

Task 6

Detailed Evaluation of Flood Mitigation Alternatives

City of Allen Park

City of Dearborn Heights

City of Ecorse

City of Inkster

City of Lincoln Park

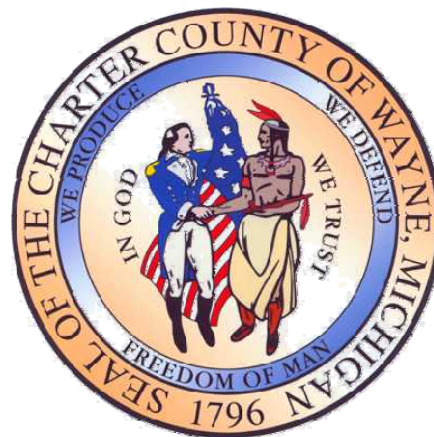
City of Melvindale

City of Taylor

City of Romulus

City of Westland

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TASK 6 - DETAILED EVALUATION OF FLOOD MITIGATION ALTERNATIVES

Introduction

The objective of Task 6 is to evaluate viable flood mitigation alternatives in more detail than Task 5 and provide a recommended flood mitigation alternative. Task 6 includes completing:

- Detailed modeling of four (4) comprehensive flood mitigation alternatives
- Developing planning-level cost estimates for each comprehensive alternative
- Developing a scoring/ranking matrix for alternatives
- Obtaining a ranking of each alternative from the Policy Committee
- Recommending a flood mitigation alternative

Information that is provided in Task 6 includes the following:

- Flood mitigation alternatives 14 through 17
- Component maps for these flood mitigation alternatives
- Computer modeling results including water surface profiles and flood maps
- Initial estimates for right-of-way acquisition required for each alternative
- Planning level cost estimates for each alternative

Detailed Development of Flood Mitigation Alternatives

In Task 5, computer modeling and analysis of initial flood mitigation alternatives was completed. Five (5) viable flood mitigation alternatives for the NBECD and two (2) viable flood mitigation alternatives for the Reeck Drain were identified, developed, and evaluated. The flood mitigation alternatives identified in Task 5 were based on mitigation measures and design criteria that were screened and determined acceptable in Task 4. Four (4) of the NBECD alternatives and one (1) of the Reeck Drain alternatives identified in Task 5 were selected and used for the basis of developing the Task 6 flood mitigation alternatives. Task 5 alternatives selected include:

- Alternative 5 – “Storm Water Detention Intensive” Alternative

- Alternative 8 – “Greenway” Alternative
- Alternative 12 – “Tunnel to Rouge River” Alternative
- Alternative 13 – “Tunnel to Lower NBECD” Alternative
- Alternative R-5 – “Reeck Drain Improvement” Alternative

Alternative 10 and Alternative R-4 were identified in Task 5 as viable but were not selected for Task 6. Alternative 10 is a storm water detention basin intensive alternative that is very similar to Alternative 5 in cost and predicted flood reduction. The primary difference between the two alternatives is the location of the detention sites in Romulus. Because of the similarity of the alternatives, it was decided to select only one for detailed analysis. Alternative 5 was selected over Alternative 10 because the detention basins in Romulus for Alternative 10 are in near proximity of each other and not as efficient as the detention basins in Romulus for Alternative 5. Also, if the “storm water detention intensive” approach (Alternative 5) becomes recommended as the flood mitigation alternative, additional analysis of detention site selection in Romulus will be completed.

With regards to the Reeck Drain, Alternative R-5 was selected for analysis over Alternative R-4 as it provides a higher level of service that is similar with the level of service of the NBECD.

Four (4) comprehensive flood mitigation alternatives were developed for Task 6. Alternatives were developed by integrating the HEC-RAS model of the Reeck Drain alternative with the models of the selected NBECD alternatives and updating alternatives based on input from Technical and Policy Committees. Task 6 flood mitigation alternatives include:

- Alternative 14 - Greenway (Alt. 8 and Reeck Alt. R-5)
- Alternative 15 - Storm Water Detention Basin (Alt. 5 and Reeck Alt. R-5)
- Alternative 16 - Tunnel to the Rouge River (Alt.12 and Reeck Alt. R-5)
- Alternative 17 - Tunnel to the Lower NBECD (Alt.13 and Reeck Alt. R-5)

The following paragraphs provide a general summary of mitigation alternatives 14 through 17. The geometric elements of each flood mitigation alternative are illustrated in the component maps provided in Appendix A and shown in Figures 6-1 through 6-4.

