-04	1.301	4.45	8.34	73.9	5.95
North Creek	NC-LD-Torr-01	1.948	2.98	5.58	73.9	3.51
North Creek	NC-LD-Torr-02	0.630	5.00	9.38	75.6	3.17
North Creek	NC-LD-Torr-03	0.209	2.96	5.55	80.8	4.20
North Creek	NC-LD-TribA-01	0.339	0.87	1.64	66.3	0.54
North Creek	NC-LD-TribA-02	0.364	1.38	2.59	68.0	2.99
North Creek	NC-LD-TribA-03	0.105	0.68	1.27	67.5	3.07
North Creek	NC-LD-West-01	0.518	1.86	3.49	73.7	6.38
North Creek	NC-LD-West-02	0.168	1.17	2.19	74.1	4.40
Plum Creek	PC-01	10.285	6.05	11.35	78.7	0.68
Plum Creek	PC-02	4.817	2.93	5.49	75.8	5.54
Plum Creek	PC-03	4.439	3.55	6.66	75.1	1.33
Plum Creek	PC-04	2.043	2.44	4.58	76.5	0.74
Plum Creek	PC-05	4.286	4.27	8.00	72.9	1.26
Plum Creek	PC-06	4.580	2.72	5.10	76.3	2.21
Plum Creek	PC-07	1.899	1.44	2.69	75.7	3.58
Plum Creek	PC-08	3.519	7.77	14.57	71.9	1.92
Plum Creek	PC-09	1.524	2.85	5.35	71.0	1.98
Thorn Creek	TC-01	4.224	3.14	5.88	77.1	7.38
Thorn Creek	TC-02	2.364	1.75	3.29	71.8	3.42
Thorn Creek	TC-03	0.120	0.42	0.79	71.0	3.21
Thorn Creek	TC-04	1.498	1.36	2.54	68.7	2.82
Thorn Creek	TC-05	0.506	1.43	2.68	68.6	0.19
Thorn Creek	TC-06	0.410	0.99	1.86	69.9	3.48
Thorn Creek	TC-07	0.380	0.83	1.56	71.2	6.99
Thorn Creek	TC-08	1.128	1.82	3.41	75.2	12.29
Thorn Creek	TC-09	0.339	1.29	2.42	71.4	6.87
Thorn Creek	TC-10	0.107	2.01	3.76	65.5	0.54
Thorn Creek	TC-11	0.201	1.12	2.10	66.2	0.74
Thorn Creek	TC-12	0.557	3.30	6.19	67.8	4.40
Thorn Creek	TC-13	0.201	0.63	1.18	61.9	1.82
Thorn Creek	TC-14	1.414	1.80	3.37	67.1	6.27
Thorn Creek	TC-15	0.455	1.88	3.53	66.5	1.04
Thorn Creek	TC-16	0.501	1.33	2.50	70.7	7.74
Thorn Creek	TC-17	0.541	1.25	2.34	59.9	1.49
Thorn Creek	TC-18	1.002	1.76	3.30	69.8	3.18
Thorn Creek	TC-19	0.792	1.39	2.61	71.9	7.66
Thorn Creek	TC-20	0.458	2.09	3.93	74.2	7.77
Thorn Creek	TC-TA-01	2.091	2.14	4.01	73.6	8.82
Thorn Creek	TC-TA-02	0.475	1.16	2.17	76.3	13.95

Thorn Creek	TC-TA-03	0.277	1.28	2.40	73.6	13.85
Thorn Creek	TC-TA-04	0.018	0.10	0.19	70.2	6.71
Thorn Creek	TC-TA-05	0.137	0.44	0.82	68.8	1.60
Thorn Creek	TC-TA-06	0.529	1.60	3.00	73.4	8.23
Thorn Creek	TC-TA-07	0.139	1.01	1.90	77.7	7.75
Thorn Creek	TC-TA-08	1.572	1.47	2.75	76.0	15.75
Thorn Creek	TC-TA-09	0.500	4.06	7.61	78.3	21.34
Thorn Creek	TC-TB-01	0.461	1.32	2.48	79.1	20.67
Thorn Creek	TC-TB-02	0.068	0.68	1.28	70.0	3.76
Thorn Creek	TC-TB-03	0.039	0.26	0.49	72.6	6.52
Thorn Creek	TC-TB-04	0.491	1.05	1.97	73.8	8.69
Thorn Creek	TC-TB-05	0.110	0.81	1.52	74.1	7.54
Thorn Creek	TC-TB-06	0.960	1.62	3.04	75.9	14.78
Thorn Creek	TC-TC-01	0.485	2.19	4.11	74.6	10.22
Thorn Creek	TC-TC-02	0.152	0.87	1.64	72.5	9.70
Thorn Creek	TC-TC-03	0.287	1.51	2.83	71.3	7.95
Thorn Creek	TC-TD-01	1.461	1.91	3.58	73.2	5.72
Thorn Creek	TC-TD-02	0.105	0.66	1.23	64.3	2.41
Thorn Creek	TC-TD-03	0.117	0.84	1.57	70.0	5.26
Thorn Creek	TC-TD-04	0.257	1.22	2.28	77.5	12.93
Thorn Creek	TC-TD-05	0.315	1.34	2.52	76.7	19.36
Thorn Creek	TC-TD-06	0.104	2.04	3.83	69.5	2.83
Thorn Creek	TC-TD-TA-01	1.008	2.43	4.56	76.7	5.68
Thorn Creek	TC-TD-TA-02	0.353	1.28	2.40	79.8	19.11
Thorn Creek	TC-TE-01	1.153	1.36	2.55	68.7	2.77
Thorn Creek	TC-TE-02	0.031	0.31	0.58	67.7	1.36



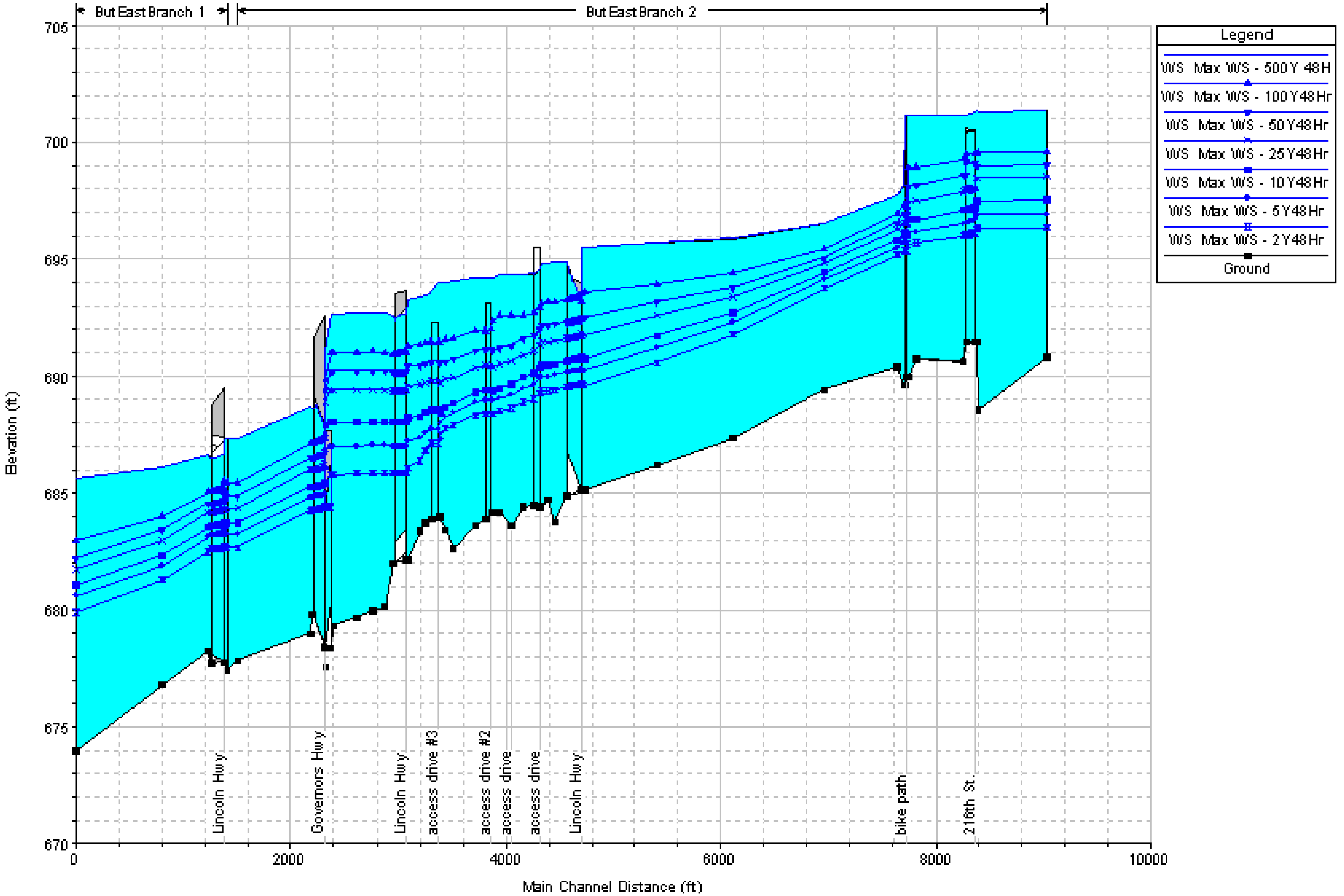
Unnamed Tributary to Butterfield Creek East Branch South

Imperial Drive & Lorraine Ct. (1000' southwest of Kostner Ave.) to confluence with Butterfield Creek East Branch, Reach 3



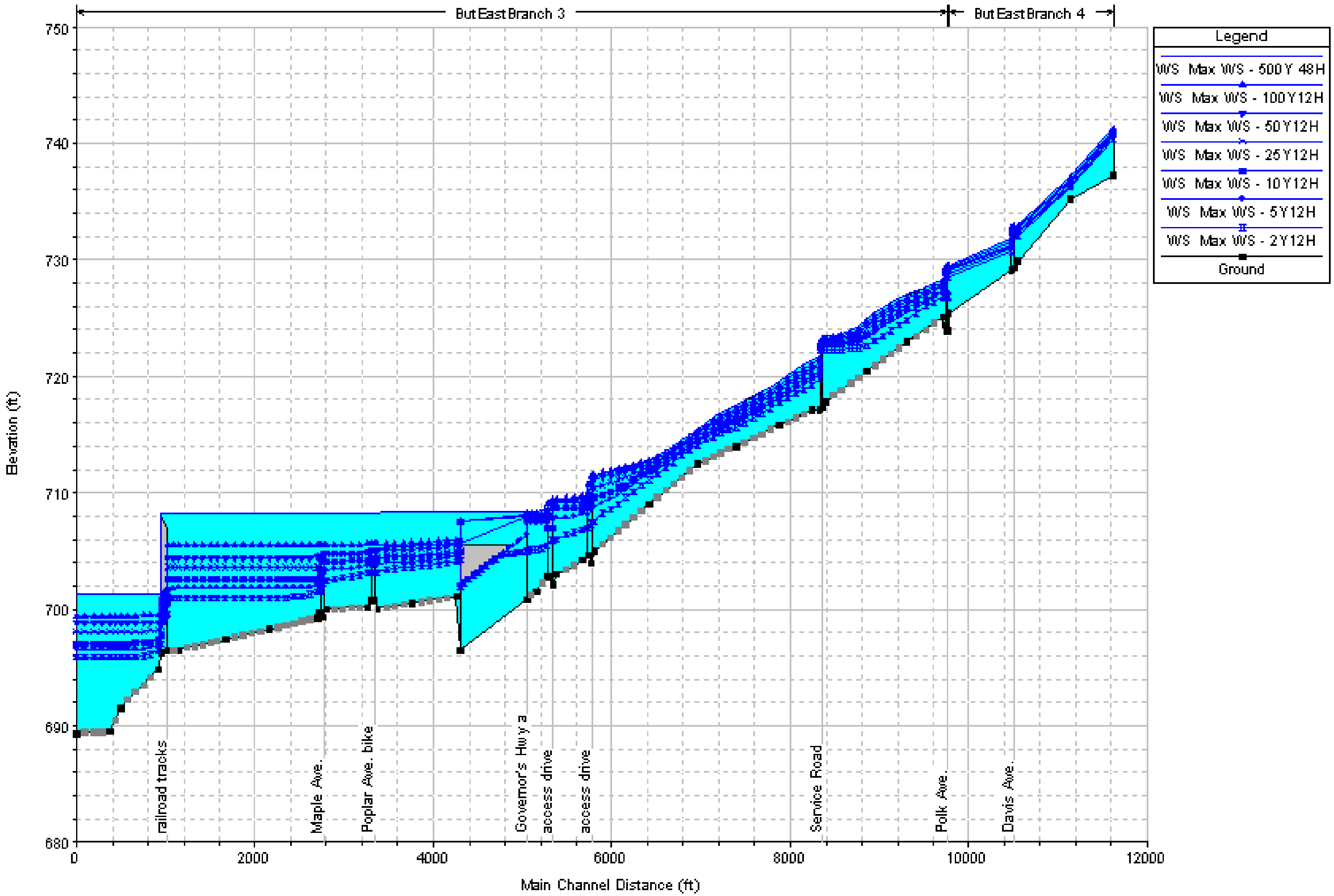
Butterfield Creek, Reach 6

Ridgeland Ave. & Lincoln Hwy to confluence with Unnamed Tributary to Butterfield Creek West



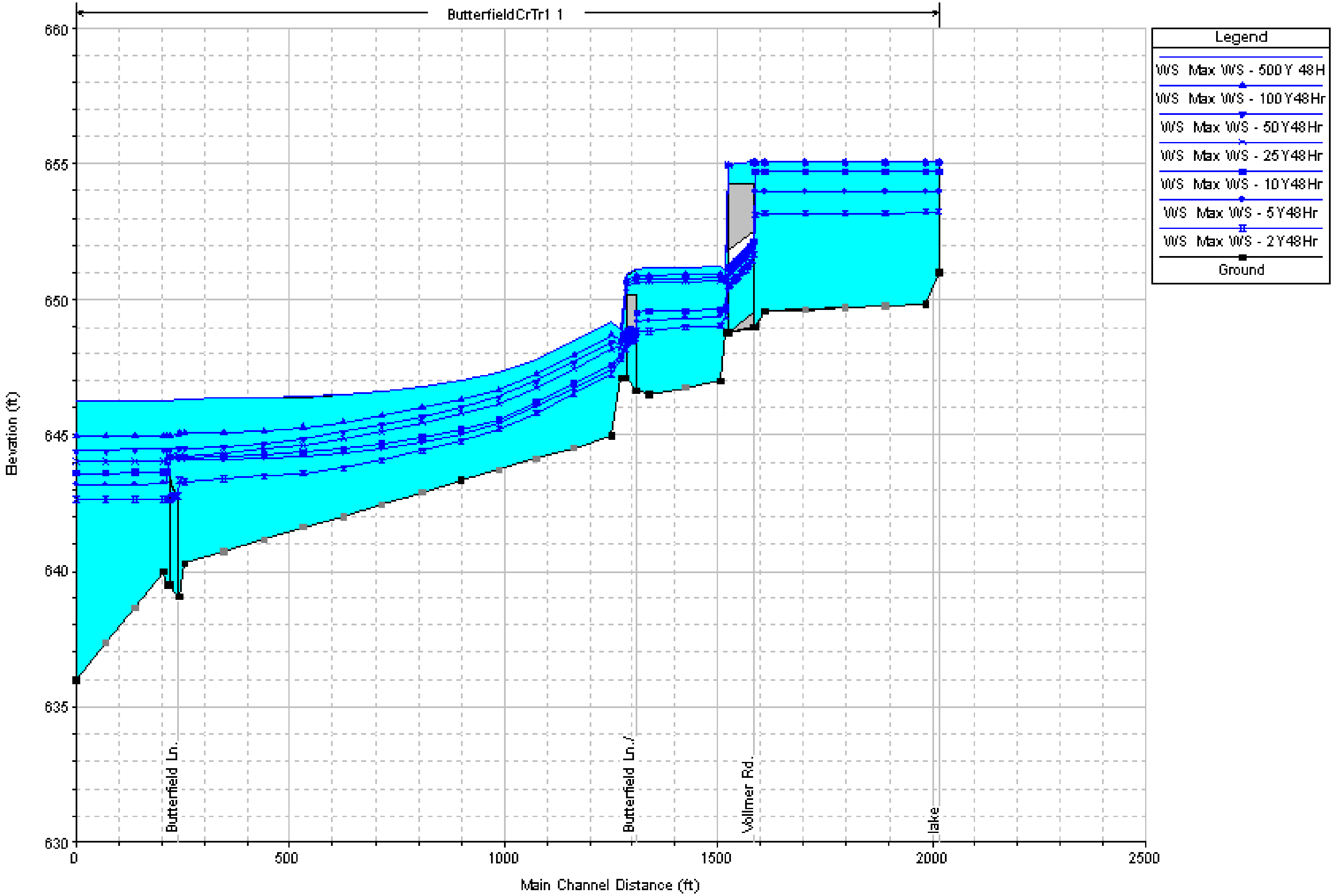
Butterfield Creek East Branch, Reaches 1 & 2

Butterfield Creek East Branch Tributary to confluence with Butterfield Creek, Reach 4



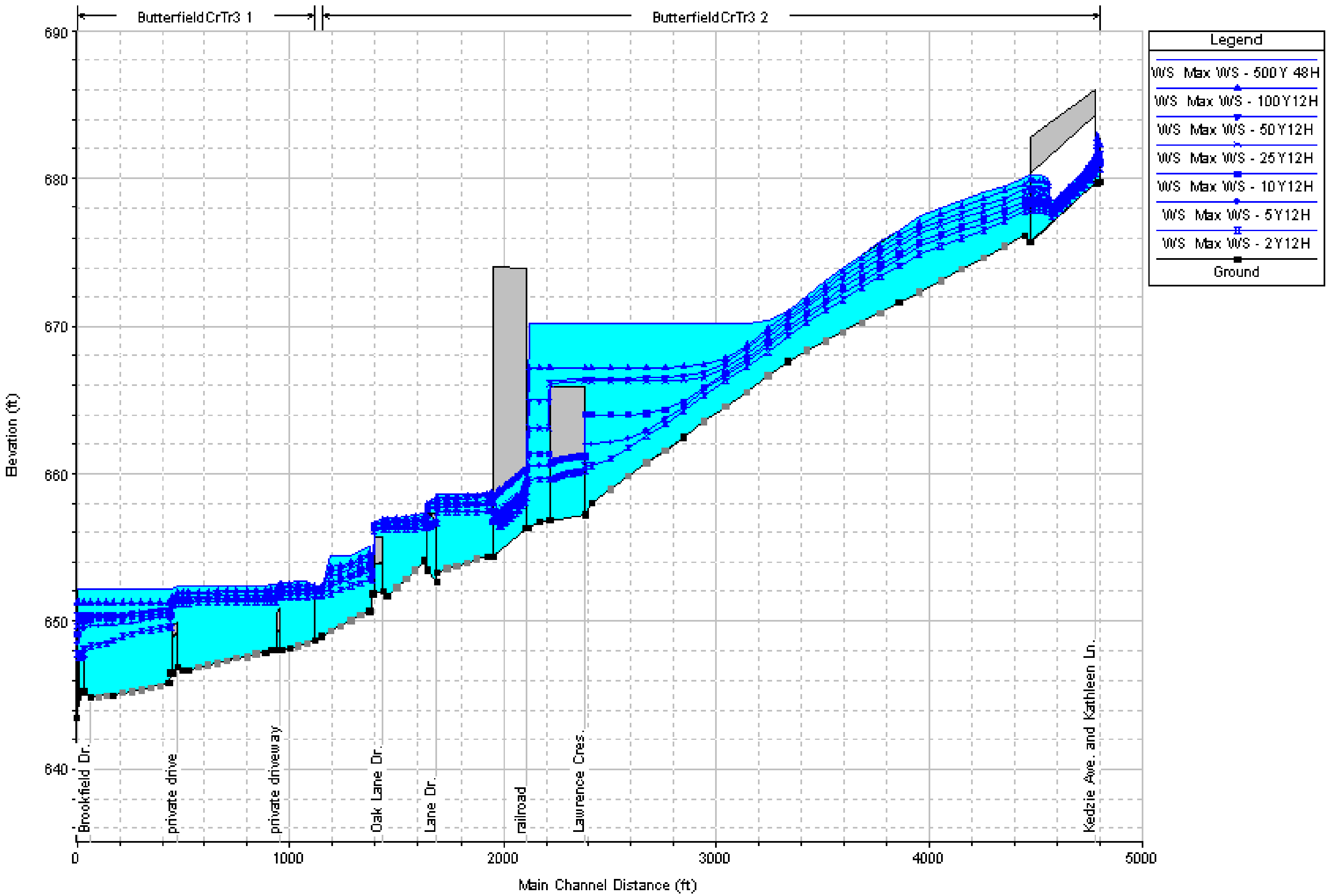
Butterfield Creek East Branch, Reaches 3 & 4

Steger Road (Will Co. Line) to confluence with Butterfield Creek East Branch Tributary



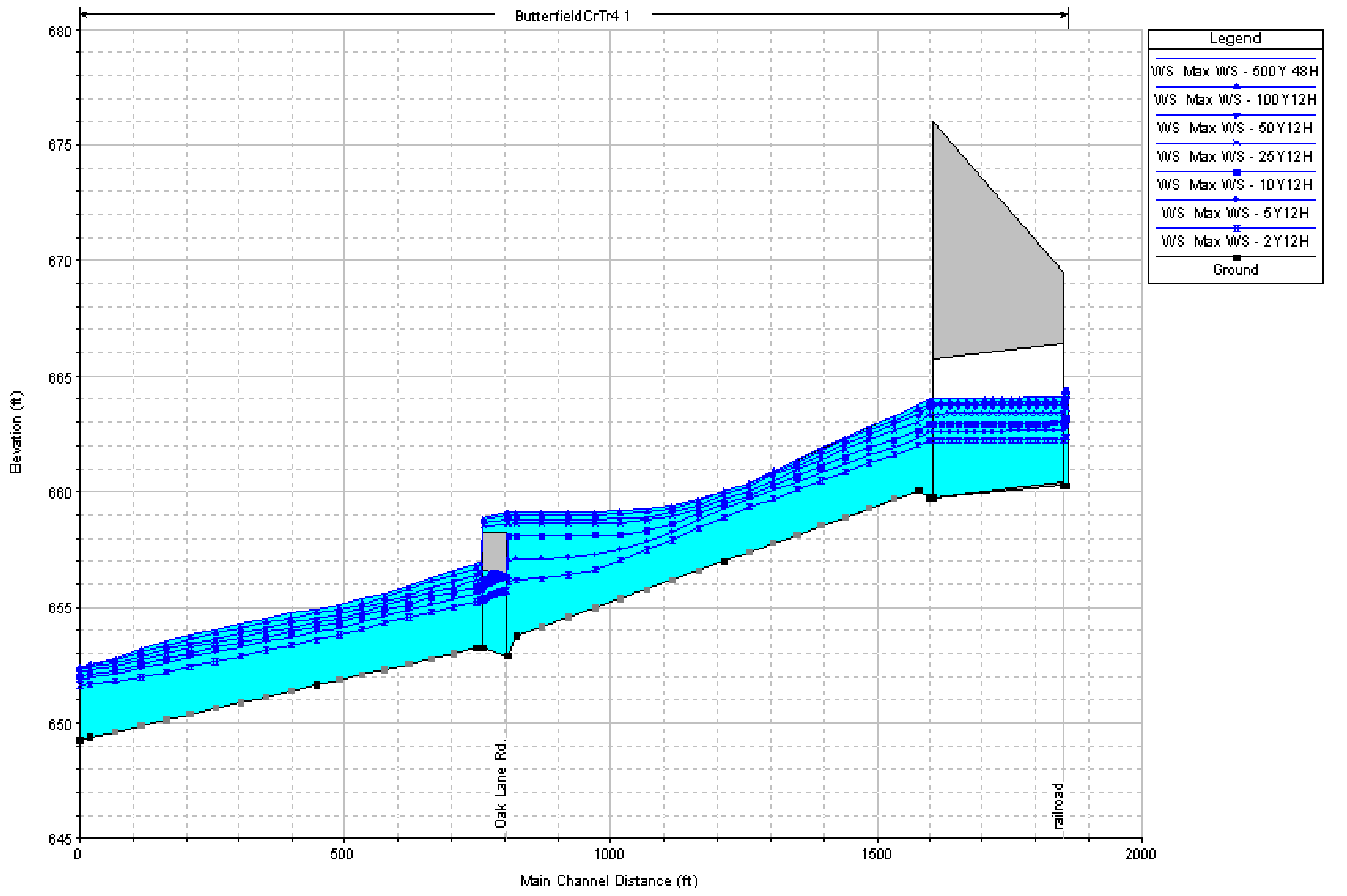
Butterfield Creek Tributary 1

Lake (450' south of Vollmer Road) to confluence with Butterfield Creek, Reach 2



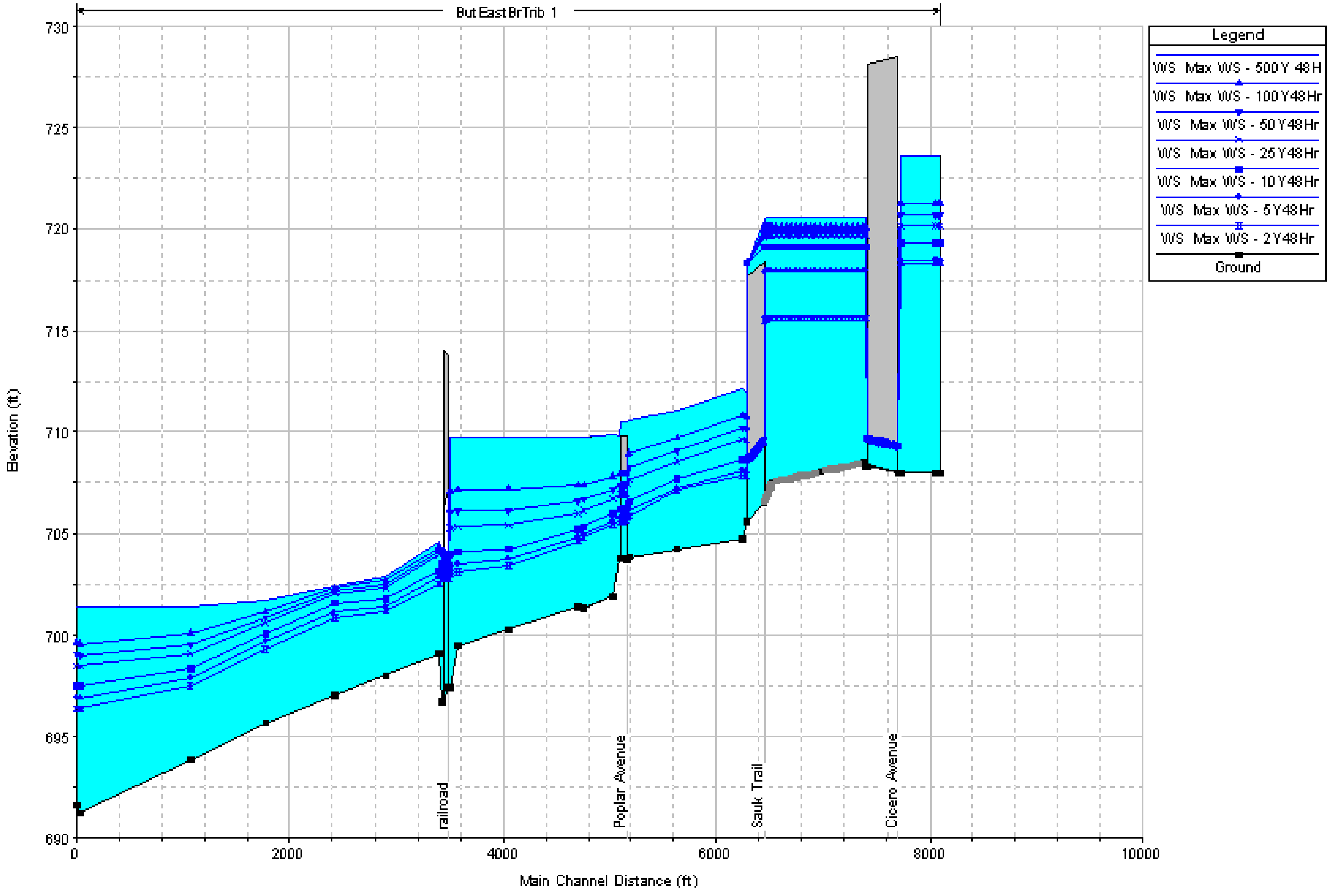
Butterfield Creek Tributary 3

Kedzie Ave. & Governors Hwy. to confluence with Butterfield Creek, Reach 3 (at Brookwood Drive)



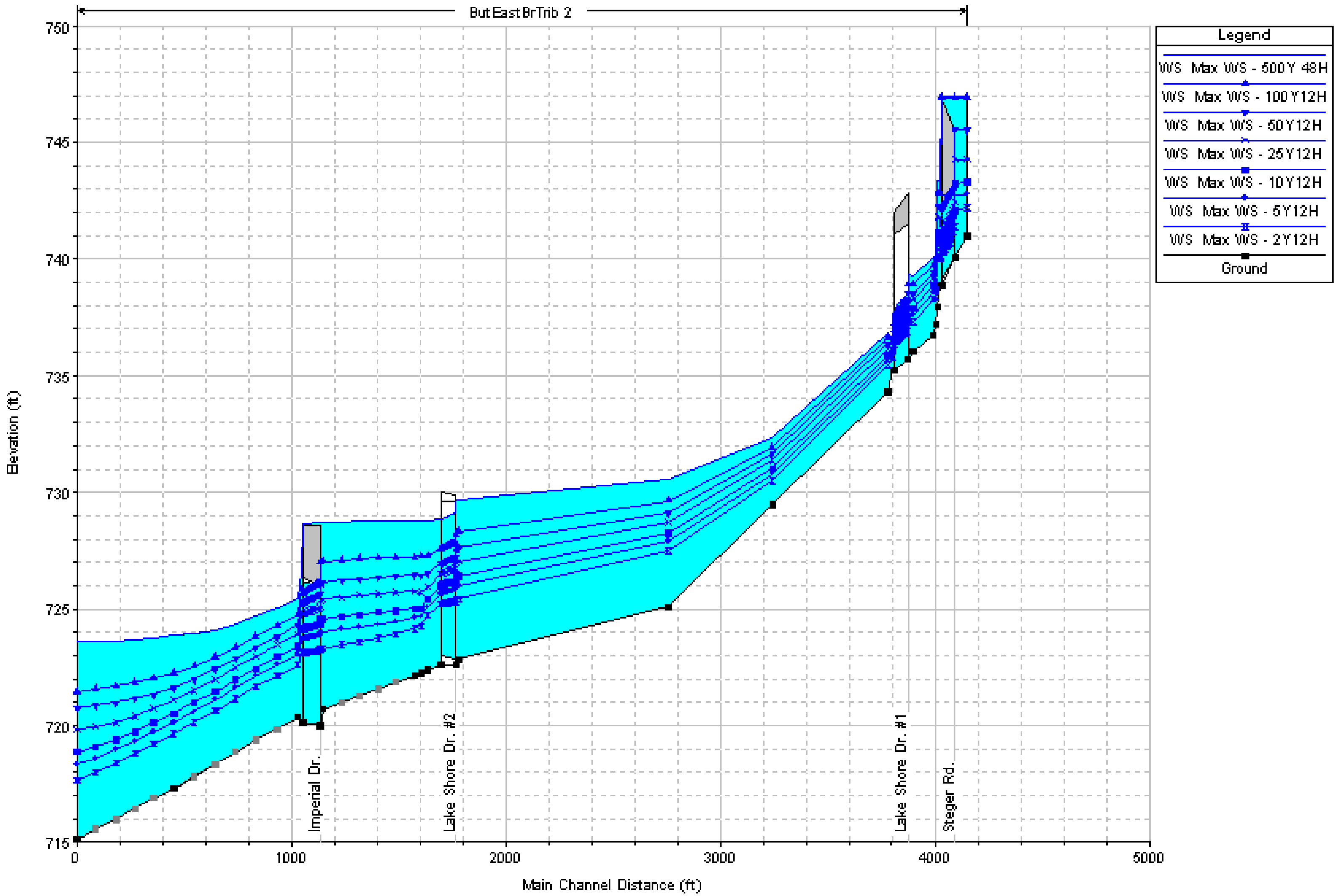
Butterfield Creek Tributary 4

Vollmer Road and railroad crossing to confluence with Butterfield Creek Tributary 3



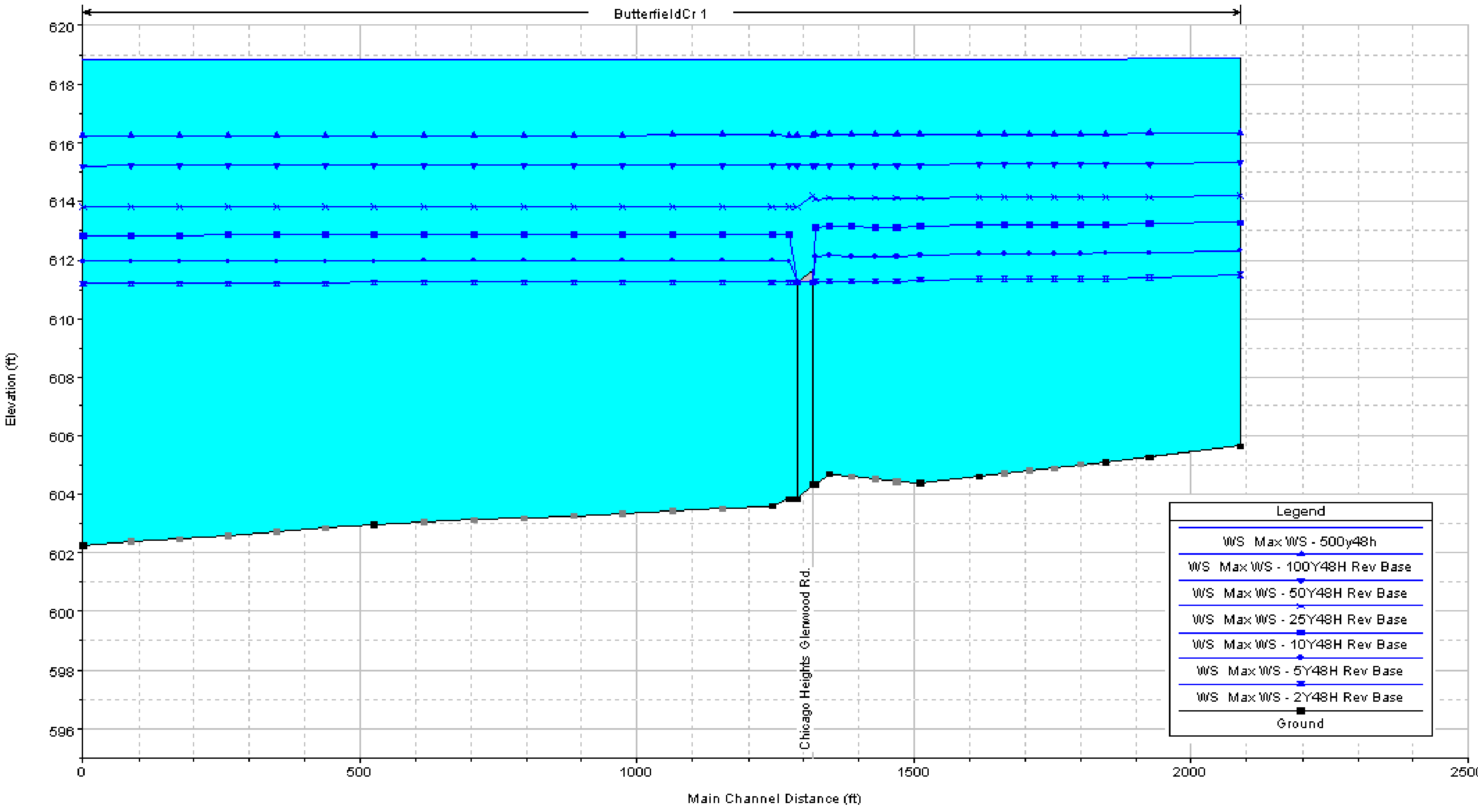
Butterfield Creek East Branch Tributary, Reach 1

Butterfield Creek East Branch Tributary A to confluence with Butterfield Creek East Branch



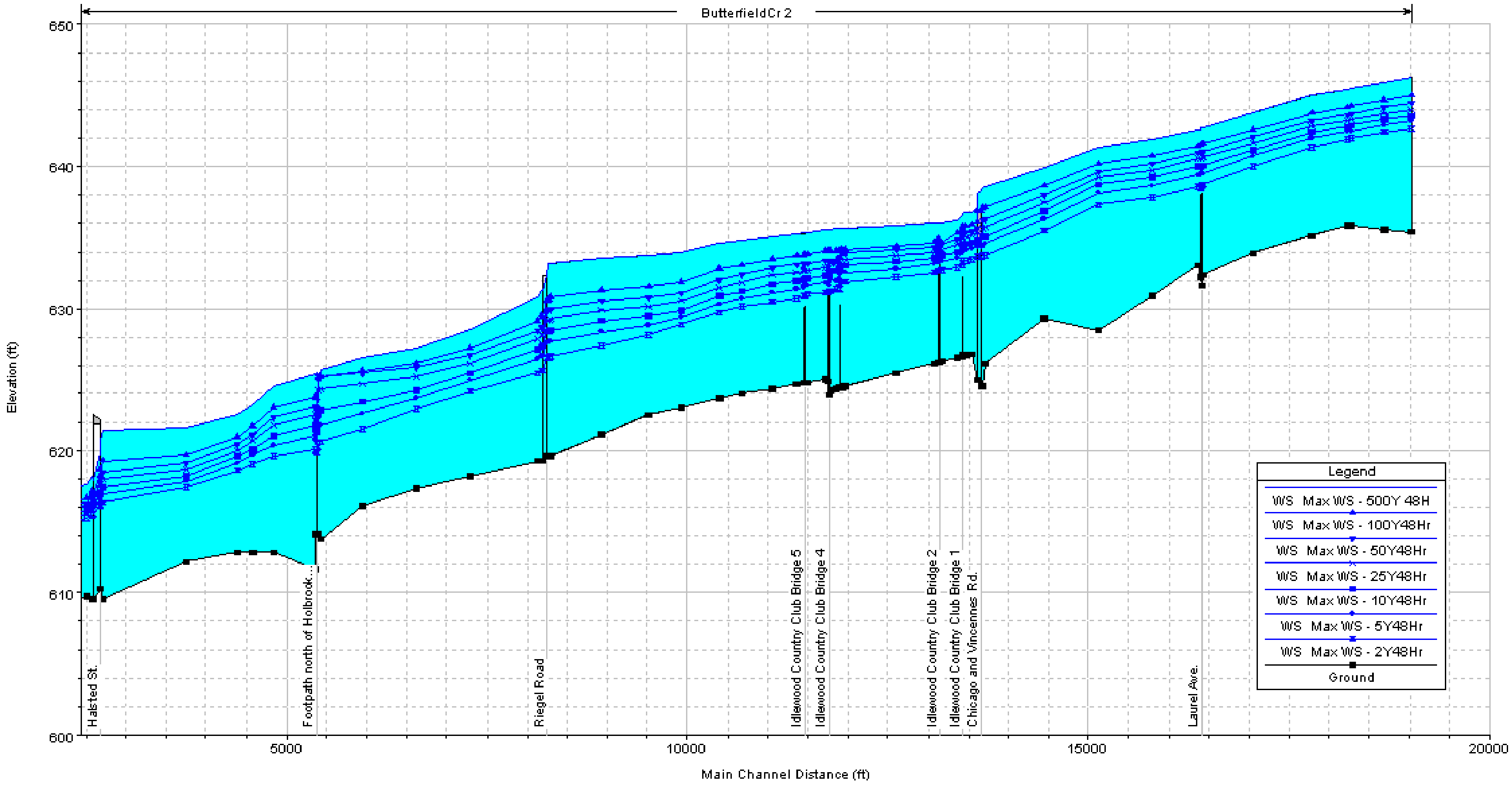
Butterfield Creek East Branch Tributary, Reach 2

Steger Road (Will County Line) to confluence with Butterfield Creek East Branch Tributary A



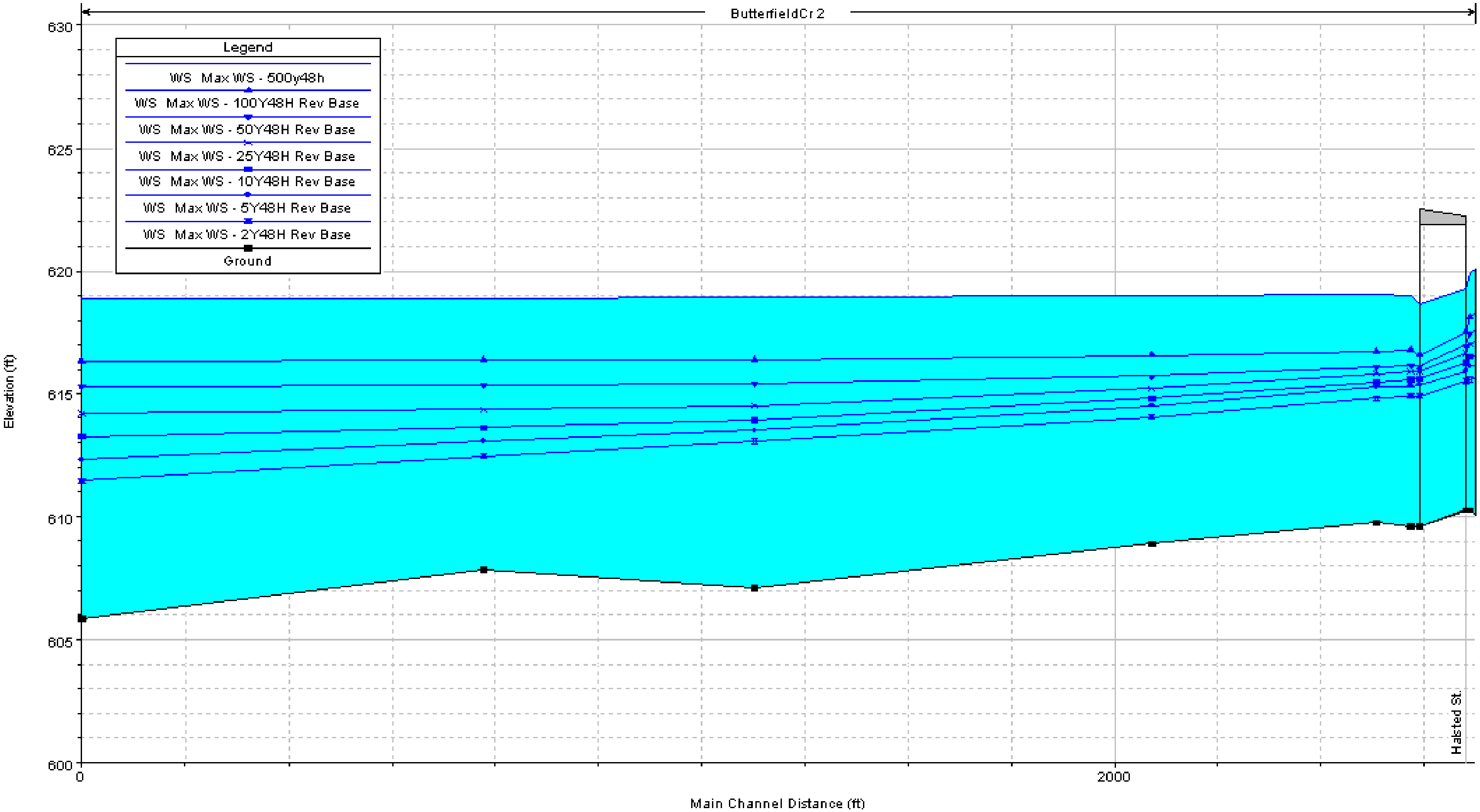
Butterfield Creek, Reach 1

Unnamed Trib. To Butterfield Creek East to confluence with Thorn Creek



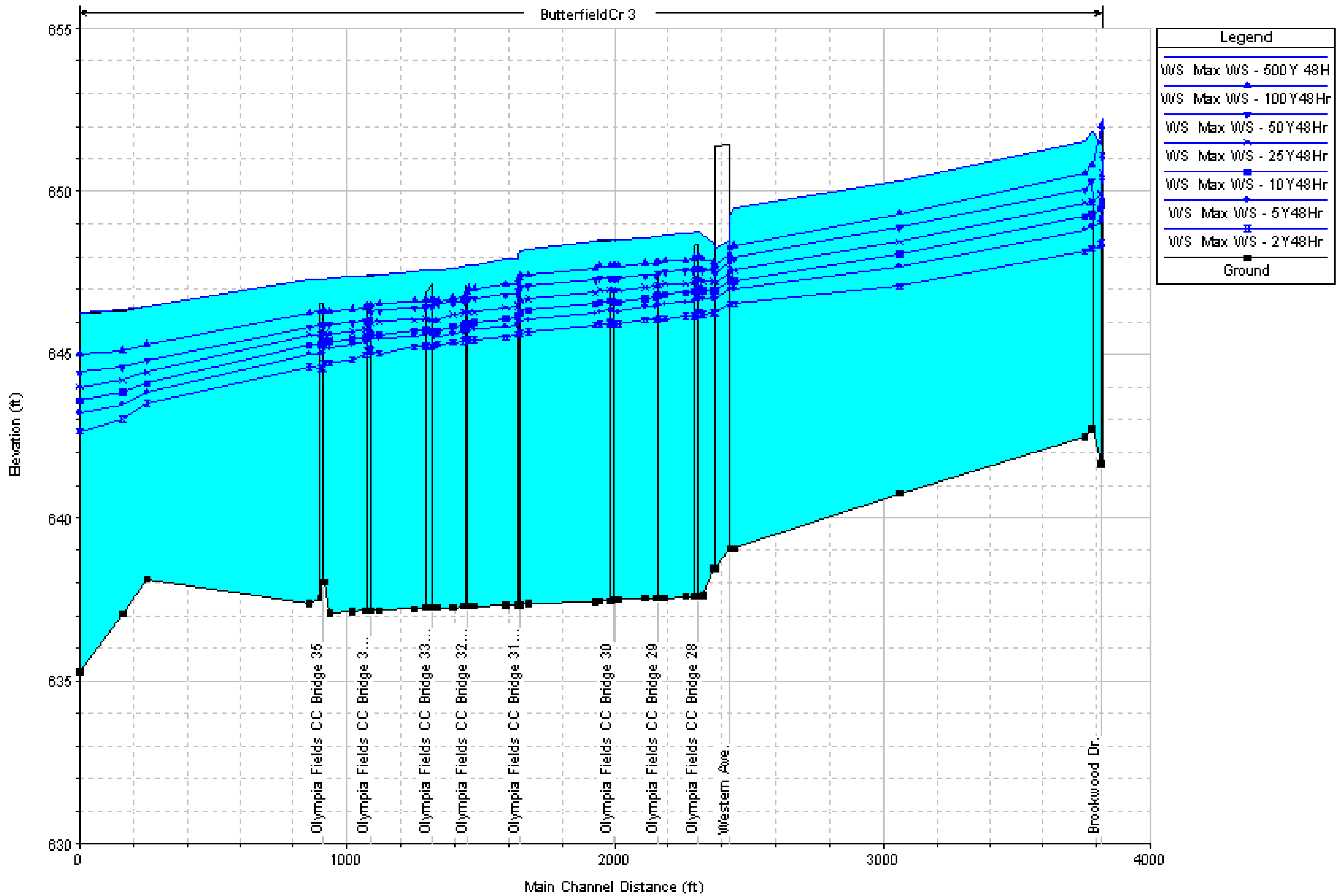
Butterfield Creek, Reach 2

Butterfield Creek Tributary 1 to Halsted St.



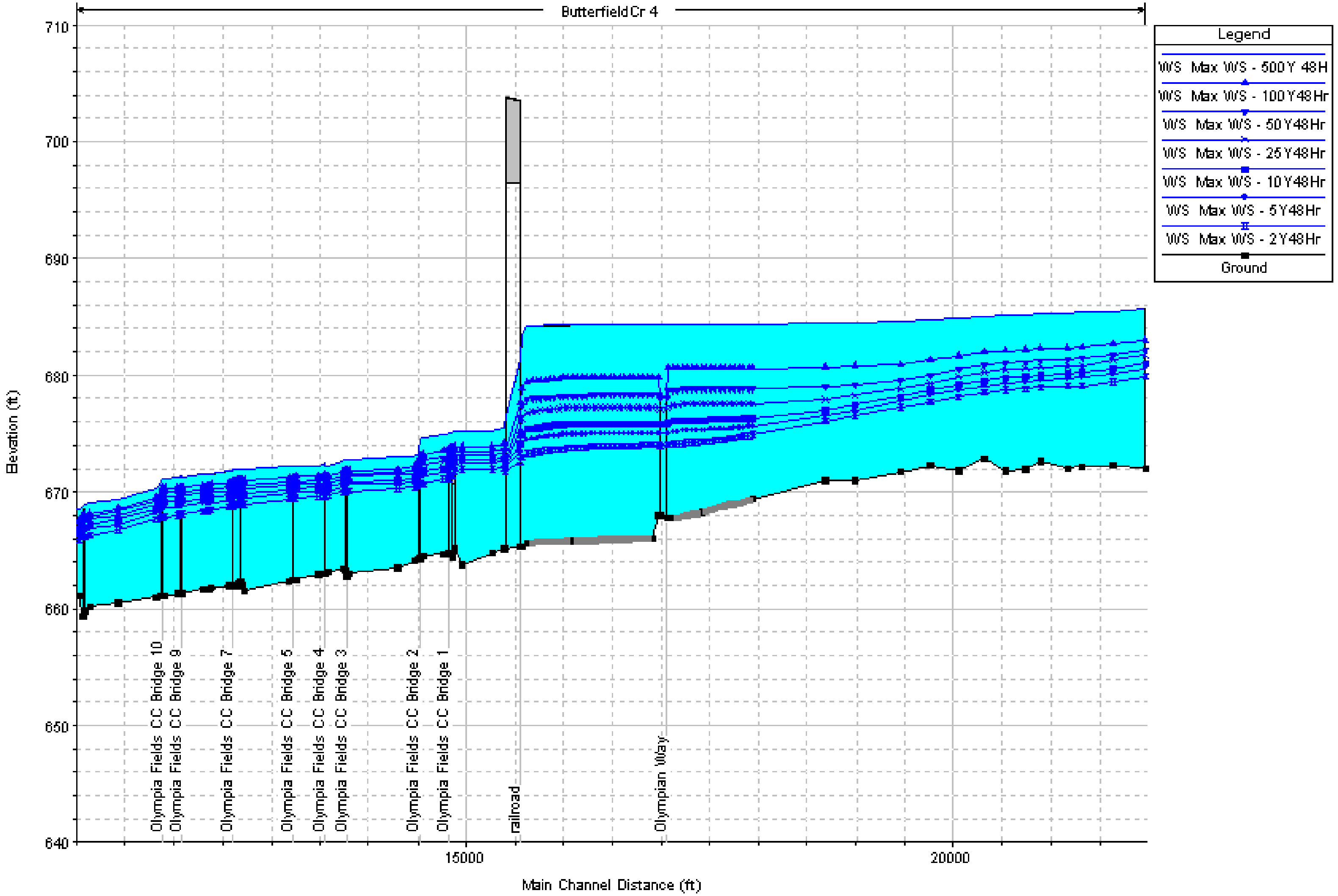
Butterfield Creek, Reach 2

Halsted St. to confluence with Unnamed Trib. To Butterfield Creek East



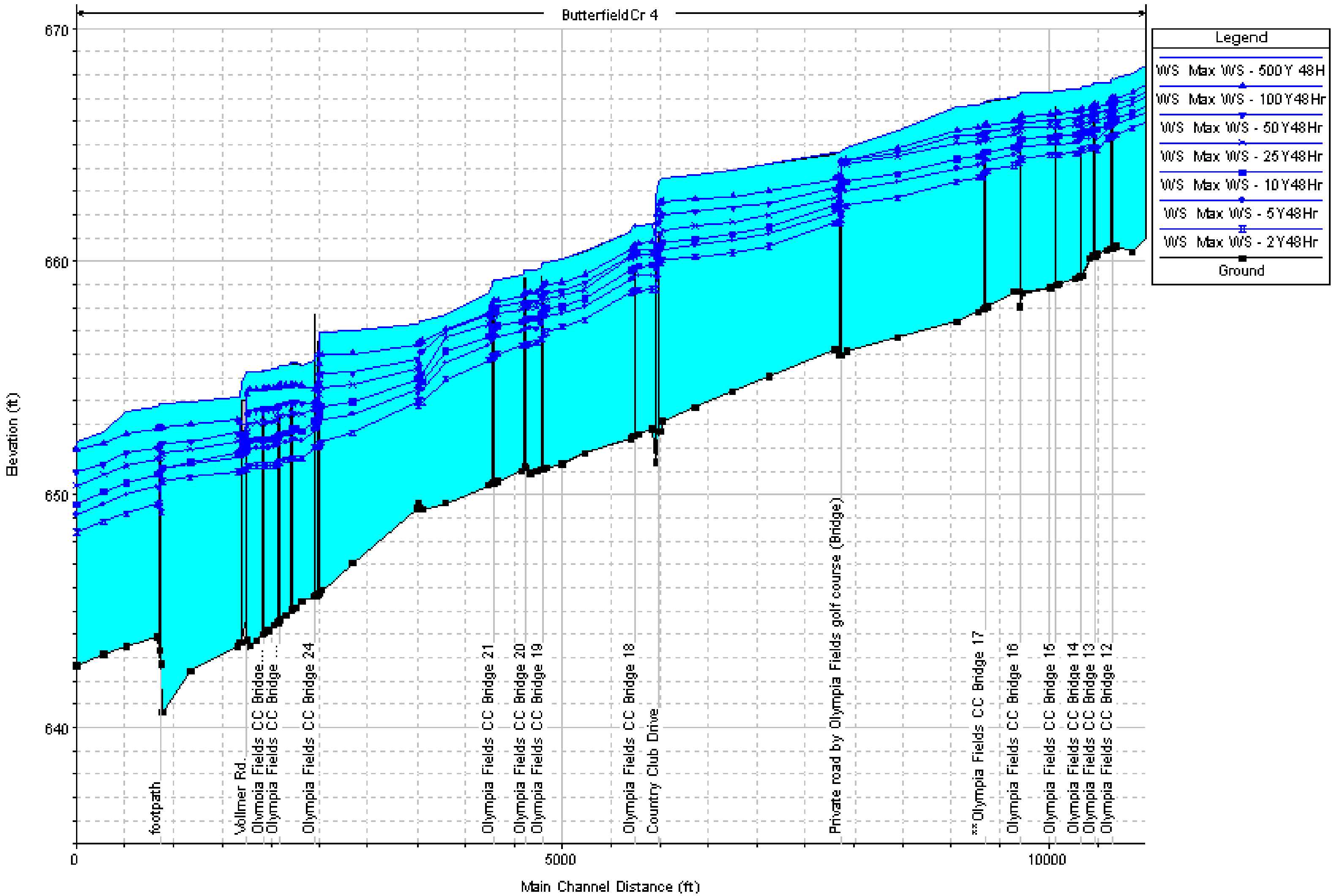
Butterfield Creek, Reach 3

Brookwood Drive (at Butterfield Creek Tributary 3 & Butterfield Creek, Reach 4) to confluence with Butterfield Creek Tributary 1



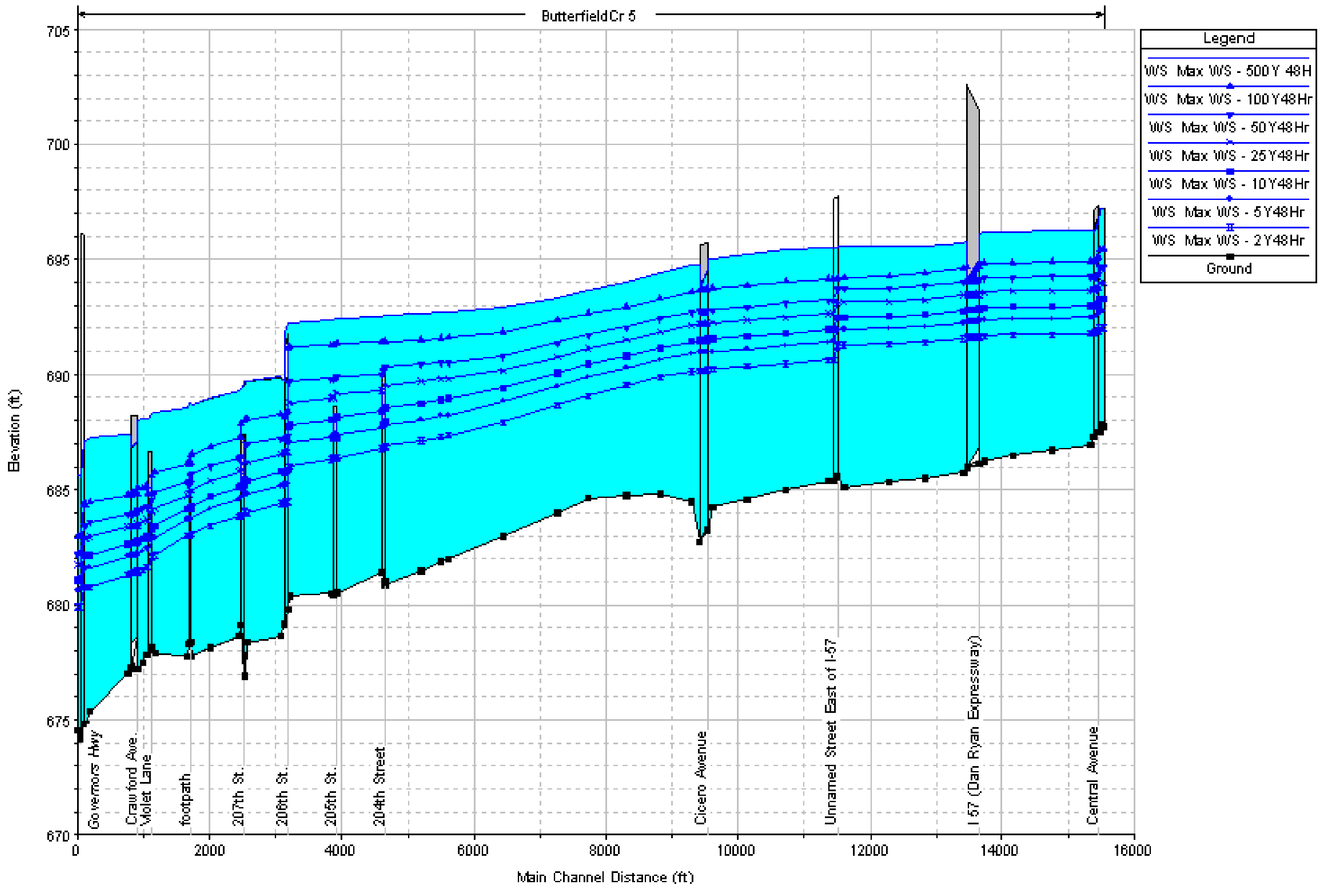
Butterfield Creek, Reach 4

Butterfield Creek East Branch to Olympia Fields Country Club



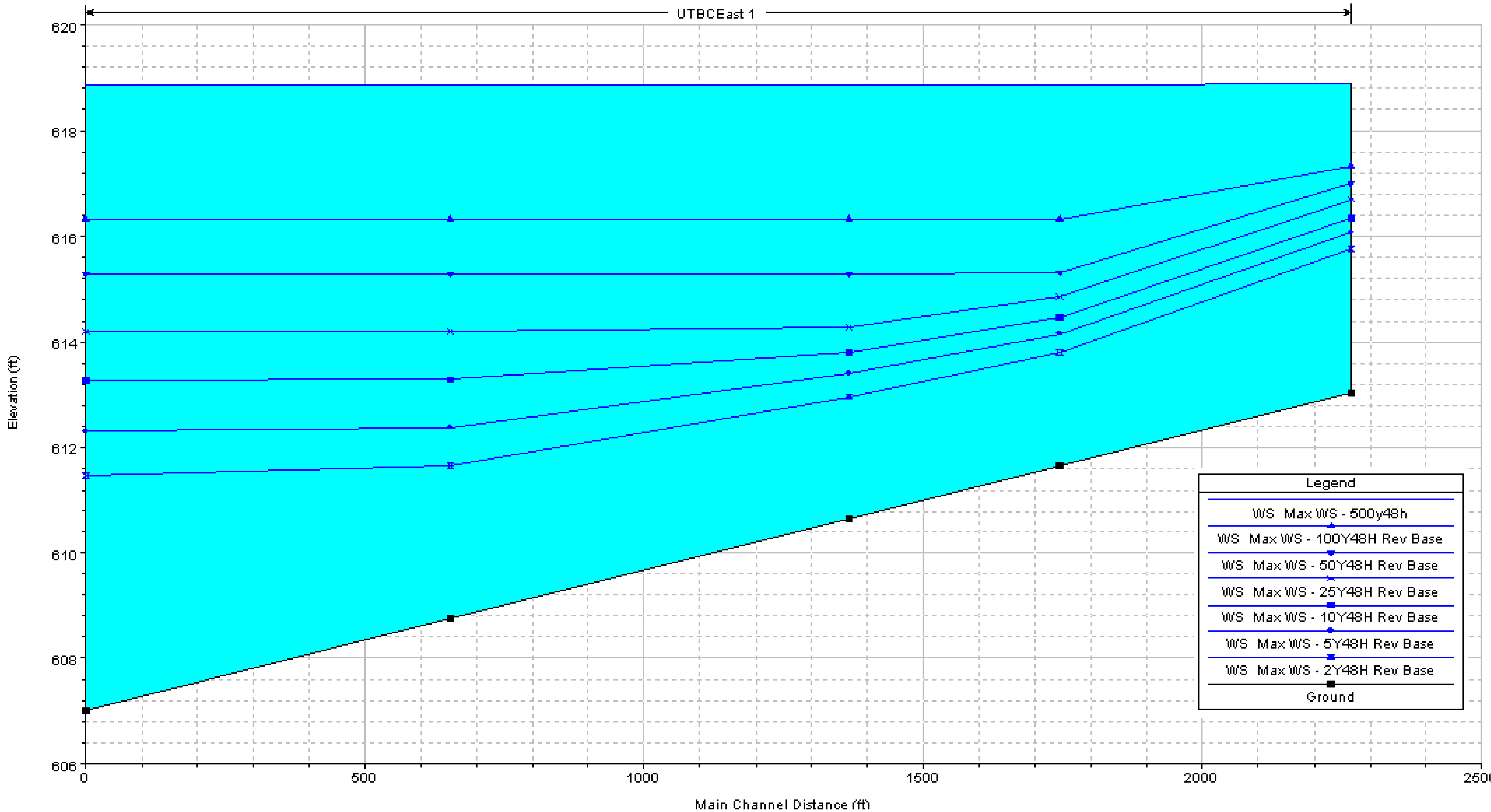
Butterfield Creek, Reach 4

Olympia Fields Country Club to confluence with Butterfield Creek Tributary 3 at Brookwood Drive



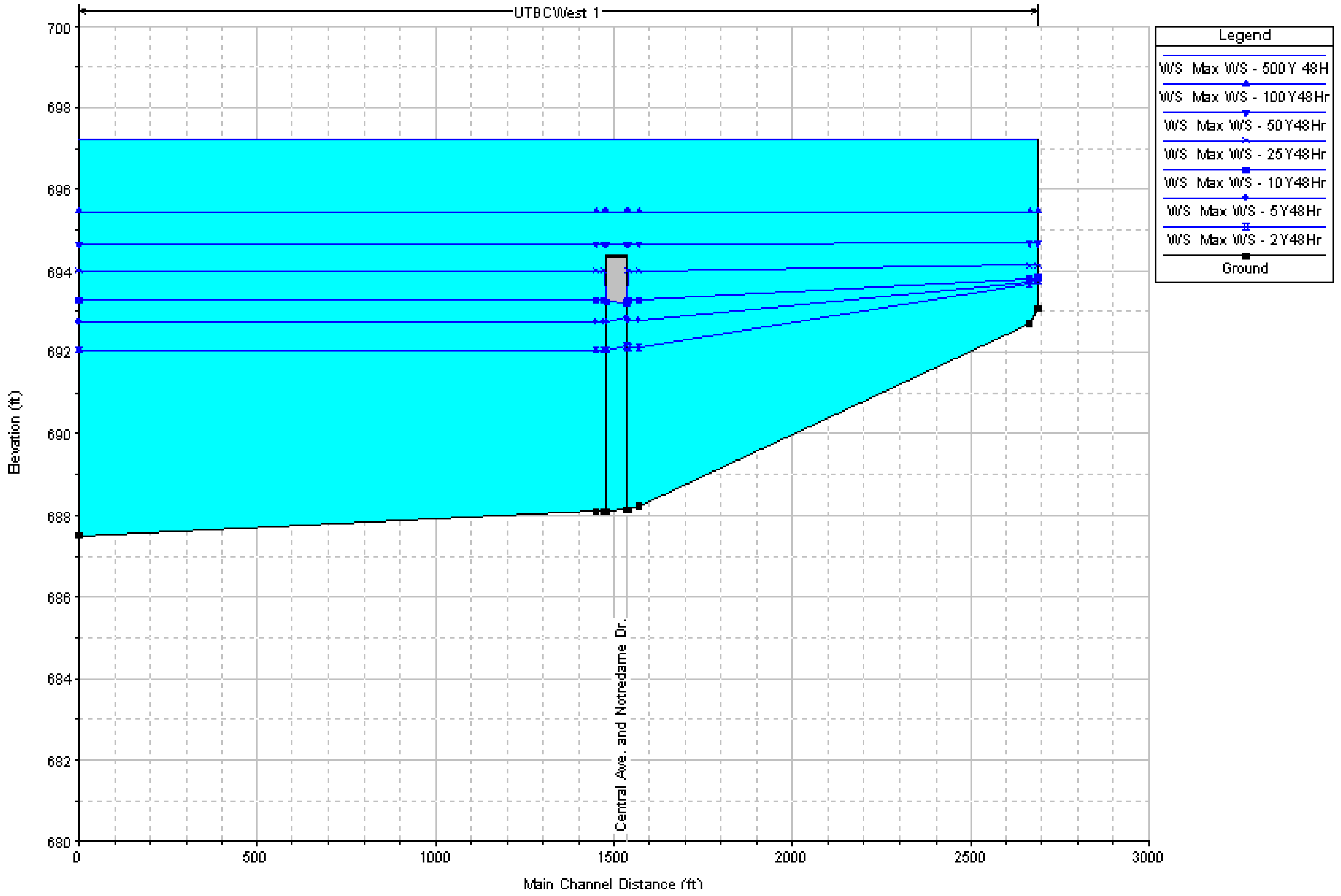
Butterfield Creek, Reach 5

Unnamed Tributary to Butterfield Creek West to confluence with Butterfield Creek East Branch



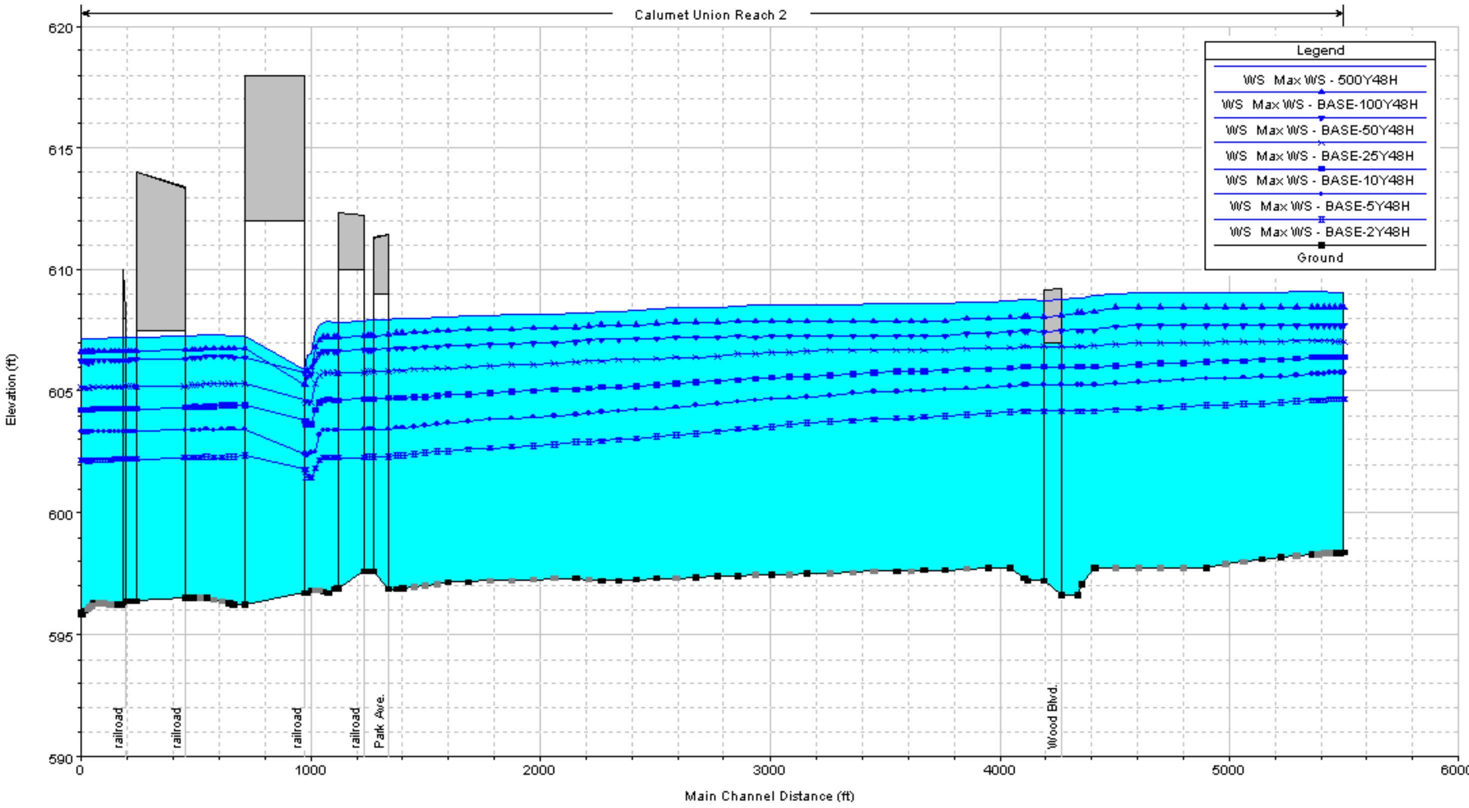
Unnamed Tributary to Butterfield Creek East Branch

187th & Halstead St. to confluence with Butterfield Creek



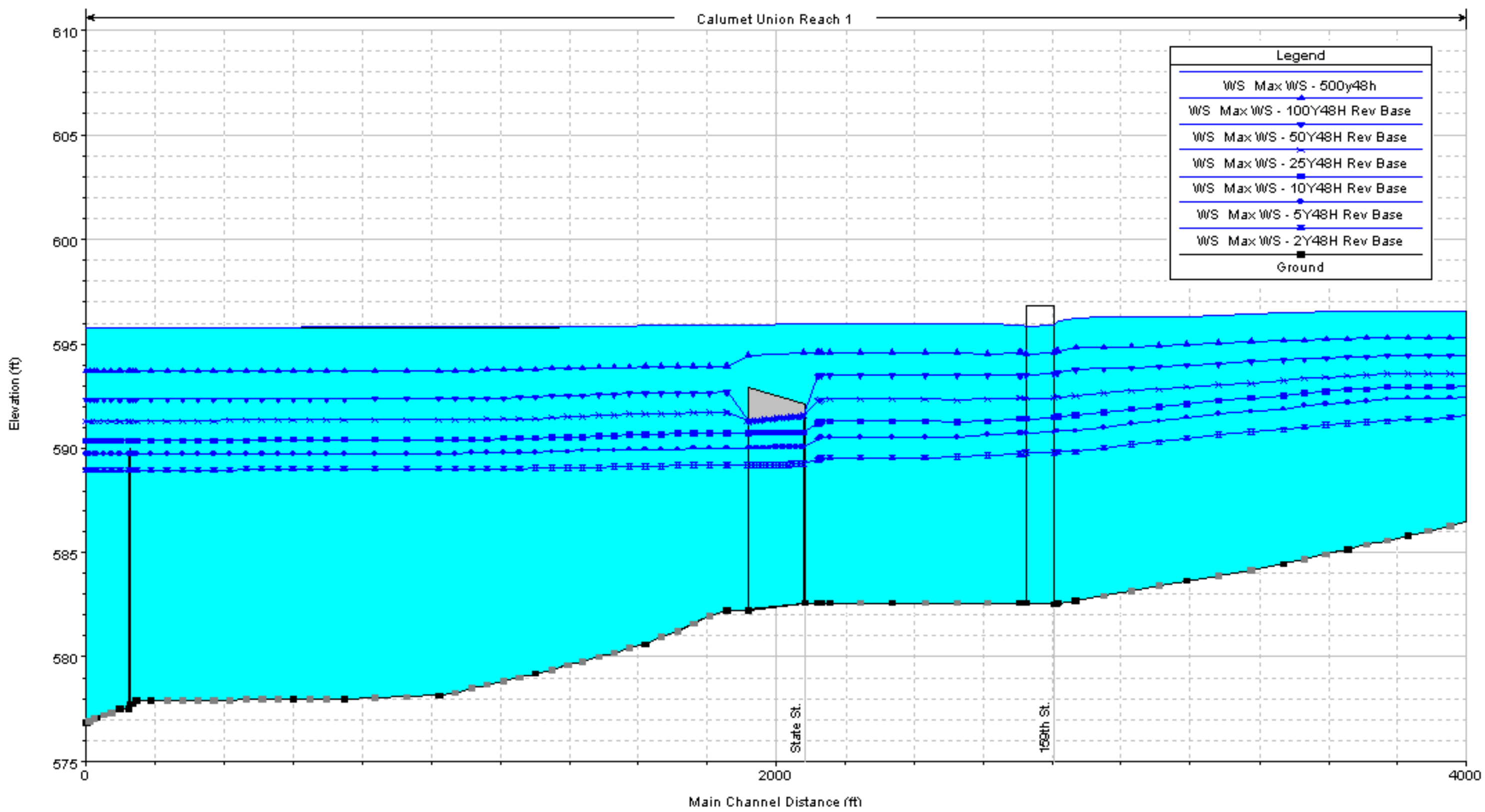
Unnamed Tributary to Butterfield Creek West

Lincoln Hwy. & Central Ave. to confluence with Butterfield Creek, Reach 5



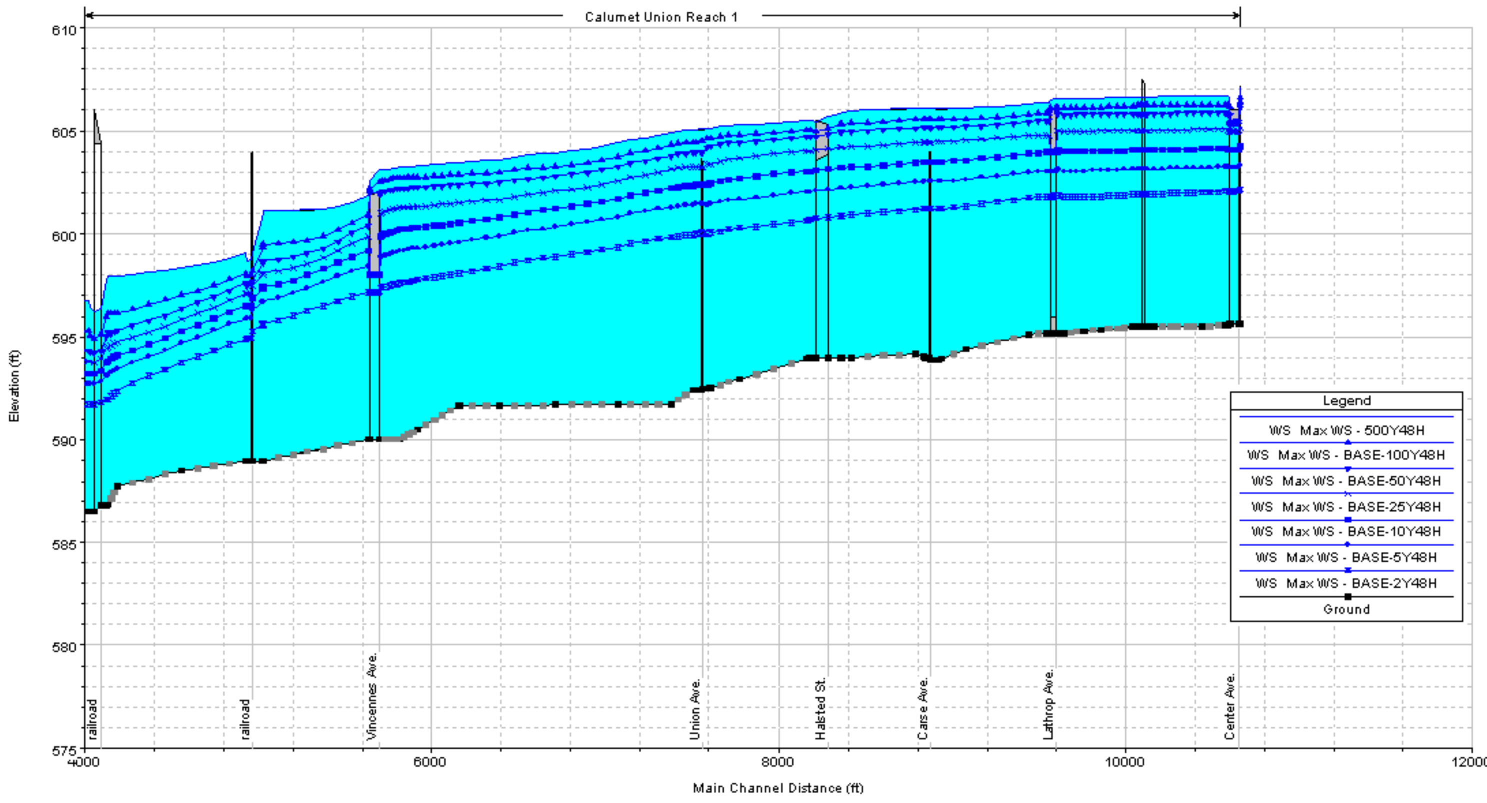
Calumet Union Drainage Ditch, Reach 2

Robey Street Diversion Conduit at 161st St. & Damen Ave. to Confluence with Canadian Central Drainage Ditch



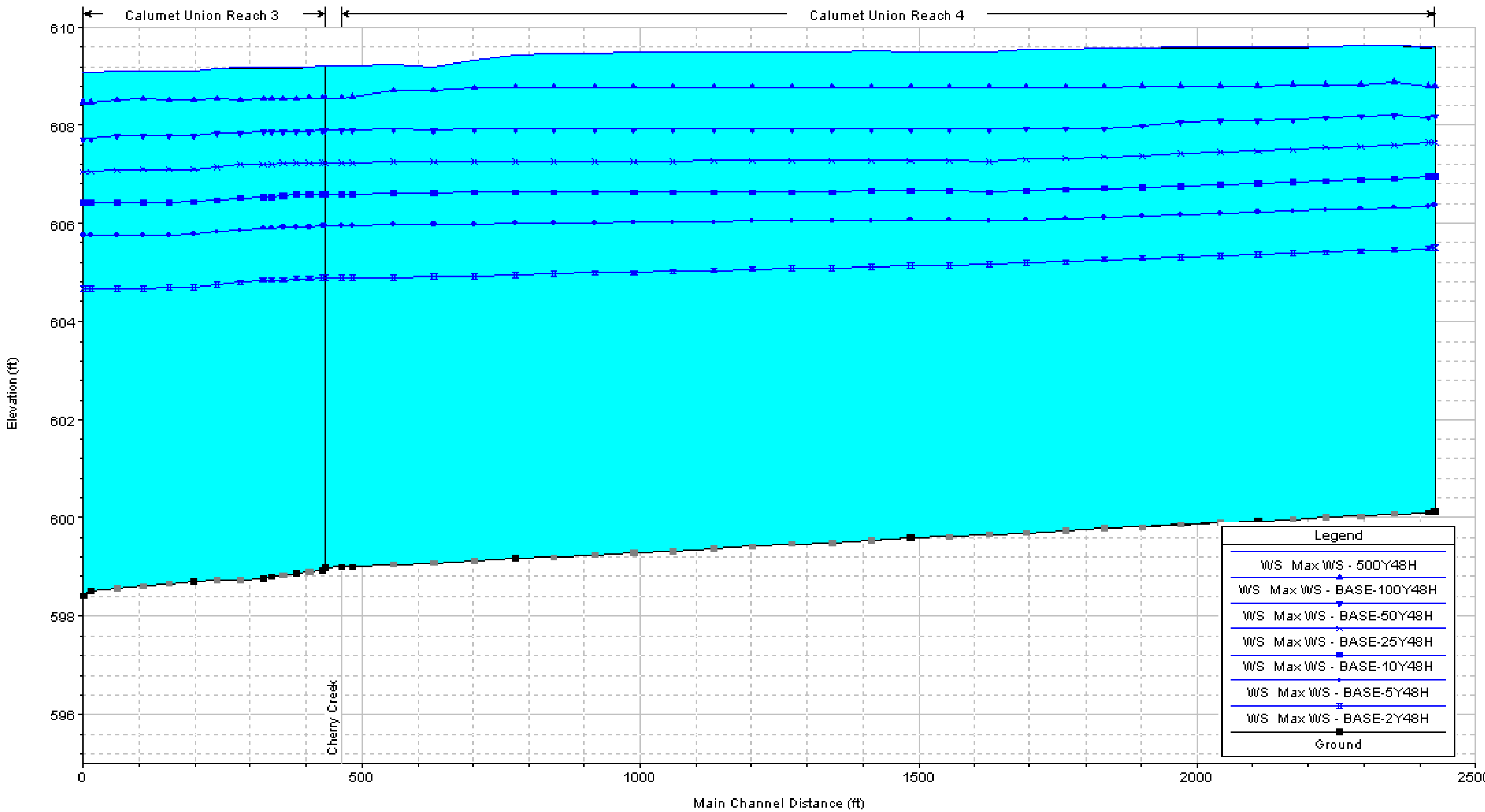
Calumet Union Drainage Ditch, Reach 1

Upstream of 159th Street to confluence with Little Calumet River West



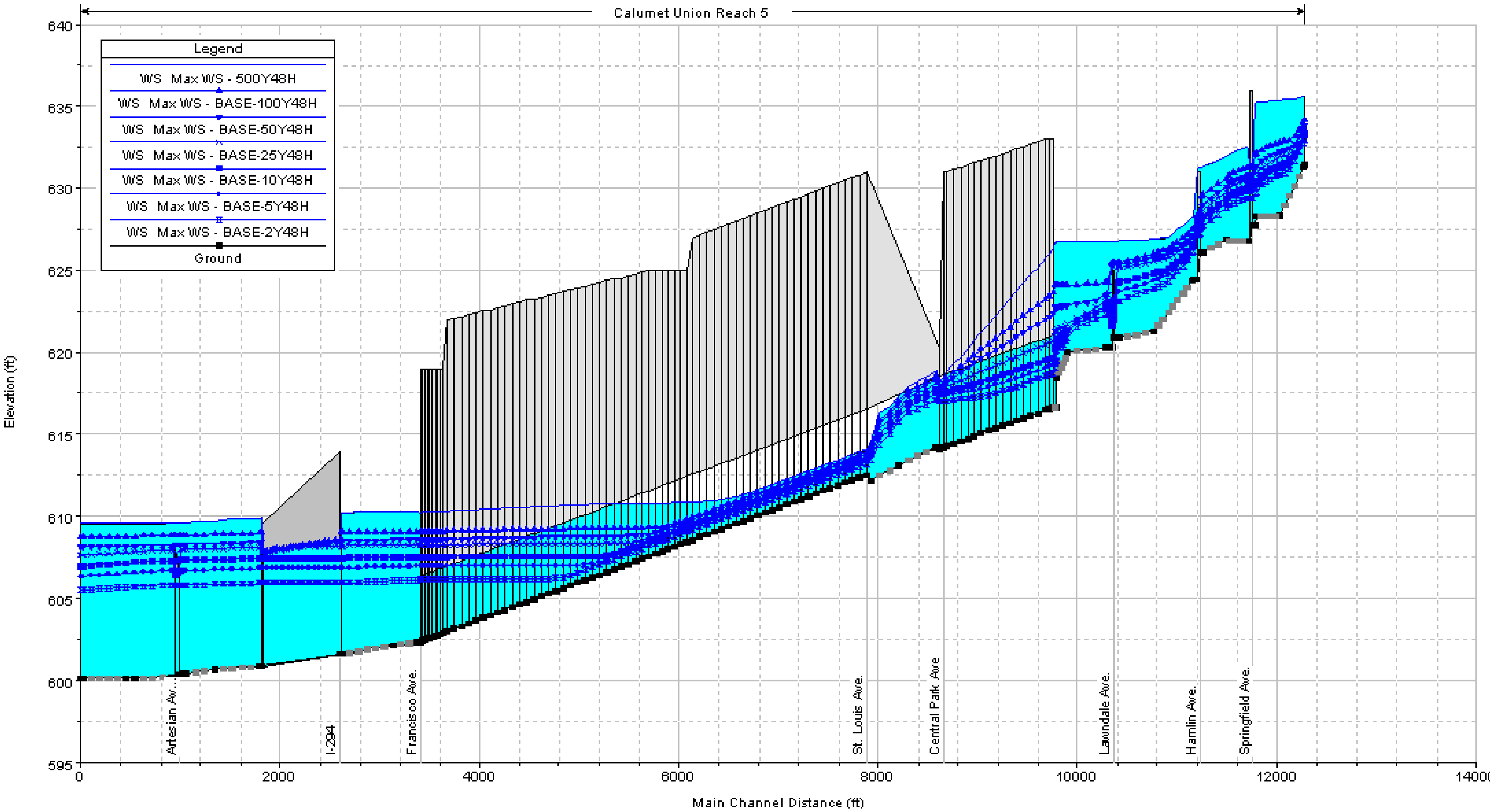
Calumet Union Drainage Ditch, Reach 1

Canadian Central Drainage Ditch to upstream of 159th Street



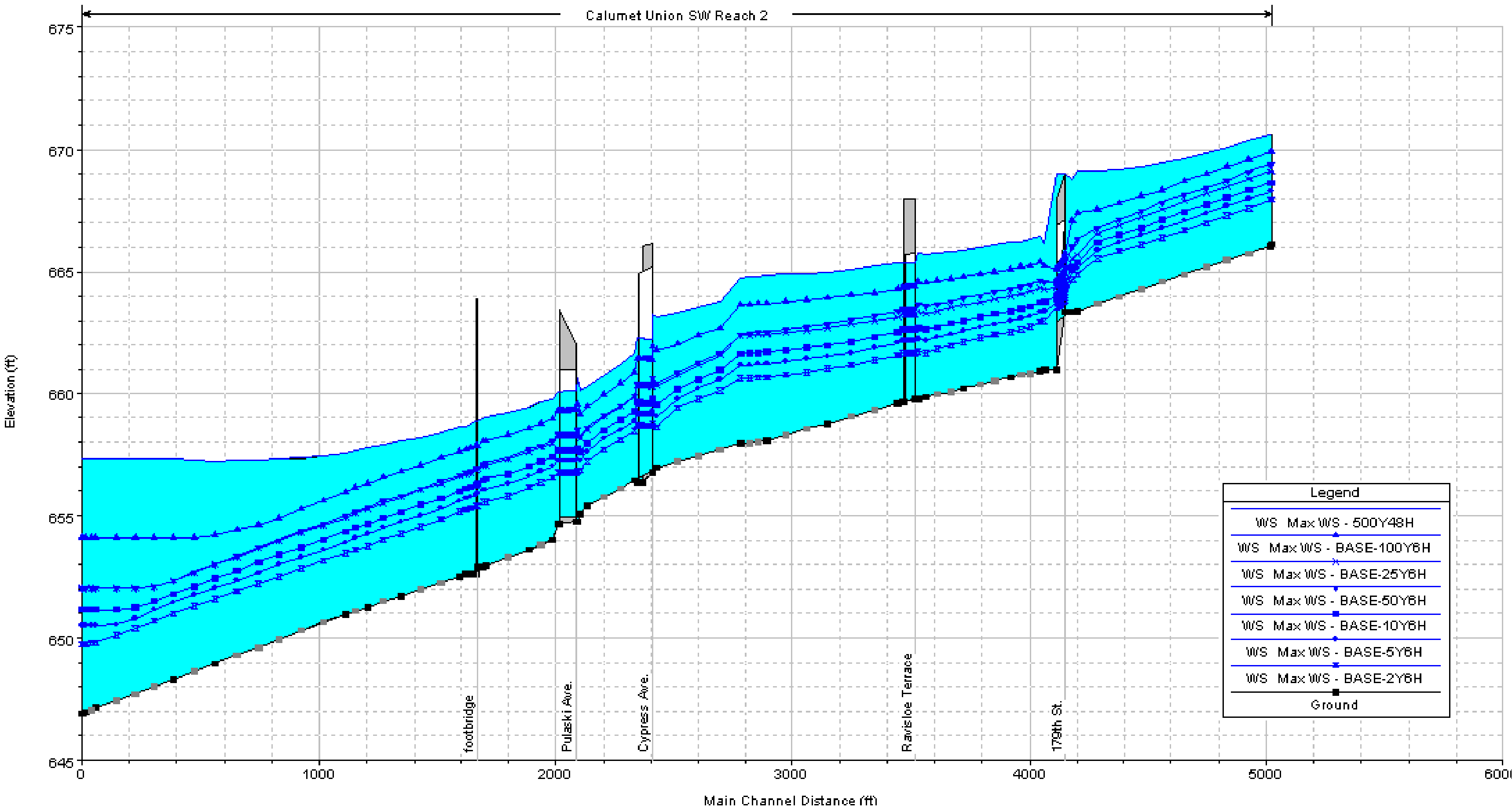
Calumet Union Drainage Ditch, Reaches 3 & 4

CUDD Southwest Branch to confluence with Robey Street Diversion Conduit at 161st Street & Damen Ave.



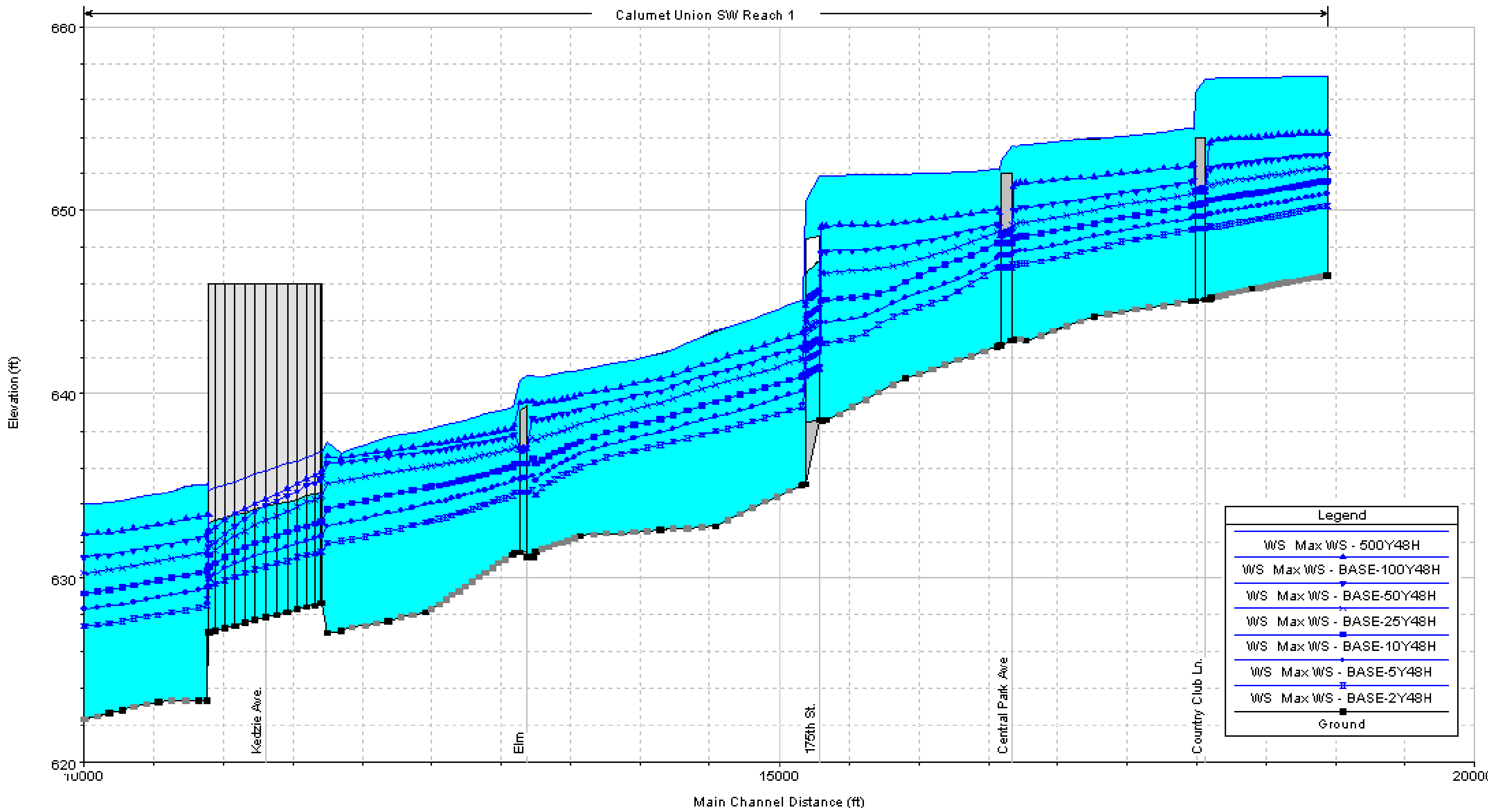
Calumet Union Drainage Ditch, Reach 5

Sunset Avenue to confluence with CUDD Southwest Branch



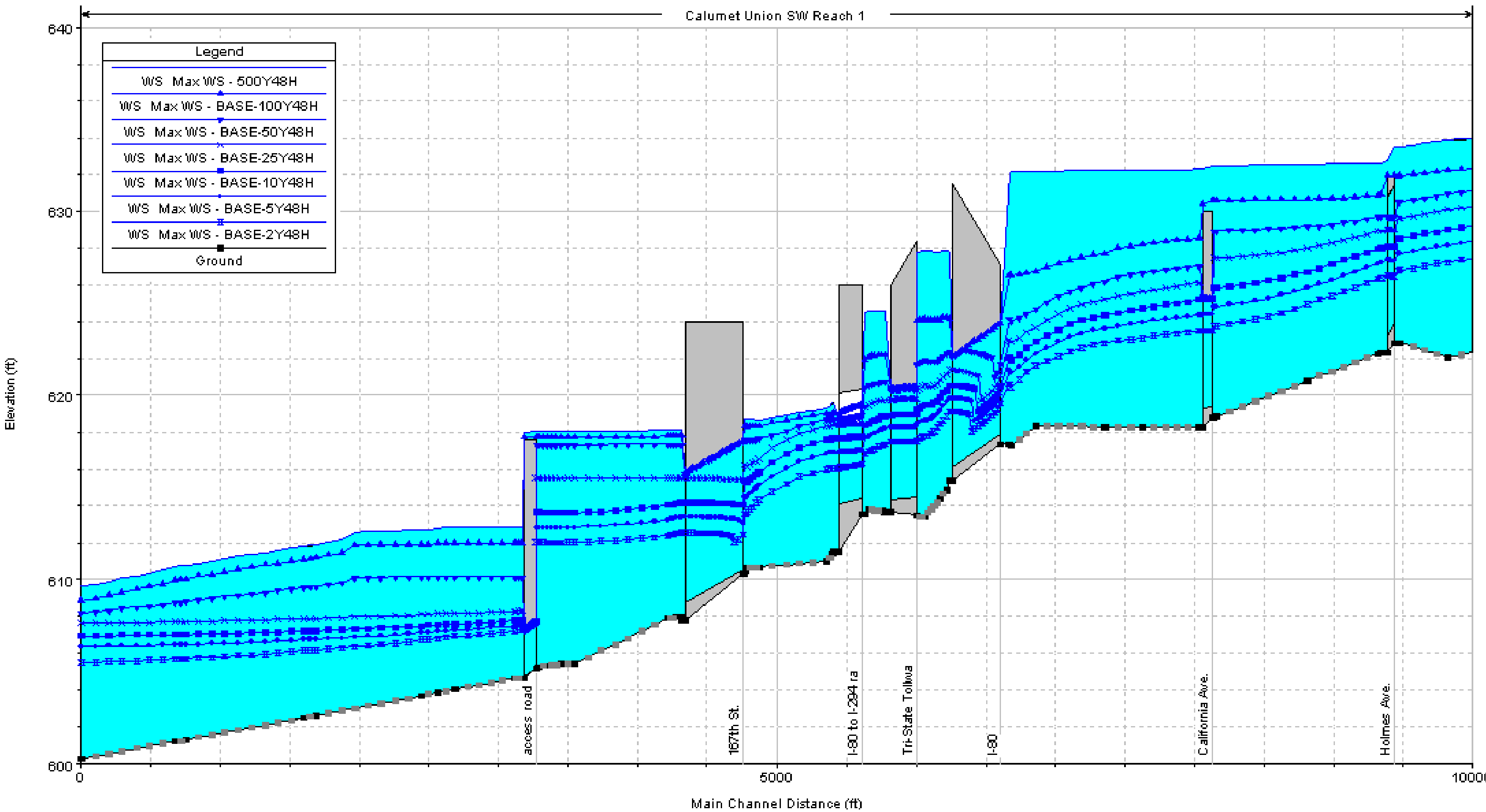
Calumet Union Drainage Ditch Southwest Branch, Reach 2

Kostner Avenue to confluence with Calumet Union Drainage Ditch SW Branch Trib. N (near Pulaski Ave. and 175th St.)