Alternative 14 – Greenway Intensive Alternative

Alternative 14 was developed by merging and updating Alternatives 8 and R-5. This alternative primarily consists of implementing large scale channel and drain crossing improvements along the NBECD. The channel and crossing improvements include significant widening to enlarge the cross sectional area of open channel and the drain crossings. The enlarged cross sectional area increases the flow capacity of the NBECD thus enabling flood flows to be conveyed downstream to the Detroit River instead of flooding neighborhoods along the NBECD. The channel also provides flood storage capacity to help reduce downstream flood flows.

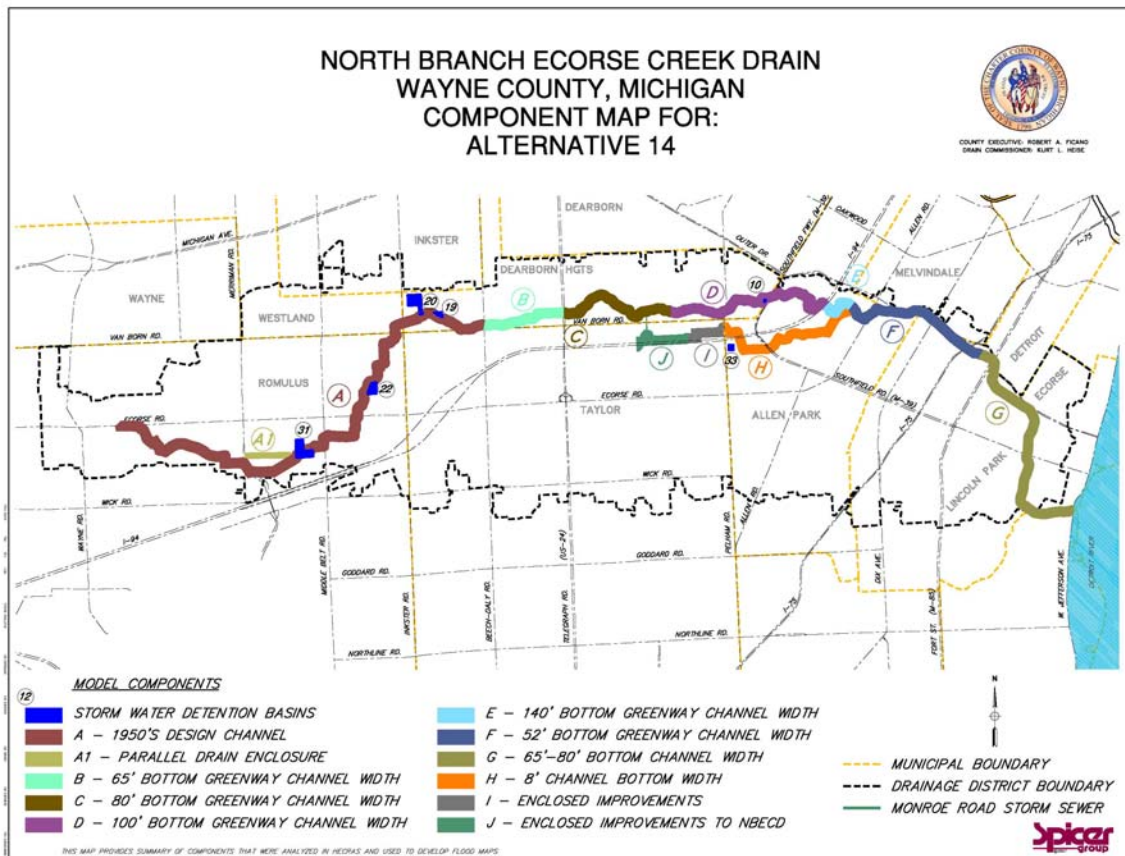
Alternative 14 also includes six (6) regional storm water detention basins. A storm water detention basin holds excess storm water thus reducing the peak flow rates in the drain and lessening the extent of required downstream channel and bridge improvements. Preliminary site plans for the detention sites are provided in the Task 5 report. Table 6-1 lists the storm water detention sites included in Alternative 14. The table also shows the locations, size, and storage volume capacity of each basin.

In comparing Alternative 14 with Alternative 8, several updates to storm water detention sites from Alternative 8 were made. These updates were based on engineering evaluation and policy decisions, with input from the Policy and Technical Committees. Changes included removal of Detention Sites 17 and 25 and the addition of Detention Site 31. Figure 6-1 is the component map for Alternative 14, the Greenway Alternative.

**Table 6-1
 NBECD - Greenway Alternative (14)
 Storm Water Detention Sites**

Site No.	Drain	Nearest Intersection	City	Site Size (ac.)	Storage Volume (ac.-ft.)
10	NBECD	Raymond and Southfield Freeway	Dearborn Heights	2	2
19	NBECD	Power and John Daly	Dearborn Heights	9	36
20	NBECD	Inkster and Powers	Dearborn Heights	38	25
22	NBECD	Beverly and Inskter	Romulus	28	80
31	NBECD	Middlebelt and Smith	Romulus	28	222
33	Reeck	Pelham and I-94	Allen Park	6	20

**Figure 6-1
 NBECD - Greenway Alternative (14)
 Component Map**



Alternative 15 – Storm Water Detention Intensive Alternative

Alternative 15 was developed by merging and updating Alternatives 5 and R-5. Alternative 15 includes 13 regional storm water detention basins. Preliminary site plans of the basin are provided in the Task 5 report. Table 6-2 lists the storm water detention

sites included in Alternative 15. The table also shows the locations, size, and storage volume capacity of each basin.

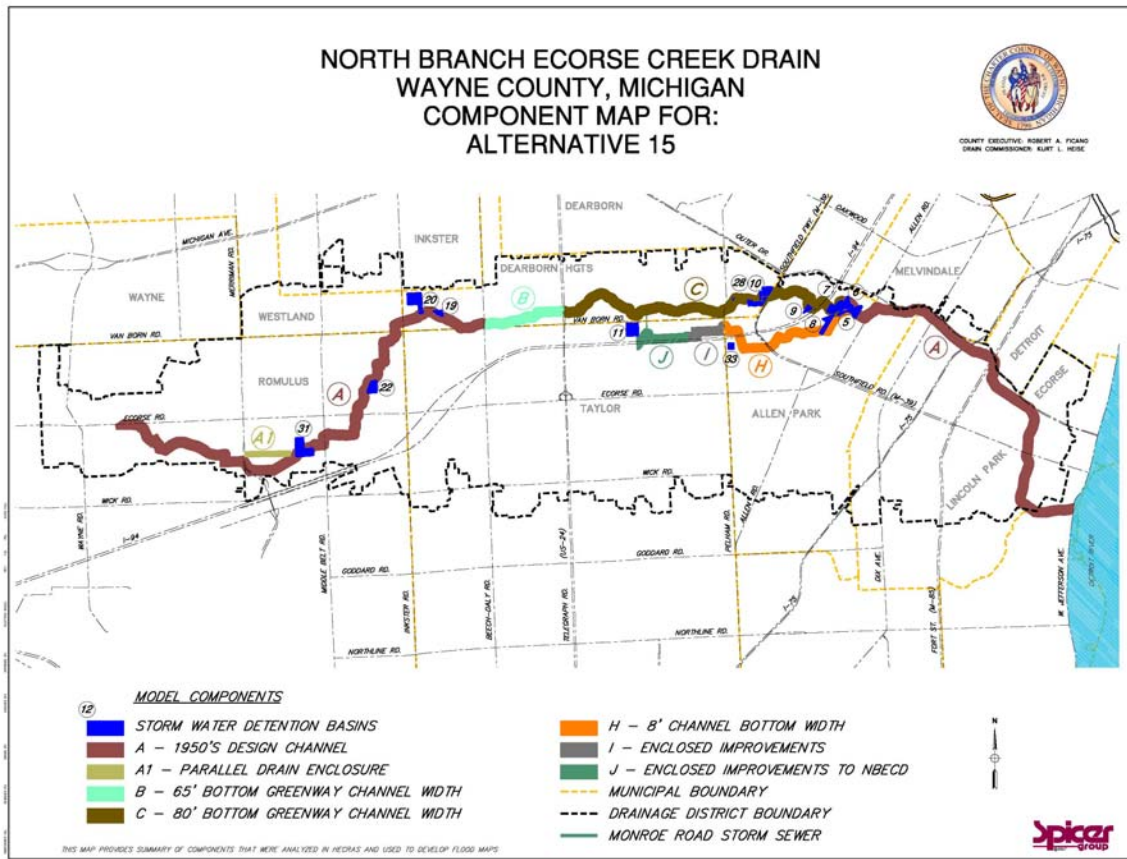
Table 6-2
NBECD – Storm Water Detention Alternative (15)
Storm Water Detention Sites