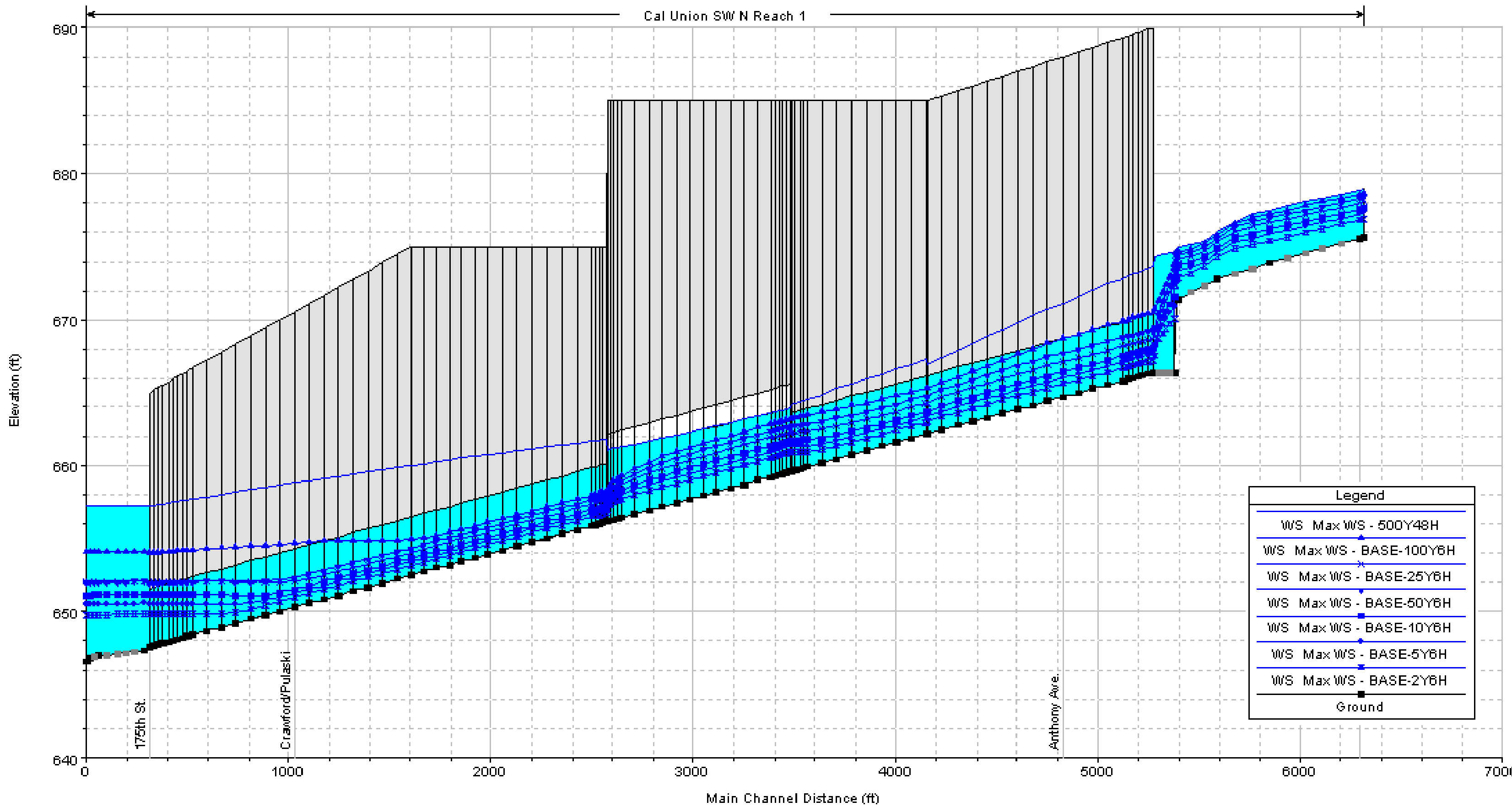
Calumet Union Drainage Ditch Southwest Branch, Reach 1

Calumet Union Drainage Ditch SW Branch N Trib. (Crawford Ave. & 175th St.) to 1000' downstream of Kedzie Ave.



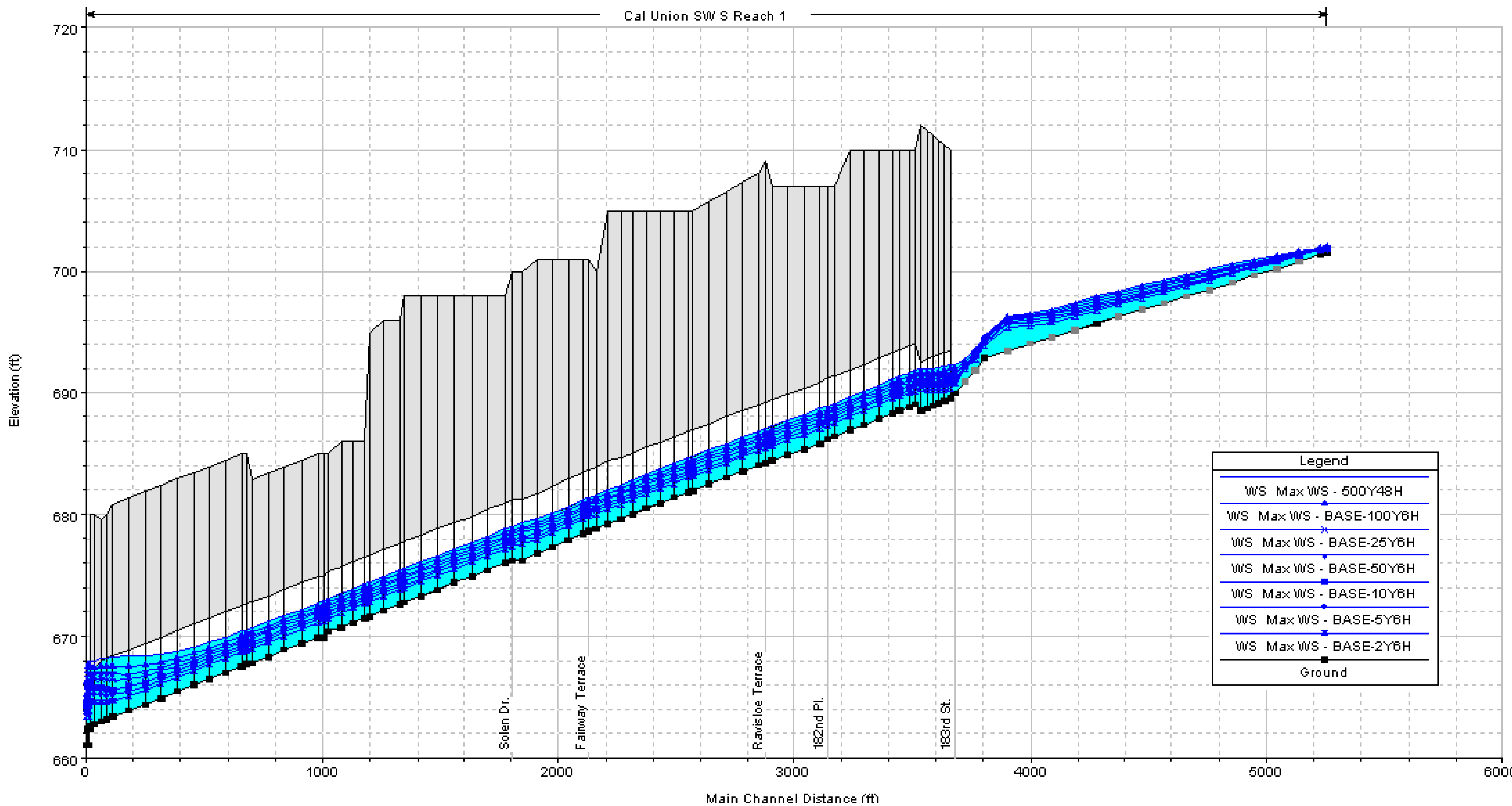
Calumet Union Drainage Ditch Southwest Branch, Reach 1 DS

1000' Downstream of Kedzie Ave. to confluence with Calumet Union Drainage Ditch



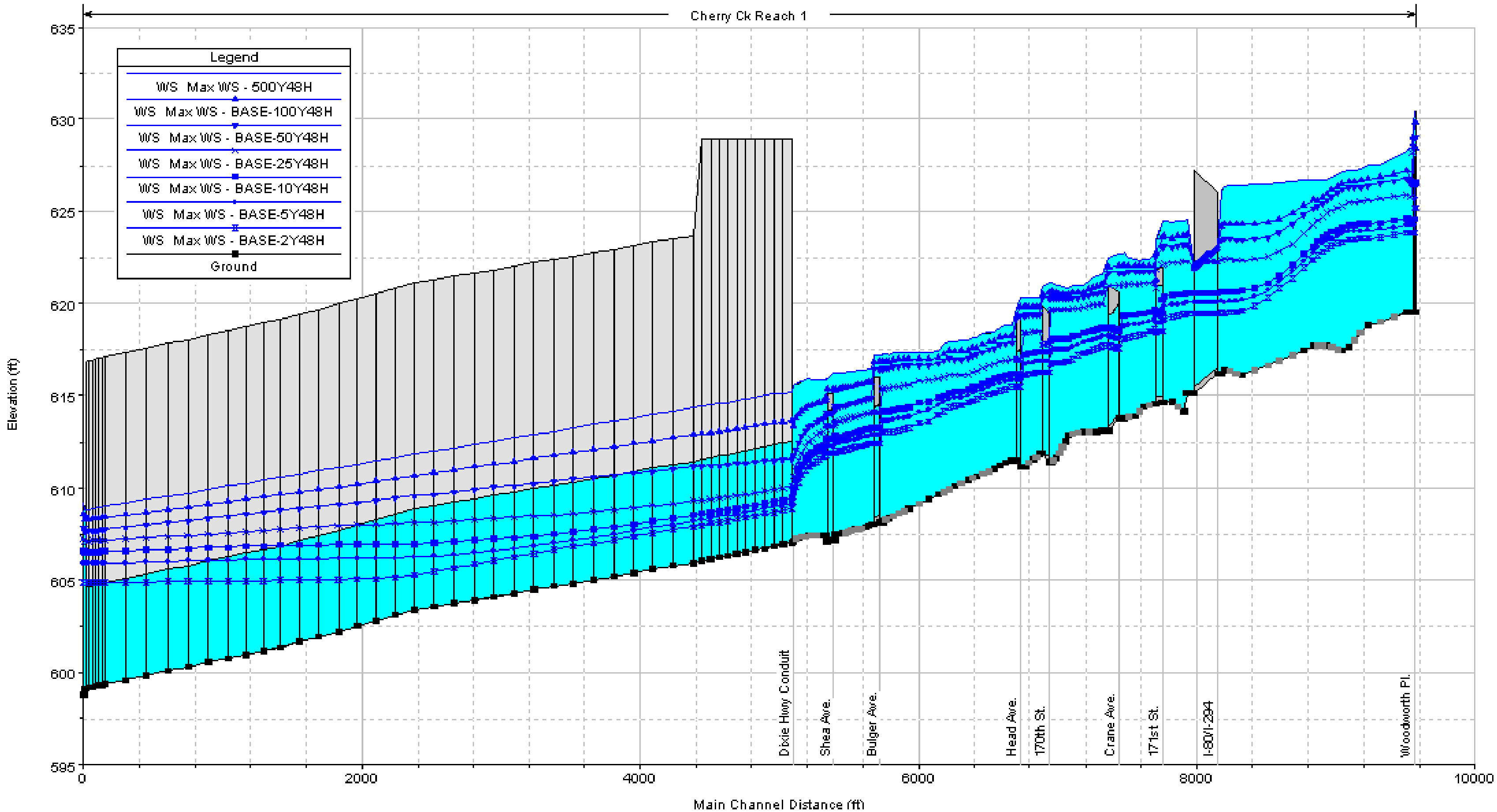
Calumet Union Drainage Ditch Southwest Branch Tributary N

Cicero Ave. and I-80 to confluence with Calumet Union Drainage Ditch SW Branch



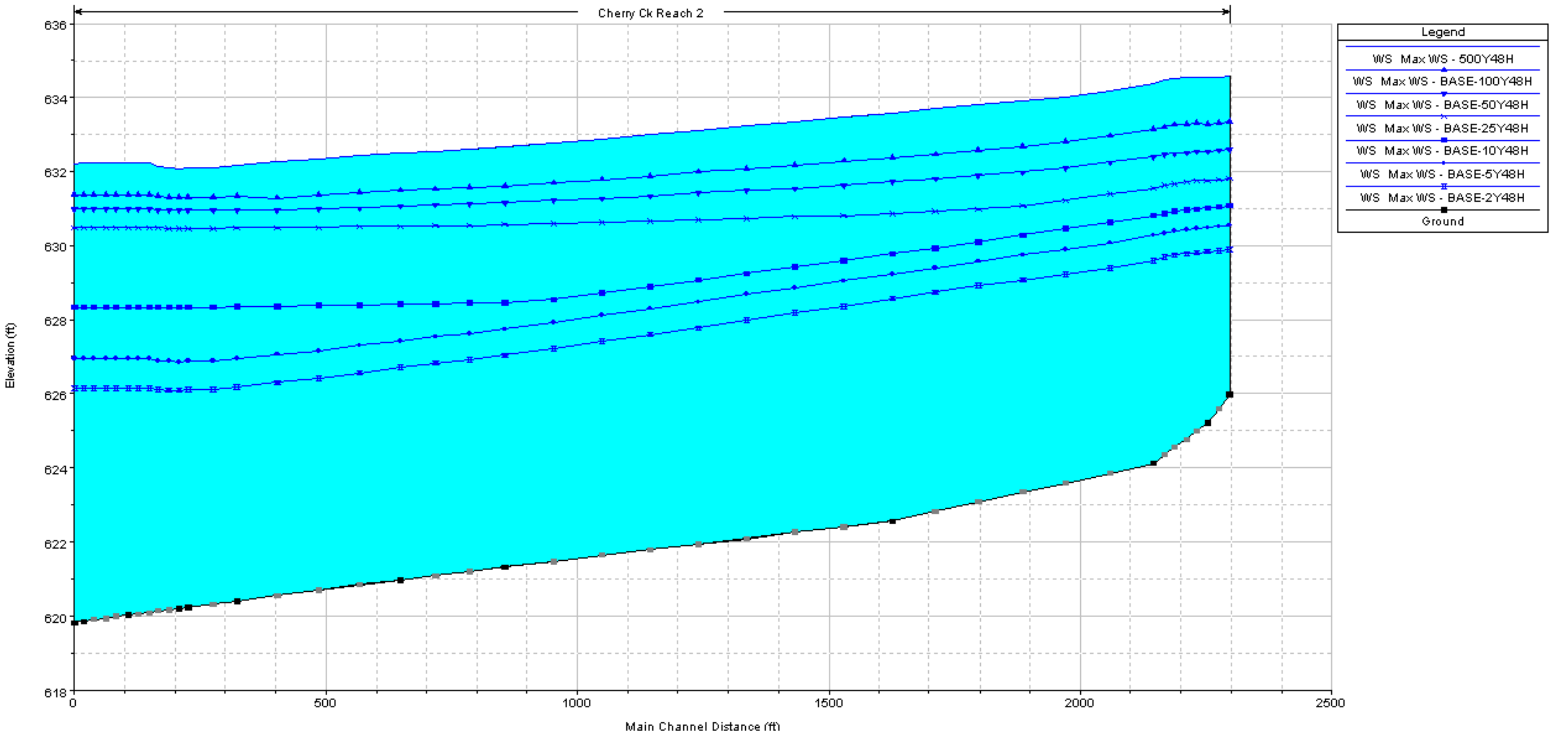
Calumet Union Drainage Ditch Southwest Branch Tributary S

186th Avenue to confluence with Calumet Union Drainage Ditch SW Branch



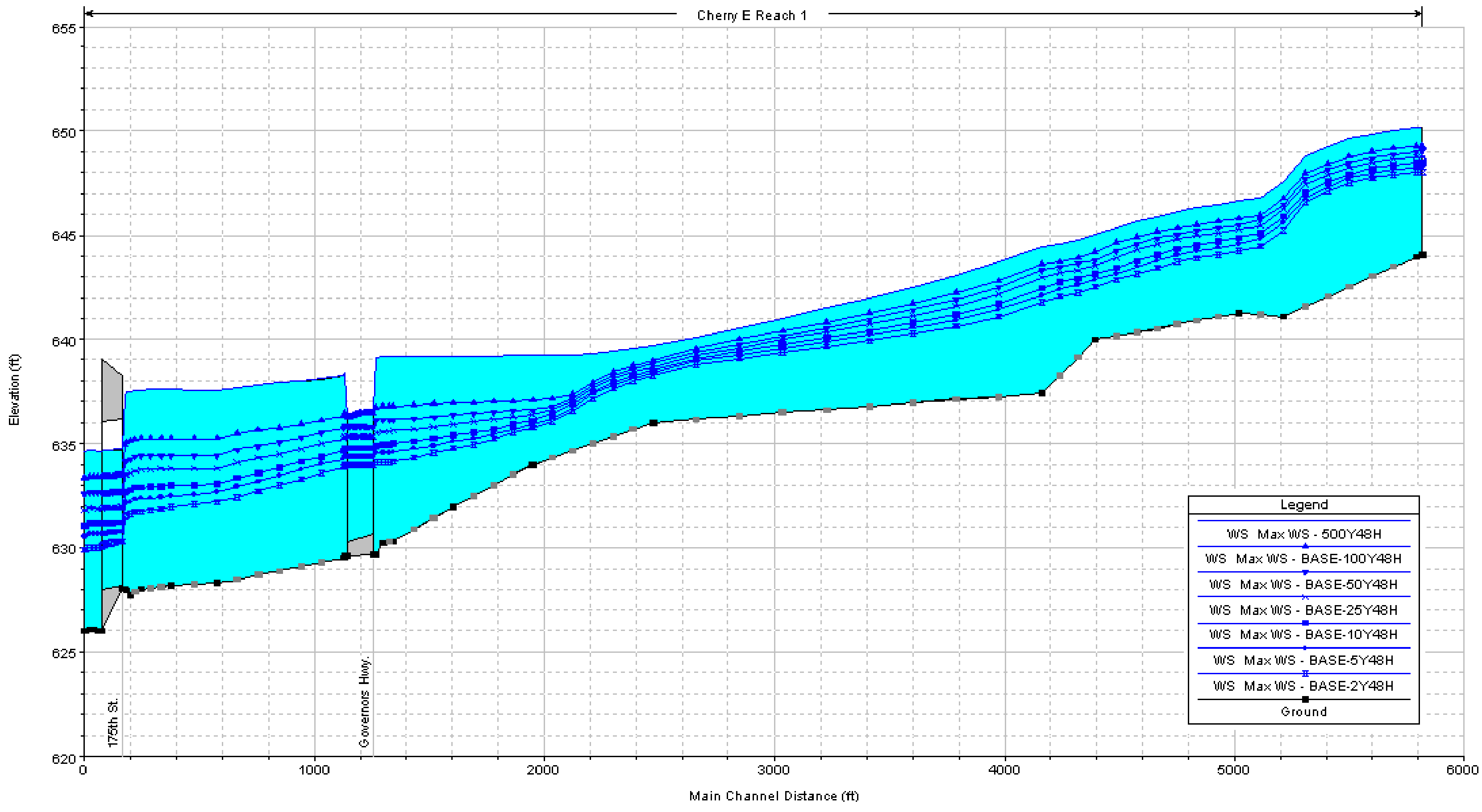
Cherry Creek, Reach 1

Calumet Union Reservoir to confluence with Calumet Union Drainage Ditch



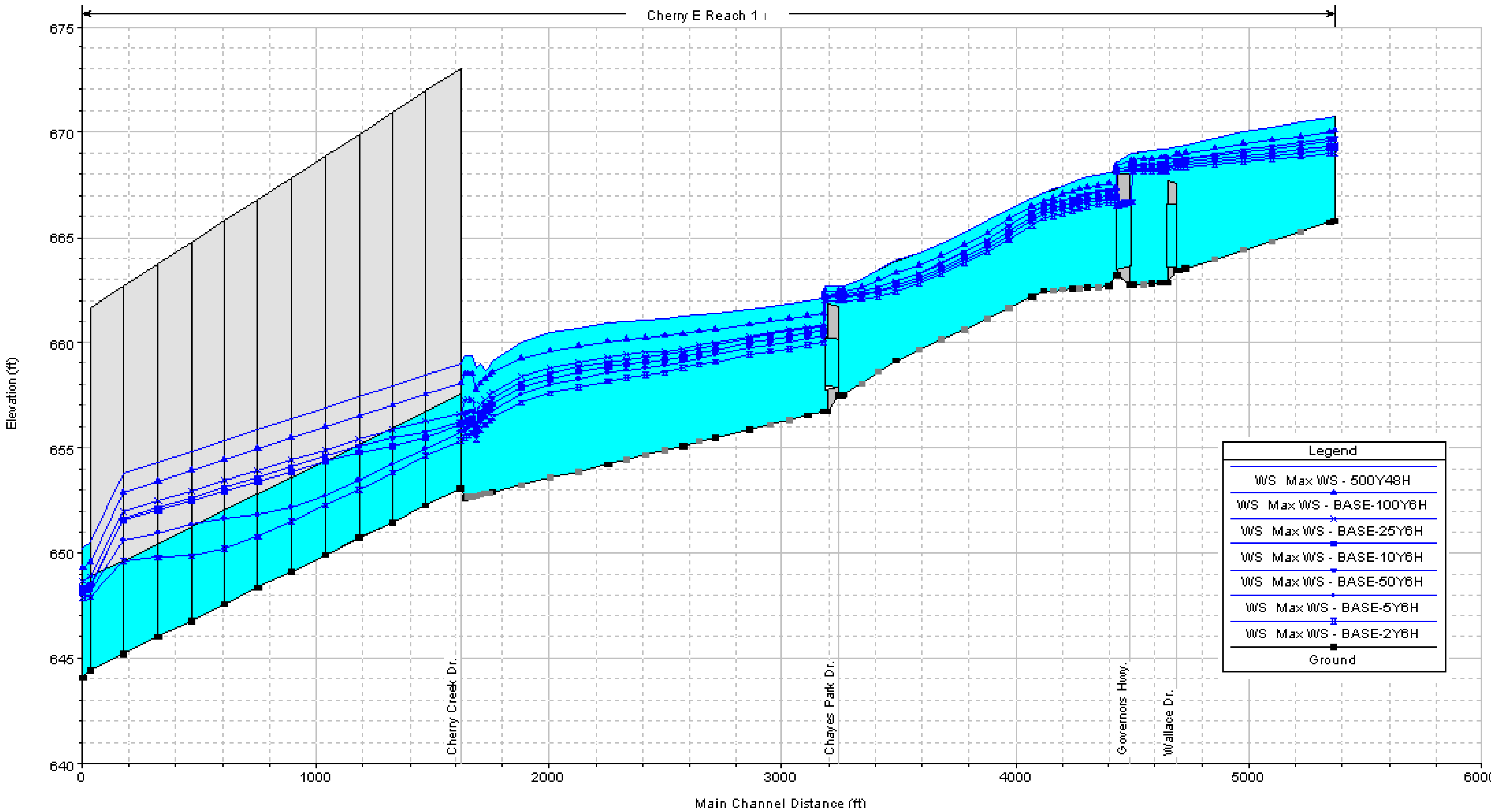
Cherry Creek, Reach 2

Confluence of Cherry Creek East Branch and Cherry Creek West Branch to Calumet Union Reservoir



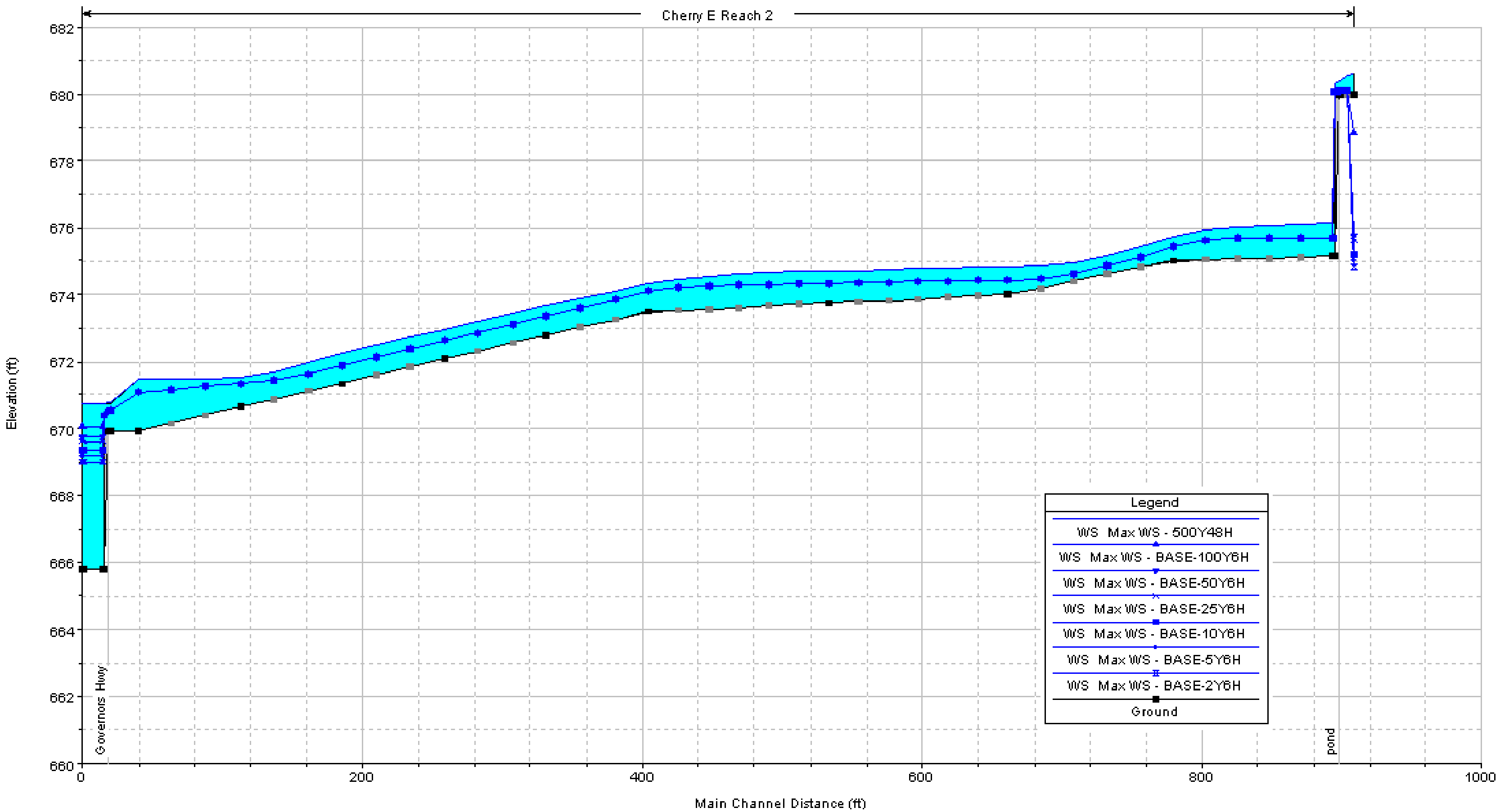
Cherry Creek East Branch, Reach 1

183rd and Governors Hwy. to confluence with Cherry Creek



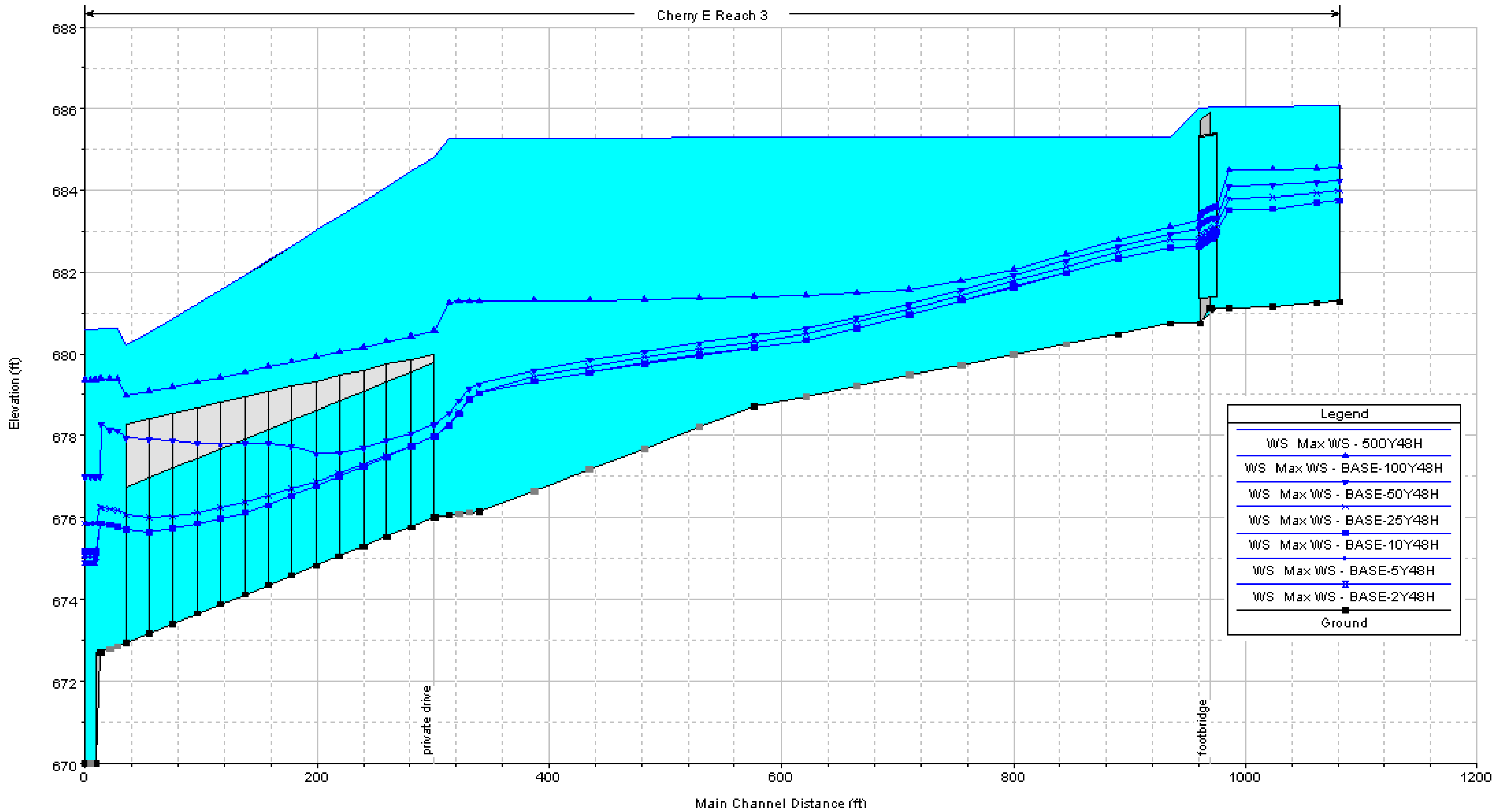
Cherry Creek East Branch, Reach 1

Cherry Creek East Branch Tributary to 183rd St. and Governors Highway



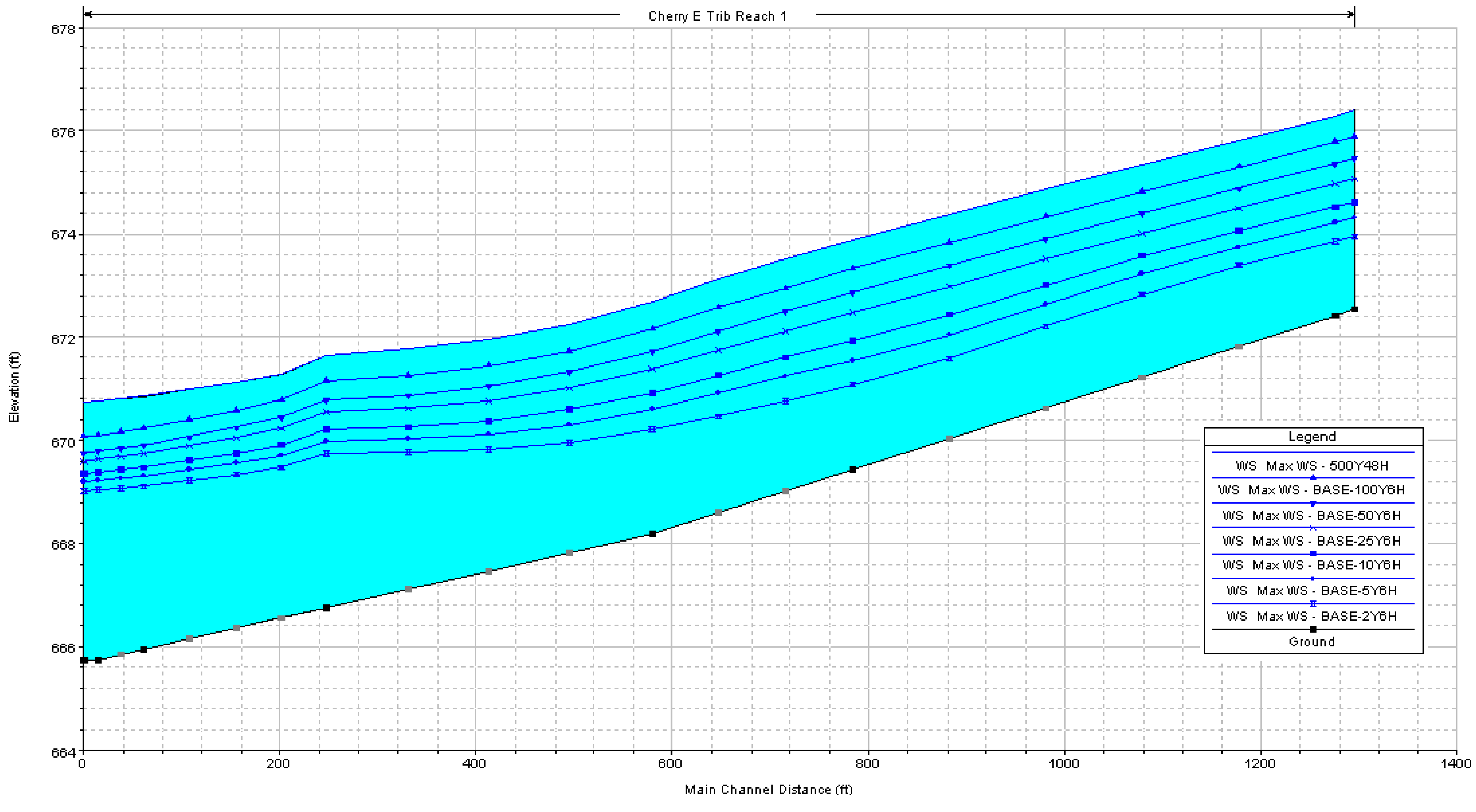
Cherry Creek East Branch, Reach 2

Pond at Homewood Flossmoor HS to confluence with Cherry Creek East Branch Tributary at Governors Highway



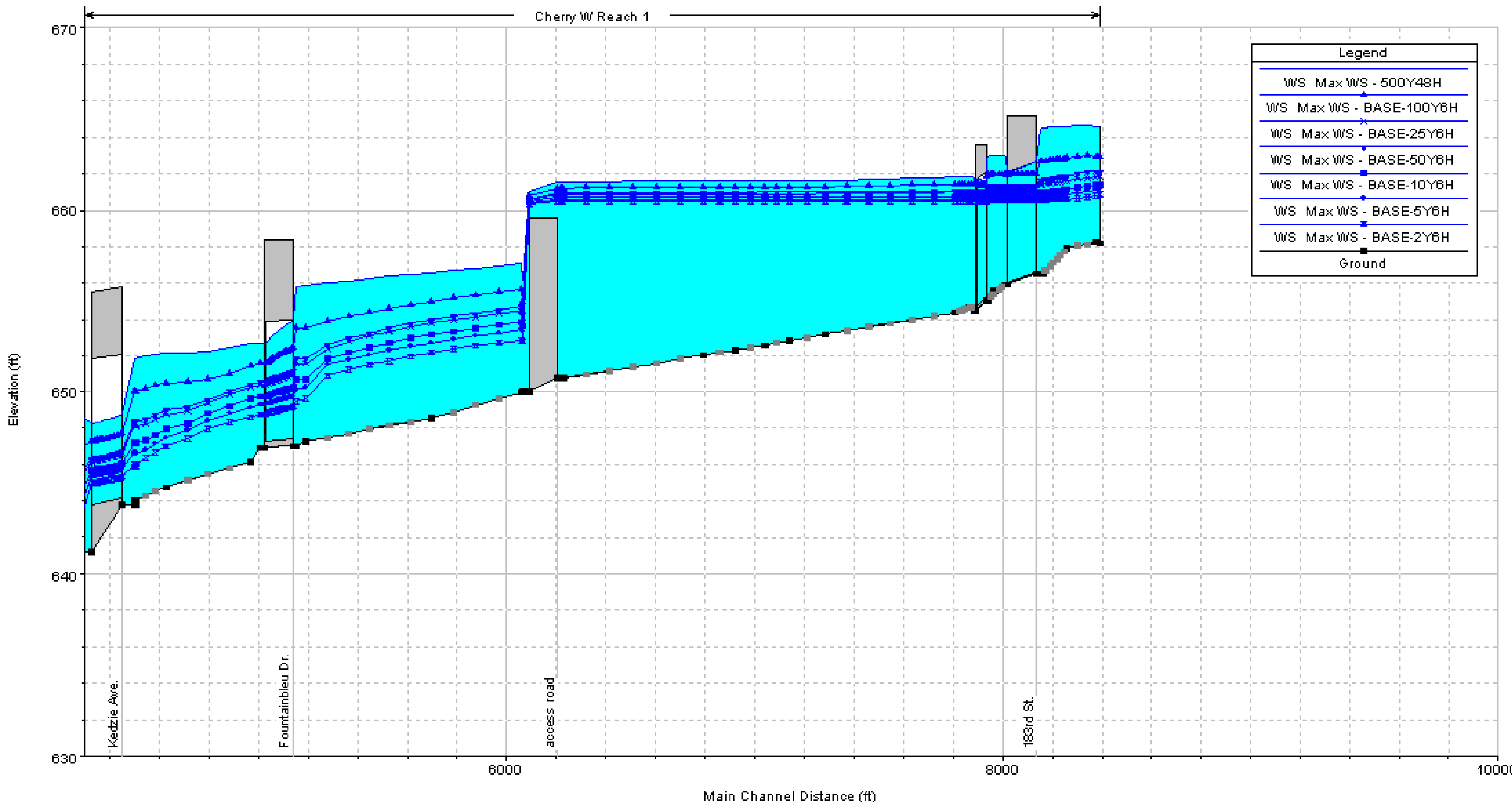
Cherry Creek East Branch, Reach 3

Kedzie Avenue to pond at Homewood Flossmoor HS



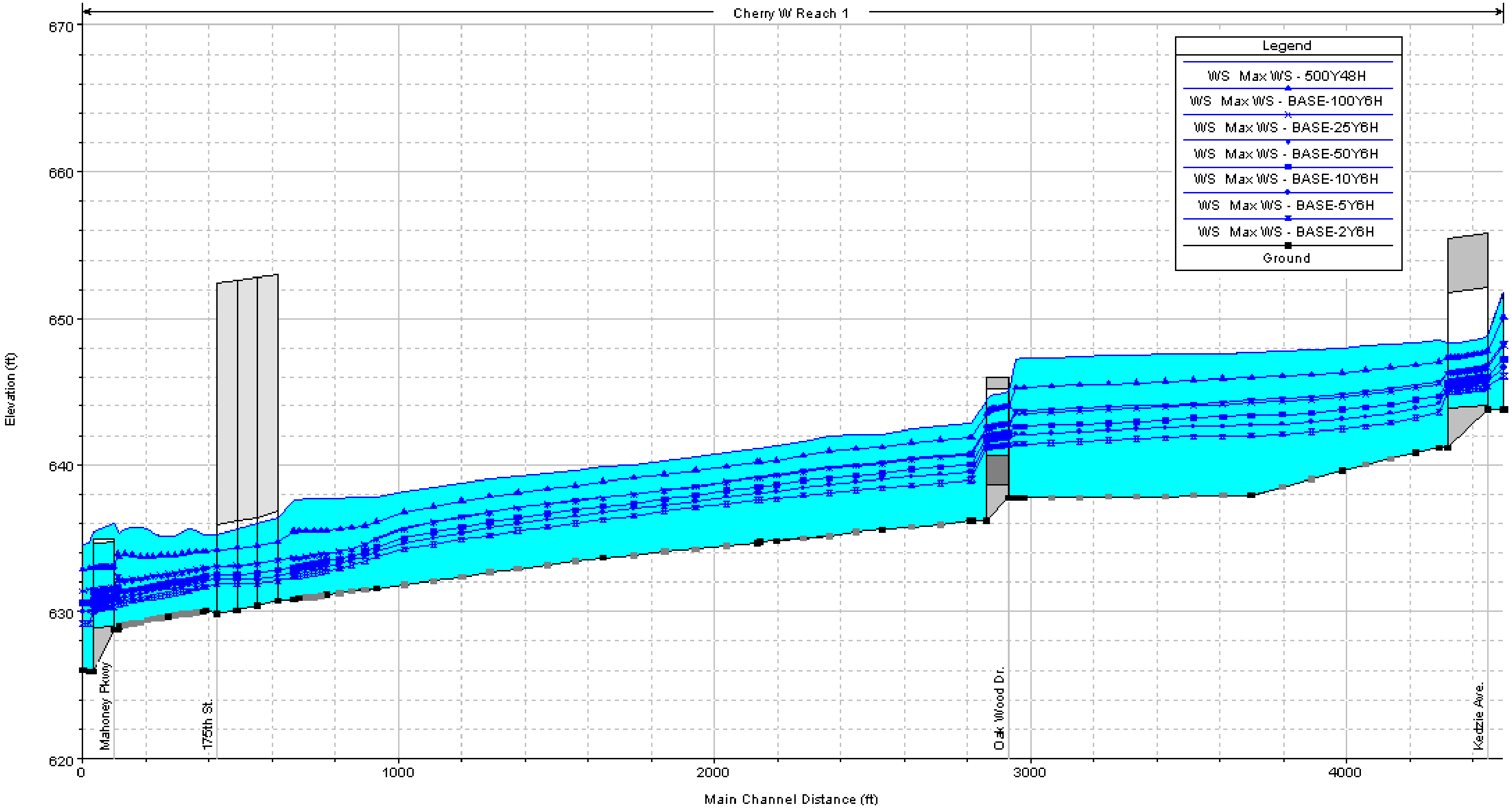
Cherry Creek East Branch Tributary

Flossmoor Road to confluence with Cherry Creek East Branch



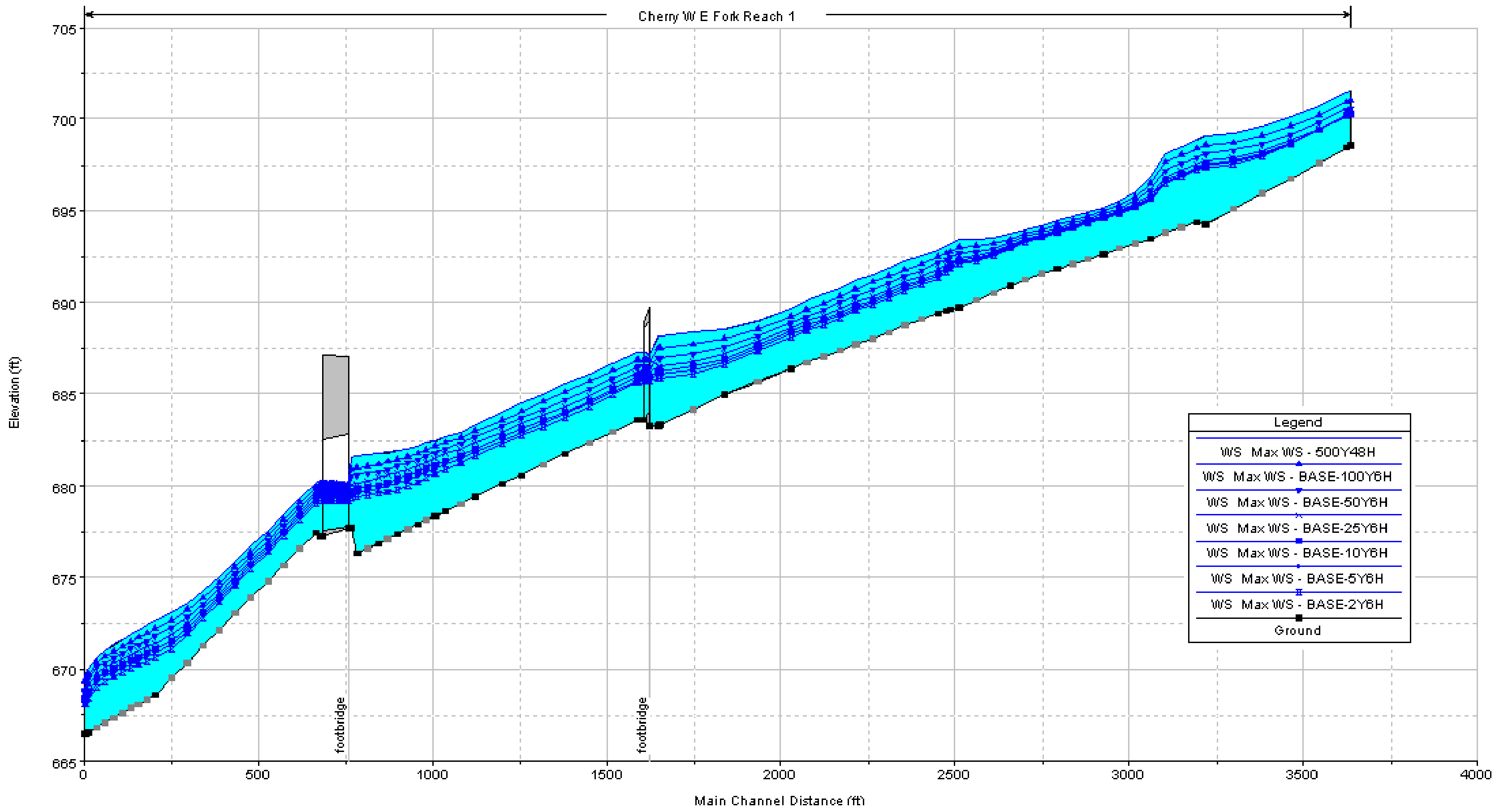
Cherry Creek West Branch

Detention basin south of 183rd Street to Kedzie Avenue



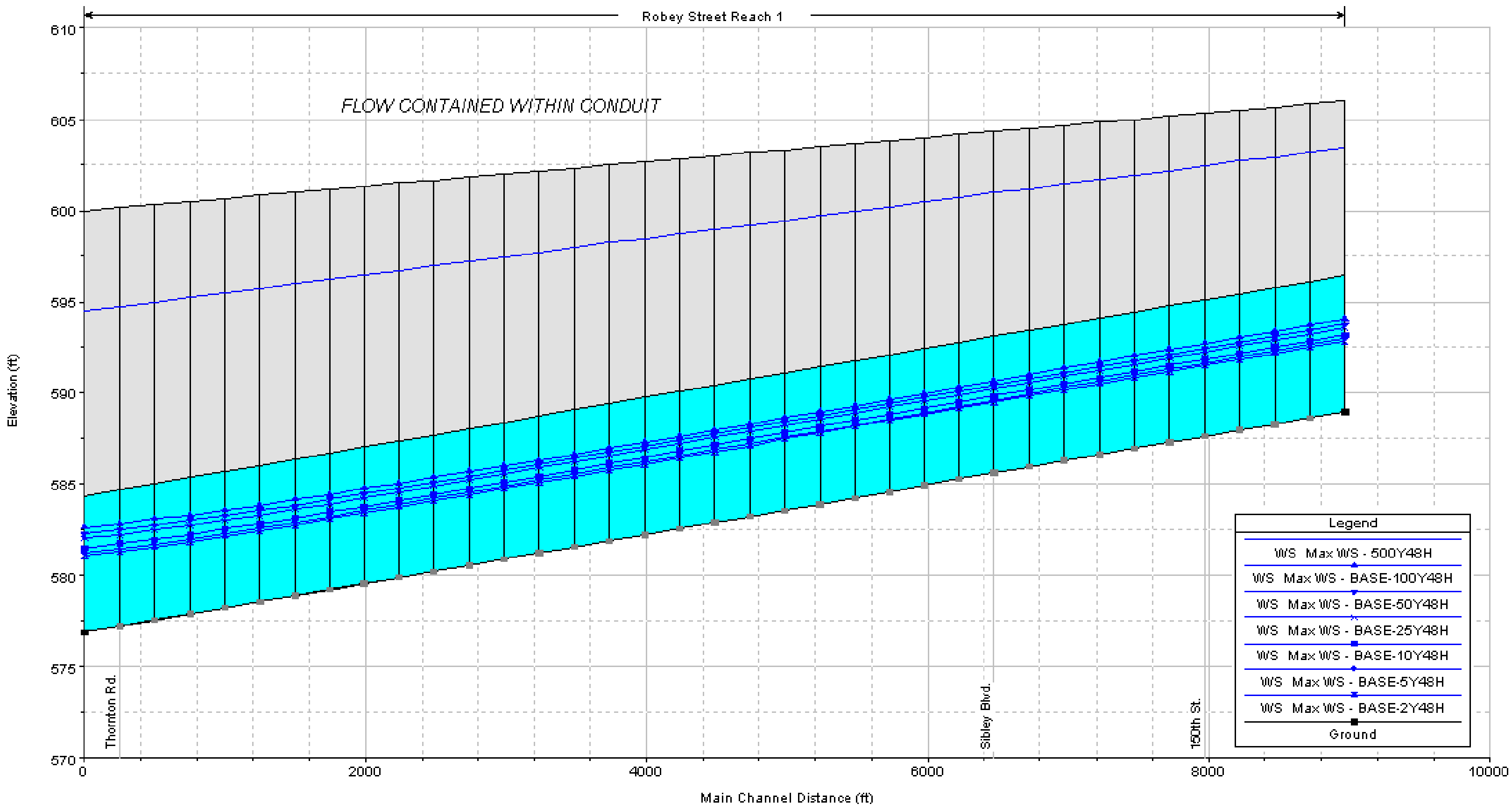
Cherry Creek West Branch

Kedzie Avenue to confluence with Cherry Creek at Mahoney Pkwy and 175th St.



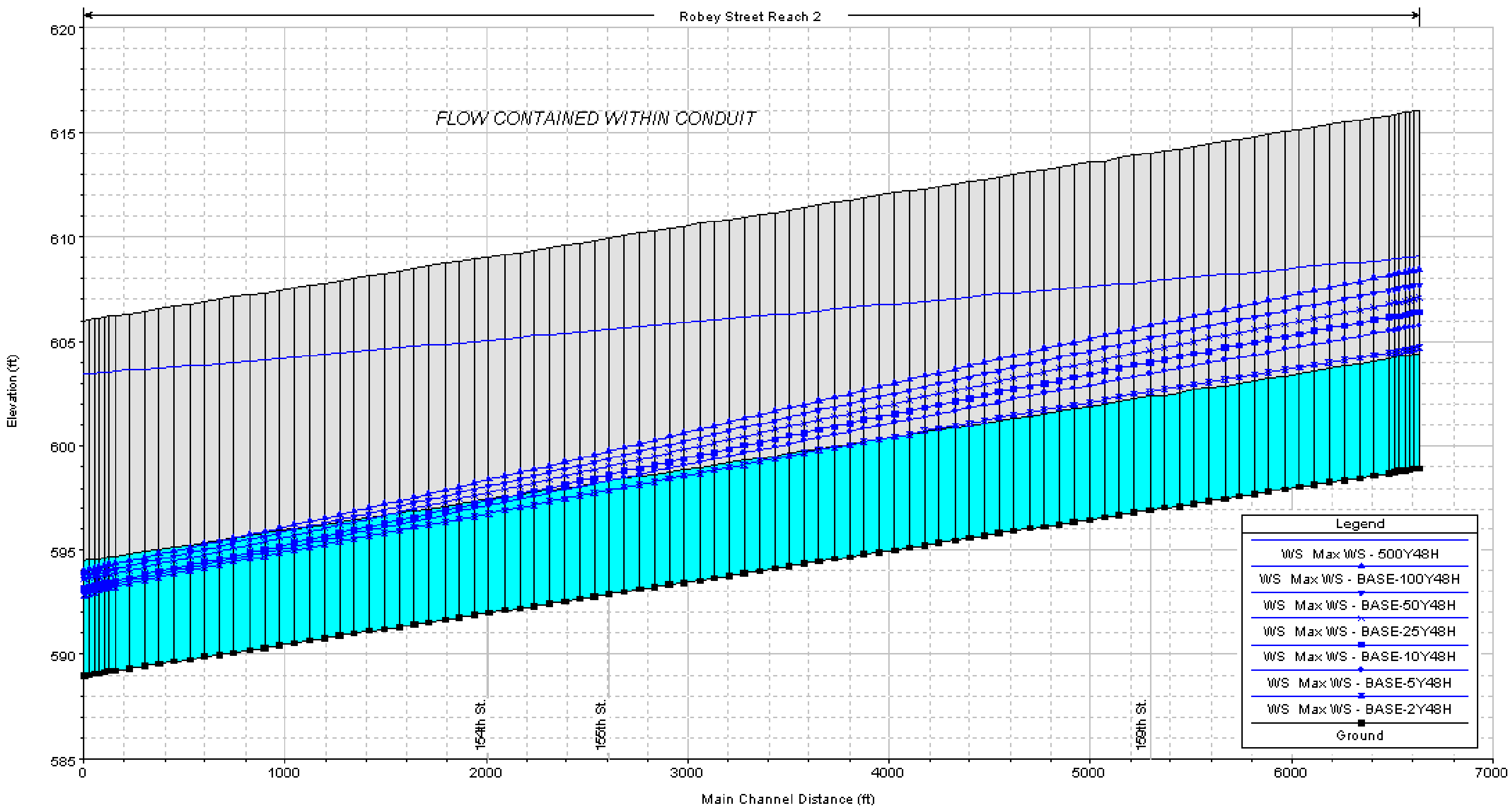
Cherry Creek West Branch East Fork

Crawford Avenue to detention basin south of 183rd Street



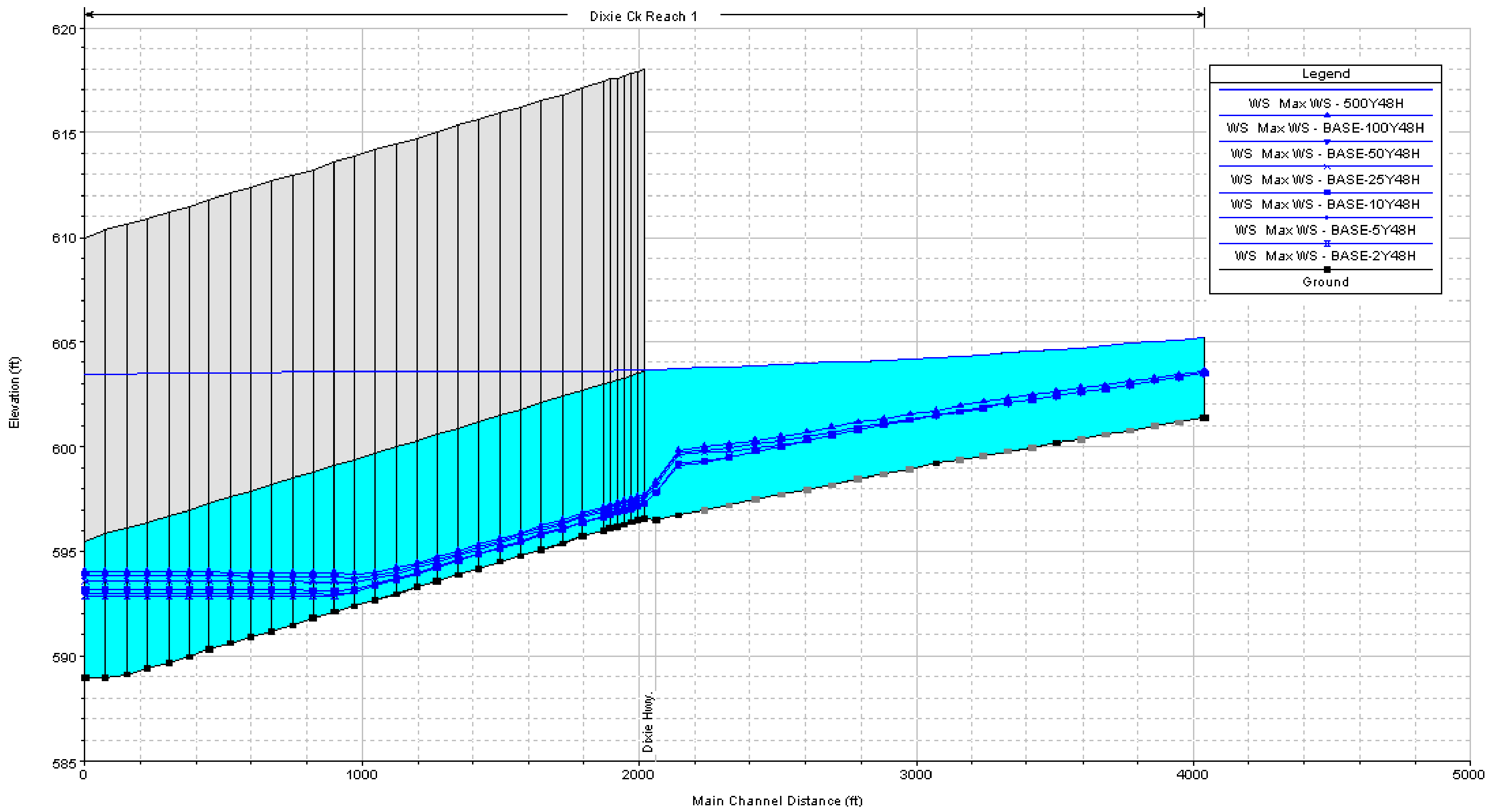
Robey Street Diversion Conduit, Reach 1

Dixie Creek to confluence with Little Calumet River at Thornton Road



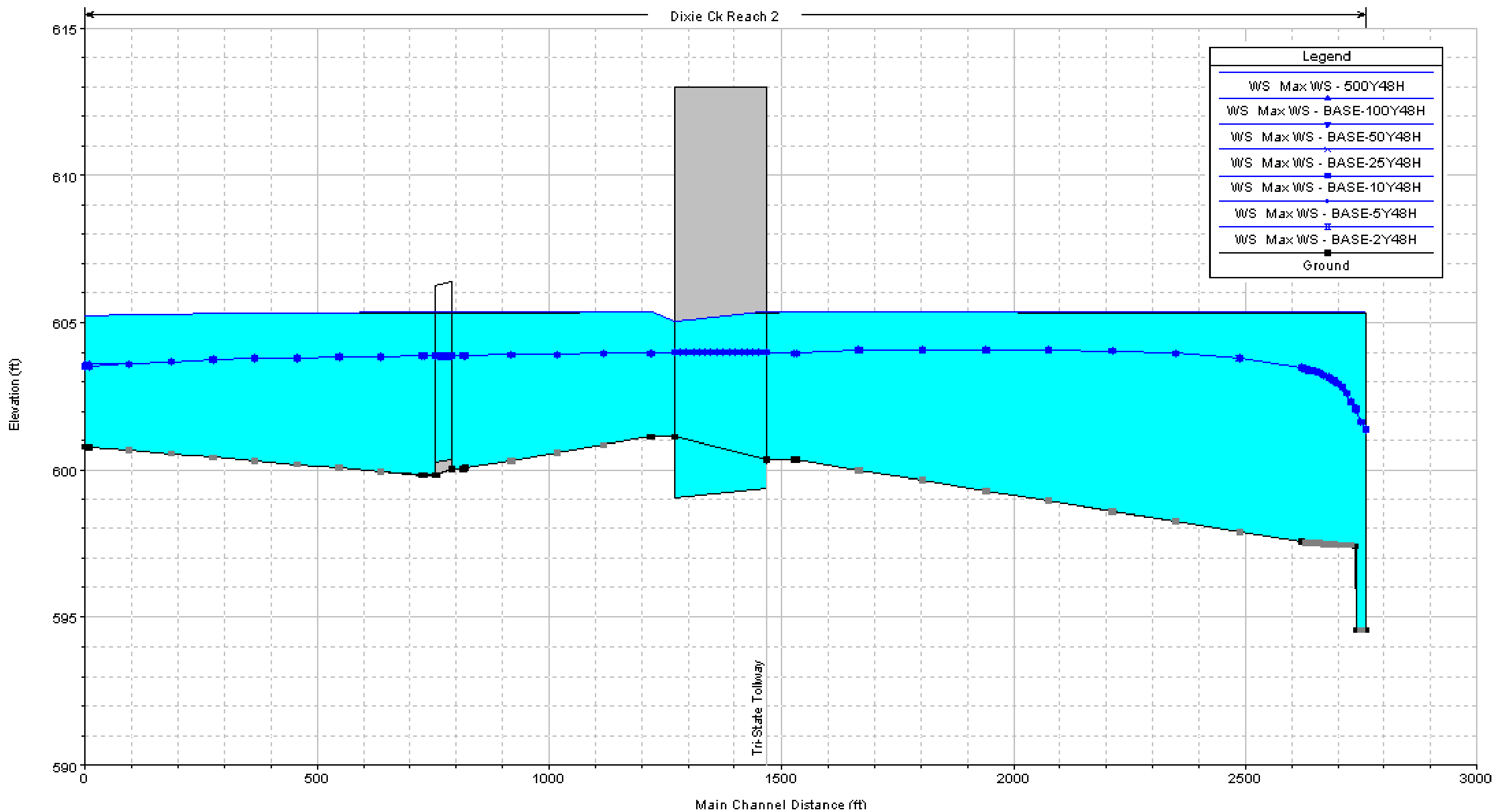
Robey Street Diversion Conduit, Reach 2

Calumet Union Drainage Ditch to confluence with Dixie Creek



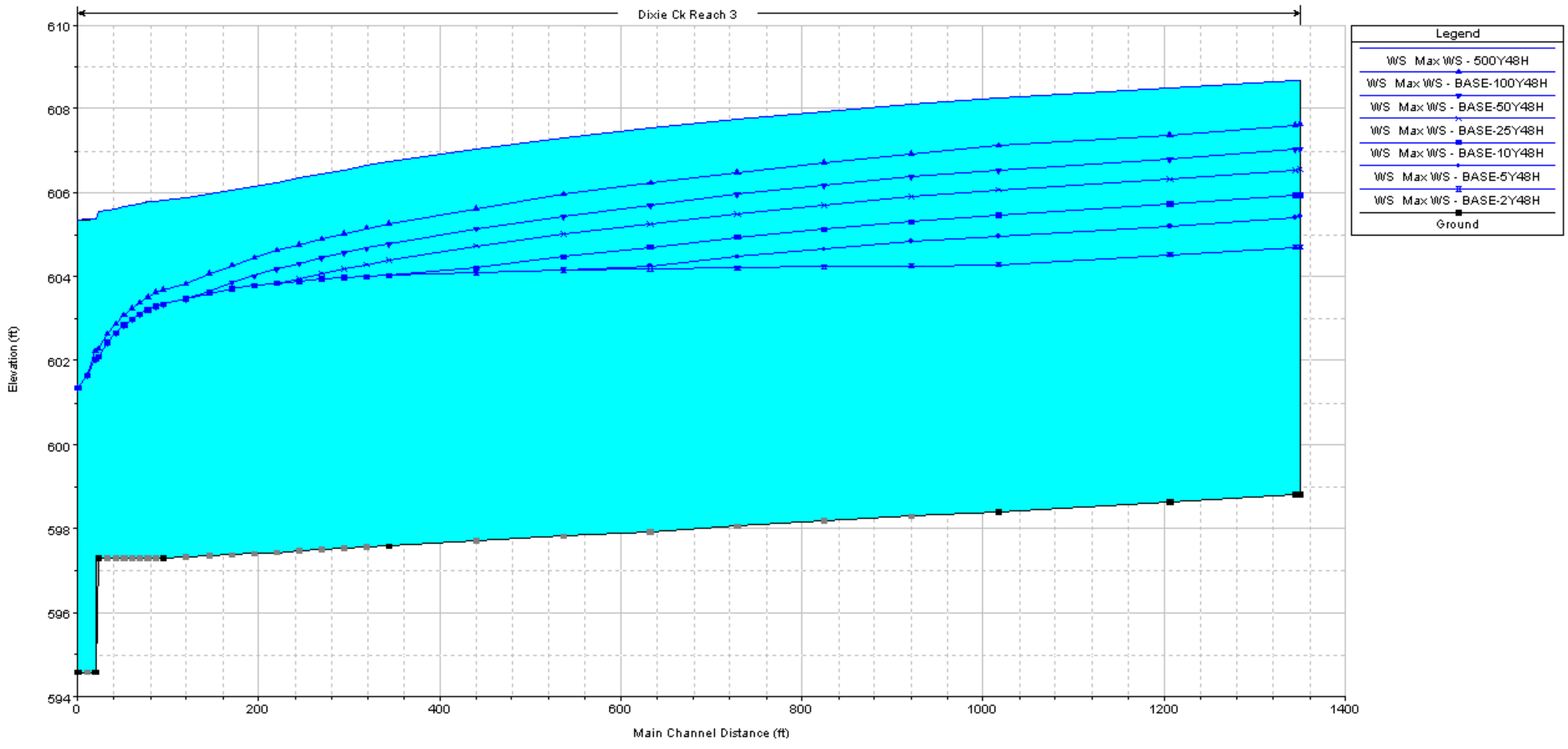
Dixie Creek, Reach 1

Belaire Creek to confluence with Robey Street Diversion Culvert



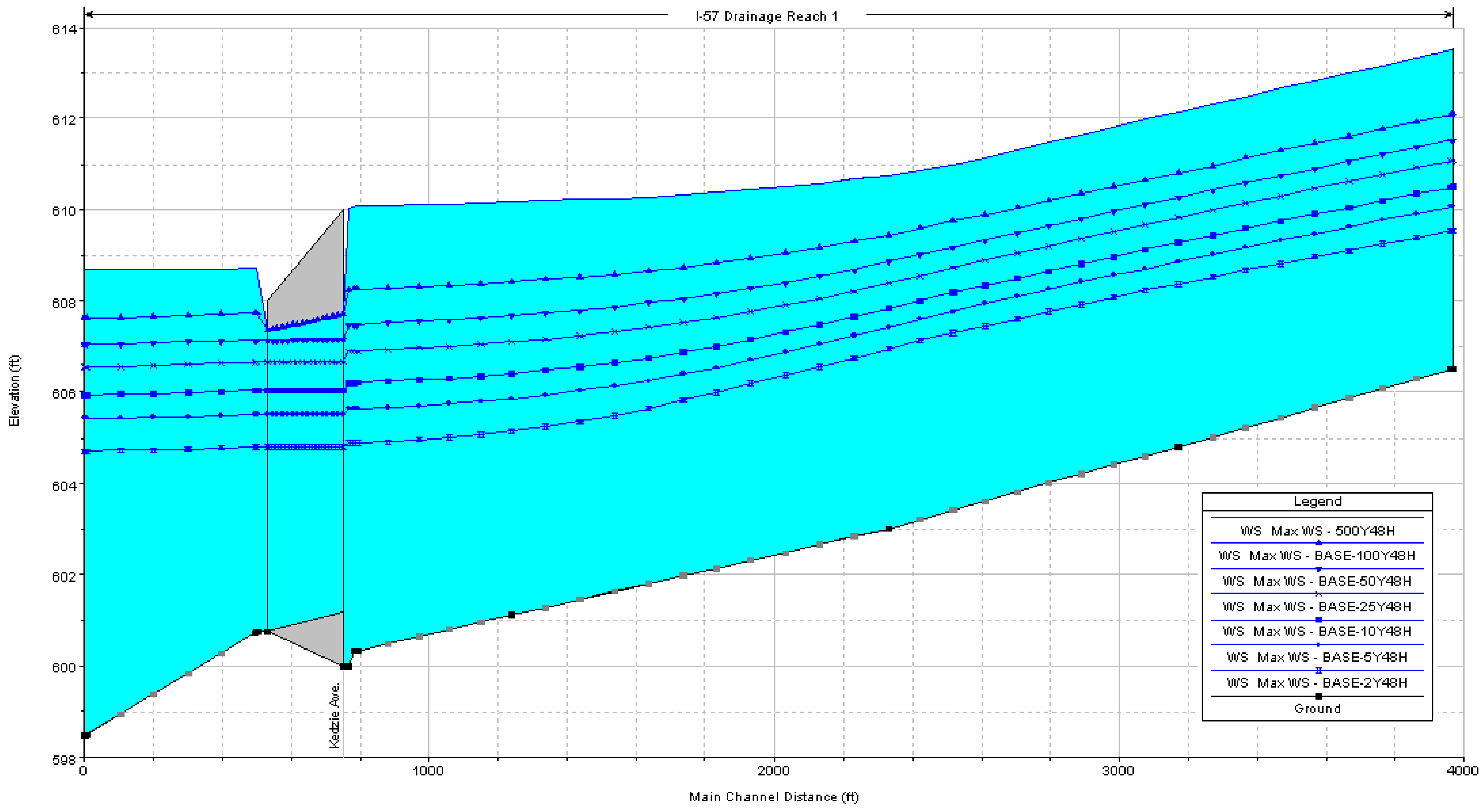
Dixie Creek, Reach 2

1300' west of Tri-State Tollway to confluence with Belaire Creek



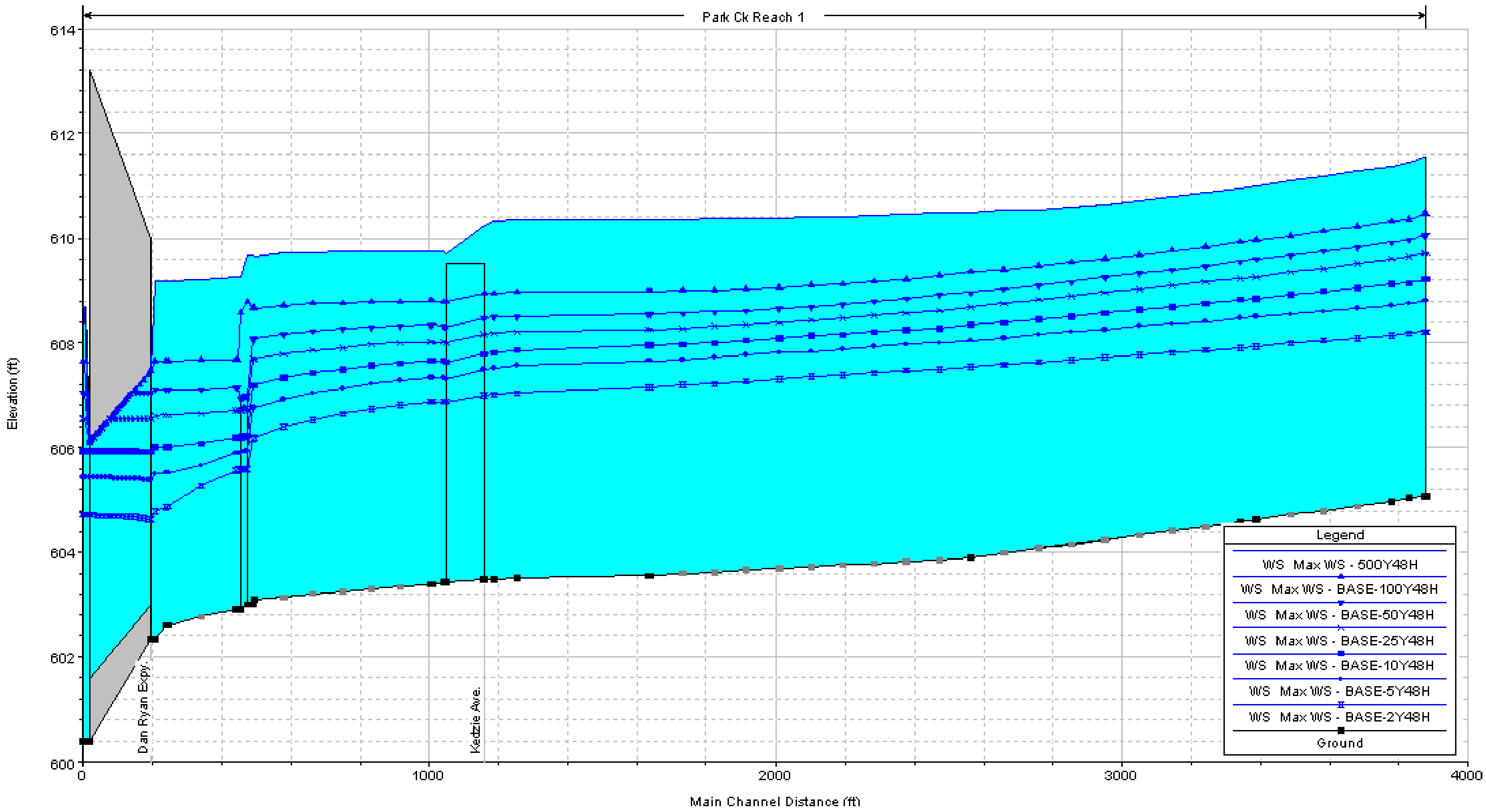
Dixie Creek, Reach 3

Confluence of Park Creek & I-57 Drainage Ditch to 1300' west of Tri-State Tollway



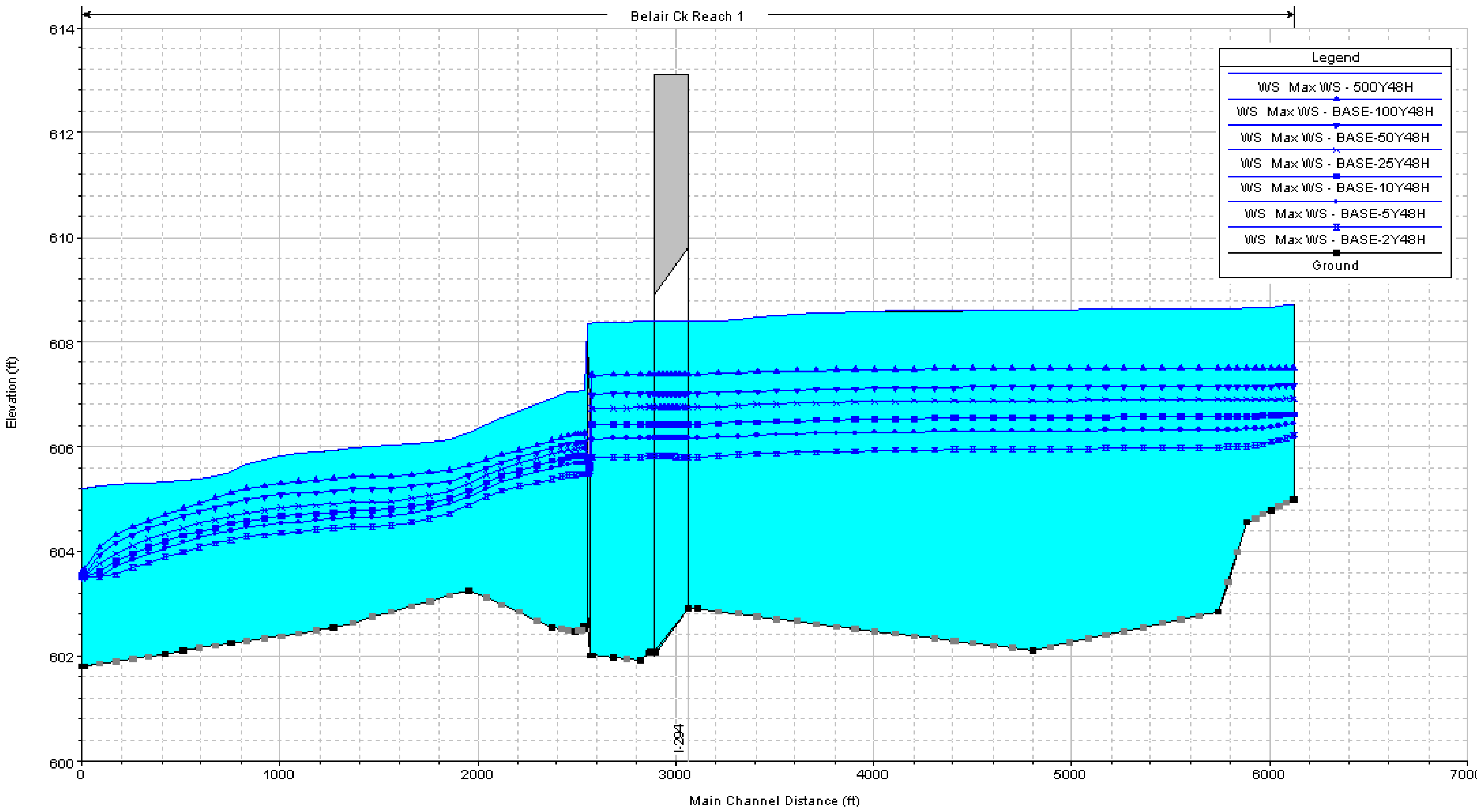
I-57 Drainage Ditch

I-57/159th Street Interchange to confluence with Dixie Creek



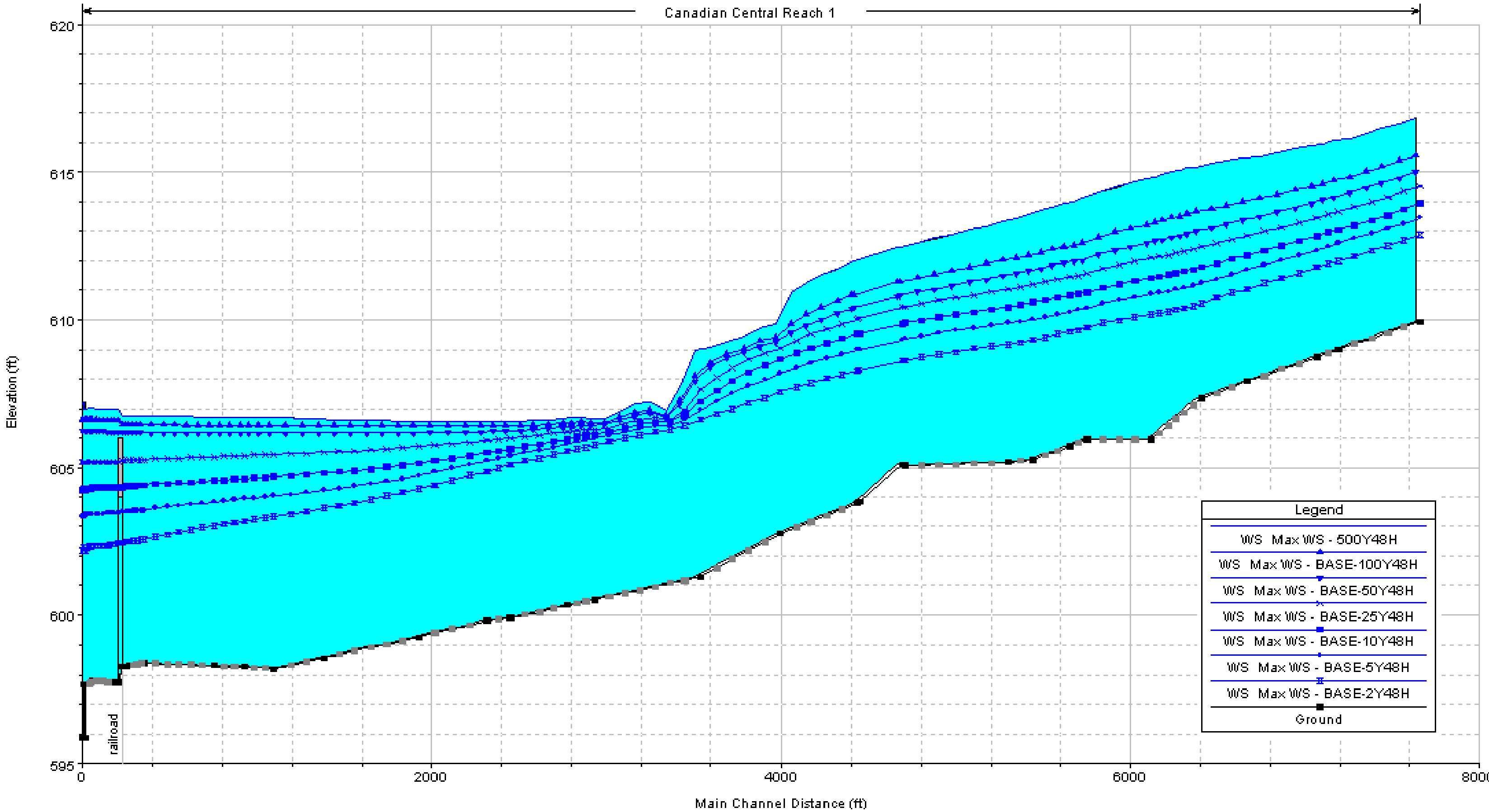
Park Creek

Birch Road to confluence with Dixie Creek & I-57 Drainage Ditch



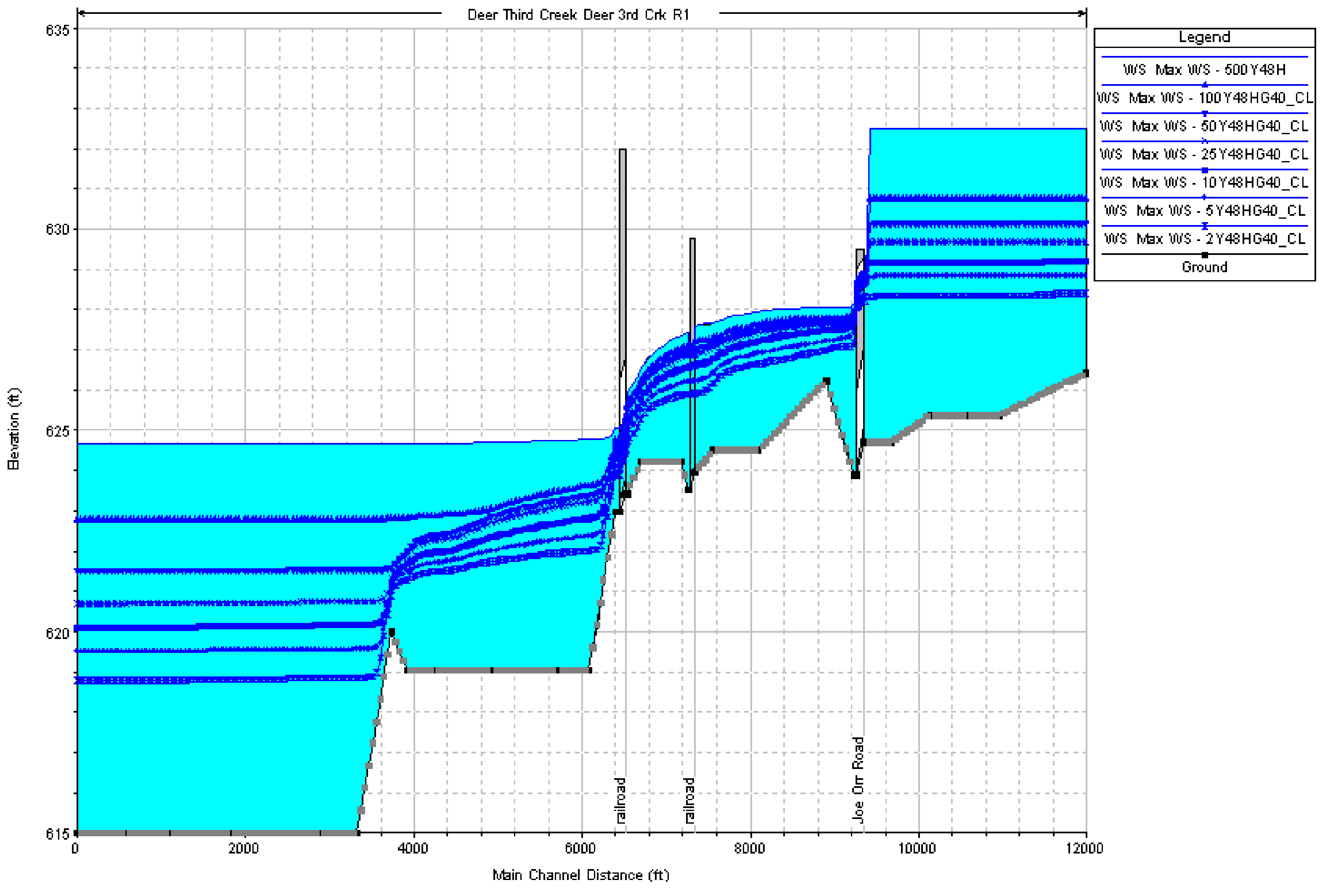
Belaire Creek

Kedzie Avenue to confluence with Dixie Creek



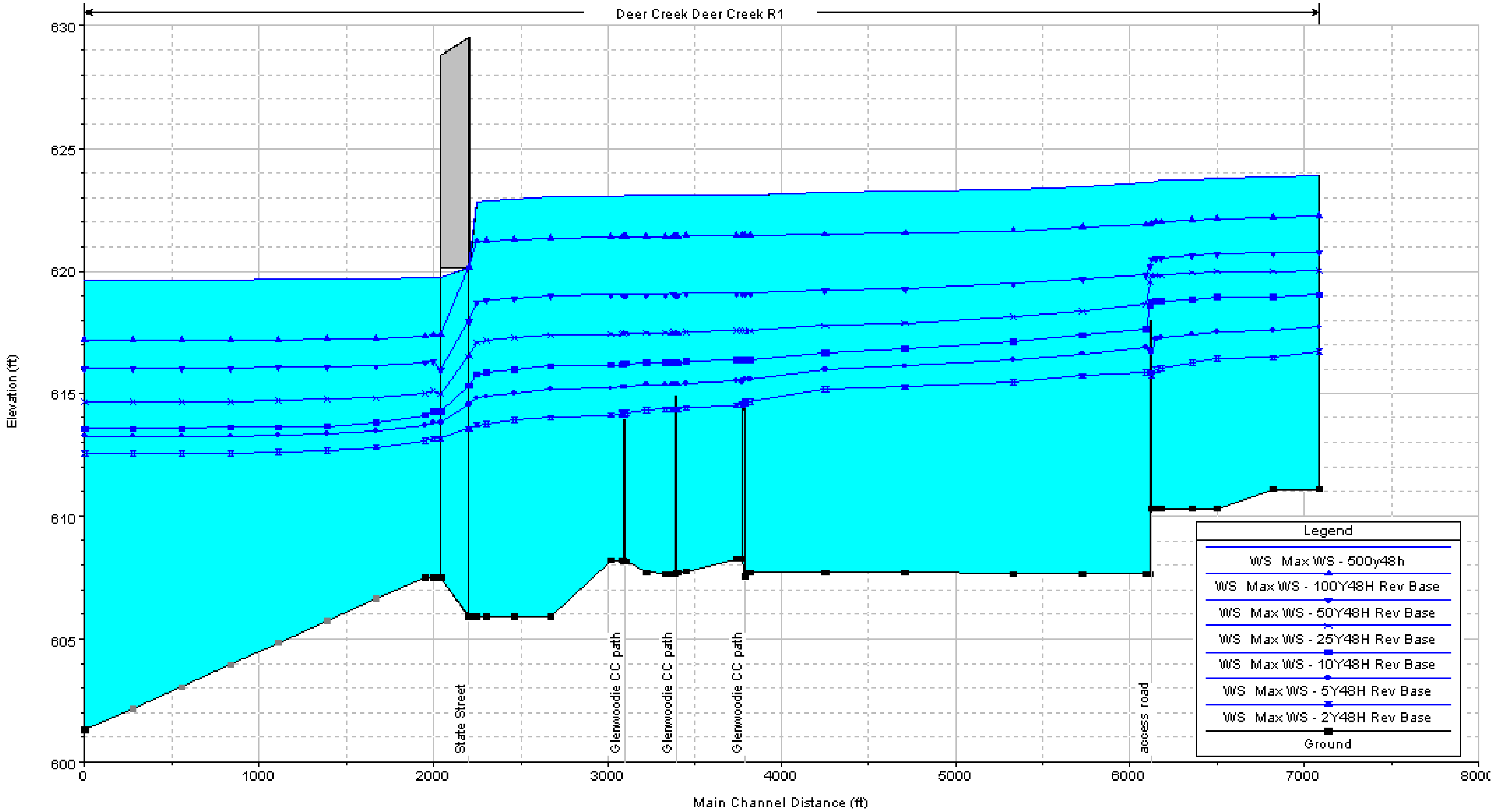
Canadian Central Drainage Ditch

171st Street to confluence with Calumet Union Drainage Ditch



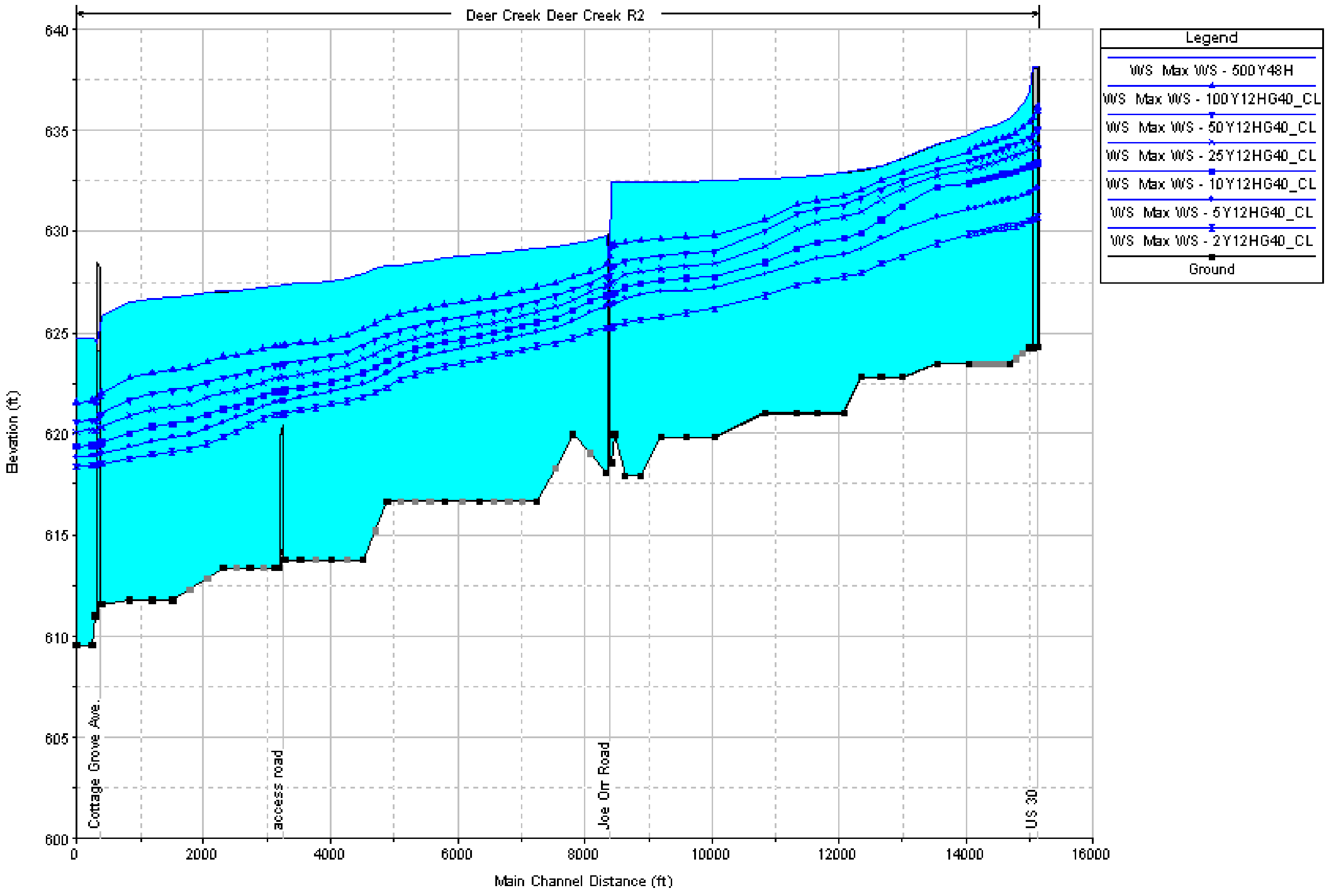
Third Creek

South of Joe Orr Road to confluence with Deer Creek Reach 2



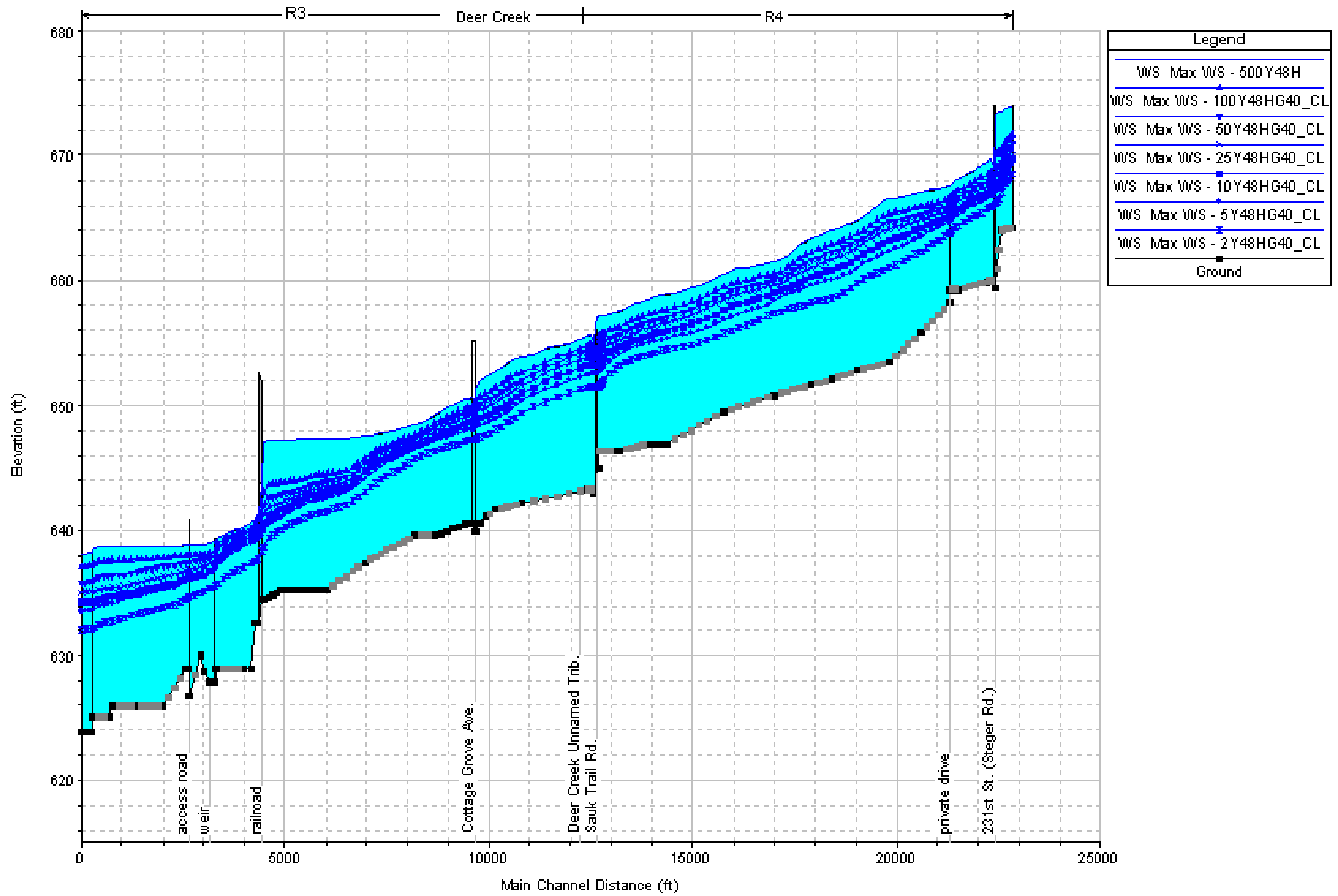
Deer Creek, Reach 1

Third Creek to confluence with Thorn Creek



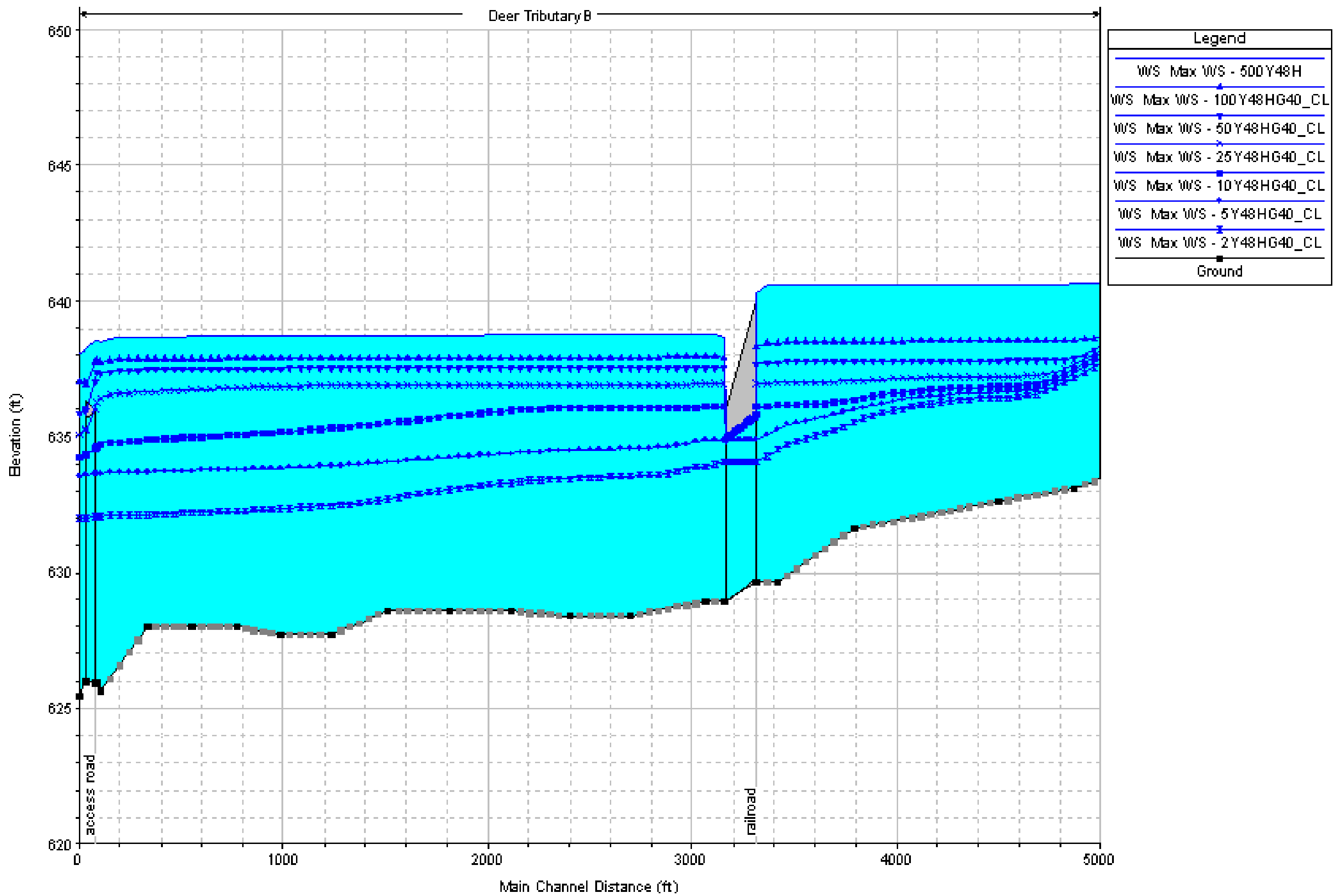
Deer Creek, Reach 2

Deer Creek Tributary B to confluence with Third Creek



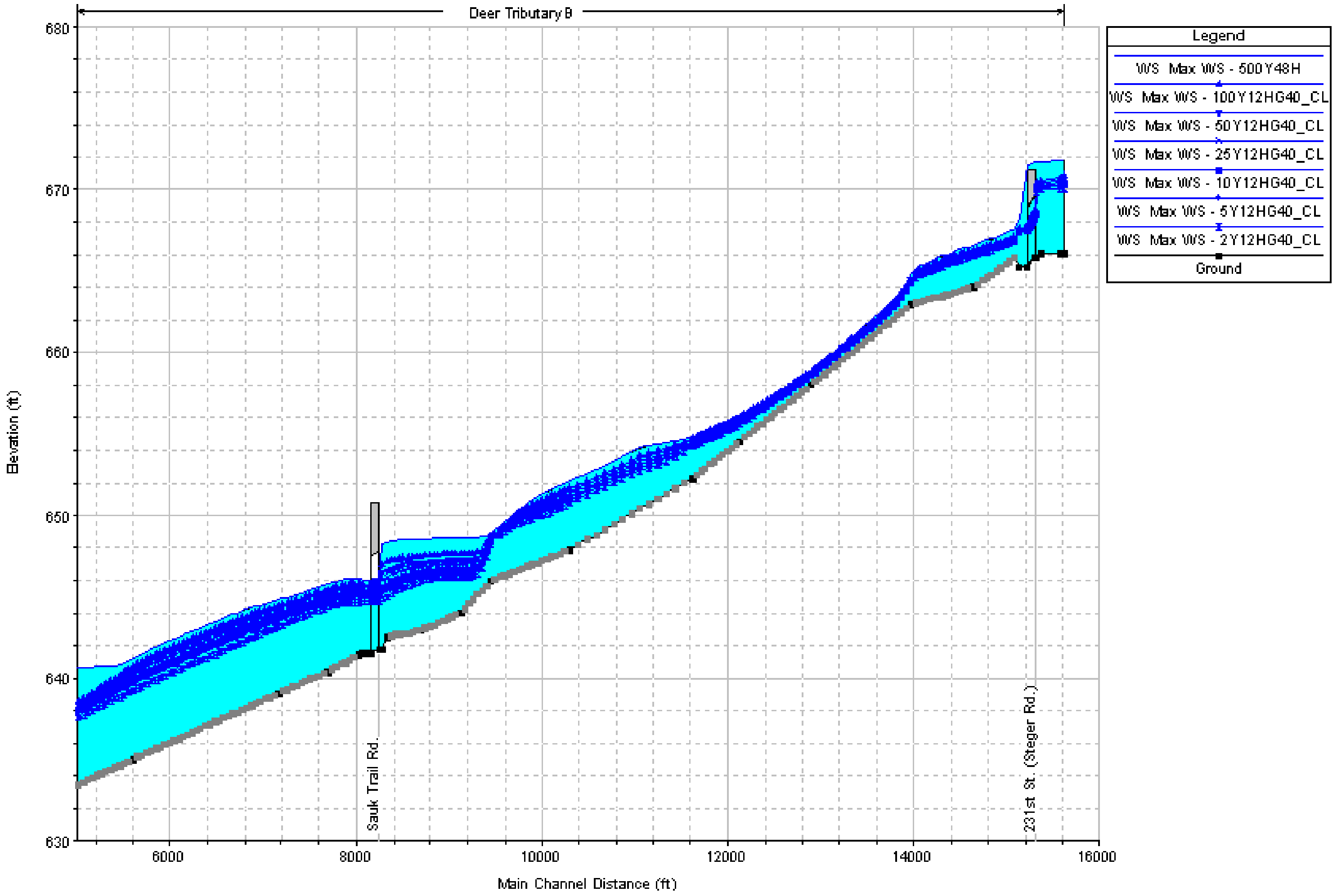
Deer Creek, Reaches 3 and 4

Steger Road (Will Co. Line) to confluence with Deer CreekTributary B (upstream of US 30)