Site No.	Drain	Nearest Intersection	City	Site Size (ac.)	Storage Volume (ac.-ft)
5	NBECD	N.S. Railway and Hanford	Allen Park	23	85
6	NBECD	N.S. Railway and C.N. Railway	Allen Park	21	59
7	NBECD	I-94 and C.N. Railway	Allen Park	32	157
8	NBECD	Enterprise Dr. and N.S. Railway	Allen Park	24	157
9	NBECD	Shenandoah and I-94	Allen Park	15	15
10	NBECD	Raymond and Southfield Highway	Dearborn Heights	2	2
11	NBECD	Van Born and Roosevelt	Taylor	23	75
19	NBECD	Power and John Daly	Dearborn Heights	8	36
20	NBECD	Inkster and Powers	Dearborn Heights	37	25
22	NBECD	Beverly and Inskter	Romulus	28	81
28	NBECD	I-94/M-39 Interchange	Dearborn Heights	42	71
31	NBECD	Middlebelt and Smith	Romulus	28	222
33	Reeck	Pelham and I-94	Allen Park	5	18

In comparison with Alternative 14, this alternative provides significantly more storm water detention storage volume and therefore, the extent of the channel and crossing improvements less. However, with Alternative 15, channel and crossing improvements are still required. Channel and crossing improvements are needed to convey storm water to and from each of the detention basins. This includes a greenway channel between Allen Road and Beech Daly Road.

In comparing Alternative 15 to Alternative 5, several updates to storm water detention sites from Alternative 5 were made. These updates were based on engineering evaluation and policy decisions, with input from the Policy and Technical Committees. Changes included removal of Detention Sites 17 and 25 and the addition of Detention Site 31. Figure 6-2 is the component map of Alternative 15, Storm Water Detention Alternative.

**Figure 6-2
 NBECD- Storm Water Detention Alternative (15)
 Component Map**



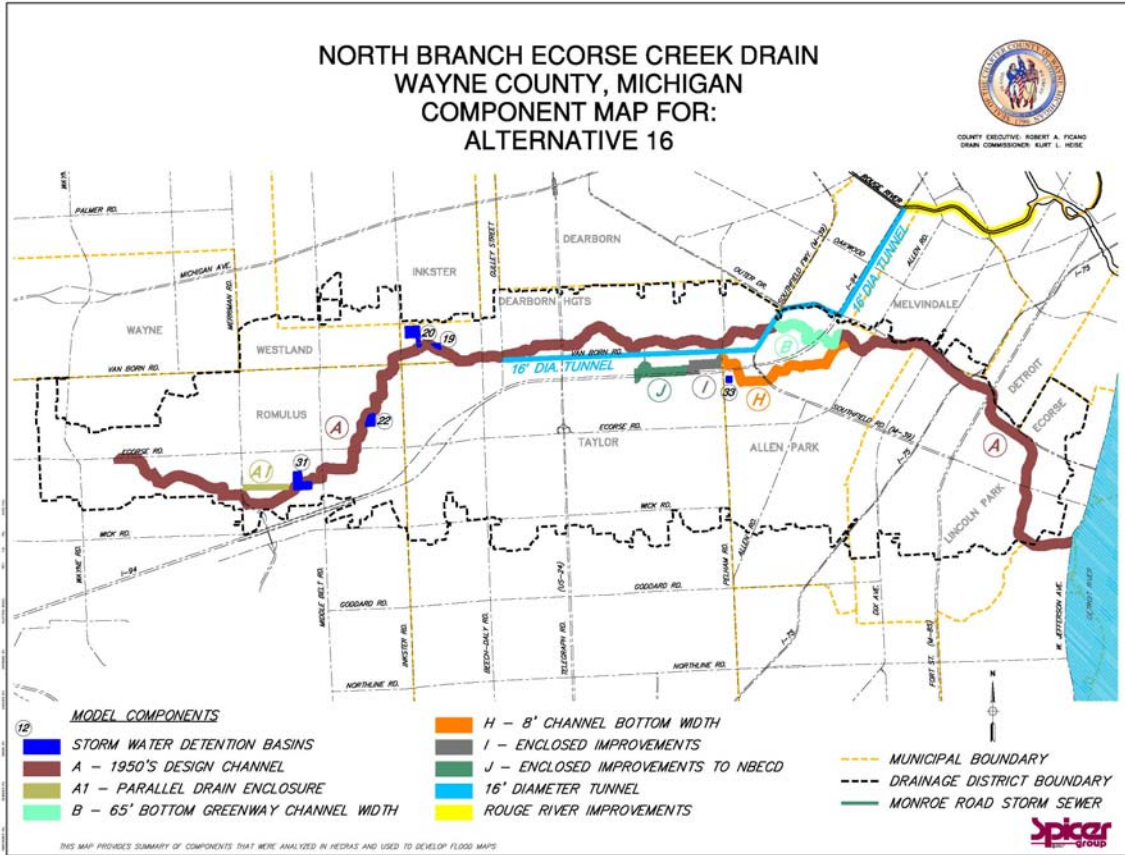
Alternative 16 – Tunnel to the Rouge River

Alternative 16 was developed by merging and updating Alternatives 12 and R-5. Alternative 16 consists of diverting flow from the NBECD to the Rouge River and eliminating the need for a greenway channel and many storm water detention sites.

In developing Alternative 16, several updates to storm water detention sites from Alternative 12 were made. These updates were based on engineering evaluation and policy decisions, with input from the Policy and Technical Committees. Changes included removal of Detention Sites 17 and 25 and the addition of Detention Site 31. The storm water detention sites included in Alternative 16 are shown in Table 6-1 and are the same as Alternative 14 with the exception of Detention Site 10. This site is not included

in Alternative 16. Figure 6-3 is the component map of Alternative 16, Tunnel to the Rouge River Alternative.

Figure 6-3
NBECD – Tunnel to Rouge River Alternative (16)
Component Map



With Alternative 16, peak flood flow rates in the open channel of the NBECD are reduced by diverting storm water from the channel and into a 16 foot diameter tunnel. The potential tunnel would be located to run along Van Born Road from Gully Road to the Southfield Freeway and then extend to the Rouge River along the I-94 corridor. A constructability analysis of the maximum soft ground tunnel diameter and this tunnel route is provided in the Task 4 report.

Diverting the flow from the NBECD to the Rouge River through the tunnel enables a substantial reduction in the magnitude of channel, crossing, and detention basin

improvements in comparison to Alternatives 14 and 15; however, the tunnel does not completely eliminate the need for these types of improvements. Channel and crossing improvements in the upper reaches are still required to convey storm water into the various “tunnel inlet” locations, at which the storm water is diverted from the NBECD into the tunnel. Also, diverting 100% of the flow from the NBECD upstream of Southfield Freeway through the tunnel to the Rouge River was determined not feasible. The peak flood flow rate near Southfield Freeway is approximately 2,600 cubic feet per second (cfs) and the maximum flow capacity of the tunnel is approximately 1,950 cfs. All water cannot be diverted through tunnel and improvements and maintenance to the downstream reaches of the NBECD channel and drain crossings are still required with this alternative.

Alternative 16 also includes improvements to the Rouge River channel from I-94 to the turning basin. Improvements would be required in order to accept additional flow from the NBECD. The required Rouge River improvements are outline in the Task 5 report.

Alternative 17 – Tunnel to Lower NBECD

Alternative 17 was developed by merging and updating Alternatives 13 and R-5. Alternative 17 is also a tunnel alternative and includes a 16 foot diameter storm water tunnel. Alternative 17 is very similar to Alternative 16 with the primary difference between the two being the route of the tunnel and location of tunnel outlet.

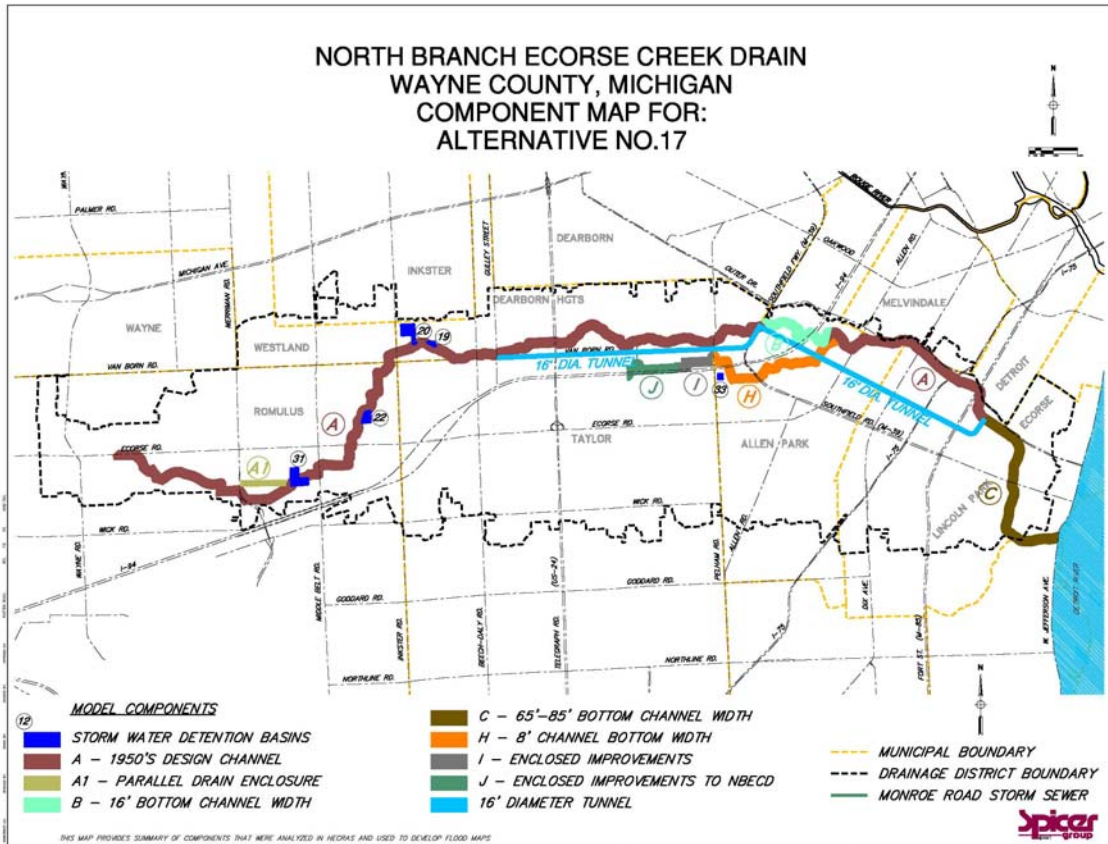
For Alternative 17, the tunnel extends to the lower section of the NBECD instead of the Rouge River. The proposed route is along Van Born Road from Gulley Road to the Southfield Freeway and then from the Southfield Freeway to Austin Avenue under various residential streets through Allen Park and Lincoln Park.