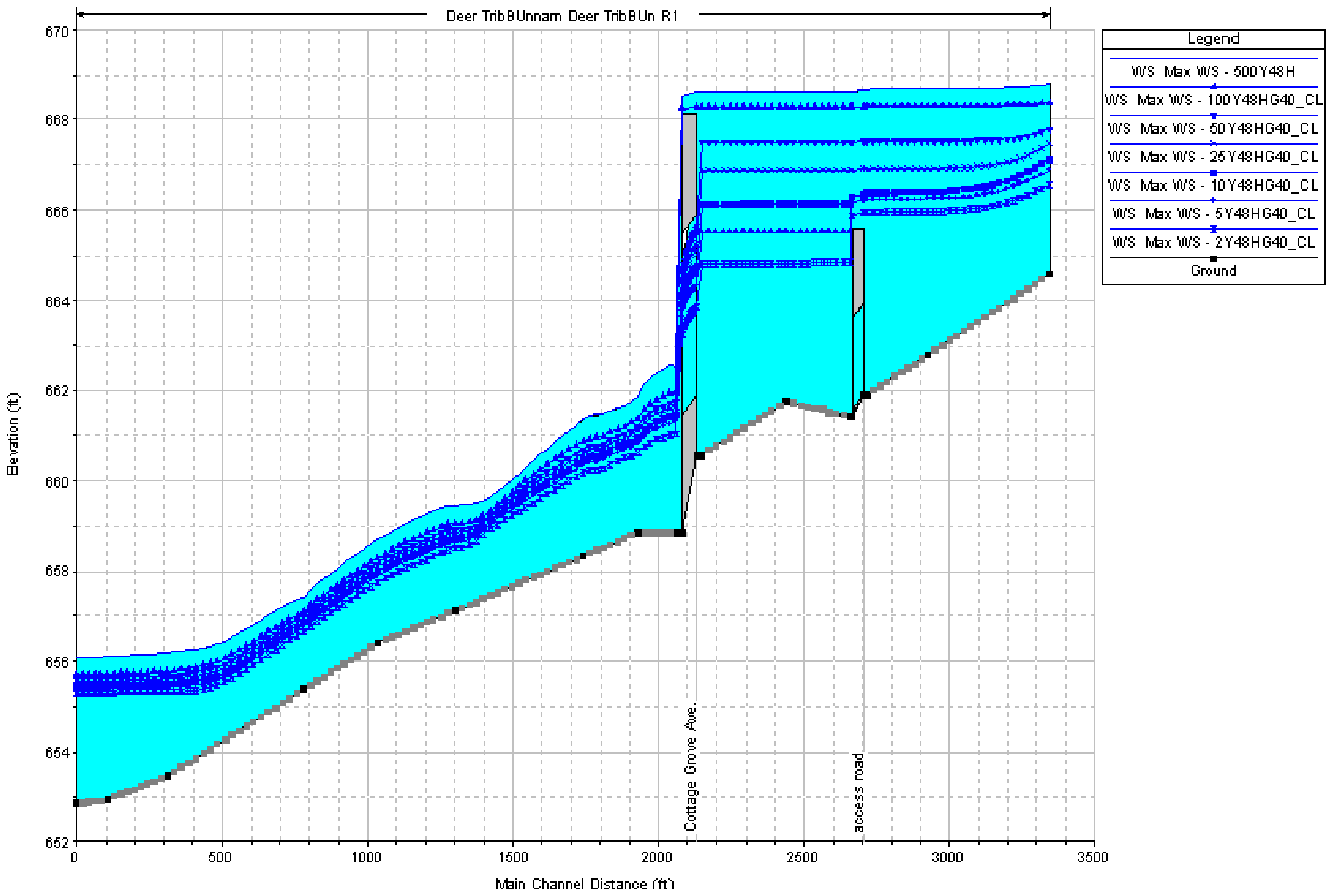
Deer Creek Tributary B

Along Deer Creek Reservoir, from Upstream of Railroad Tracks to confluence with Deer Creek



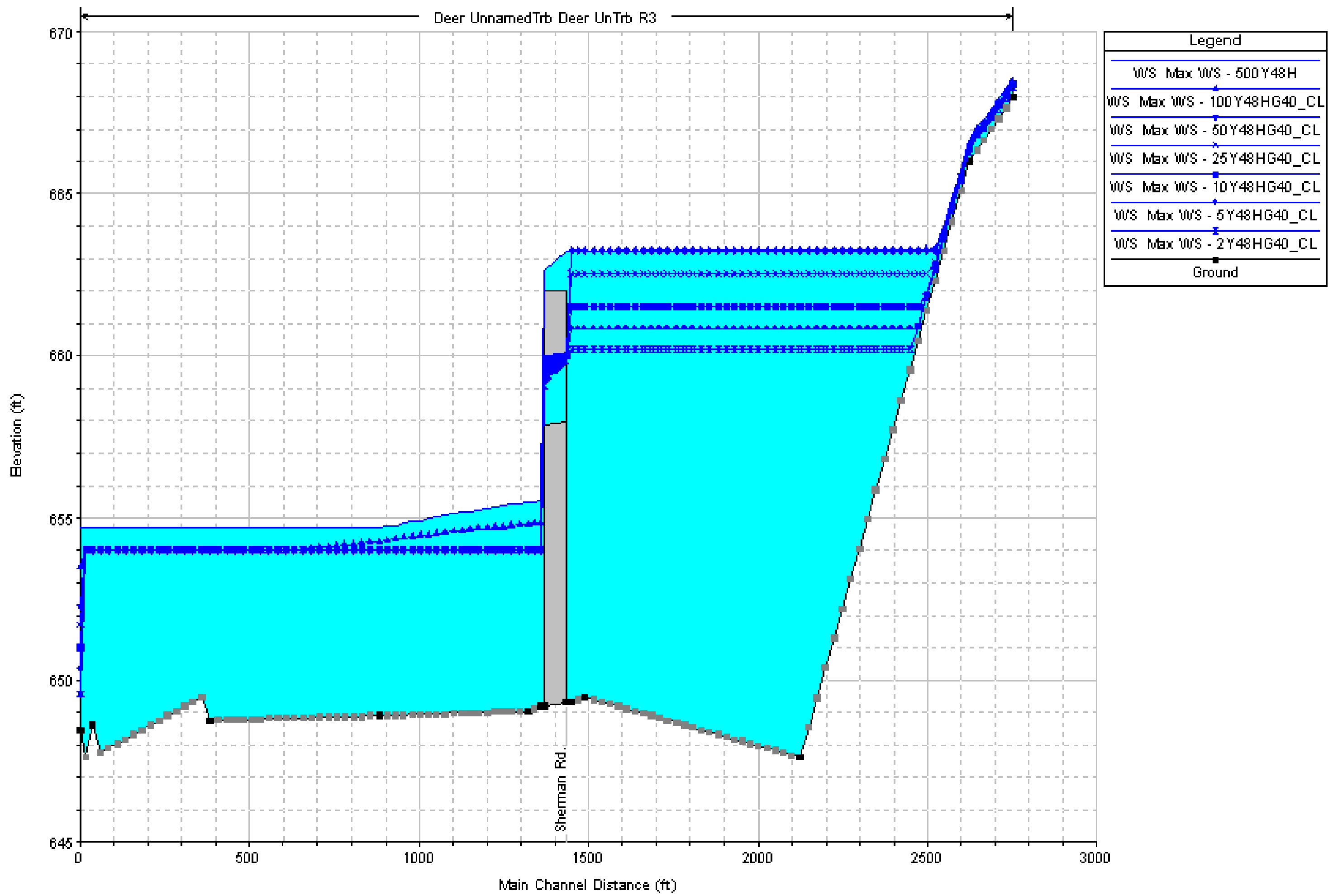
Deer Creek Tributary B

Steger Road (Will Co. Line) to Downstream of Sauk Trail Road



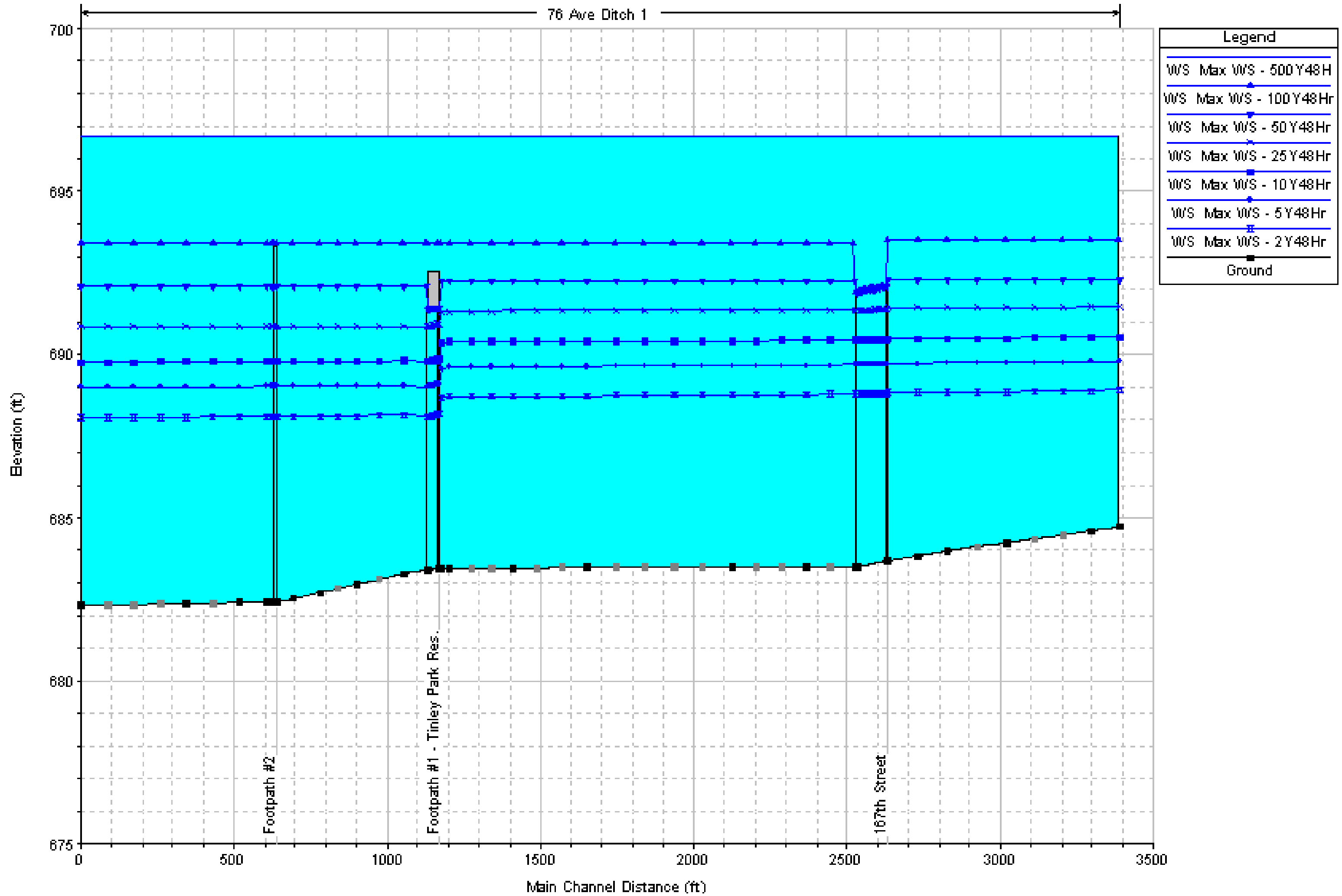
Unnamed Tributary to Deer Creek Tributary B

West of Cottage Grove Ave. to confluence with Deer Creek Tributary B



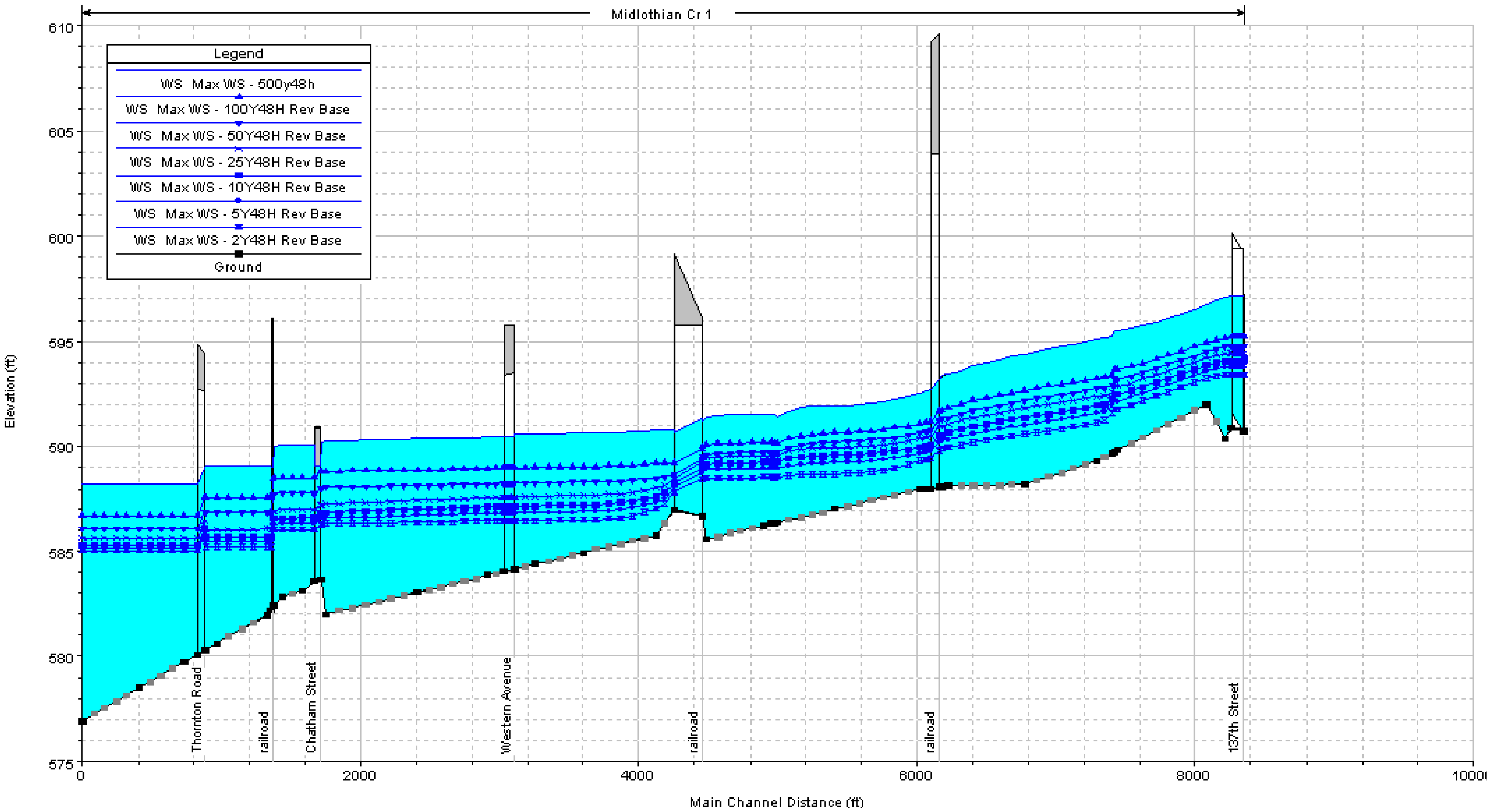
Unnamed Tributary to Deer Creek

Exelon Property to confluence with Deer Creek Reach 4



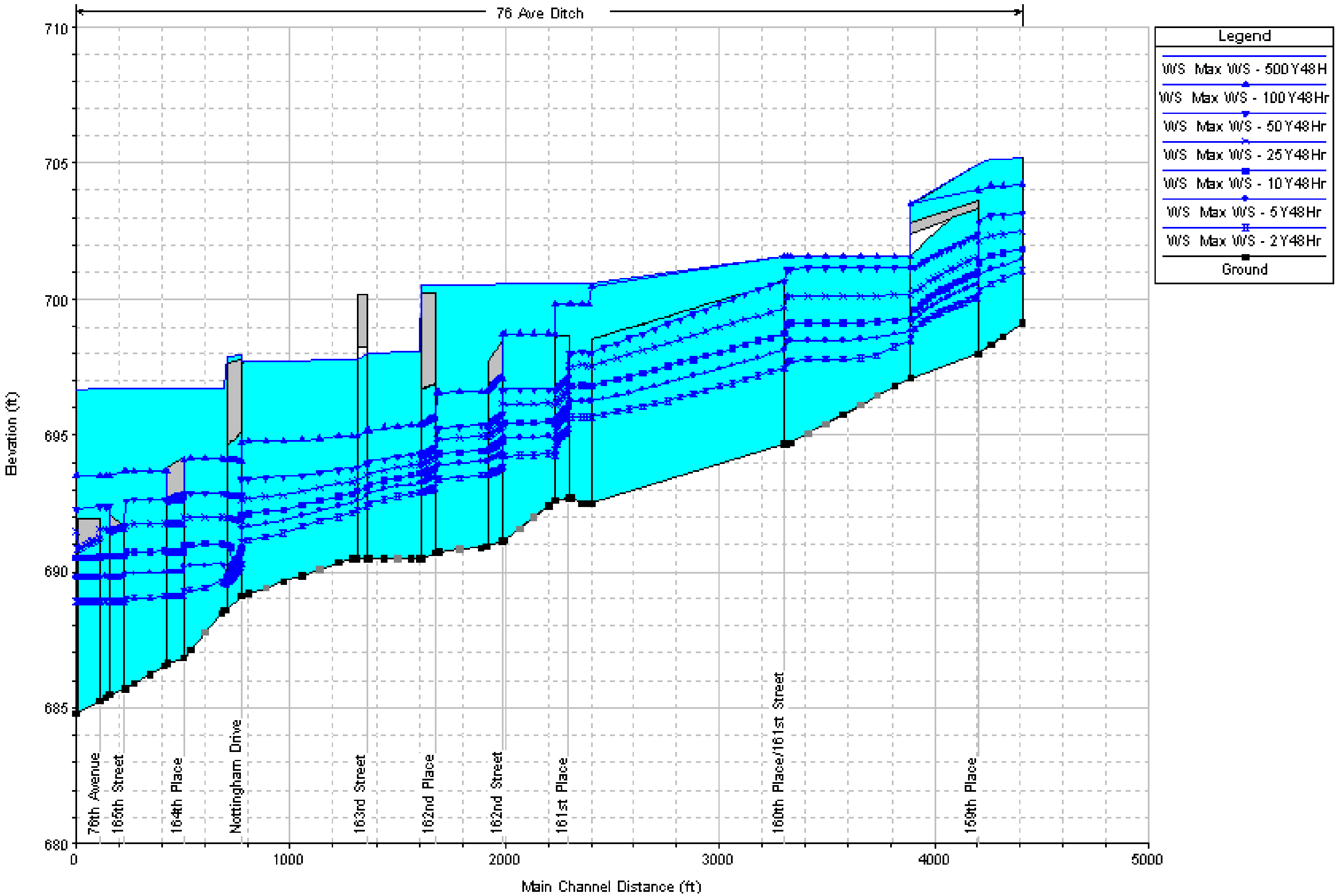
76th Avenue Ditch, Reach 1

Filsen Park Ditch to confluence with Midlothian Creek



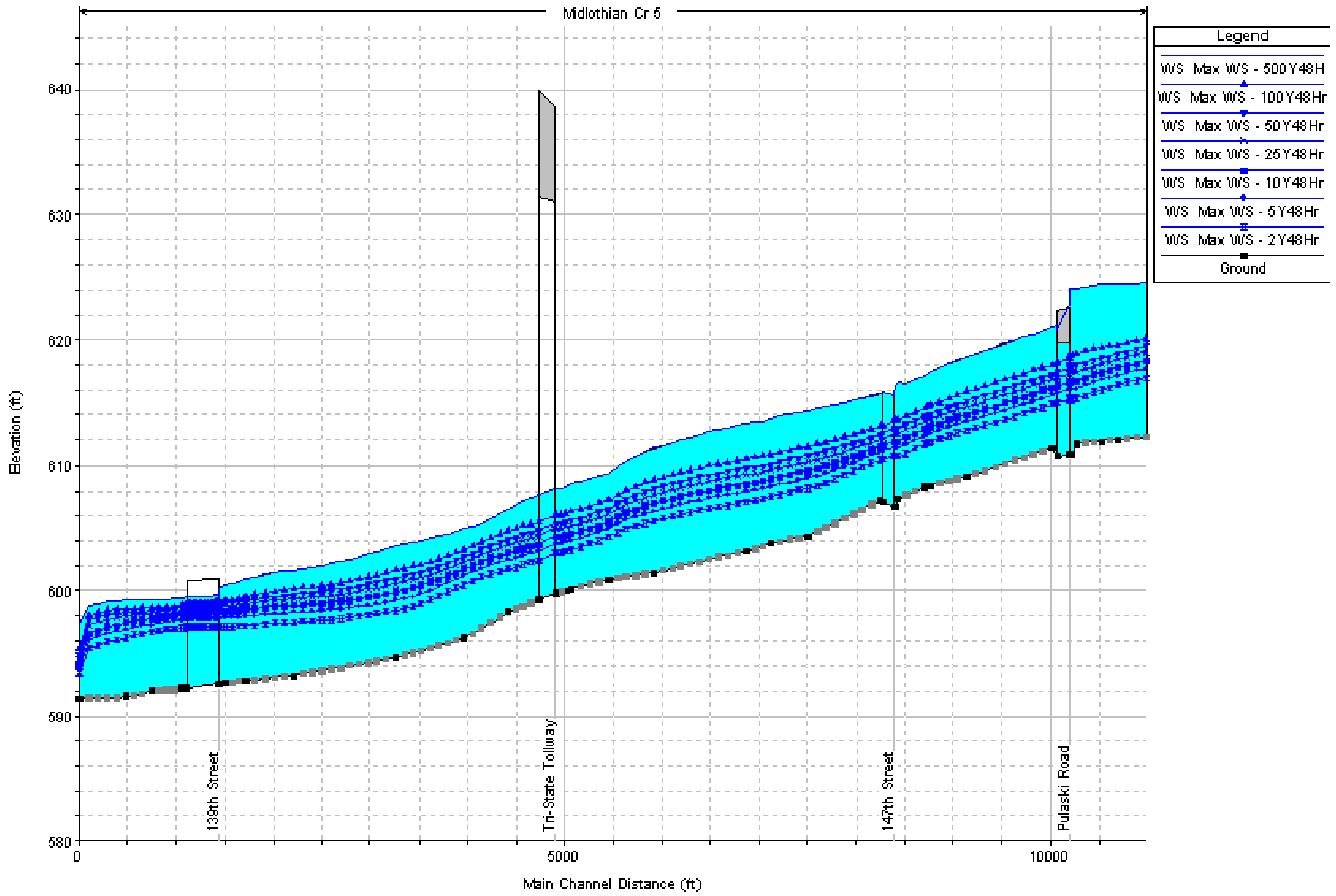
Midlothian Creek, Reach 1

Midlothian Creek Diversion Channel at 137th St. & Kedzie Ave. to confluence with Little Calumet River



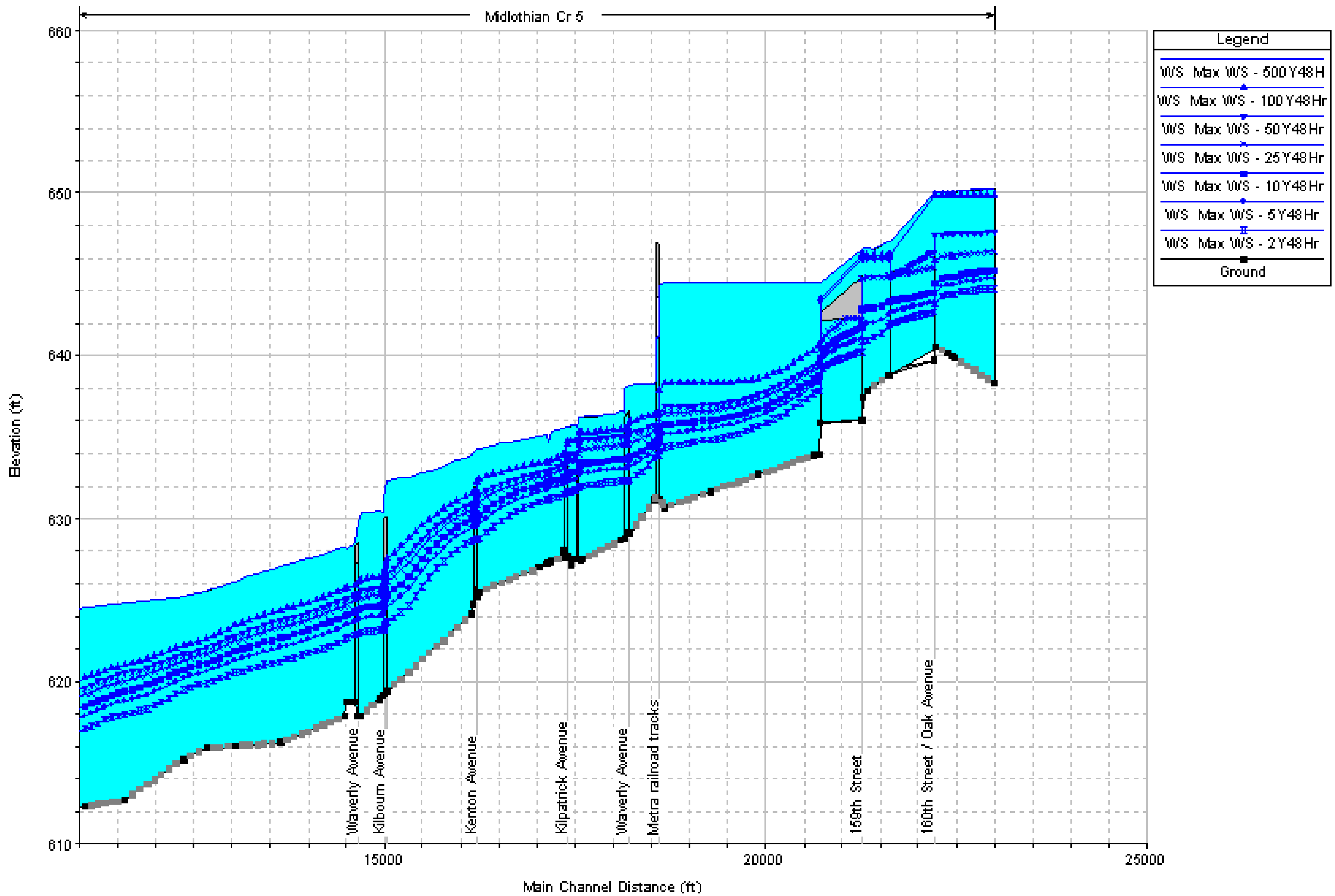
76th Avenue Ditch, Reach 2

159th Street to confluence with Filsen Park Ditch



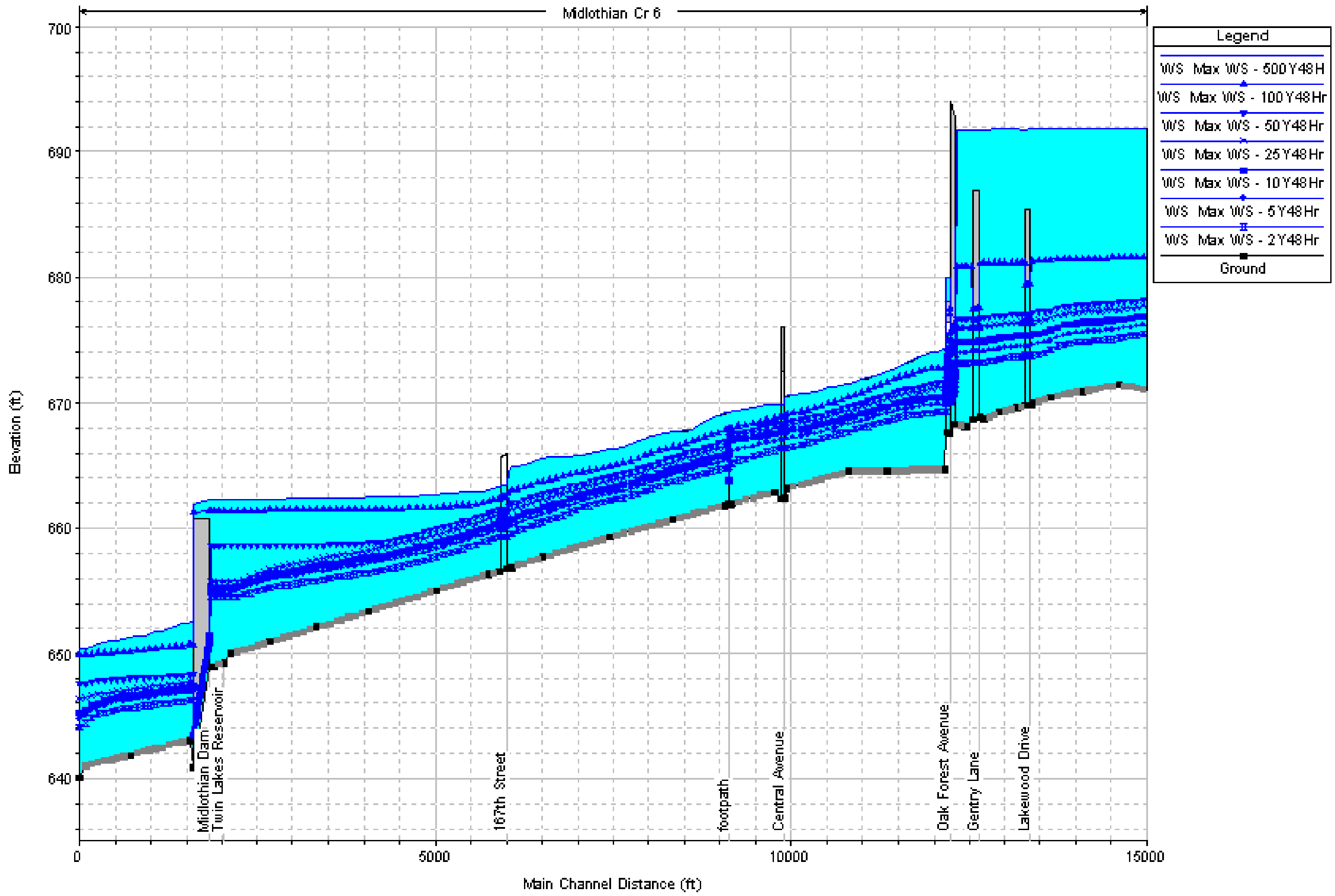
Midlothian Creek, Reach 5 (encompassing Reaches 2,3,& 4)

Pulaski Road to confluence with Midlothian Cr. Diversion Channel



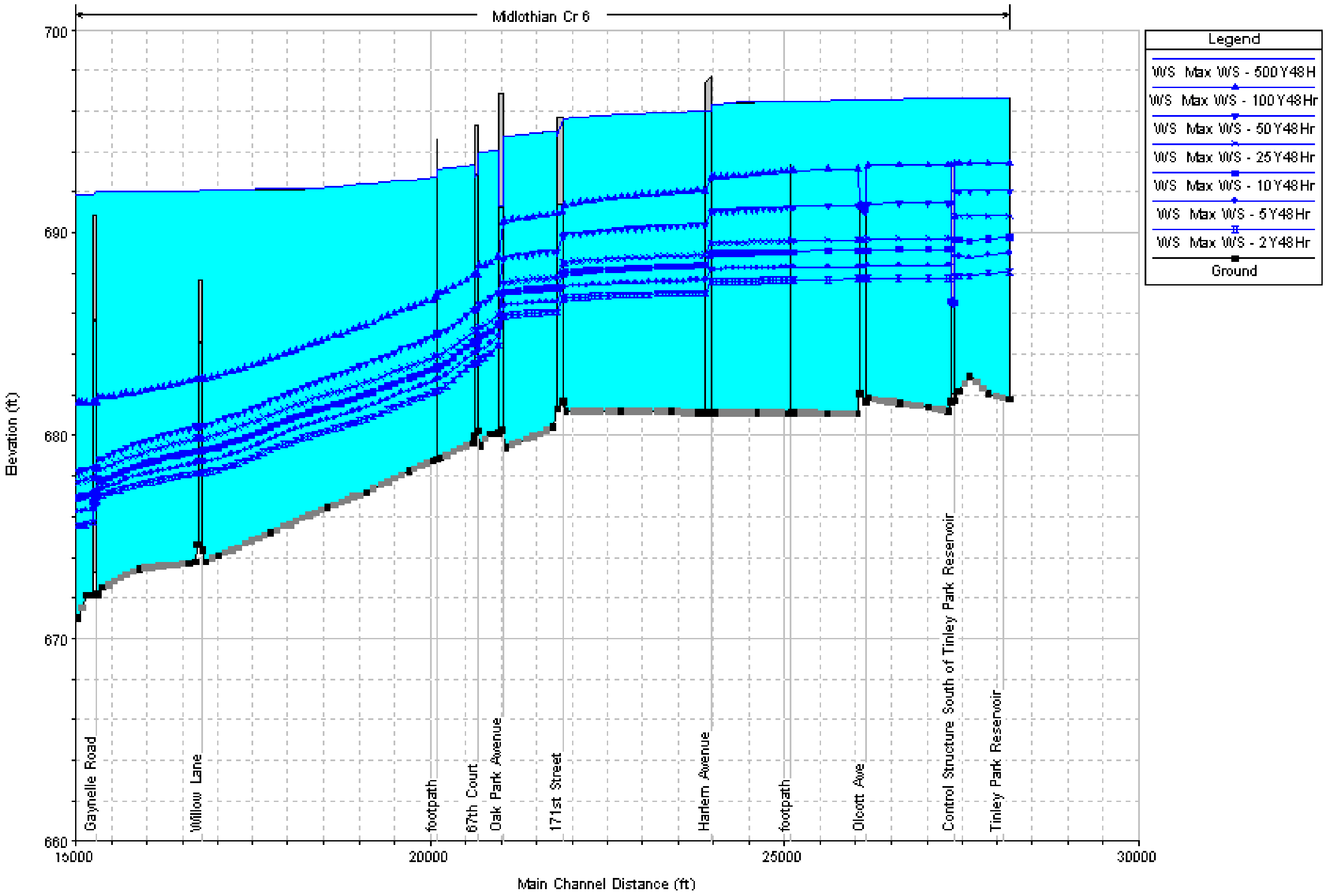
Midlothian Creek, Reach 5 (encompassing Reach 2,3 & 4)

Midlothian Cr. Western Branch (at Grove Ave. & 161st St.) to upstream of Pulaski Road



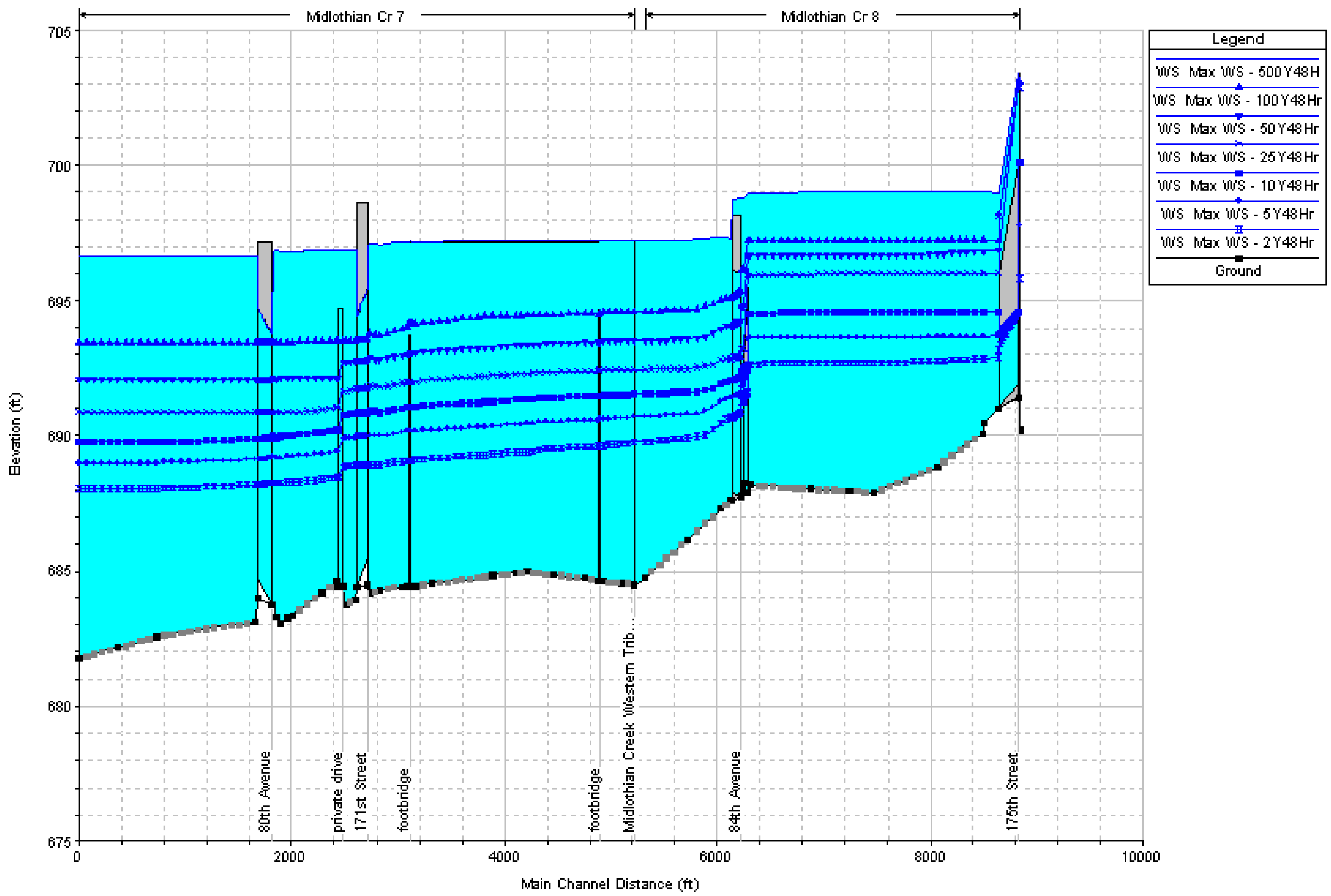
Midlothian Creek, Reach 6

Downstream of Gaynelle Road to confluence with Midlothian Creek Western Branch at Grove Ave. & 161st Street



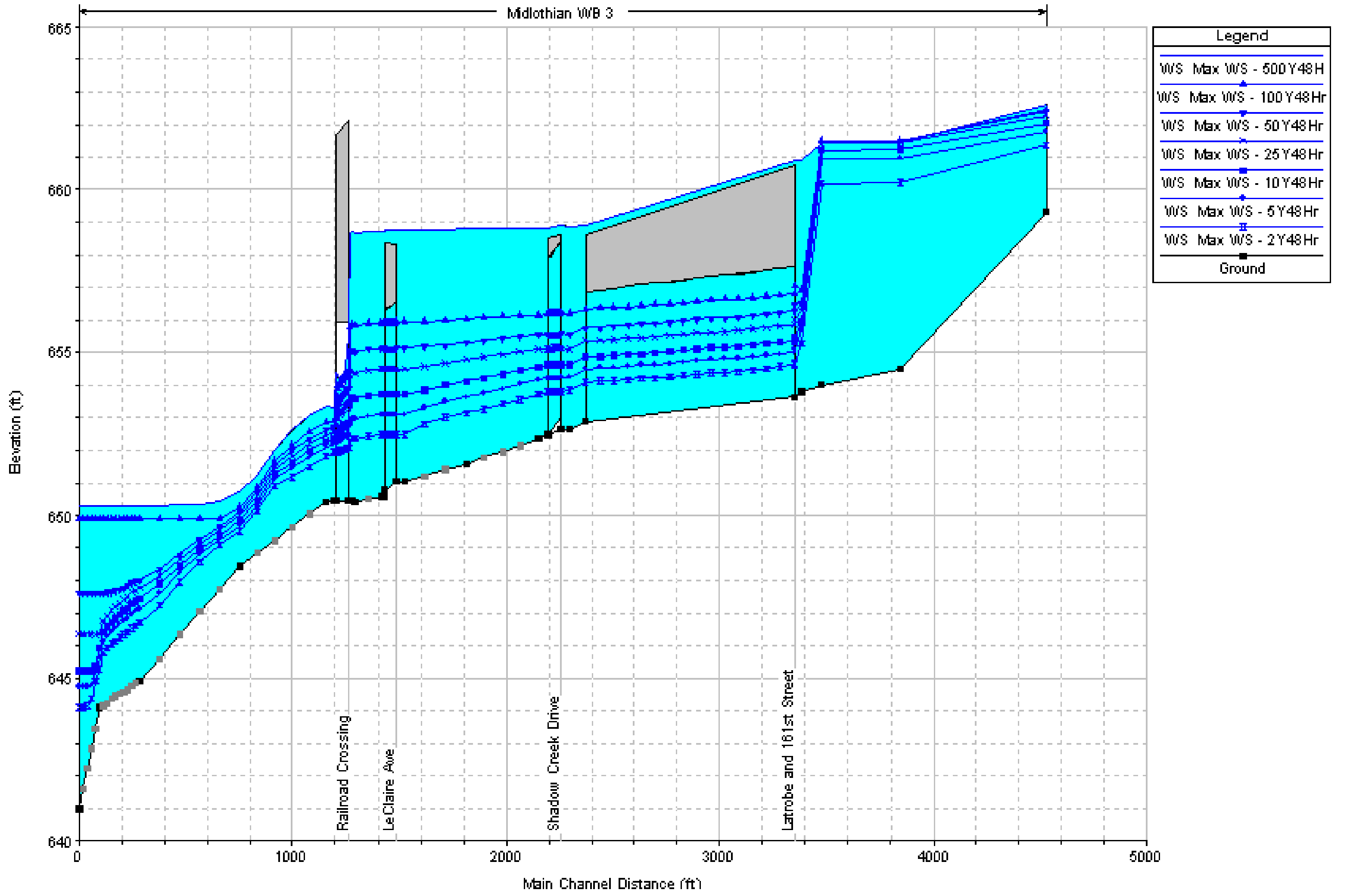
Midlothian Creek, Reach 6

76th Avenue Ditch (near 170th Pl. & Ozark Ave.) to Gaynelle Road



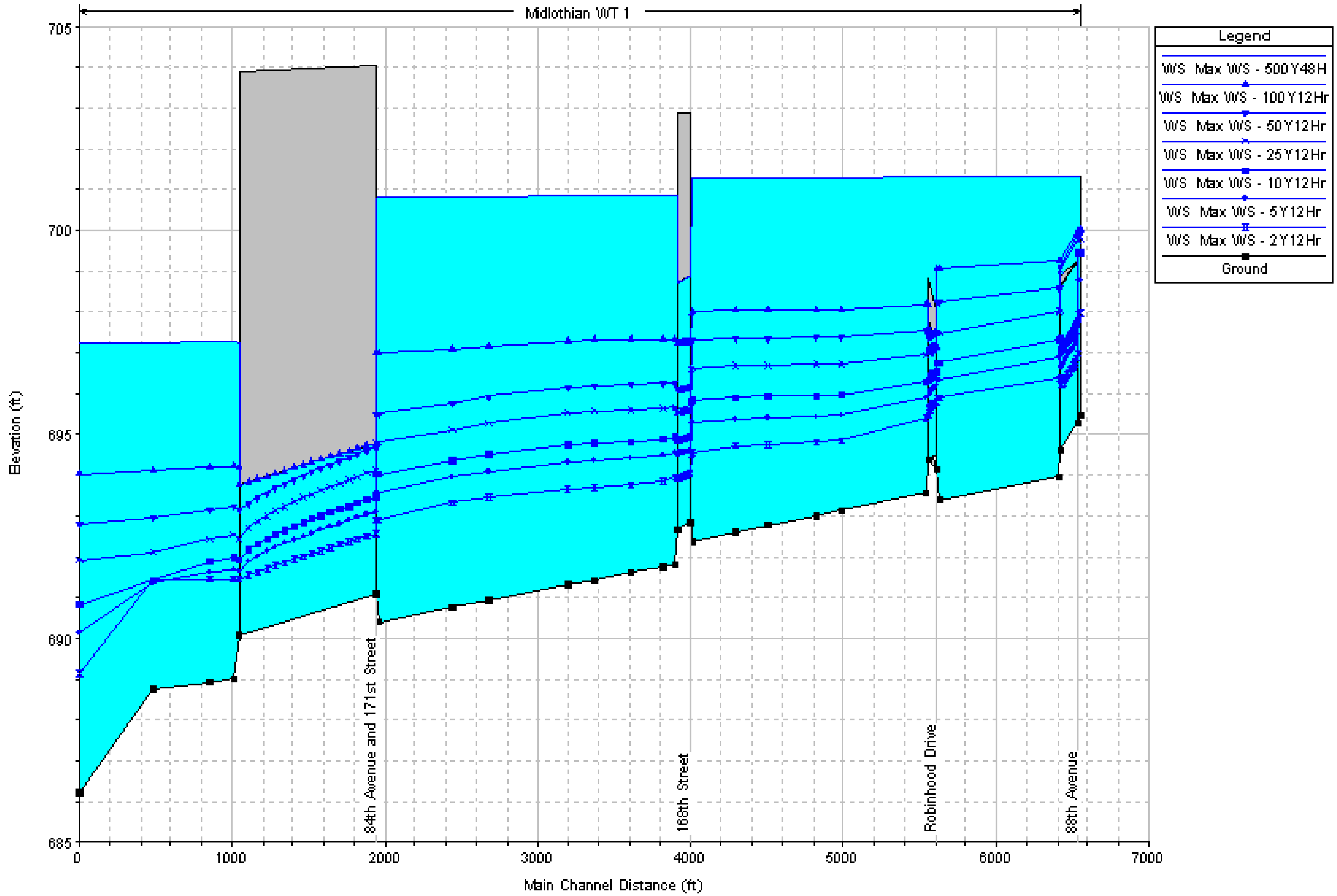
Midlothian Creek, Reaches 7 & 8

84th Avenue and 175th Street to confluence with 76th Avenue Ditch (near 170th Pl. & Ozark Ave.)



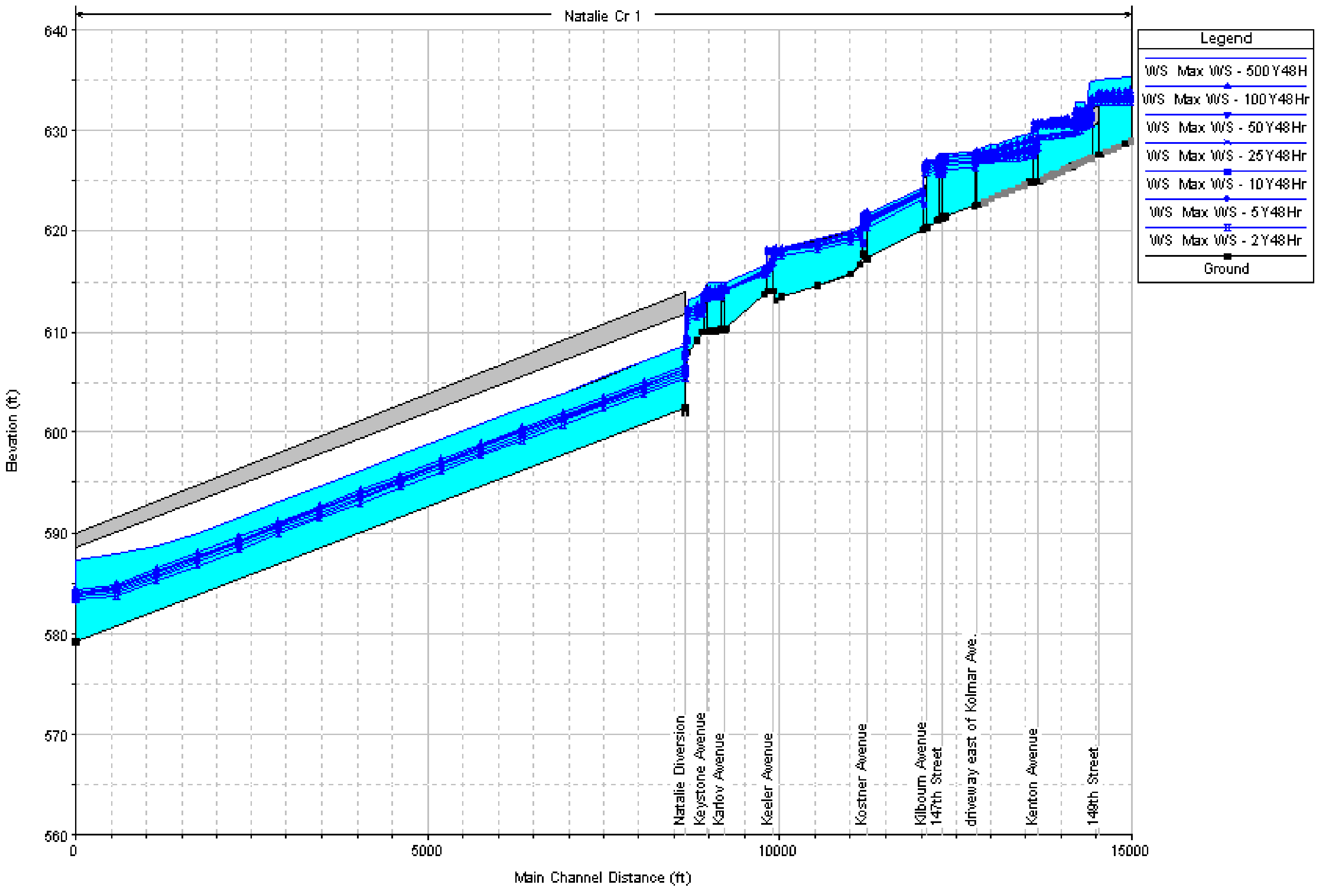
Midlothian Creek Western Branch

163rd Street and Long Avenue to confluence with Midlothian Creek at Grove Ave. & 161st Street



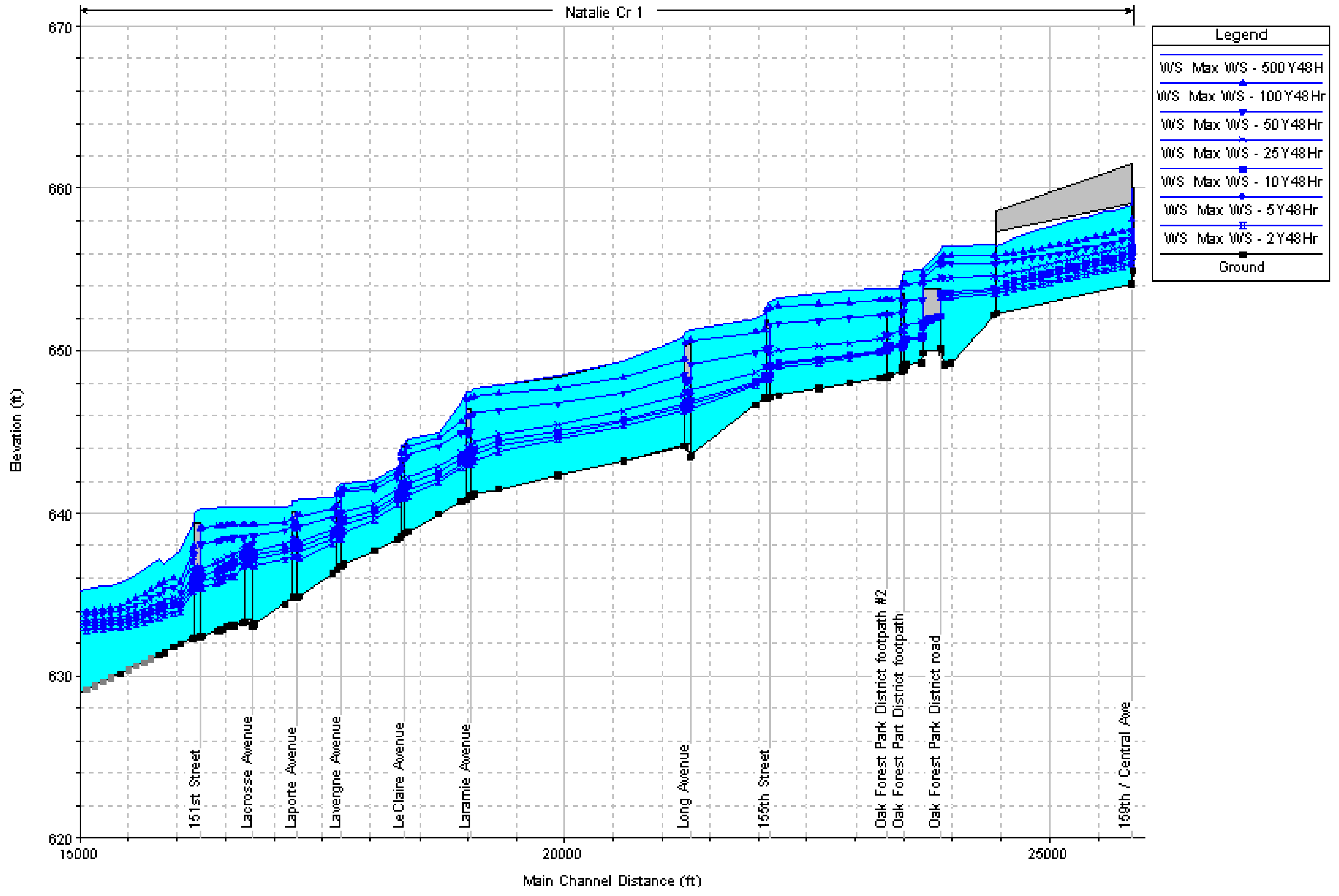
Midlothian Creek Western Tributary

88th Avenue to confluence with Midlothian Creek (near Queen Elizabeth Lane & Queen Victoria Lane)



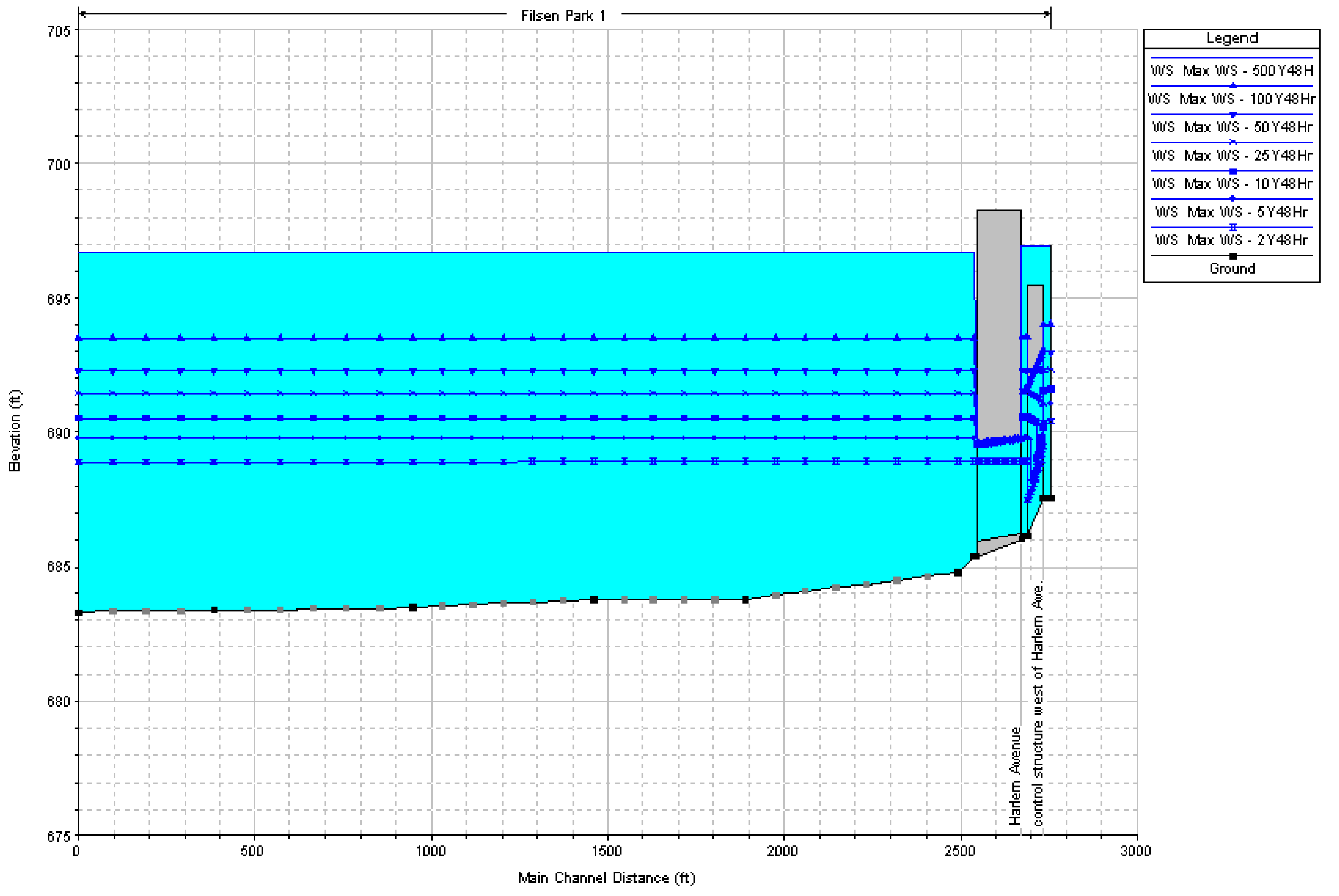
Natalie Creek

d/s of Cicero Avenue to Natalie Creek Diversion Conduit



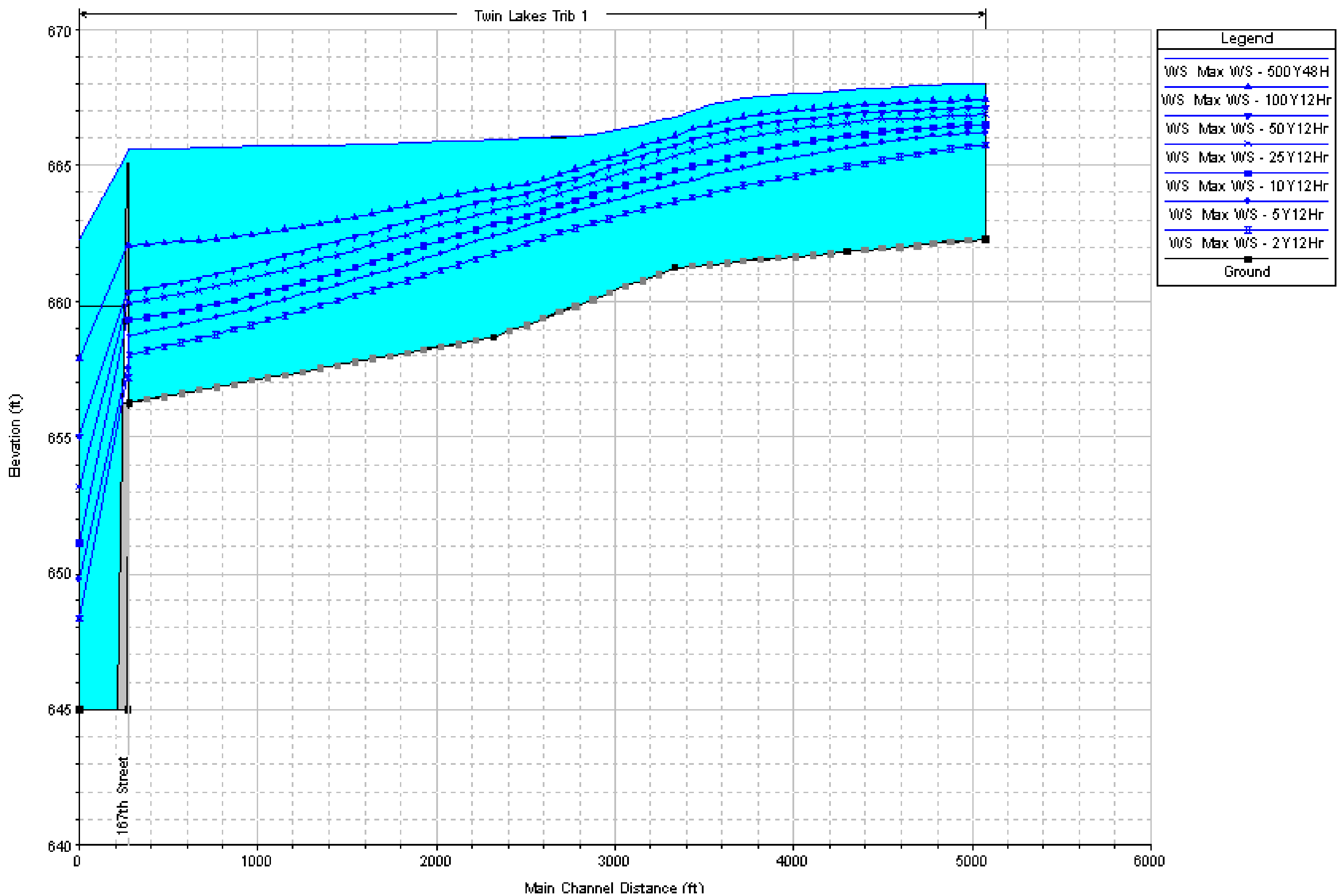
Natalie Creek

159th Street and Central Avenue to d/s of Cicero Avenue



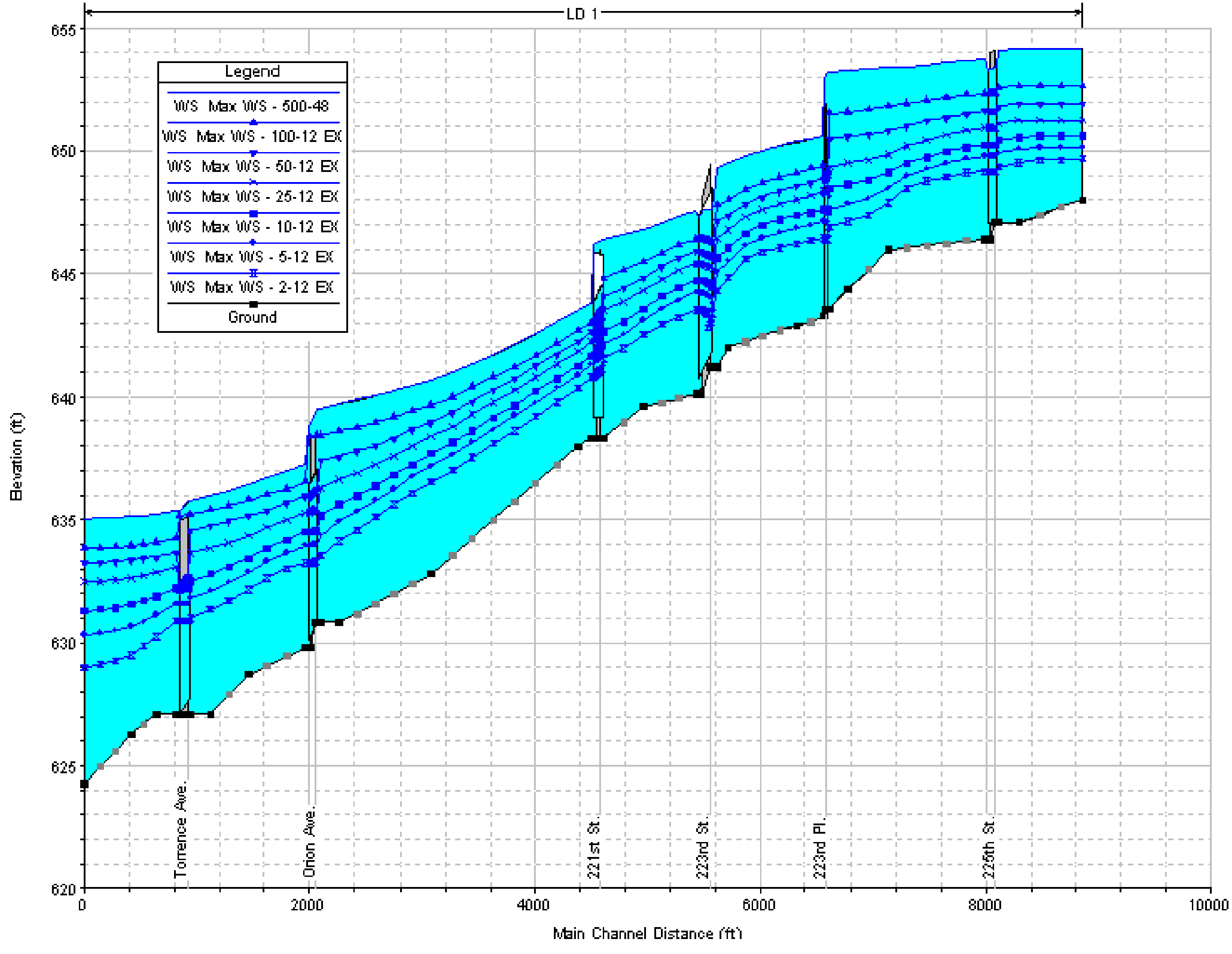
Filsen Park Ditch

Harlem Avenue to confluence with 76th Avenue Ditch



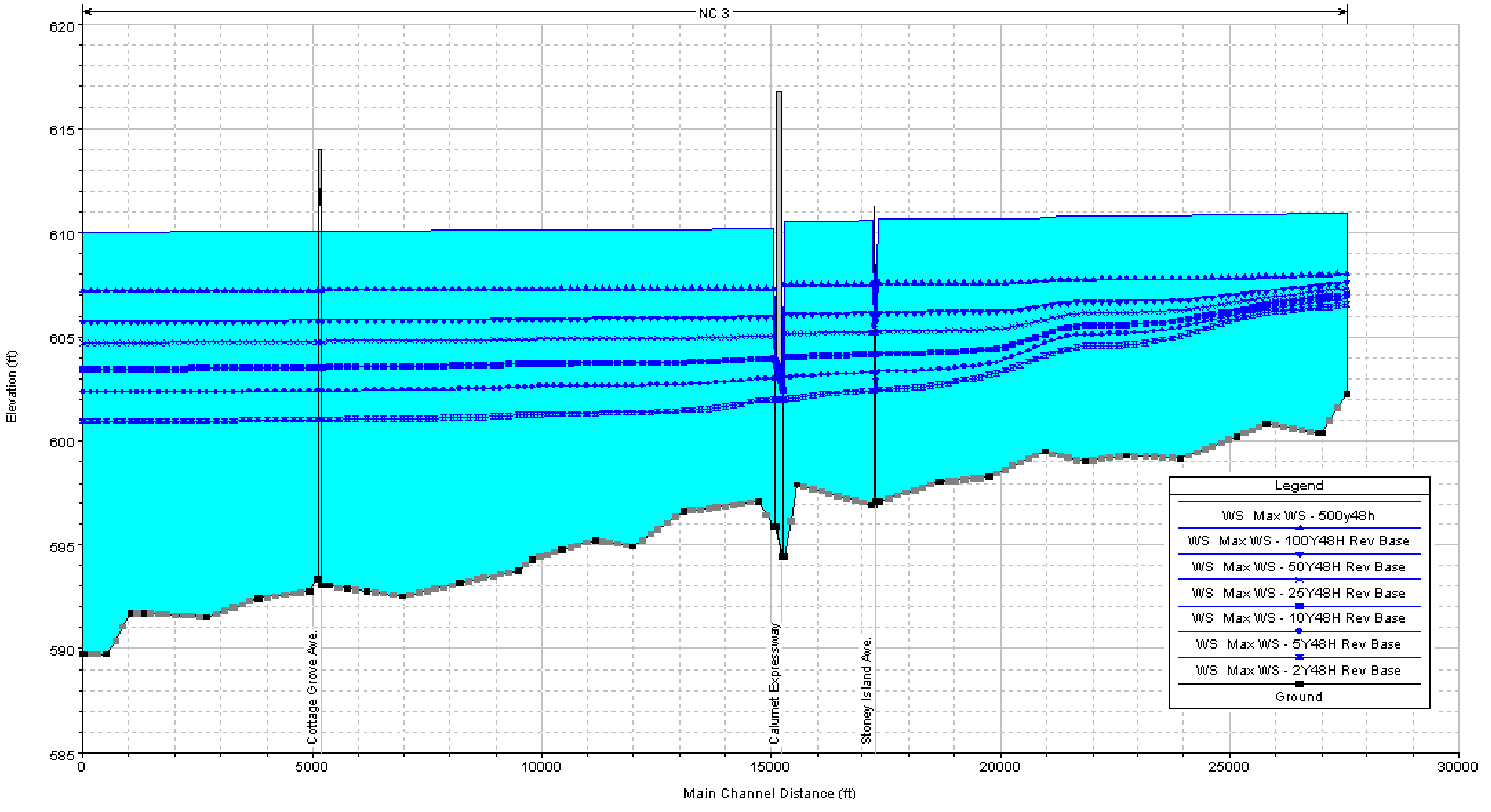
Twin Lakes Tributary

I-57 Expressway to confluence with Twin Lakes Reservoir



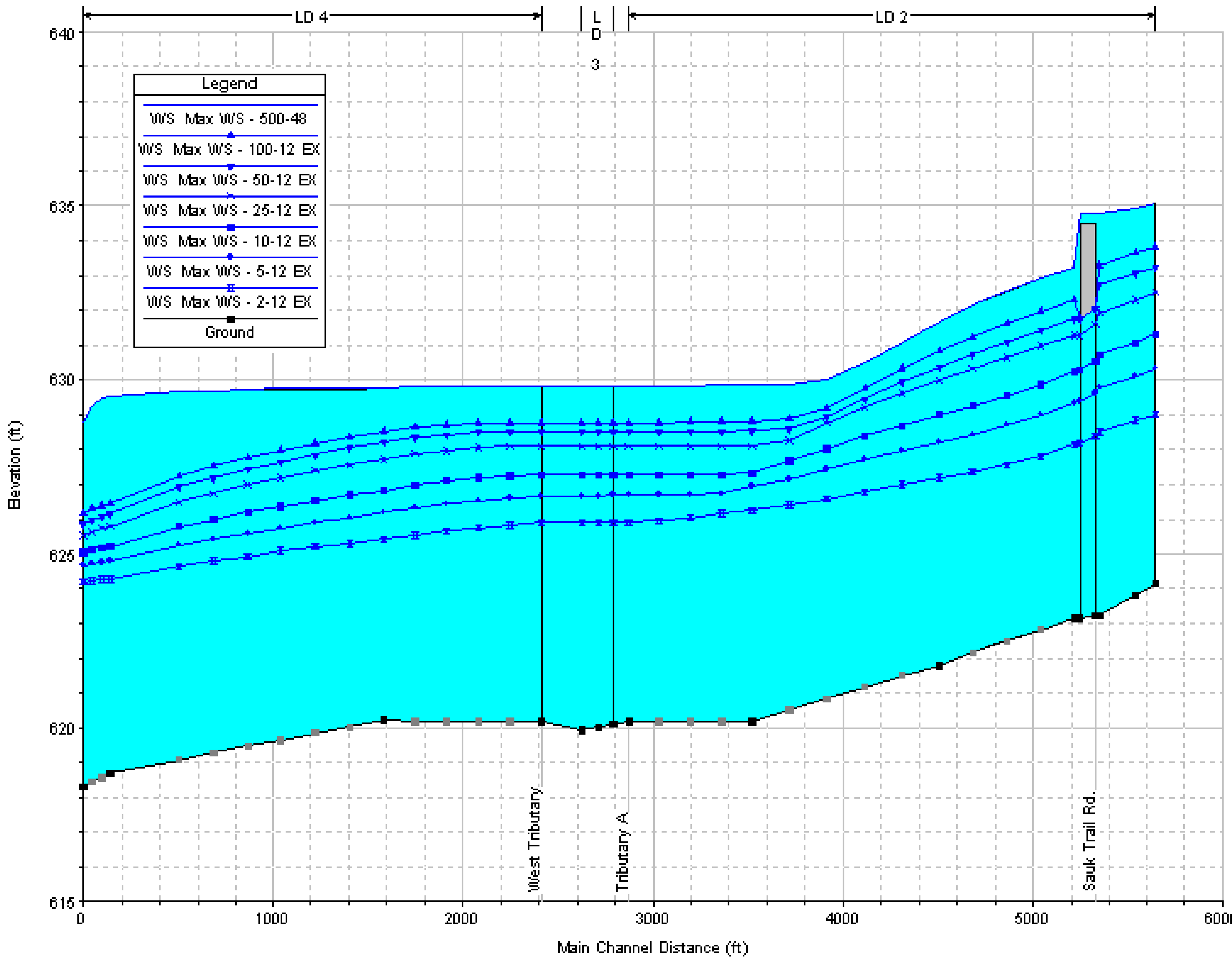
Lansing Ditch, Reach 1

800’ upstream of 225th Street to confluence with Lansing Ditch East Tributary



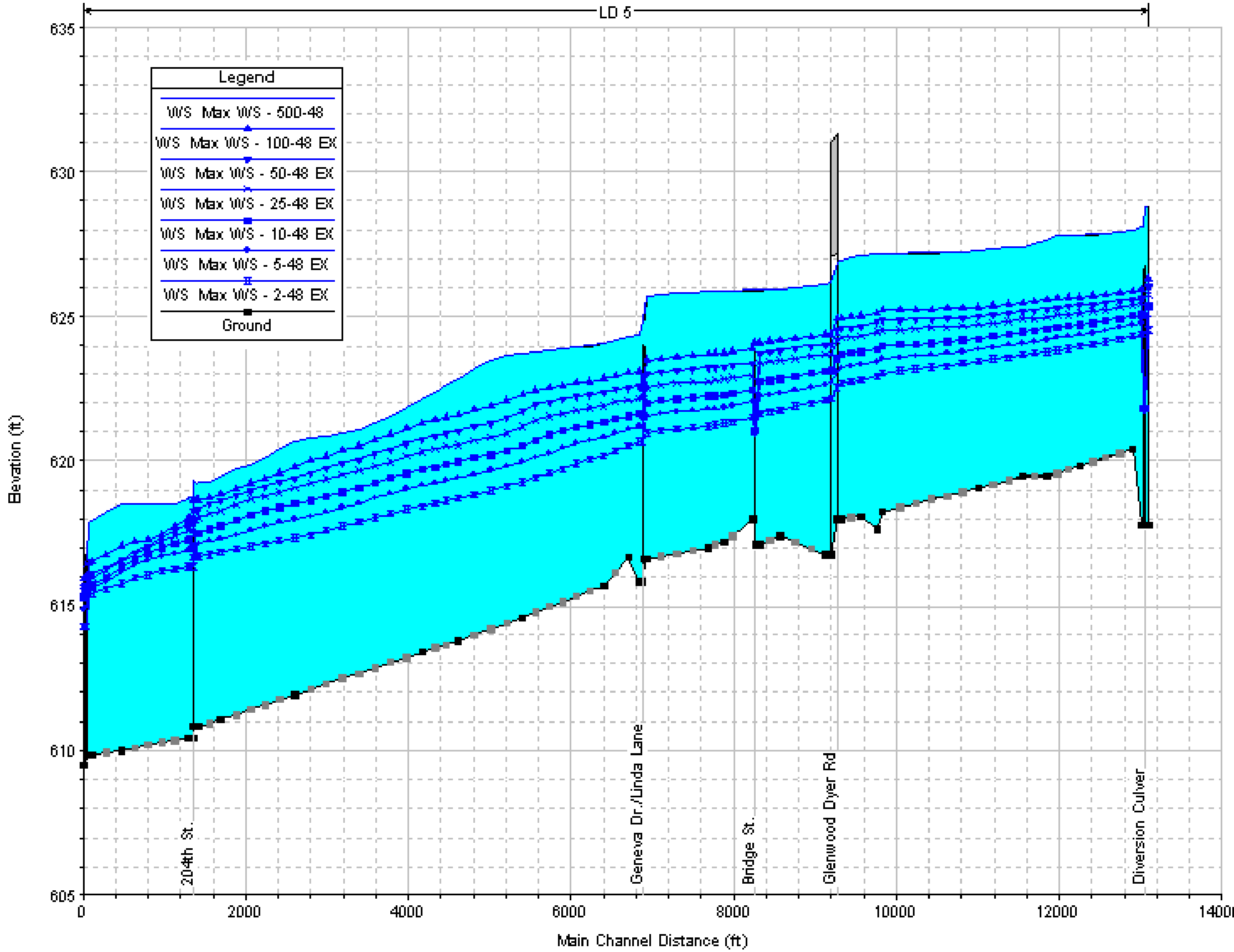
North Creek, Reach 3

Lansing Ditch Lynwood Trib. (at Torrence Ave.) to confluence with Thorn Creek



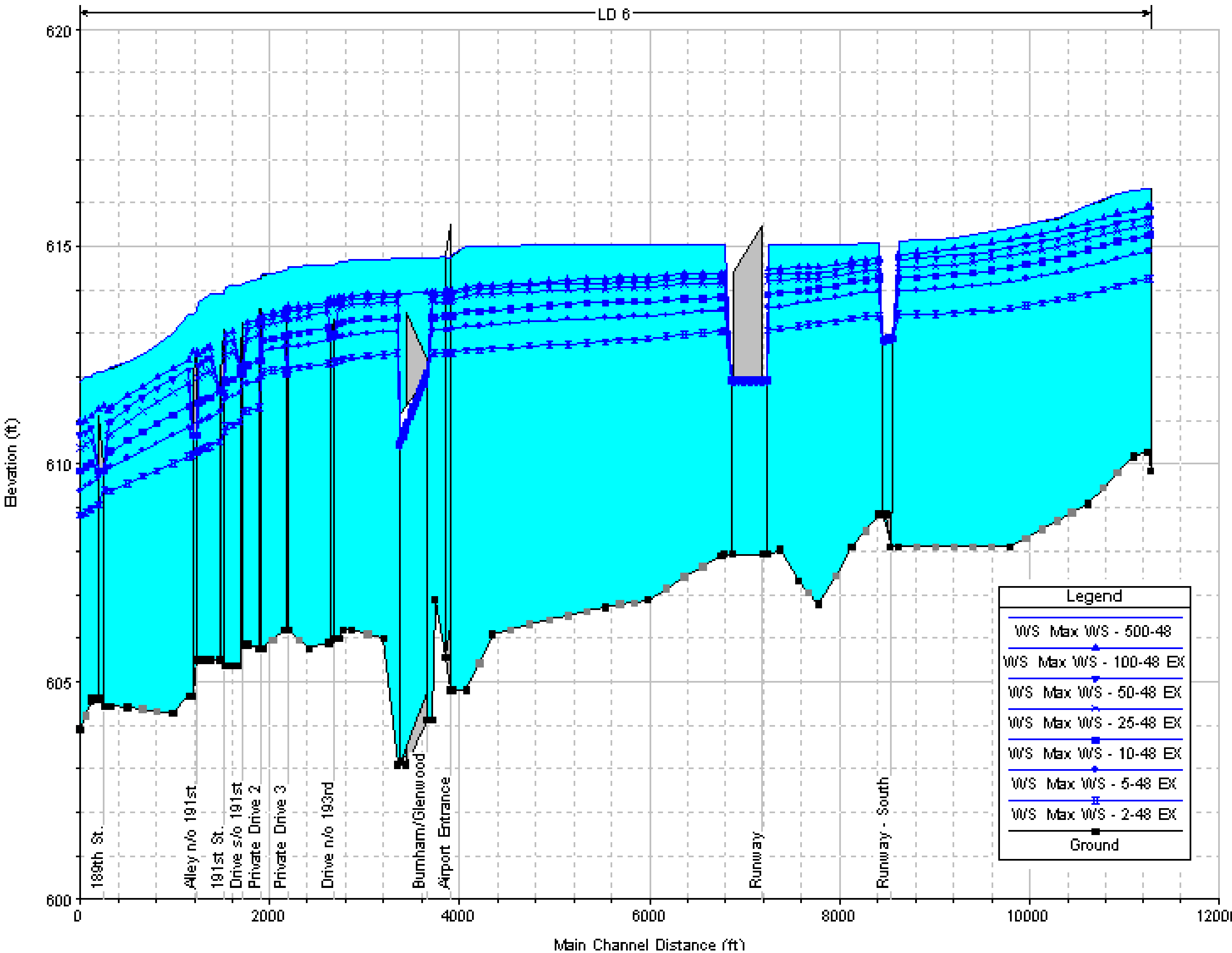
Lansing Ditch, Reaches 2, 3 & 4

Lansing Ditch East Trib. (near Torrence Ave. and Sauk Trail Rd.) to confluence with Lansing Ditch Torrence Trib.



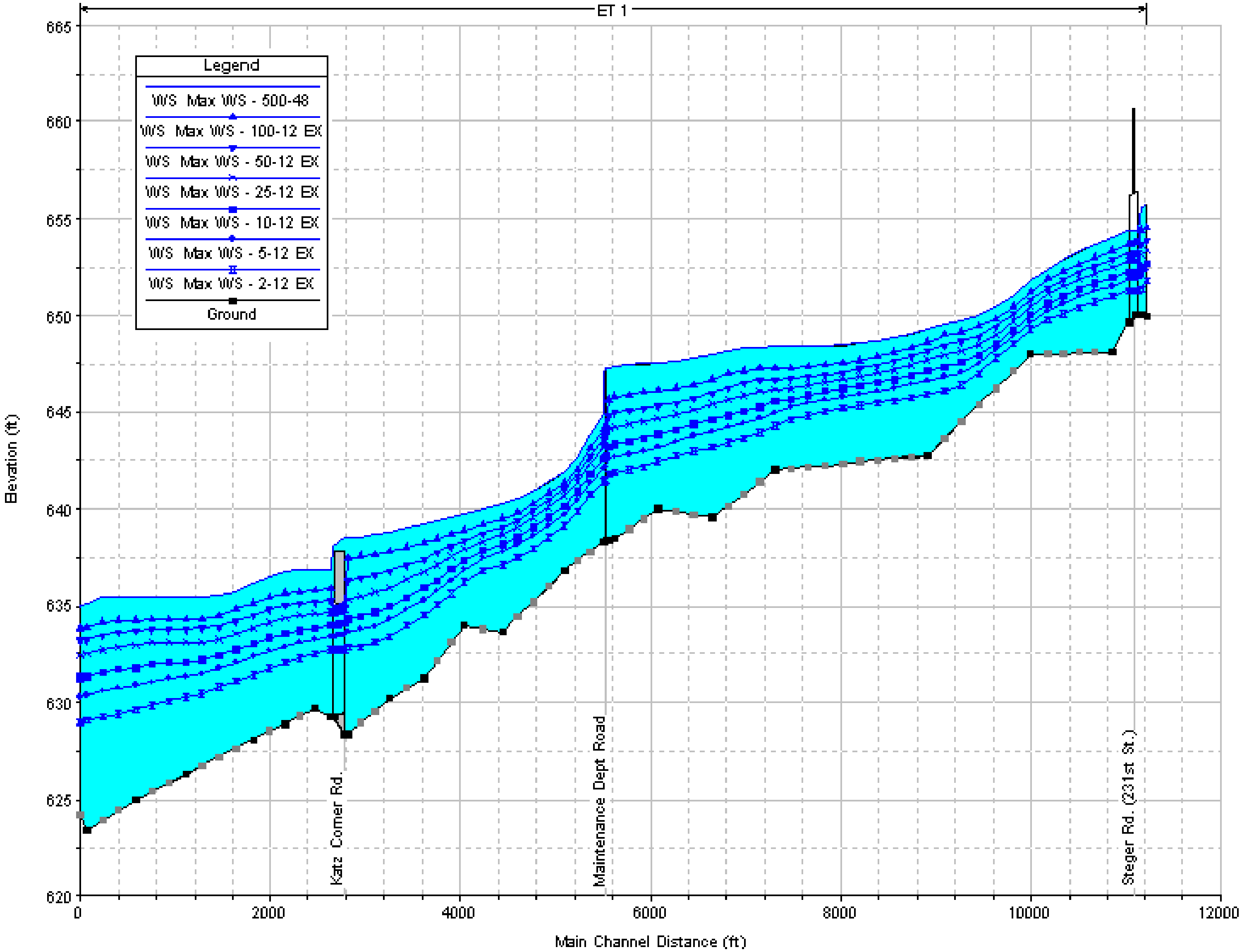
Lansing Ditch, Reach 5

Lansing Ditch Torrence Trib (downstream of railroad) to confluence with Lansing Ditch Lynwood Trib.



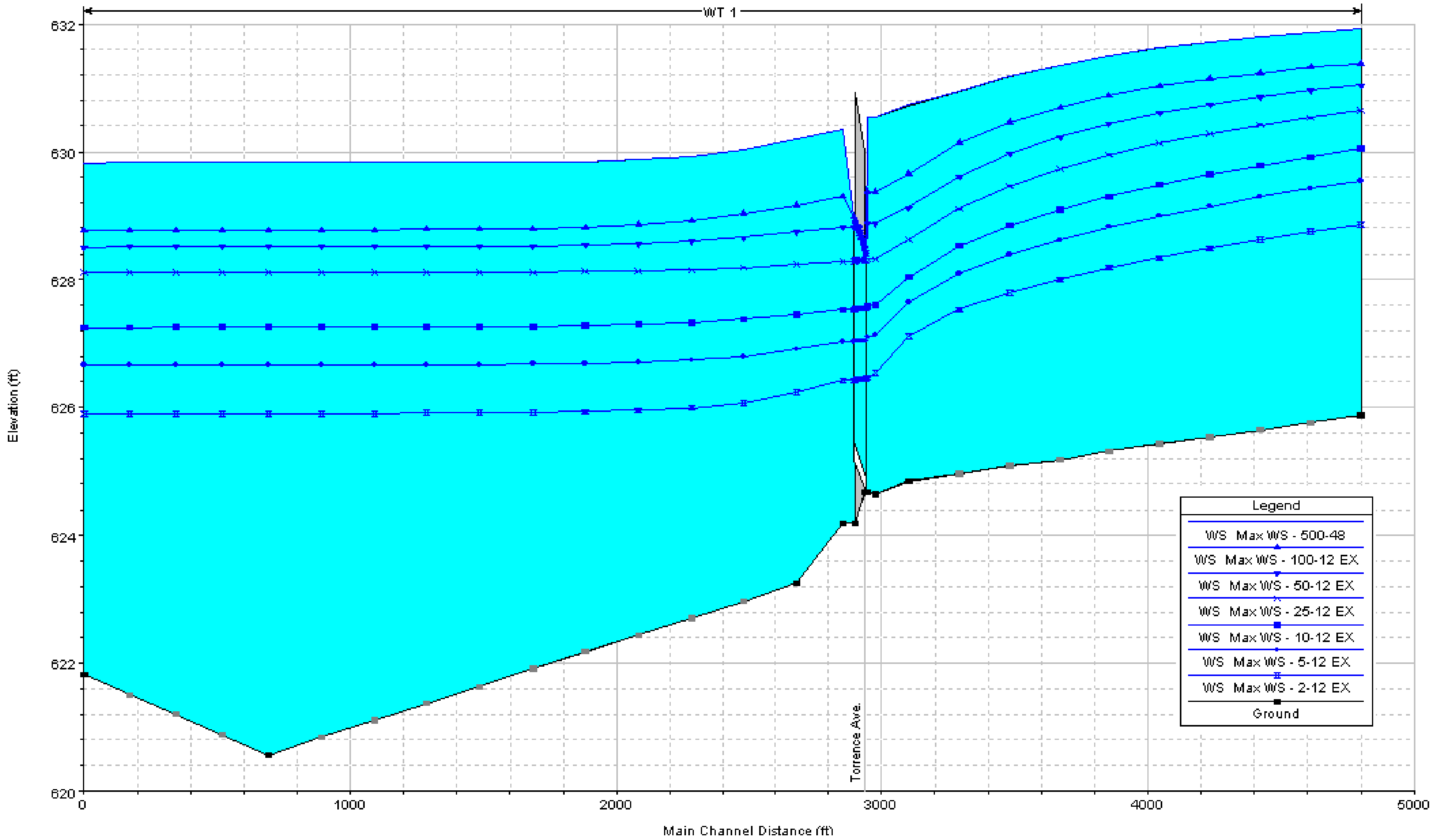
Lansing Ditch, Reach 6

Lansing Ditch Lynwood Trib. to confluence with North Creek (north of 189th Street)



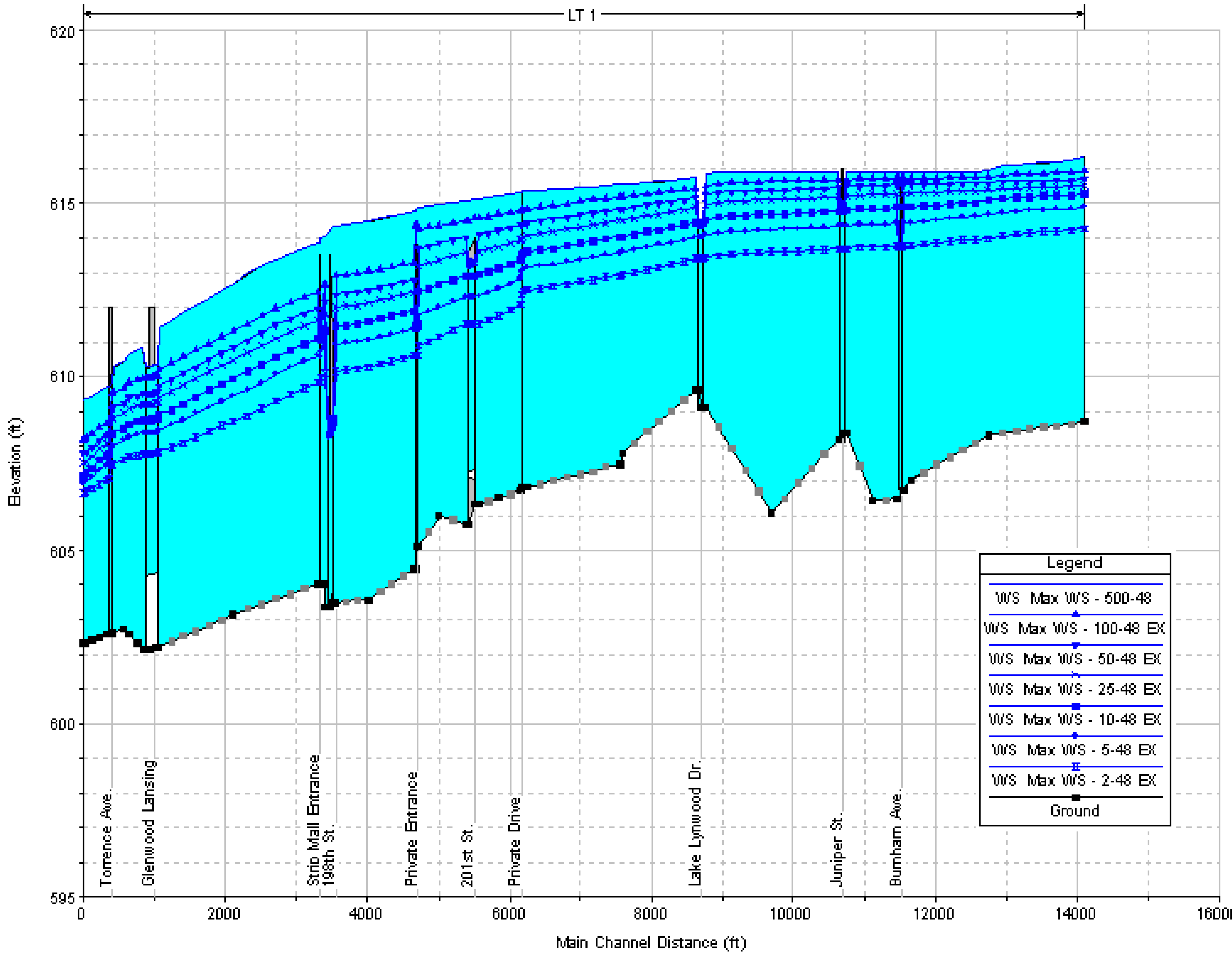
Lansing Ditch East Tributary

Steger Road to confluence with Lansing Ditch



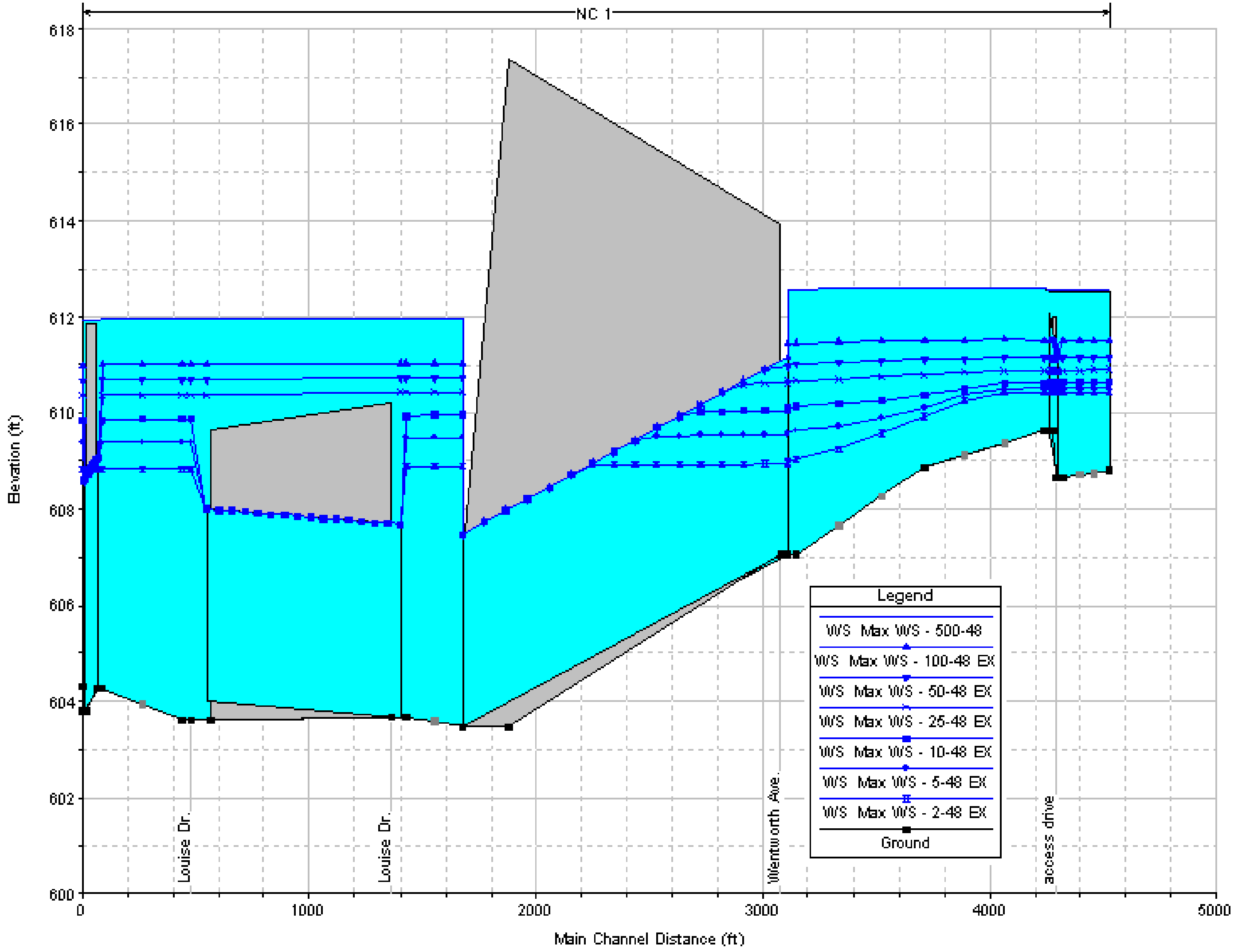
Lansing Ditch West Tributary

900' upstream of Torrence Ave. to confluence with Lansing Ditch



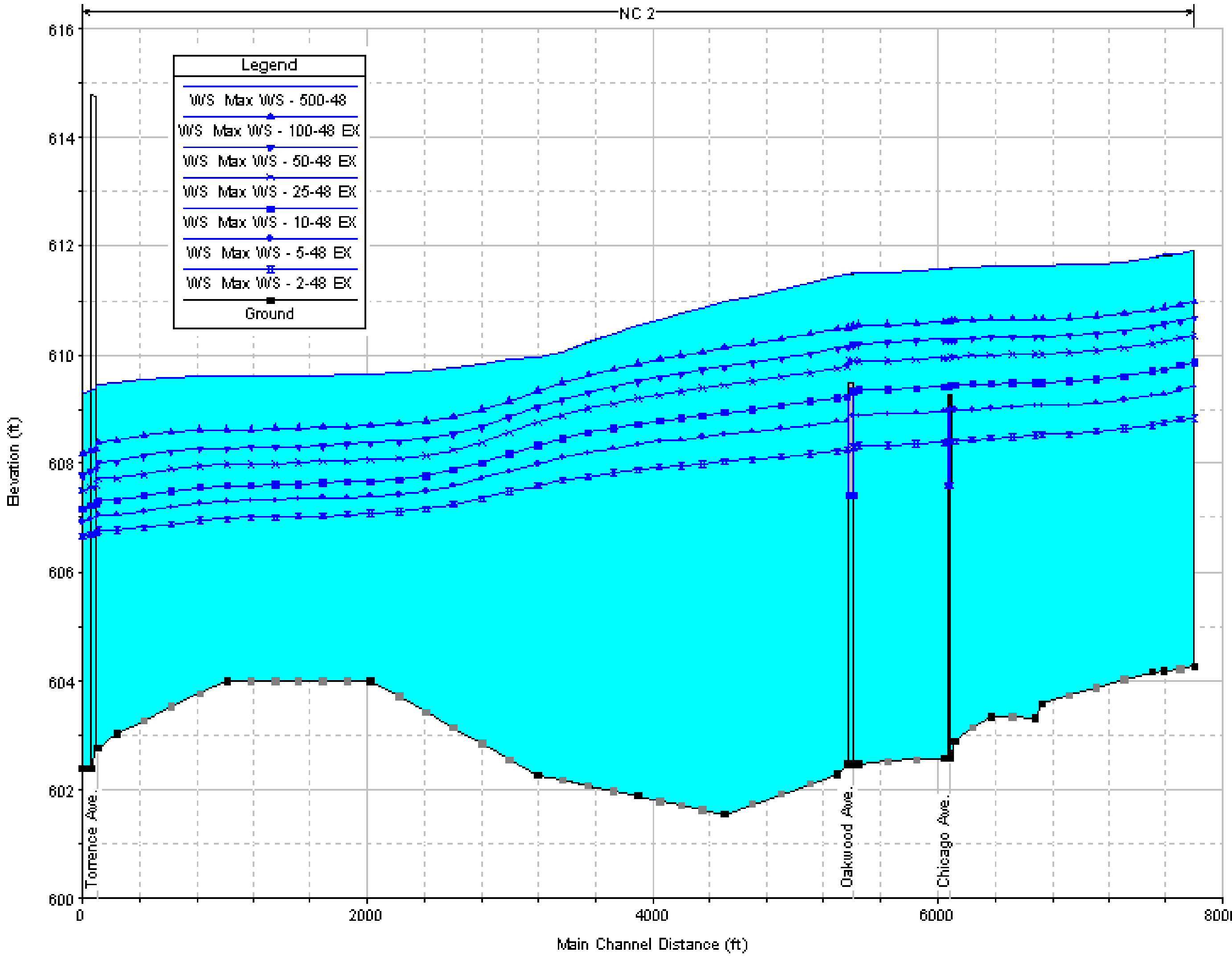
Lansing Ditch Lynwood Tributary

Lansing Ditch (199th St. & Kruse Rd.) to confluence with North Creek Reach 2



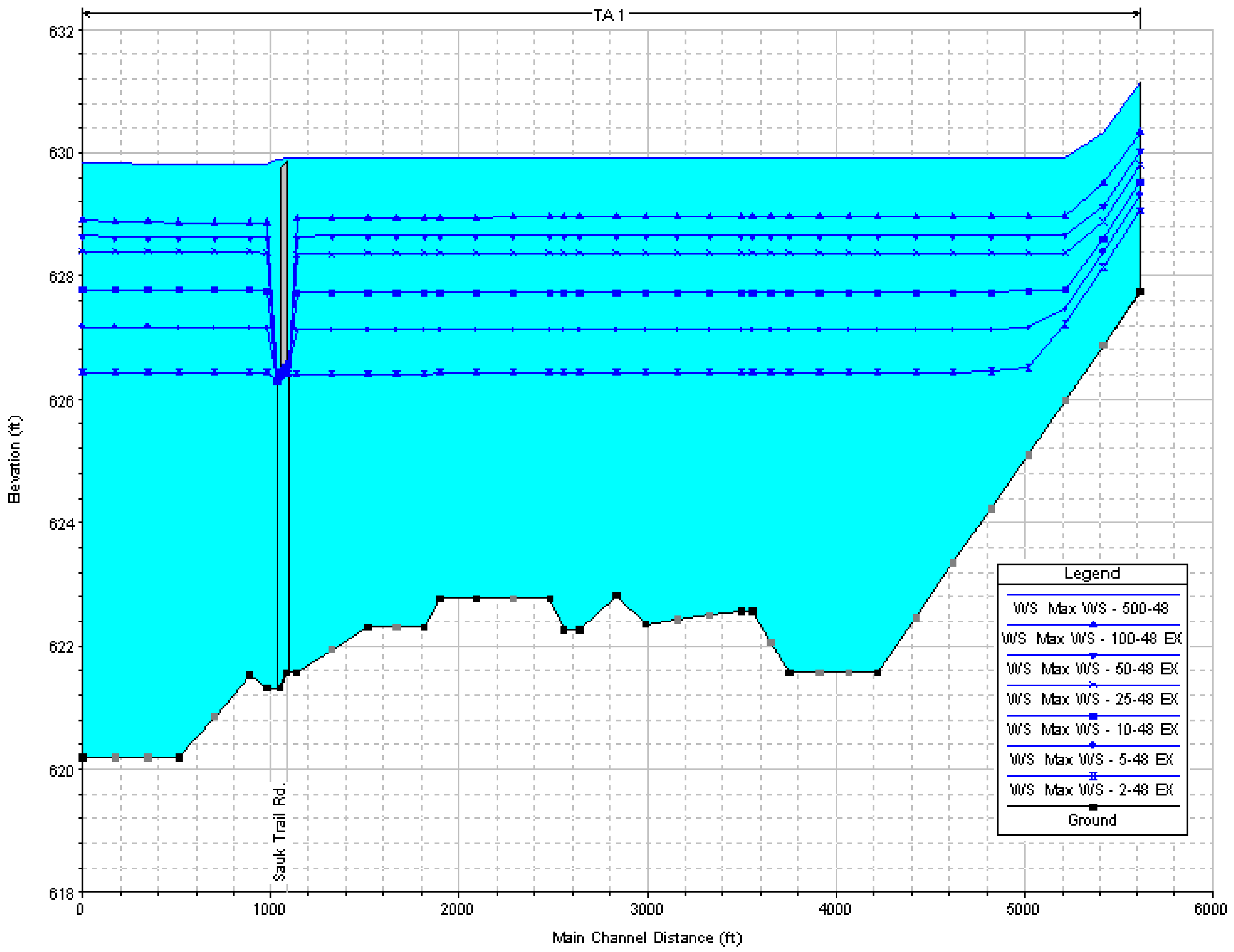
North Creek, Reach 1

Indiana State Line to confluence with Lansing Ditch at Burnham Ave.