In developing Alternative 17, several updates to storm water detention sites from Alternative 13 were made. These updates were based on engineering evaluation and policy decisions, with input from the Policy and Technical Committees. Changes

included removal of Detention Sites 17 and 25 and the addition of Detention Site 31. The storm water detention sites included in Alternative 17 are shown in Table 6-1 and with the exception of Site 10, which is not included in Alternative 17.

Alternative 17 also includes large scale dredging/channel improvements of the lower portion of the NBECD between Austin Avenue and the Detroit River. These improvements are required so the channel can adequately convey storm water from the tunnel. Figure 6-4 is the component map of Alternative 17, Tunnel to Lower NBECD Alternative.

Figure 6-4
NBECD – Tunnel to Lower NBECD Alternative (17)
Component Map



Modeling of Flood Mitigation Alternatives

The flood mitigation alternatives in Task 6 were evaluated using the unsteady-state mode of the HEC-RAS model as discussed in Task 2. The matrix of mitigation alternative model runs is presented in Table 6-3.

**Table 6-3
Matrix of Flood Mitigation Alternatives
HEC-RAS Model Runs**

Alternative No.	Model Run No.	Design Storm	NBECD Channel Condition	Storm Water Detention Basin Sites Included	Reeck Drain Channel Condition
14	103	100 year, 24 hour	Alternative 8 Geometry	6 Detention Basins (10,19, 20, 22, 31 & 33)	Alternative R-5 Geometry
14	104	10 year, 24 hour	Alternative 8 Geometry	6 Detention Basins (10,19, 20, 22, 31 & 33)	Alternative R-5 Geometry
14	105	2 year, 24 hour	Alternative 8 Geometry	6 Detention Basins (10,19, 20, 22, 31 & 33)	Alternative R-5 Geometry
15	106	100 year, 24 hour	Alternative 5 Geometry	10 Detention Basins (5, 6, 7, 10,11, 19, 20, 22, 31 & 33)	Alternative R-5 Geometry
15	107	10 year, 24 hour	Alternative 5 Geometry	10 Detention Basins (5, 6, 7, 10,11, 19, 20, 22, 31 & 33)	Alternative R-5 Geometry
15	108	2 year, 24 hour	Alternative 5 Geometry	10 Detention Basins (5, 6, 7, 10,11, 19, 20, 22, 31 & 33)	Alternative R-5 Geometry
16	109	100 year, 24 hour	Alternative 12 Geometry	5 Detention Basins (19, 20, 22, 31 & 33)	Alternative R-5 Geometry
16	110	10 year, 24 hour	Alternative 12 Geometry	5 Detention Basins (19, 20, 22, 31 & 33)	Alternative R-5 Geometry
16	111	2 year, 24 hour	Alternative 12 Geometry	5 Detention Basins (19, 20, 22, 31 & 33)	Alternative R-5 Geometry
17	112	100 year, 24 hour	Alternative 13 Geometry	5 Detention Basins (19, 20, 22, 31 & 33)	Alternative R-5 Geometry
17	113	10 year, 24 hour	Alternative 13 Geometry	5 Detention Basins (19, 20, 22, 31 & 33)	Alternative R-5 Geometry
17	114	2 year, 24 hour	Alternative 13 Geometry	5 Detention Basins (19, 20, 22, 31 & 33)	Alternative R-5 Geometry

The results of the HEC-RAS model runs were used to develop flood maps for each of the alternatives. Flood maps for each alternative are provided in Appendix B. The maps show the limits of flooding for each alternative. By comparing the flood maps for each alternative with the flood maps for baseline conditions, as provided in Task 3, the horizontal extent of flood reduction that each alternative provides can be easily identified.