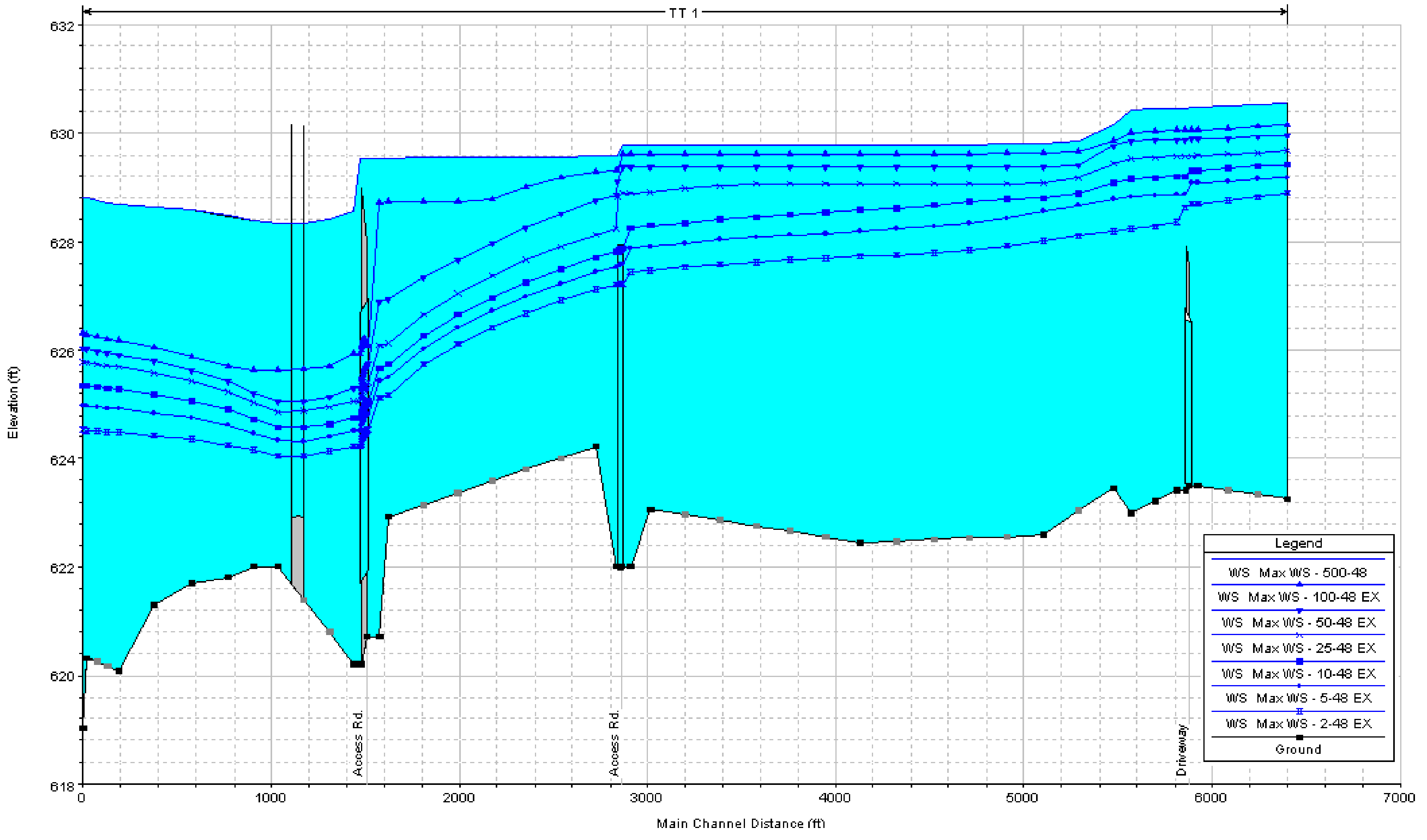
North Creek, Reach 2

Lansing Ditch at Burnham Ave. to confluence with Lansing Ditch Lynwood Tributary at Torrence Ave.



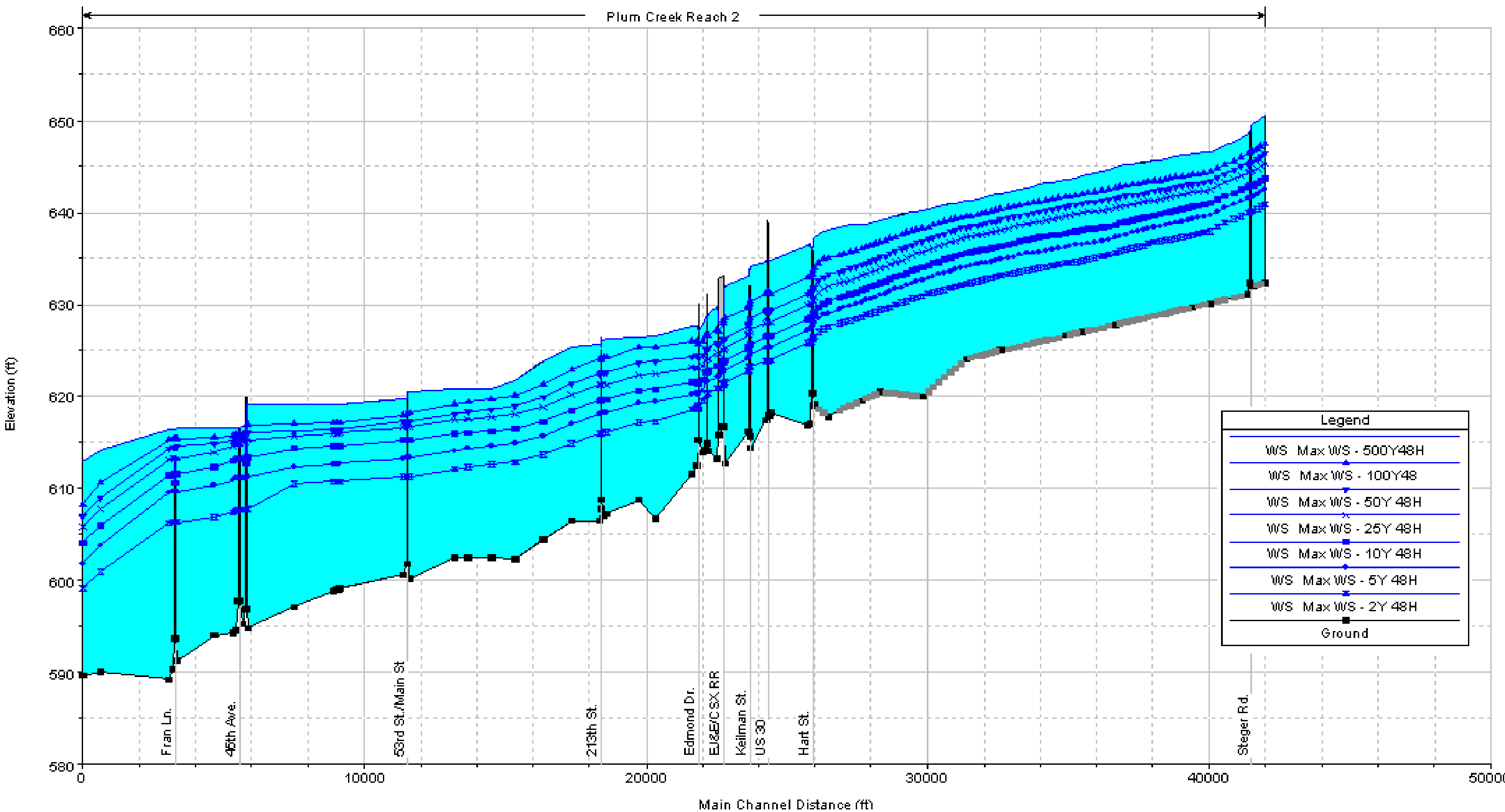
Lansing Ditch Tributary A

Katz Corner Rd. to confluence with Lansing Ditch



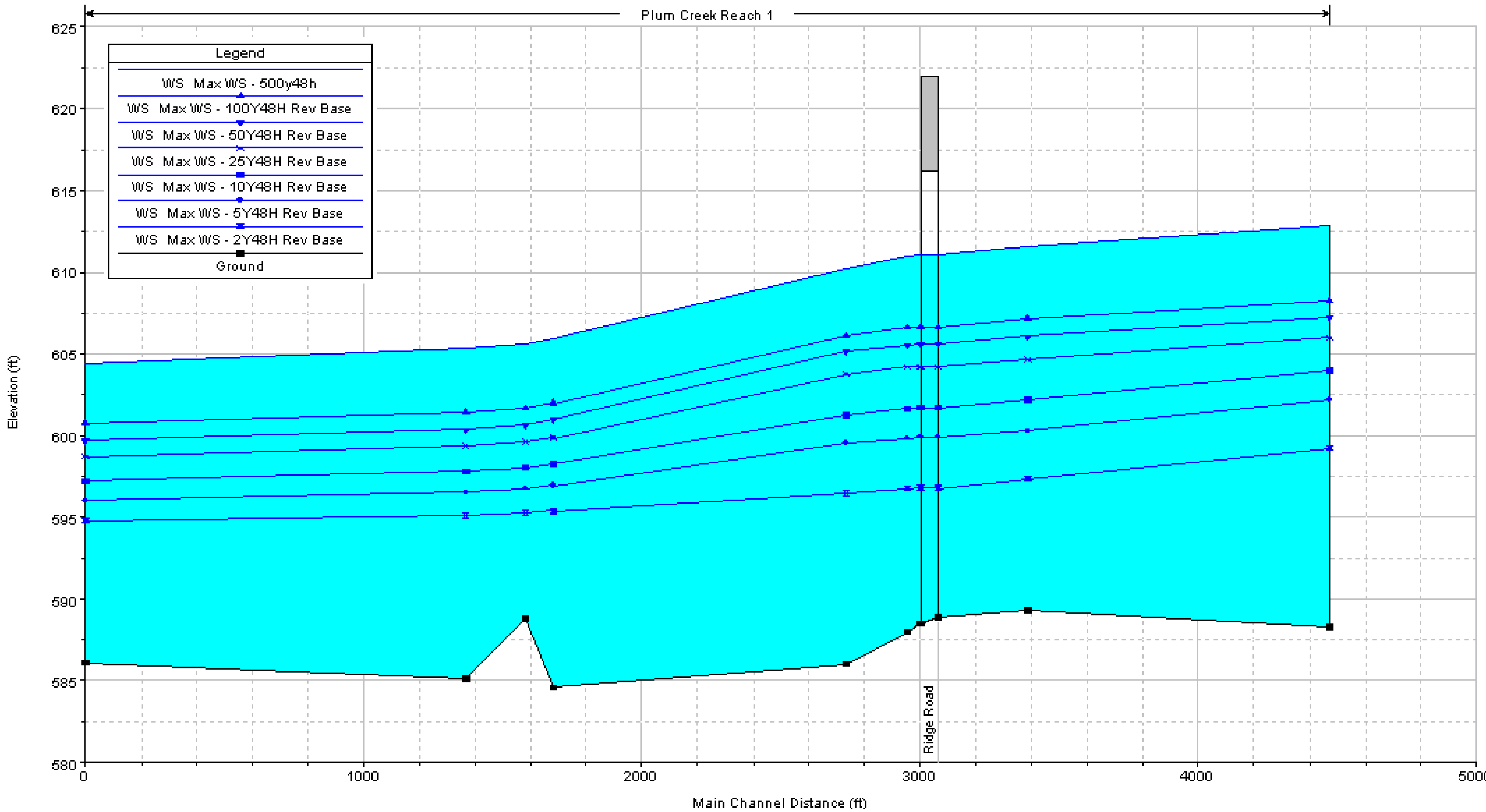
Lansing Ditch Torrence Tributary

Downstream of US 30 to confluence with Lansing Ditch



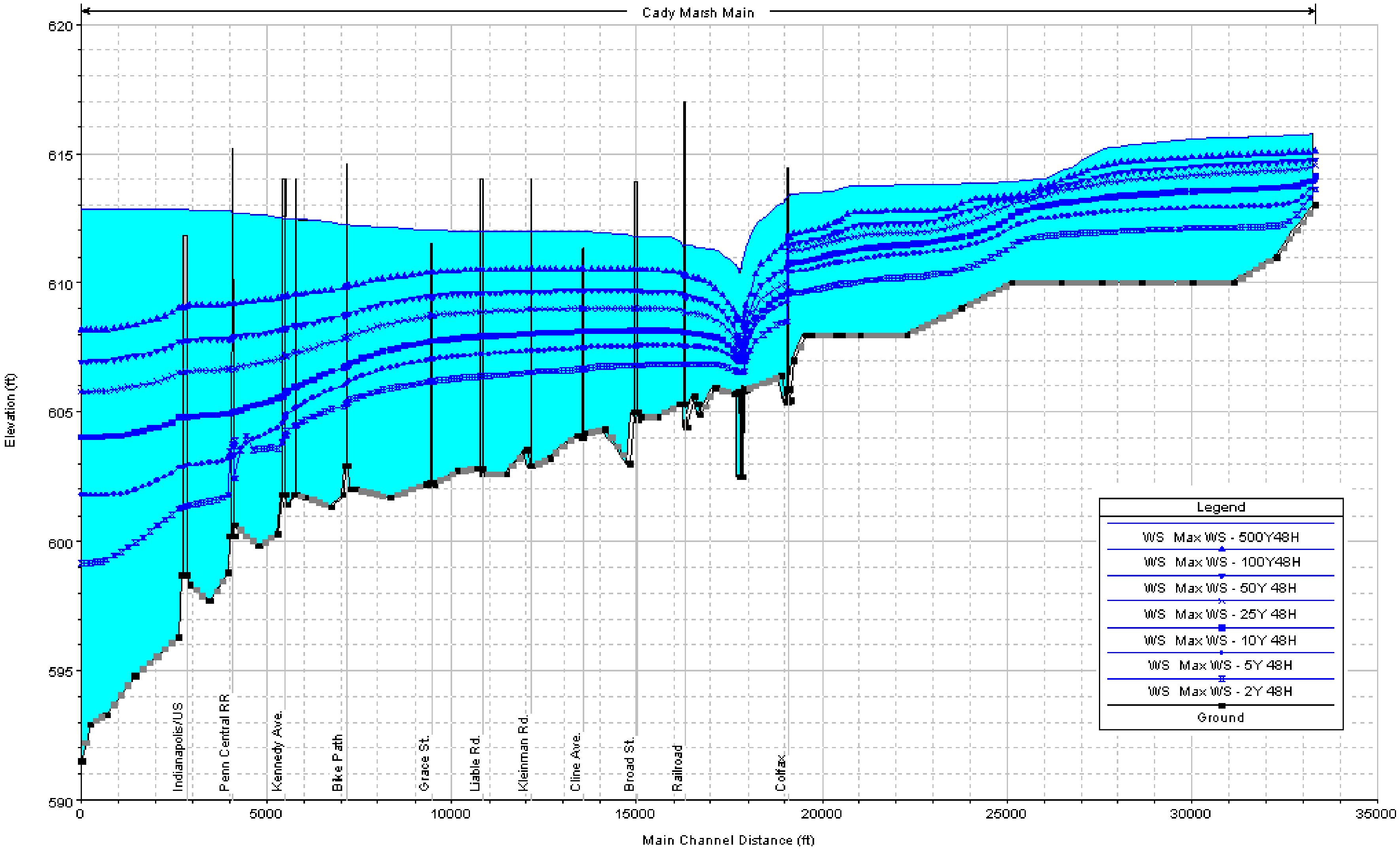
Plum Creek (Hart Ditch), Reach 2

Steger Road to confluence with Cady Marsh Ditch



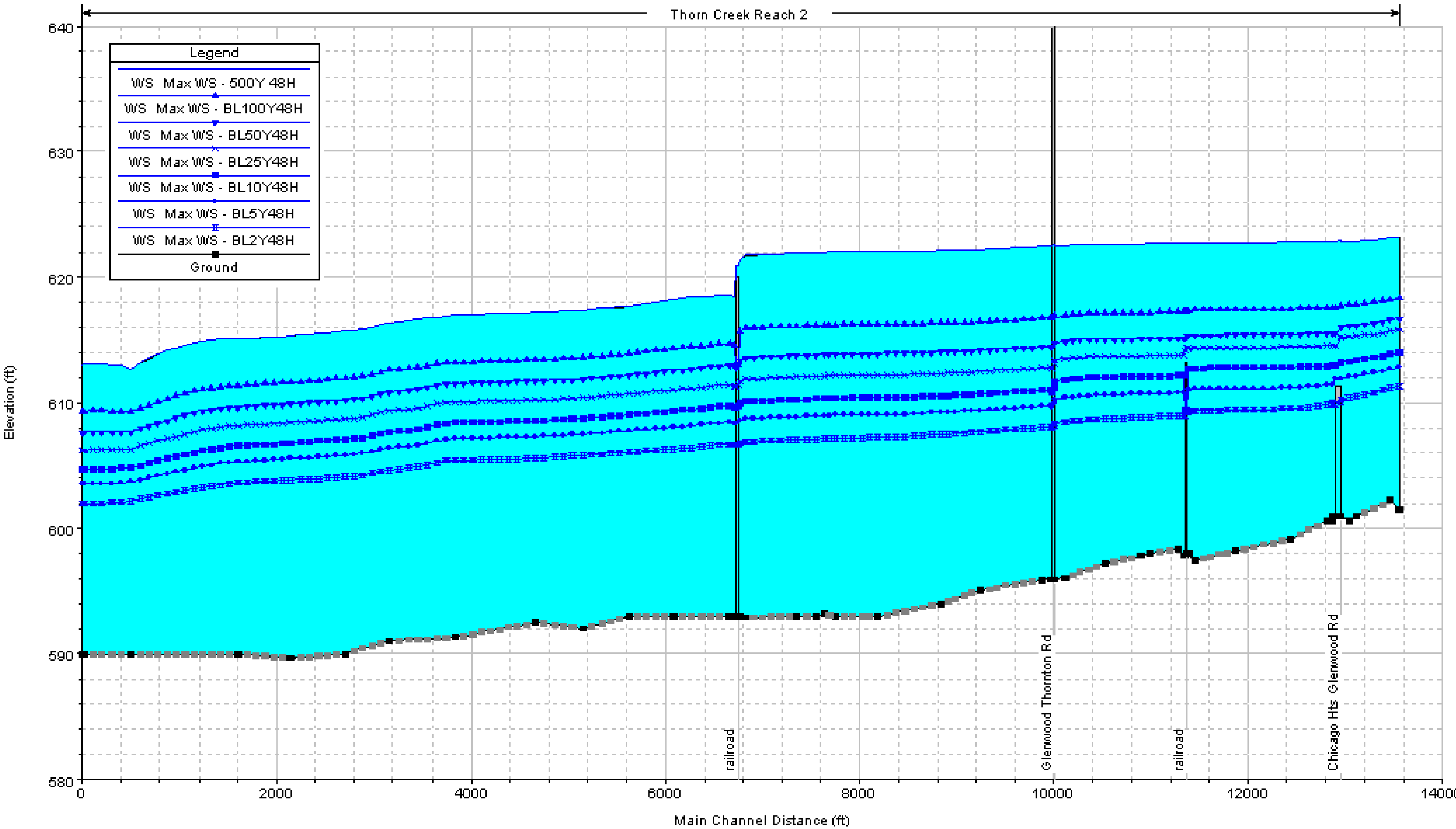
Plum Creek (Hart Ditch), Reach 1

Cady Marsh Ditch to confluence with Little Calumet River



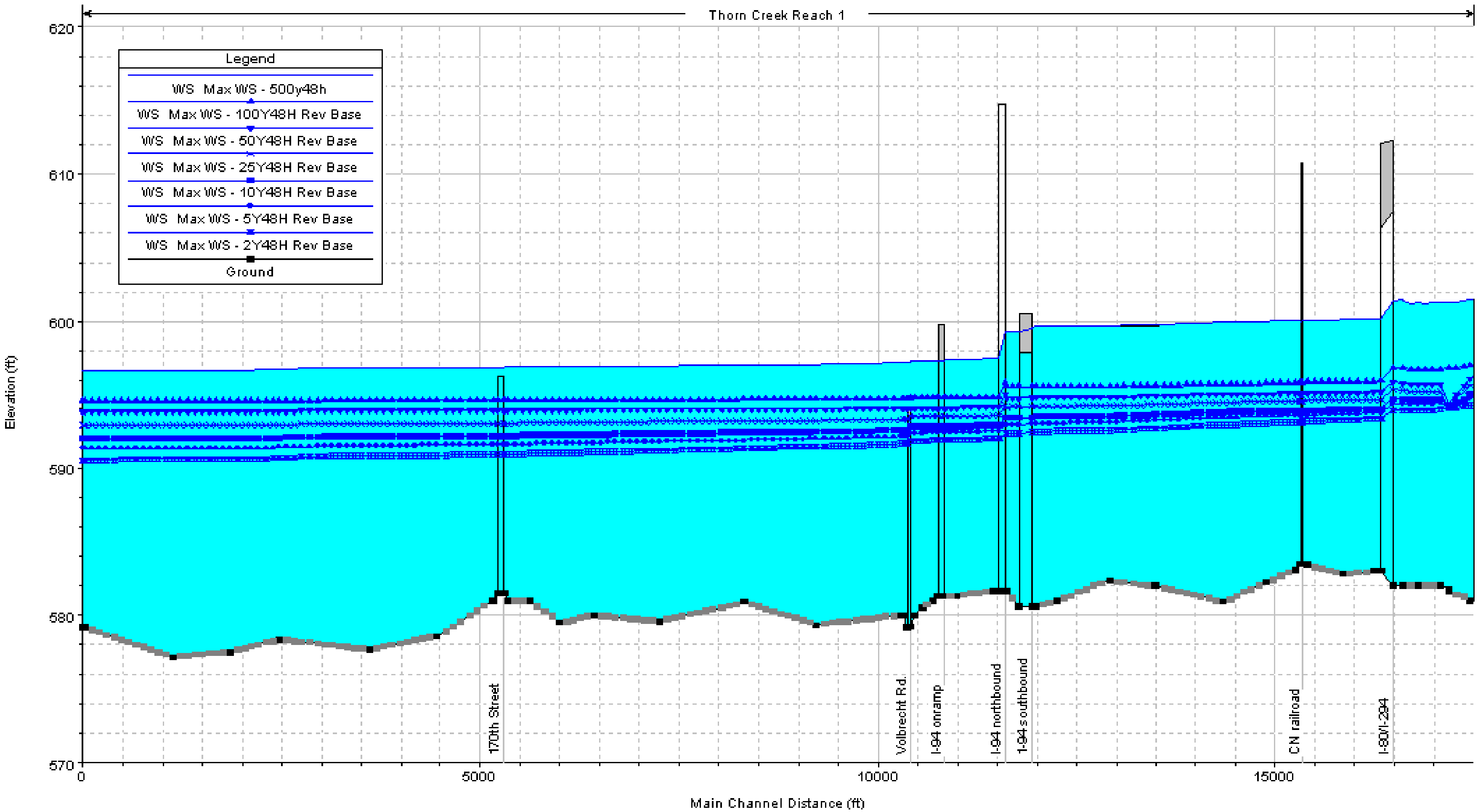
Cady Marsh Ditch

Cleveland Street to confluence with Plum Creek



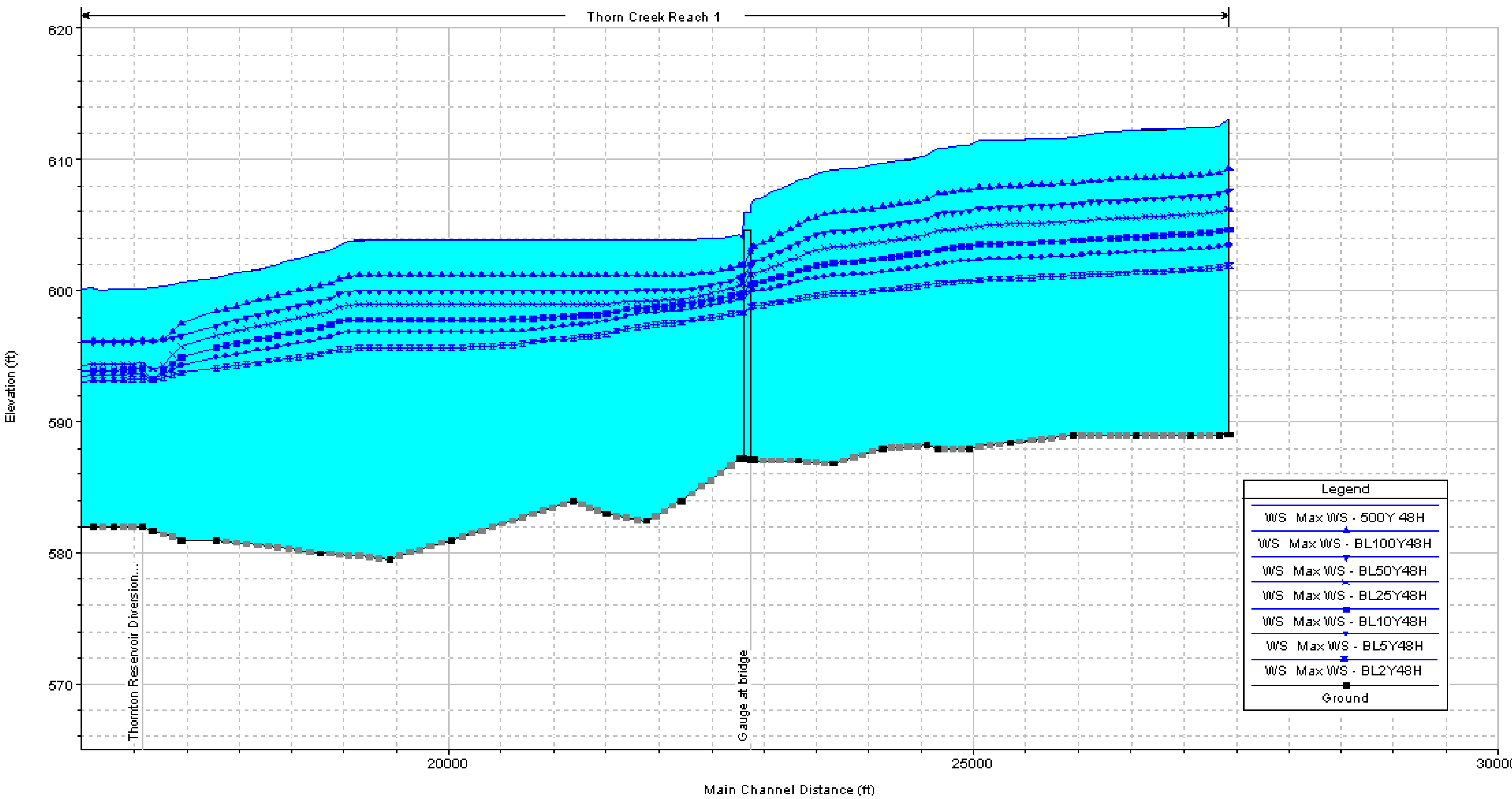
Thorn Creek, Reach 2

Butterfield Creek to confluence with North Creek



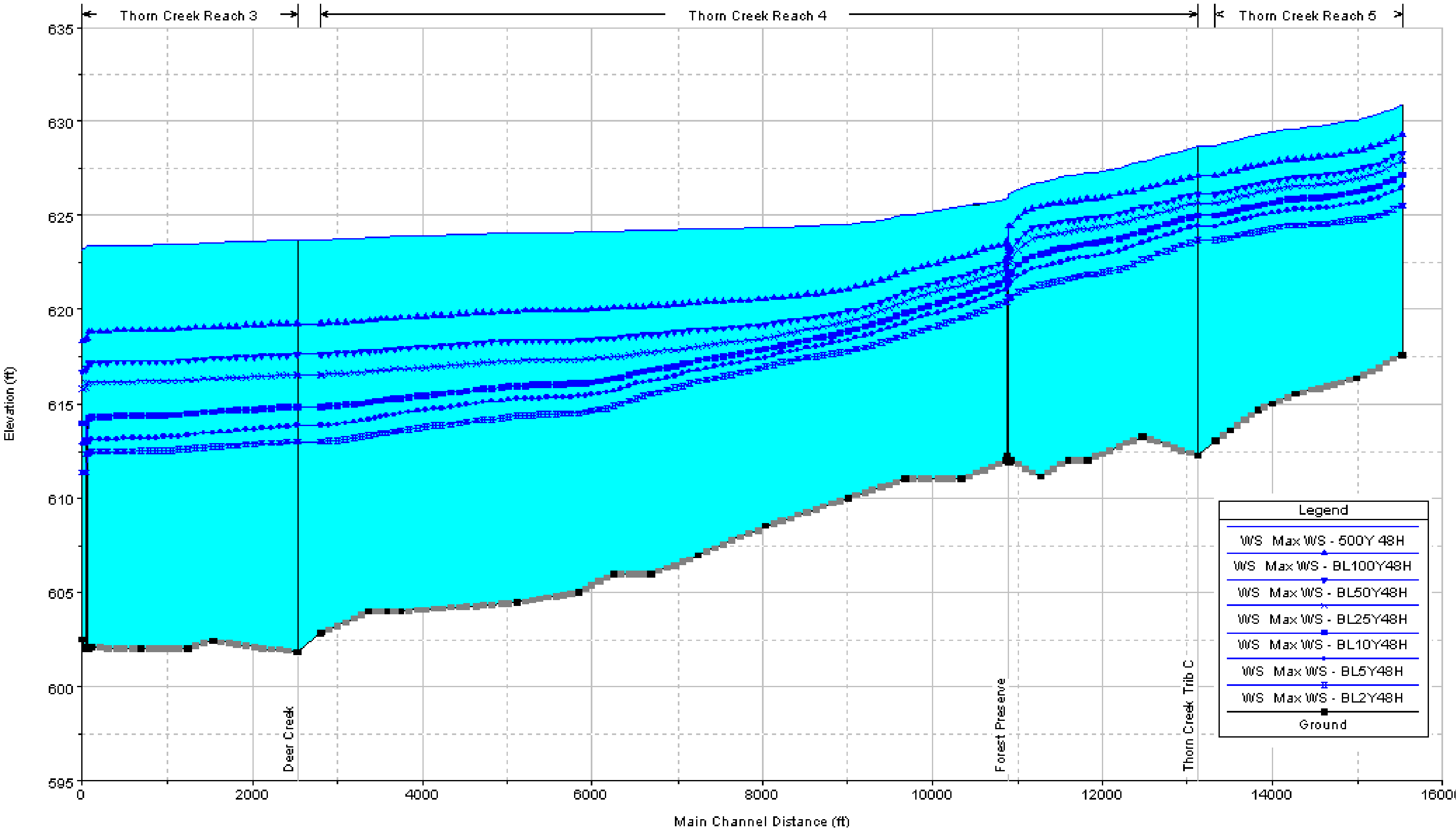
Thorn Creek, Reach 1

Thornton Reservoir Diversion to confluence with Little Calumet River



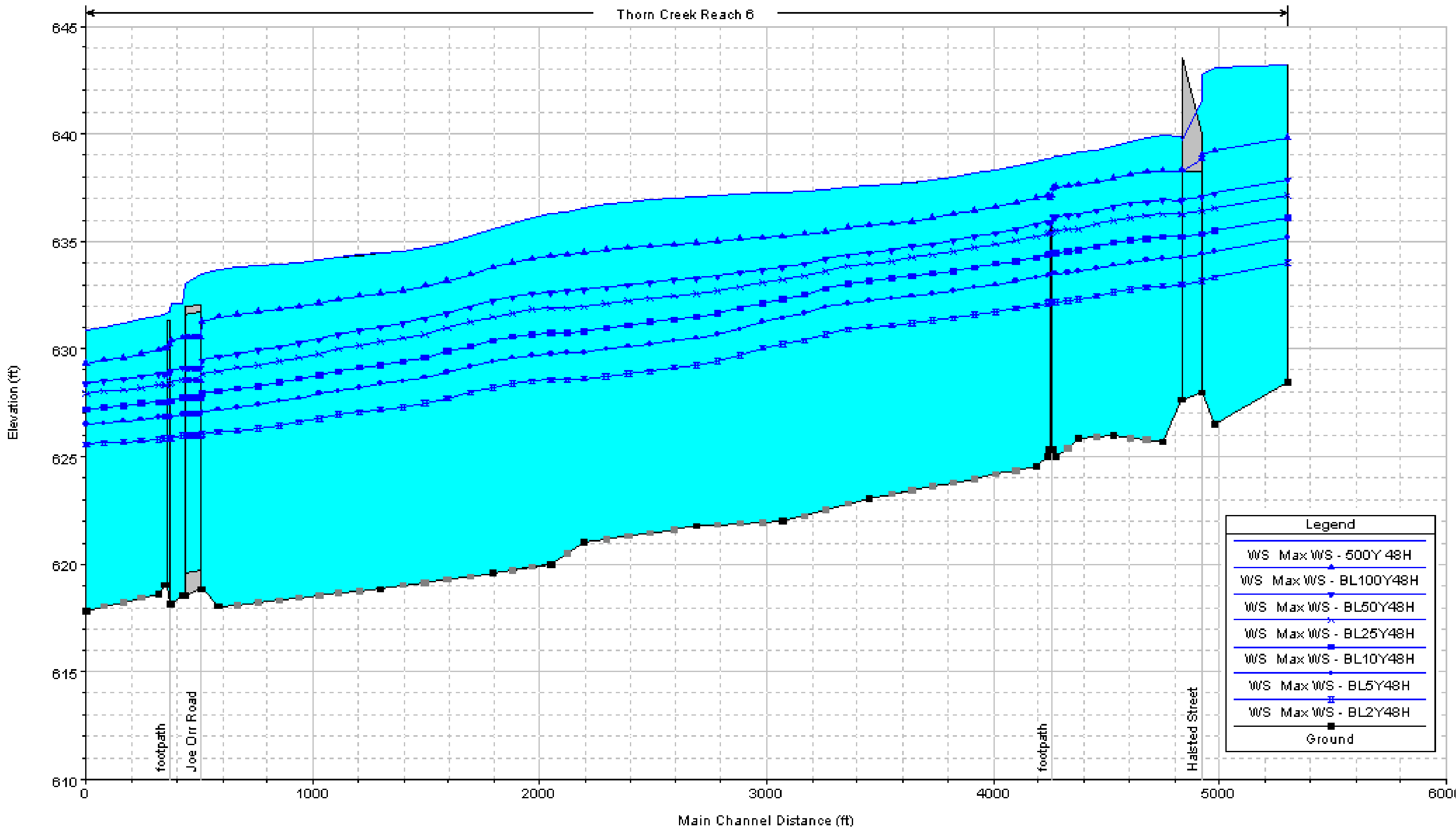
Thorn Creek, Reach 1

North Creek to Thornton Reservoir Diversion



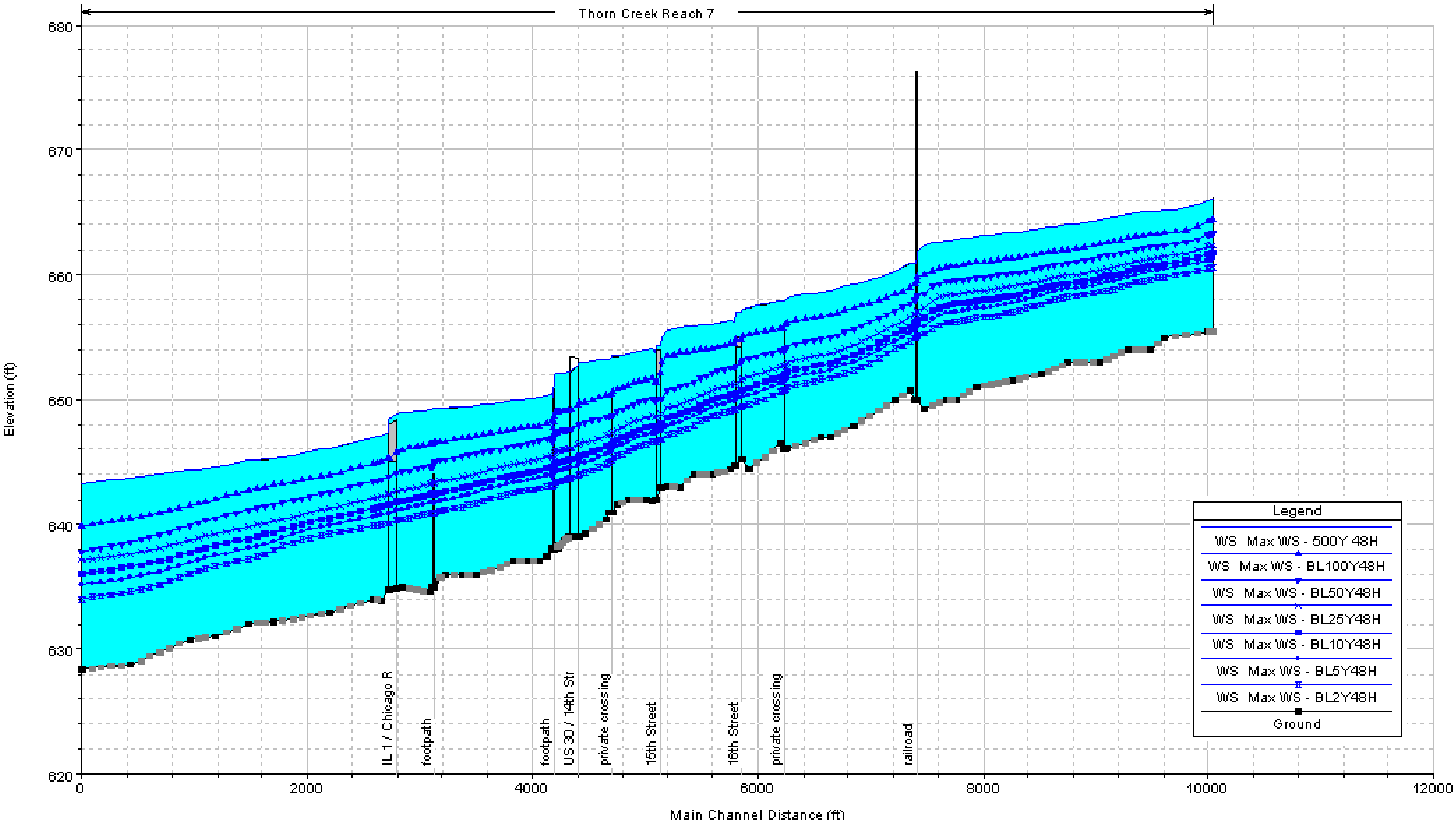
Thorn Creek, Reaches 3, 4 and 5

Thorn Creek Tributary A to confluence with Butterfield Creek



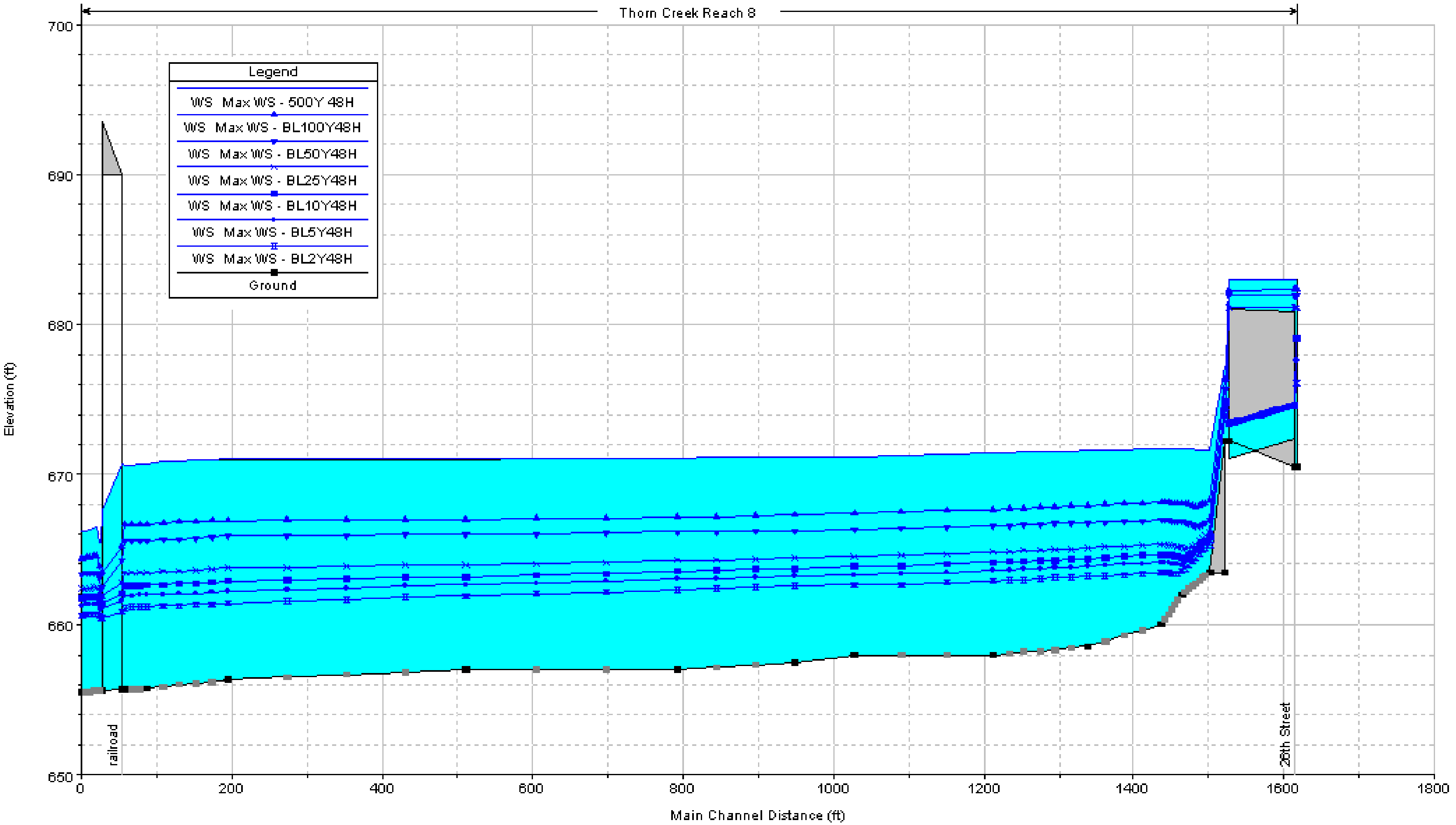
Thorn Creek, Reach 6

Thorn Creek Tributary B (South of IL 1) to confluence with Thorn Creek Tributary A (North of Joe Orr Rd.)



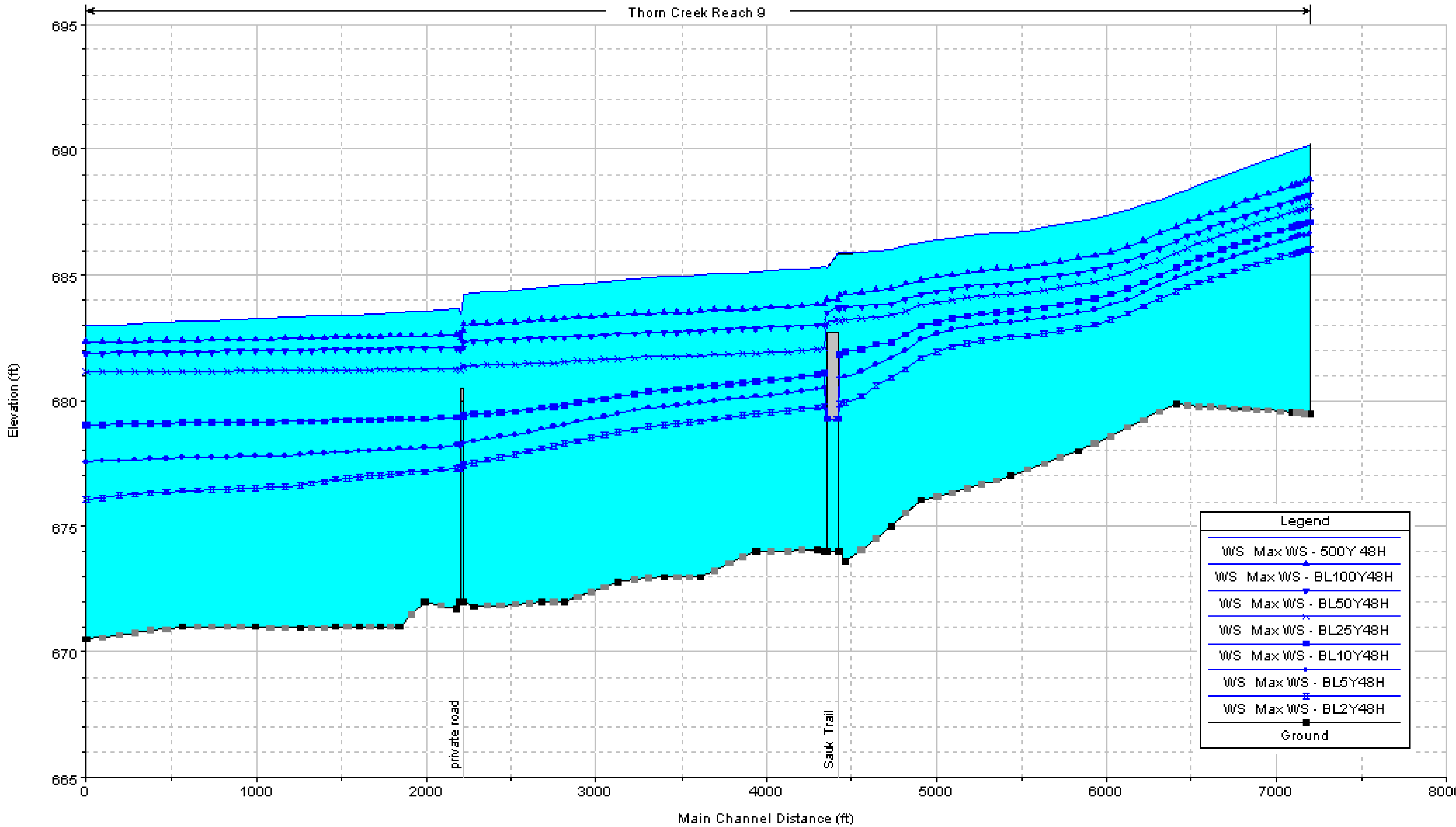
Thorn Creek, Reach 7

Thorn Creek Tributary D (at Beacon Blvd.) to confluence with Thorn Creek Tributary B (South of IL 1)



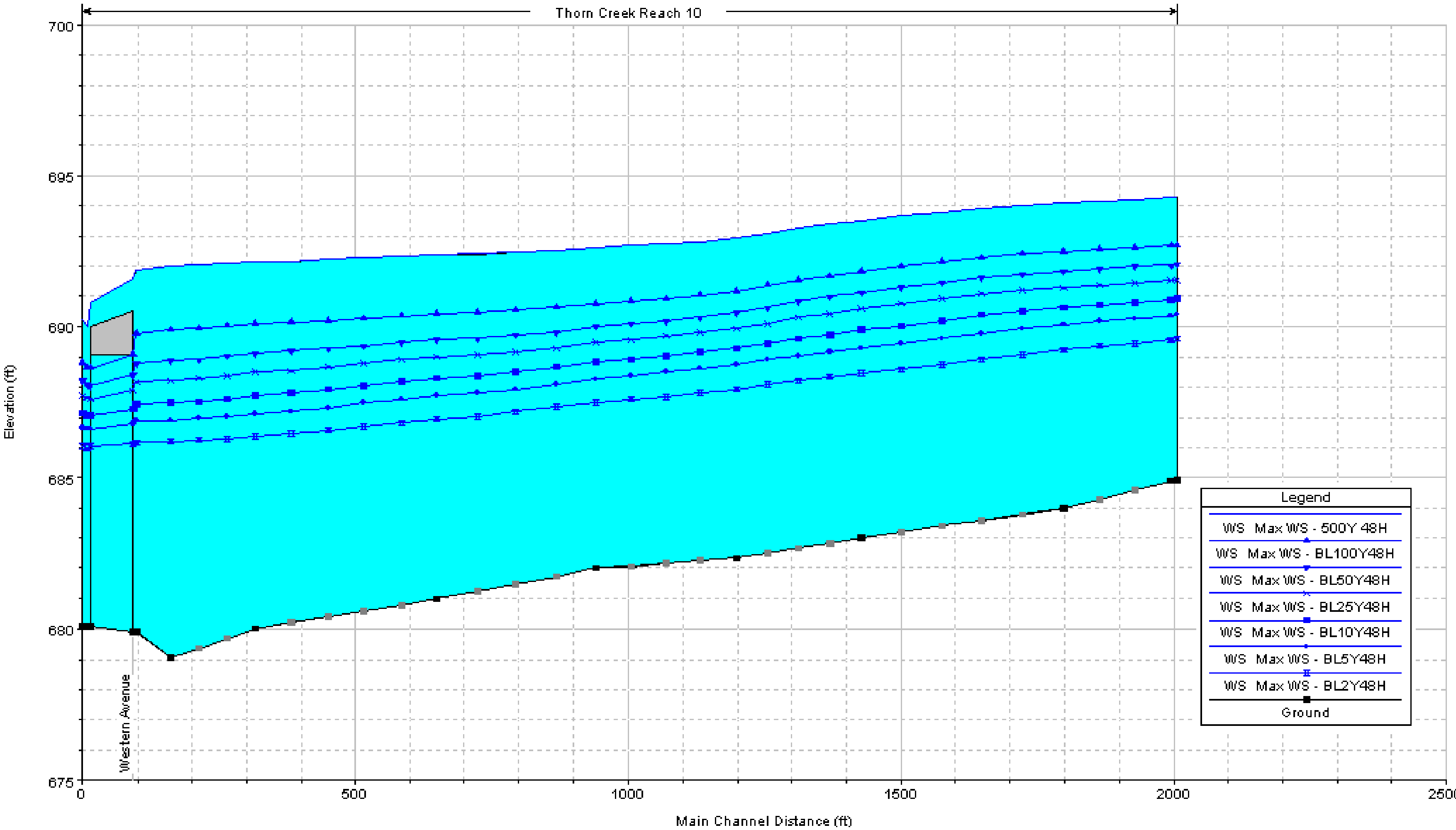
Thorn Creek, Reach 8

Sauk Trail Lake (at 26th Street) to confluence with Thorn Creek Tributary D (at Beacon Boulevard)



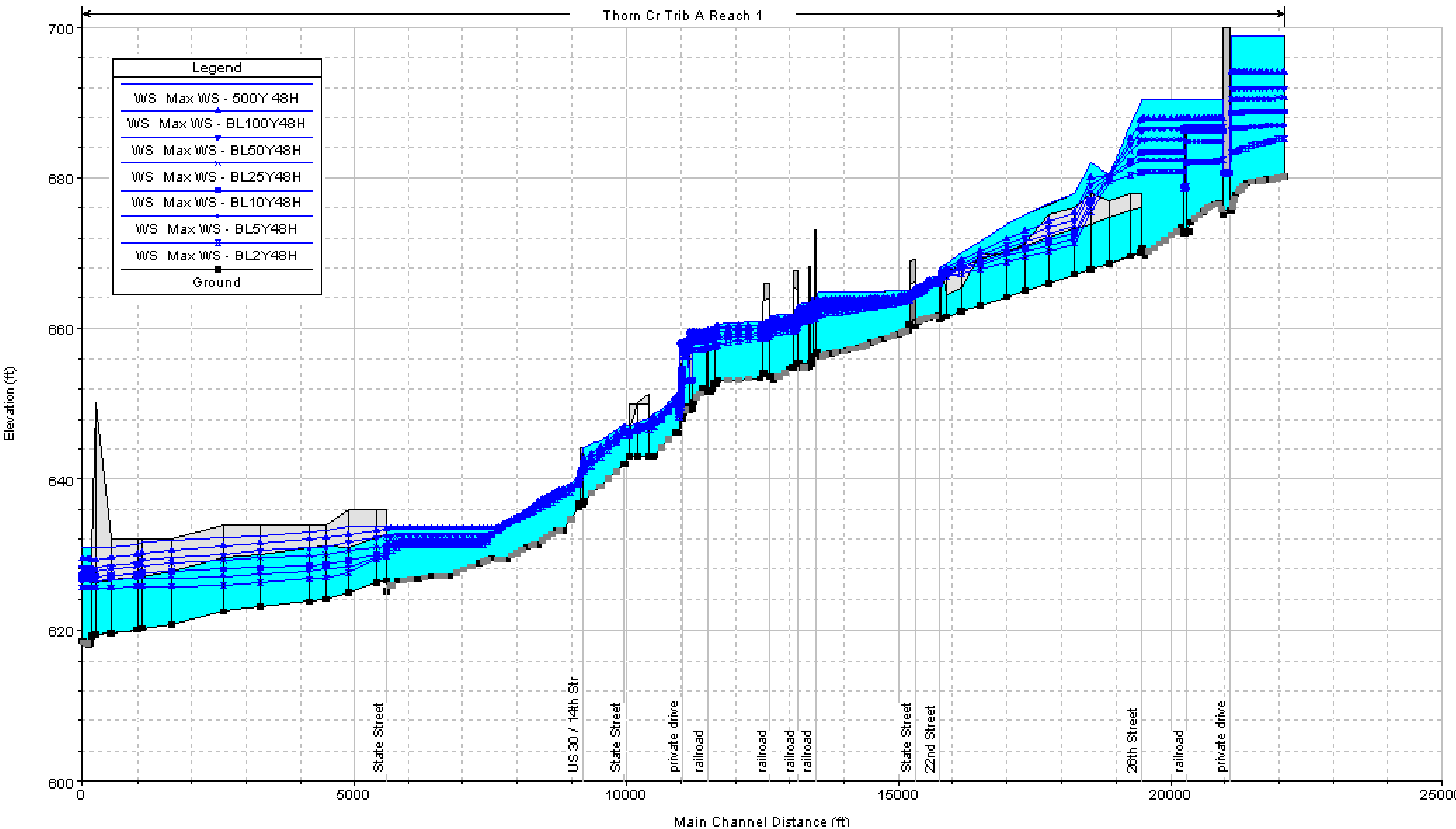
Thorn Creek, Reach 9

Thorn Creek Tributary E (at Western Avenue) to Sauk Trail Lake



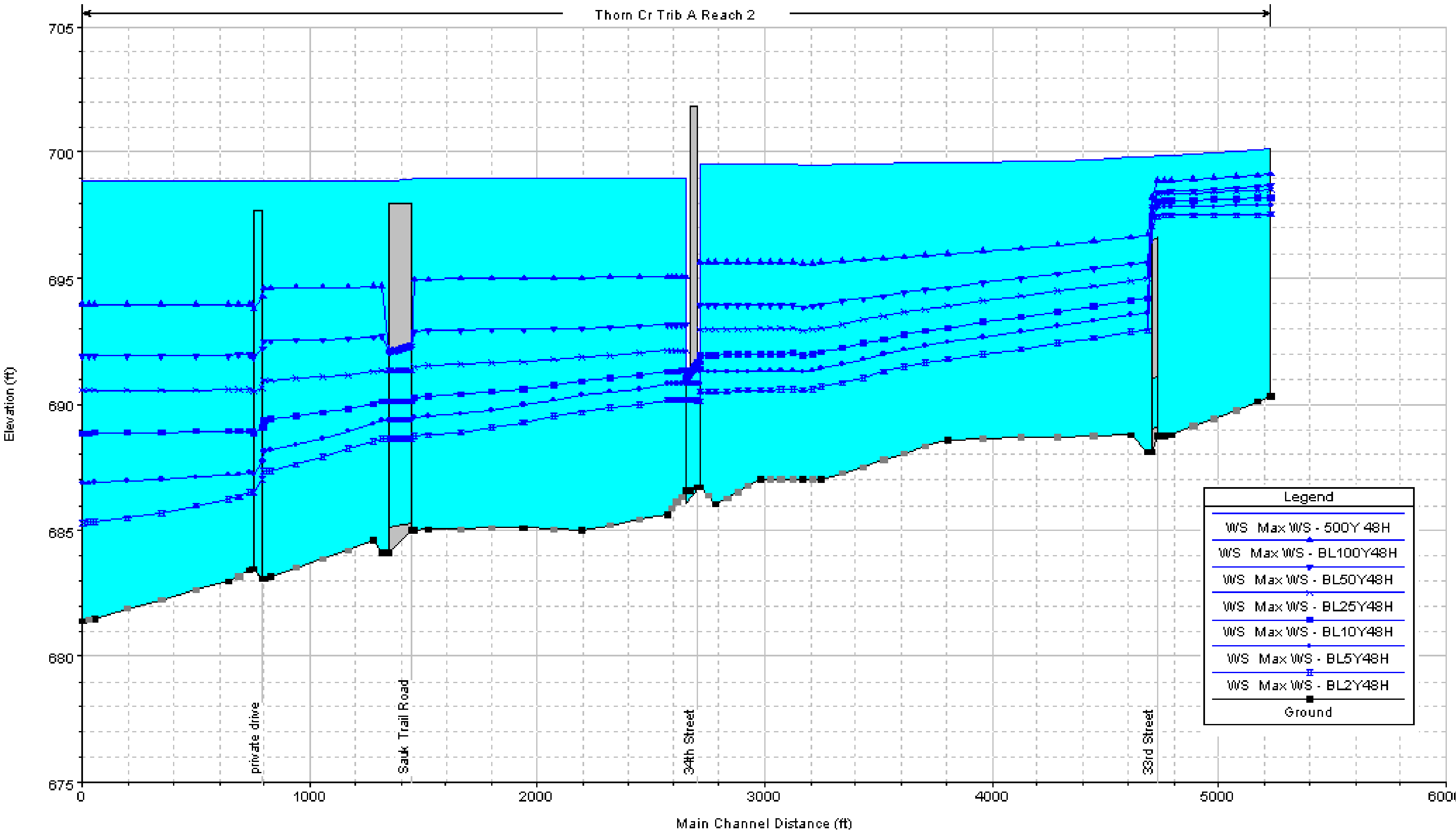
Thorn Creek, Reach 10

Will County Line to confluence with Thorn Creek Tributary E (at Western Avenue)



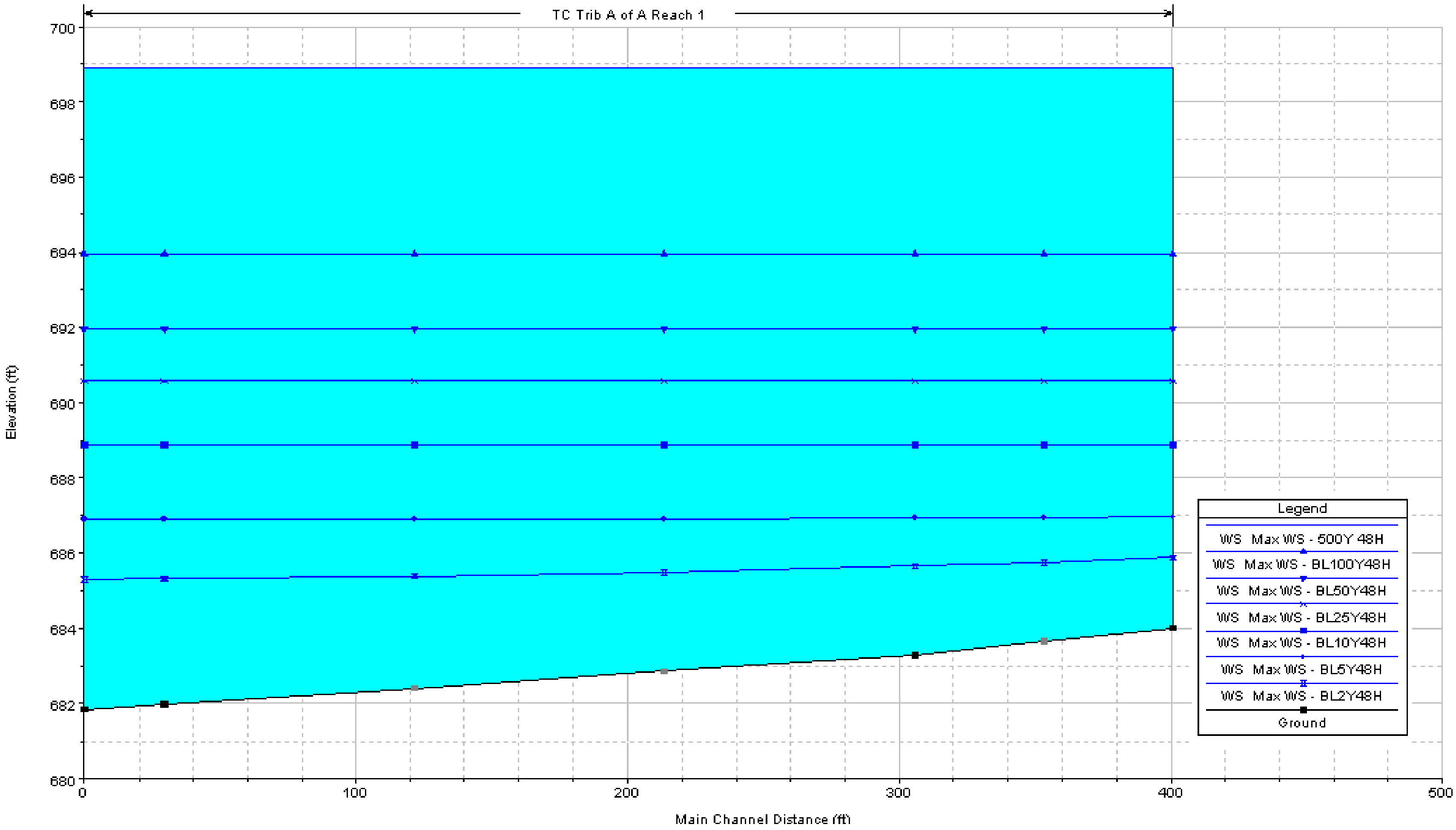
Thorn Creek Tributary A , Reach 1

Thorn Creek Tributary A of A (1400' north of Sauk Trail Road) to confluence with Thorn Creek (north of Joe Orr Road)



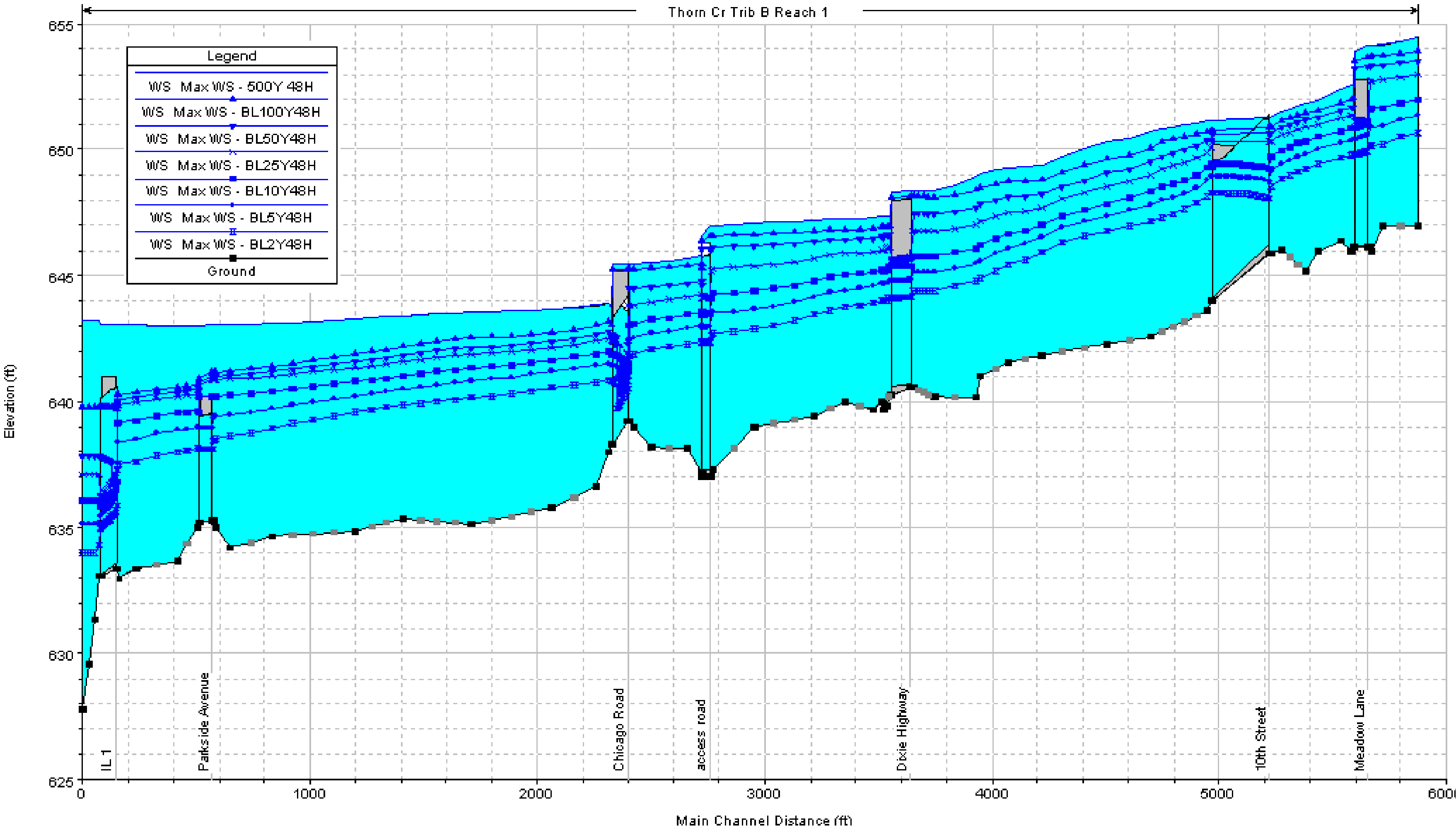
Thorn Creek Tributary A, Reach 2

33rd Street to confluence with Thorn Creek Tributary A of A



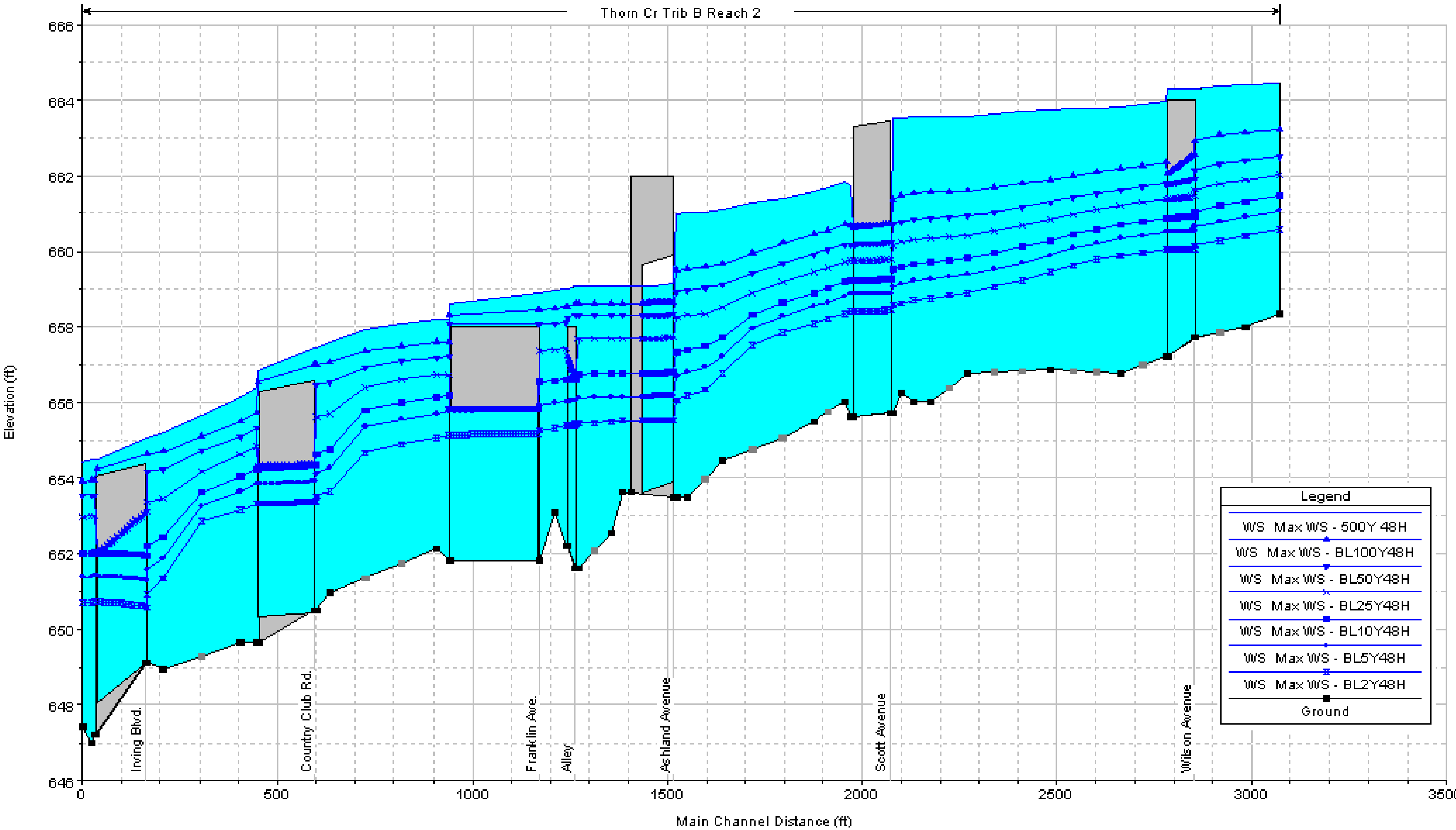
Thorn Creek Tributary A of A

End Avenue to confluence with Thorn Creek Tributary A



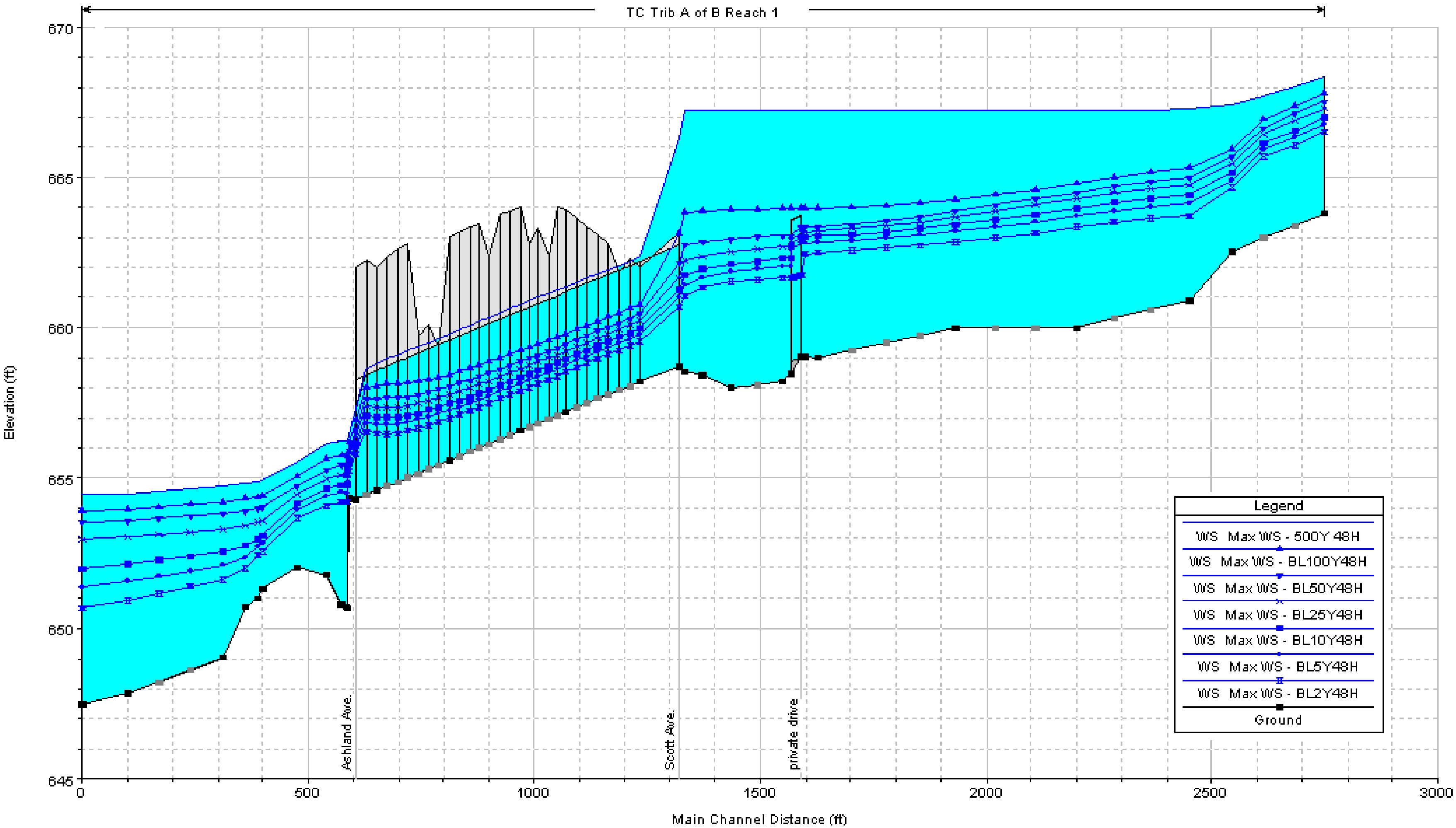
Thorn Creek Tributary B, Reach 1

Thorn Creek Tributary A of B (at Irving Blvd. & Franklin Ave.) to confluence with Thorn Creek (south of IL 1)



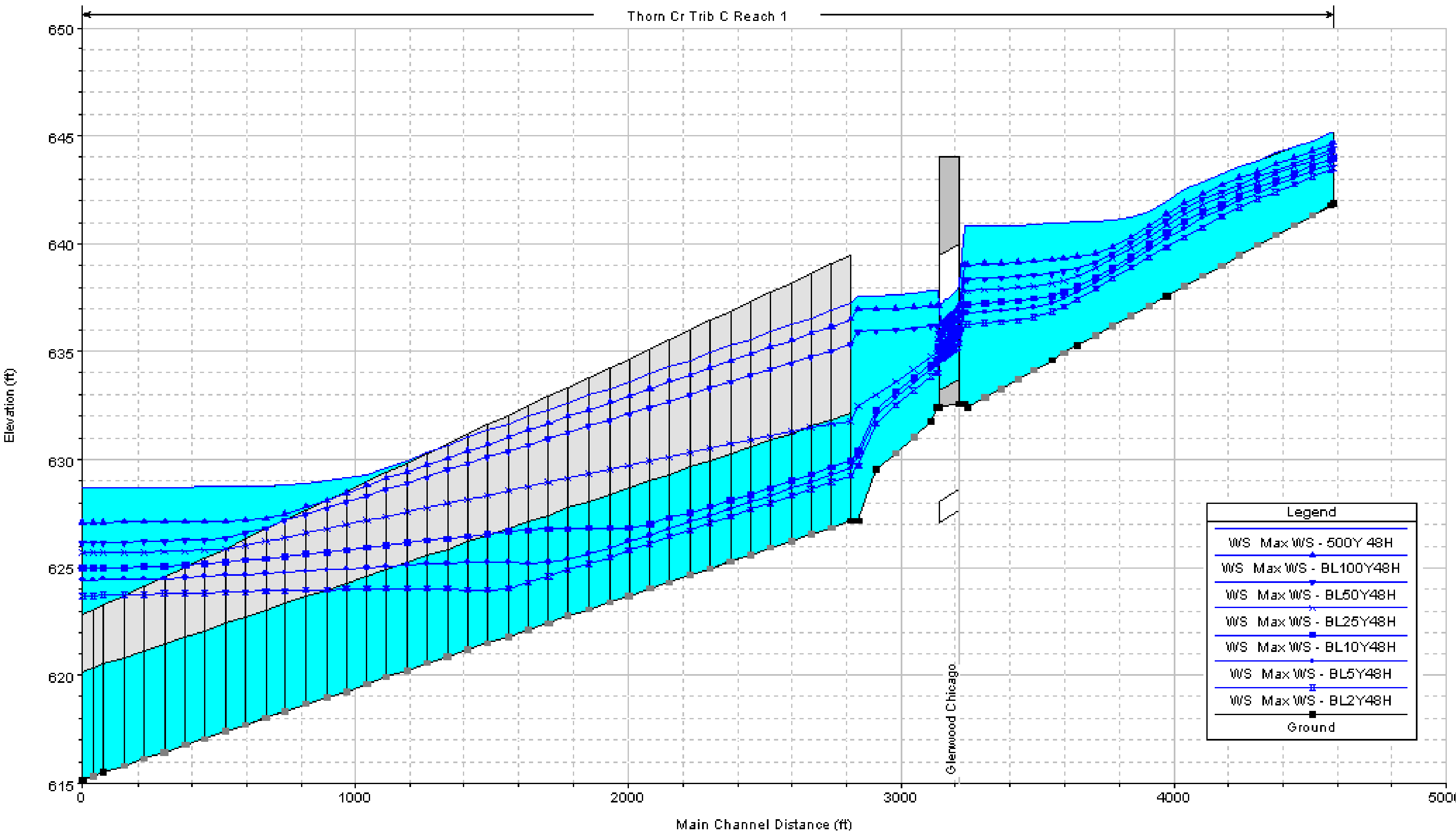
Thorn Creek Tributary B, Reach 2

US 30 and Wilson Ave. to confluence with Thorn Creek Tributary A of B (at Irving Blvd. & Franklin Ave.)



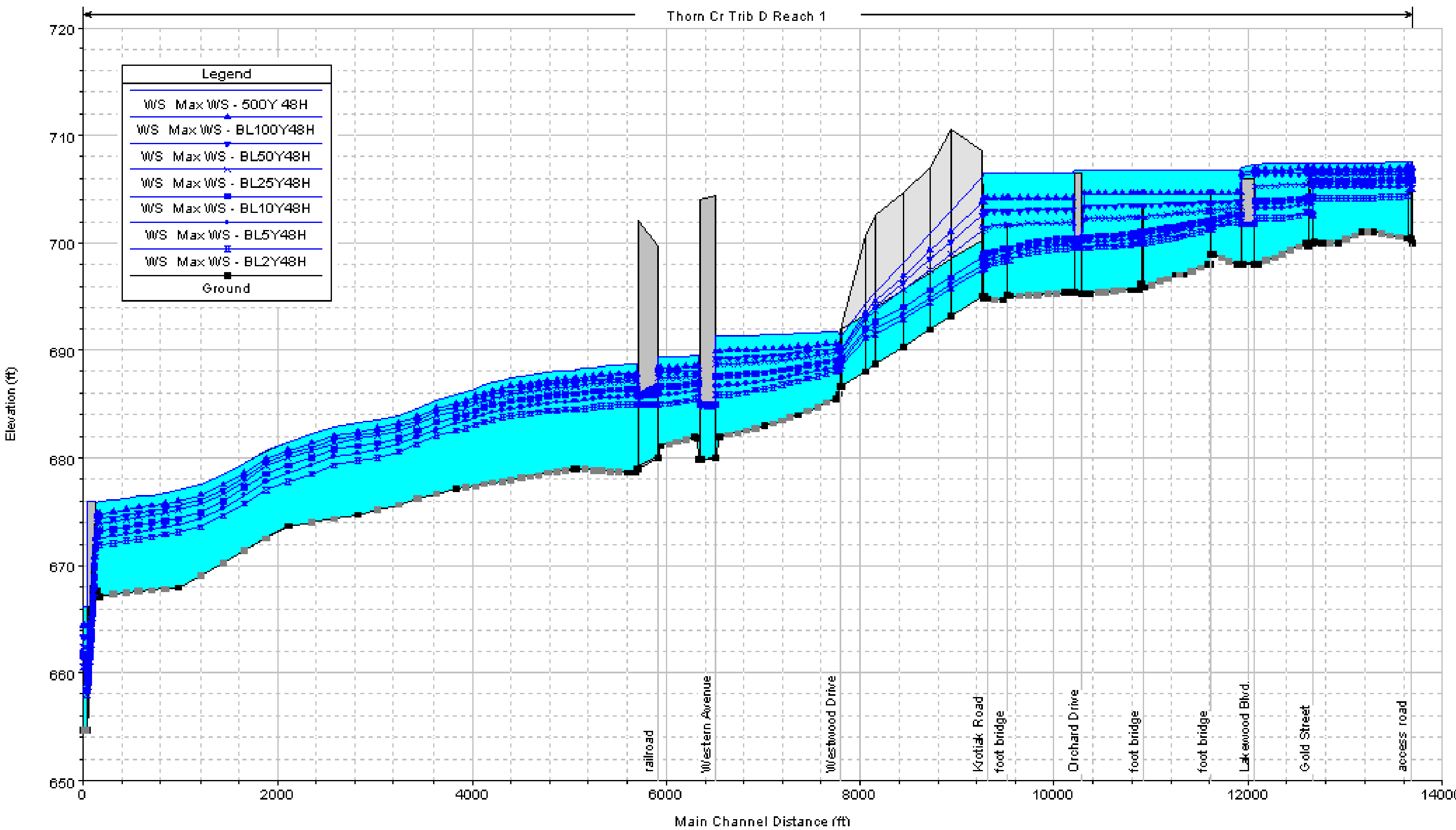
Thorn Creek Tributary A of B

10th St. and Damico Drive to confluence with Thorn Creek Tributary B (at Irving Blvd. & Franklin Ave.)



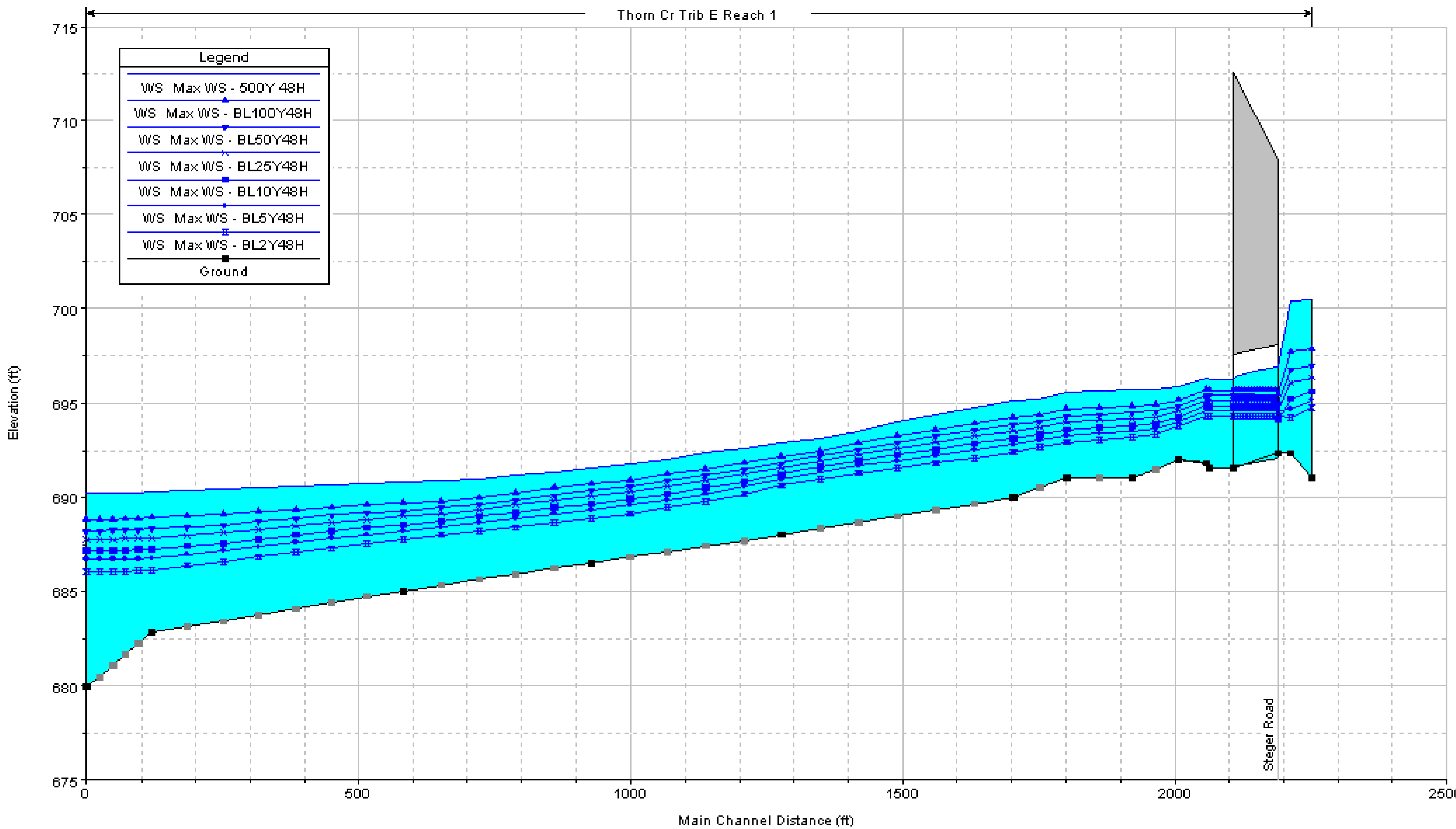
Thorn Creek Tributary C

Coolidge St. & Glengate Ave. to confluence with Thorn Creek Reach 4



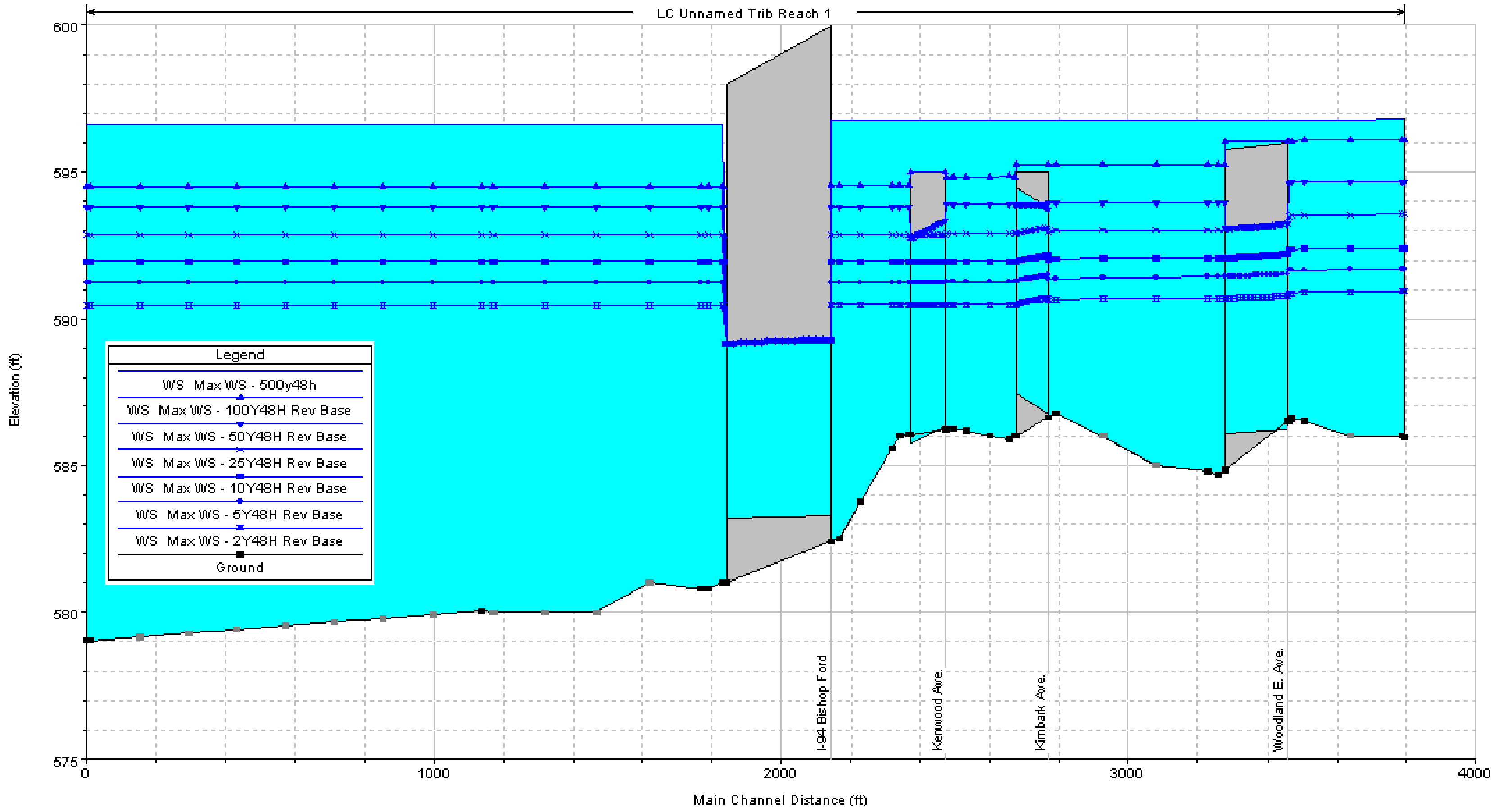
Thorn Creek Tributary D

Rich East HS Pond to confluence with Thorn Creek Reach 8 (at Campbell Ave. & Beacon Blvd.)



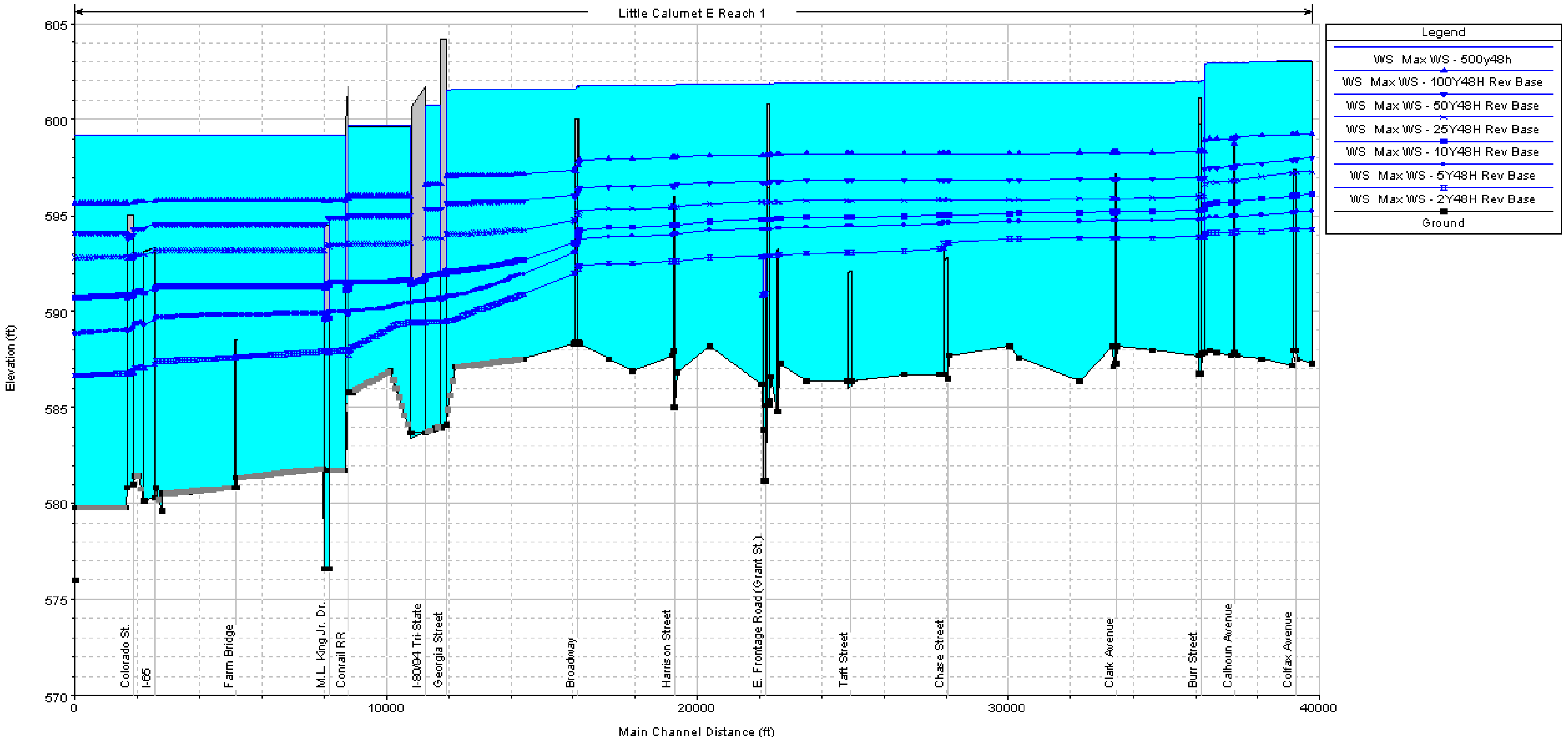
Thorn Creek Tributary E

34th St. (at Steger Road) to confluence with Thorn Creek Reach 10 (at Western Ave.)