The methodology of flood mapping is outlined in Task 5 and is based upon a digital terrain model with 2-foot contour elevation map that was developed in Task 2.

The results of the HEC-RAS model runs were also used to developed hydraulic profiles for each alternative. Hydraulic profiles are provided in Appendix C and in Figures 6-5 through 6-12. The hydraulic profiles allow a comparison of the modeled water surface elevations for baseline conditions, as provided in the Task 3 report, and for each of the alternatives. Figures 6-5 through 6-12 illustrate the reduction in flood elevations that each alternative will provide.

As shown by flood maps and hydraulic profiles, each of the flood mitigation alternatives mitigates flooding for the 10 year storm (with minor street flooding in some areas) and substantially reduces flooding for the 100 year storm event. Each alternative was intentionally developed to provide a similar level of flood reduction so that when comparing and ranking alternatives in Task 6, a consistent comparison is being completed in terms of the level of flood protection that each alternative provides.

Figure 6-5
Comparison of Hydraulic Profiles along NBECD
For Baseline Conditions and Alternative 14 for 10 Year Design Storm

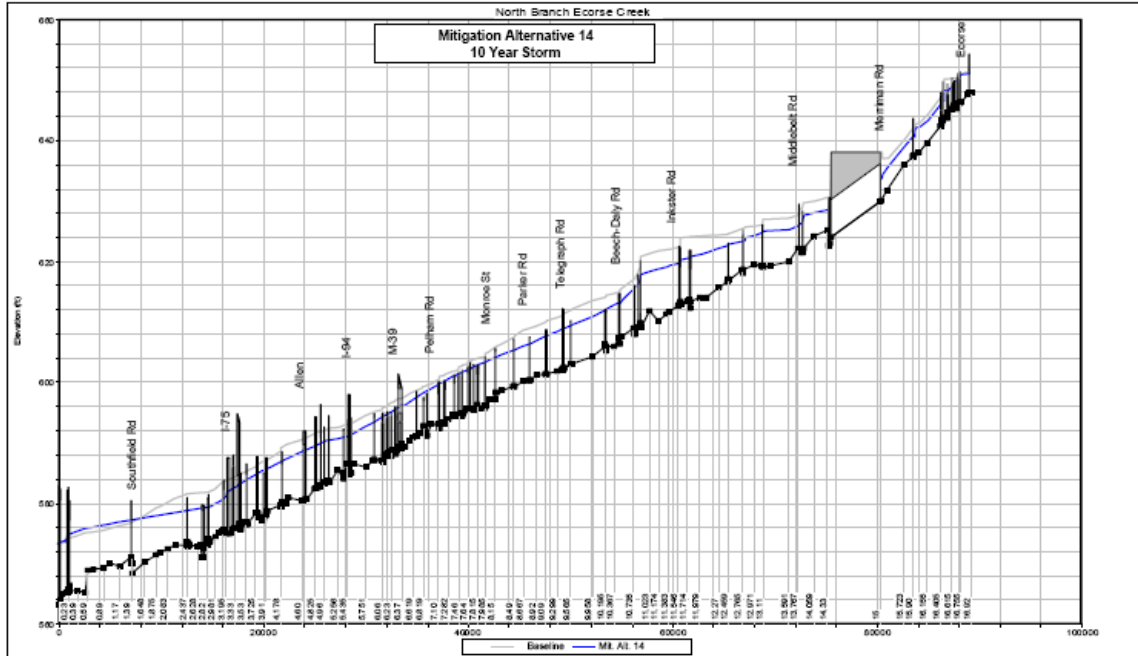


Figure 6-6
Comparison of Hydraulic Profiles along NBECD
For Baseline Conditions and Alternative 14 for 100 Year Design Storm