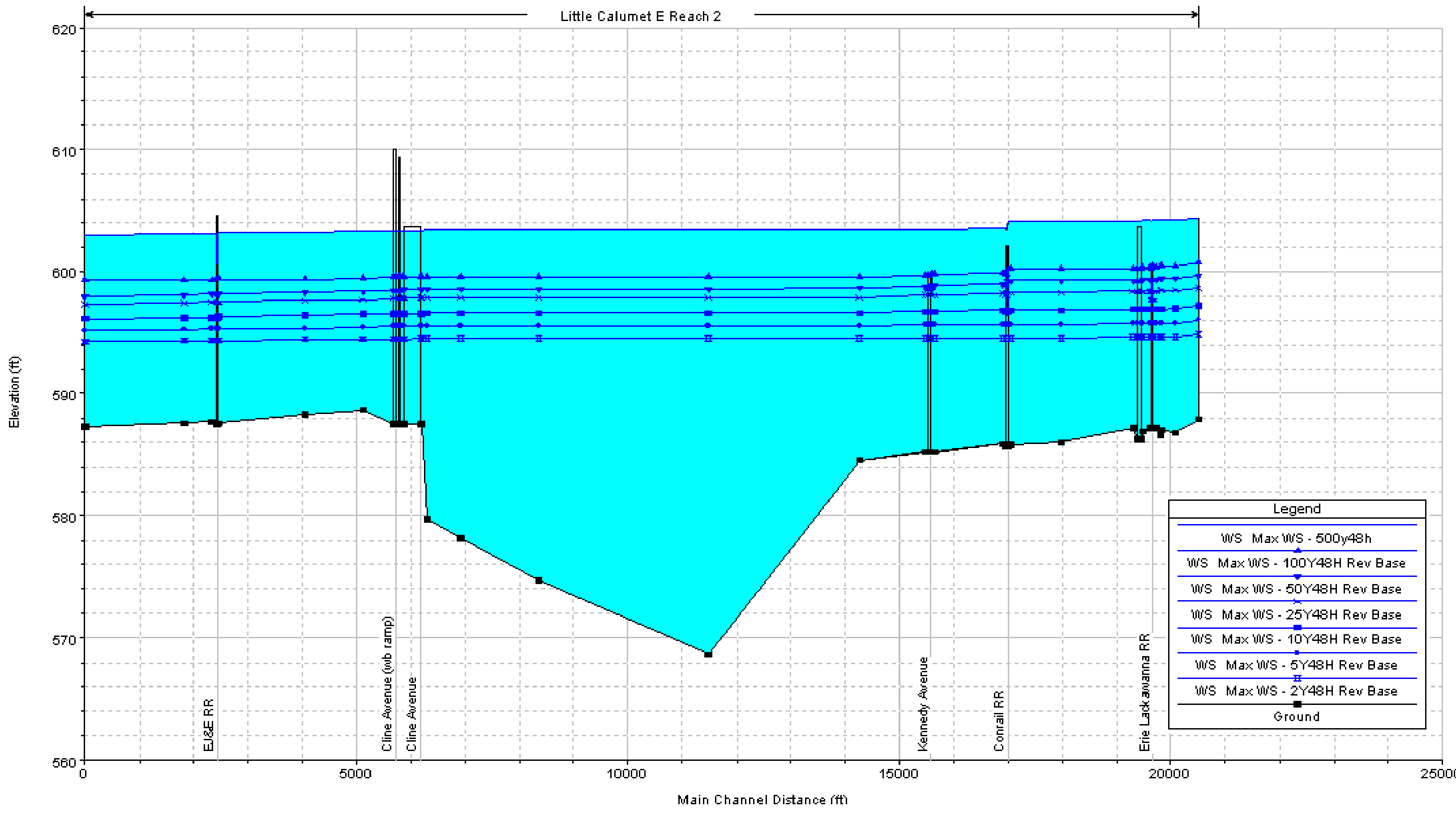
Unnamed Tributary to Little Calumet River

165th and Cottage Grove Ave. to confluence with Little Calumet River



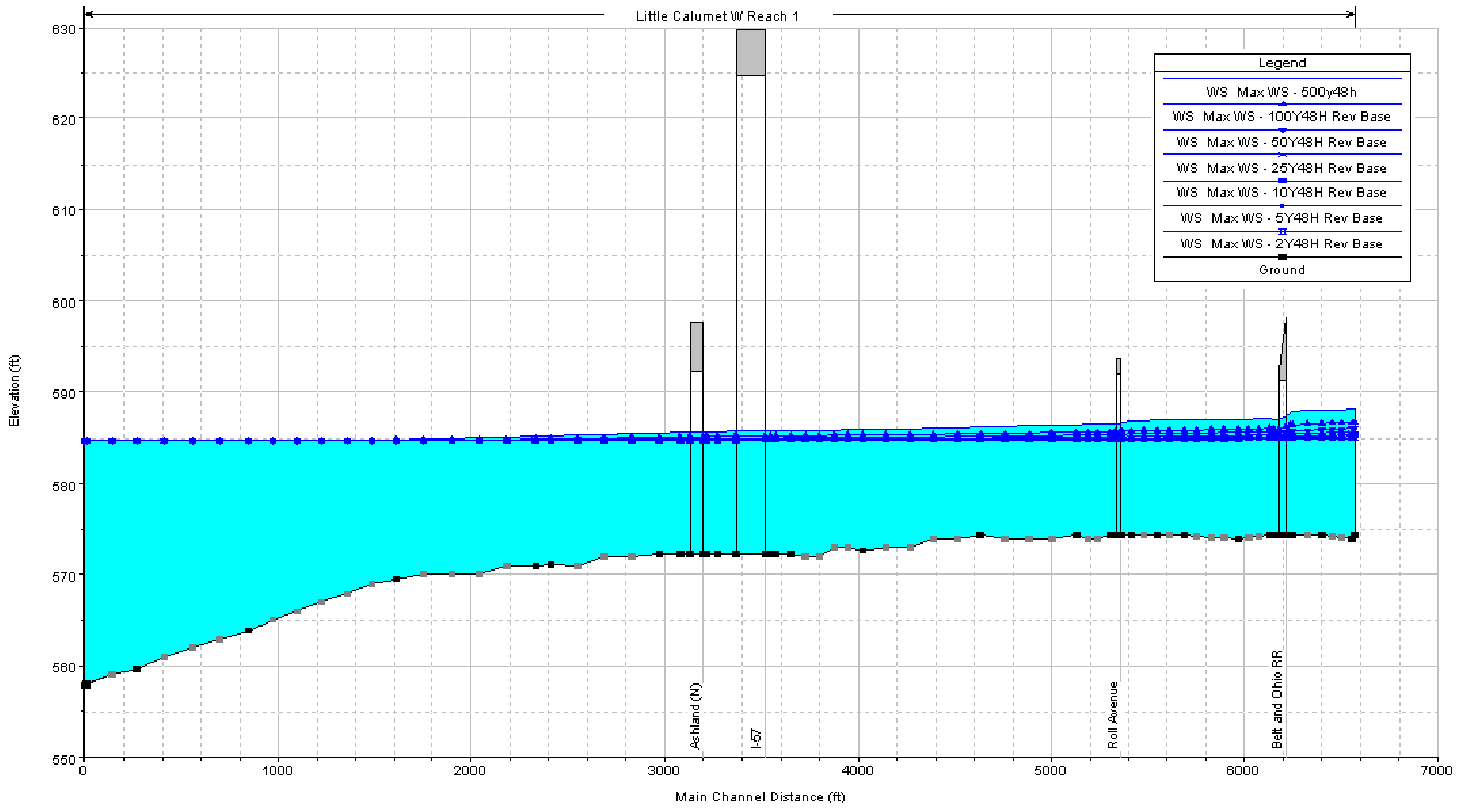
Little Calumet River East, Reach 1

Arborgast Diversion to confluence of Deep River & Burns Ditch



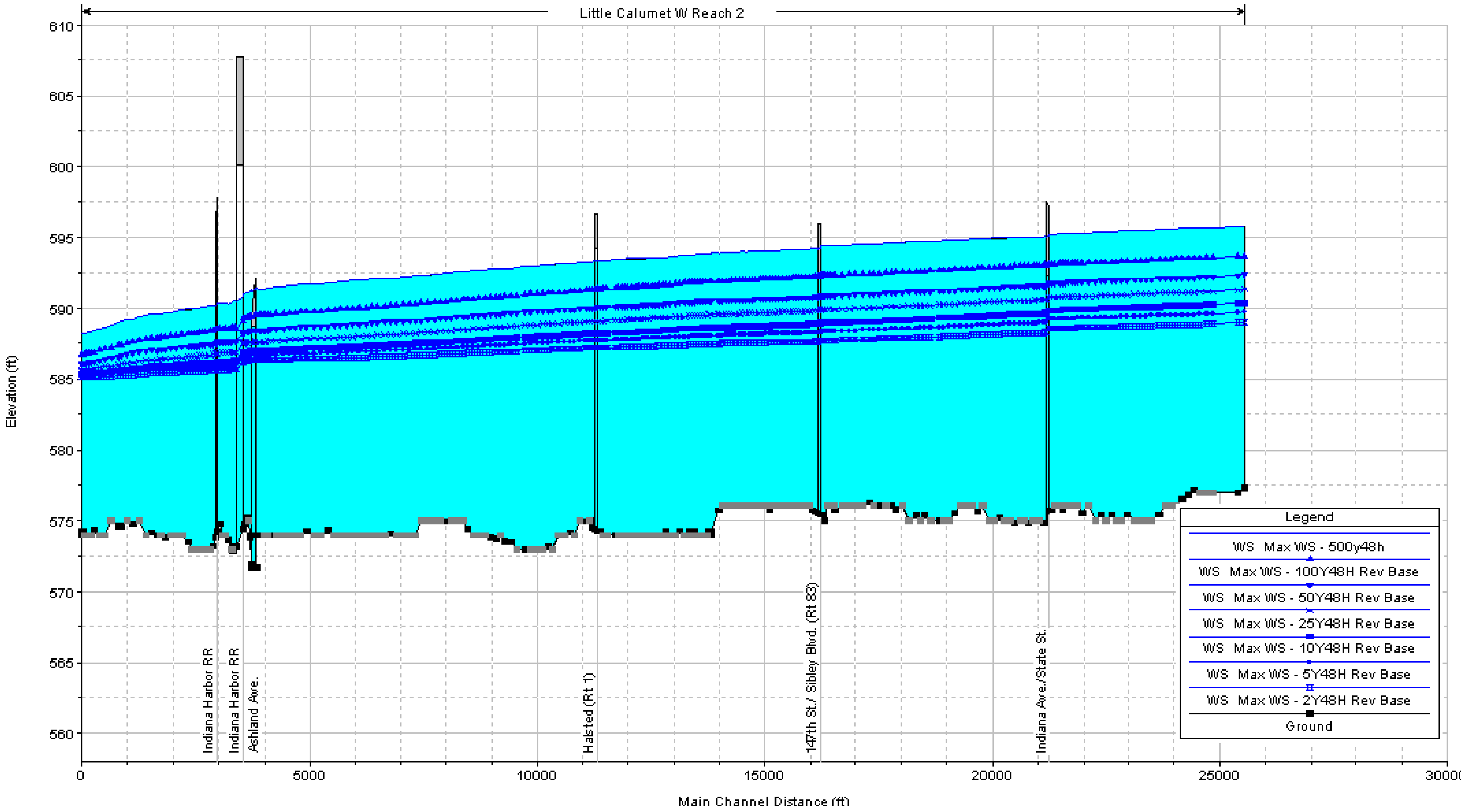
Little Calumet River East, Reach 2

Confluence of Little Calumet River West and Plum Creek to Arborgast Diversion



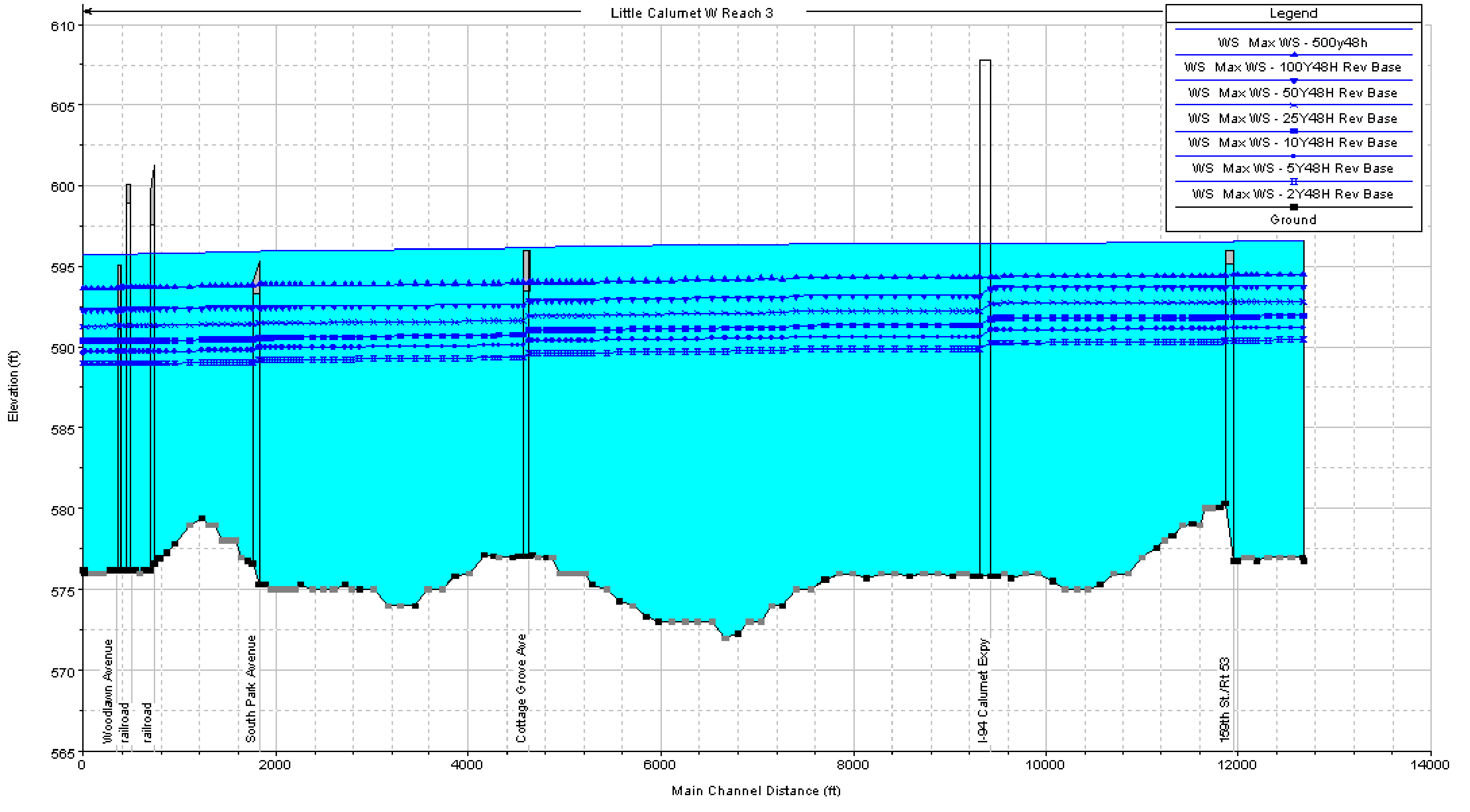
Little Calumet River West, Reach 1

Midlothian Creek to confluence with Calumet-Sag Channel



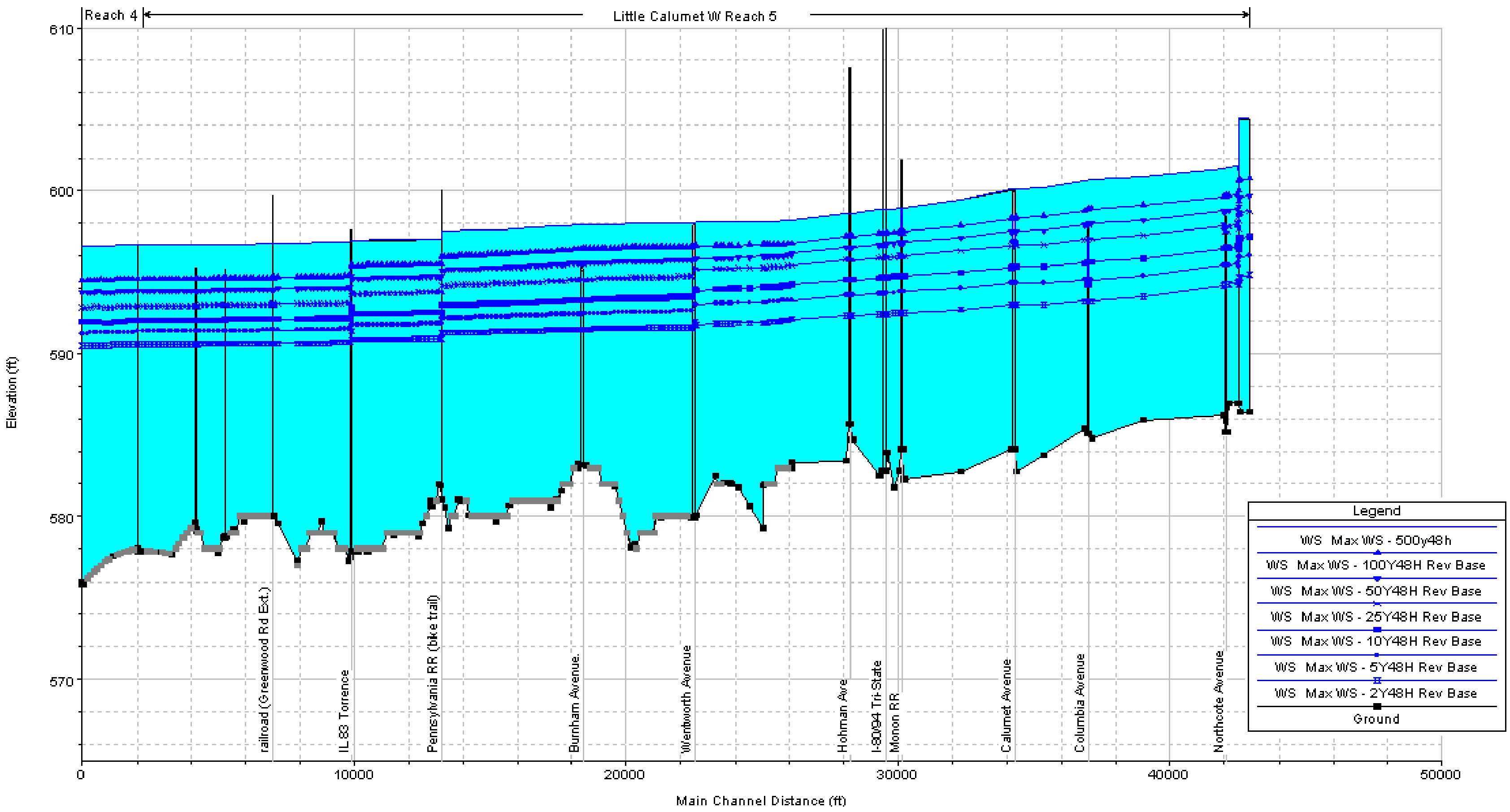
Little Calumet River West, Reach 2

Calumet Union Drainage Ditch to confluence with Midlothian Creek



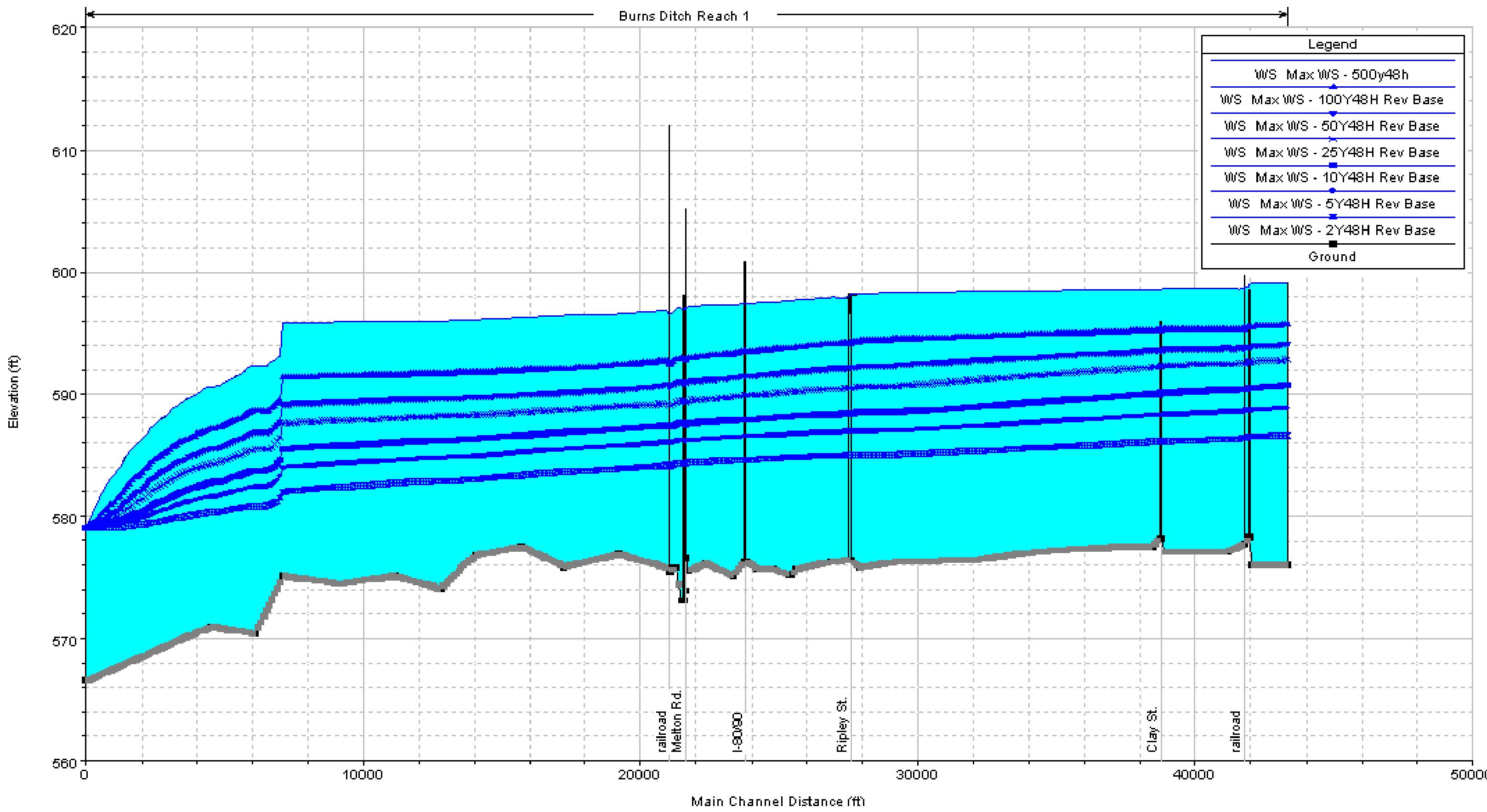
Little Calumet River West, Reach 3

Little Calumet Unnamed Trib. (900 ft south of US 6) to confluence with Calumet Union Drainage Ditch



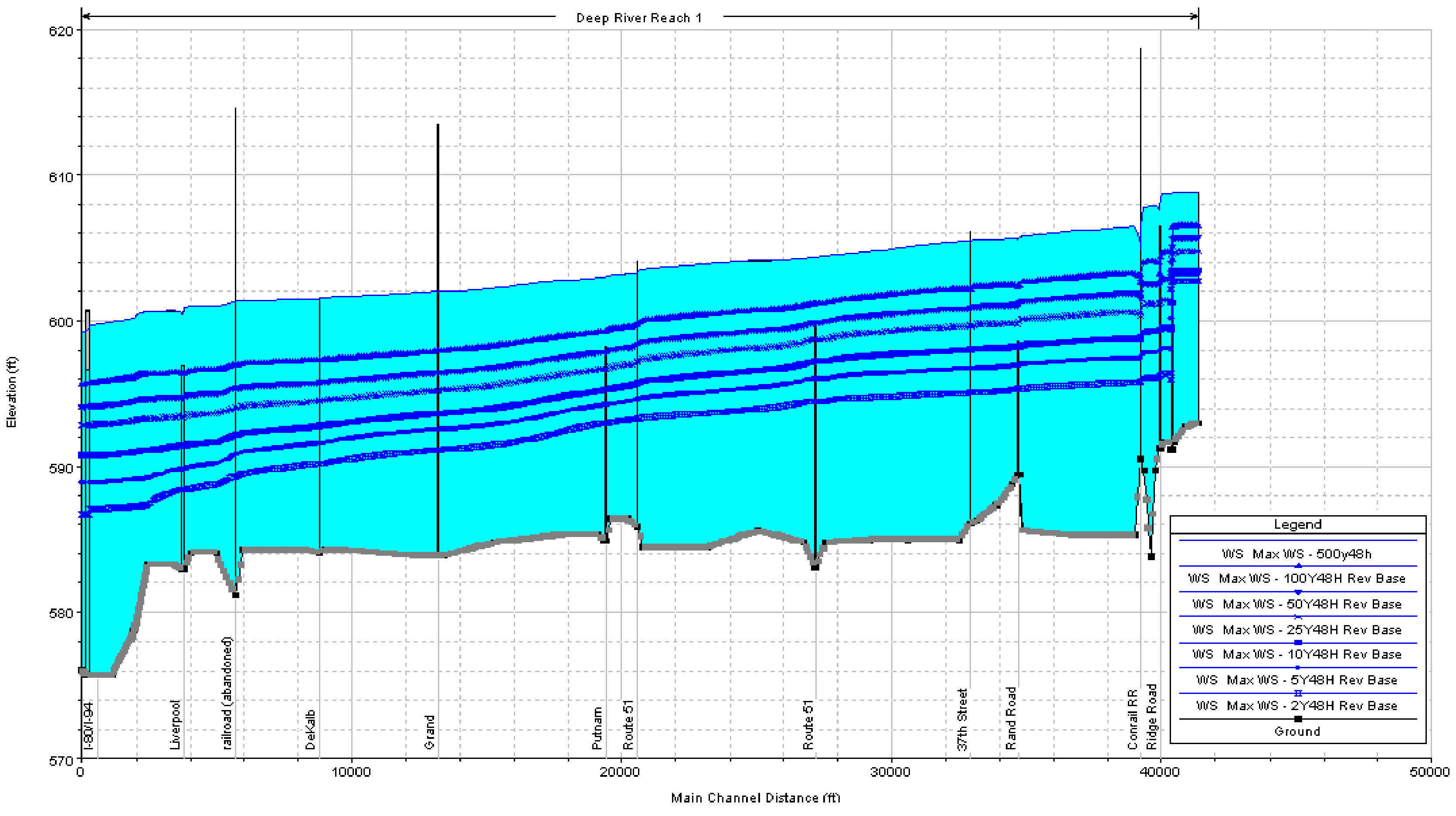
Little Calumet River West, Reaches 4 & 5

Confluence of Little Calumet River East and Plum Creek to confluence with Little Calumet River Unnamed Tributary (900 ft south of US 6)



Burns Ditch

Confluence of Little Calumet River East and Deep River to Lake Michigan



Deep River, Reach 1

Upstream of Ridge Road to confluence with Burns Ditch

Metropolitan Water Reclamation District of Greater Chicago
Little Calumet River Watershed Detailed Watershed Plan
Total Conceptual Cost Report

Alternative Name	BCEB-G1
Problem Description	Overbank Flooding
Strategy	Replace Sauk Trail culvert, construct 130 ac-ft detention facility and a levee along Governor's Highway
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Demolition: Brick, concrete, or stone construction	ft2	8275	$4	$35,334	$0	$0	Remove existing culvert at Sauk and Bike Trail
Pipe under pavement (city): 72 to 84 inches / box culvert (28 to 38 ft2)	lf	114	$425	$48,452	$45,060	$0	Install new culvert at Bike Trail
Pipe under pavement (city): 36 inches or less	lf	4	$304	$1,217	$1,132	$0	Install new culvert at Maple Ave.
Inlet structures (Headwall): 42 to 66 inches	each	16	$4,758	$75,882	$70,569	$0	Install new culverts at Sauk Trail, Bike Trail, and Maple Ave. and Storage spillway/Outlet Structure
Inlet structures (Headwall): 36 inches or less	each	1	$2,600	$2,600	$2,418	$0	Install new culverts at Sauk Trail, Bike Trail, and Maple Ave. and Storage spillway/Outlet Structure
Outlet structures (Headwall): 42 to 66 inches	each	16	$4,758	$75,882	$70,569	$0	Install new culverts at Sauk Trail, Bike Trail, and Maple Ave. and Storage spillway/Outlet Structure
Outlet structures (Headwall): 36 inches or less	each	1	$2,600	$2,600	$2,418	$0	Install new culverts at Sauk Trail, Bike Trail, and Maple Ave. and Storage spillway/Outlet Structure
Outlet structures (Headwall): 42 to 66 inches	each	4	$4,758	$19,982	$18,582	$0	Install new culverts at Sauk Trail, Bike Trail, and Maple Ave. and Storage spillway/Outlet Structure
Inlet structures (Headwall): 42 to 66 inches	each	4	$4,758	$19,982	$18,582	$0	Install new culverts at Sauk Trail, Bike Trail, and Maple Ave. and Storage spillway/Outlet Structure
Pipe in earth (city): 36 inches or less	lf	75	$217	$16,259	$15,120	$0	Storage spillway/Outlet Structure
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	120	$5	$600	$558	$144	Install new culverts at Sauk Trail, Bike Trail, and Maple Ave. and Storage spillway/Outlet Structure
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	250	$148	$37,118	$34,519	$0	Install new culverts at Sauk Trail, Bike Trail, and Maple Ave. and Storage spillway/Outlet Structure
Channel treatment: Excavation	yd3	222945	$11	$2,381,053	$0	$0	Remove existing culverts at Sauk and Bike Trail and Maple Ave. Channel Improvements/Earthen Embankments, and Levee Excavations

Alternative Name	BCEB-G1
Problem Description	Overbank Flooding
Strategy	Replace Sauk Trail culvert, construct 130 ac-ft detention facility and a levee along Governor's Highway
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Compaction	yd3	215605	$7	$1,612,725	$0	$0	Remove existing and install new culverts at Sauk and Bike Trail and Maple Ave. Channel Improvements/Earthen Embankments, and Levee Excavations
Channel treatment: Soil stabilization and vegetative cover	yd2	21080	$14	$292,590	$272,105	$70,062	Install new culverts at Sauk Trail, Bike Trail, and Maple Ave.
Pipe under pavement (city): Box culvert (51 to 60 ft2)	lf	1315	$661	$869,254	$808,393	$0	Install new culvert at Bike Trail
Concrete: Cast in place	yd3	130	$250	$32,500	$0	$0	Storage spillway/Outlet Structure
Pump Station: 10ac-ft per day interior drainage	each	2	$800,000	$1,688,000	$1,569,814	$0	Storage Spillway/Outlet Structure
Pump Station: 10ac-ft per day interior drainage	each	5	$800,000	$3,760,000	$3,496,742	$0	Levee Construction
Demolition: Metal construction	ft2	488	$2	$1,044	$0	$0	Remove existing culvert at Maple Ave.
Channel treatment: Reinforced one sided concrete wall	yd3	250	$587	$146,838	$136,557	$35,161	Levee Construction
Land Acquisition: Permanent Easement *	dollar	123240	$1	$123,240	$0	$0	Land Acquisition
Land Acquisition: Temporary Easement *	dollar	37305	$1	$37,305	$0	$0	Land Acquisition
Buyout: Property *	dollar	178779	$1	$178,779	$0	$0	Land Acquisition
Embankment construction, grading and restoration: Material hauled from offsite	yd3	183575	$11	$1,960,581	$0	$0	Remove existing culverts at Sauk and Bike Trail and Maple Ave. Channel Improvements/Earthen Embankments, and Levee Excavations

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$13,080,494**	**$6,563,140**	**$105,367**
Utility Relocation	4 %	$523,220		
Mobilization \ General Conditions	5%	$654,025		
Subtotal with Percent Allowances		**$14,257,738**		
Contingency	30%	$4,277,321		
Profit	5%	$926,753		
Probable Construction Cost Estimate		**$19,461,812**		
Design Engineering, Geotechnical, and Construction Management	10%	$1,946,181		
Property Acquisition Cost:		$339,324		
Total Conceptual Cost Estimate (2008 Dollars)		**$28,415,825**		

Metropolitan Water Reclamation District of Greater Chicago
Little Calumet River Watershed Detailed Watershed Plan
Total Conceptual Cost Report

Alternative Name BTCR-G1

Problem Description Overbank Flooding

Strategy Replace 206th St. culvert and construct new 65 ac-ft detention facility

District Minimum Criteria for Funding: Met

Recommended Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	105720	$11	$1,129,090	$0	$0	Remove existing culvert, storage excavation
Channel treatment: Compaction	yd3	105680	$7	$790,486	$0	$0	Storage construction, Remove existing and install new culvert
Embankment construction, grading and restoration: Material hauled from offsite	yd3	98080	$11	$1,047,494	$0	$0	Remove existing and install new culvert, Storage excavation
Demolition: Brick, concrete, or stone construction	ft2	684	$4	$2,921	$0	$0	Remove existing culvert
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	171	$609	$104,088	$96,800	$0	Install new culvert
Inlet structures (Headwall): 42 to 66 inches	each	5	$4,758	$21,409	$19,910	$0	Install new culvert
Inlet structures (Headwall): 36 inches or less	each	1	$2,600	$2,600	$2,418	$0	Storage Spillway/Outlet Structure
Outlet structures (Headwall): 42 to 66 inches	each	5	$4,758	$21,409	$19,910	$0	Install new culvert
Outlet structures (Headwall): 36 inches or less	each	1	$2,600	$2,600	$2,418	$0	Storage Spillway/Outlet Structure
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	40	$5	$200	$186	$48	Install new culvert
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	30	$148	$4,454	$4,142	$0	Install new culvert
Concrete: Cast in place	yd3	250	$250	$62,500	$0	$0	Storage Spillway/Outlet Structure
Pipe in earth (city): 36 inches or less	lf	125	$217	$27,098	$25,200	$0	Storage Spillway/Outlet Structure
Floodproofing: Residence	each	3	$21,358	$64,074	$59,588	$24,707	Floodproofing
Land Acquisition: Temporary Easement *	dollar	15000	$1	$15,000	$0	$0	Land Acquistion
Land Acquisition: Purchase of Property *	dollar	200000	$1	$200,000	$0	$0	Land Acquistion
Channel treatment: Soil stabilization and vegetative cover	yd2	160	$14	$2,221	$2,065	$532	Install new culvert
Channel treatment: Soil stabilization and vegetative cover	yd2	10500	$14	$145,740	$135,536	$34,898	Storage excavation
Pump Station: 10ac-ft per day interior drainage	each	1	$800,000	$848,000	$788,627	$0	Storage Spillway/Outlet Structure

Alternative Name	BTCR-G1
Problem Description	Overbank Flooding
Strategy	Replace 206th St. culvert and construct new 65 ac-ft detention facility
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)							
Subtotal (direct costs)				**$4,276,383**	**$1,156,801**	**$60,185**	
Utility Relocation			4 %	$171,055			
Mobilization \ General Conditions			5%	$213,819			
Subtotal with Percent Allowances				**$4,661,258**			
Contingency			30%	$1,398,377			
Profit			5%	$302,982			
Probable Construction Cost Estimate				**$6,362,617**			
Design Engineering, Geotechnical, and Construction Management			10%	$636,262			
Property Acquisition Cost:				$215,000			
Total Conceptual Cost Estimate (2008 Dollars)				**$8,430,865**			

Metropolitan Water Reclamation District of Greater Chicago
Little Calumet River Watershed Detailed Watershed Plan
Total Conceptual Cost Report

Alternative Name BTCR-G2

Problem Description Overbank Flooding

Strategy Construct a 700 LF levee along Greenwood Drive

District Minimum Criteria for Funding: Met

Recommended Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Embankment construction, grading and restoration: Additional fill	yd3	6575	$14	$91,261	$0	$0	Construct embankment
Channel treatment: Compaction	yd3	910	$7	$6,807	$0	$0	Construct embankment
Channel treatment: Soil stabilization and vegetative cover	yd2	2725	$14	$37,823	$35,175	$9,057	Construct embankment
Pump Station: 10ac-ft per day interior drainage	each	4	$800,000	$3,520,000	$3,273,546	$0	Construct embankment
Floodproofing: Residence	each	4	$21,358	$85,432	$79,451	$32,943	Floodproofing
Land Acquisition: Permanent Easement *	dollar	2365	$1	$2,365	$0	$0	Land Acquisition
Land Acquisition: Temporary Easement *	dollar	635	$1	$635	$0	$0	Land Acquisition

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$3,741,323**	**$3,388,171**	**$42,000**
Utility Relocation	4 %	$149,653		
Mobilization \ General Conditions	5%	$187,066		
Subtotal with Percent Allowances		**$4,078,042**		
Contingency	30%	$1,223,413		
Profit	5%	$265,073		
Probable Construction Cost Estimate		**$5,566,527**		
Design Engineering, Geotechnical, and Construction Management	10%	$556,653		
Property Acquisition Cost:		$3,000		
Total Conceptual Cost Estimate (2008 Dollars)		**$9,556,351**		

Metropolitan Water Reclamation District of Greater Chicago
Little Calumet River Watershed Detailed Watershed Plan
Total Conceptual Cost Report

Alternative Name	BTCR-G3
Problem Description	Overbank Flooding
Strategy	Channel improvements near Laurel Avenue and construct a floodwall on west bank from Cambridge Avenue
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	29375	$11	$313,725	$0	$0	Levee excavation and channel improvements
Channel treatment: Compaction	yd3	29375	$7	$219,725	$0	$0	Levee excavation and construction, channel improvements
Channel treatment: Soil stabilization and vegetative cover	yd2	6165	$14	$85,570	$79,579	$20,490	Levee construction, channel improvements
Channel treatment: Reinforced one sided concrete wall	yd3	1470	$587	$863,405	$802,953	$206,744	Levee construction
Embankment construction, grading and restoration: Material hauled from offsite	yd3	23225	$11	$248,043	$0	$0	Levee excavation and channel improvements
Pump Station: 10ac-ft per day interior drainage	each	13	$800,000	$10,080,000	$9,374,246	$0	Levee construction
Land Acquisition: Permanent Easement *	dollar	45300	$1	$45,300	$0	$0	Land acquisition
Land Acquisition: Temporary Easement *	dollar	17455	$1	$17,455	$0	$0	Land acquisition

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$11,810,468**	**$10,256,77**	**$227,234**
Utility Relocation	4 %	$472,419		
Mobilization \ General Conditions	5%	$590,523		
Subtotal with Percent Allowances		**$12,873,41**		
Contingency	30%	$3,862,023		
Profit	5%	$836,772		
Probable Construction Cost Estimate		**$17,572,20**		
Design Engineering, Geotechnical, and Construction Management	10%	$1,757,220		
Property Acquisition Cost:		$62,755		
Total Conceptual Cost Estimate (2008 Dollars)		**$29,876,191**		

Metropolitan Water Reclamation District of Greater Chicago
Little Calumet River Watershed Detailed Watershed Plan
Total Conceptual Cost Report

Alternative Name	BLCR-G1
Problem Description	Overbank Flooding
Strategy	Construct a levee along Belaire Creek from Albany to Afton Avenue, a new 125 ac-ft storage area, and
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	201667	$11	$2,153,804	$0	$0	Removal of excavated materials for detention pond
Channel treatment: Material to be hauled offsite	yd3	201667	$12	$2,369,587	$0	$0	Removal of excavated materials for detention pond
Channel treatment: Additional fill	yd3	16556	$14	$229,797	$0	$0	Material needed for clay liner
Embankment construction, grading and restoration: Additional fill	yd3	4237	$14	$58,810	$0	$0	Fill Required to build earthen levee
Embankment construction, grading and restoration: Compaction of fill	yd3	4237	$5	$22,626	$0	$0	Compaction of soil of new levee
Concrete: Cast in place	yd3	47	$250	$11,750	$0	$0	Concrete Spillway
Pipe in earth (city): 72 to 84 inches / box culvert (28 to 38 ft2)	lf	1400	$303	$424,592	$394,864	$0	Installation of (2) new diversion culverts to the new pond
Channel treatment: Vegetative cover only	yd2	4889	$9	$41,752	$38,829	$9,998	Vegetative cover of excavated areas
Pump Station: 10ac-ft per day interior drainage	each	2	$800,000	$1,624,000	$1,510,295	$0	Assume a cost of $13,000 per ac-ft of storage volume
Channel treatment: Vegetative cover only	yd2	16326	$9	$139,424	$129,662	$33,385	Vegetative cover of excavated basin areas
Pump Station: 10ac-ft per day interior drainage	each	0	$800,000	$48,000	$44,639	$0	
Land Acquisition: Purchase of Property *	dollar	20303	$1	$20,303	$0	$0	Purchase of two plots of land

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$7,124,141**	**$2,118,289**	**$43,383**
Utility Relocation	4 %	$284,966		
Mobilization \ General Conditions	5%	$356,207		
Subtotal with Percent Allowances		**$7,765,314**		
Contingency	30%	$2,329,594		
Profit	5%	$504,745		
Probable Construction Cost Estimate		**$10,599,65**		
Design Engineering, Geotechnical, and Construction Management	10%	$1,059,965		
Property Acquisition Cost:		$20,303		
Total Conceptual Cost Estimate (2008 Dollars)		**$13,841,595**		

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Alternative Name CHEB-G1

Problem Description Overbank Flooding

Strategy Replace Governors Highway and 175th St. crossings, channel improvements from Ravisole Country Club to

District Minimum Criteria for Funding: Met

Recommended Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	16467	$11	$175,868	$0	$0	Channel widening from RS 1960 - RS 1309
Channel treatment: Vegetative cover only	yd2	17333	$9	$148,024	$137,660	$35,445	Vegetative cover of excavated areas
Channel treatment: Material to be hauled offsite	yd3	16467	$12	$193,487	$0	$0	Hauling of excess soil from excavation activities
Embankment construction, grading and restoration: Compaction of fill	yd3	16847	$5	$89,963	$0	$0	Compaction of soil of newly graded channel and engineered fill above new culverts
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	198	$148	$29,397	$27,339	$0	New roadway of span section above CU-18 and CU-19
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	600	$609	$365,220	$339,649	$0	Installation of (6) box culverts replacing CU-18
Pipe under pavement (city): Box culvert (51 to 60 ft2)	lf	660	$661	$436,280	$405,734	$0	Installation of (6) box culverts replacing CU-19

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$1,438,238**	**$910,381**	**$35,445**
Utility Relocation	4 %	$57,530		
Mobilization \ General Conditions	5%	$71,912		
Subtotal with Percent Allowances		**$1,567,680**		
Contingency	30%	$470,304		
Profit	5%	$101,899		
Probable Construction Cost Estimate		**$2,139,883**		
Design Engineering, Geotechnical, and Construction Management	10%	$213,988		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate (2008 Dollars)		**$3,299,698**		

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Alternative Name CHEB-G3
Problem Description Overbank Flooding
Strategy Replace Governors Highway, Braemer Road, and channel improvements
District Minimum Criteria for Funding: Met
Recommended Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	5945	$11	$63,493	$0	$0	Channel widening from RS 10333.71 - RS 11272.35
Channel treatment: Vegetative cover only	yd2	5736	$9	$48,985	$45,556	$11,730	Vegetative cover of excavated areas
Channel treatment: Material to be hauled offsite	yd3	5945	$12	$69,854	$0	$0	Hauling of excess soil from excavation activities
Embankment construction, grading and restoration: Compaction of fill	yd3	594	$5	$3,172	$0	$0	Compaction of soil of newly graded channel
Embankment construction, grading and restoration: Compaction of fill	yd3	700	$5	$3,738	$0	$0	Compaction of engineered fill above new culverts
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	132	$148	$19,598	$18,226	$0	New roadway of span section above CU-27
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	390	$609	$237,393	$220,772	$0	Installation of (6) box culverts replacing CU-27
Embankment construction, grading and restoration: Compaction of fill	yd3	500	$5	$2,670	$0	$0	Compaction of engineered fill above new culverts
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	83	$148	$12,323	$11,460	$0	New roadway of span section above CU-28
Land Acquisition: Permanent Easement *	dollar	830000	$1	$830,000	$0	$0	Permanent easements for 9 homes along channel imprs.
Land Acquisition: Purchase of Property *	dollar	108000	$1	$108,000	$0	$0	Home acquisition just U/S of CU-28
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	180	$609	$109,566	$101,895	$0	Installation of (4) box culverts replacing CU-28

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

		Base Cost	Maint. Cost	Replacement Cost
Subtotal (direct costs)		**$570,792**	**$397,908**	**$11,730**
Utility Relocation	4 %	$22,832		
Mobilization \ General Conditions	5%	$28,540		
Subtotal with Percent Allowances		**$622,163**		
Contingency	30%	$186,649		
Profit	5%	$40,441		
Probable Construction Cost Estimate		**$849,253**		
Design Engineering, Geotechnical, and Construction Management	10%	$84,925		
Property Acquisition Cost:		$938,000		
Total Conceptual Cost Estimate (2008 Dollars)		**$2,281,816**		

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Alternative Name	CUDD-G1A
Problem Description	Overbank Flooding
Strategy	Expansion and improvements to Calumet Union Reservoir, and upsizing the Robey St. diversion conduit
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	443699	$11	$4,738,705	$0	$0	Excavation for path of new 12 x 7 box culvert
Channel treatment: Compaction	yd3	443115	$7	$3,314,500	$0	$0	Compaction of soil on new culvert
Channel treatment: Material to be hauled offsite	yd3	584	$12	$6,862	$0	$0	Material displaced by new culvert
Channel treatment: Vegetative cover only	yd2	66555	$9	$568,380	$528,584	$136,100	Vegetation on top of culvert
Pipe in earth (city): Box culvert (51 to 60 ft2)	lf	57377	$472	$27,082,518	$25,186,32	$0	New Diversion Culverts (2)
Inlet structures (Headwall): 42 to 66 inches	each	2	$4,758	$9,515	$8,849	$0	Two inlet structures for the diversion tunnels
Outlet structures (Headwall): 42 to 66 inches	each	2	$4,758	$9,515	$8,849	$0	Two outlet structures for the diversion tunnels

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$35,729,995**	**$25,732,60**	**$136,100**
Utility Relocation	4 %	$1,429,200		
Mobilization \ General Conditions	5%	$1,786,500		
Subtotal with Percent Allowances		**$38,945,69**		
Contingency	30%	$11,683,708		
Profit	5%	$2,531,470		
Probable Construction Cost Estimate		**$53,160,87**		
Design Engineering, Geotechnical, and Construction Management	10%	$5,316,087		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate (2008 Dollars)		**$84,345,669**		

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Alternative Name CUDD-G1B

Problem Description Overbank Flooding

Strategy Expansion and improvements to Calumet Union Reservoir, and upsizing the Robey St. diversion conduit

District Minimum Criteria for Funding: Met

Recommended Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Soil stabilization and vegetative cover	yd2	33003	$14	$458,082	$426,009	$109,689	Stabilization of side slopes and vegetation
Embankment construction, grading and restoration: Compaction of fill	yd3	13090	$5	$69,901	$0	$0	Compact clay liner of detention basin (assume 1 thick liner)
Embankment construction, grading and restoration: Additional fill	yd3	13090	$14	$181,689	$0	$0	Material needed to construct clay liner
Concrete: Cast in place	yd3	114	$250	$28,500	$0	$0	Assumed cost for concrete spillway
Channel treatment: Excavation	yd3	621333	$11	$6,635,836	$0	$0	Soil Excavation for new offline detention facility
Channel treatment: Material to be hauled offsite	yd3	618394	$12	$7,266,130	$0	$0	Haul Away excess soil and existing concrete & pavement
Pipe in earth (city): 36 inches or less	lf	800	$217	$173,424	$161,282	$0	To drain south pond back to the north

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$14,813,561**	**$587,291**	**$109,689**
Utility Relocation	4 %	$592,542		
Mobilization \ General Conditions	5%	$740,678		
Subtotal with Percent Allowances		**$16,146,78**		
Contingency	30%	$4,844,035		
Profit	5%	$1,049,541		
Probable Construction Cost Estimate		**$22,040,35**		
Design Engineering, Geotechnical, and Construction Management	10%	$2,204,036		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate (2006 Dollars)		**$24,941,373**		

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Alternative Name CUDD-G1C

Problem Description Overbank Flooding

Strategy Expansion and improvements to Calumet Union Reservoir, and upsizing the Robey St. diversion conduit

District Minimum Criteria for Funding: Met

Recommended Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	744639	$11	$7,952,745	$0	$0	Soil Excavation for new offline detention facility
Channel treatment: Soil stabilization and vegetative cover	yd2	33003	$14	$458,082	$426,009	$109,689	Stabilization of side slopes and vegetation
Channel treatment: Material to be hauled offsite	yd3	741700	$12	$8,714,975	$0	$0	Haul Away excess soil and existing concrete & pavement
Embankment construction, grading and restoration: Additional fill	yd3	13090	$14	$181,689	$0	$0	Material needed to construct clay liner
Embankment construction, grading and restoration: Compaction of fill	yd3	21872	$5	$116,796	$0	$0	Compact clay liner of detention basin (assume 1 thick liner)
Concrete: Cast in place	yd3	47	$250	$11,750	$0	$0	Assumed cost for concrete spillway
Pump Station: 10ac-ft per day interior drainage	each	4	$800,000	$3,056,000	$2,842,033	$0	Pump Station to dewater back into channel
Pipe in earth (city): 36 inches or less	lf	230	$217	$49,859	$46,368	$0	Culvert to convey dewatering flow back to channel

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

		Base Cost	Maint. Cost	Replacement Cost
Subtotal (direct costs)		**$20,541,896**	**$3,314,411**	**$109,689**
Utility Relocation	4 %	$821,676		
Mobilization \ General Conditions	5%	$1,027,095		
Subtotal with Percent Allowances		**$22,390,66**		
Contingency	30%	$6,717,200		
Profit	5%	$1,455,393		
Probable Construction Cost Estimate		**$30,563,26**		
Design Engineering, Geotechnical, and Construction Management	10%	$3,056,326		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate (2008 Dollars)		**$37,043,686**		

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Alternative Name CUDD-G1D

Problem Description Overbank Flooding

Strategy Expansion and improvements to Calumet Union Reservoir, and upsizing the Robey St. diversion conduit

District Minimum Criteria for Funding: Met

Recommended Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	300	$609	$182,610	$169,825	$0	Two box culverts each with a length of 150
Land Acquisition: Permanent Easement *	dollar	50000	$1	$50,000	$0	$0	PIN14=28252020150000
Pipe in earth (city): 36 inches or less	lf	800	$217	$173,424	$161,282	$0	
Pipe in earth (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	1200	$435	$521,568	$485,050	$0	Culvert to Drain pond back to North reservoir
Outlet structures (Headwall): 42 to 66 inches	each	3	$4,758	$14,273	$13,273	$0	Outlet structure
Inlet structures (Headwall): 42 to 66 inches	each	2	$4,758	$9,515	$8,849	$0	Inlet structure
Concrete: Cast in place	yd3	47	$250	$11,750	$0	$0	Assumed cost for concrete spillway
Channel treatment: Excavation	yd3	243283	$11	$2,598,262	$0	$0	Soil Excavation for new offline detention facility
Embankment construction, grading and restoration: Compaction of fill	yd3	9989	$5	$53,341	$0	$0	Compact clay liner of detention basin (assume 1 think liner)
Channel treatment: Soil stabilization and vegetative cover	yd2	65617	$14	$910,764	$846,997	$218,085	Stabilization of side slopes and vegetation
Channel treatment: Material to be hauled offsite	yd3	243283	$12	$2,858,575	$0	$0	Haul Away excess soil and existing concrete & pavement
Pump Station: 10ac-ft per day interior drainage	each	2	$800,000	$1,960,000	$1,822,770	$0	Assume a cost of $13,000 per ac-ft of storage volume

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$9,294,082**	**$3,508,045**	**$218,085**
Utility Relocation	4 %	$371,763		
Mobilization \ General Conditions	5%	$464,704		
Subtotal with Percent Allowances		**$10,130,55**		
Contingency	30%	$3,039,165		
Profit	5%	$658,486		
Probable Construction Cost Estimate		**$13,828,20**		
Design Engineering, Geotechnical, and Construction Management	10%	$1,382,820		
Property Acquisition Cost:		$50,000		
Total Conceptual Cost Estimate (2008 Dollars)		**$18,987,151**		

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Alternative Name	CUDD-G2
Problem Description	Overbank Flooding
Strategy	Construct a 450 ac-ft detention facility and a new diversion conduit from Tri-State Tollway
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Concrete: Cast in place	yd3	47	$250	$11,750	$0	$0	Concrete Spillway
Pipe in earth (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	3000	$435	$1,303,920	$1,212,626	$0	Installation of (2) new diversion culverts to the new pond
Channel treatment: Additional fill	yd3	24612	$14	$341,615	$0	$0	Material needed for clay liner
Pump Station: 10ac-ft per day interior drainage	each	7	$800,000	$5,848,000	$5,438,550	$0	Assume a cost of $13,000 per ac-ft of storage volume
Channel treatment: Material to be hauled offsite	yd3	853776	$12	$10,031,868	$0	$0	Removal of excavated materials for detention pond
Channel treatment: Excavation	yd3	853776	$11	$9,118,328	$0	$0	Excavation for new detention pond
Channel treatment: Vegetative cover only	yd2	4889	$9	$41,752	$38,829	$9,998	Vegetative cover of excavated basin areas
Concrete: Cast in place	yd3	30	$250	$7,500	$0	$0	Concrete Weir

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$26,704,732**	**$6,690,005**	**$9,998**
Utility Relocation	4 %	$1,068,189		
Mobilization \ General Conditions	5%	$1,335,237		
Subtotal with Percent Allowances		**$29,108,15**		
Contingency	30%	$8,732,447		
Profit	5%	$1,892,030		
Probable Construction Cost Estimate		**$39,732,63**		
Design Engineering, Geotechnical, and Construction Management	10%	$3,973,264		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate (2008 Dollars)		**$50,405,902**		

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Alternative Name CUDD-G3

Problem Description Overbank Flooding/Streambank Erosion

Strategy Construct a floodwall from Hamlin to Central Park Avenue and streambank stabilization from Sunset to Central

District Minimum Criteria for Funding: Met

Recommended Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Inlet structures (Headwall): 42 to 66 inches	each	1	$4,758	$4,758	$4,424	$0	Improve inlet to junction box
Channel treatment: Soil stabilization and vegetative cover	yd2	10189	$14	$141,423	$131,522	$33,864	Calculation of soil erosion prevention
Pipe under pavement (city): 72 to 84 inches / box culvert (28 to 38 ft2)	lf	25	$425	$10,626	$9,882	$0	Install new culvert at CU-54
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	25	$148	$3,712	$3,452	$0	Replace Roadway Pavement
Pipe under pavement (city): 72 to 84 inches / box culvert (28 to 38 ft2)	lf	30	$425	$12,751	$11,858	$0	Install new culvert at CU-55
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	25	$148	$3,712	$3,452	$0	Replace Roadway Pavement
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	25	$148	$3,712	$3,452	$0	Replace Roadway Pavement
Pipe under pavement (city): 72 to 84 inches / box culvert (28 to 38 ft2)	lf	20	$425	$8,500	$7,905	$0	Install new culvert at CU-56
Channel treatment: Reinforced one sided concrete wall	yd3	1185	$587	$696,010	$647,278	$166,661	Levee floodwall on both sides of channel
Pump Station: 10ac-ft per day interior drainage	each	0	$800,000	$128,000	$119,038	$0	Interior drainage behind levees
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	135	$148	$20,043	$18,640	$0	Replace Junction Box

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$1,033,246**	**$960,903**	**$200,525**
Utility Relocation	4 %	$41,330		
Mobilization \ General Conditions	5%	$51,662		
Subtotal with Percent Allowances		**$1,126,238**		
Contingency	30%	$337,871		
Profit	5%	$73,205		
Probable Construction Cost Estimate		**$1,537,315**		
Design Engineering, Geotechnical, and Construction Management	10%	$153,731		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate (2008 Dollars)		**$2,852,474**		

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Alternative Name	CUSW-G1
Problem Description	Overbank Flooding
Strategy	Replace California Ave. culvert
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	80	$148	$11,878	$11,046	$0	Replace Roadway Pavement, extra for additional lanes
Pipe in earth (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	390	$435	$169,510	$157,641	$0	Install new culvert to increase conveyance
Embankment construction, grading and restoration: Material hauled from offsite	yd3	1556	$11	$16,618	$0	$0	All excavated soils to be hauled away
Channel treatment: Vegetative cover only	yd2	667	$9	$5,696	$5,297	$1,364	Vegetation cover for excavated areas
Channel treatment: Excavation	yd3	1556	$11	$16,618	$0	$0	Removal of ex. pavement & soil for new culverts at CU-18

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$220,320**	**$173,985**	**$1,364**
Utility Relocation	4 %	$8,813		
Mobilization \ General Conditions	5%	$11,016		
Subtotal with Percent Allowances		**$240,148**		
Contingency	30%	$72,044		
Profit	5%	$15,610		
Probable Construction Cost Estimate		**$327,802**		
Design Engineering, Geotechnical, and Construction Management	10%	$32,780		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate (2008 Dollars)		**$535,931**		

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Alternative Name	CUSW-G2
Problem Description	Overbank Flooding
Strategy	Construct an 860 LF diversion conduit parallel to Kedzie Ave.
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	**Quantity**	**Unit Cost**	**Base Cost**	**Maint. Cost**	**Replacement Cost**	**Notes/Issues**
Channel treatment: Excavation	yd3	4148	$11	$44,301	$0	$0	Removal of ex. pavement & soil for new culverts at CU-18
Channel treatment: Vegetative cover only	yd2	2500	$9	$21,350	$19,855	$5,112	Vegetation cover for excavated areas
Embankment construction, grading and restoration: Material hauled from offsite	yd3	2548	$11	$27,213	$0	$0	All excavated soils to be hauled away
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	70	$609	$42,609	$39,626	$0	Install third culvert to increase conveyance
Pipe in earth (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	790	$435	$343,366	$319,325	$0	Install third culvert to increase conveyance
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	100	$148	$14,847	$13,807	$0	Replace Roadway Pavement, extra for additional lanes

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$493,685**	**$392,613**	**$5,112**
Utility Relocation	4 %	$19,747		
Mobilization \ General Conditions	5%	$24,684		
Subtotal with Percent Allowances		**$538,117**		
Contingency	30%	$161,435		
Profit	5%	$34,978		
Probable Construction Cost Estimate		**$734,529**		
Design Engineering, Geotechnical, and Construction Management	10%	$73,453		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate (2008 Dollars)		**$1,205,707**		

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Alternative Name	CUTS-G1
Problem Description	Overbank Flooding
Strategy	Construct a 945 LF levee along Baker Avenue
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	280	$11	$2,990	$0	$0	Soil Excavation for new levee foundation
Channel treatment: Excavation	yd3	96	$11	$1,025	$0	$0	Soil excavation for new storm sewer
Channel treatment: Excavation	yd3	1111	$11	$11,865	$0	$0	Removal of ex. pavement & soil for new culverts at CU-18
Channel treatment: Compaction	yd3	6324	$7	$47,304	$0	$0	Compact levee and surrounding areas
Channel treatment: Soil stabilization and vegetative cover	yd2	44060	$14	$611,553	$568,735	$146,438	Stabilization of side slopes and vegetation
Channel treatment: Soil stabilization and vegetative cover	yd2	200	$14	$2,776	$2,582	$665	Stabilization of side slopes and vegetation around sewer
Channel treatment: Vegetative cover only	yd2	17750	$9	$151,585	$140,972	$36,297	Vegetation cover for excavated areas
Embankment construction, grading and restoration: Additional fill	yd3	5594	$14	$77,645	$0	$0	Fill soil if any required
Embankment construction, grading and restoration: Material hauled from offsite	yd3	1111	$11	$11,865	$0	$0	All excavated soils to be hauled away
Pipe in earth (city): 36 inches or less	lf	168	$217	$36,419	$33,869	$0	Stormsewer to drain surface runoff
Pipe in earth (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	180	$435	$78,235	$72,758	$0	Install new culvert to increase conveyance
Outlet structures (Headwall): 36 inches or less	each	3	$2,600	$7,801	$7,255	$0	Outlet structure
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	100	$148	$14,847	$13,807	$0	Replace Roadway Pavement, extra for additional lanes
Pump Station: 10ac-ft per day interior drainage	each	0	$800,000	$64,000	$59,519	$0	

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

		Base Cost	Maint. Cost	Replacement Cost
Subtotal (direct costs)		**$1,119,911**	**$899,496**	**$183,400**
Utility Relocation	4 %	$44,796		
Mobilization \ General Conditions	5%	$55,996		
Subtotal with Percent Allowances		**$1,220,703**		
Contingency	30%	$366,211		
Profit	5%	$79,346		
Probable Construction Cost Estimate		**$1,666,259**		
Design Engineering, Geotechnical, and Construction Management	10%	$166,626		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate (2008 Dollars)		**$2,915,782**		

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Alternative Name PKCR-G1

Problem Description Overbank Flooding

Strategy Construct a 200 ac-ft detention facility, implement channel and conveyance improvements from Kedzie

District Minimum Criteria for Funding: Met

Recommended Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	2963	$11	$31,645	$0	$0	Channel Modifications excavation
Channel treatment: Vegetative cover only	yd2	3333	$9	$28,464	$26,471	$6,816	Vegetative cover of excavated areas
Embankment construction, grading and restoration: Compaction of fill	yd3	2444	$5	$13,051	$0	$0	Compaction of soil of new levee
Channel treatment: Vegetative cover only	yd2	41564	$9	$354,957	$330,104	$84,995	Vegetative cover of excavated basin areas
Channel treatment: Additional fill	yd3	18411	$14	$255,545	$0	$0	Material needed for clay liner
Concrete: Cast in place	yd3	47	$250	$11,750	$0	$0	Concrete Spillway
Concrete: Cast in place	yd3	111	$250	$27,750	$0	$0	Construction of new diversion structure to pond
Concrete: Cast in place	yd3	30	$250	$7,500	$0	$0	Concrete Weir
Pump Station: 10ac-ft per day interior drainage	each	3	$800,000	$2,600,000	$2,417,960	$0	Assume a cost of $13,000 per ac-ft of storage volume
Pump Station: 10ac-ft per day interior drainage	each	0	$800,000	$64,000	$59,519	$0	
Channel treatment: Material to be hauled offsite	yd3	322667	$12	$3,791,337	$0	$0	Removal of excavated materials for detention pond
Channel treatment: Excavation	yd3	322667	$11	$3,446,084	$0	$0	Excavation for new detention pond

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$10,632,082**	**$2,834,054**	**$91,811**
Utility Relocation	4 %	$425,283		
Mobilization \ General Conditions	5%	$531,604		
Subtotal with Percent Allowances		**$11,588,96**		
Contingency	30%	$3,476,691		
Profit	5%	$753,283		
Probable Construction Cost Estimate		**$15,818,94**		
Design Engineering, Geotechnical, and Construction Management	10%	$1,581,894		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate (2008 Dollars)		**$20,326,702**		

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Alternative Name	DRCR-G1
Problem Description	Overbank Flooding
Strategy	Increase channel capacity north of US 30 HWY and excavate existing reservoir to provide additional 24 ac-ft
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	130000	$11	$1,388,400	$0	$0	Reservoir Excavation and on site material placement and add approx 24 ac-ft of storage to compensate for Cl N. of US 30
Channel treatment: Compaction	yd3	130000	$7	$972,400	$0	$0	Reservoir Excavation and on site material placement and add approx 24 ac-ft of storage to compensate for Cl N. of US 30
Channel treatment: Vegetative cover only	yd2	75000	$9	$640,500	$595,655	$153,369	Vegetation for 6500 ft appx 100 ft wide.
Channel treatment: Material to be hauled offsite	yd3	130000	$12	$1,527,500	$0	$0	Add appox 24 ac-ft of storage to compensate for CI N. of US 30
Concrete: Cast in place	yd3	30	$250	$7,500	$0	$0	Increase existing 50 ft. weir elevation from 632.5 to 637.5. Qty doubled for possible spillway modification.
Concrete: Cast in place	yd3	300	$250	$75,000	$0	$0	Floodwall for low lying properties South of US 30.
Pipe in earth (city): 36 inches or less	lf	50	$217	$10,839	$10,080	$0	New Culvert to drain reservoir at lower elevation.
Outlet structures (Headwall): 36 inches or less	each	1	$2,600	$2,600	$2,418	$0	New Outlet at lower elevation from pond

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$4,624,739**	**$608,154**	**$153,369**
Utility Relocation	4 %	$184,990		
Mobilization \ General Conditions	5%	$231,237		
Subtotal with Percent Allowances		**$5,040,966**		
Contingency	30%	$1,512,290		
Profit	5%	$327,663		
Probable Construction Cost Estimate		**$6,880,918**		
Design Engineering, Geotechnical, and Construction Management	10%	$688,092		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate (2008 Dollars)		**$8,330,533**		

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Alternative Name	DRCR-G2
Problem Description	Overbank Flooding
Strategy	Channel improvements for 1,800 LF upstream of Sauk Trail Road.
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Outlet structures (Headwall): 36 inches or less	each	1	$2,600	$2,600	$2,418	$0	Inlet to Storage
Inlet structures (Headwall): 36 inches or less	each	1	$2,600	$2,600	$2,418	$0	Outlet from Storage
Channel treatment: Excavation	yd3	170000	$11	$1,815,600	$0	$0	Reservoir Excavation and on site material placement.
Channel treatment: Compaction	yd3	170000	$7	$1,271,600	$0	$0	Reservoir Compaction and on site material placement.
Channel treatment: Material to be hauled offsite	yd3	170000	$12	$1,997,500	$0	$0	Removal of material
Channel treatment: Soil stabilization and vegetative cover	yd2	150000	$14	$2,082,000	$1,936,228	$498,540	Area of Excavation
Land Acquisition: Purchase of Property *	dollar	135000	$1	$135,000	$0	$0	Buyout Agricultural, cost per acre based on average farmland of vicinity

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$7,171,901**	**$1,941,065**	**$498,540**
Utility Relocation	4 %	$286,876		
Mobilization \ General Conditions	5%	$358,595		
Subtotal with Percent Allowances		**$7,817,372**		
Contingency	30%	$2,345,212		
Profit	5%	$508,129		
Probable Construction Cost Estimate		**$10,670,71**		
Design Engineering, Geotechnical, and Construction Management	10%	$1,067,071		
Property Acquisition Cost:		$135,000		
Total Conceptual Cost Estimate (2008 Dollars)		**$14,312,388**		

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Alternative Name	LCRW-G1
Problem Description	Overbank flooding
Strategy	Construct a 600 LF floodwall near Sibley Blvd.
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	4860	$11	$51,905	$0	$0	Soil Excavation for new levee foundation.
Channel treatment: Soil stabilization and vegetative cover	yd2	667	$14	$9,258	$8,610	$2,217	Stabilization of side slopes and vegetation
Channel treatment: Material to be hauled offsite	yd3	54	$12	$635	$0	$0	Haul Away excess soil from foundation excavation
Channel treatment: Reinforced one sided concrete wall	yd3	710	$587	$417,019	$387,821	$99,856	Levee
Pipe in earth (county): 36 inches or less	lf	20	$217	$4,336	$4,032	$0	Stormsewer to drain surface runoff (5x4)
Outlet structures (Headwall): 36 inches or less	each	4	$2,600	$10,401	$9,673	$0	Inlet/Outlet structure
Pump Station: 10ac-ft per day interior drainage	each	1	$800,000	$800,000	$743,988	$0	Assume Pump Station Required at all Levees
Land Acquisition: Permanent Easement *	dollar	39143	$1	$39,143	$0	$0	

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

		Base Cost	Maint. Cost	Replacement Cost
Subtotal (direct costs)		**$1,293,553**	**$1,154,123**	**$102,073**
Utility Relocation	4 %	$51,742		
Mobilization \ General Conditions	5%	$64,678		
Subtotal with Percent Allowances		**$1,409,972**		
Contingency	30%	$422,992		
Profit	5%	$91,648		
Probable Construction Cost Estimate		**$1,924,612**		
Design Engineering, Geotechnical, and Construction Management	10%	$192,461		
Property Acquisition Cost:		$39,143		
Total Conceptual Cost Estimate (2008 Dollars)		**$3,412,413**		

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Alternative Name	LCRW-G2
Problem Description	Overbank flooding
Strategy	Construct a 1,900 LF levee/floodwall near 158th Place and 159th St.
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	18844	$11	$201,254	$0	$0	Soil Excavation for new levee foundation, earthen levee.
Channel treatment: Soil stabilization and vegetative cover	yd2	9385	$14	$130,264	$121,143	$31,192	Stabilization of side slopes and vegetation and covering
Channel treatment: Material to be hauled offsite	yd3	671	$12	$7,884	$0	$0	Haul Away excess soil from foundation excavation
Channel treatment: Reinforced one sided concrete wall	yd3	1342	$587	$788,224	$733,036	$188,742	Levee
Pipe in earth (county): 36 inches or less	lf	188	$217	$40,755	$37,901	$0	Stormsewer to drain surface runoff (5x4)
Outlet structures (Headwall): 36 inches or less	each	8	$2,600	$20,803	$19,346	$0	Inlet/Outlet structure
Channel treatment: Compaction	yd3	12805	$7	$95,781	$0	$0	Compact Levee
Pump Station: 10ac-ft per day interior drainage	each	1	$800,000	$800,000	$743,988	$0	Assume Pump Station Required at all Levees
Land Acquisition: Permanent Easement *	dollar	464561	$1	$464,561	$0	$0	

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$2,084,964**	**$1,655,414**	**$219,934**
Utility Relocation	4 %	$83,399		
Mobilization \ General Conditions	5%	$104,248		
Subtotal with Percent Allowances		**$2,272,611**		
Contingency	30%	$681,783		
Profit	5%	$147,720		
Probable Construction Cost Estimate		**$3,102,114**		
Design Engineering, Geotechnical, and Construction Management	10%	$310,211 **$3,412,413**		
Property Acquisition Cost:		$464,561		
Total Conceptual Cost Estimate (2006 Dollars)		**$5,752,235**		

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Alternative Name	LCRW-G3
Problem Description	Overbank flooding
Strategy	Construct an 850 LF floodwall near 158th St. and Chicago Ave.
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	4374	$11	$46,714	$0	$0	Soil Excavation for new levee foundation.
Channel treatment: Soil stabilization and vegetative cover	yd2	944	$14	$13,103	$12,185	$3,137	Stabilization of side slopes and vegetation
Channel treatment: Material to be hauled offsite	yd3	486	$12	$5,711	$0	$0	Haul Away excess soil from foundation excavation
Channel treatment: Reinforced one sided concrete wall	yd3	972	$587	$570,904	$530,932	$136,705	Levee
Pipe in earth (county): 36 inches or less	lf	20	$217	$4,336	$4,032	$0	Stormsewer to drain surface runoff (5x4)
Outlet structures (Headwall): 36 inches or less	each	2	$2,600	$5,201	$4,837	$0	Inlet/Outlet structure
Pump Station: 10ac-ft per day interior drainage	each	1	$800,000	$800,000	$743,988	$0	Assume Pump Station Required at all Levees
Land Acquisition: Permanent Easement *	dollar	529965	$1	$529,965	$0	$0	

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$1,445,968**	**$1,295,974**	**$139,842**
Utility Relocation	4 %	$57,839		
Mobilization \ General Conditions	5%	$72,298		
Subtotal with Percent Allowances		**$1,576,105**		
Contingency	30%	$472,832		
Profit	5%	$102,447		
Probable Construction Cost Estimate		**$2,151,384**		
Design Engineering, Geotechnical, and Construction Management	10%	$215,138		
Property Acquisition Cost:		$529,965		
Total Conceptual Cost Estimate (2008 Dollars)		**$4,332,303**		

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Alternative Name	LCRW-G4
Problem Description	Overbank flooding
Strategy	Construct an 825 LF floodwall near Parkside Ave. and School St.
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	5526	$11	$59,018	$0	$0	Soil Excavation for new levee foundation and earthen levee
Channel treatment: Soil stabilization and vegetative cover	yd2	2848	$14	$39,530	$36,763	$9,466	Stabilization of side slopes and vegetation and covering
Channel treatment: Material to be hauled offsite	yd3	296	$12	$3,478	$0	$0	Haul Away excess soil from foundation excavation
Channel treatment: Reinforced one sided concrete wall	yd3	592	$587	$347,711	$323,366	$83,260	Levee
Channel treatment: Compaction	yd3	2862	$7	$21,408	$0	$0	Compact Levee
Pipe in earth (county): 36 inches or less	lf	20	$217	$4,336	$4,032	$0	Stormsewer to drain surface runoff (5x4)
Outlet structures (Headwall): 36 inches or less	each	4	$2,600	$10,401	$9,673	$0	Inlet/Outlet structure
Pump Station: 10ac-ft per day interior drainage	each	1	$800,000	$800,000	$743,988	$0	Assume Pump Station Required at all Levees
Land Acquisition: Purchase of Property *	dollar	111666	$1	$111,666	$0	$0	

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$1,285,882**	**$1,117,822**	**$92,726**
Utility Relocation	4 %	$51,435		
Mobilization \ General Conditions	5%	$64,294		
Subtotal with Percent Allowances		**$1,401,611**		
Contingency	30%	$420,483		
Profit	5%	$91,105		
Probable Construction Cost Estimate		**$1,913,199**		
Design Engineering, Geotechnical, and Construction Management	10%	$191,320		
Property Acquisition Cost:		$111,666		
Total Conceptual Cost Estimate (2008 Dollars)		**$3,426,733**		

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Alternative Name	LCRW-G5
Problem Description	Overbank Flooding
Strategy	Construct a 930 LF floodwall near 158th St. and Church Dr.
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Land Acquisition: Permanent Easement *	dollar	375100	$1	$375,100	$0	$0	Land Acquisition
Channel treatment: Excavation	yd3	7450	$11	$79,566	$0	$0	Soil Excavation for new levee foundation
Channel treatment: Soil stabilization and vegetative cover	yd2	5891	$14	$81,767	$76,042	$19,579	Stabilization of side slopes and vegetation and Covering
Channel treatment: Material to be hauled offsite	yd3	84	$12	$987	$0	$0	Haul Away excess soil from foundation excavation
Channel treatment: Reinforced one sided concrete wall	yd3	169	$587	$99,262	$92,312	$23,769	Levee
Pipe in earth (county): 36 inches or less	lf	4	$217	$867	$806	$0	Stormsewer to drain surface runoff (5x4)
Outlet structures (Headwall): 36 inches or less	each	4	$2,600	$10,401	$9,673	$0	Inlet/Outlet structure
Channel treatment: Compaction	yd3	6691	$7	$50,049	$0	$0	Compact Levee

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$322,899**	**$178,834**	**$43,348**
Utility Relocation	4 %	$12,916		
Mobilization \ General Conditions	5%	$16,145		
Subtotal with Percent Allowances		**$351,960**		
Contingency	30%	$105,588		
Profit	5%	$22,877		
Probable Construction Cost Estimate		**$480,426**		
Design Engineering, Geotechnical, and Construction Management	10%	$48,043		
Property Acquisition Cost:		$375,100		
Total Conceptual Cost Estimate (2008 Dollars)		**$1,125,750**		

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Alternative Name LCRW-G6

Problem Description Overbank Flooding

Strategy Construct a 1,285 LF floodwall near Blouin Drive

District Minimum Criteria for Funding: Met

Recommended Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Land Acquisition: Permanent Easement *	dollar	1260000	$1	$1,260,000	$0	$0	Land Acquisition
Channel treatment: Excavation	yd3	2263	$11	$24,169	$0	$0	Soil Excavation for new levee foundation.
Channel treatment: Excavation	yd3	1642	$11	$17,537	$0	$0	Earthen Levee
Channel treatment: Soil stabilization and vegetative cover	yd2	900	$14	$12,492	$11,617	$2,991	Stabilization of side slopes and vegetation
Channel treatment: Soil stabilization and vegetative cover	yd2	2810	$14	$39,003	$36,272	$9,339	Covering
Channel treatment: Material to be hauled offsite	yd3	251	$12	$2,949	$0	$0	Haul Away excess soil from foundation excavation
Channel treatment: Reinforced one sided concrete wall	yd3	503	$587	$295,437	$274,752	$70,743	Levee
Channel treatment: Compaction	yd3	1642	$7	$12,282	$0	$0	Compact Levee
Pipe in earth (county): 36 inches or less	lf	86	$217	$18,643	$17,338	$0	Stormsewer to drain surface runoff (5x4)
Outlet structures (Headwall): 36 inches or less	each	4	$2,600	$10,401	$9,673	$0	Inlet/Outlet structure

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$432,913**	**$349,652**	**$83,073**
Utility Relocation	4 %	$17,317		
Mobilization \ General Conditions	5%	$21,646		
Subtotal with Percent Allowances		**$471,875**		
Contingency	30%	$141,563		
Profit	5%	$30,672		
Probable Construction Cost Estimate		**$644,110**		
Design Engineering, Geotechnical, and Construction Management	10%	$64,411		
Property Acquisition Cost:		$1,260,000		
Total Conceptual Cost Estimate (2008 Dollars)		**$2,401,246**		

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Alternative Name LCRW-G7

Problem Description Overbank Flooding
Strategy Construct a 785 LF floodwall near 158th St.
District Minimum Criteria for Funding: Met
Recommended Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Outlet structures (Headwall): 36 inches or less	each	4	$2,600	$10,401	$9,673	$0	Inlet/Outlet structure
Pipe in earth (county): 36 inches or less	lf	112	$217	$24,279	$22,579	$0	Stormsewer to drain surface runoff (5x4)
Land Acquisition: Permanent Easement *	dollar	495000	$1	$495,000	$0	$0	Land Acquisition
Channel treatment: Excavation	yd3	5541	$11	$59,178	$0	$0	Earthen Levee
Channel treatment: Compaction	yd3	5541	$7	$41,447	$0	$0	Compact Levee
Channel treatment: Soil stabilization and vegetative cover	yd2	6100	$14	$84,668	$78,740	$20,274	Covering
Pump Station: 10ac-ft per day interior drainage	each	1	$800,000	$800,000	$743,988	$0	Assume Pump Station Required at all Levees

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$1,019,973**	**$854,980**	**$20,274**
Utility Relocation	4 %	$40,799		
Mobilization \ General Conditions	5%	$50,999		
Subtotal with Percent Allowances		**$1,111,771**		
Contingency	30%	$333,531		
Profit	5%	$72,265		
Probable Construction Cost Estimate		**$1,517,567**		
Design Engineering, Geotechnical, and Construction Management	10%	$151,757		
Property Acquisition Cost:		$495,000		
Total Conceptual Cost Estimate (2008 Dollars)		**$3,039,578**		

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Alternative Name	LCRW-G8
Problem Description	Overbank Flooding
Strategy	Modify existing berm to act as a levee parallel to 158th St. near Greenwood Dr. and Madison Ave.
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Soil stabilization and vegetative cover	yd2	4573	$14	$63,473	$59,029	$15,199	Covering
Channel treatment: Compaction	yd3	2249	$7	$16,823	$0	$0	Compact Levee
Channel treatment: Excavation	yd3	2249	$11	$24,019	$0	$0	Earthen Levee
Pipe in earth (county): 36 inches or less	lf	86	$217	$18,643	$17,338	$0	Stormsewer to drain surface runoff (5x4)
Outlet structures (Headwall): 36 inches or less	each	4	$2,600	$10,401	$9,673	$0	Inlet/Outlet structure
Pump Station: 10ac-ft per day interior drainage	each	1	$800,000	$800,000	$743,988	$0	Pumping, 25 cfs

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$933,360**	**$830,028**	**$15,199**
Utility Relocation	4 %	$37,334		
Mobilization \ General Conditions	5%	$46,668		
Subtotal with Percent Allowances		**$1,017,362**		
Contingency	30%	$305,209		
Profit	5%	$66,129		
Probable Construction Cost Estimate		**$1,388,699**		
Design Engineering, Geotechnical, and Construction Management	10%	$138,870		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate (2008 Dollars)		**$2,372,796**		

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Alternative Name MTCR-G1

Problem Description Overbank flooding

Strategy Construct a 700 LF levee along Overhill Ave. and Oleander Ave.

District Minimum Criteria for Funding: Met

Recommended Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Embankment construction, grading and restoration: Additional fill	yd3	16910	$14	$234,711	$0	$0	Construct Embankment
Channel treatment: Compaction	yd3	2775	$7	$20,757	$0	$0	Construct Embankment
Channel treatment: Soil stabilization and vegetative cover	yd2	10253	$14	$142,312	$132,348	$34,077	Construct Embankment
Channel treatment: Excavation	yd3	955	$11	$10,199	$0	$0	New Culvert in Subdivision
Embankment construction, grading and restoration: Material hauled from offsite	yd3	680	$11	$7,262	$0	$0	New Culvert in Subdivision
Channel treatment: Compaction	yd3	680	$7	$5,086	$0	$0	New Culvert in Subdivision
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	460	$609	$280,002	$260,398	$0	New Culvert in Subdivision
Outlet structures (Headwall): 42 to 66 inches	each	2	$4,758	$8,564	$7,964	$0	New Culvert in Subdivision
Embankment construction, grading and restoration: Additional fill	yd3	0	$14	$0	$0	$0	New Culvert in Subdivision
Channel treatment: Compaction	yd3	275	$7	$2,057	$0	$0	New Culvert in Subdivision
Channel treatment: Soil stabilization and vegetative cover	yd2	30	$14	$416	$387	$100	New Culvert in Subdivision
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	20	$5	$100	$93	$24	New Culvert in Subdivision
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	268	$148	$39,790	$37,004	$0	New Culvert in Subdivision
Land Acquisition: Temporary Easement *	dollar	7750	$1	$7,750	$0	$0	Land Acquisition

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$751,257**	**$438,193**	**$34,201**
Utility Relocation	4 %	$30,050		
Mobilization \ General Conditions	5%	$37,563		
Subtotal with Percent Allowances		**$818,870**		
Contingency	30%	$245,661		
Profit	5%	$53,227		
Probable Construction Cost Estimate		**$1,117,757**		
Design Engineering, Geotechnical, and Construction Management	10%	$111,776		
Property Acquisition Cost:		$7,750		
Total Conceptual Cost Estimate (2008 Dollars)		**$1,709,677**		

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Alternative Name MTCR-G2

Problem Description Streambank erosion

Strategy Streambank stabilization at Oakpark Ave. and 172nd St. and Hickory St. and 66th Court

District Minimum Criteria for Funding: Met

Recommended Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Reinforced trapezoidal concrete channel	yd3	1000	$587	$587,350	$546,227	$0	
Channel treatment: Excavation	yd3	1500	$11	$16,020	$0	$0	
Channel treatment: Soil stabilization and vegetative cover	yd2	260	$14	$3,609	$3,356	$864	
Channel treatment: Compaction	yd3	500	$7	$3,740	$0	$0	
Channel treatment: Material to be hauled offsite	yd3	1000	$12	$11,750	$0	$0	

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$622,469**	**$549,583**	**$864**
Utility Relocation	4 %	$24,899		
Mobilization \ General Conditions	5%	$31,123		
Subtotal with Percent Allowances		**$678,491**		
Contingency	30%	$203,547		
Profit	5%	$44,102		
Probable Construction Cost Estimate		**$926,140**		
Design Engineering, Geotechnical, and Construction Management	10%	$92,614		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate (2008 Dollars)		**$1,569,201**		

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Alternative Name	MTCR-G3
Problem Description	Overbank flooding
Strategy	Replace 160th and 159th St. culverts and channel improvements between 160th and Oak Ave.
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	2075	$11	$22,161	$0	$0	Remove Existing Culvert @ 160th
Demolition: Brick, concrete, or stone construction	ft2	6900	$4	$29,463	$0	$0	Remove Existing Culvert @ 160th
Embankment construction, grading and restoration: Material hauled from offsite	yd3	2110	$11	$22,535	$0	$0	Remove Existing Culvert @ 160th
Channel treatment: Compaction	yd3	900	$7	$6,732	$0	$0	Remove Existing Culvert @ 160th
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	1150	$609	$700,005	$650,994	$0	Install New Culvert @ 160th
Inlet structures (Headwall): 42 to 66 inches	each	3	$4,758	$15,700	$14,601	$0	Install New Culvert @ 160th
Outlet structures (Headwall): 42 to 66 inches	each	3	$4,758	$15,700	$14,601	$0	Install New Culvert @ 160th
Channel treatment: Compaction	yd3	1175	$7	$8,789	$0	$0	Install New Culvert @ 160th
Channel treatment: Soil stabilization and vegetative cover	yd2	100	$14	$1,388	$1,291	$332	Install New Culvert @ 160th
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	40	$5	$200	$186	$48	Install New Culvert @ 160th
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	155	$148	$23,013	$21,402	$0	Install New Culvert @ 160th
Channel treatment: Excavation	yd3	1105	$11	$11,801	$0	$0	Remove Existing Culvert @ 159th/Cicero
Demolition: Brick, concrete, or stone construction	ft2	1545	$4	$6,597	$0	$0	Remove Existing Culvert @ 159th/Cicero
Embankment construction, grading and restoration: Material hauled from offsite	yd3	835	$11	$8,918	$0	$0	Remove Existing Culvert @ 159th/Cicero
Channel treatment: Compaction	yd3	550	$7	$4,114	$0	$0	Remove Existing Culvert @ 159th/Cicero
Pipe under pavement (city): Box culvert (51 to 60 ft2)	lf	368	$661	$243,259	$226,227	$0	Install New Culvert @ 159th/Cicero
Inlet structures (Headwall): 42 to 66 inches	each	3	$4,758	$11,894	$11,061	$0	Install New Culvert @ 159th/Cicero
Outlet structures (Headwall): 42 to 66 inches	each	3	$4,758	$11,894	$11,061	$0	Install New Culvert @ 159th/Cicero
Channel treatment: Compaction	yd3	555	$7	$4,151	$0	$0	Install New Culvert @ 159th/Cicero
Channel treatment: Soil stabilization and vegetative cover	yd2	75	$14	$1,041	$968	$249	Install New Culvert @ 159th/Cicero
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	40	$5	$200	$186	$48	Install New Culvert @ 159th/Cicero
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	145	$148	$21,528	$20,021	$0	Install New Culvert @ 159th/Cicero
Channel treatment: Excavation	yd3	1075	$11	$11,481	$0	$0	Channel Improvements
Channel treatment: Soil stabilization and vegetative cover	yd2	1530	$14	$21,236	$19,750	$5,085	Channel Improvements

Alternative Name	MTCR-G3
Problem Description	Overbank flooding
Strategy	Replace 160th and 159th St. culverts and channel improvements between 160th and Oak Ave.
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Compaction	yd3	390	$7	$2,917	$0	$0	Channel Improvements
Embankment construction, grading and restoration: Material hauled from offsite	yd3	685	$11	$7,316	$0	$0	Channel Improvements
Channel treatment: Compaction	yd3	685	$7	$5,124	$0	$0	Channel Improvements
Land Acquisition: Permanent Easement *	dollar	32335	$1	$32,335	$0	$0	Land Acquisition
Land Acquisition: Temporary Easement *	dollar	14560	$1	$14,560	$0	$0	Land Acquisition

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$1,219,157**	**$992,347**	**$5,762**
Utility Relocation	4 %	$48,766		
Mobilization \ General Conditions	5%	$60,958		
Subtotal with Percent Allowances		**$1,328,881**		
Contingency	30%	$398,664		
Profit	5%	$86,377		
Probable Construction Cost Estimate		**$1,813,922**		
Design Engineering, Geotechnical, and Construction Management	10%	$181,392		
Property Acquisition Cost:		$46,895		
Total Conceptual Cost Estimate (2008 Dollars)		**$3,040,319**		

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Alternative Name	MTCR-G4
Problem Description	Overbank flooding
Strategy	Replace 155th and Kilpatrick Ave. culverts and construct a 700 LF floodwall along north bank downstream of
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	155	$11	$1,655	$0	$0	Levee Excavation at Metra RR
Embankment construction, grading and restoration: Material hauled from offsite	yd3	105	$11	$1,121	$0	$0	Levee Excavation at Metra RR
Channel treatment: Compaction	yd3	105	$7	$785	$0	$0	Levee Excavation at Metra RR
Channel treatment: Compaction	yd3	50	$7	$374	$0	$0	Levee Construction at Metra RR
Channel treatment: Reinforced one sided concrete wall	yd3	315	$587	$185,015	$172,061	$44,302	Levee Construction at Metra RR
Channel treatment: Soil stabilization and vegetative cover	yd2	1170	$14	$16,240	$15,103	$3,889	Levee Construction at Metra RR
Pump Station: 10ac-ft per day interior drainage	each	9	$800,000	$7,360,000	$6,844,687	$0	Levee Construction at Metra RR
Channel treatment: Excavation	yd3	1860	$11	$19,865	$0	$0	Remove Existing Culvert at 155th/Kilpatrick
Demolition: Brick, concrete, or stone construction	ft2	1731	$4	$7,391	$0	$0	Remove Existing Culvert at 155th/Kilpatrick
Embankment construction, grading and restoration: Material hauled from offsite	yd3	1600	$11	$17,088	$0	$0	Remove Existing Culvert at 155th/Kilpatrick
Channel treatment: Compaction	yd3	1245	$7	$9,313	$0	$0	Remove Existing Culvert at 155th/Kilpatrick
Pipe under pavement (city): Box culvert (51 to 60 ft2)	lf	720	$661	$475,942	$442,618	$0	Install New Culvert at 155th/Kilpatrick
Inlet structures (Headwall): 42 to 66 inches	each	7	$4,758	$30,924	$28,759	$0	Install New Culvert at 155th/Kilpatrick
Outlet structures (Headwall): 42 to 66 inches	each	7	$4,758	$30,924	$28,759	$0	Install New Culvert at 155th/Kilpatrick
Channel treatment: Compaction	yd3	615	$7	$4,600	$0	$0	Install New Culvert at 155th/Kilpatrick
Channel treatment: Soil stabilization and vegetative cover	yd2	180	$14	$2,498	$2,323	$598	Install New Culvert at 155th/Kilpatrick
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	40	$5	$200	$186	$48	Install New Culvert at 155th/Kilpatrick
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	105	$148	$15,589	$14,498	$0	Install New Culvert at 155th/Kilpatrick
Channel treatment: Excavation	yd3	155	$11	$1,655	$0	$0	Levee Excavation at Kilpatrick
Embankment construction, grading and restoration: Material hauled from offsite	yd3	105	$11	$1,121	$0	$0	Levee Excavation at Kilpatrick
Channel treatment: Compaction	yd3	105	$7	$785	$0	$0	Levee Excavation at Kilpatrick
Channel treatment: Compaction	yd3	50	$7	$374	$0	$0	Levee Construction at Kilpatrick
Channel treatment: Reinforced one sided concrete wall	yd3	394	$587	$231,416	$215,213	$55,413	Levee Construction at Kilpatrick

Alternative Name	MTCR-G4
Problem Description	Overbank flooding
Strategy	Replace 155th and Kilpatrick Ave. culverts and construct a 700 LF floodwall along north bank downstream of
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Soil stabilization and vegetative cover	yd2	1170	$14	$16,240	$15,103	$3,889	Levee Construction at Kilpatrick
Pump Station: 10ac-ft per day interior drainage	each	3	$800,000	$2,320,000	$2,157,564	$0	Levee Construction at Kilpatrick

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$10,751,117**	**$9,936,875**	**$108,139**
Utility Relocation	4 %	$430,045		
Mobilization \ General Conditions	5%	$537,556		
Subtotal with Percent Allowances		**$11,718,71**		
Contingency	30%	$3,515,615		
Profit	5%	$761,717		
Probable Construction Cost Estimate		**$15,996,04**		
Design Engineering, Geotechnical, and Construction Management	10%	$1,599,605		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate (2008 Dollars)		**$27,640,667**		

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Alternative Name	MTCR-G5
Problem Description	Overbank flooding
Strategy	Construct a 25 ac-ft detention at Kilbourn and Waverly, channel improvements from 151st St. to Pulaski Rd.
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	13665	$11	$145,942	$0	$0	Channel Improvements/ Earthen Embankments
Channel treatment: Soil stabilization and vegetative cover	yd2	13660	$14	$189,601	$176,326	$45,400	Channel Improvements/ Earthen Embankments
Channel treatment: Compaction	yd3	5205	$7	$38,933	$0	$0	Channel Improvements/ Earthen Embankments
Channel treatment: Compaction	yd3	6040	$7	$45,179	$0	$0	Channel Improvements/ Earthen Embankments
Channel treatment: Soil stabilization and vegetative cover	yd2	18115	$14	$251,436	$233,832	$60,207	Channel Improvements/ Earthen Embankments
Pump Station: 10ac-ft per day interior drainage	each	9	$800,000	$6,800,000	$6,323,896	$0	Channel Improvements/ Earthen Embankments
Channel treatment: Excavation	yd3	40335	$11	$430,778	$0	$0	Storage Excavation
Embankment construction, grading and restoration: Material hauled from offsite	yd3	27730	$11	$296,156	$0	$0	Storage Excavation
Channel treatment: Compaction	yd3	27730	$7	$207,420	$0	$0	Storage Excavation
Channel treatment: Compaction	yd3	1450	$7	$10,846	$0	$0	Storage Construction
Channel treatment: Soil stabilization and vegetative cover	yd2	3600	$14	$49,968	$46,469	$11,965	Storage Construction
Concrete: Cast in place	yd3	125	$250	$31,250	$0	$0	Storage Spillway/Outlet Structure
Pipe in earth (city): 36 inches or less	lf	44	$217	$9,538	$8,870	$0	Storage Spillway/Outlet Structure
Inlet structures (Headwall): 36 inches or less	each	2	$2,600	$5,201	$4,837	$0	Storage Spillway/Outlet Structure
Outlet structures (Headwall): 36 inches or less	each	2	$2,600	$5,201	$4,837	$0	Storage Spillway/Outlet Structure
Land Acquisition: Purchase of Property *	dollar	77469	$1	$77,469	$0	$0	Land Acquisition
Land Acquisition: Permanent Easement *	dollar	34725	$1	$34,725	$0	$0	Land Acquisition
Land Acquisition: Temporary Easement *	dollar	33350	$1	$33,350	$0	$0	Land Acquisition

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$8,517,450**	**$6,799,067**	**$117,572**
Utility Relocation	4 %	$340,698		
Mobilization \ General Conditions	5%	$425,873		
Subtotal with Percent Allowances		**$9,284,021**		
Contingency	30%	$2,785,206		
Profit	5%	$603,461		
Probable Construction Cost Estimate		**$12,672,68**		
Design Engineering, Geotechnical, and Construction Management	10%	$1,267,269		
Property Acquisition Cost:		$145,544		
Total Conceptual Cost Estimate (2008 Dollars)		**$21,002,140**		

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Little Calumet River Watershed Detailed Watershed Plan
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Alternative Name	MTCR-G6
Problem Description	Overbank flooding
Strategy	Channel improvements between 137th and 139th St.
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	8665	$11	$92,542	$0	$0	Channel Improvements
Channel treatment: Soil stabilization and vegetative cover	yd2	2431	$14	$33,742	$31,380	$8,080	Channel Improvements
Channel treatment: Compaction	yd3	1455	$7	$10,883	$0	$0	Channel Improvements
Embankment construction, grading and restoration: Material hauled from offsite	yd3	7210	$11	$77,003	$0	$0	Channel Improvements
Channel treatment: Compaction	yd3	7210	$7	$53,931	$0	$0	Channel Improvements
Land Acquisition: Permanent Easement *	dollar	225	$1	$225	$0	$0	Land Acquisition
Land Acquisition: Temporary Easement *	dollar	210	$1	$210	$0	$0	Land Acquisition

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$268,101**	**$31,380**	**$8,080**
Utility Relocation	4 %	$10,724		
Mobilization \ General Conditions	5%	$13,405		
Subtotal with Percent Allowances		**$292,231**		
Contingency	30%	$87,669		
Profit	5%	$18,995		
Probable Construction Cost Estimate		**$398,895**		
Design Engineering, Geotechnical, and Construction Management	10%	$39,889		
Property Acquisition Cost:		$435		
Total Conceptual Cost Estimate (2008 Dollars)		**$478,679**		

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Alternative Name NTCR-G1

Problem Description Overbank flooding

Strategy Construct a 210 ac-ft detention facility at Leclaire Ave. and 153rd St. and a 6600 LF diversion conduit from

District Minimum Criteria for Funding: Met

Recommended Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Demolition: Brick, concrete, or stone construction	ft2	590	$4	$2,519	$0	$0	Remove Existing Culvert @ LeClaire
Channel treatment: Compaction	yd3	15	$7	$112	$0	$0	Remove Existing Culvert @ LeClaire
Inlet structures (Headwall): 42 to 66 inches	each	4	$4,758	$17,127	$15,928	$0	Install New Culvert @ LeClaire
Channel treatment: Compaction	yd3	75	$7	$561	$0	$0	Install New Culvert @ LeClaire
Channel treatment: Soil stabilization and vegetative cover	yd2	110	$14	$1,527	$1,420	$366	Install New Culvert @ LeClaire
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	25	$148	$3,712	$3,452	$0	Install New Culvert @ LeClaire
Demolition: Brick, concrete, or stone construction	ft2	560	$4	$2,391	$0	$0	Remove Existing Culvert @ Lavergne
Pipe under pavement (city): 72 to 84 inches / box culvert (28 to 38 ft2)	lf	40	$425	$17,001	$15,810	$0	Install New Culvert @ Lavergne
Inlet structures (Headwall): 42 to 66 inches	each	1	$4,758	$6,185	$5,752	$0	Install New Culvert @ Lavergne
Channel treatment: Compaction	yd3	280	$7	$2,094	$0	$0	Install New Culvert @ Lavergne
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	40	$5	$200	$186	$48	Install New Culvert @ Lavergne
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	38	$148	$5,642	$5,247	$0	Install New Culvert @ Lavergne
Channel treatment: Soil stabilization and vegetative cover	yd2	313035	$14	$4,344,926	$4,040,714	$1,040,404	Storage Construction
Channel treatment: Compaction	yd3	313035	$7	$2,341,502	$0	$0	Storage Construction
Channel treatment: Soil stabilization and vegetative cover	yd2	16000	$14	$222,080	$206,531	$53,178	Storage Construction
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	1875	$148	$278,381	$258,890	$0	Storage Construction
Pipe in earth (city): 36 inches or less	lf	50	$217	$10,839	$10,080	$0	Storage Spillway/Outlet Structure
Outlet structures (Headwall): 36 inches or less	each	1	$2,600	$2,600	$2,418	$0	Storage Spillway/Outlet Structure
Channel treatment: Excavation	yd3	270	$11	$2,884	$0	$0	Levee Excavation
Embankment construction, grading and restoration: Material hauled from offsite	yd3	180	$11	$1,922	$0	$0	Levee Excavation
Channel treatment: Compaction	yd3	180	$7	$1,346	$0	$0	Levee Excavation
Channel treatment: Compaction	yd3	90	$7	$673	$0	$0	Levee Construction
Channel treatment: Soil stabilization and vegetative cover	yd2	1800	$14	$24,984	$23,235	$5,982	Levee Construction
Pump Station: 10ac-ft per day interior drainage	each	10	$800,000	$8,000,000	$7,439,878	$0	Levee Construction
Land Acquisition: Temporary Easement *	dollar	2615	$1	$2,615	$0	$0	Land Acquisition
Floodproofing: Residence	each	1	$21,358	$21,358	$19,863	$8,236	Floodproofing

Alternative Name	NTCR-G1
Problem Description	Overbank flooding
Strategy	Construct a 210 ac-ft detention facility at Leclaire Ave. and 153rd St. and a 6600 LF diversion conduit from
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Demolition: Brick, concrete, or stone construction	ft2	52980	$4	$226,225	$0	$0	Land Acquisition
Channel treatment: Excavation	yd3	24800	$11	$264,864	$0	$0	New Diversion Structure
Channel treatment: Compaction	yd3	9725	$7	$72,743	$0	$0	New Diversion Structure
Inlet structures (Headwall): 42 to 66 inches	each	2	$4,758	$7,136	$6,637	$0	New Diversion Structure
Outlet structures (Headwall): 42 to 66 inches	each	2	$4,758	$7,136	$6,637	$0	New Diversion Structure
Channel treatment: Soil stabilization and vegetative cover	yd2	53	$14	$736	$684	$176	New Diversion Structure
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	40	$5	$200	$186	$48	New Diversion Structure
Demolition: Brick, concrete, or stone construction	ft2	575	$4	$2,455	$0	$0	Remove Existing Culvert at Karlov
Channel treatment: Compaction	yd3	40	$7	$299	$0	$0	Remove Existing Culvert at Karlov
Inlet structures (Headwall): 42 to 66 inches	each	3	$4,758	$11,894	$11,061	$0	Install New Culvert at Karlov
Outlet structures (Headwall): 42 to 66 inches	each	3	$4,758	$11,894	$11,061	$0	Install New Culvert at Karlov
Channel treatment: Soil stabilization and vegetative cover	yd2	90	$14	$1,249	$1,162	$299	Install New Culvert at Karlov
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	25	$148	$3,712	$3,452	$0	Install New Culvert at Karlov
Channel treatment: Excavation	yd3	665	$11	$7,102	$0	$0	Channel Improvements
Embankment construction, grading and restoration: Material hauled from offsite	yd3	530	$11	$5,660	$0	$0	Channel Improvements
Channel treatment: Compaction	yd3	530	$7	$3,964	$0	$0	Channel Improvements
Inlet structures (Headwall): 42 to 66 inches	each	20	$4,758	$95,150	$88,488	$0	Other
Embankment construction, grading and restoration: Material hauled from offsite	yd3	9725	$11	$103,863	$0	$0	New Diversion Structure
Land Acquisition: Temporary Easement *	dollar	865	$1	$865	$0	$0	Land Acquisition
Channel treatment: Excavation	yd3	130	$11	$1,388	$0	$0	Remove Existing Culvert @ LeClaire
Embankment construction, grading and restoration: Material hauled from offsite	yd3	115	$11	$1,228	$0	$0	Remove Existing Culvert @ LeClaire
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	84	$609	$51,131	$47,551	$0	Install New Culvert @ LeClaire
Outlet structures (Headwall): 42 to 66 inches	each	4	$4,758	$17,127	$15,928	$0	Install New Culvert @ LeClaire
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	40	$5	$200	$186	$48	Install New Culvert @ LeClaire
Channel treatment: Excavation	yd3	240	$11	$2,563	$0	$0	Remove Existing Culvert @ Lavergne
Embankment construction, grading and restoration: Material hauled from offsite	yd3	85	$11	$908	$0	$0	Remove Existing Culvert @ Lavergne
Outlet structures (Headwall): 42 to 66 inches	each	1	$4,758	$6,185	$5,752	$0	Install New Culvert @ Lavergne
Channel treatment: Soil stabilization and vegetative cover	yd2	100	$14	$1,388	$1,291	$332	Install New Culvert @ Lavergne
Channel treatment: Excavation	yd3	338000	$11	$3,609,840	$0	$0	Storage Excavation
Channel treatment: Compaction	yd3	25765	$7	$192,722	$0	$0	Storage Construction

Alternative Name	NTCR-G1
Problem Description	Overbank flooding
Strategy	Construct a 210 ac-ft detention facility at Leclaire Ave. and 153rd St. and a 6600 LF diversion conduit from
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Concrete: Cast in place	yd3	100	$250	$25,000	$0	$0	Storage Spillway/Outlet Structure
Inlet structures (Headwall): 36 inches or less	each	1	$2,600	$2,600	$2,418	$0	Storage Spillway/Outlet Structure
Pump Station: 10ac-ft per day interior drainage	each	3	$800,000	$2,728,000	$2,536,998	$0	Storage Spillway/Outlet Structure
Channel treatment: Reinforced one sided concrete wall	yd3	580	$587	$340,663	$316,811	$81,573	Levee Construction
Land Acquisition: Purchase of Property *	dollar	406600	$1	$406,600	$0	$0	Land Acquisition
Embankment construction, grading and restoration: Material hauled from offsite	yd3	52980	$11	$565,826	$0	$0	Land Acquisition
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	6565	$609	$3,996,116	$3,716,326	$0	New Diversion Structure
Channel treatment: Compaction	yd3	15075	$7	$112,761	$0	$0	New Diversion Structure
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	3283	$148	$487,427	$453,300	$0	New Diversion Structure
Embankment construction, grading and restoration: Material hauled from offsite	yd3	90	$11	$961	$0	$0	Remove Existing Culvert at Karlov
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	48	$609	$29,218	$27,172	$0	Install New Culvert at Karlov
Channel treatment: Compaction	yd3	40	$7	$299	$0	$0	Install New Culvert at Karlov
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	40	$5	$200	$186	$48	Install New Culvert at Karlov
Channel treatment: Compaction	yd3	135	$7	$1,010	$0	$0	Channel Improvements
Pipe under pavement (city): Box culvert (51 to 60 ft2)	lf	265	$661	$175,173	$162,908	$0	Channel Improvements
Channel treatment: Excavation	yd3	125	$11	$1,335	$0	$0	Remove Existing Culvert at Karlov

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$28,490,119**	**$19,465,59**	**$1,190,738**
Utility Relocation	4 %	$1,139,605		
Mobilization \ General Conditions	5%	$1,424,506		
Subtotal with Percent Allowances		**$31,054,23**		
Contingency	30%	$9,316,269		
Profit	5%	$2,018,525		
Probable Construction Cost Estimate		**$42,389,02**		
Design Engineering, Geotechnical, and Construction Management	10%	$4,238,902		
Property Acquisition Cost:		$410,080		
Total Conceptual Cost Estimate (2008 Dollars)		**$67,694,342**		

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Alternative Name	LDET-G1
Problem Description	Overbank flooding
Strategy	Replace existing crossing on Katz Corner Rd.
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	900	$11	$9,612	$0	$0	Soil Excavation for new culvert, 2 ft buffer along edges, cut down at 1:2 side slopes
Channel treatment: Additional fill	yd3	710	$14	$9,855	$0	$0	Replace soil on top of new culvert
Channel treatment: Compaction	yd3	710	$7	$5,311	$0	$0	Compact soil on top of new culvert
Channel treatment: Material to be hauled offsite	yd3	285	$12	$3,349	$0	$0	Haul Away excess soil and existing concrete & pavement
Channel treatment: Vegetative cover only	yd2	35	$9	$299	$278	$72	Vegetation restoration - road embankment
Concrete: Cast in place	yd3	110	$250	$27,500	$0	$0	Oversize culvert construction (2- 10 ft x 7 ft)
Outlet structures (Headwall): 42 to 66 inches	each	3	$4,758	$14,273	$13,273	$0	Outlet structure - used 3 units to cover larger size
Inlet structures (Headwall): 42 to 66 inches	each	3	$4,758	$14,273	$13,273	$0	Inlet structure - used 3 units to cover larger size
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	100	$5	$500	$465	$120	Clean-up around inlet & outlet
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	150	$148	$22,271	$20,711	$0	Replace Roadway Pavement, extra for additional lanes
Floodproofing: Residence	each	1	$21,358	$21,358	$19,863	$8,236	Residential Acq - PIN 33311200260000

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$128,599**	**$67,863**	**$8,428**
Utility Relocation	4 %	$5,144		
Mobilization \ General Conditions	5%	$6,430		
Subtotal with Percent Allowances		**$140,173**		
Contingency	30%	$42,052		
Profit	5%	$9,111		
Probable Construction Cost Estimate		**$191,336**		
Design Engineering, Geotechnical, and Construction Management	10%	$19,134		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate (2008 Dollars)		**$286,760**		

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Alternative Name	NCLD-G1
Problem Description	Overbank flooding
Strategy	Construct 700 ac-ft detention facility and replace crossings at 198th St. and downstream private drives
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	470	$11	$5,020	$0	$0	Soil Excavation for new culvert, 2 ft buffer along edges, cut down at 1:2 side slopes
Channel treatment: Additional fill	yd3	335	$14	$4,650	$0	$0	Replace soil on top of new culvert
Channel treatment: Compaction	yd3	335	$7	$2,506	$0	$0	Compact soil on top of new culvert
Channel treatment: Material to be hauled offsite	yd3	165	$12	$1,939	$0	$0	Haul Away excess soil and existing concrete & pavement
Demolition: Brick, concrete, or stone construction	ft2	2615	$4	$11,166	$0	$0	Demolition of existing concrete culvert
Channel treatment: Vegetative cover only	yd2	24	$9	$205	$191	$49	Vegetation restoration - road embankment
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	174	$609	$105,914	$98,498	$0	2, 6x8 box culverts, 87 length
Outlet structures (Headwall): 42 to 66 inches	each	3	$4,758	$14,273	$13,273	$0	Outlet structure - used 3 units to cover larger size
Inlet structures (Headwall): 42 to 66 inches	each	3	$4,758	$14,273	$13,273	$0	Inlet structure - used 3 units to cover larger size
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	100	$5	$500	$465	$120	Clean-up around inlet & outlet
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	85	$148	$12,620	$11,736	$0	Replace Roadway Pavement, extra for additional lanes
Floodproofing: Industry	2,500 ft2	23	$21,358	$488,031	$453,861	$188,189	Commercial Floodproof - PIN 33303000140000
Floodproofing: Residence	each	1	$21,358	$21,358	$19,863	$8,236	Residential - PIN 32254050140000
Channel treatment: Excavation	yd3	1040	$11	$11,107	$0	$0	Soil Excavation for new culvert, 2 ft buffer along edges, cut down at 1:2 side slopes
Channel treatment: Additional fill	yd3	830	$14	$11,520	$0	$0	Replace soil on top of new culvert
Channel treatment: Compaction	yd3	830	$7	$6,208	$0	$0	Compact soil on top of new culvert
Channel treatment: Material to be hauled offsite	yd3	270	$12	$3,173	$0	$0	Haul Away excess soil and existing concrete & pavement
Demolition: Brick, concrete, or stone construction	ft2	4850	$4	$20,710	$0	$0	Demolition of existing concrete culvert
Channel treatment: Vegetative cover only	yd2	60	$9	$512	$477	$123	Vegetation restoration - road embankment
Concrete: Cast in place	yd3	75	$250	$18,750	$0	$0	Bridge construction - 29 span

Alternative Name	NCLD-G1
Problem Description	Overbank flooding
Strategy	Construct 700 ac-ft detention facility and replace crossings at 198th St. and downstream private drives
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Outlet structures (Headwall): 42 to 66 inches	each	3	$4,758	$14,273	$13,273	$0	Outlet structure - used 3 units to cover larger size
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	100	$5	$500	$465	$120	Clean-up around inlet & outlet
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	160	$148	$23,755	$22,092	$0	Replace Roadway Pavement, extra for additional lanes
Inlet structures (Headwall): 42 to 66 inches	each	3	$4,758	$14,273	$13,273	$0	Inlet structure - used 3 units to cover larger size

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$807,233**	**$660,740**	**$196,837**
Utility Relocation	4 %	$32,289		
Mobilization \ General Conditions	5%	$40,362		
Subtotal with Percent Allowances		**$879,884**		
Contingency	30%	$263,965		
Profit	5%	$57,192		
Probable Construction Cost Estimate		**$1,201,042**		
Design Engineering, Geotechnical, and Construction Management	10%	$120,104		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate (2008 Dollars)		**$2,178,723**		

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Total Conceptual Cost Report

Alternative Name	NCLD-G2
Problem Description	Overbank flooding
Strategy	Replace Bridge St. and Linda Lane and relocate mobile homes
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	130	$11	$1,388	$0	$0	Soil Excavation for new culvert, 2 ft buffer along edges, cut down at 1:2 side slopes
Channel treatment: Additional fill	yd3	100	$14	$1,388	$0	$0	Replace soil on top of new culvert
Channel treatment: Compaction	yd3	100	$7	$748	$0	$0	Compact soil on top of new culvert
Channel treatment: Material to be hauled offsite	yd3	50	$12	$588	$0	$0	Haul Away excess soil and existing concrete & pavement
Demolition: Brick, concrete, or stone construction	ft2	1620	$4	$6,917	$0	$0	Demolition of existing concrete culvert
Channel treatment: Vegetative cover only	yd2	20	$9	$171	$159	$41	Vegetation restoration - road embankment
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	58	$609	$35,305	$32,833	$0	2, 7x5 box at INV 617.67, 29 length
Outlet structures (Headwall): 42 to 66 inches	each	3	$4,758	$14,273	$13,273	$0	Outlet structure - used 3 units to cover larger size
Inlet structures (Headwall): 42 to 66 inches	each	3	$4,758	$14,273	$13,273	$0	Inlet structure - used 3 units to cover larger size
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	100	$5	$500	$465	$120	Clean-up around inlet & outlet
Buyout: Property *	dollar	36000	$1	$36,000	$0	$0	Relocate mobile homes to other pads within park
Channel treatment: Excavation	yd3	170	$11	$1,816	$0	$0	Soil Excavation for new culvert, 2 ft buffer along edges, cut down at 1:2 side slopes
Channel treatment: Additional fill	yd3	110	$14	$1,527	$0	$0	Replace soil on top of new culvert
Channel treatment: Compaction	yd3	110	$7	$823	$0	$0	Compact soil on top of new culvert
Channel treatment: Material to be hauled offsite	yd3	70	$12	$823	$0	$0	Haul Away excess soil and existing concrete & pavement
Demolition: Brick, concrete, or stone construction	ft2	815	$4	$3,480	$0	$0	Demolition of existing concrete culvert
Channel treatment: Vegetative cover only	yd2	30	$9	$256	$238	$61	Vegetation restoration - road embankment
Concrete: Cast in place	yd3	30	$250	$7,500	$0	$0	Bridge deck construction
Outlet structures (Headwall): 42 to 66 inches	each	4	$4,758	$19,030	$17,698	$0	Outlet structure - used 4 units to cover larger size
Inlet structures (Headwall): 42 to 66 inches	each	4	$4,758	$19,030	$17,698	$0	Inlet structure - used 4 units to cover larger size
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	100	$5	$500	$465	$120	Clean-up around inlet & outlet

Alternative Name	NCLD-G2
Problem Description	Overbank flooding
Strategy	Replace Bridge St. and Linda Lane and relocate mobile homes
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	30	$148	$4,454	$4,142	$0	Replace Roadway Pavement, extra for additional lanes

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

		Base Cost	Maint. Cost	Replacement Cost
Subtotal (direct costs)		**$134,788**	**$100,244**	**$342**
Utility Relocation	4 %	$5,392		
Mobilization \ General Conditions	5%	$6,739		
Subtotal with Percent Allowances		**$146,919**		
Contingency	30%	$44,076		
Profit	5%	$9,550		
Probable Construction Cost Estimate		**$200,544**		
Design Engineering, Geotechnical, and Construction Management	10%	$20,054		
Property Acquisition Cost:		$36,000		
Total Conceptual Cost Estimate (2008 Dollars)		**$357,184**		

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Little Calumet River Watershed Detailed Watershed Plan
Total Conceptual Cost Report

Alternative Name	NCLD-G3
Problem Description	Overbank flooding
Strategy	Replace Torrence Ave. and Sauk Trail Rd.
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	1074500	$11	$11,475,660	$0	$0	Excavation for detention area
Channel treatment: Material to be hauled offsite	yd3	1068700	$12	$12,557,225	$0	$0	Haul Away excess soil
Channel treatment: Soil stabilization and vegetative cover	yd2	57000	$14	$791,160	$735,767	$189,445	Vegetation restoration - berms and along creek
Channel treatment: Vegetative cover only	yd2	210000	$9	$1,793,400	$1,667,835	$429,434	Vegetation restoration - pond bottom
Embankment construction, grading and restoration: Additional fill	yd3	5800	$14	$80,504	$0	$0	Levee surface reconstruction: 6,500 linear feet
Embankment construction, grading and restoration: Compaction of fill	yd3	5800	$5	$30,972	$0	$0	Levee surface reconstruction compaction: 6,500 linear feet
Channel treatment: Excavation	yd3	3300	$11	$35,244	$0	$0	Weir excavation, 530 ft wide, 6 ft deep, assume 4:1 side slopes across levee on channel and pond sides.
Pump Station: 10ac-ft per day interior drainage	each	10	$800,000	$8,000,000	$7,439,878	$0	Pump Sta. for 700 ac-ft - assume 10x size of 10ac/day PS
Pipe in earth (city): 36 inches or less	lf	250	$217	$54,195	$50,401	$0	Pipe to outlet from pump
Outlet structures (Headwall): 36 inches or less	each	1	$2,600	$2,600	$2,418	$0	Outlet structure from pump
Inlet structures (Headwall): 36 inches or less	each	1	$2,600	$2,600	$2,418	$0	Inlet structure to pump
Land Acquisition: Purchase of Property *	dollar	137075	$1	$137,075	$0	$0	Buyout Residential, PIN 33171000090000
Land Acquisition: Purchase of Property *	dollar	217668	$1	$217,668	$0	$0	Buyout Residential, PIN 33171000070000
Land Acquisition: Purchase of Property *	dollar	240026	$1	$240,026	$0	$0	Buyout Residential, PIN 33171000080000
Land Acquisition: Purchase of Property *	dollar	172474	$1	$172,474	$0	$0	Buyout Residential, PIN 33171000060000
Land Acquisition: Purchase of Property *	dollar	354804	$1	$354,804	$0	$0	Buyout Residential, PIN 33171010020000
Demolition: Wood construction	ft2	7386	$2	$15,806	$0	$0	Demolition of existing homes; square footage for 5 homes from the CCAD
Channel treatment: Excavation	yd3	155	$11	$1,655	$0	$0	Soil Excavation for new culvert, 2 ft buffer along edges, cut down at 1:2 side slopes

Alternative Name	NCLD-G3
Problem Description	Overbank flooding
Strategy	Replace Torrence Ave. and Sauk Trail Rd.
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Additional fill	yd3	95	$14	$1,319	$0	$0	Replace soil on top of new culvert
Channel treatment: Compaction	yd3	95	$7	$711	$0	$0	Compact soil on top of new culvert
Channel treatment: Material to be hauled offsite	yd3	70	$12	$823	$0	$0	Haul Away excess soil and existing concrete & pavement
Demolition: Brick, concrete, or stone construction	ft2	815	$4	$3,480	$0	$0	Demolition of existing concrete culvert
Channel treatment: Vegetative cover only	yd2	33	$9	$282	$262	$67	Vegetation restoration - road embankment
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	63	$609	$38,348	$35,663	$0	3, 7x6.5 box at INV 605.55, 21 length
Outlet structures (Headwall): 42 to 66 inches	each	4	$4,758	$19,030	$17,698	$0	Outlet structure - used 4 units to cover larger size
Inlet structures (Headwall): 42 to 66 inches	each	4	$4,758	$19,030	$17,698	$0	Inlet structure - used 4 units to cover larger size
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	100	$5	$500	$465	$120	Clean-up around inlet & outlet
Channel treatment: Excavation	yd3	695	$11	$7,423	$0	$0	Soil Excavation for new culvert, 2 ft buffer along edges, cut down at 1:2 side slopes
Channel treatment: Additional fill	yd3	621	$14	$8,619	$0	$0	Replace soil on top of new culvert
Channel treatment: Compaction	yd3	621	$7	$4,645	$0	$0	Compact soil on top of new culvert
Channel treatment: Material to be hauled offsite	yd3	127	$12	$1,492	$0	$0	Haul Away excess soil and existing concrete & pavement
Demolition: Brick, concrete, or stone construction	ft2	53	$4	$226	$0	$0	Demolition of existing concrete culvert
Channel treatment: Vegetative cover only	yd2	50	$9	$427	$397	$102	Vegetation restoration - road embankment
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	118	$609	$71,827	$66,798	$0	2, 8x8.5 box at INV 603.5, 59 length
Outlet structures (Headwall): 42 to 66 inches	each	3	$4,758	$14,273	$13,273	$0	Outlet structure - used 3 units to cover larger size
Inlet structures (Headwall): 42 to 66 inches	each	3	$4,758	$14,273	$13,273	$0	Inlet structure - used 3 units to cover larger size
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	100	$5	$500	$465	$120	Clean-up around inlet & outlet
Channel treatment: Excavation	yd3	155	$11	$1,655	$0	$0	Soil Excavation for new culvert, 2 ft buffer along edges, cut down at 1:2 side slopes
Channel treatment: Additional fill	yd3	150	$14	$2,082	$0	$0	Replace soil on top of new culvert
Channel treatment: Compaction	yd3	150	$7	$1,122	$0	$0	Compact soil on top of new culvert

Alternative Name	NCLD-G3
Problem Description	Overbank flooding
Strategy	Replace Torrence Ave. and Sauk Trail Rd.
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Material to be hauled offsite	yd3	17	$12	$200	$0	$0	Haul Away excess soil and existing concrete & pavement
Demolition: Brick, concrete, or stone construction	ft2	975	$4	$4,163	$0	$0	Demolition of existing concrete culvert
Channel treatment: Vegetative cover only	yd2	42	$9	$359	$334	$86	Vegetation restoration - road embankment
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	48	$609	$29,218	$27,172	$0	2, 8x8.5 box at INV 603.5, 24 width
Outlet structures (Headwall): 42 to 66 inches	each	3	$4,758	$14,273	$13,273	$0	Outlet structure - used 3 units to cover larger size
Inlet structures (Headwall): 42 to 66 inches	each	3	$4,758	$14,273	$13,273	$0	Inlet structure - used 3 units to cover larger size
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	100	$5	$500	$465	$120	Clean-up around inlet & outlet
Land Acquisition: Purchase of Property *	dollar	128414	$1	$128,414	$0	$0	Buyout Agricultural, cost per acre based on average farmland of vicinity

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$35,116,092**	**$10,119,22**	**$619,494**
Utility Relocation	4 %	$1,404,644		
Mobilization \ General Conditions	5%	$1,755,805		
Subtotal with Percent Allowances		**$38,276,54**		
Contingency	30%	$11,482,962		
Profit	5%	$2,487,975		
Probable Construction Cost Estimate		**$52,247,47**		
Design Engineering, Geotechnical, and Construction Management	10%	$5,224,748		
Property Acquisition Cost:		$1,250,460		
Total Conceptual Cost Estimate (2008 Dollars)		**$69,461,403**		

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Little Calumet River Watershed Detailed Watershed Plan
Total Conceptual Cost Report

Alternative Name NOCR-G1

Problem Description Overbank Flooding

Strategy Replace culvert from Wenworth Ave. and Grand Truck Railroad and construct a 12 ac-ft detention facility

District Minimum Criteria for Funding: Met

Recommended Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	40500	$11	$432,540	$0	$0	Excavation for detention area, including down to HWL
Channel treatment: Material to be hauled offsite	yd3	40500	$12	$475,875	$0	$0	Haul Away excess soil
Channel treatment: Vegetative cover only	yd2	13100	$9	$111,874	$104,041	$26,789	Vegetation restoration - pond
Pump Station: 10ac-ft per day interior drainage	each	1	$800,000	$800,000	$743,988	$0	Pump Station for 12 ac-ft basin
Outlet structures (Headwall): 36 inches or less	each	2	$2,600	$5,201	$4,837	$0	Outlet structure to pond and outlet from pump
Inlet structures (Headwall): 36 inches or less	each	2	$2,600	$5,201	$4,837	$0	Inlet from ditch to sewer and inlet to pump
Land Acquisition: Permanent Easement *	dollar	3	$1	$3	$0	$0	Permanent Easement (50%) - based on local per acre average value, Golf course (2.7 acre)
Pipe under pavement (city): 36 inches or less	lf	2730	$304	$830,876	$772,702	$0	Storm sewer under streets (varies 12" to 36")
Pipe in earth (city): 36 inches or less	lf	510	$217	$110,558	$102,817	$0	Storm sewer along lot lines and out from pond (varies 12" to 36")
Pipe under pavement (city): 42 to 66 inches / box culvert (15 to 27 ft2)	lf	1100	$292	$320,694	$298,241	$0	Culvert under streets (4 x 6ft)
Pipe in earth (city): 42 to 66 inches / box culvert (15 to 27 ft2)	lf	0	$208	$0	$0	$0	Culvert along lot lines (4 x 6ft)
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	400	$5	$2,000	$1,860	$479	Regrade drainage ditch in the vicinity of proposed storm sewer inlet

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$3,094,818**	**$2,033,321**	**$27,268**
Utility Relocation	4 %	$123,793		
Mobilization \ General Conditions	5%	$154,741		
Subtotal with Percent Allowances		**$3,373,351**		
Contingency	30%	$1,012,005		
Profit	5%	$219,268		
Probable Construction Cost Estimate		**$4,604,624**		
Design Engineering, Geotechnical, and Construction Management	10%	$460,462		
Property Acquisition Cost:		$3		
Total Conceptual Cost Estimate (2008 Dollars)		**$7,125,679**		

Metropolitan Water Reclamation District of Greater Chicago
Little Calumet River Watershed Detailed Watershed Plan
Table X-X Total Conceptual Cost Report

Alternative Name	PLCR-G1
Problem Description	Overbank flooding
Strategy	Construct a levee with a compensatory storage
District Minimum Criteria for Funding:	Not Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Concrete: Cast in place	yd3	1688	$250	$422,000	$0	$0	Floodwall to elev 640, tied into elev 638.
Pipe under pavement (city): 36 inches or less	lf	630	$304	$191,741	$178,316	$0	2- 15 ft. long culverts, 36 inch diameter for low flow interior drainage. +600 ft "culverts" for hosp site drainage.
Channel treatment: Soil stabilization and vegetative cover	yd2	48400	$14	$671,792	$624,756	$160,862	Assumed appx 10 acres at 2 ft deep of flood fringe removed = 20 acre-ft *1.1= 22 acre-feet = 35000 cubic yards.
Channel treatment: Excavation	yd3	35000	$11	$373,800	$0	$0	Assumed excavation area about 10 acres - 48400 square yards.
Pump Station: 10ac-ft per day interior drainage	each	0	$800,000	$48,000	$44,639	$0	Total of 5 acre ft pumping per day (can be more than one pump station).

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$1,707,333**	**$847,711**	**$160,862**
Utility Relocation	4 %	$68,293		
Mobilization \ General Conditions	5%	$85,367		
Subtotal with Percent Allowances		**$1,860,992**		
Contingency	30%	$558,298		
Profit	5%	$120,965		
Probable Construction Cost Estimate		**$2,540,255**		
Design Engineering, Geotechnical, and Construction Management	10%	$254,025		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate (2006 Dollars)		**$3,802,853**		
Additional Comments				
Total Conceptual Cost Estimate (2008 Dollars)		**$4,031,024**		

Metropolitan Water Reclamation District of Greater Chicago
Little Calumet River Watershed Detailed Watershed Plan
Table X-X Total Conceptual Cost Report

Alternative Name	TCTA-G1
Problem Description	Overbank Flooding
Strategy	Replace culvert from 26th St. and Stewart Ave. to State and 22nd St.
District Minimum Criteria for Funding:	Not Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Compaction	yd3	5932	$7	$44,371	$0	$0	Compact areas around culverts
Channel treatment: Excavation	yd3	1240425	$11	$13,247,739	$0	$0	Soil Excavation for detention and culverts
Channel treatment: Material to be hauled offsite	yd3	1183606	$12	$13,907,371	$0	$0	Haul Away excess soil and existing concrete & pavement
Channel treatment: Reinforced one sided concrete wall	yd3	95	$587	$55,798	$51,892	$13,361	Assumed cost for concrete spillway
Channel treatment: Soil stabilization and vegetative cover	yd2	158595	$14	$2,201,299	$2,047,174	$527,107	Stabilization of side slopes and vegetation
Channel treatment: Vegetative cover only	yd2	5469	$9	$46,705	$43,435	$11,184	Vegetation cover for excavated areas
Demolition: Brick, concrete, or stone construction	ft2	550	$4	$2,349	$0	$0	Demolition of existing concrete outlet structure
Embankment construction, grading and restoration: Compaction of fill	yd3	46611	$5	$248,903	$0	$0	Compact clay liner of detention basin (assume 1 thick liner)
Inlet structures (Headwall): 42 to 66 inches	each	5	$4,758	$23,788	$22,122	$0	Inlet structure
Land Acquisition: Purchase of Property *	dollar	1500000	$1	$1,500,000	$0	$0	Land Acquisition
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	130	$5	$650	$604	$156	Clean-up around inlet & outlet
Outlet structures (Headwall): 42 to 66 inches	each	5	$4,758	$23,788	$22,122	$0	Outlet structure
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	8706	$148	$1,292,580	$1,202,079	$0	Replace Roadway Pavement, extra for additional lanes
Pipe in earth (city): 36 inches or less	lf	3840	$217	$832,435	$774,152	$0	Culvert construction between reservoir and waterway
Pipe under pavement (city): Box culvert (51 to 60 ft2)	lf	3700	$661	$2,445,811	$2,274,567	$0	Culvert construction assumed cost of 1.25X Cost 51
Pump Station: 10ac-ft per day interior drainage	each	12	$800,000	$9,600,000	$8,927,853	$0	
Land Acquisition: Purchase of Property *	dollar	30000	$1	$30,000	$0	$0	Land Acquisition

Alternative Name	TCTA-G1
Problem Description	Overbank Flooding
Strategy	Replace culvert from 26th St. and Stewart Ave. to State and 22nd St.
District Minimum Criteria for Funding:	Not Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$43,973,585**	**$15,366,00**	**$551,808**
Utility Relocation	4 %	$1,758,943		
Mobilization \ General Conditions	5%	$2,198,679		
Subtotal with Percent Allowances		**$47,931,20**		
Contingency	30%	$14,379,362		
Profit	5%	$3,115,529		
Probable Construction Cost Estimate		**$65,426,09**		
Design Engineering, Geotechnical, and Construction Management	10%	$6,542,610		
Property Acquisition Cost:		$1,530,000		
Total Conceptual Cost Estimate (2006 Dollars)		**$89,416,517**		
Additional Comments				
Total Conceptual Cost Estimate (2008 Dollars)		**$94,781,508**		

Metropolitan Water Reclamation District of Greater Chicago
Little Calumet River Watershed Detailed Watershed Plan
Table X-X Total Conceptual Cost Report

Alternative Name TCTB-G1
Problem Description Overbank Flooding
Strategy Channel improvements along Thorn Creek Tributary B
District Minimum Criteria for Funding: Not Met
Recommended Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Reinforced trapezoidal concrete channel	yd3	4083	$587	$2,398,150	$2,230,243	$0	Concrete lining cost for the entire tributary
Channel treatment: Excavation	yd3	8167	$11	$87,224	$0	$0	Must excavate in order to get grading correct for lining
Channel treatment: Material to be hauled offsite	yd3	4083	$12	$47,975	$0	$0	Displaced material by concrete lining
Embankment construction, grading and restoration: Compaction of fill	yd3	4083	$5	$21,803	$0	$0	Compaction of soil of newly graded embankments (2:1) slope
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	3119	$5	$15,595	$14,503	$3,734	Compaction of soil of newly graded embankments (2:1) slope
Land Acquisition: Temporary Easement *	dollar	13000	$1	$13,000	$0	$0	Assume Property value of $130,000. 1 Year Easement

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

		Base Cost	Maint. Cost	Replacement Cost
Subtotal (direct costs)		**$2,570,747**	**$2,244,746**	**$3,734**
Utility Relocation	4 %	$102,830		
Mobilization \ General Conditions	5%	$128,537		
Subtotal with Percent Allowances		**$2,802,114**		
Contingency	30%	$840,634		
Profit	5%	$182,137		
Probable Construction Cost Estimate		**$3,824,886**		
Design Engineering, Geotechnical, and Construction Management	10%	$382,489		
Property Acquisition Cost:		$13,000		
Total Conceptual Cost Estimate (2006 Dollars)		**$6,468,855**		
Additional Comments				
Total Conceptual Cost Estimate (2008 Dollars)		**$6,856,986**		

Metropolitan Water Reclamation District of Greater Chicago
Little Calumet River Watershed Detailed Watershed Plan
Table X-X Total Conceptual Cost Report

Alternative Name TCTD-G1

Problem Description Overbank Flooding

Strategy Construct 530 ac-ft detention facility and replace culverts at Lakwood Blvd., east of Gold St., and East Rocket

District Minimum Criteria for Funding: Not Met

Recommended Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	946222	$11	$10,105,651	$0	$0	Soil Excavation for new offline detention facility and remove Structure 56
Channel treatment: Soil stabilization and vegetative cover	yd2	222907	$14	$3,093,949	$2,877,325	$740,854	Stabilization of side slopes and vegetation
Channel treatment: Material to be hauled offsite	yd3	940625	$12	$11,052,344	$0	$0	Haul Away excess soil and existing concrete & pavement
Outlet structures (Headwall): 42 to 66 inches	each	3	$4,758	$14,273	$13,273	$0	Inlet/Outlet Structure
Inlet structures (Headwall): 42 to 66 inches	each	2	$4,758	$9,515	$8,849	$0	Inlet/Outlet Structure
Concrete: Cast in place	yd3	47	$250	$11,750	$0	$0	Assumed cost for concrete spillway
Land Acquisition: Permanent Easement *	dollar	25000	$1	$25,000	$0	$0	Land Acquisition
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	50	$5	$250	$233	$60	Clean-up around inlet & outlet
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	3918	$148	$581,705	$540,977	$0	Replace Roadway Pavement, extra for additional lanes
Pump Station: 10ac-ft per day interior drainage	each	10	$800,000	$8,000,000	$7,439,878	$0	

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$32,869,437**	**$10,880,53**	**$740,914**
Utility Relocation	4 %	$1,314,777		
Mobilization \ General Conditions	5%	$1,643,472		
Subtotal with Percent Allowances		**$35,827,68**		
Contingency	30%	$10,748,306		
Profit	5%	$2,328,800		
Probable Construction Cost Estimate		**$48,904,79**		
Design Engineering, Geotechnical, and Construction Management	10%	$4,890,479		
Property Acquisition Cost:		$25,000		
Total Conceptual Cost Estimate (2006 Dollars)		**$65,441,719**		
Additional Comments				
Total Conceptual Cost Estimate (2008 Dollars)		**$69,368,222**		

Metropolitan Water Reclamation District of Greater Chicago
Little Calumet River Watershed Detailed Watershed Plan
Table X-X Total Conceptual Cost Report

Alternative Name	THCR-G1
Problem Description	Overbank Flooding
Strategy	Channel capacity improvements along Thorn Creek Tributary B, levees along Thorn Creek, a diversion
District Minimum Criteria for Funding:	Not Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Additional fill	yd3	92860	$14	$1,288,897	$0	$0	Additional fill for new storm sewer
Channel treatment: Compaction	yd3	147185	$7	$1,100,944	$0	$0	Compact soil near the levee, on top of new storm sewer, around new sidewall, and on new culvert.
Channel treatment: Excavation	yd3	195041	$11	$2,083,038	$0	$0	Multiple projects/uses
Channel treatment: Material to be hauled offsite	yd3	84821	$12	$996,647	$0	$0	Multiple projects/uses
Channel treatment: Reinforced one sided concrete wall	yd3	3576	$587	$2,100,364	$1,953,306	$502,938	Levee assume 3 feet thick, 10 feet high
Channel treatment: Soil stabilization and vegetative cover	yd2	57458	$14	$797,517	$741,679	$190,968	Stabilization of side slopes and vegetation
Channel treatment: Vegetative cover only	yd2	16604	$9	$141,798	$131,870	$33,954	Vegetative cover of excavated areas
Concrete: Cast in place	yd3	1156	$250	$289,000	$0	$0	New Bridge for Chicago Hts Glenwood Road and assumed cost for spillway
Demolition: Brick, concrete, or stone construction	ft2	546100	$4	$2,331,847	$0	$0	RR/Path Bridge and road removal
Embankment construction, grading and restoration: Additional fill	yd3	6681	$14	$92,732	$0	$0	Additional fill required to raise road and fill to match grade of raised road
Embankment construction, grading and restoration: Compaction of fill	yd3	7283	$5	$38,891	$0	$0	Compaction of soil of newly graded channel
Embankment construction, grading and restoration: Material hauled from offsite	yd3	9806	$11	$104,728	$0	$0	Remove Bike Path/Railroad
maintenance: Large Channel Maintenance	lf	1192	$100	$119,200	$110,854	$28,543	Clear Trees etc.
maintenance: Small Channel Maintenance (Brush and debris removal)	lf	20	$5	$100	$93	$24	Clean-up around inlet & outlet
Outlet structures (Headwall): 36 inches or less	each	6	$2,600	$15,602	$14,510	$0	Inlet/Outlet structure
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	13214	$148	$1,961,883	$1,824,521	$0	Replace Roadway Pavement, extra for additional lanes
Pipe in earth (city): 72 to 84 inches / box culvert (28 to 38 ft2)	lf	86	$303	$26,082	$24,256	$0	Additional Barrel 5.5 x
Pipe in earth (city): Box culvert (51 to 60 ft2)	lf	4782	$472	$2,257,152	$2,099,117	$0	Multiple uses
Pipe in earth (county): 36 inches or less	lf	221	$217	$47,908	$44,554	$0	Stormsewer to drain surface runoff (5x4)
Pump Station: 10ac-ft per day interior drainage	each	2	$800,000	$1,600,000	$1,487,976	$0	Assume Pump Station Required at all Levees

Alternative Name	THCR-G1
Problem Description	Overbank Flooding
Strategy	Channel capacity improvements along Thorn Creek Tributary B, levees along Thorn Creek, a diversion
District Minimum Criteria for Funding:	Not Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)							
Subtotal (direct costs)				**$17,394,330**	**$8,432,735**	**$756,427**	
Utility Relocation			4 %	$695,773			
Mobilization \ General Conditions			5%	$869,716			
Subtotal with Percent Allowances				**$18,959,81**			
Contingency			30%	$5,687,946			
Profit			5%	$1,232,388			
Probable Construction Cost Estimate				**$25,880,15**			
Design Engineering, Geotechnical, and Construction Management			10%	$2,588,015			
Property Acquisition Cost:				$0			
Total Conceptual Cost Estimate (2006 Dollars)				**$37,657,330**			
Additional Comments							
Total Conceptual Cost Estimate (2008 Dollars)				**$39,916,770**			

Metropolitan Water Reclamation District of Greater Chicago
Little Calumet River Watershed Detailed Watershed Plan
Table X-X Total Conceptual Cost Report

Alternative Name	THCR-G2
Problem Description	Overbank Flooding
Strategy	Modifiy the roadway profile of Sauk Trail Rd.
District Minimum Criteria for Funding:	Not Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Embankment construction, grading and restoration: Additional fill	yd3	14715	$14	$204,244	$0	$0	Additional fill required to raise road
Embankment construction, grading and restoration: Compaction of fill	yd3	14688	$5	$78,434	$0	$0	Compaction of soil to fill up to new road elevation
Channel treatment: Vegetative cover only	yd2	2033	$9	$17,362	$16,146	$4,157	Road Embankment vegetation
Demolition: Brick, concrete, or stone construction	ft2	84608	$4	$361,276	$0	$0	Excavate
Channel treatment: Material to be hauled offsite	yd3	9401	$12	$110,462	$0	$0	Haul Away existing concrete & pavement
Paving: Asphalt Pavement Installation (24 ft wide, 2 ft C&G, 1 ft Excavation	lf	3305	$148	$490,693	$456,337	$0	Replace Roadway Pavement, extra for additional lanes

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$1,262,471**	**$472,484**	**$4,157**
Utility Relocation	4 %	$50,499		
Mobilization \ General Conditions	5%	$63,124		
Subtotal with Percent Allowances		**$1,376,094**		
Contingency	30%	$412,828		
Profit	5%	$89,446		
Probable Construction Cost Estimate		**$1,878,368**		
Design Engineering, Geotechnical, and Construction Management	10%	$187,837		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate (2006 Dollars)		**$2,542,845**		
Additional Comments				
Total Conceptual Cost Estimate (2008 Dollars)		**$2,695,416**		

Figure 2.1.1

LITTLE CALUMET RIVER WATERSHED OVERVIEW MAP

Little Calumet River DWP

December, 2009

Stream Centerlines
Flood Control Facilities
County Boundaries

Sub-Watersheds

- Butterfield Creek
- Cady Marsh Ditch
- Calumet Union Drainage
- Deer Creek
- Hart Ditch
- Little Calumet River
- Midlothian/Natalie Creeks
- North Creek
- Plum Creek
- Thorn Creek

N

1 inch = 12,000 feet

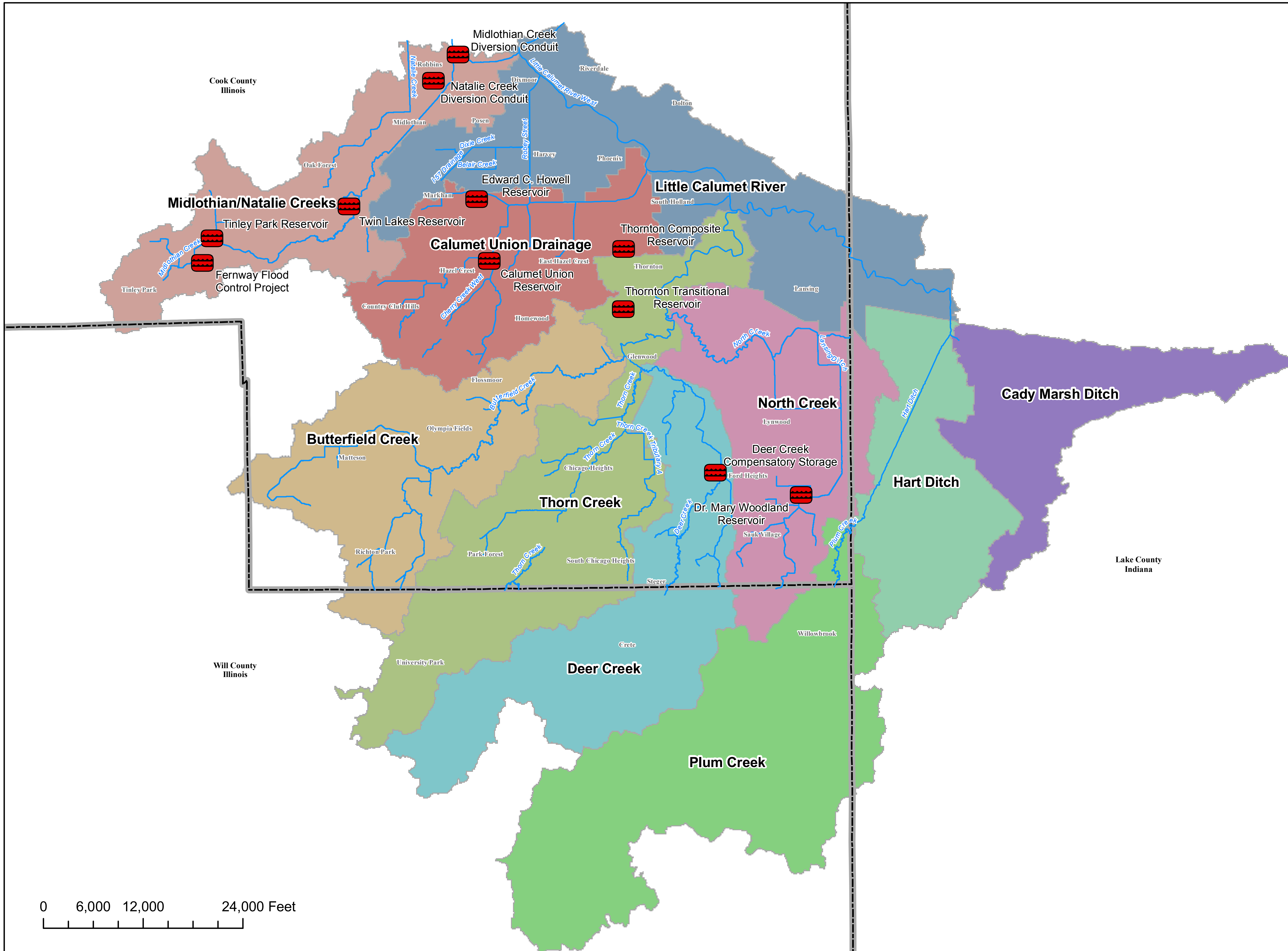
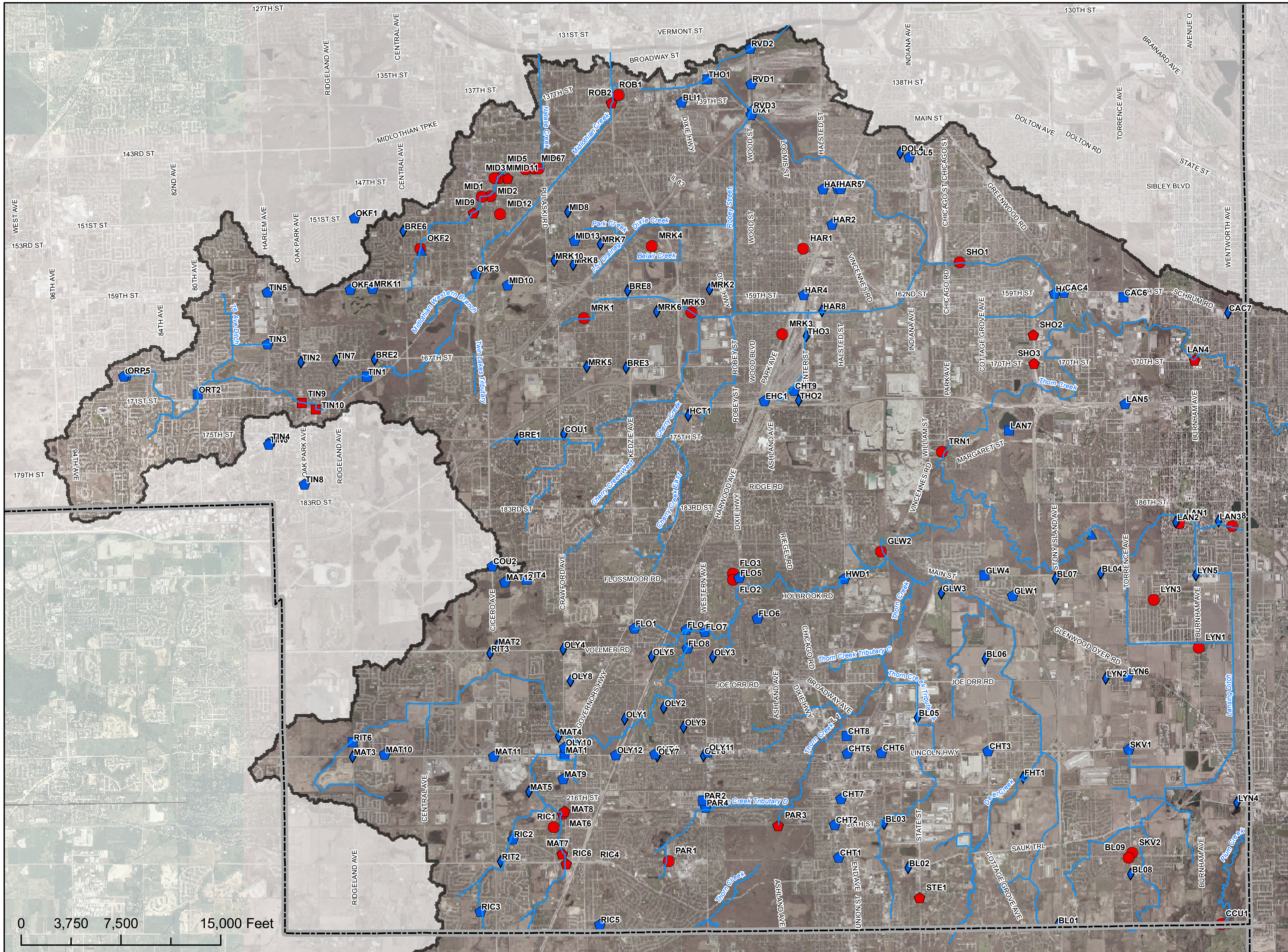


Figure 2.2.1

LITTLE CALUMET RIVER WATERSHED PROBLEM LOCATIONS

Little Calumet River DWP

December, 2009



Regional Problems

- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems

- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- Stream Centerlines
- County Boundary

N

1 inch = 7,500 feet

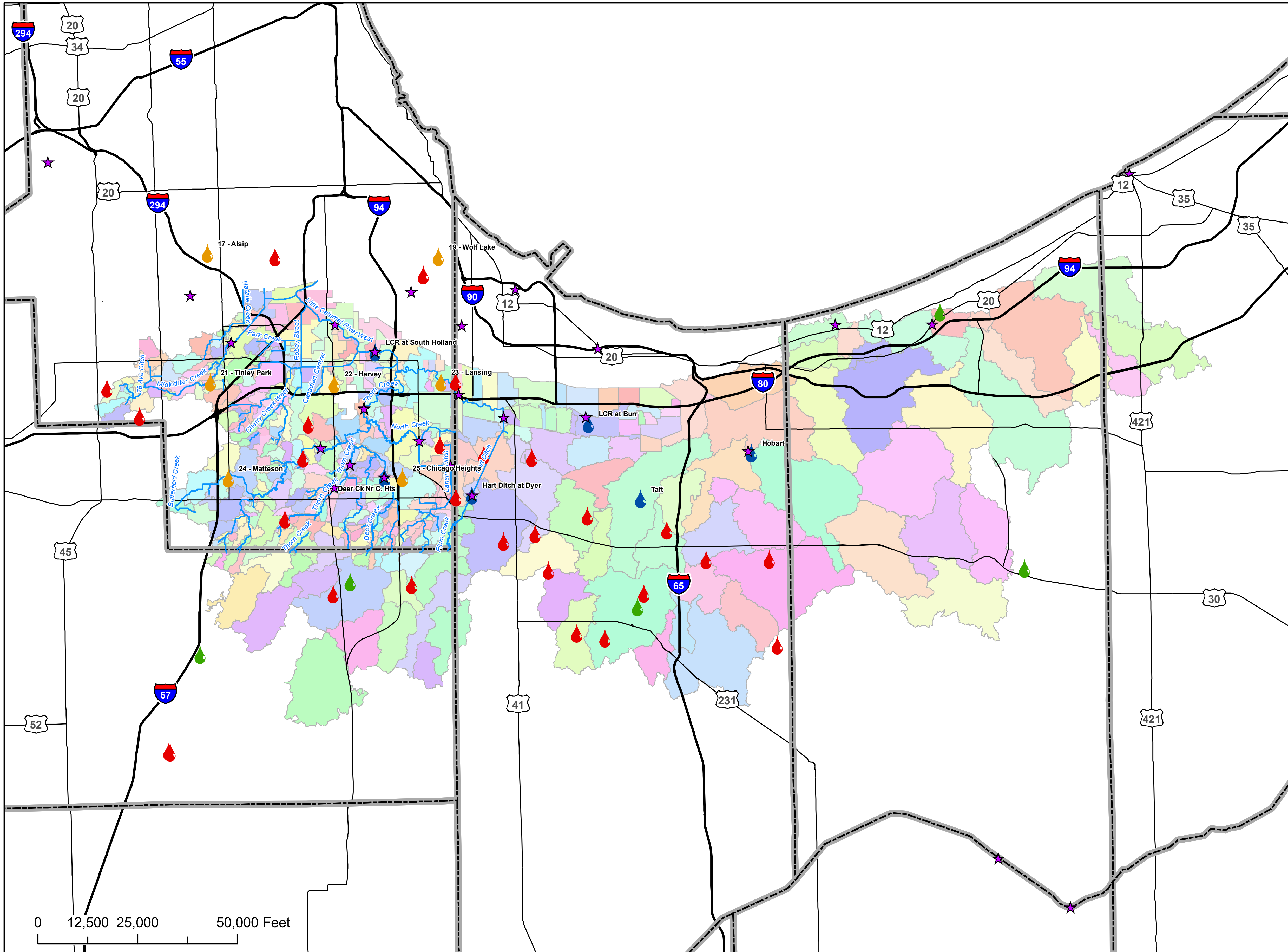
CDM

Figure 2.3.1

LITTLE CALUMET RIVER WATERSHED MONITORING LOCATIONS

Little Calumet River DWP

December, 2009



Stream Gauges

Rain Gauges

- CoCoRaHS
- ISWS
- NWS
- USGS

Stream Centerlines

Limited Access Highway

Highway

County Boundary

N

1 inch = 25,000 feet

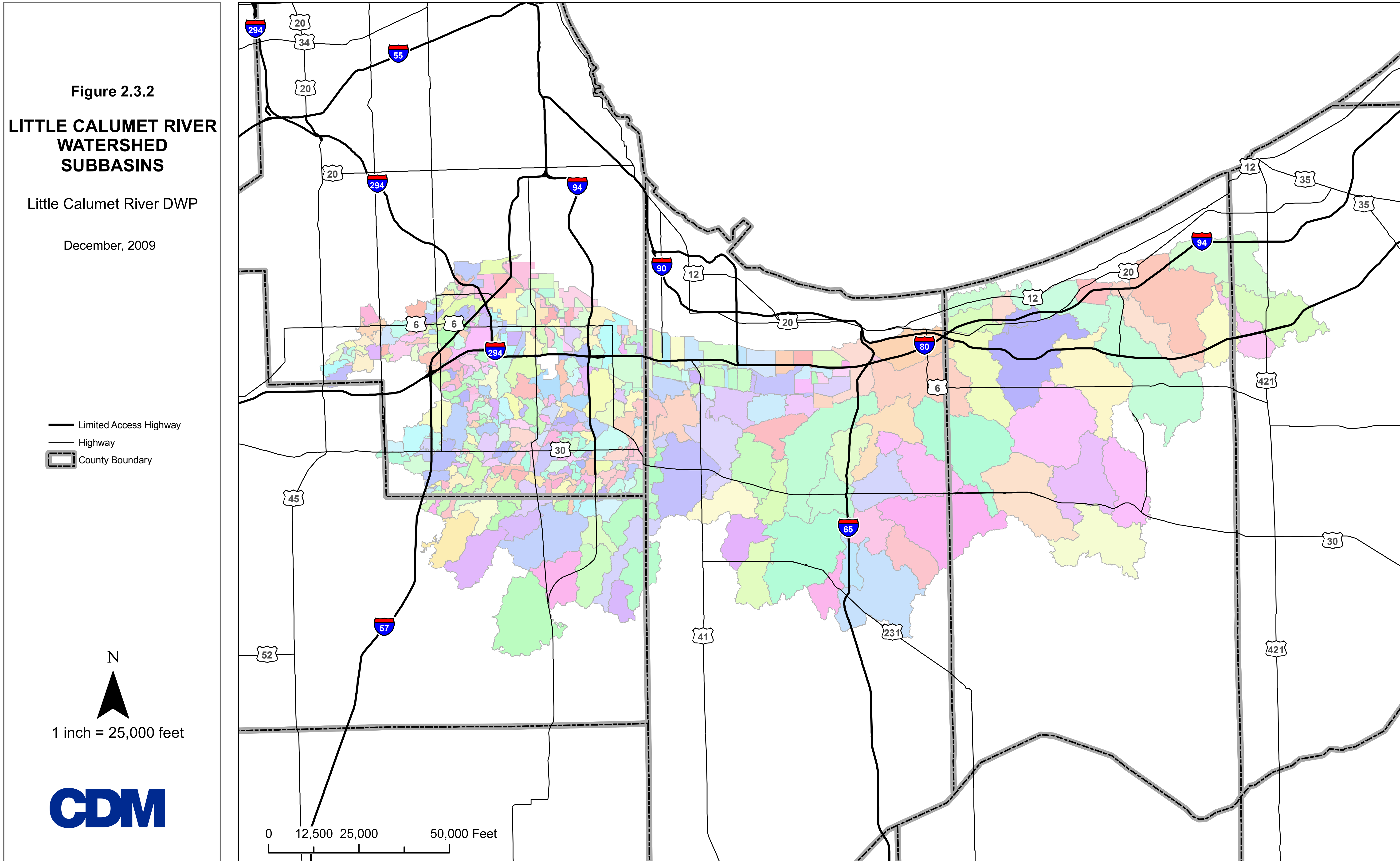
CDM

Figure 2.3.2

LITTLE CALUMET RIVER WATERSHED SUBBASINS

Little Calumet River DWP

December, 2009



CDM

Figure 2.3.3

LITTLE CALUMET RIVER WATERSHED TOPOGRAPHY AND DRAINAGE NETWORK

Little Calumet River DWP

December, 2009

Watershed Boundary
County Boundary
Stream Centerlines

N

1 inch = 7,500 feet

CDM

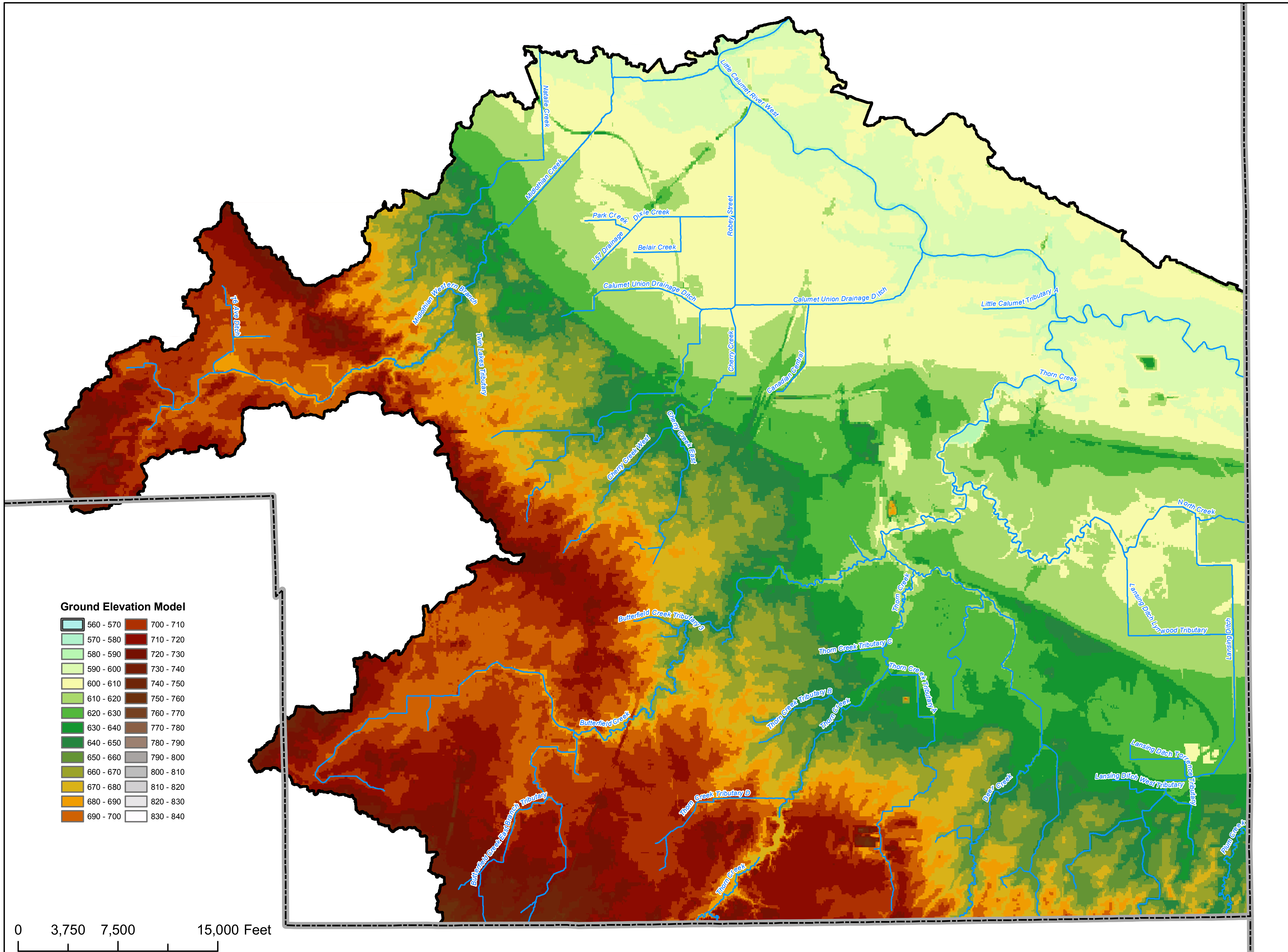
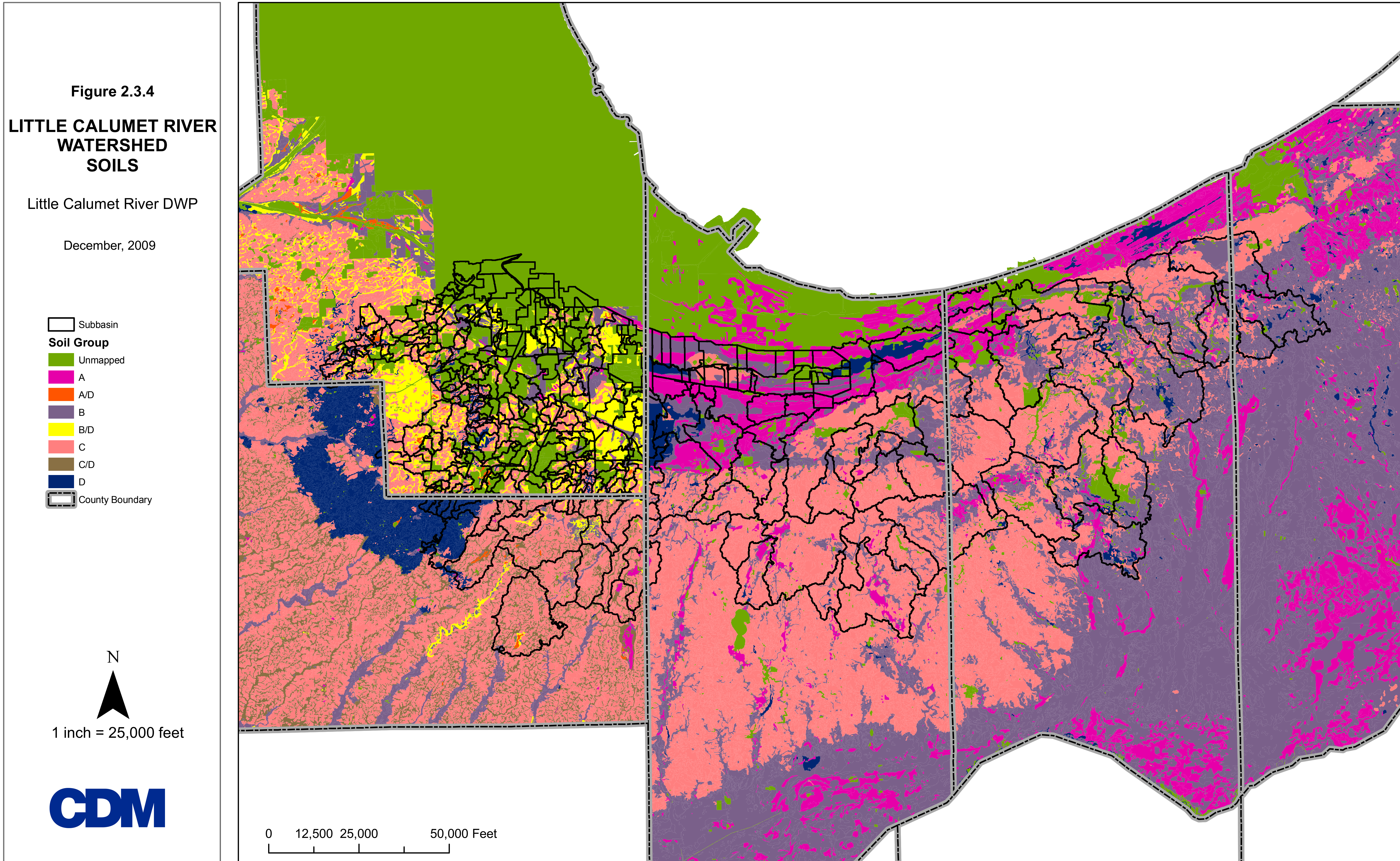


Figure 2.3.4

LITTLE CALUMET RIVER WATERSHED SOILS

Little Calumet River DWP

December, 2009



CDM

Figure 2.3.5

LITTLE CALUMET RIVER WATERSHED LANDUSE

Little Calumet River DWP

December, 2009

Landuse Category

- Agricultural
- Commercial Industrial
- Forest/Open Land
- Institutional
- Residential
- Transportation/Utility
- Water/Wetland
- Stream Centerlines
- Watershed Boundary

N

1 inch = 7,500 feet

CDM

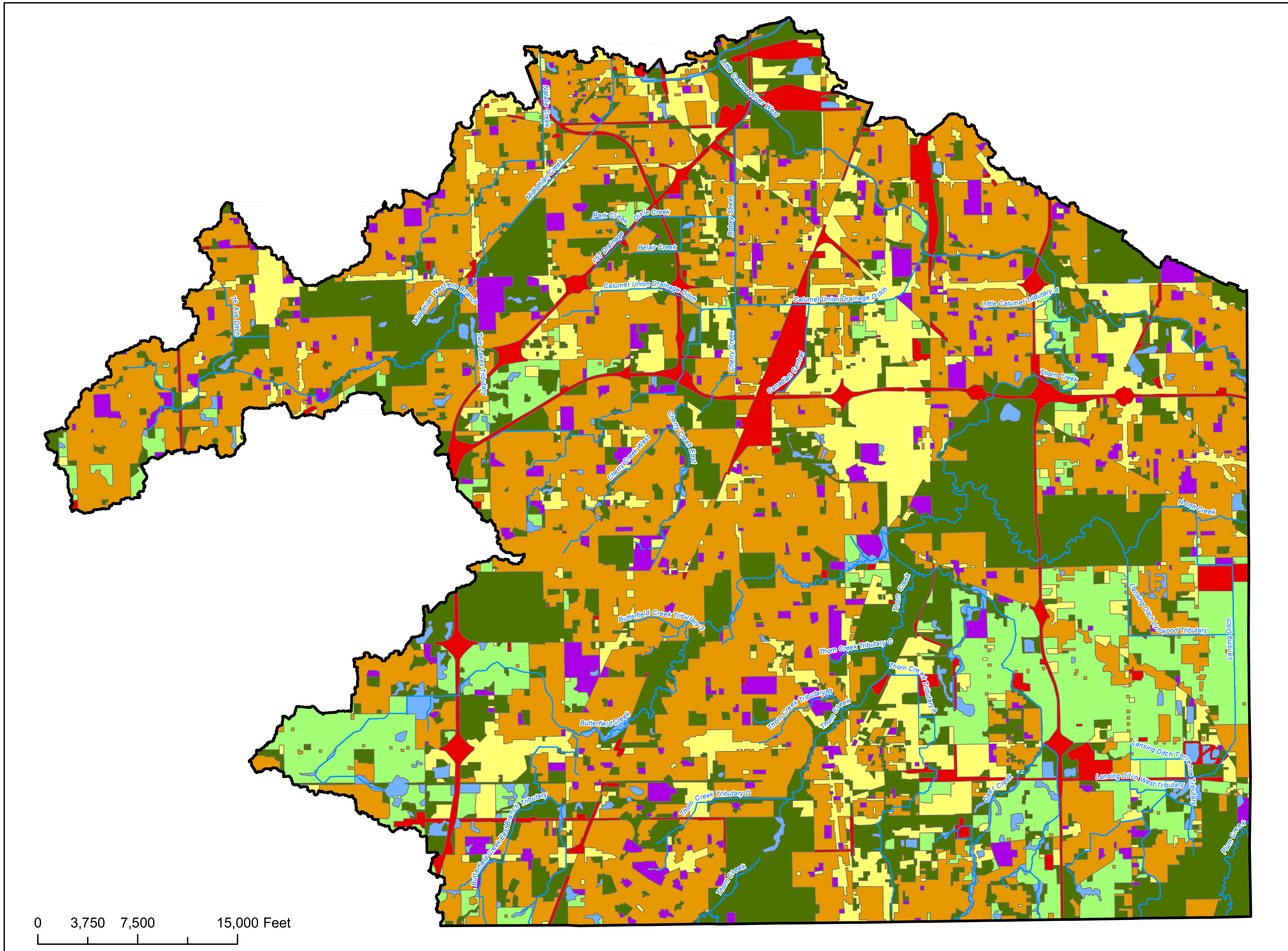
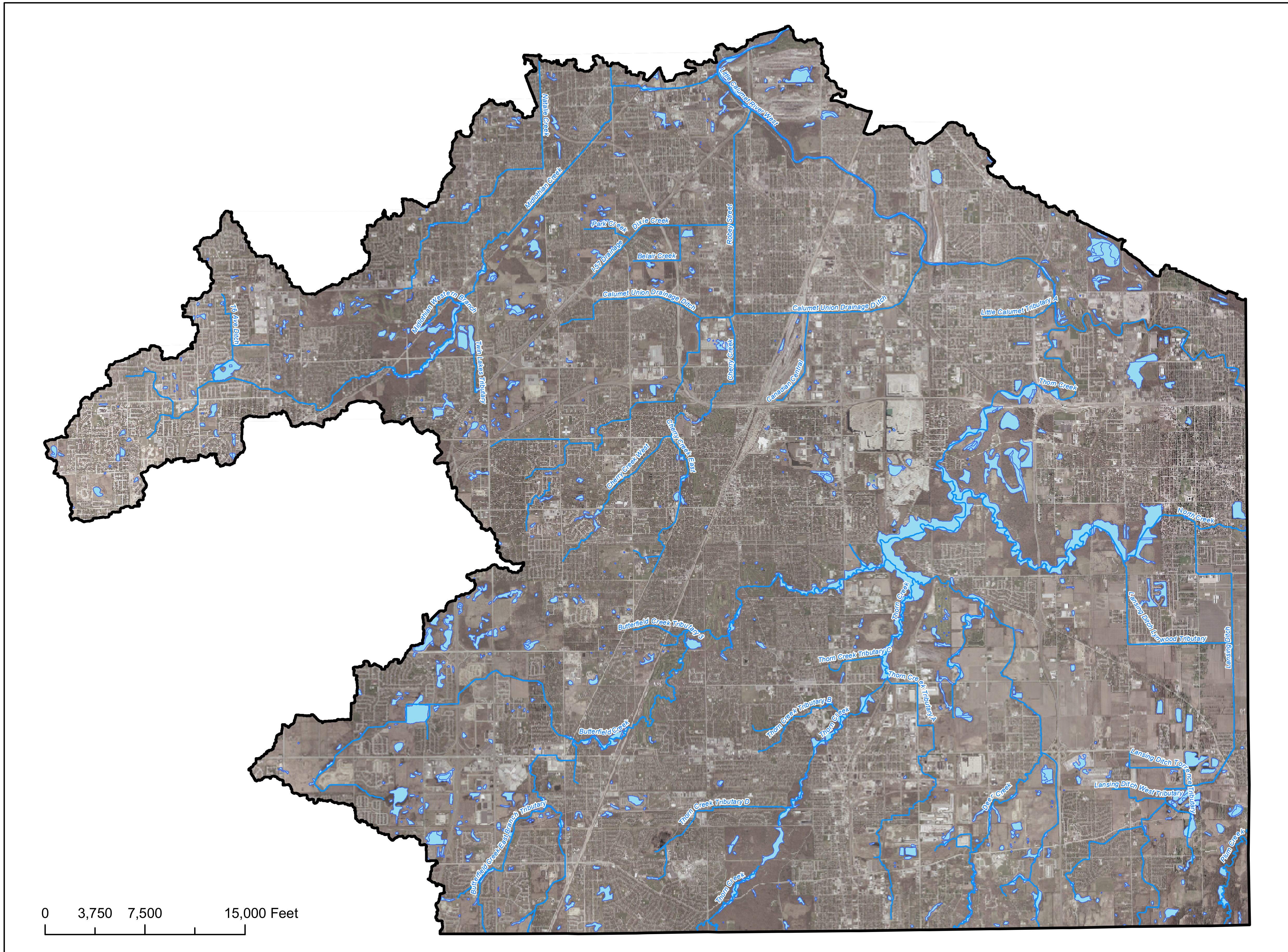


Figure 2.3.6

LITTLE CALUMET RIVER WATERSHED NATIONAL WETLANDS INVENTORY

Little Calumet River DWP

December, 2009



Stream Centerlines
NWI Wetlands
Watershed Boundary

N

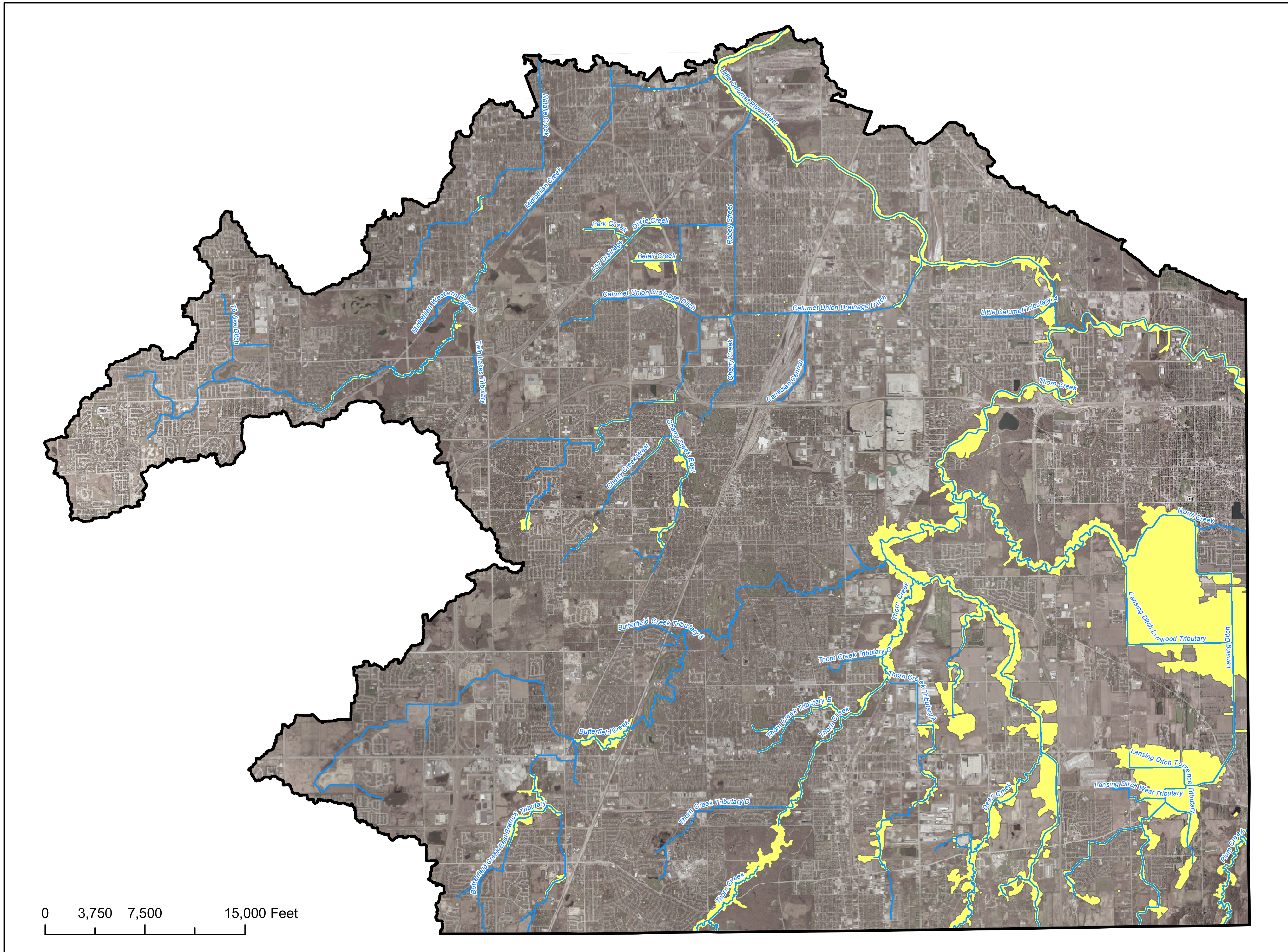
1 inch = 7,500 feet

Figure 2.3.7

LITTLE CALUMET RIVER WATERSHED RIPARIAN AREAS

Little Calumet River DWP

December, 2009



Stream Centerlines

RiparianAreas

Watershed Boundary

N

1 inch = 7,500 feet

CDM

Figure 3.1.1

BUTTERFIELD CREEK SUBWATERSHED OVERVIEW

Little Calumet River DWP

Local Problems

- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

Regional Problems

- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding
- Problem Area Identified Through Modeling
- Candidate Structures for Floodproofing/Acquisition
- Project Alternative Location
- River/Stream
- Municipal Boundary
- County Boundary
- DWP 100-year Inundation Area

FEMA Floodplain

- Zone A; Zone AH; Zone AO
- Zone AE

N

1 inch = 4,000 feet

0 1 2

Inches

CDM

December, 2009

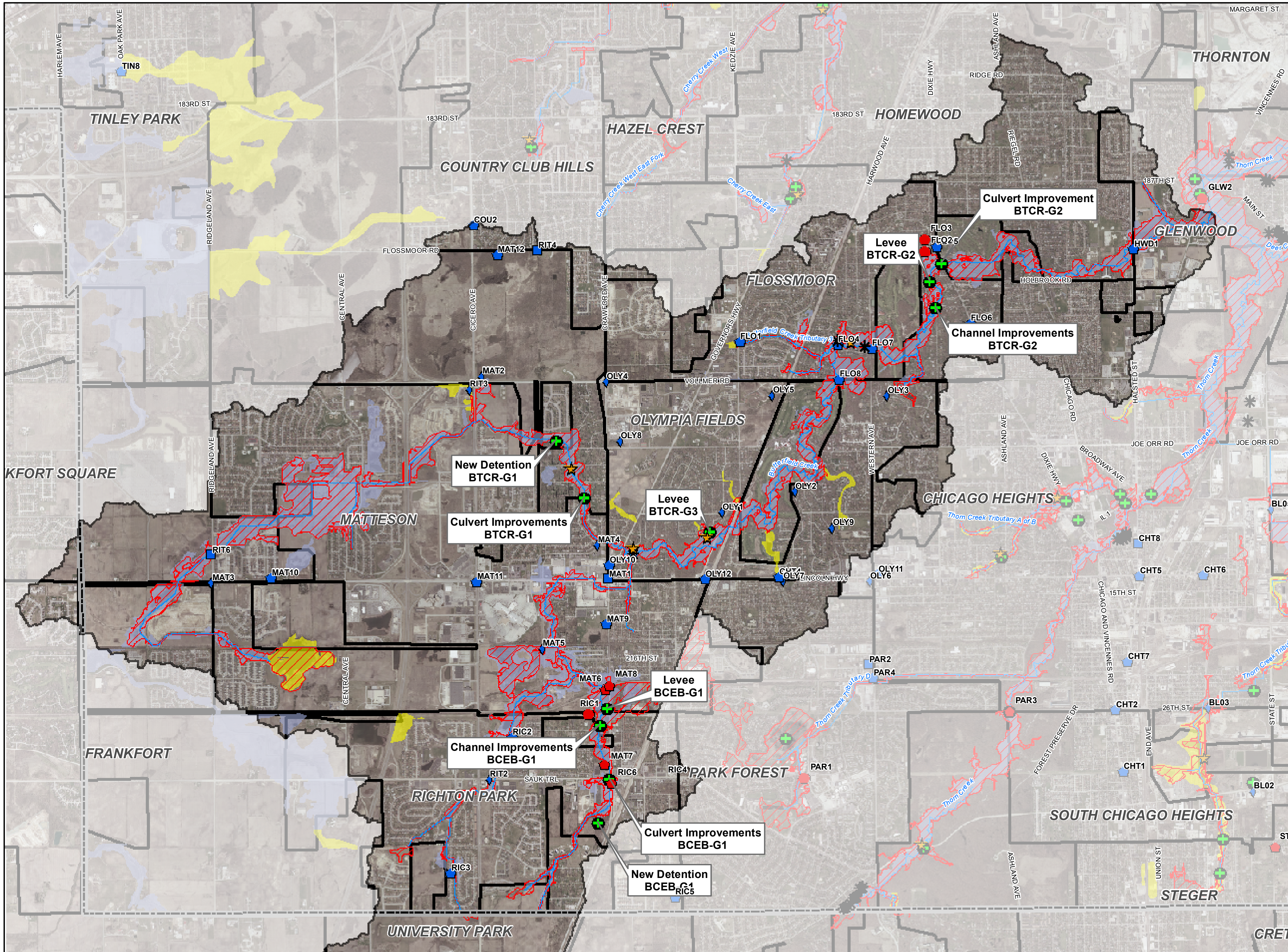


Figure 3.1.5

BUTTERFIELD CREEK
ALTERNATIVE
BTCR-G1
Little Calumet River DWP

Alternative Description:
Replace 206th Street culvert and construct new 65 ac-ft detention facility

Conceptual Level Cost:
$8,494,000

Benefit: $1,495,000
B/C Ratio: 0.18

Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

River/Stream
Municipalities
County Boundary
Project Alternative Location
100-year Inundation Area With Project
100-year Inundation Area Without Project

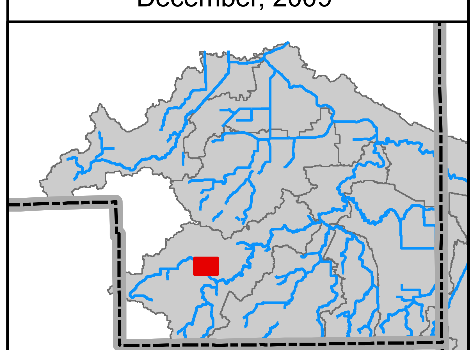
0 1 2 Inches

1 inch = 400 feet

N

CDM

December, 2009



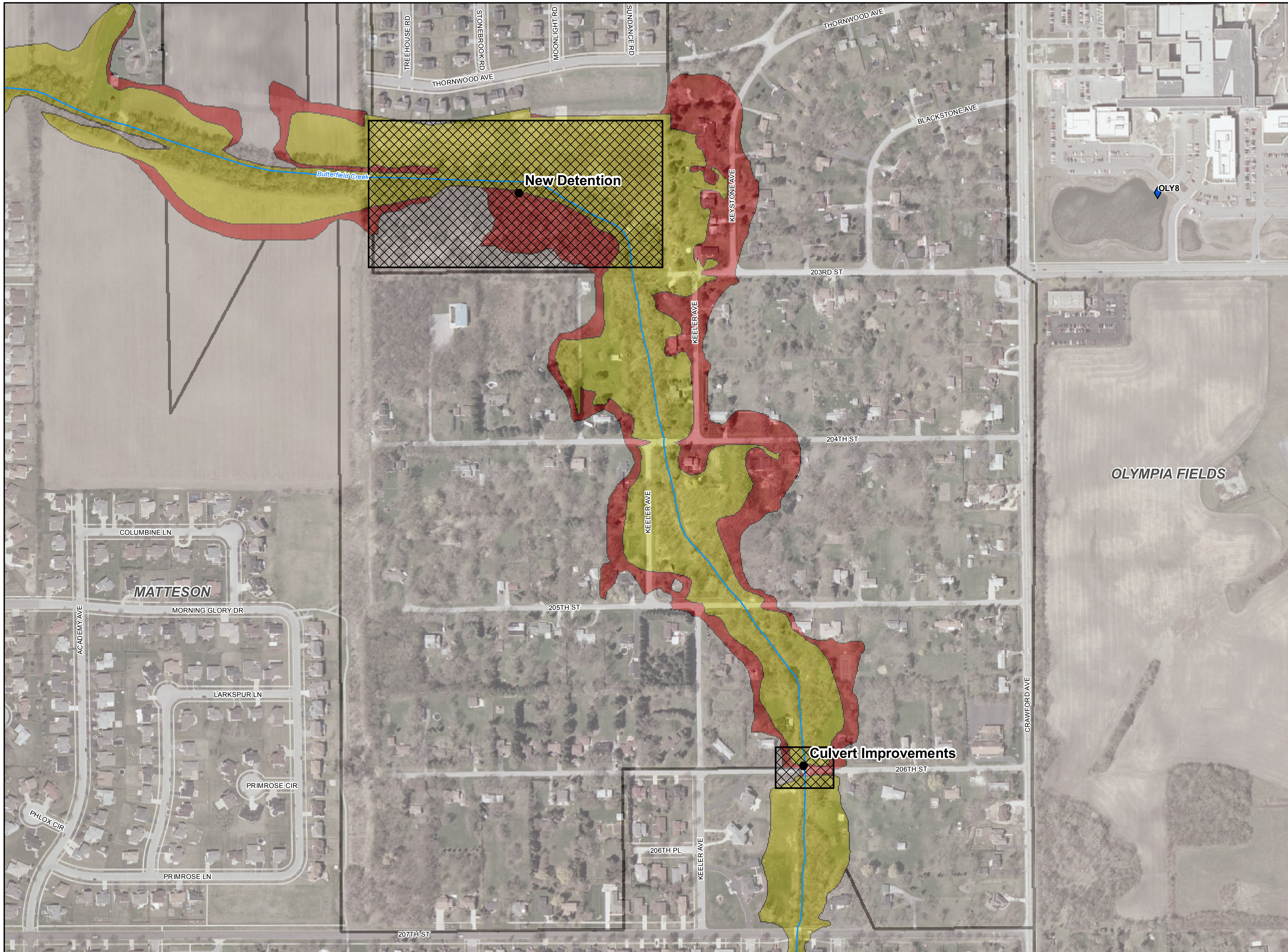


Figure 3.1.6

BUTTERFIELD CREEK
ALTERNATIVE
BTCR-G2
Little Calumet River DWP

Alternative Description:
Construct a 700 LF levee along Greenwood Drive

Conceptual Level Cost:
$9,556,000

Benefit: $13,000
B/C Ratio: <0.01

✱ Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

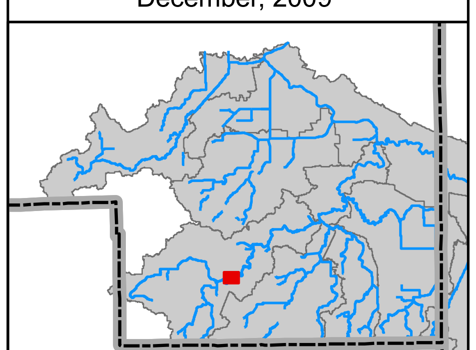
0 1 2 Inches

1 inch = 250 feet

N

CDM

December, 2009



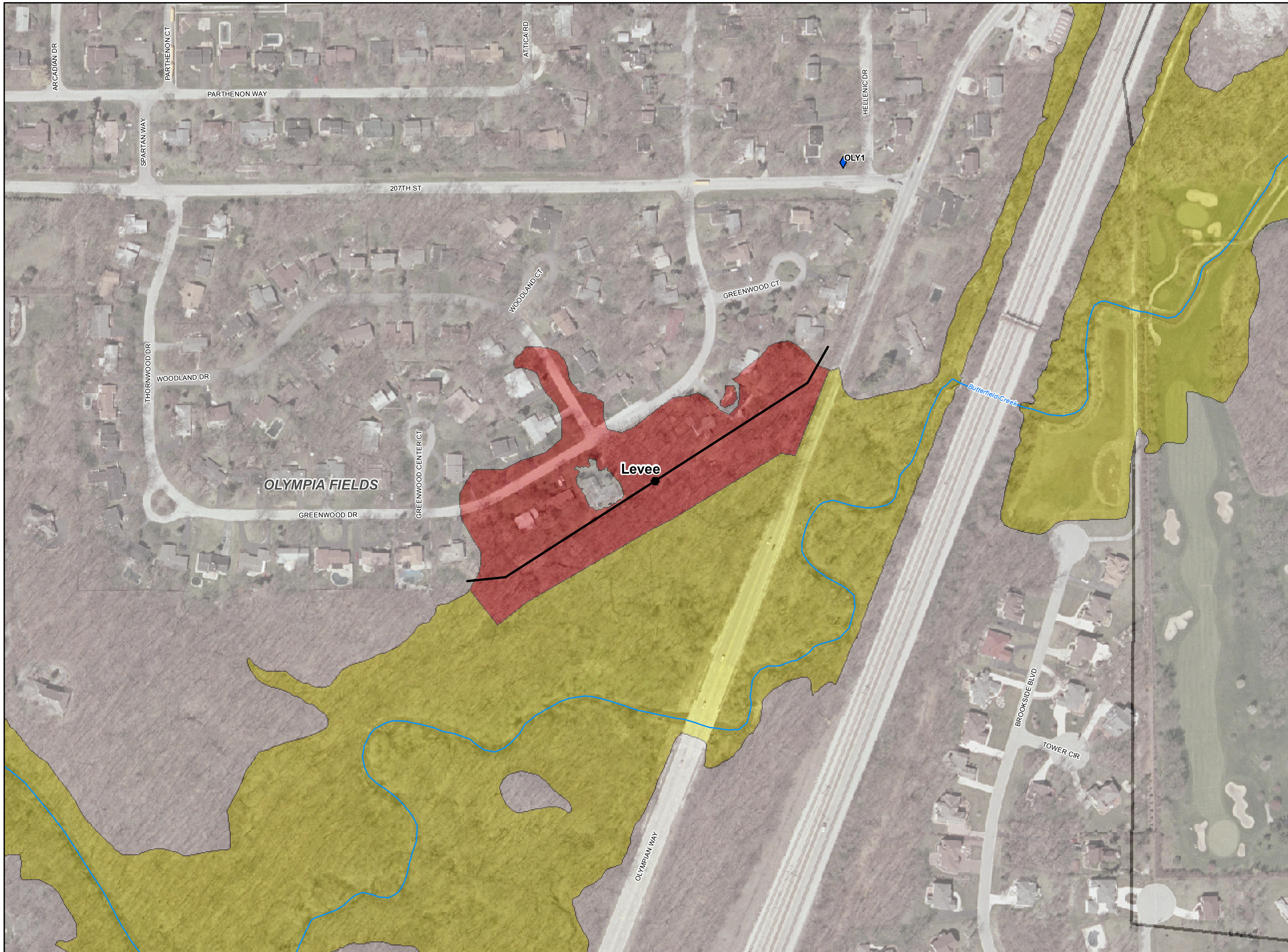


Figure 3.1.7

BUTTERFIELD CREEK
ALTERNATIVE
BTCR-G3
Little Calumet River DWP

Alternative Description:
Channel improvements near Laurel Avenue and construct a floodwall on west bank from Cambridge Avenue to Dixie Avenue

Conceptual Level Cost:
$29,876,000

Benefit:	**B/C Ratio:**
$1,109,000	0.04

- Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

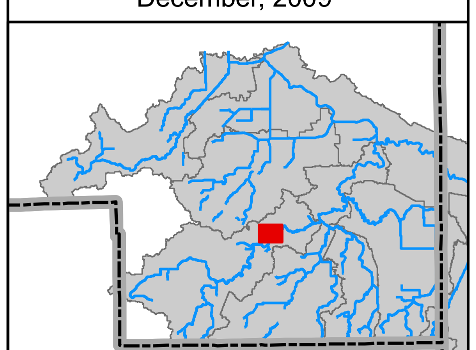
0 1 2 Inches

1 inch = 400 feet

N

CDM

December, 2009



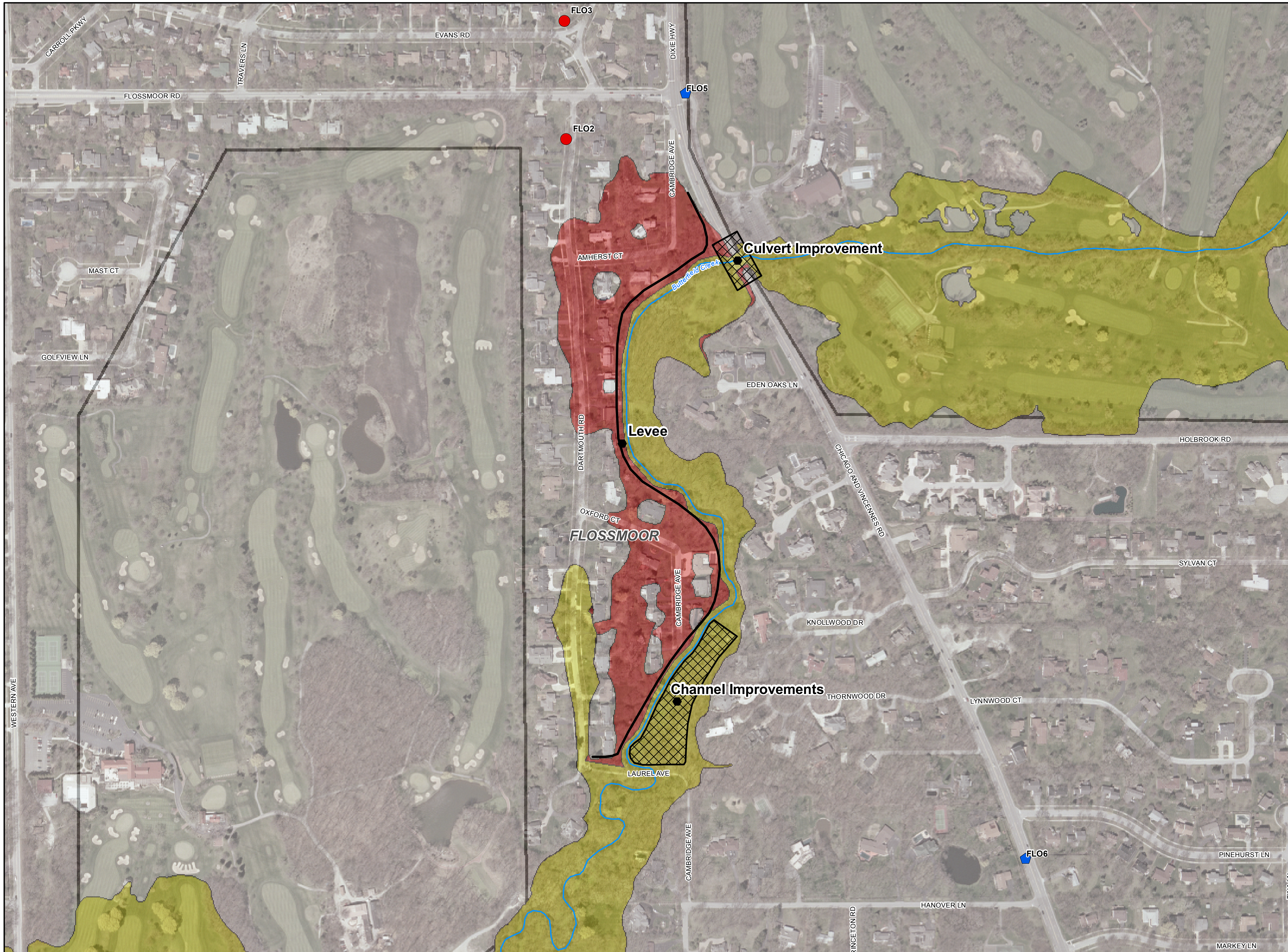


Figure 3.1.8

BUTTERFIELD CREEK
ALTERNATIVE
BCEB-G1
Little Calumet River DWP

Alternative Description:
Repalce Sauk Trail culvert, constrcut 130 ac-ft detention facility and a levee along Governor's Highway

Conceptual Level Cost:
$28,079,000

Benefit: $515,000
B/C Ratio: 0.02

- ✱ Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

0 1 2 Inches

1 inch = 700 feet

N

CDM

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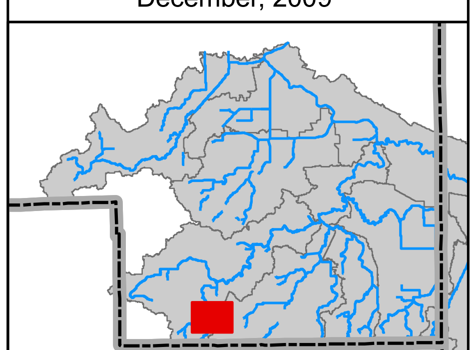


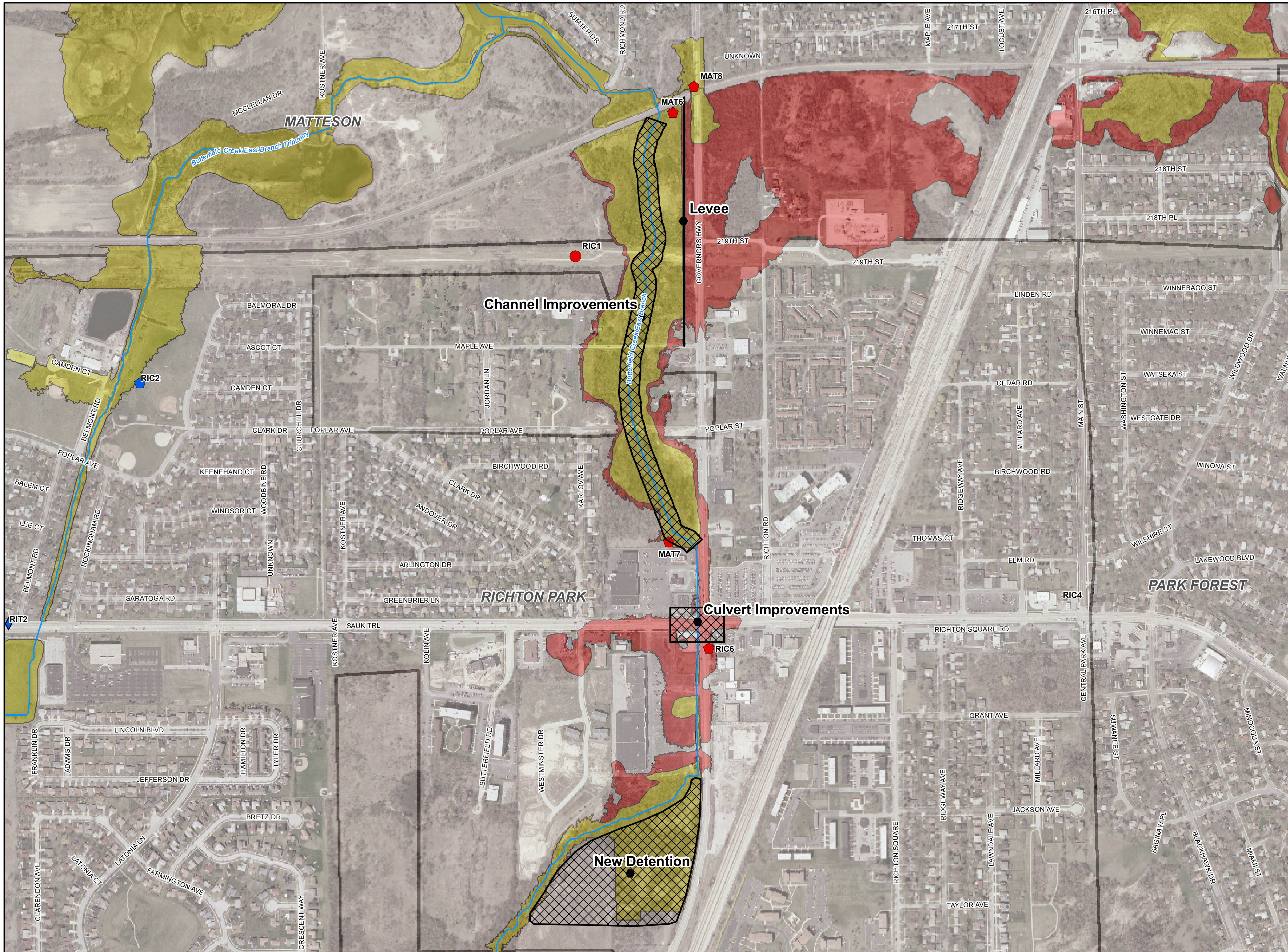
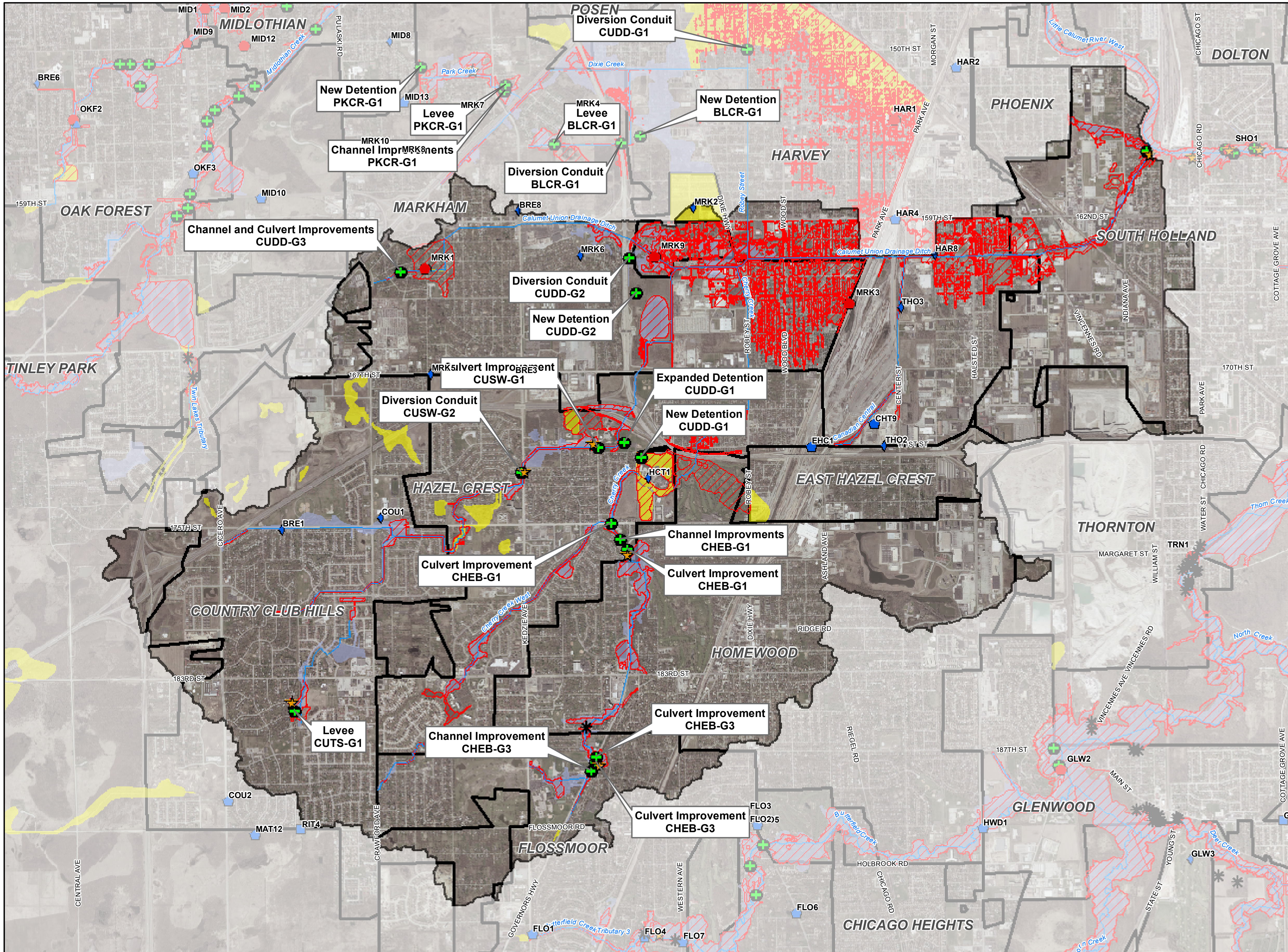


Figure 3.2.1

CAL UNION DRAINAGE DITCH SUBWATERSHED OVERVIEW

Little Calumet River DWP



Local Problems

- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

Regional Problems

- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding
- Problem Area Identified Through Modeling
- Candidate Structures for Floodproofing/Acquisition
- Project Alternative Location
- River/Stream
- Municipal Boundary
- County Boundary
- DWP 100-year Inundation Area

FEMA Floodplain

- Zone A; Zone AH; Zone AO
- Zone AE

N

1 inch = 3,500 feet

0 1 2
Inches

CDM

December, 2009

Figure 3.2.2

CAL UNION DRAINAGE DITCH
ALTERNATIVE
CUDD-G1
Little Calumet River DWP

Alternative Description:
Expansion and improvements to Calumet Union Reservoir and upsizing the Robey Street Diversion Conduit

Conceptual Level Cost:
$165,318,000

Benefit: $5,782,000

B/C Ratio: 0.03

Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

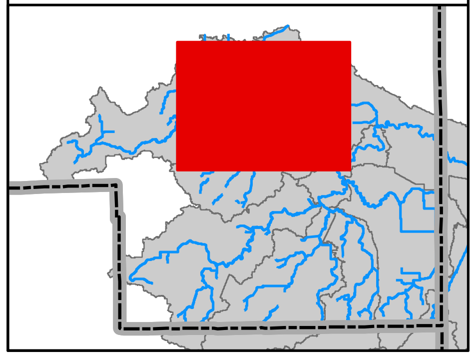
0 1 2 Inches

1 inch = 3,000 feet

N

CDM

December, 2009



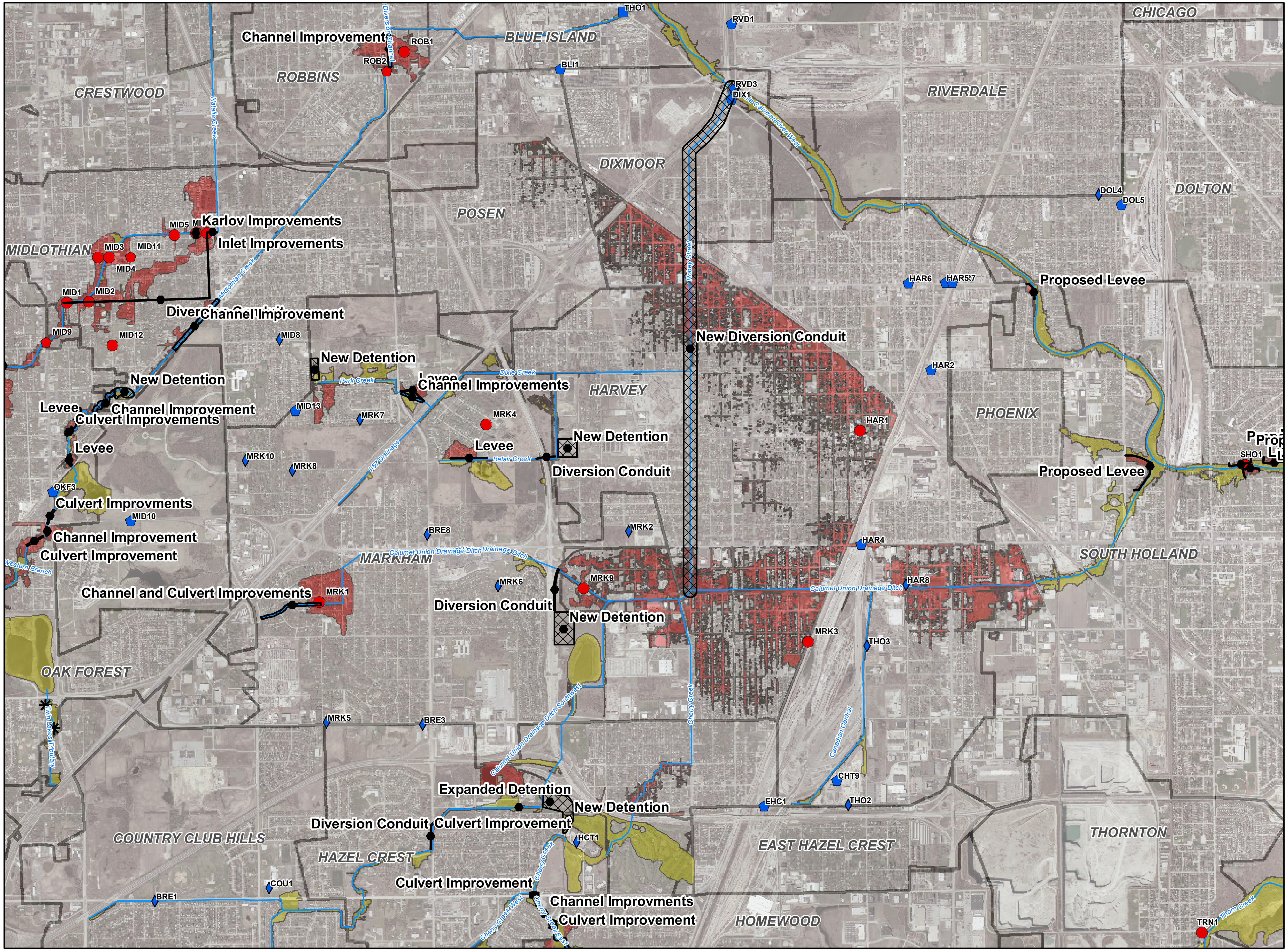


Figure 3.2.3

CAL UNION DRAINAGE DITCH
ALTERNATIVE CUDD-G2
Little Calumet River DWP

Alternative Description:
Construct a 450 ac-ft detention facility and a new diversion conduit from Tri-State Tollway

Conceptual Level Cost:
$50,406,000

Benefit:	**B/C Ratio:**
$3,377,000	0.07

- Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

0 1 2 Inches

1 inch = 400 feet

N

CDM

December, 2009

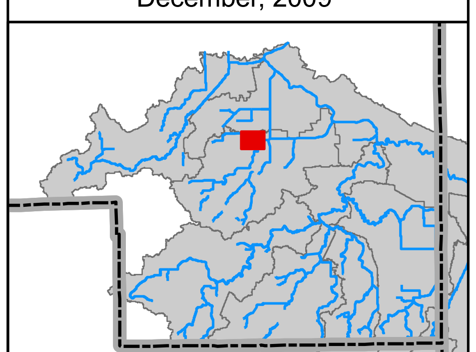


Figure 3.2.4

CAL UNION DRAINAGE DITCH

ALTERNATIVE CUDD-G3

Little Calumet River DWP

Alternative Description:
Construct a floodwall from Hamlin to Central Park Avenue and streambank stabilization from Sunset to Central Park Avenue

Conceptual Level Cost:
$2,852,000

Benefit: $1,144,000

B/C Ratio: 0.40

* Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

River/Stream
Municipalities
County Boundary
Project Alternative Location
100-year Inundation Area With Project
100-year Inundation Area Without Project

0 1 2 Inches

1 inch = 250 feet

N

CDM

December, 2009

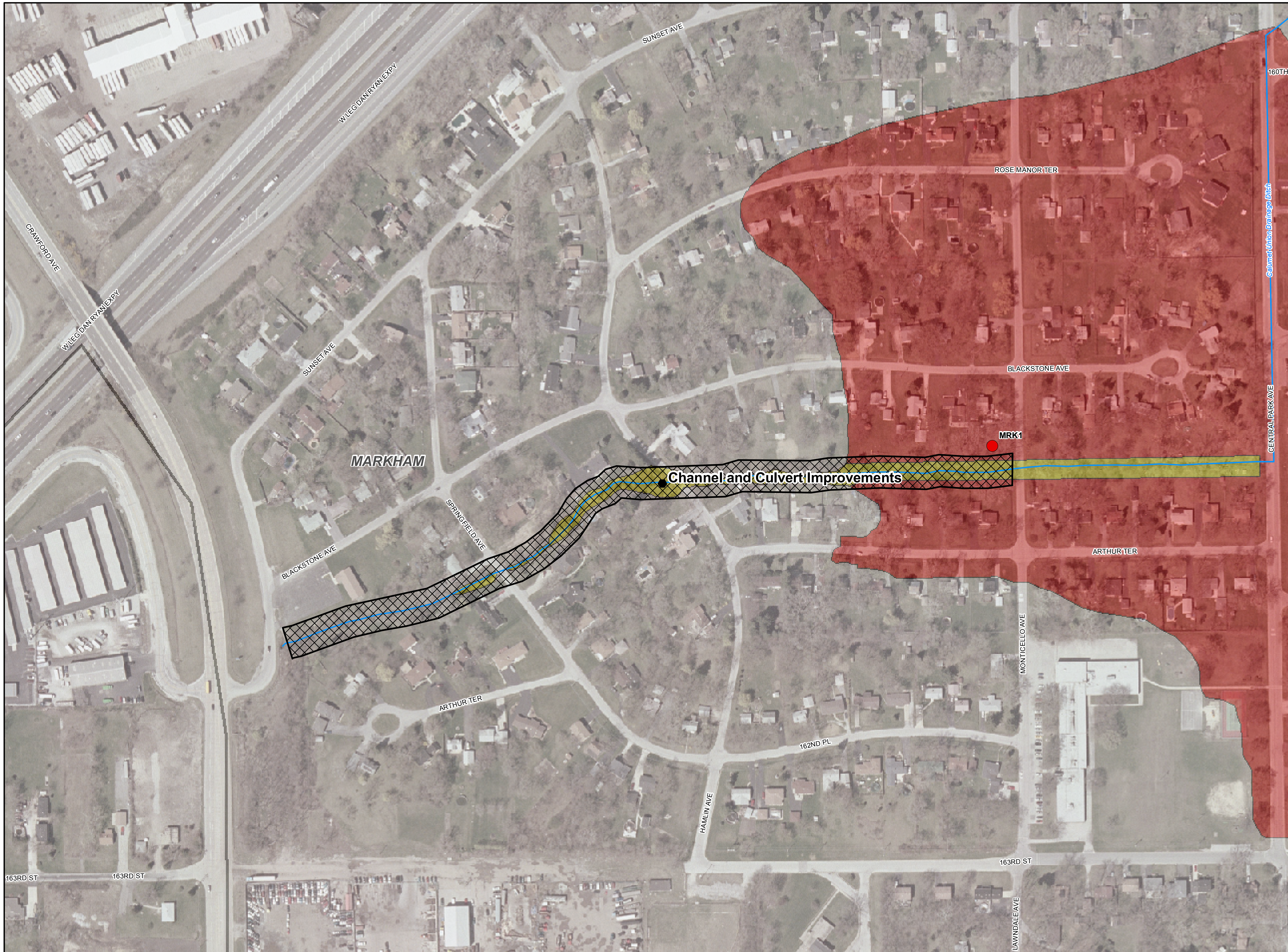


Figure 3.2.5

CAL UNION DRAINAGE DITCH
ALTERNATIVE
CUSW-G1
Little Calumet River DWP

Alternative Description:
Repalce California Avenue culvert

Conceptual Level Cost:
$536,000

Benefit: $15,000
B/C Ratio: 0.03

✱ Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

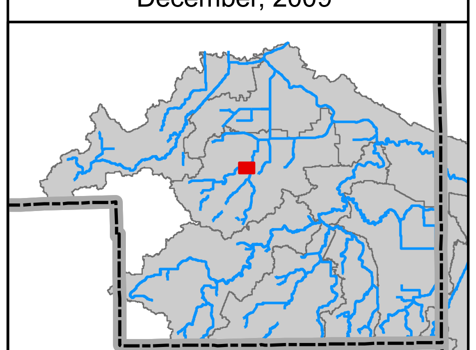
0 1 2 Inches

1 inch = 250 feet

N

CDM

December, 2009



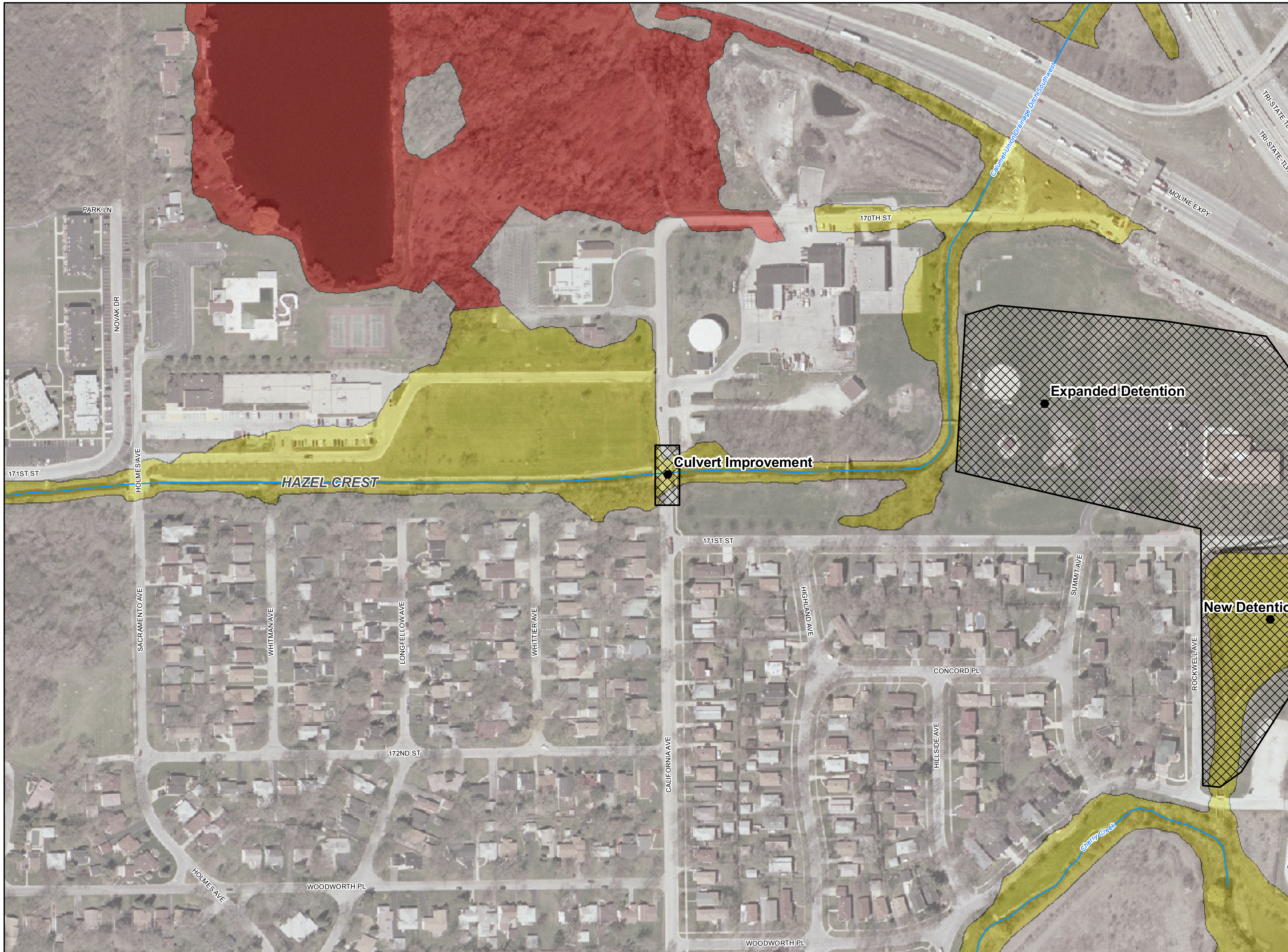


Figure 3.2.6

CAL UNION DRAINAGE DITCH
ALTERNATIVE
CUSW-G2
Little Calumet River DWP

Alternative Description:
Construct a 860 LF diversion conduit parallel to Kedzie Avenue

Conceptual Level Cost:
$1,206,000

Benefit: $6,000

B/C Ratio: <0.01

Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

River/Stream
Municipalities
County Boundary
Project Alternative Location
100-year Inundation Area With Project
100-year Inundation Area Without Project

0 1 2 Inches
1 inch = 250 feet

N

CDM

December, 2009

Figure 3.2.7

CAL UNION DRAINAGE DITCH

ALTERNATIVE CUTS-G1

Little Calumet River DWP

Alternative Description:
Construct a 945 LF levee along Baker Avenue

Conceptual Level Cost:
$2,917,000

Benefit: $62,900

B/C Ratio: 0.02

- ✱ Candidate Structures for Floodproofing/Acquisition

Regional Problems

- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems

- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

0 1 2 Inches

1 inch = 400 feet

N

CDM

December, 2009

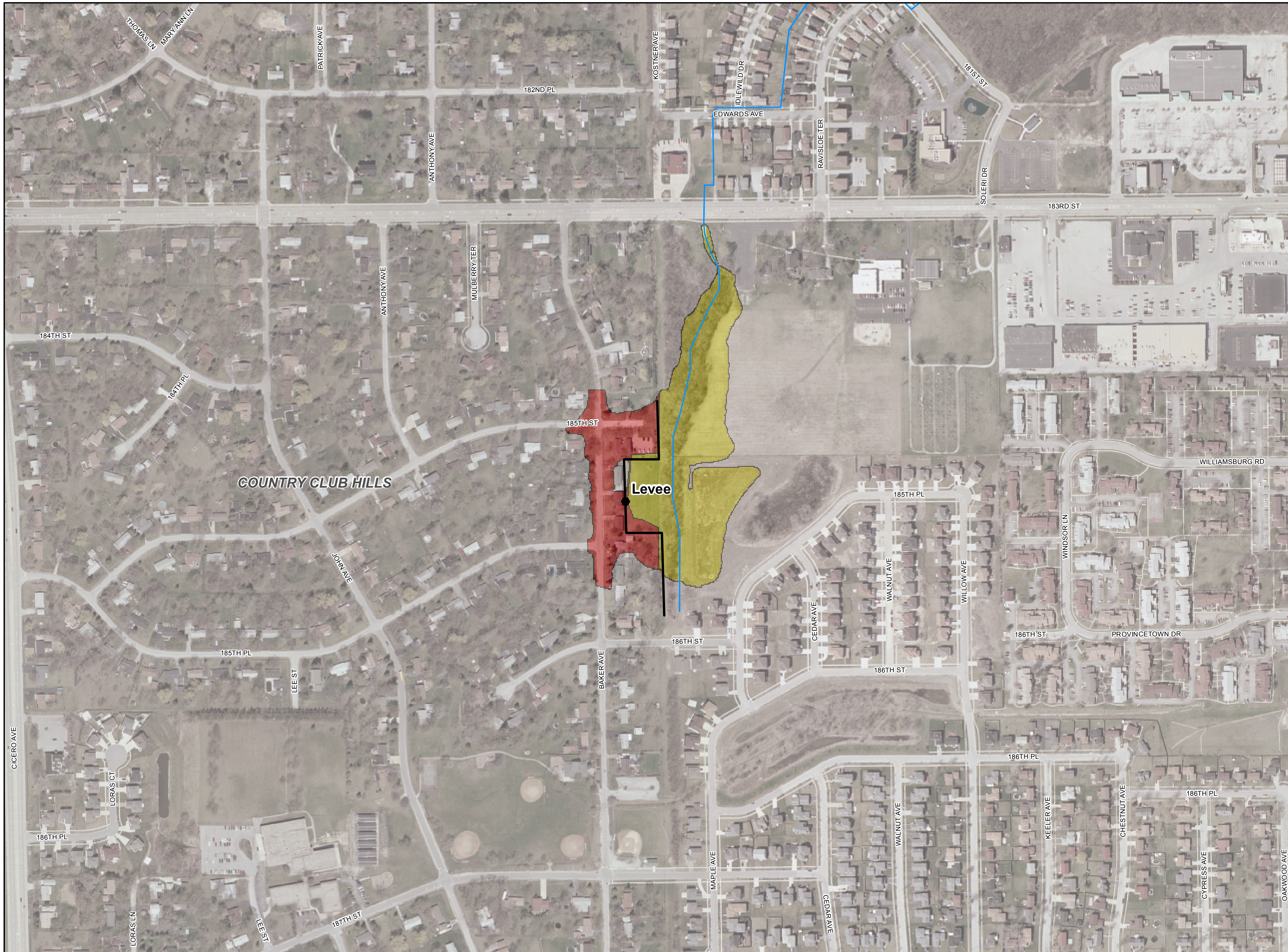


Figure 3.2.8

CAL UNION DRAINAGE DITCH

ALTERNATIVE CHEB-G1

Little Calumet River DWP

Alternative Description:
Replace Governors Highway and 175th Street Crossings, channel improvements from Ravisole Country Club to 175th Street and Provide overbank storage at Hillcrest Park

Conceptual Level Cost:
$3,300,000

Benefit:	**B/C Ratio:**
$170,000	0.05

* Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

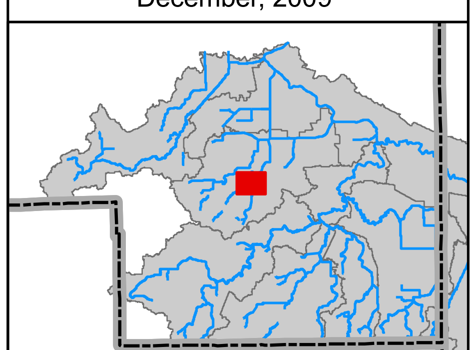
0 1 2 Inches

1 inch = 500 feet

N

CDM

December, 2009



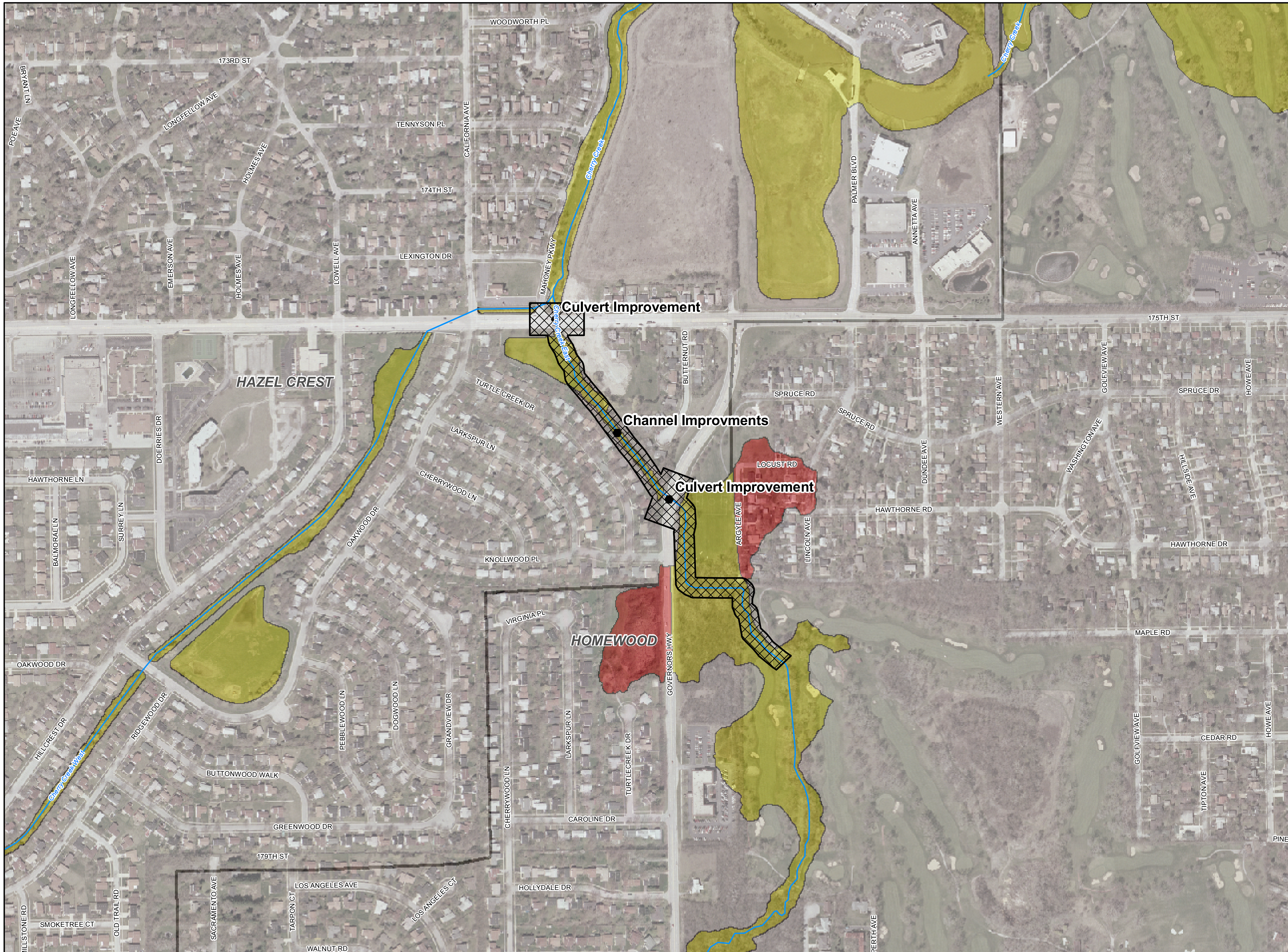


Figure 3.2.9

CAL UNION DRAINAGE DITCH
ALTERNATIVE
CHEB-G3
Little Calumet River DWP

Alternative Description:
Replace Governors Highway, Braemer Road and channel improvements

Conceptual Level Cost:
$2,282,000
Benefit: $7,680,000
B/C Ratio: 3.37

- Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

0 1 2 Inches
1 inch = 250 feet

N

CDM

December, 2009

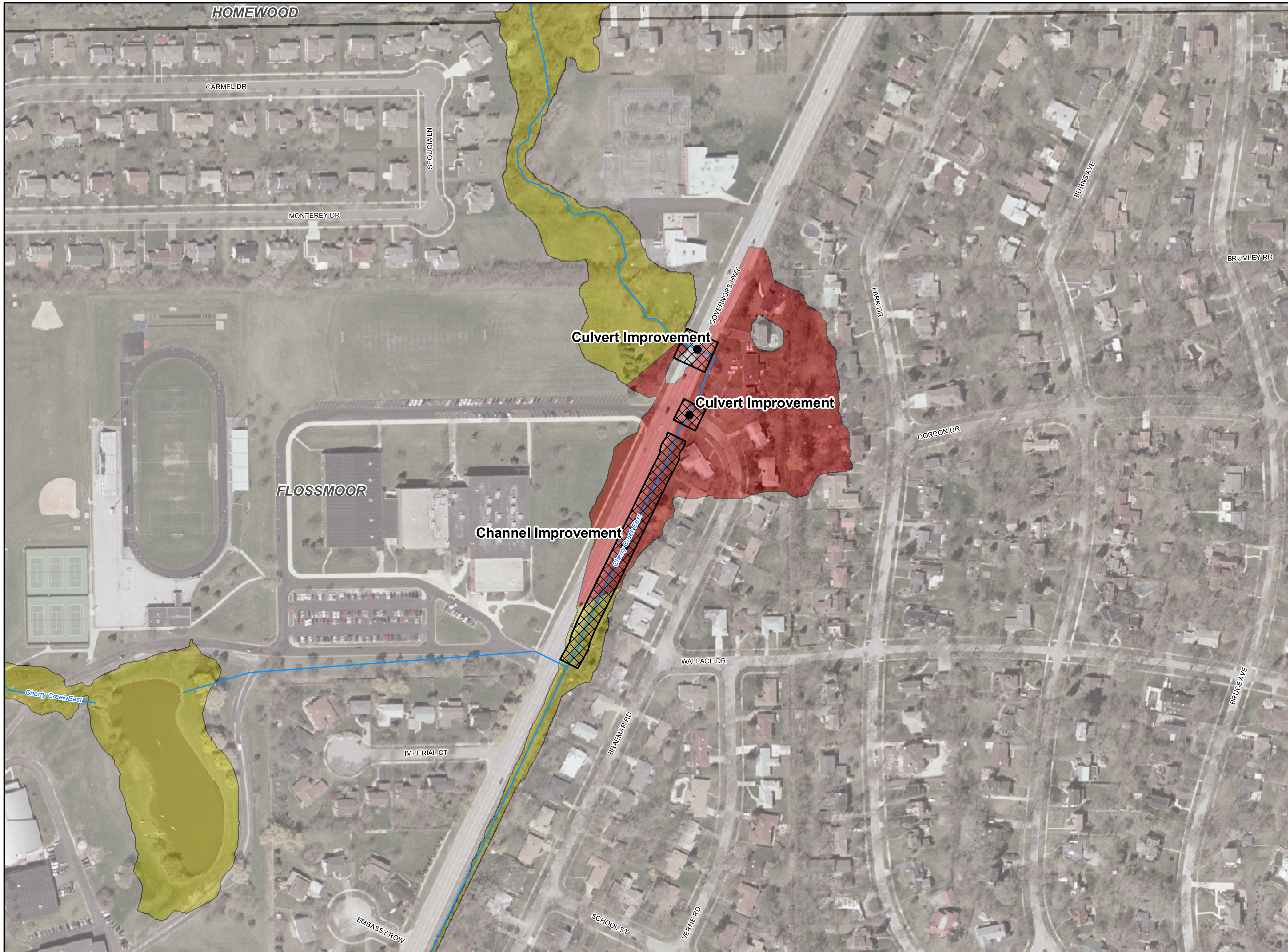


Figure 3.2.10

CAL UNION DRAINAGE DITCH
ALTERNATIVE
BLCR-G1
Little Calumet River DWP

Alternative Description:
Construct a levee along Belaire Creek from Albany to Afton Avenue, a new 125 ac-ft storage area and diversion conduit

Conceptual Level Cost:
$13,842,000

Benefit:	**B/C Ratio:**
$2,293,000	0.17

- ✱ Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

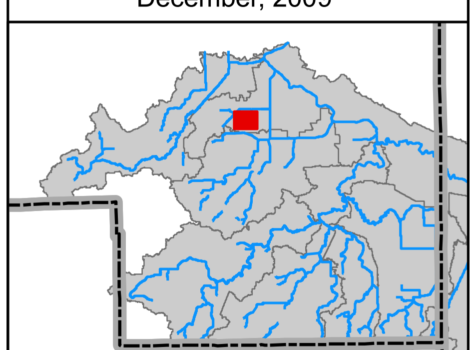
0 1 2 Inches

1 inch = 400 feet

N

CDM

December, 2009



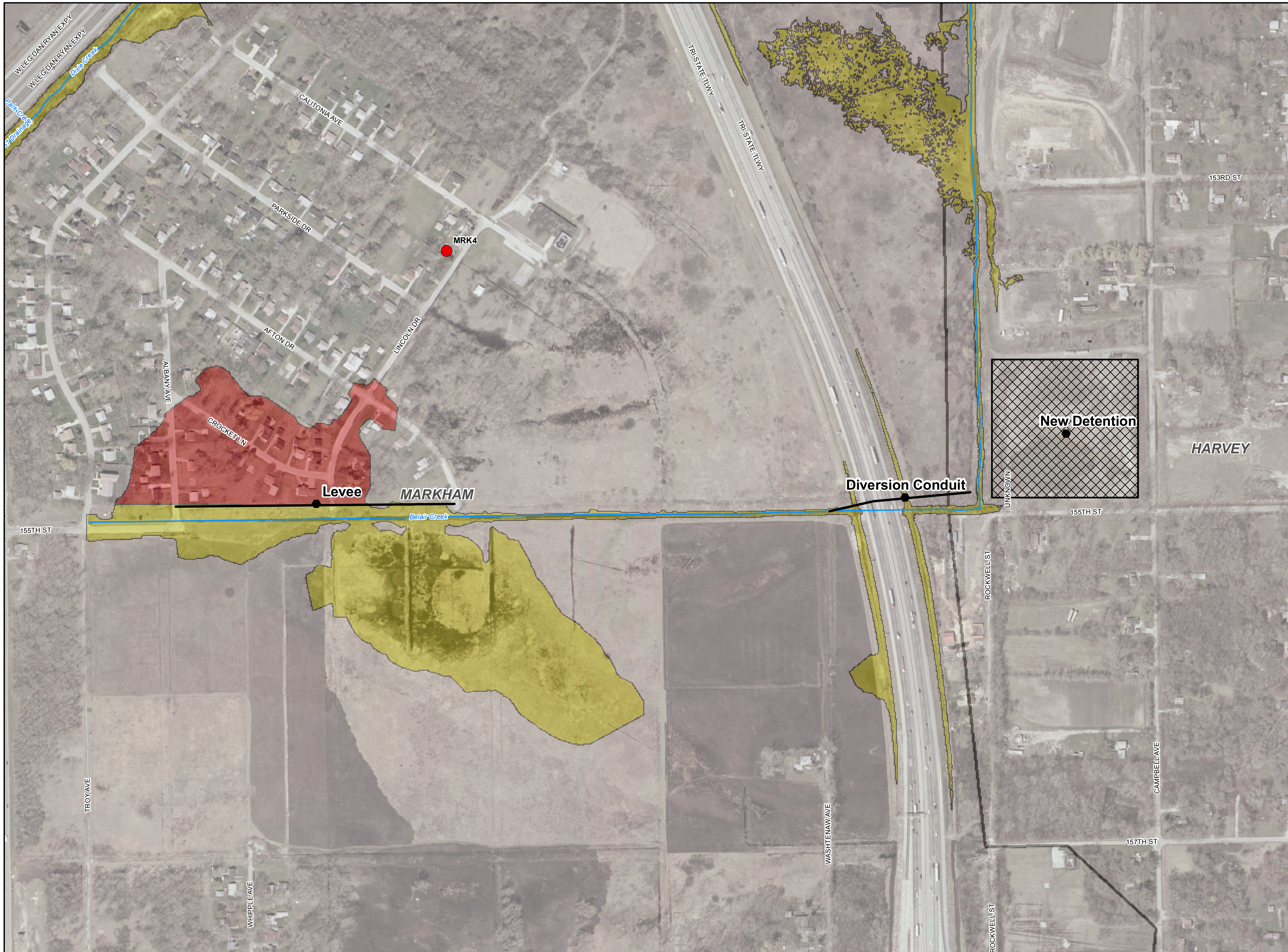


Figure 3.2.11

CAL UNION DRAINAGE DITCH
ALTERNATIVE
PKCR-G1
Little Calumet River DWP

Alternative Description:
Construct 200 ac-ft detention facility, implement channel and conveyance improvements from Kedzie AVenue to I-57 and 1000 LF levee between Kedzie Avenue and I-57 Interstate

Conceptual Level Cost:
$20,327,000

Benefit:	**B/C Ratio:**
$5,187,000	0.26

- Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

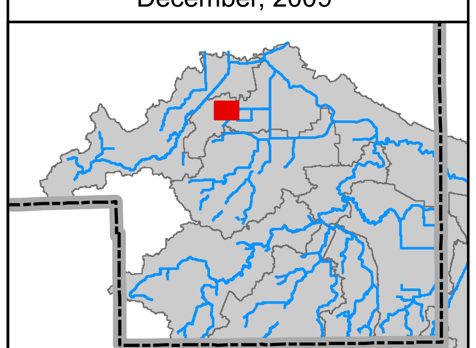
0 1 2 Inches

1 inch = 400 feet

N

CDM

December, 2009



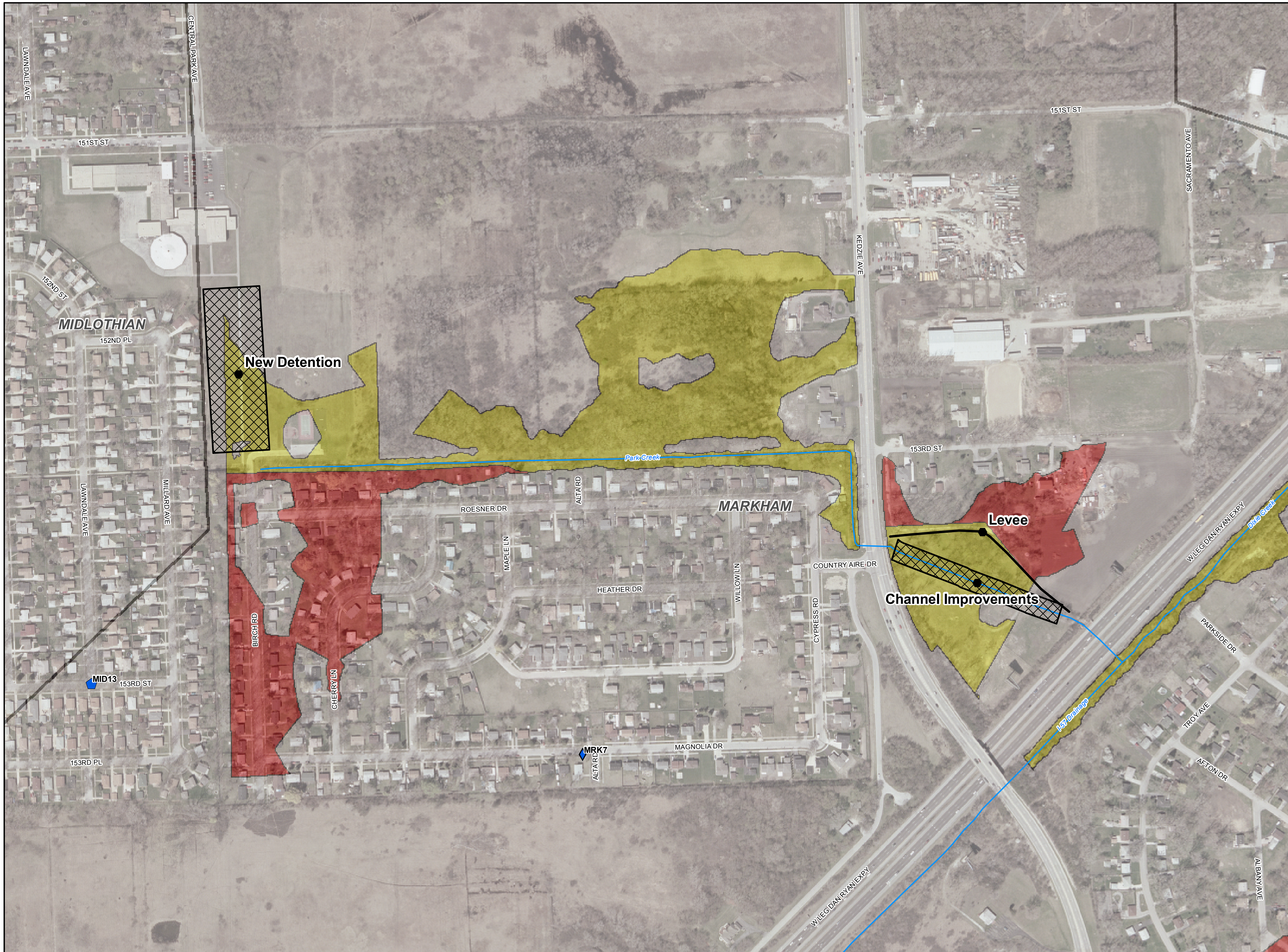


Figure 3.3.1

DEER CREEK SUBWATERSHED OVERVIEW

Little Calumet River DWP

Local Problems

- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

Regional Problems

- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding
- Problem Area Identified Through Modeling
- Candidate Structures for Floodproofing/Acquisition
- Project Alternative Location
- River/Stream
- Municipal Boundary
- County Boundary
- DWP 100-year Inundation Area

FEMA Floodplain

- Zone A; Zone AH; Zone AO
- Zone AE

N

1 inch = 3,000 feet

0 1 2
Inches

CDM

December, 2009

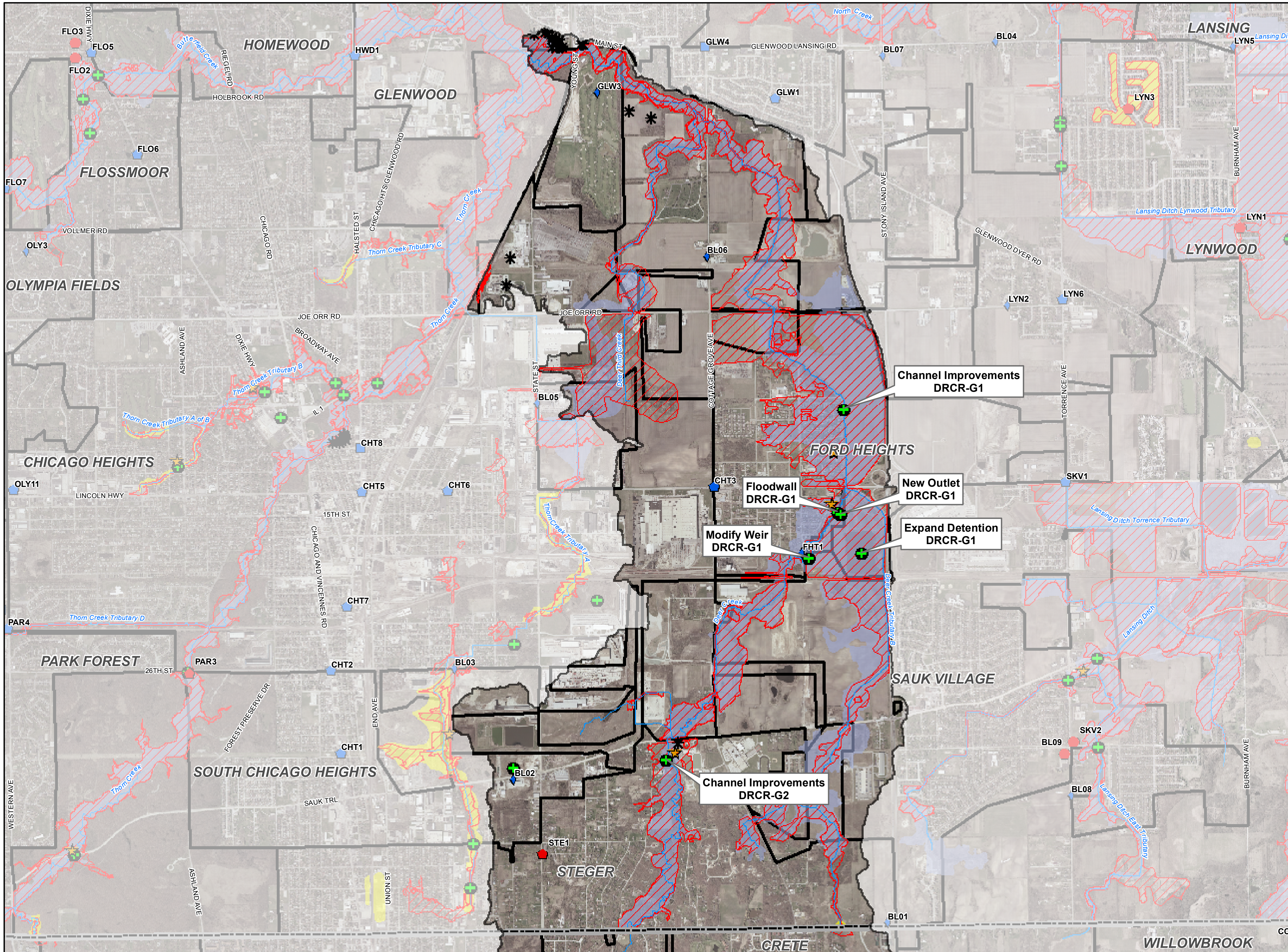


Figure 3.3.6

DEER CREEK
ALTERNATIVE
DRCR-G1
Little Calumet River DWP

Alternative Description:
Increase channel capacity north of US 30 HWY and excavate existing reservoir to provide additional 24 ac-ft storage

Conceptual Level Cost:
$8,331,000

Benefit:	**B/C Ratio:**
$3,801,000	0.49

Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

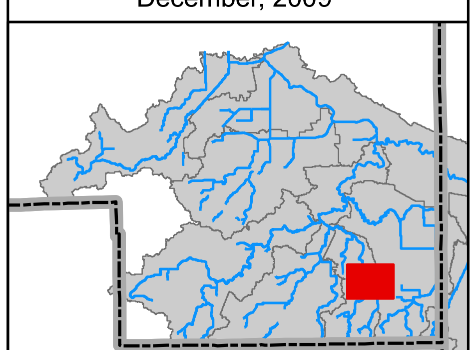
Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

0 1 2 Inches
1 inch = 800 feet

N

CDM

December, 2009



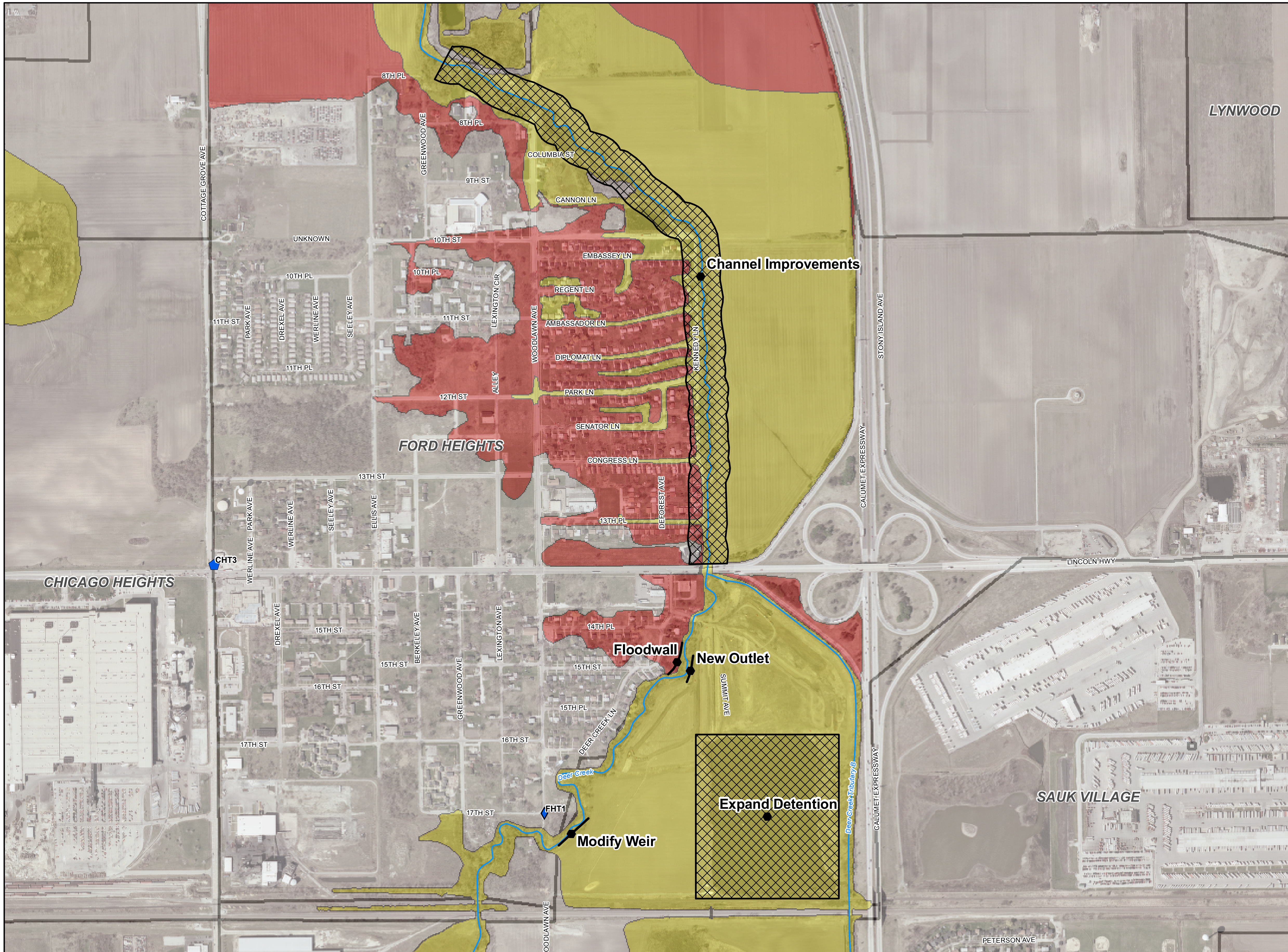


Figure 3.3.7

DEER CREEK
ALTERNATIVE
DRCR-G2
Little Calumet River DWP

Alternative Description:
Channel improvements for 1,800 LF upstream of Sauk Trail Road

Conceptual Level Cost:
$14,312,000

Benefit: $55,000

B/C Ratio: <0.01

Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

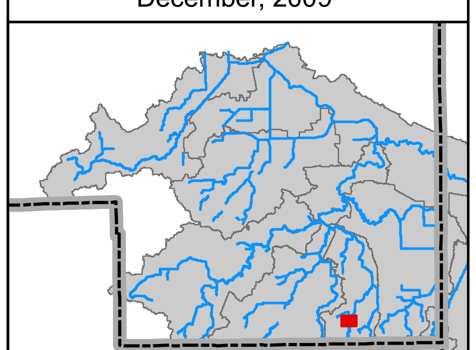
River/Stream
Municipalities
County Boundary
Project Alternative Location
100-year Inundation Area With Project
100-year Inundation Area Without Project

0 1 2 Inches
1 inch = 250 feet

N

CDM

December, 2009



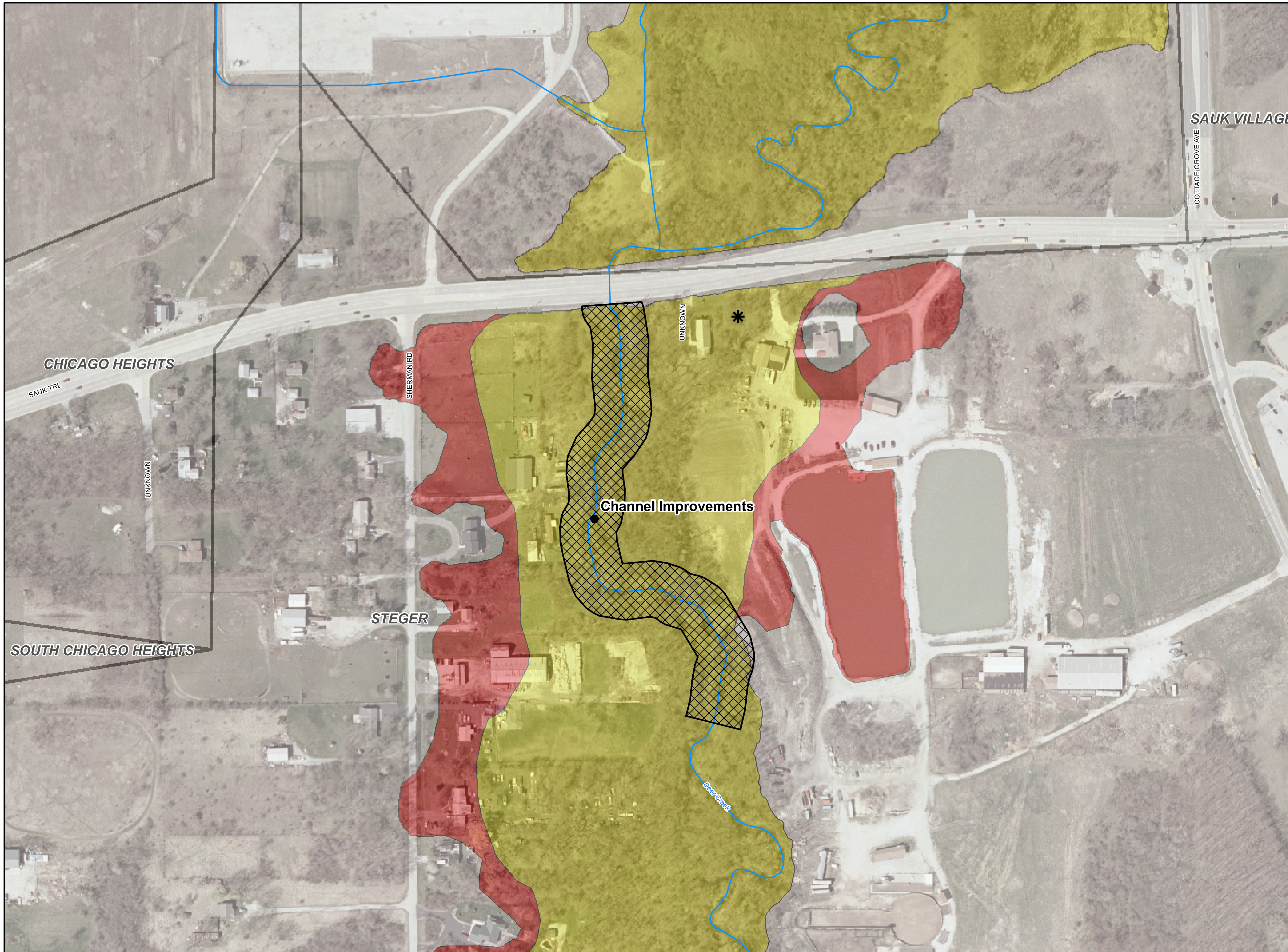


Figure 3.4.1

MIDLOTHIAN CREEK SUBWATERSHED OVERVIEW

Little Calumet River DWP

Local Problems

- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

Regional Problems

- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding
- Problem Area Identified Through Modeling
- Candidate Structures for Floodproofing/Acquisition
- Project Alternative Location
- River/Stream
- Municipal Boundary
- County Boundary
- DWP 100-year Inundation Area

FEMA Floodplain

- Zone A; Zone AH; Zone AO
- Zone AE

N

1 inch = 4,500 feet

0 1 2

Inches

CDM

December, 2009

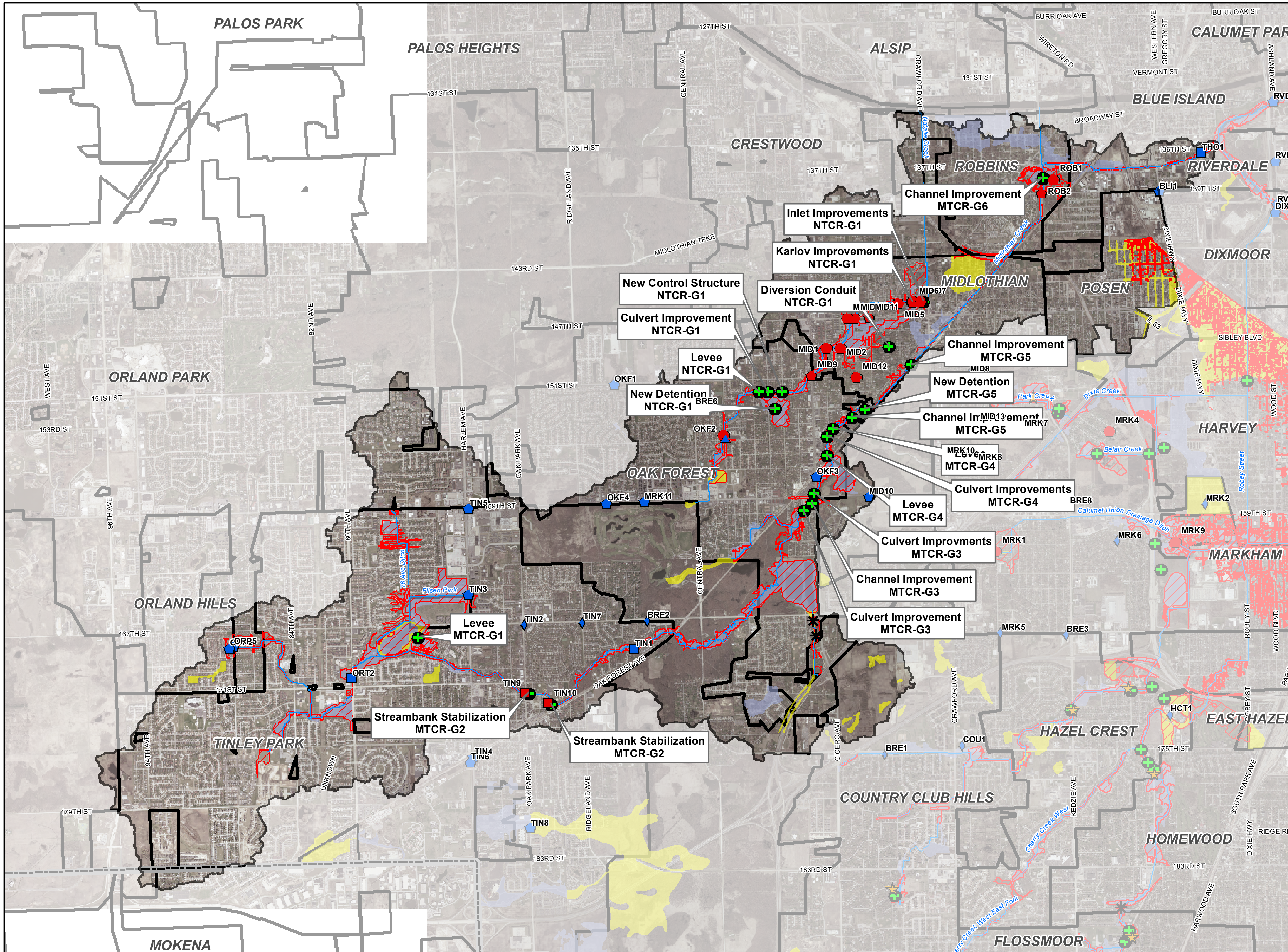


Figure 3.4.5

MIDLOTHIAN CREEK
ALTERNATIVE
MTCR-G1
Little Calumet River DWP

Alternative Description:
Construct a 700 LF levee along Overhill Avenue and Oleander Avenue

Conceptual Level Cost:
$1,710,000

Benefit:	**B/C Ratio:**
$134,000	0.08

- * Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

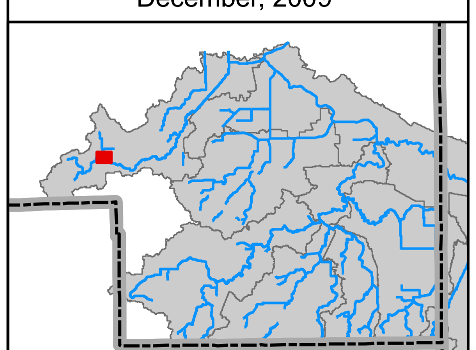
0 1 2 Inches

1 inch = 250 feet

N

CDM

December, 2009



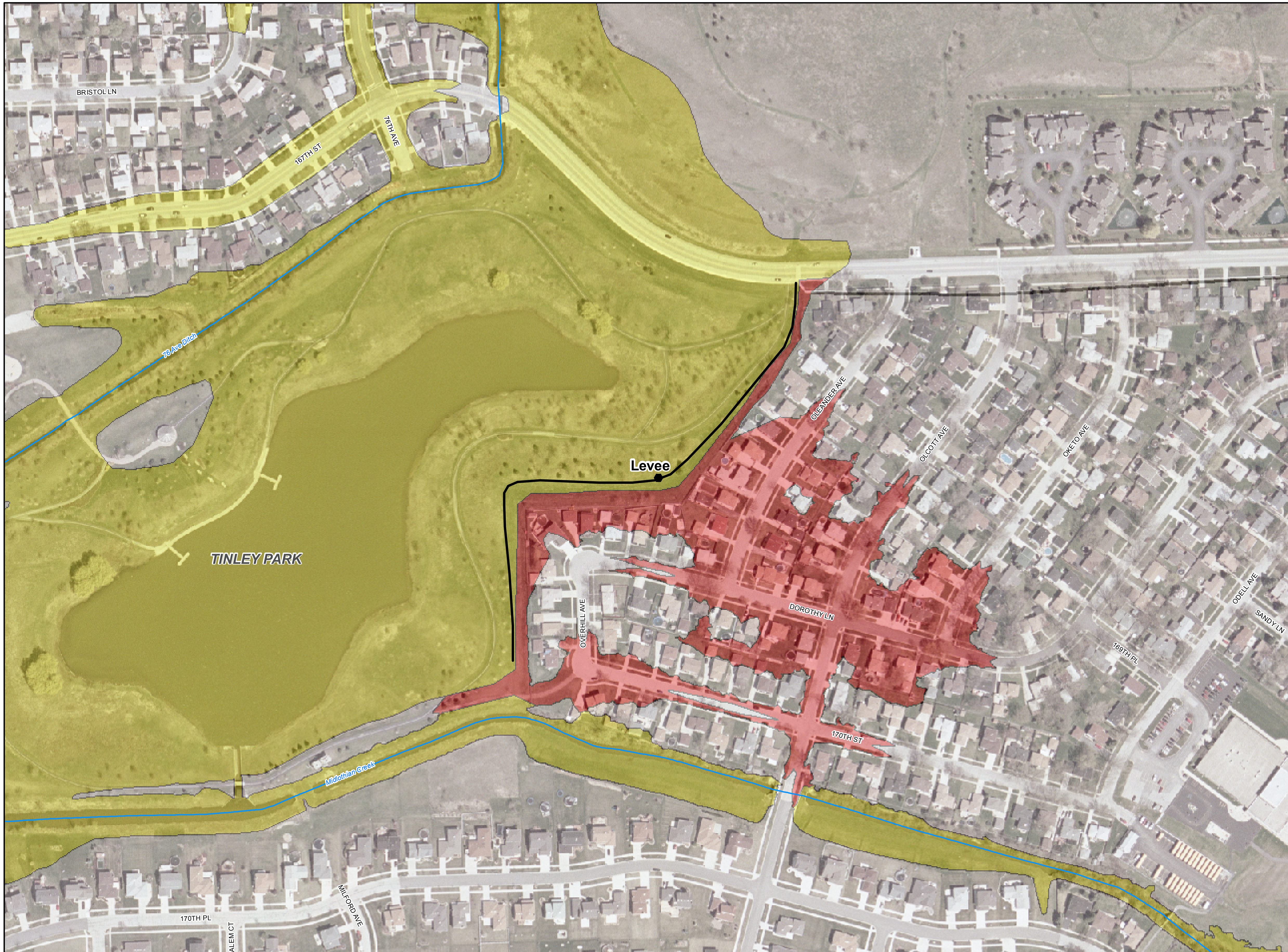


Figure 3.4.6

MIDLOTHIAN CREEK
ALTERNATIVE
MTCR-G2
Little Calumet River DWP

Alternative Description:
Streambank stabilization near Oak Park Avenue and 172nd Street and near Hickory Street and 66th Court

Conceptual Level Cost:
$1,569,000

Benefit: $1,110,000

B/C Ratio: 0.71

Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

0 1 2 Inches

1 inch = 250 feet

N

CDM

December, 2009

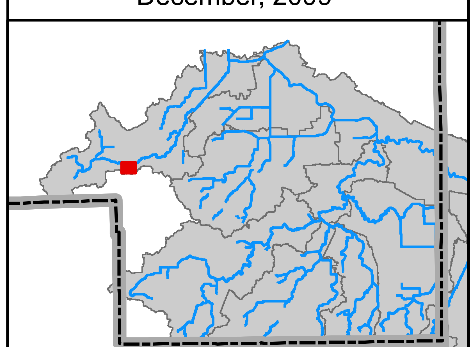


Figure 3.4.7

MIDLOTHIAN CREEK
ALTERNATIVE
MTCR-G3
Little Calumet River DWP

Alternative Description:
Replace 160th and 159th Street culverts and channel improvements between 160th and Oak Avenue

Conceptual Level Cost:
$3,455,000

Benefit:	**B/C Ratio:**
$37,000	0.01

Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

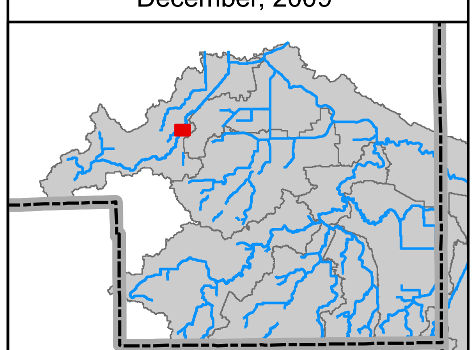
0 1 2 Inches

1 inch = 250 feet

N

CDM

December, 2009



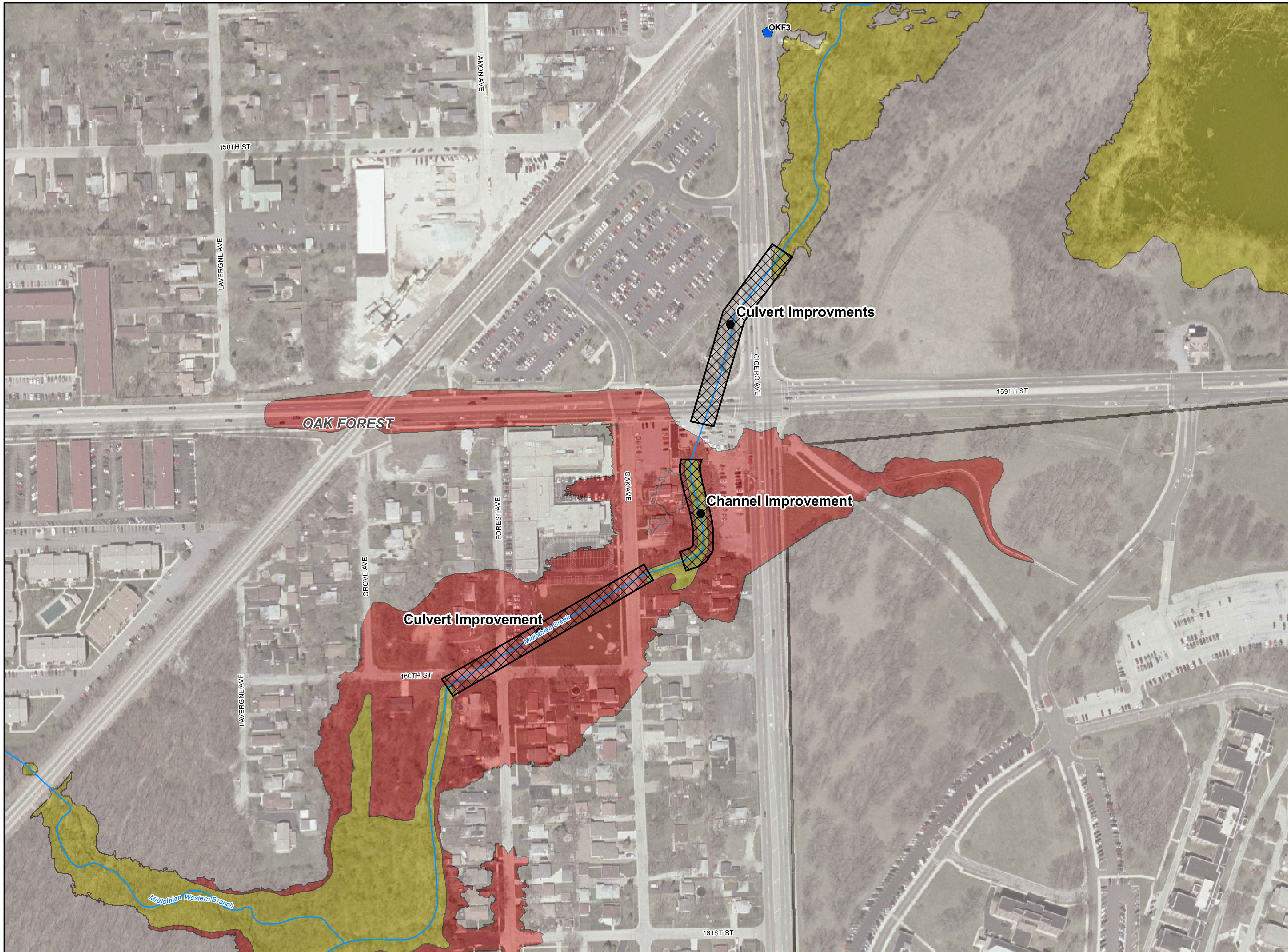


Figure 3.4.8

MIDLOTHIAN CREEK
ALTERNATIVE MTCR-G4
Little Calumet River DWP

Alternative Description:
Replace 155th and Kilpatrick Avenue culverts and construct a 700LF floodwall downstream of Kilpatrick Avenue and construct a 350LF floodwall upstream of Waverly Avenue

Conceptual Level Cost:
$27,700,000

Benefit:	**B/C Ratio:**
$1,143,000	0.04

- ✱ Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

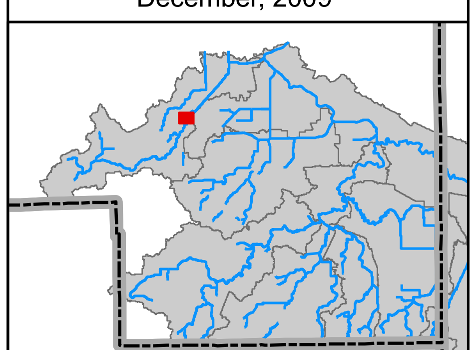
0 1 2 Inches

1 inch = 250 feet

N

CDM

December, 2009



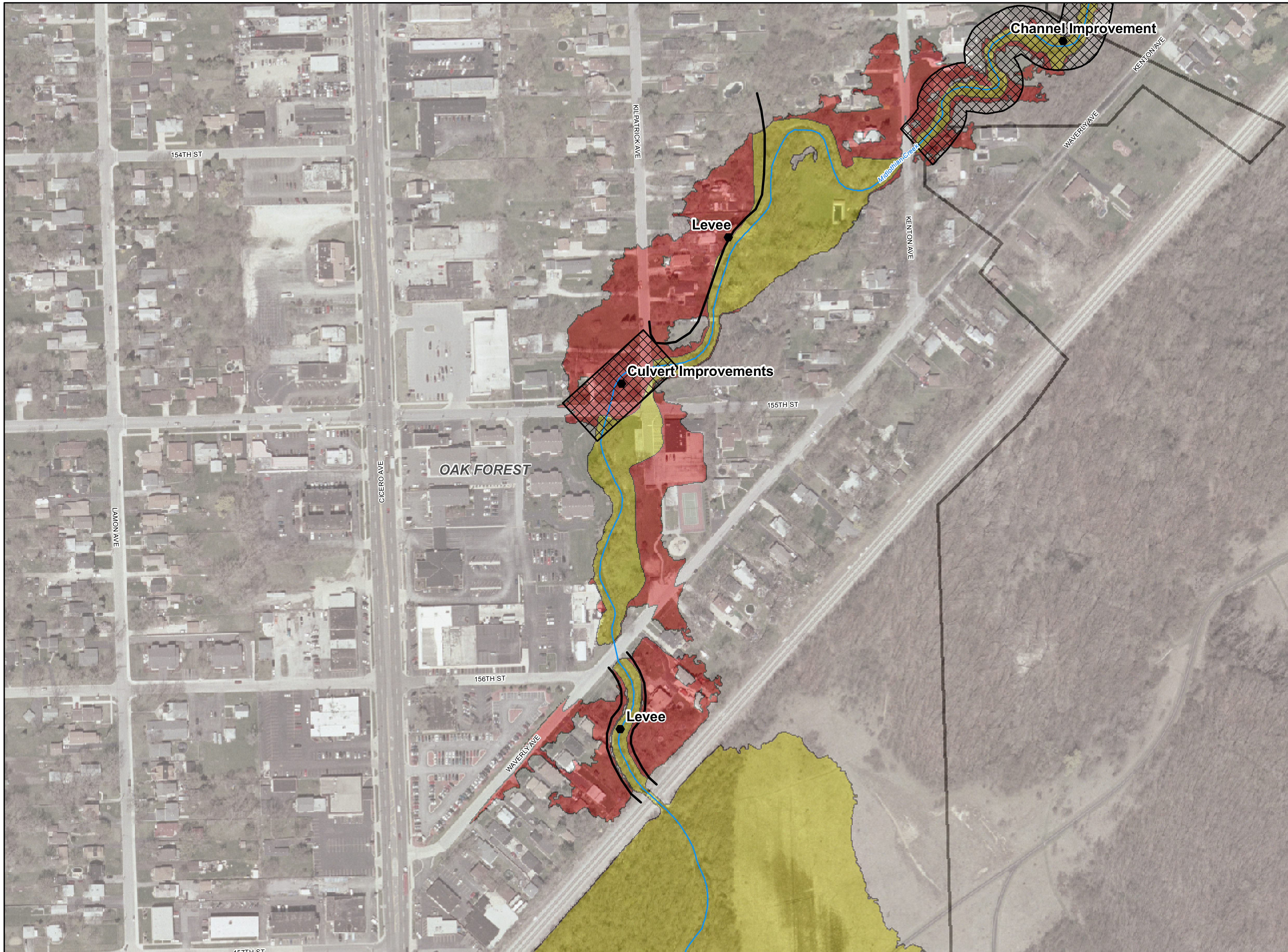


Figure 3.4.9

MIDLOTHIAN CREEK
ALTERNATIVE
MTCR-G5
Little Calumet River DWP

Alternative Description:
Construct a 25 ac-ft detention at Kilbourn and Waverly, channel improvements from 151st Street to Pulaski Road and between Kenton and Kilbourn Avenue

Conceptual Level Cost:
$21,000,000

Benefit: $58,000

B/C Ratio: < 0.01

Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

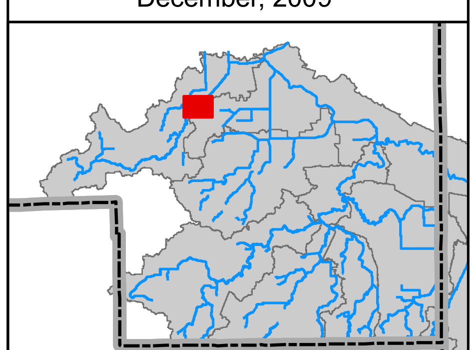
0 1 2 Inches

1 inch = 500 feet

N

CDM

December, 2009



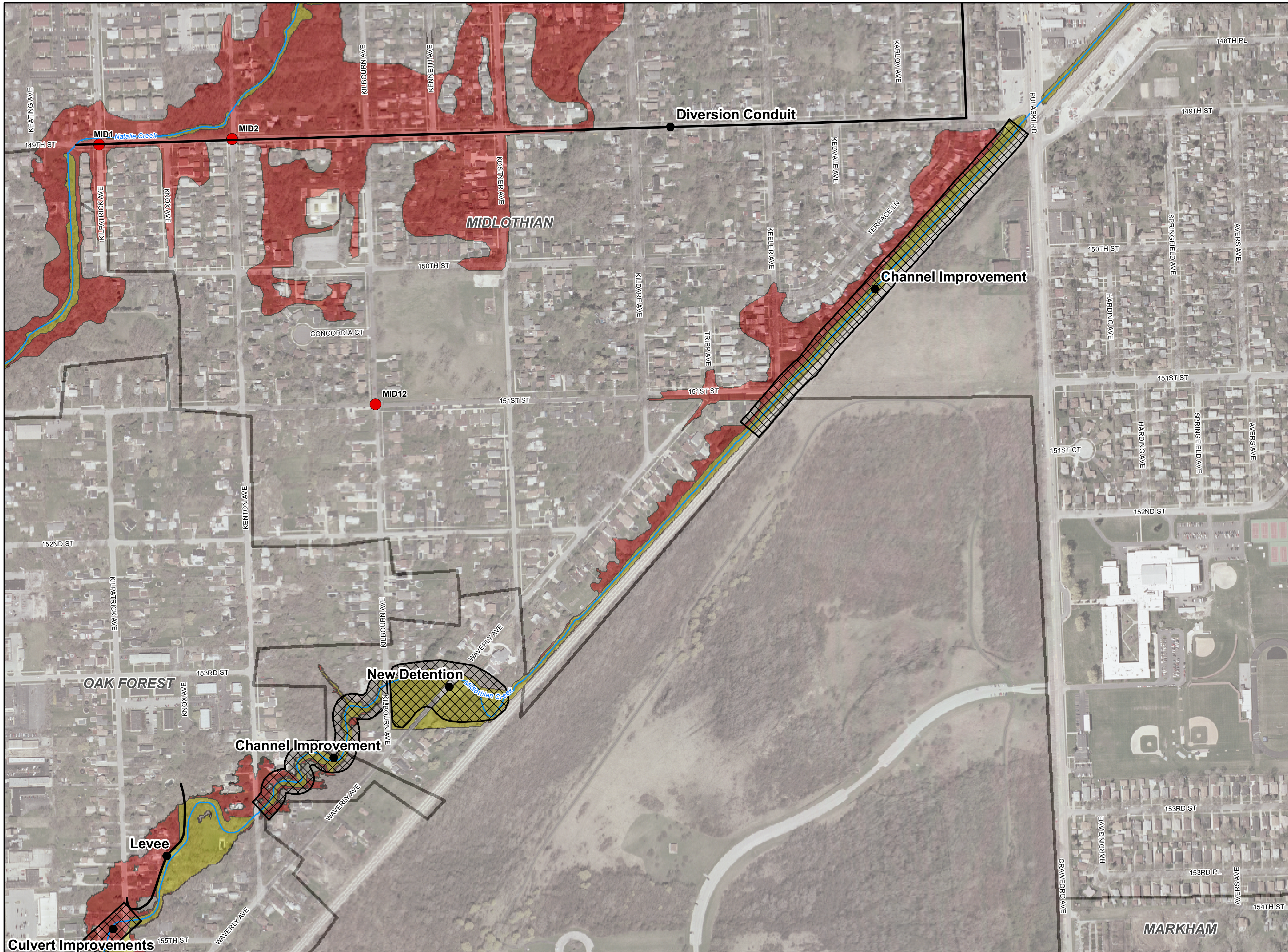


Figure 3.4.10

MIDLOTHIAN CREEK
ALTERNATIVE
MTCR-G6
Little Calumet River DWP

Alternative Description:
Channel improvements between 137th and 139th Street

Conceptual Level Cost:
$479,000

Benefit: $110,000

B/C Ratio: 0.23

- ✱ Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

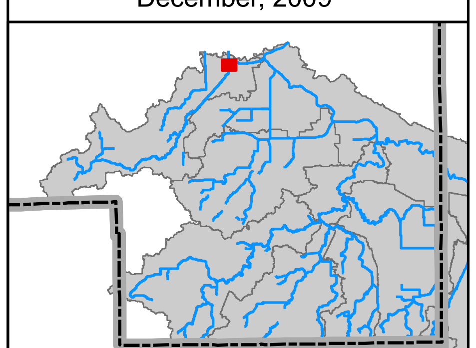
0 1 2 Inches

1 inch = 250 feet

N

CDM

December, 2009



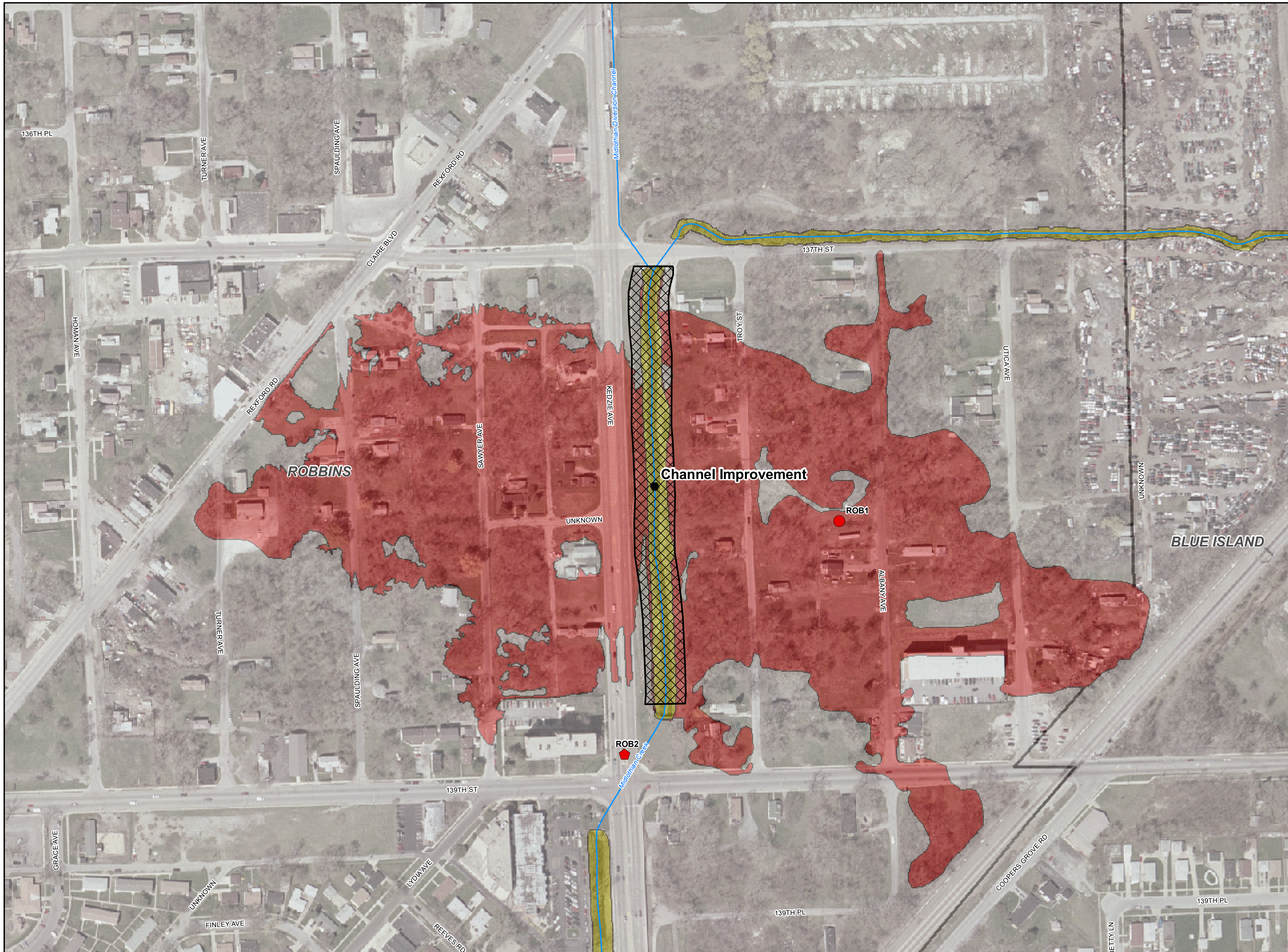


Figure 3.4.11

MIDLOTHIAN CREEK
ALTERNATIVE
NTCR-G1
Little Calumet River DWP

Alternative Description:
Construct a 190 ac-ft detention facility at Leclaire Avenue and 153rd stree and a 6600 LF diversion conduit from Kilpatrick to Keystone Avenue

Conceptual Level Cost:
$61,940,000

Benefit: $14,700,000

B/C Ratio: 0.24

Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

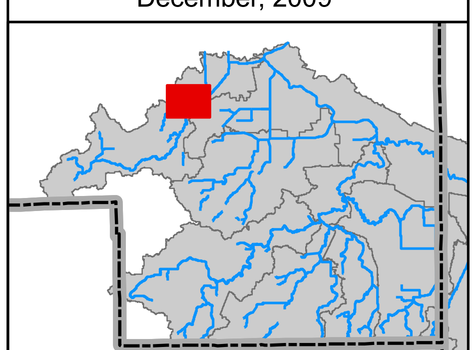
Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

River/Stream
Municipalities
County Boundary
Project Alternative Location
100-year Inundation Area With Project
100-year Inundation Area Without Project

0 1 2 Inches
1 inch = 750 feet

N

December, 2009



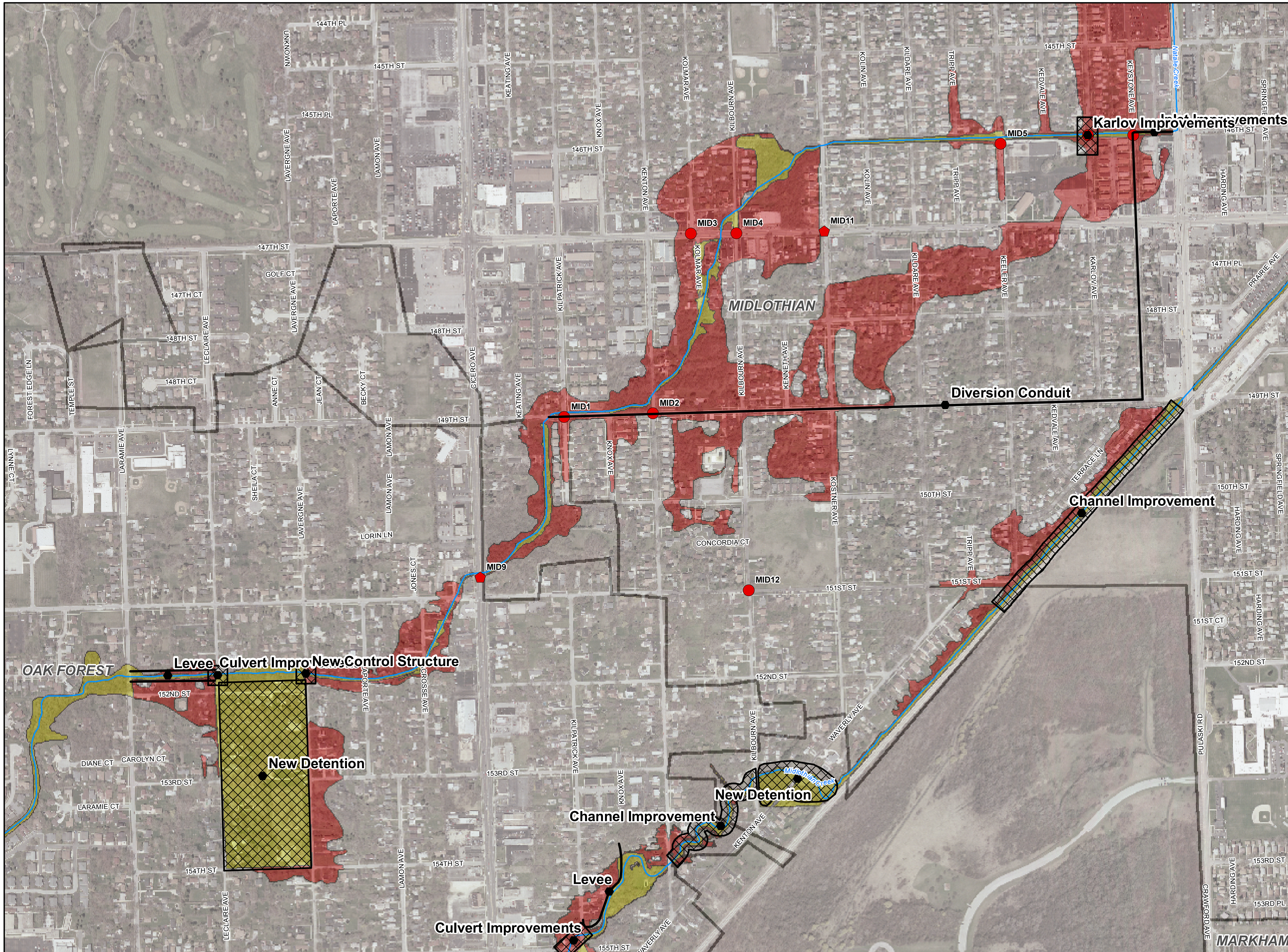


Figure 3.5.1

NORTH CREEK SUBWATERSHED OVERVIEW

Little Calumet River DWP

Local Problems

- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

Regional Problems

- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding
- Problem Area Identified Through Modeling
- Candidate Structures for Floodproofing/Acquisition
- Project Alternative Location
- River/Stream
- Municipal Boundary
- County Boundary
- DWP 100-year Inundation Area

FEMA Floodplain

- Zone A; Zone AH; Zone AO
- Zone AE

N

1 inch = 4,000 feet

0 1 2
Inches

CDM

December, 2009

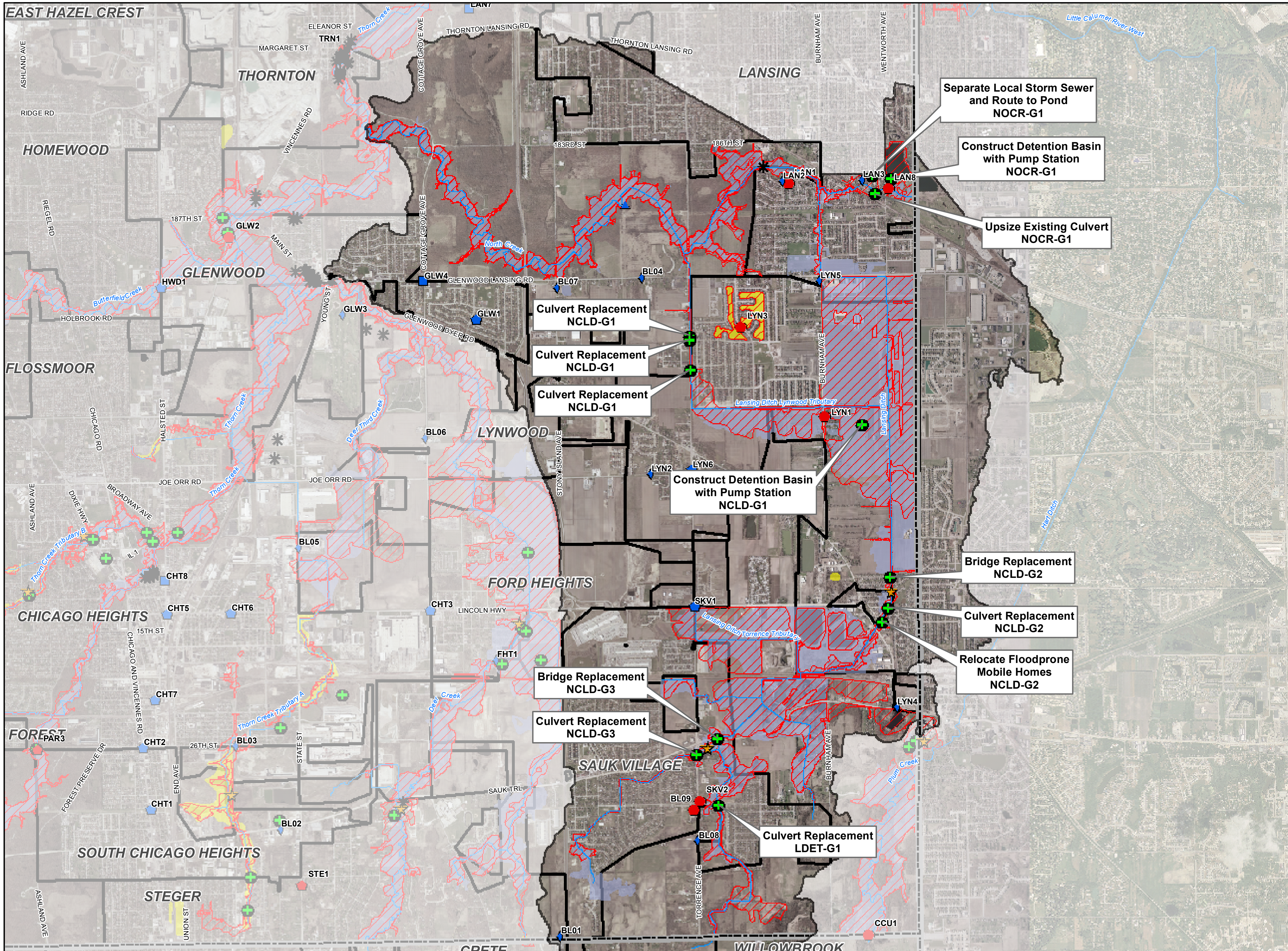


Figure 3.5.4

NORTH CREEK
ALTERNATIVE
LDET-G1
Little Calumet River DWP

Alternative Description:
Replace existing crossing on Katz Corner Road

Conceptual Level Cost:
$287,000

Benefit: $82,000

B/C Ratio: 0.29

Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

River/Stream
Municipalities
County Boundary
Project Alternative Location
100-year Inundation Area With Project
100-year Inundation Area Without Project

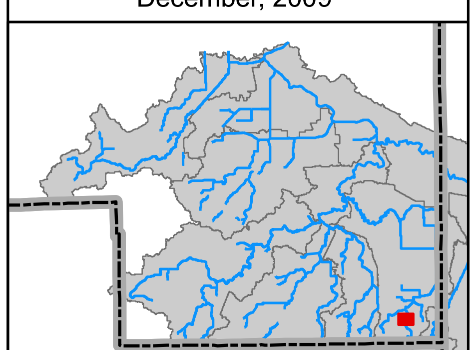
0 1 2 Inches

1 inch = 250 feet

N

CDM

December, 2009



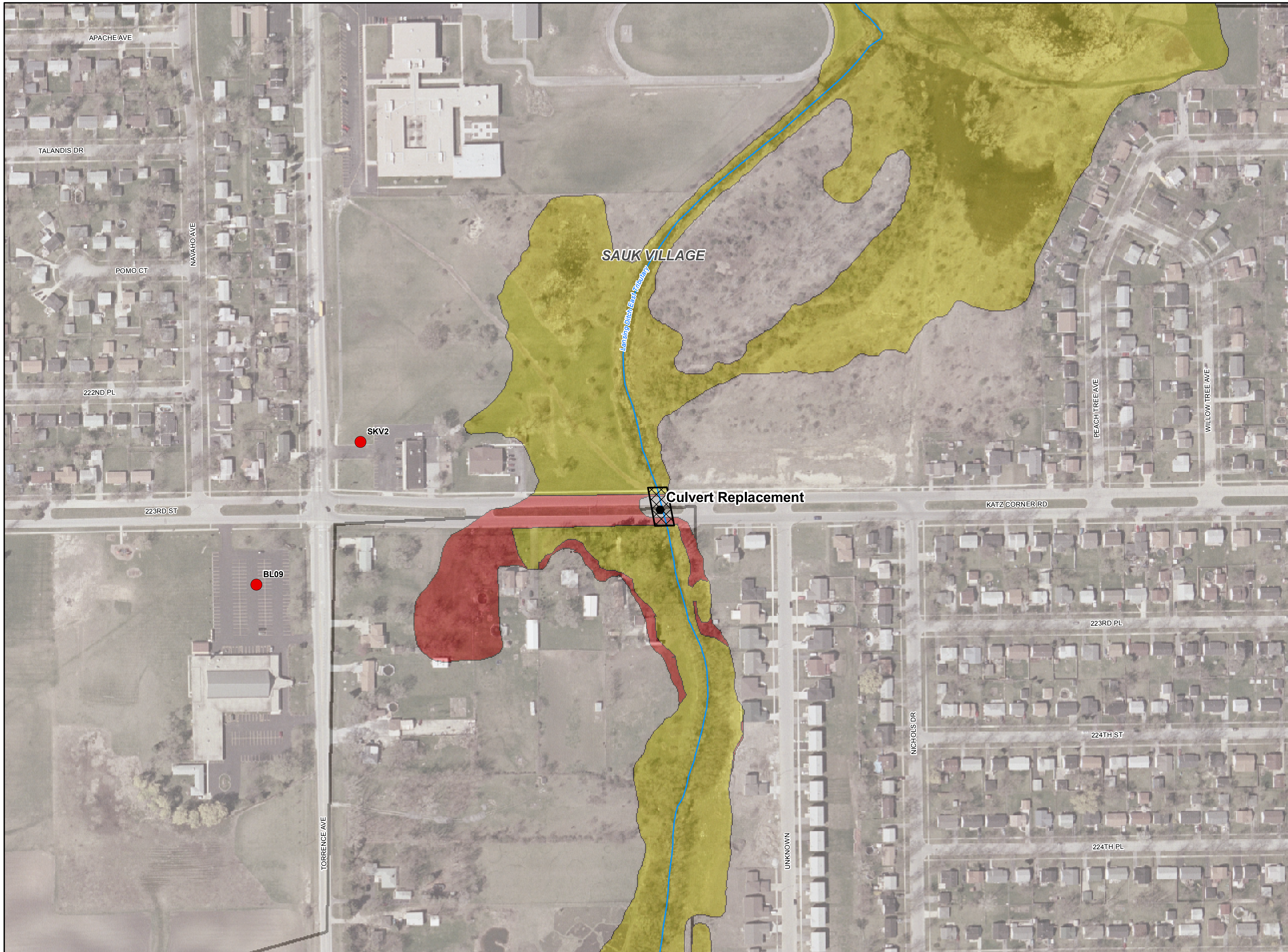


Figure 3.5.5

NORTH CREEK
ALTERNATIVE
NCLD-G1
Little Calumet River DWP

Alternative Description:
Construct 700 ac-ft detention facility and replace crossings at 198th Street and downstream private drives

Conceptual Level Cost:
$69,500,000

Benefit:	**B/C Ratio:**
$2,364,000	0.03

Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

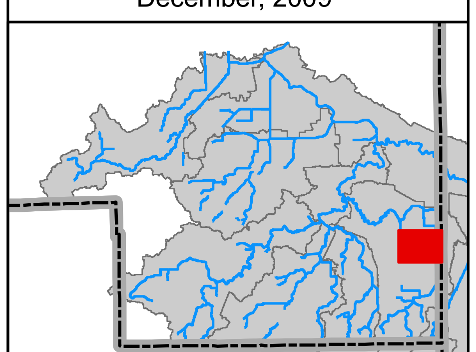
River/Stream
Municipalities
County Boundary
Project Alternative Location
100-year Inundation Area With Project
100-year Inundation Area Without Project

0 1 2 Inches
1 inch = 750 feet

N

CDM

December, 2009



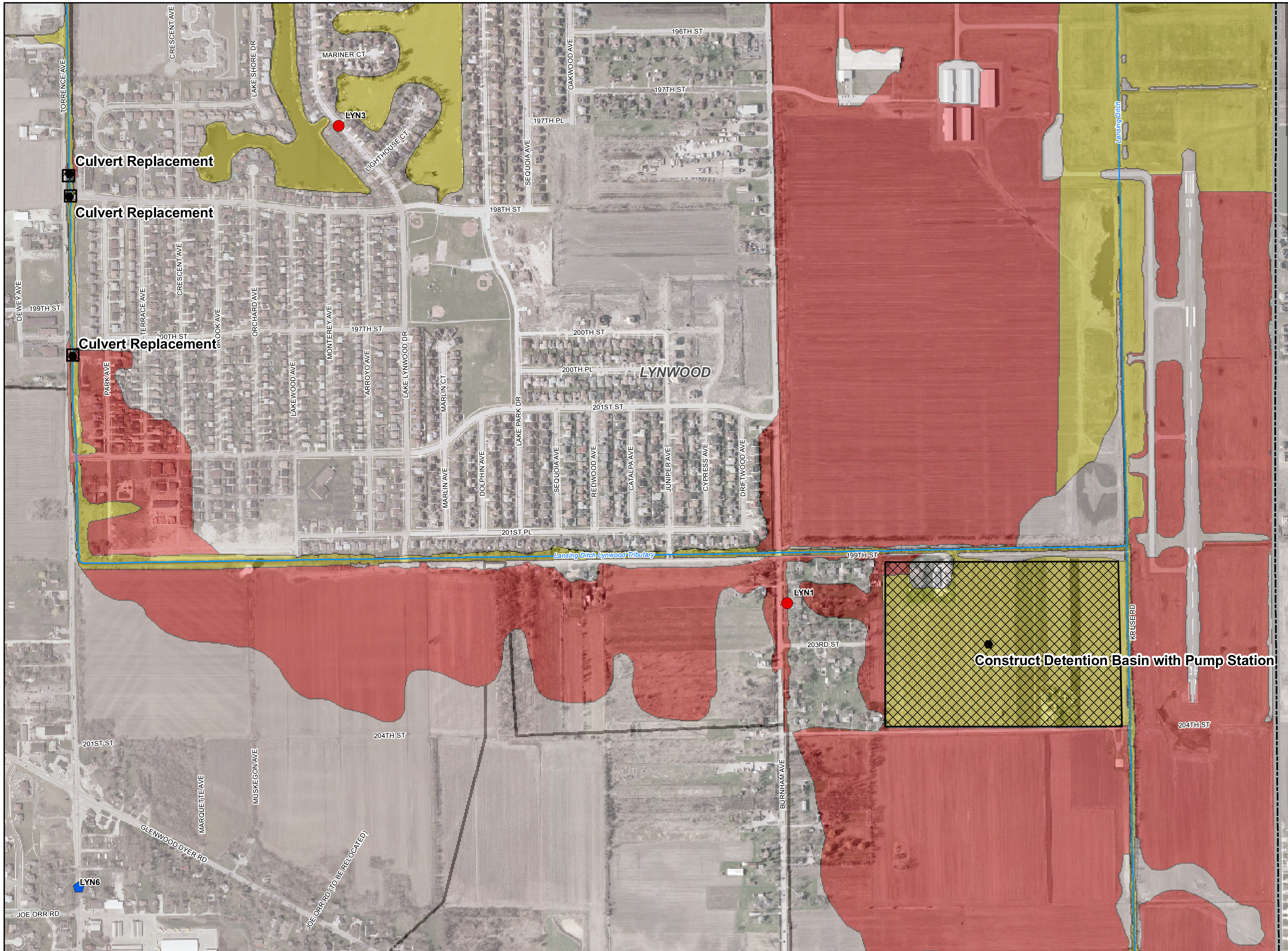


Figure 3.5.6

NORTH CREEK
ALTERNATIVE
NCLD-G2
Little Calumet River DWP

Alternative Description:
Replace Bridge Street and Linda Lane and relocate mobile homes

Conceptual Level Cost:
$357,000

Benefit: $1,000

B/C Ratio: < 0.01

- ✱ Candidate Structures for Floodproofing/Acquisition

Regional Problems

- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems

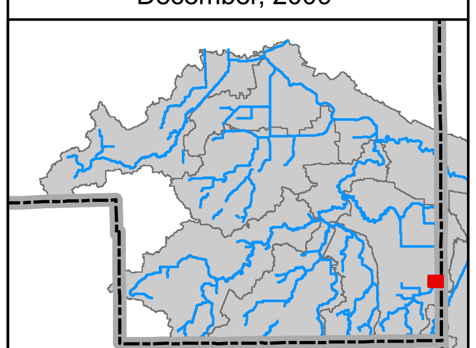
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

0 1 2 Inches

1 inch = 250 feet

N

December, 2009



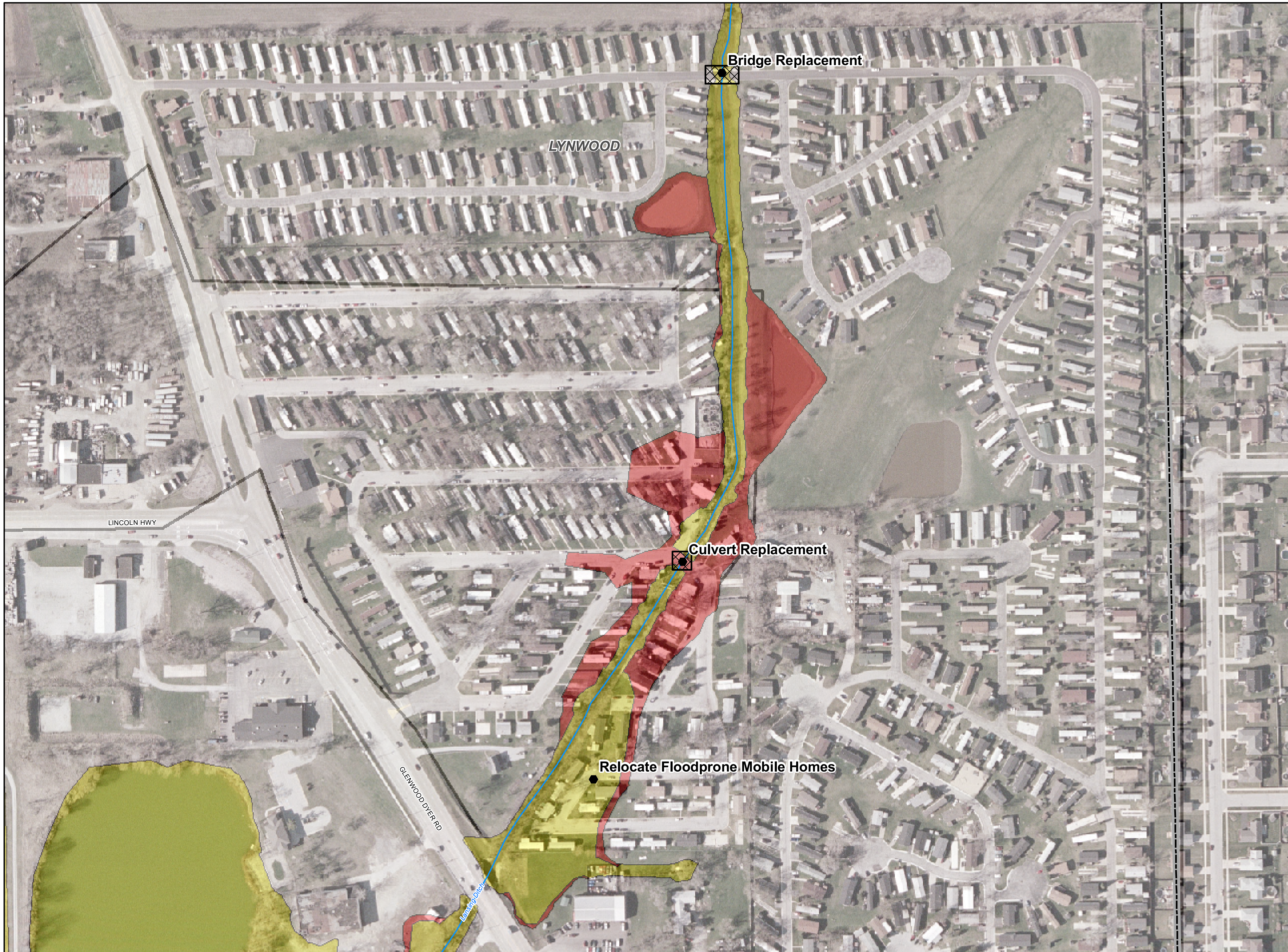


Figure 3.5.7

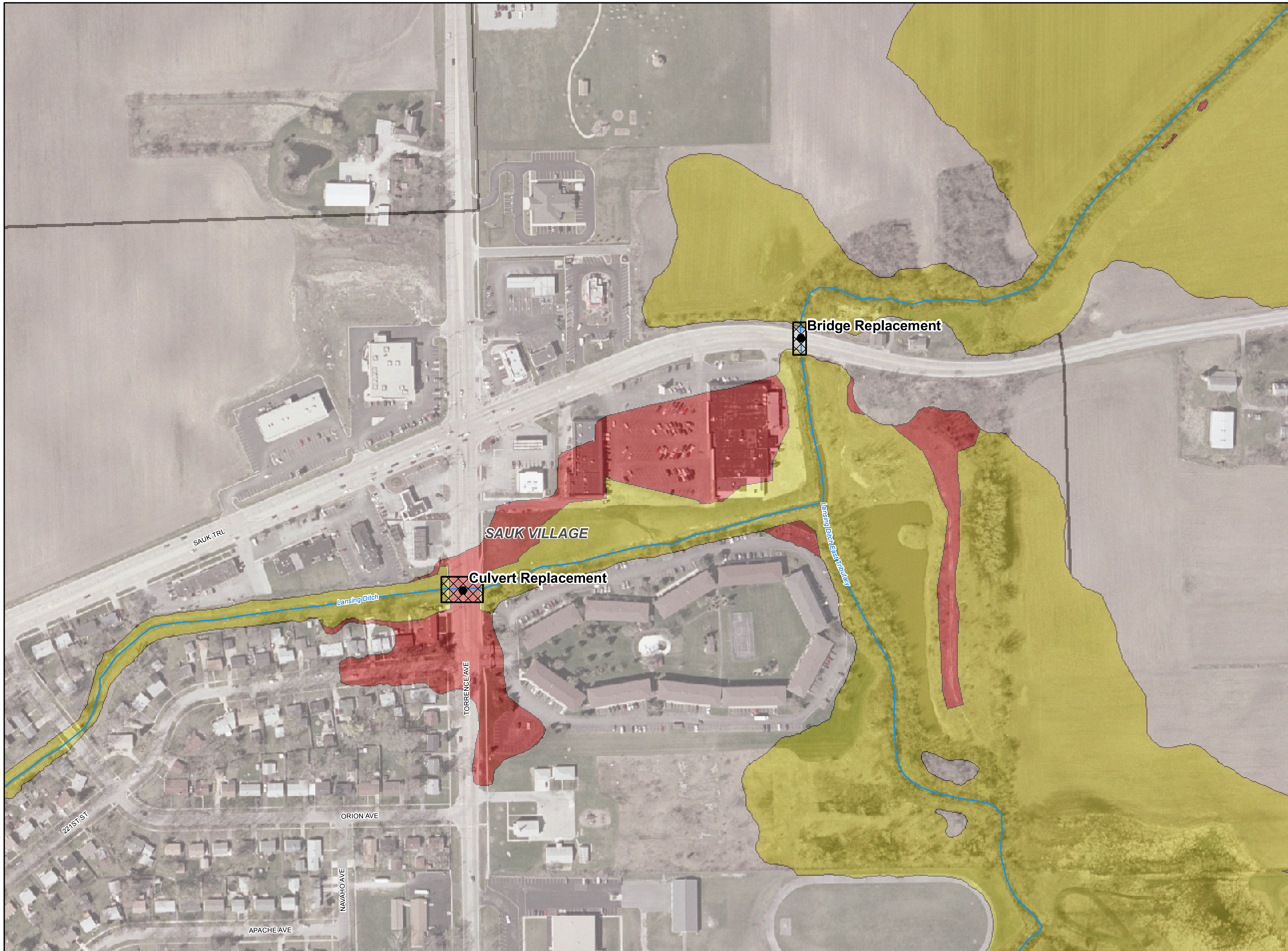
NORTH CREEK
ALTERNATIVE
NCLD-G3
Little Calumet River DWP

Alternative Description:
Replace Torrence Avenue and Sauk Trail Road

Conceptual Level Cost:
$2,180,000

Benefit: $10,000

B/C Ratio: < 0.01



Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

0 1 2 Inches

1 inch = 250 feet

N

CDM

December, 2009

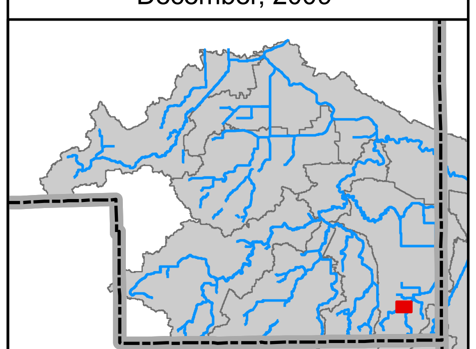


Figure 3.5.8

NORTH CREEK
ALTERNATIVE NOCR-G1
Little Calumet River DWP

Alternative Description:
Replace culvert from Wenworth Avenue and Grand Truck Railroad and construct a 12 ac-ft detention facility

Conceptual Level Cost:
$7,126,000

Benefit: $388,400

B/C Ratio: 0.05

Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

River/Stream
Municipalities
County Boundary
Project Alternative Location
100-year Inundation Area With Project
100-year Inundation Area Without Project

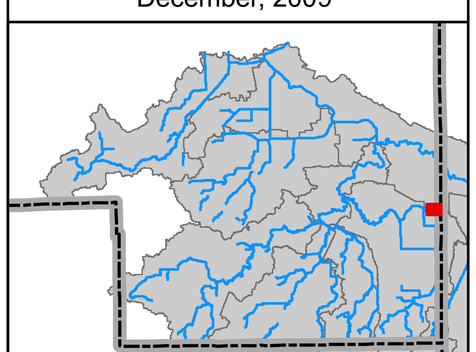
0 1 2 Inches

1 inch = 250 feet

N

CDM

December, 2009



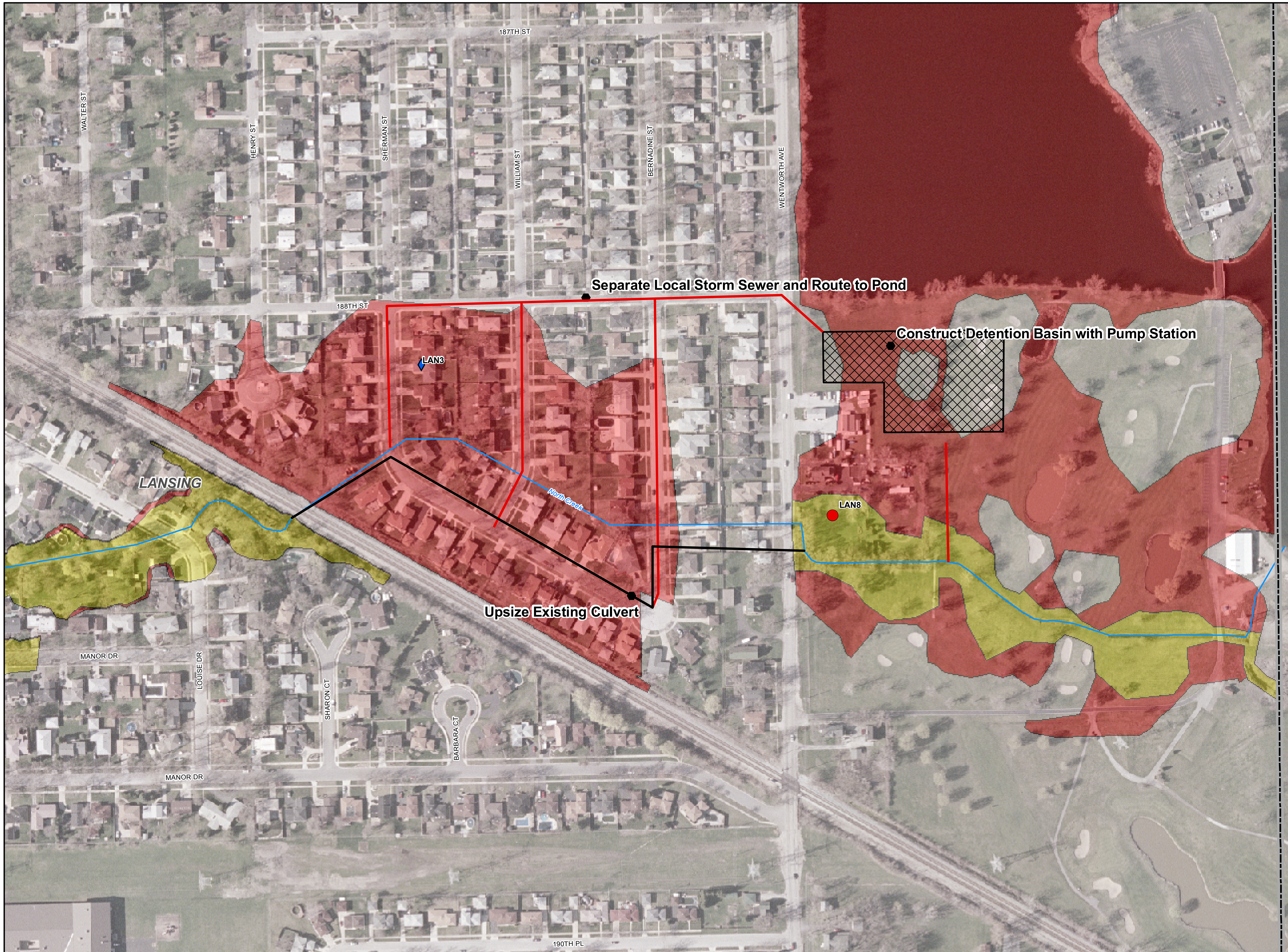


Figure 3.6.1

PLUM CREEK SUBWATERSHED OVERVIEW

Little Calumet River DWP

Local Problems

- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

Regional Problems

- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding
- Problem Area Identified Through Modeling
- Candidate Structures for Floodproofing/Acquisition
- Project Alternative Location
- River/Stream
- Municipal Boundary
- County Boundary
- DWP 100-year Inundation Area

FEMA Floodplain

- Zone A; Zone AH; Zone AO
- Zone AE

N

1 inch = 1,000 feet

0 1 2
Inches

CDM

December, 2009

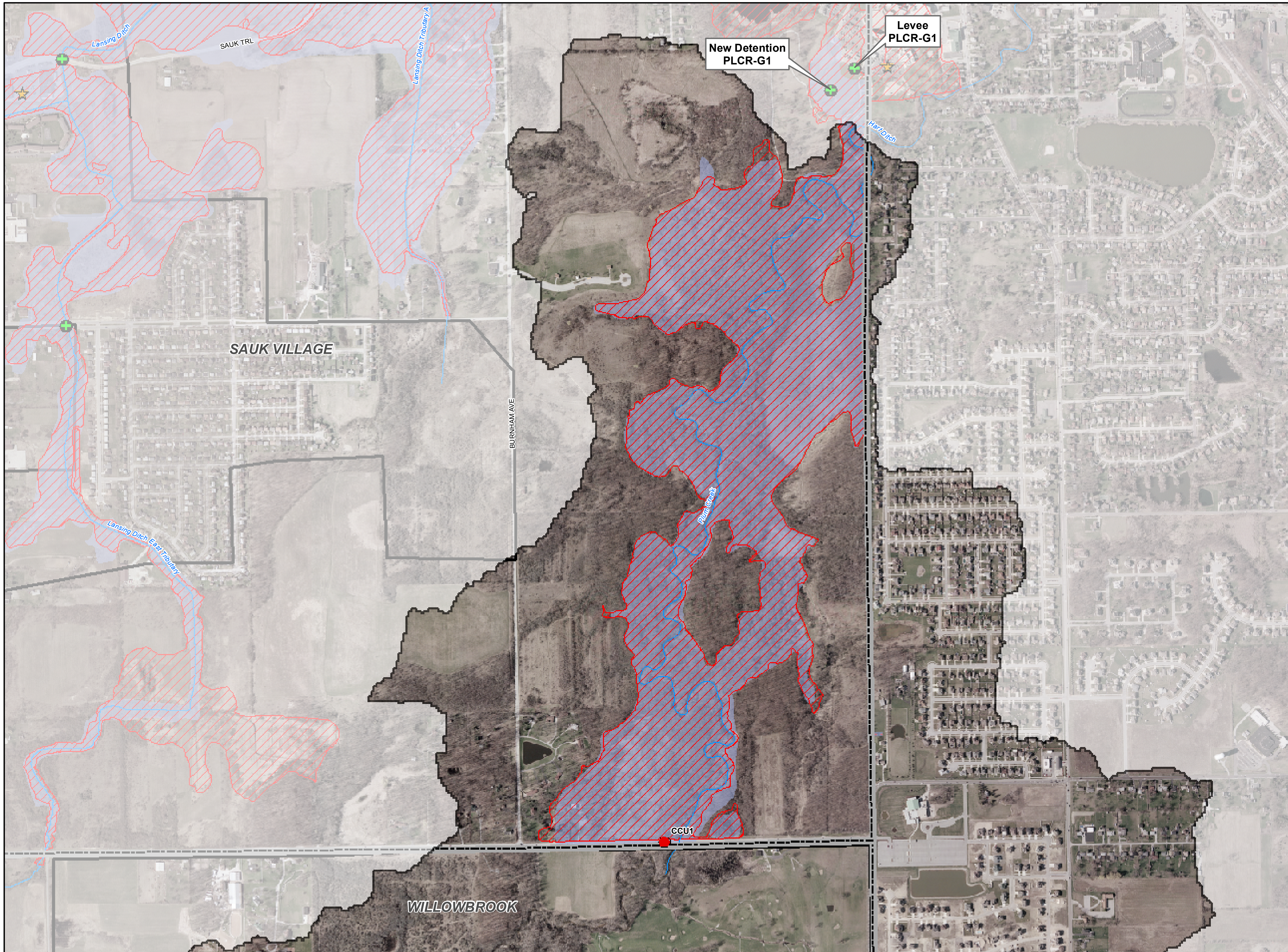


Figure 3.6.5

PLUM CREEK
ALTERNATIVE
PLCR-G1
Little Calumet River DWP

Alternative Description:
Construct a levee with a compensatory storage

Conceptual Level Cost:
$3,803,000

Benefit: $2,781,000

B/C Ratio: 0.73

* Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

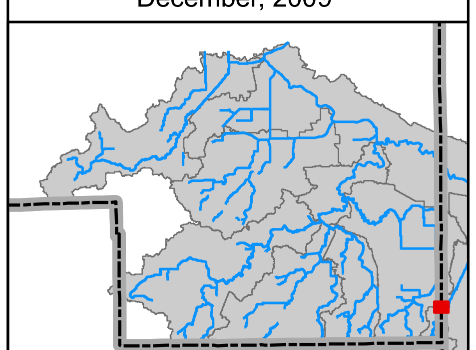
0 1 2 Inches

1 inch = 250 feet

N

CDM

December, 2009



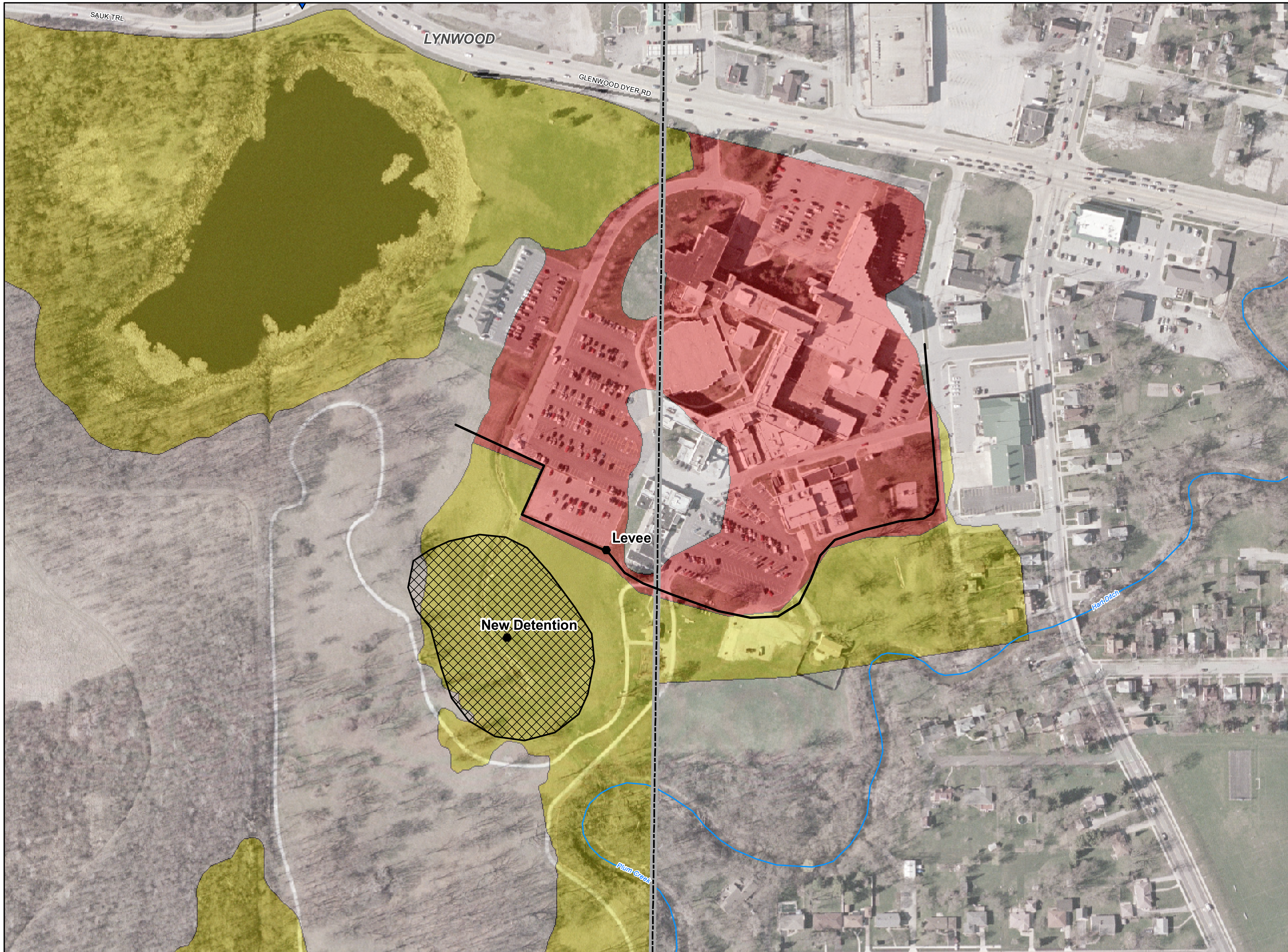


Figure 3.7.1

THORN CREEK SUBWATERSHED OVERVIEW

Little Calumet River DWP

Local Problems

- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

Regional Problems

- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding
- Problem Area Identified Through Modeling
- Candidate Structures for Floodproofing/Acquisition
- Project Alternative Location
- River/Stream
- Municipal Boundary
- County Boundary
- DWP 100-year Inundation Area

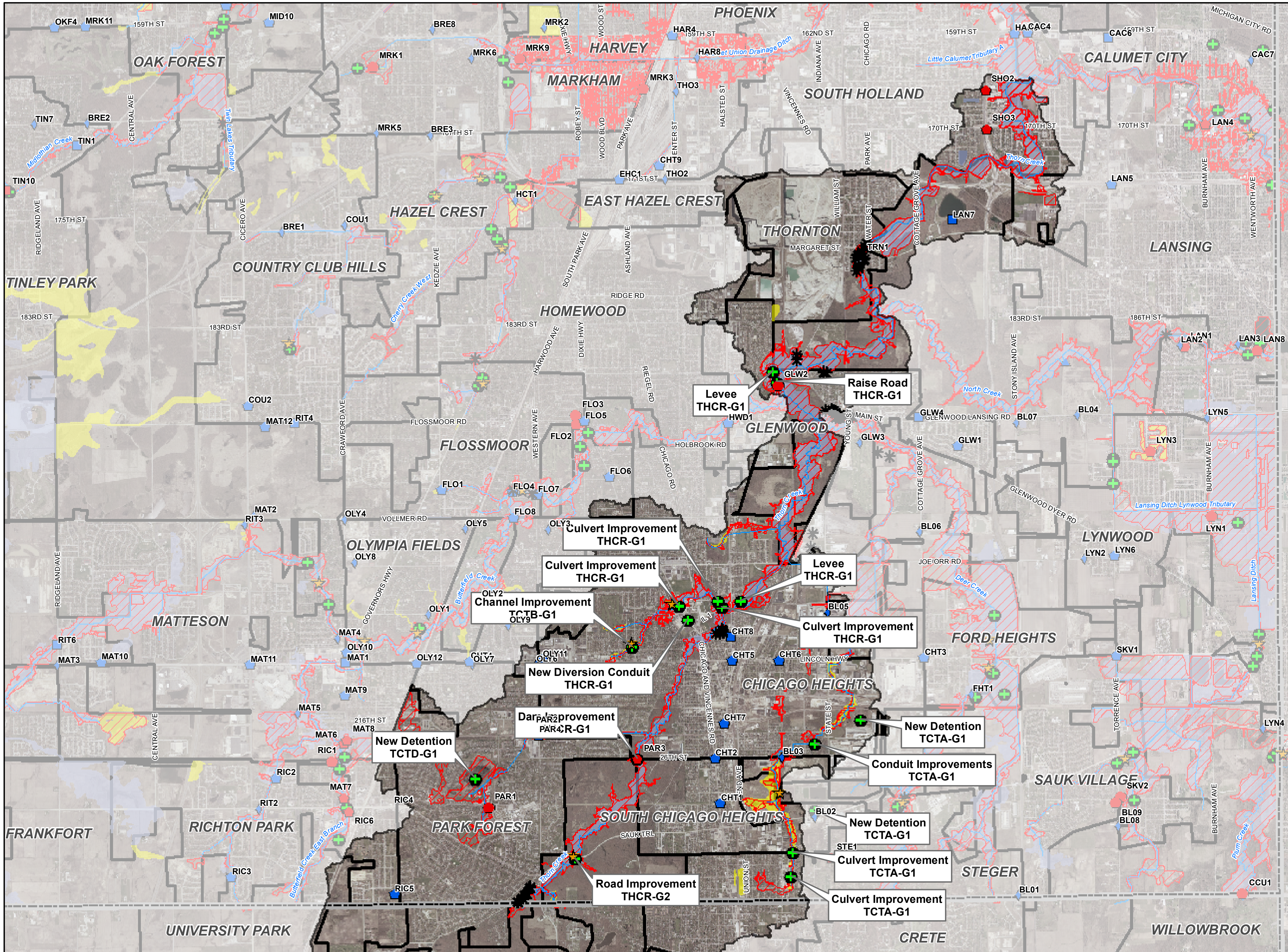
FEMA Floodplain

- Zone A; Zone AH; Zone AO
- Zone AE

N

1 inch = 5,500 feet

0 1 2
Inches



December, 2009

Figure 3.7.6a

THORN CREEK
ALTERNATIVE THCR-G1 (1 of 3)
Little Calumet River DWP

Alternative Description:
Channel capacity improvements along Thorn Creek Tributary B, levees along Thorn Creek, a diversion conduit and modifications to Sauk Lake Dam

Conceptual Level Cost:
$37,660,000

Benefit: $717,000
B/C Ratio: 0.02

- ✱ Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

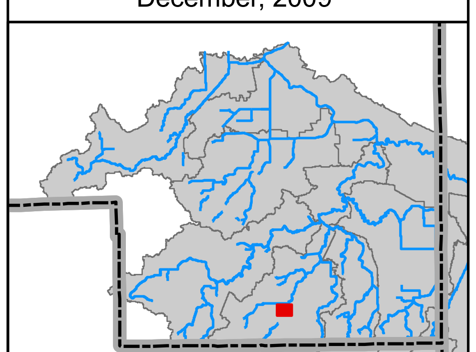
0 1 2 Inches

1 inch = 250 feet

N

CDM

December, 2009



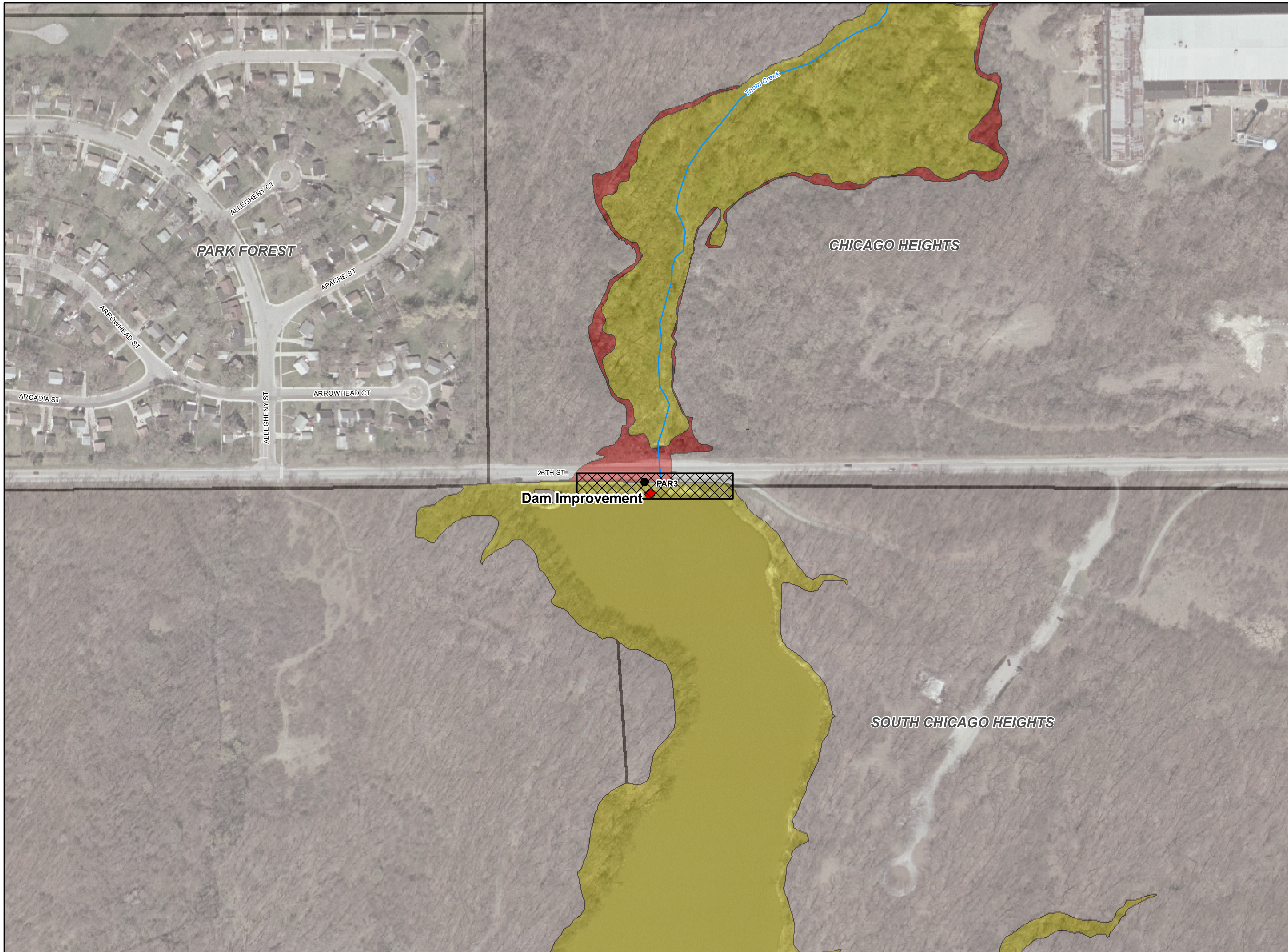


Figure 3.7.6b

THORN CREEK
ALTERNATIVE
THCR-G1 (2 of 3)
Little Calumet River DWP

Alternative Description:
Channel capacity improvements along Thorn Creek Tributary B, levees along Thorn Creek, a diversion conduit and modifications to Sauk Lake Dam

Conceptual Level Cost:
$37,660,000

Benefit: $717,000
B/C Ratio: 0.02

Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

River/Stream
Municipalities
County Boundary
Project Alternative Location
100-year Inundation Area With Project
100-year Inundation Area Without Project

0 1 2 Inches
1 inch = 400 feet

N

CDM

December, 2009

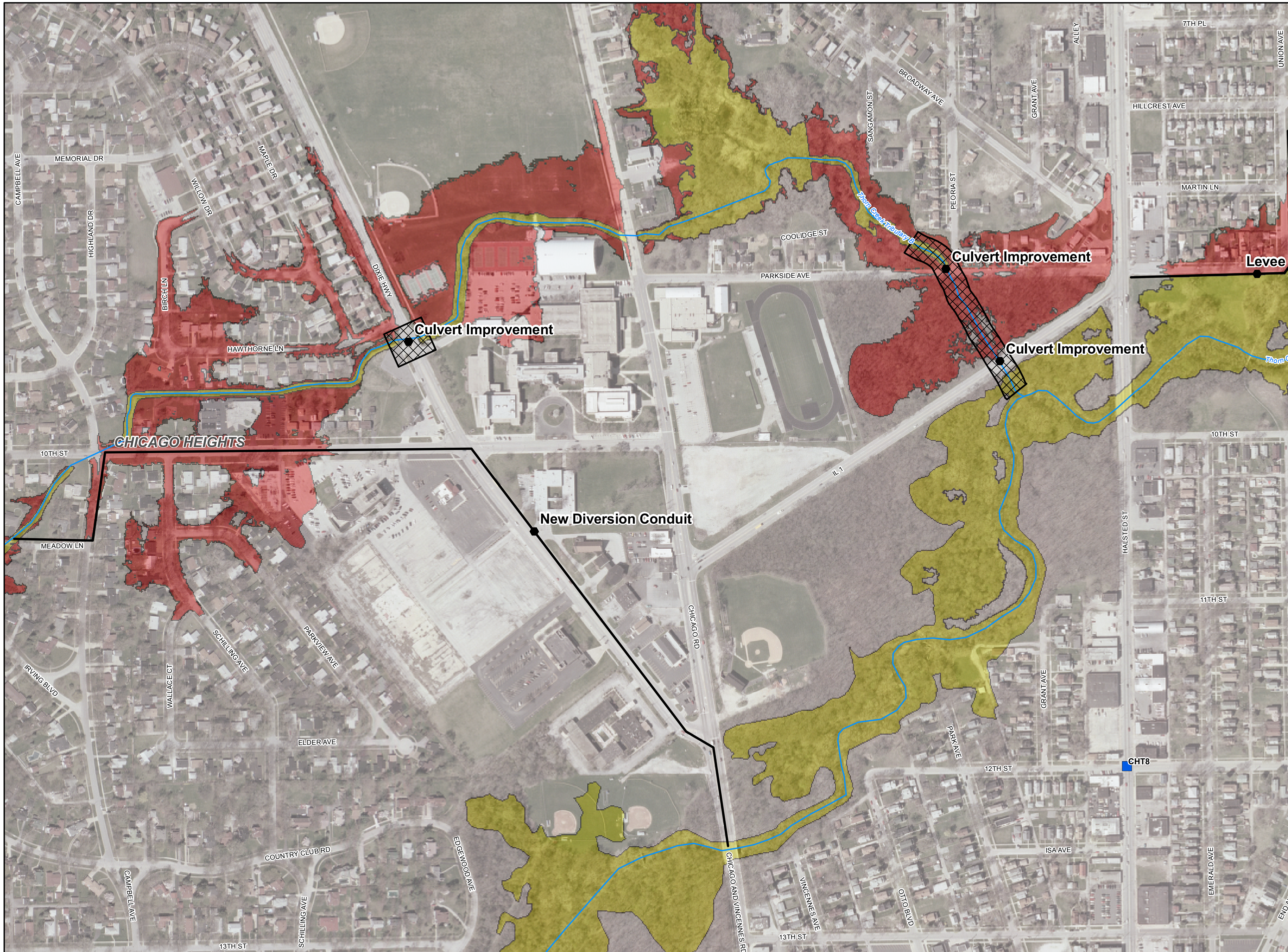


Figure 3.7.6c

THORN CREEK
ALTERNATIVE
THCR-G1 (3 of 3)
Little Calumet River DWP

Alternative Description:
Channel capacity improvements along Thorn Creek Tributary B, levees along Thorn Creek, a diversion conduit and modifications to Sauk Lake Dam

Conceptual Level Cost:
$37,660,000

Benefit: $717,000

B/C Ratio: 0.02

- Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

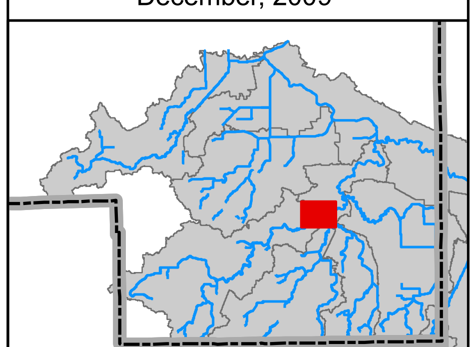
0 1 2 Inches

1 inch = 600 feet

N

CDM

December, 2009



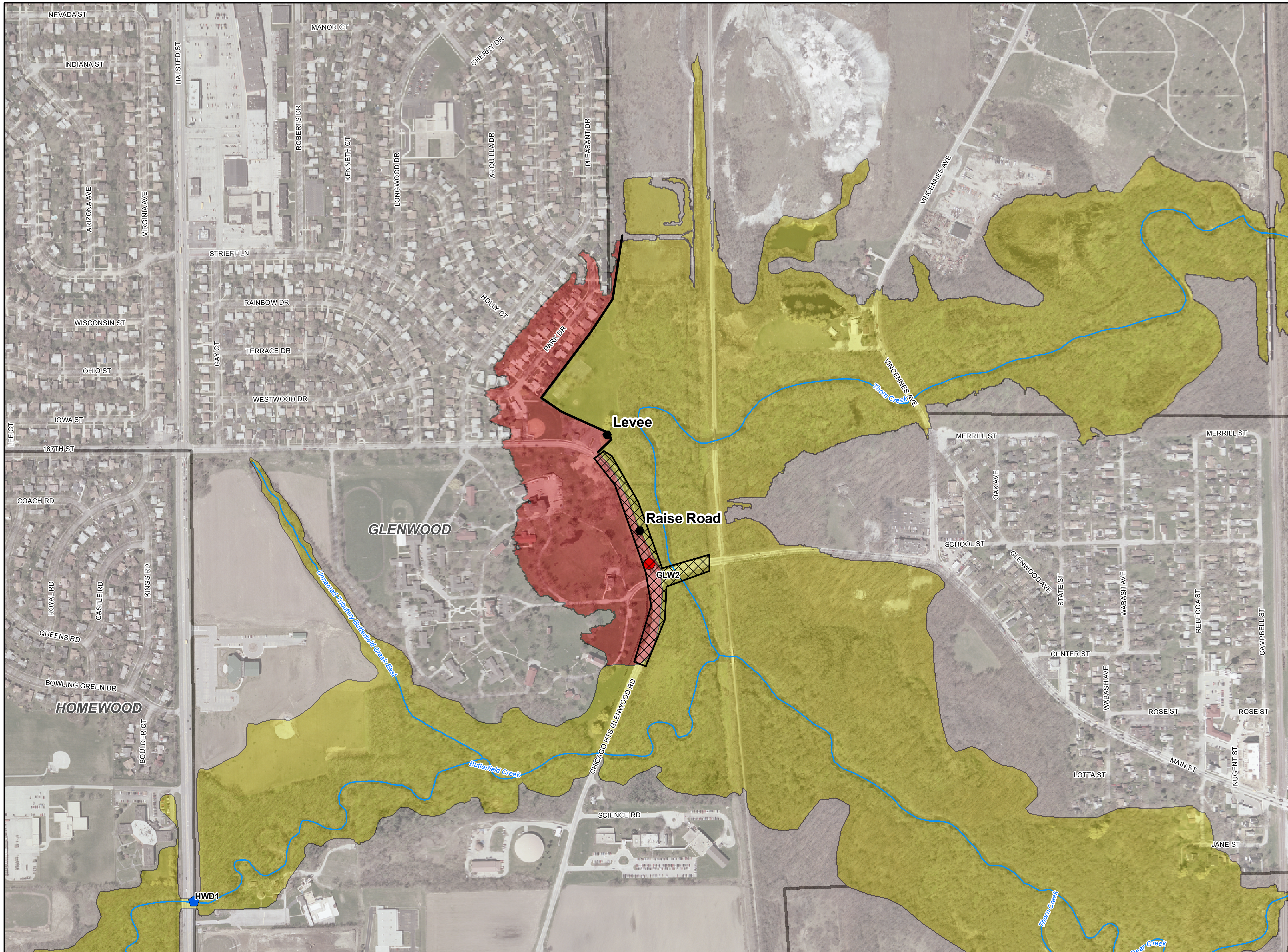


Figure 3.7.7

THORN CREEK
ALTERNATIVE
THCR-G2
Little Calumet River DWP

Alternative Description:
Modify the roadway profile of Sauk Trail Road

Conceptual Level Cost:
$2,543,000

Benefit: $1,600,000
B/C Ratio: 0.63

* Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

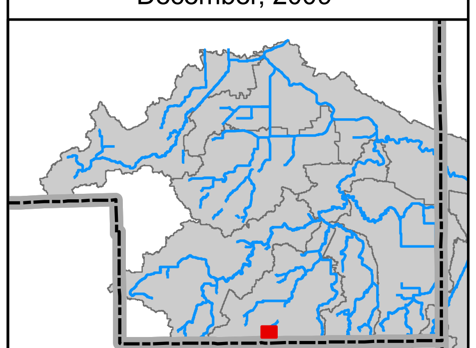
Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

0 1 2 Inches
1 inch = 250 feet

N

CDM

December, 2009



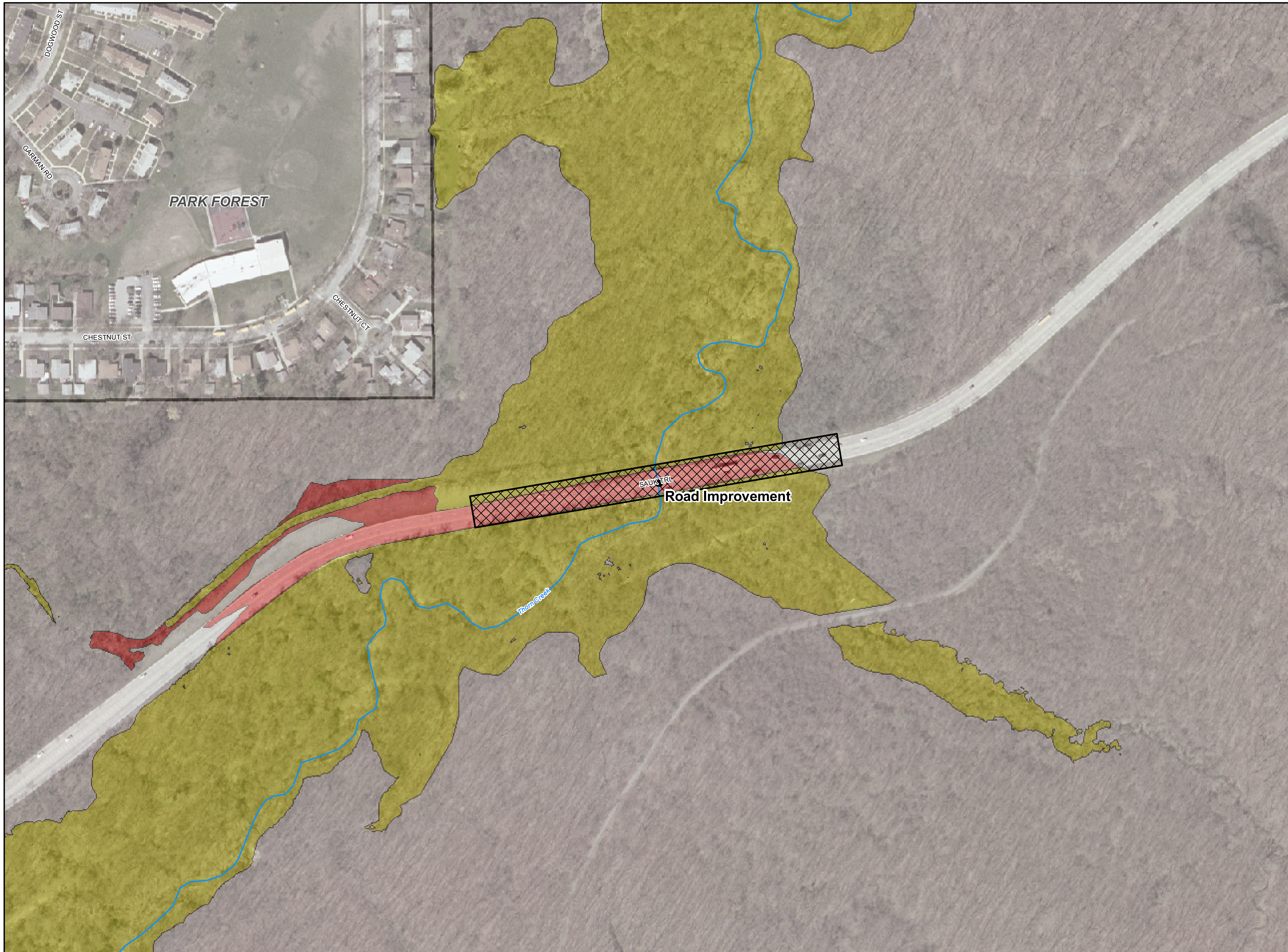


Figure 3.7.8

THORN CREEK
ALTERNATIVE
TCTA-G1
Little Calumet River DWP

Alternative Description:
Replace culvert from 26th Street and Stewart Avenue to State Street and 22nd Street

Conceptual Level Cost:
$89,000,000

Benefit:	**B/C Ratio:**
$1,415,000	0.02

* Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

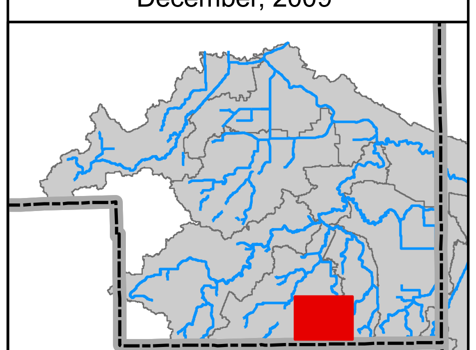
River/Stream
Municipalities
County Boundary
Project Alternative Location
100-year Inundation Area With Project
100-year Inundation Area Without Project

0 1 2 Inches
1 inch = 1,000 feet

N

CDM

December, 2009



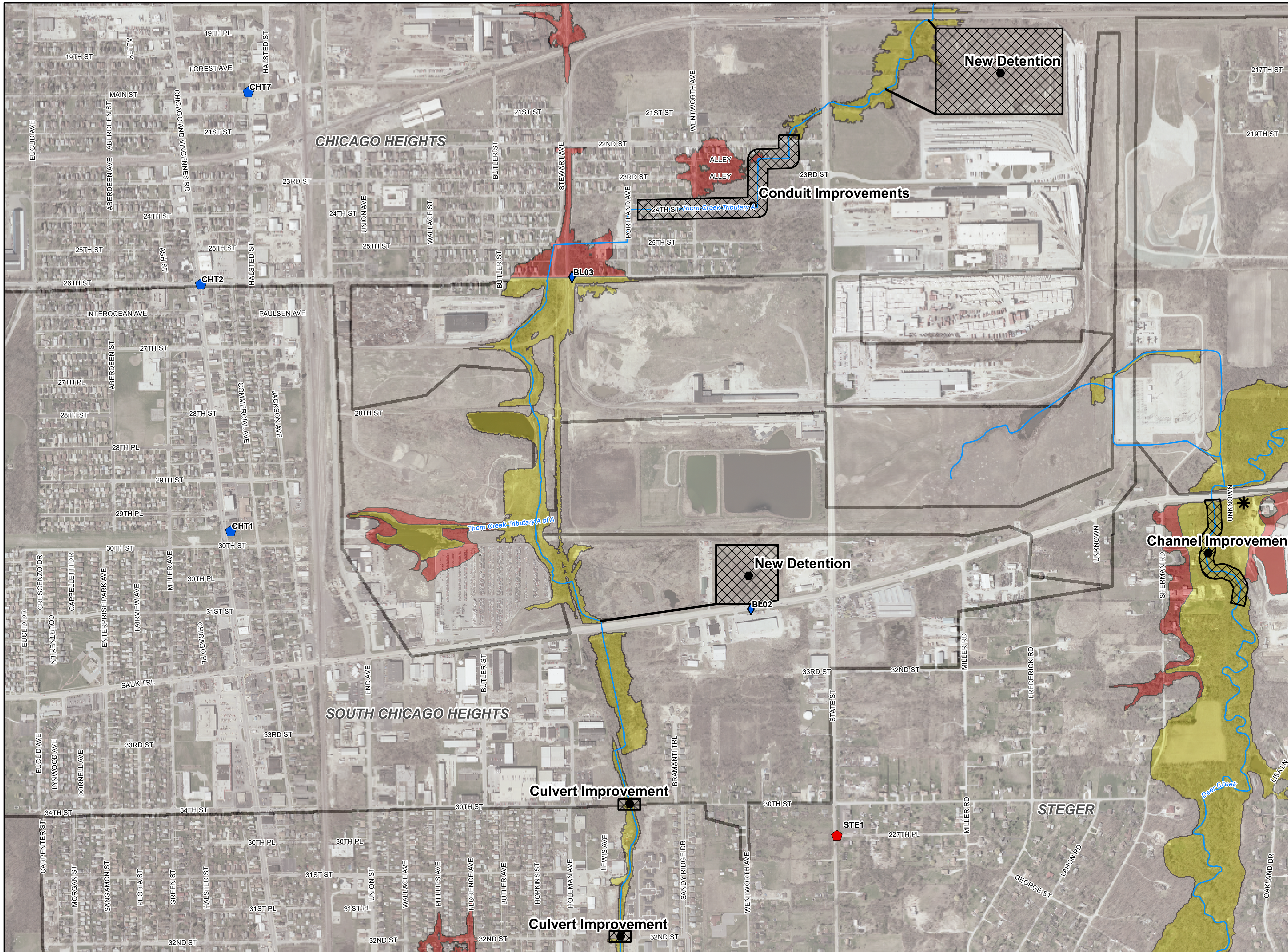


Figure 3.7.9

THORN CREEK
ALTERNATIVE
TCTB-G1
Little Calumet River DWP

Alternative Description:
Channel improvements along Thorn Creek Tributary B

Conceptual Level Cost:
$6,900,000

Benefit: $8,000

B/C Ratio: < 0.01

Candidate Structures for Floodproofing/Acquisition

Regional Problems

- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems

- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

River/Stream
Municipalities
County Boundary
Project Alternative Location
100-year Inundation Area With Project
100-year Inundation Area Without Project

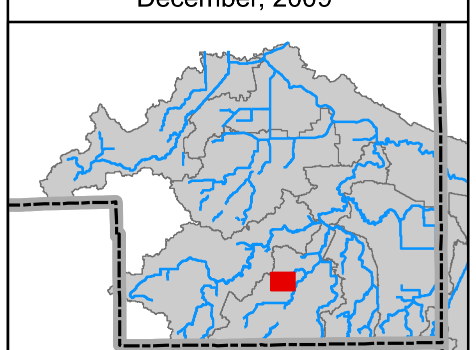
0 1 2 Inches

1 inch = 400 feet

N

CDM

December, 2009



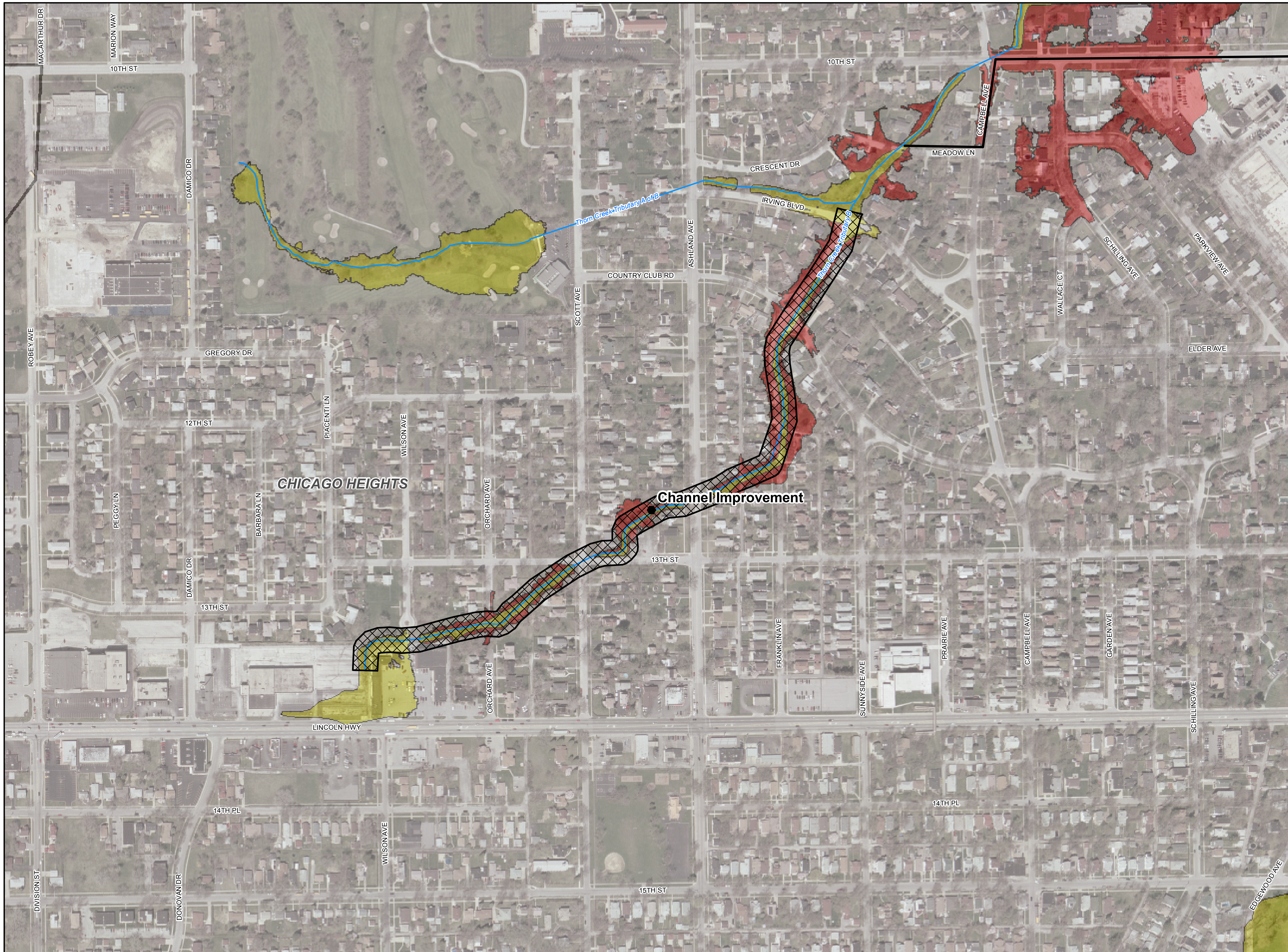


Figure 3.7.10

THORN CREEK
ALTERNATIVE
TCTD-G1
Little Calumet River DWP

Alternative Description:
Construct 530 ac-ft detention facility and replace culverts at Lakewood Bouldevard and East of Gold Street and East Rocket Circle

Conceptual Level Cost:
$65,442,000

Benefit: $5,500,000

B/C Ratio: 0.08

Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

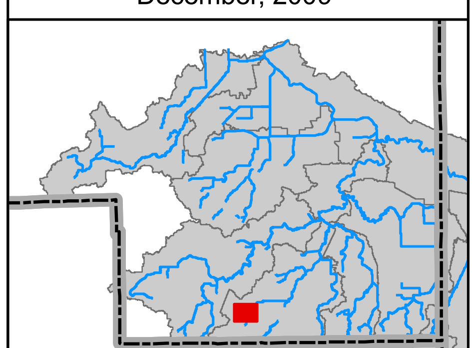
River/Stream
Municipalities
County Boundary
Project Alternative Location
100-year Inundation Area With Project
100-year Inundation Area Without Project

0 1 2 Inches
1 inch = 400 feet

N

CDM

December, 2009



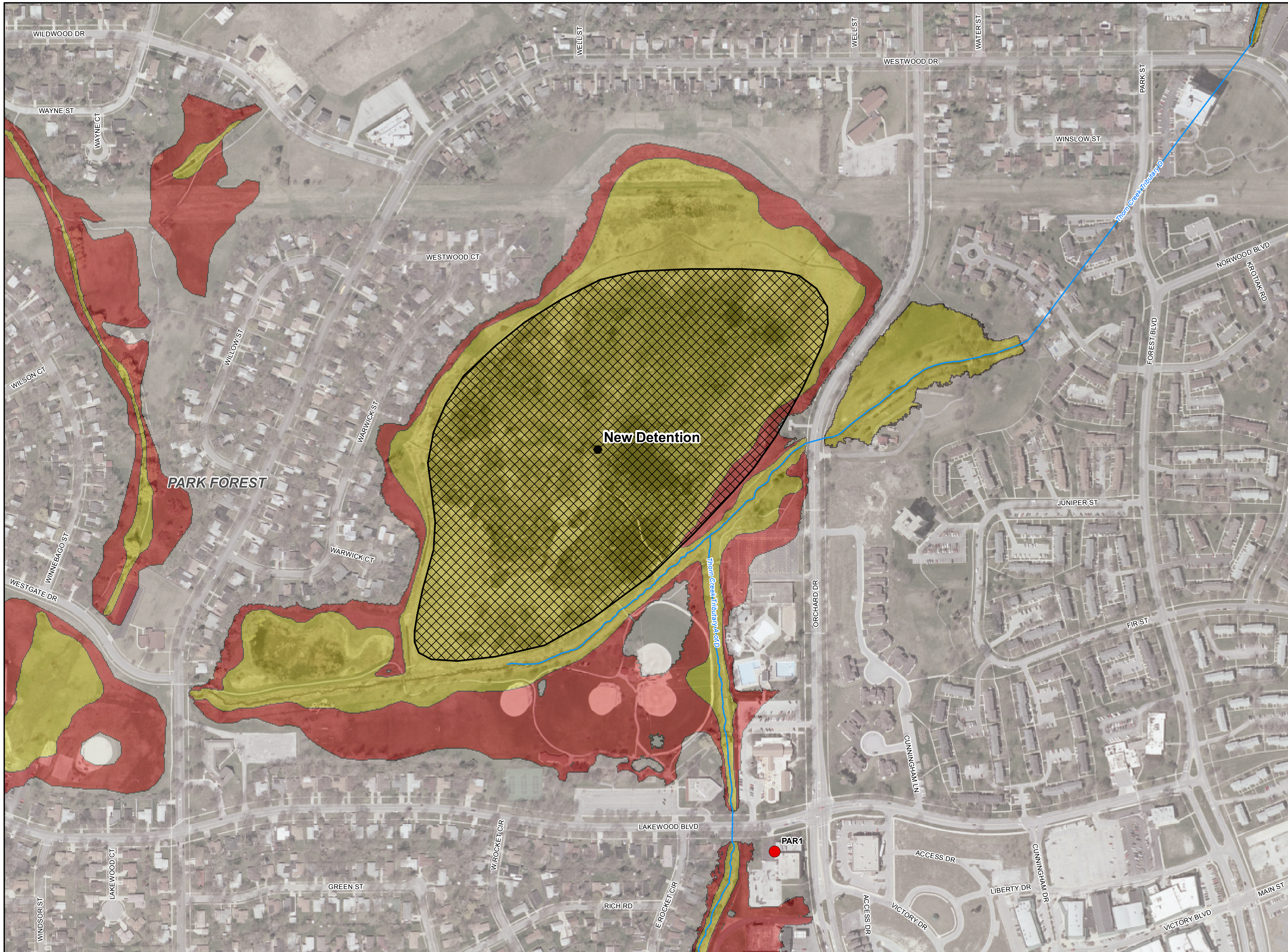


Figure 3.8.1

LITTLE CALUMET RIVER SUBWATERSHED OVERVIEW

Little Calumet River DWP

Local Problems

- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

Regional Problems

- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding
- Problem Area Identified Through Modeling
- Candidate Structures for Floodproofing/Acquisition
- Project Alternative Location
- River/Stream
- Municipal Boundary
- County Boundary
- DWP 100-year Inundation Area

FEMA Floodplain

- Zone A; Zone AH; Zone AO
- Zone AE

N

1 inch = 5,000 feet

0 1 2

Inches

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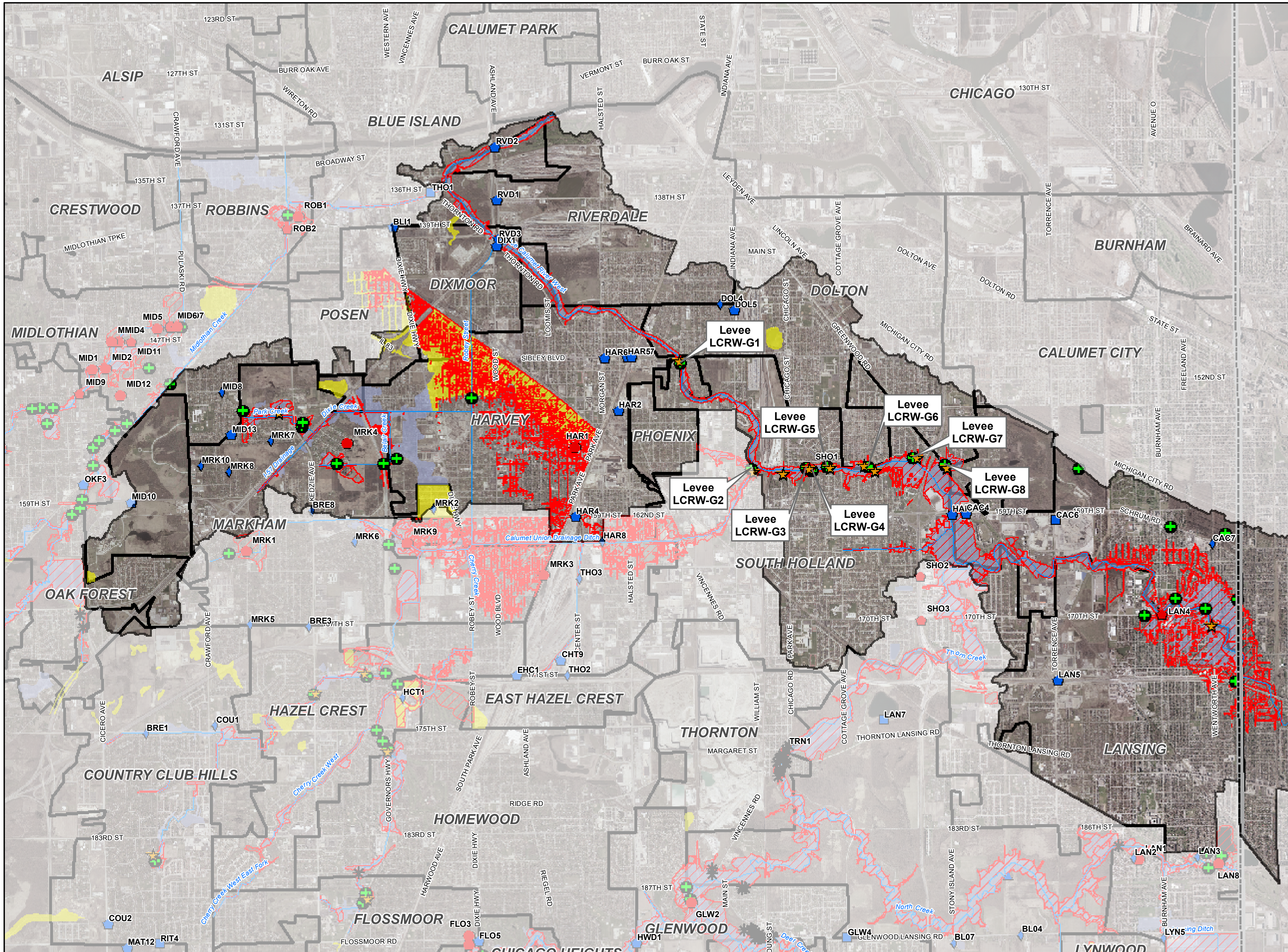

Figure 3.8.6

LITTLE CALUMET RIVER

ALTERNATIVE

LCRW-G1

Little Calumet River DWP

Alternative Description:
Construct a 600 LF floodwall near Sibley Boulevard

Conceptual Level Cost:
$3,412,000

Benefit:	**B/C Ratio:**
$16,000	<0.01

- Candidate Structures for Floodproofing/Acquisition

Regional Problems

- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems

- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

0 1 2 Inches

1 inch = 250 feet

N

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December, 2009

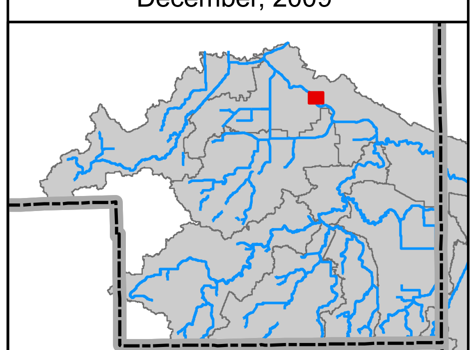


Figure 3.8.7

LITTLE CALUMET RIVER
ALTERNATIVE
LCRW-G2
Little Calumet River DWP

Alternative Description:
Construct a 1,900 LF levee/floodwall near 158th Place and 159th Street

Conceptual Level Cost:
$5,752,000

Benefit: $148,000

B/C Ratio: 0.03

Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

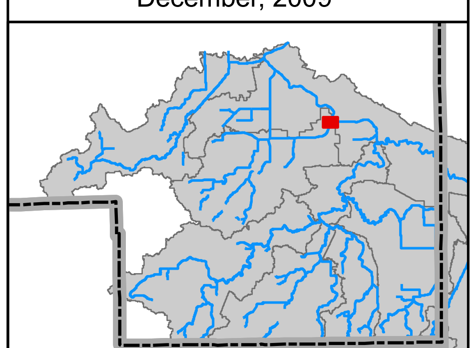
River/Stream
Municipalities
County Boundary
Project Alternative Location
100-year Inundation Area With Project
100-year Inundation Area Without Project

0 1 2 Inches
1 inch = 250 feet

N

CDM

December, 2009



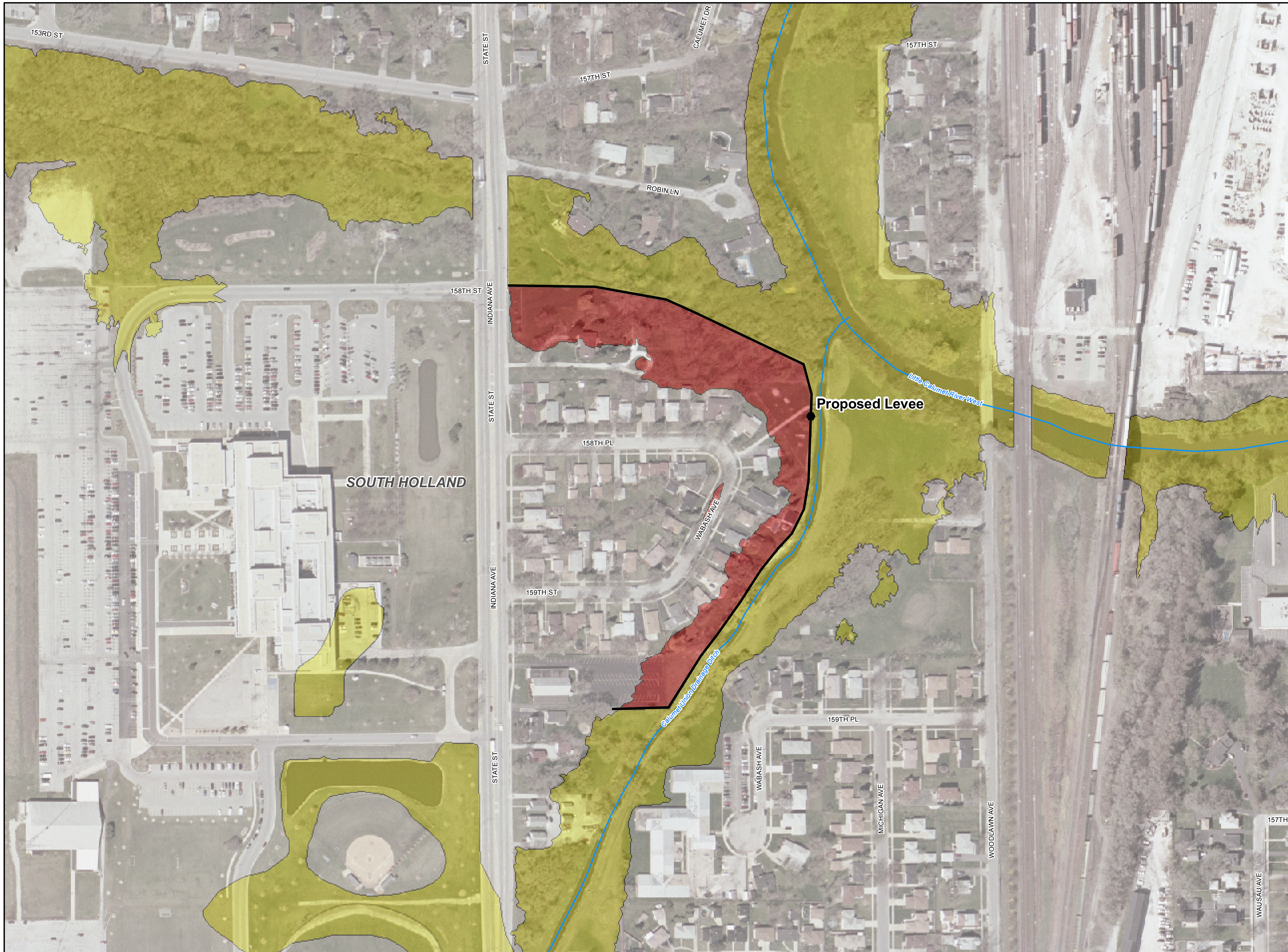


Figure 3.8.8

LITTLE CALUMET RIVER
ALTERNATIVE LCRW-G3
Little Calumet River DWP

Alternative Description:
Construct a 850 LF floowall near 158th Street and Chicago Avenue

Conceptual Level Cost:
$4,332,000

Benefit: $4,000

B/C Ratio: <0.01

✱ Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

River/Stream
Municipalities
County Boundary
Project Alternative Location
100-year Inundation Area With Project
100-year Inundation Area Without Project

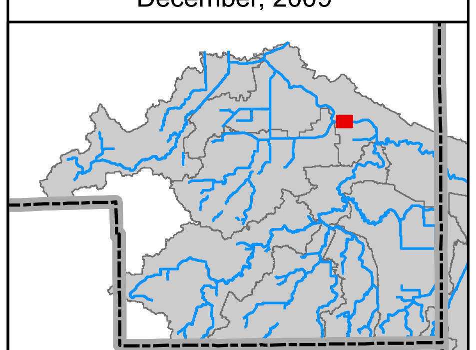
0 1 2 Inches

1 inch = 250 feet

N

CDM

December, 2009



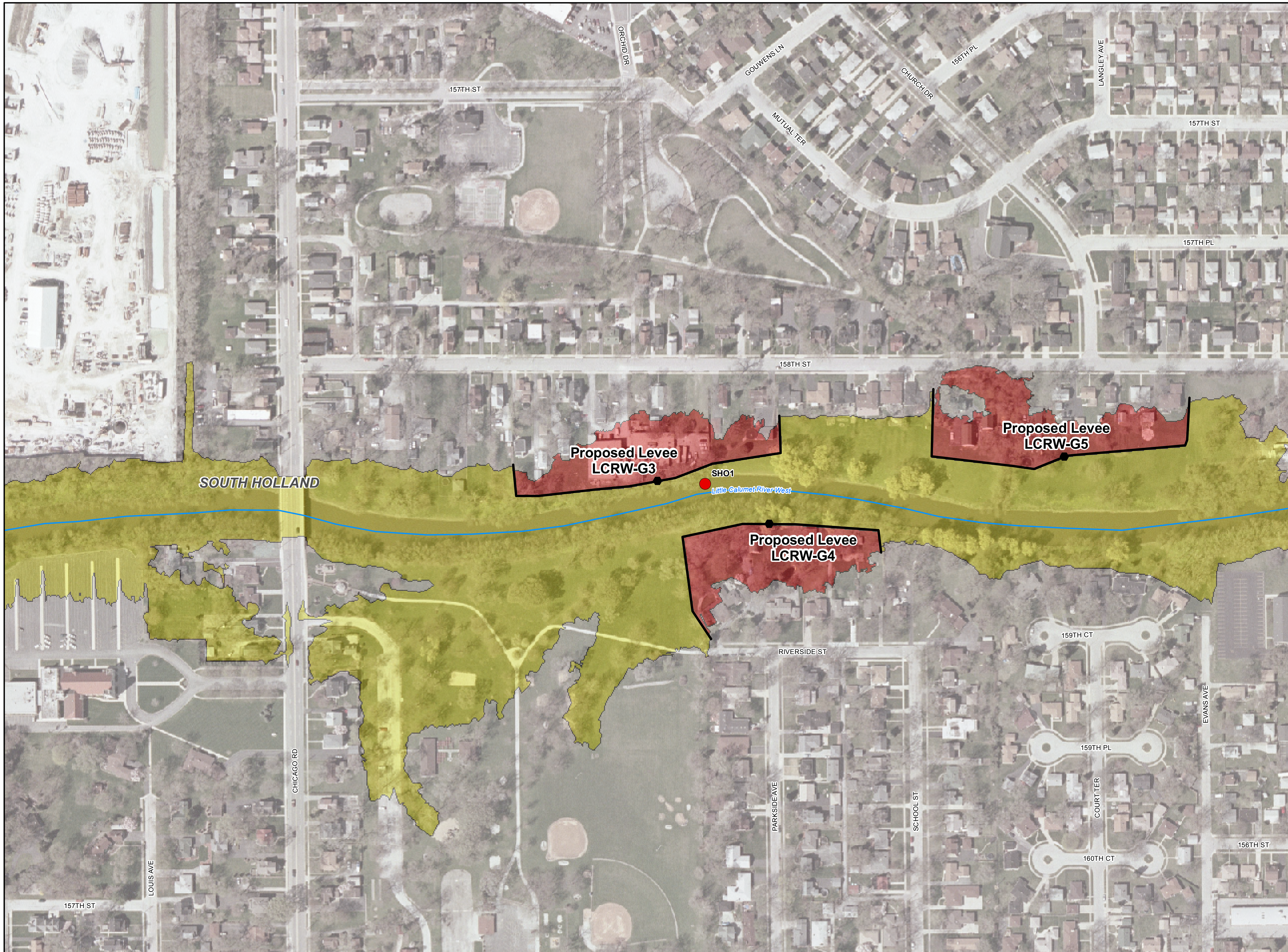


Figure 3.8.9

LITTLE CALUMET RIVER
ALTERNATIVE
LCRW-G4
Little Calumet River DWP

Alternative Description:
Construct a 825 LF floowall near Parkside Avenue and School Street

Conceptual Level Cost:
$3,427,000

Benefit: $3,000

B/C Ratio: <0.01

Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

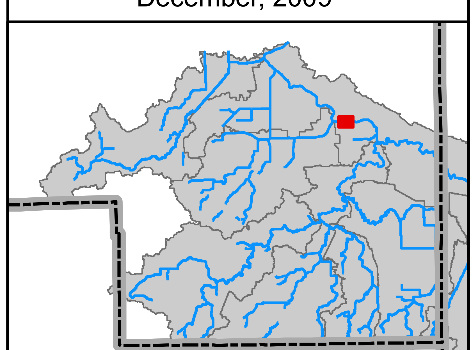
River/Stream
Municipalities
County Boundary
Project Alternative Location
100-year Inundation Area With Project
100-year Inundation Area Without Project

0 1 2 Inches
1 inch = 250 feet

N

CDM

December, 2009



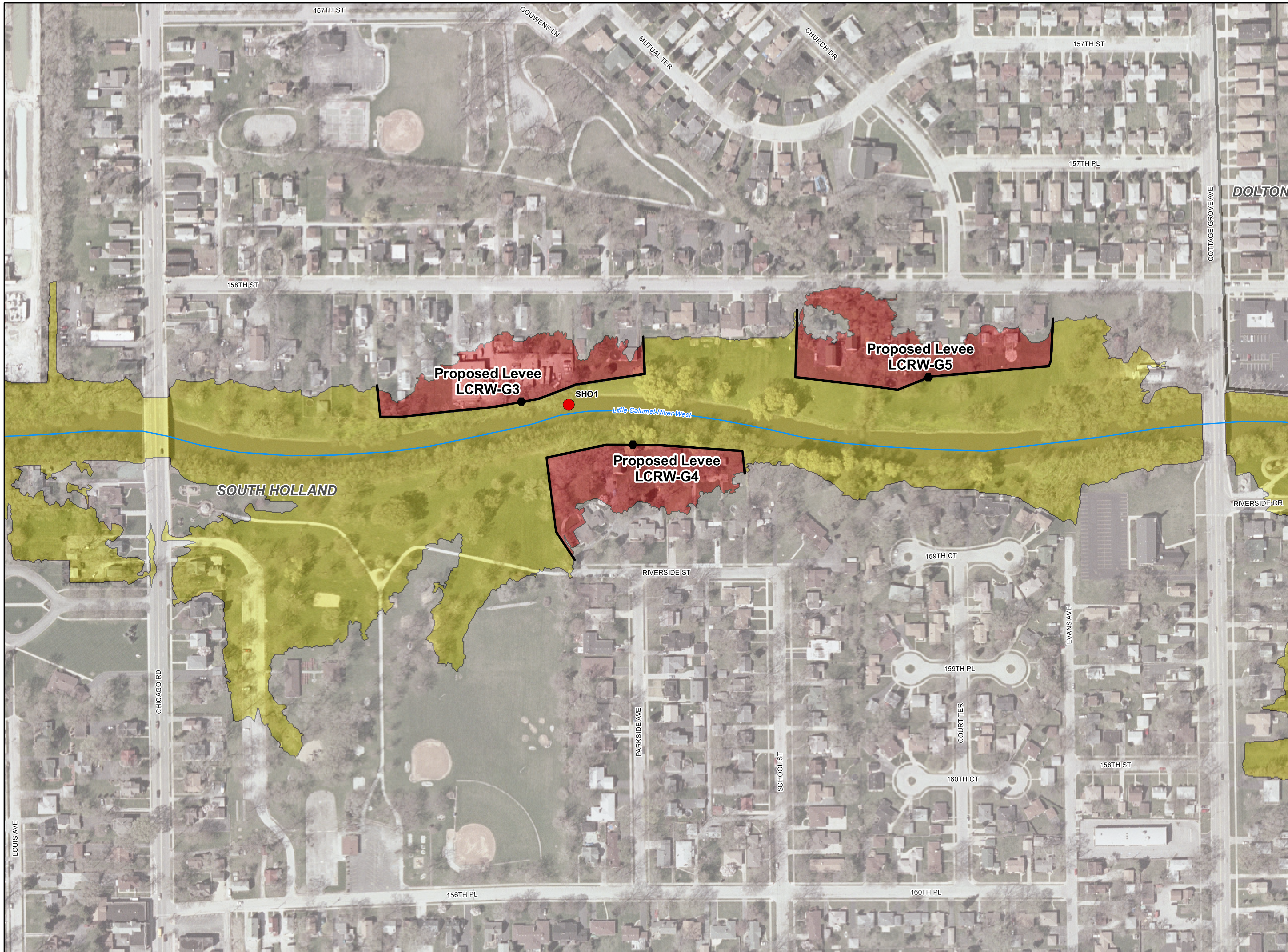


Figure 3.8.10

LITTLE CALUMET RIVER
ALTERNATIVE LCRW-G5
Little Calumet River DWP

Alternative Description:
Construct a 930 LF floowall near 158th Street and Church Drive

Conceptual Level Cost:
$1,126,000

Benefit: $2,494,000

B/C Ratio: 2.21

- ✱ Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

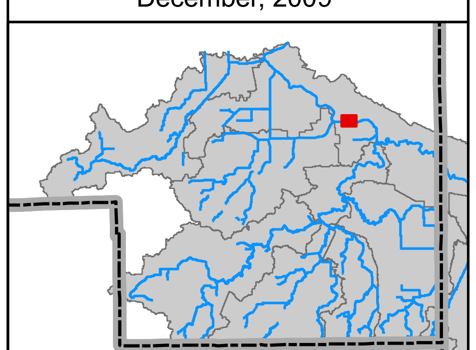
0 1 2 Inches

1 inch = 250 feet

N

CDM

December, 2009



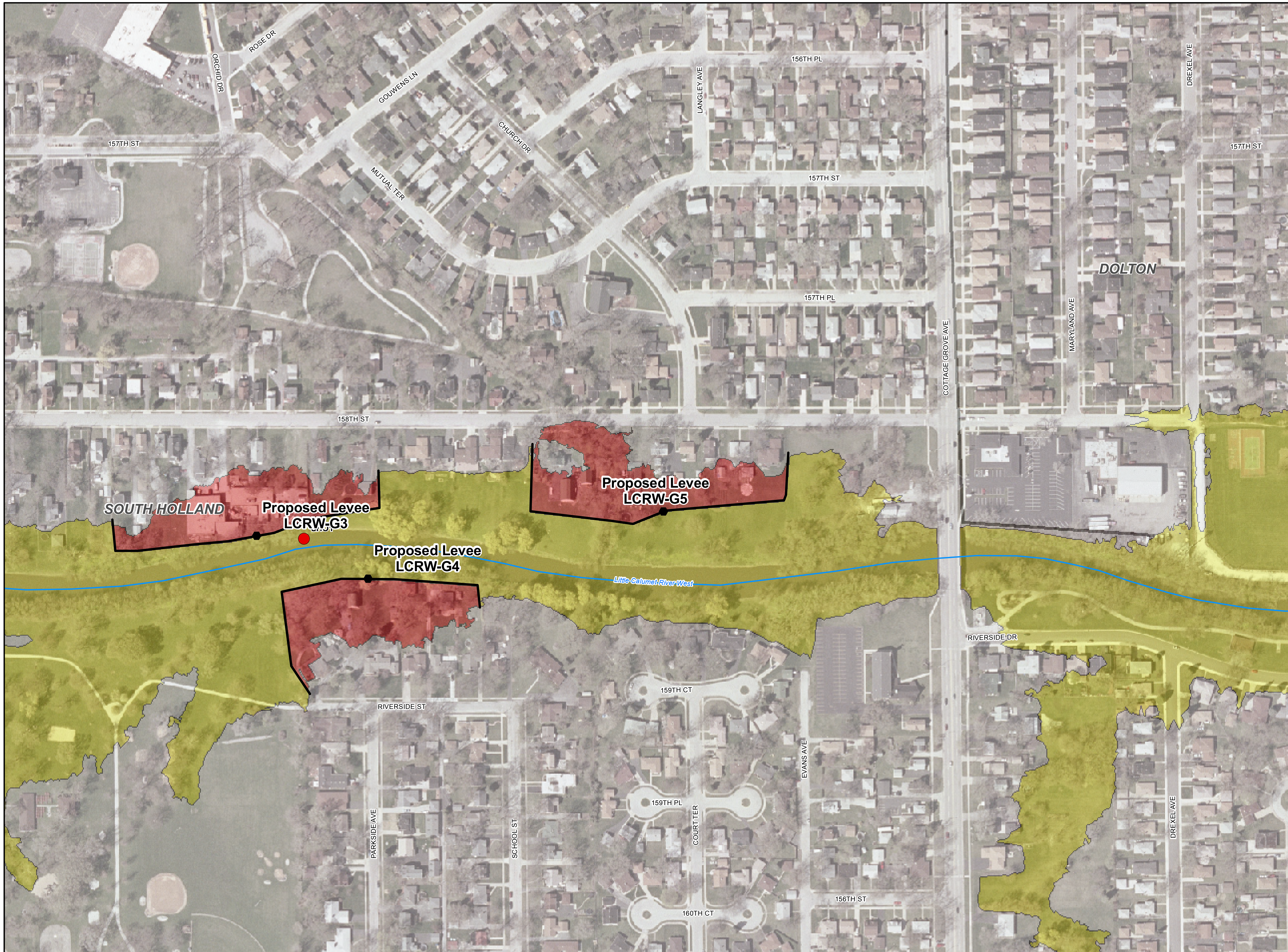


Figure 3.8.11

LITTLE CALUMET RIVER
ALTERNATIVE
LCRW-G6
Little Calumet River DWP

Alternative Description:
Construct a 1285 LF floowall near Blouin Drive

Conceptual Level Cost:
$2,401,000

Benefit:	**B/C Ratio:**
$60,000	0.03

* Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction
- River/Stream
- Municipalities
- County Boundary
- Project Alternative Location
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project

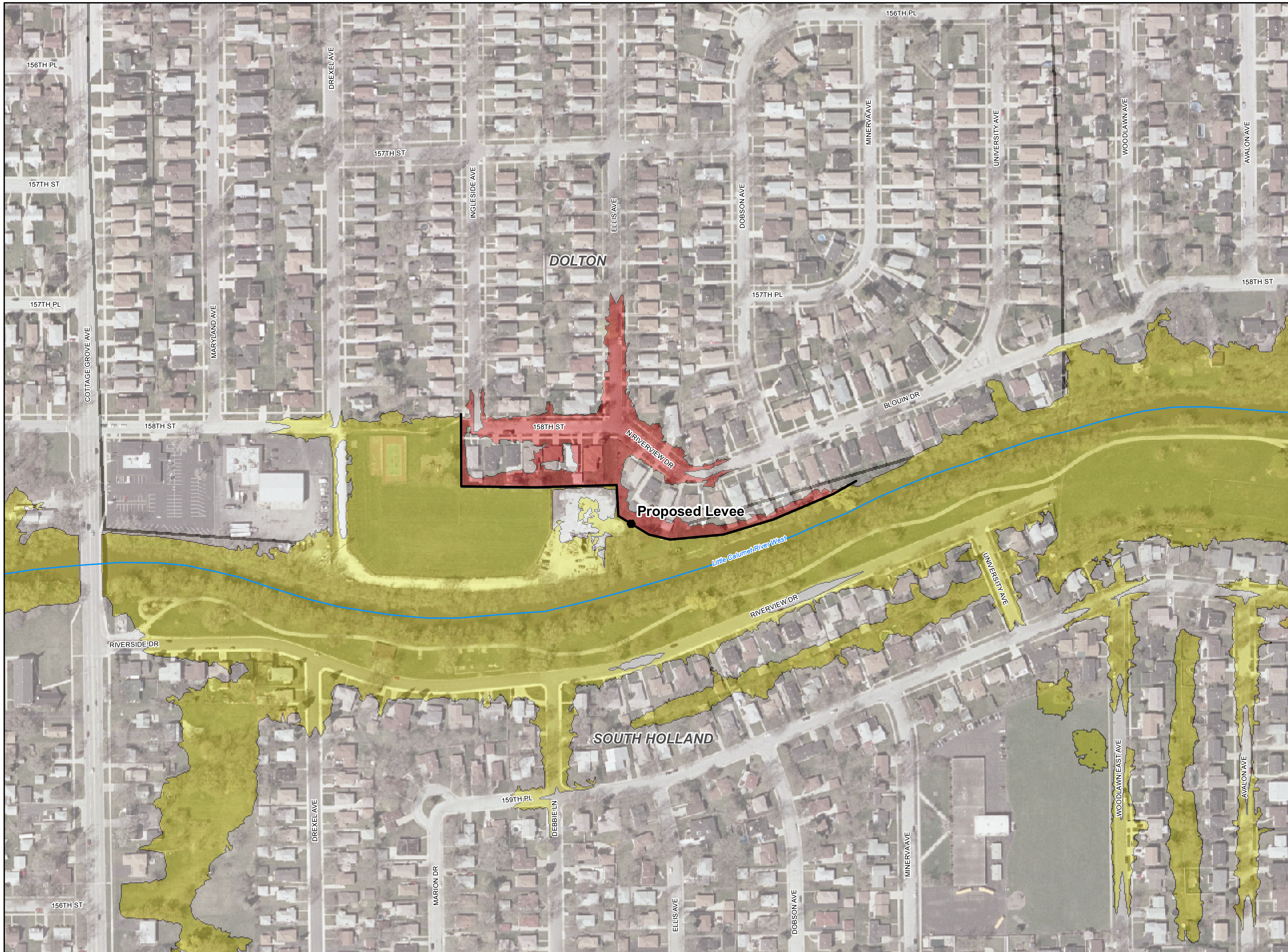
0 1 2 Inches

1 inch = 250 feet

N

CDM

December, 2009



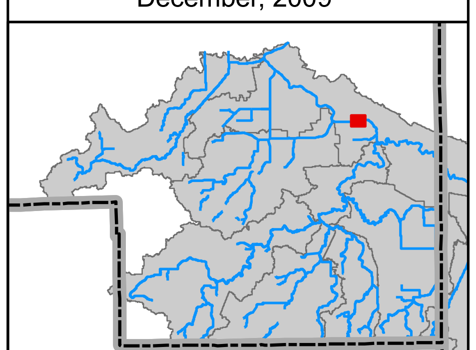


Figure 3.8.12

LITTLE CALUMET RIVER
ALTERNATIVE
LCRW-G7
Little Calumet River DWP

Alternative Description:
Construct a 785 LF floowall near 158th Street

Conceptual Level Cost:
$3,040,000

Benefit: $21,000
B/C Ratio: 0.01

Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

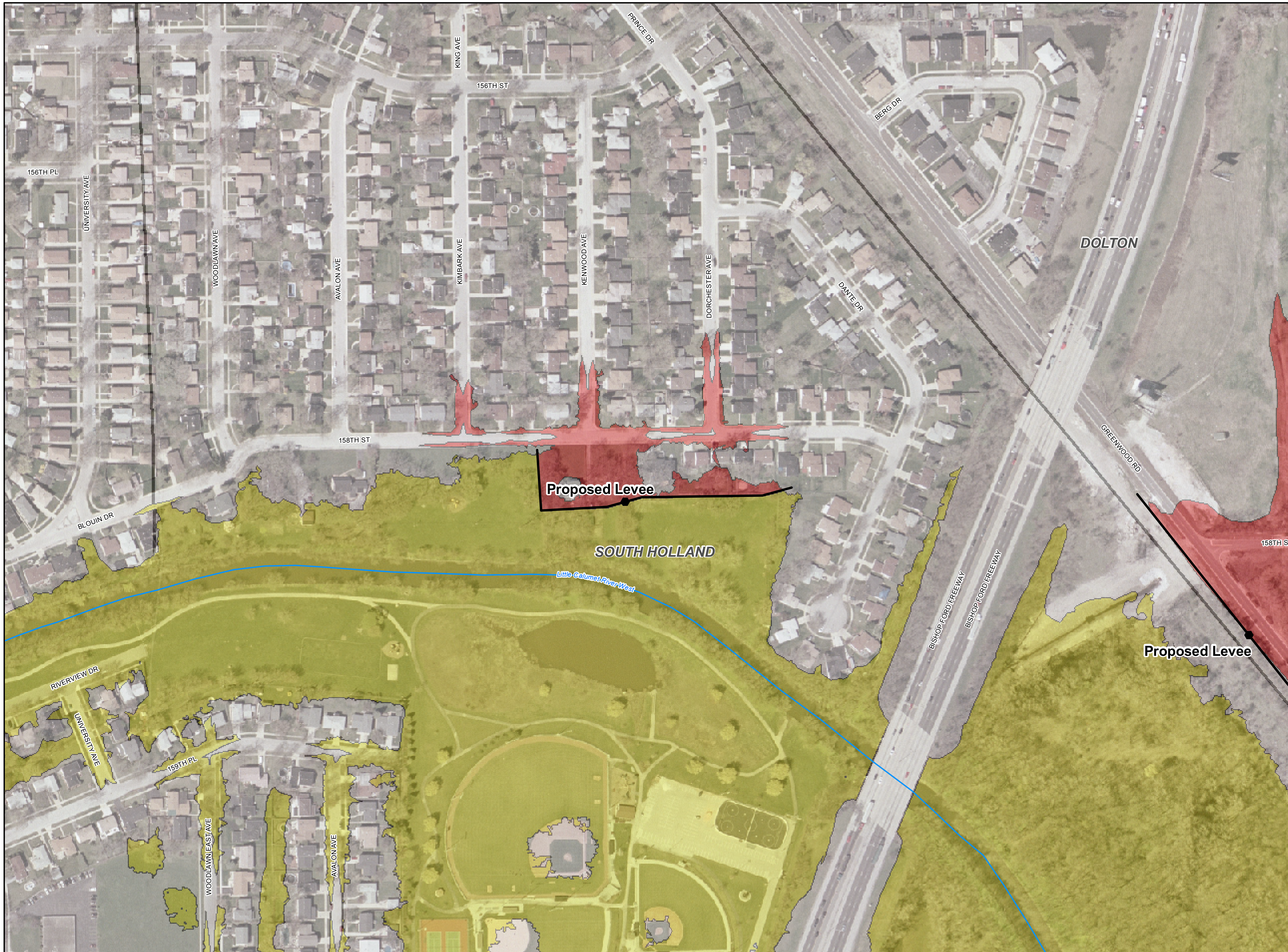
Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

River/Stream
Municipalities
County Boundary
Project Alternative Location
100-year Inundation Area With Project
100-year Inundation Area Without Project

0 1 2 Inches
1 inch = 250 feet

N

December, 2009



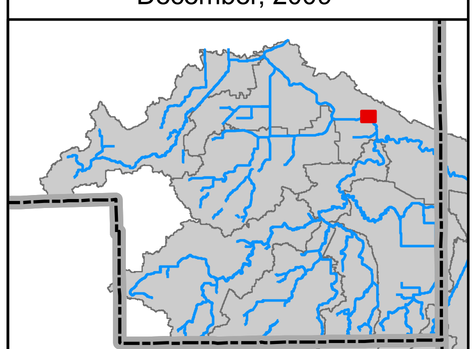


Figure 3.8.13

LITTLE CALUMET RIVER
ALTERNATIVE
LCRW-G8
Little Calumet River DWP

Alternative Description:
Modify existing berm to act as a levee to 158th Street near Greenwood Drive and Madison Avenue

Conceptual Level Cost:
$2,373,000

Benefit: $702,000

B/C Ratio: 0.30

Candidate Structures for Floodproofing/Acquisition

Regional Problems
- Bank Erosion
- Maintenance
- Overbank Flooding
- Pavement Flooding

Local Problems
- Bank Erosion
- Maintenance
- Pavement Flooding
- Storm Sewer Flow Restriction

River/Stream
Municipalities
County Boundary
Project Alternative Location
100-year Inundation Area With Project
100-year Inundation Area Without Project

0 1 2 Inches

1 inch = 250 feet

N

CDM

December, 2009