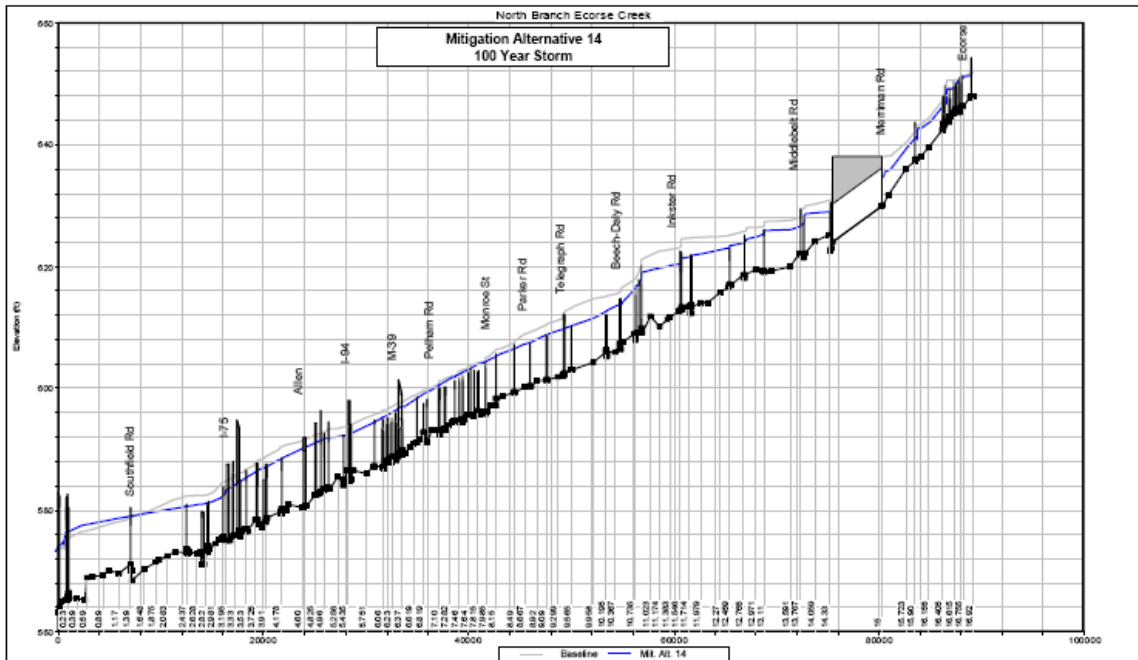


Figure 6-7
Comparison of Hydraulic Profiles along NBECD
For Baseline Conditions and Alternative 15 for 10 Year Design Storm

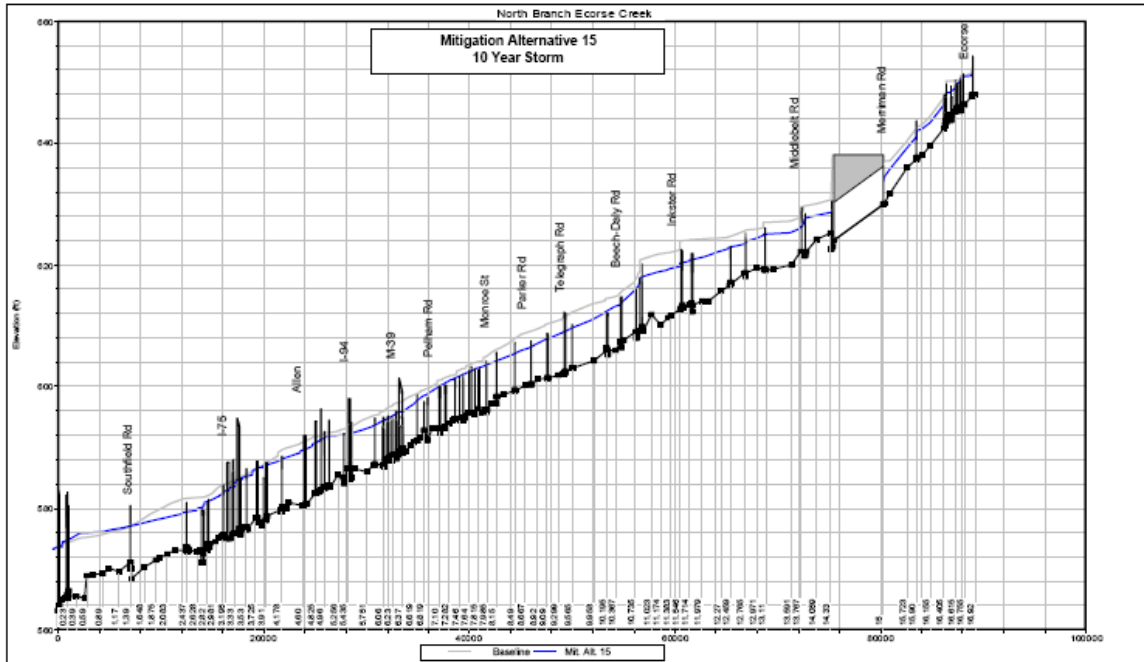


Figure 6-8
Comparison of Hydraulic Profiles along NBECD
For Baseline Conditions and Alternative 15 for 100 Year Design Storm

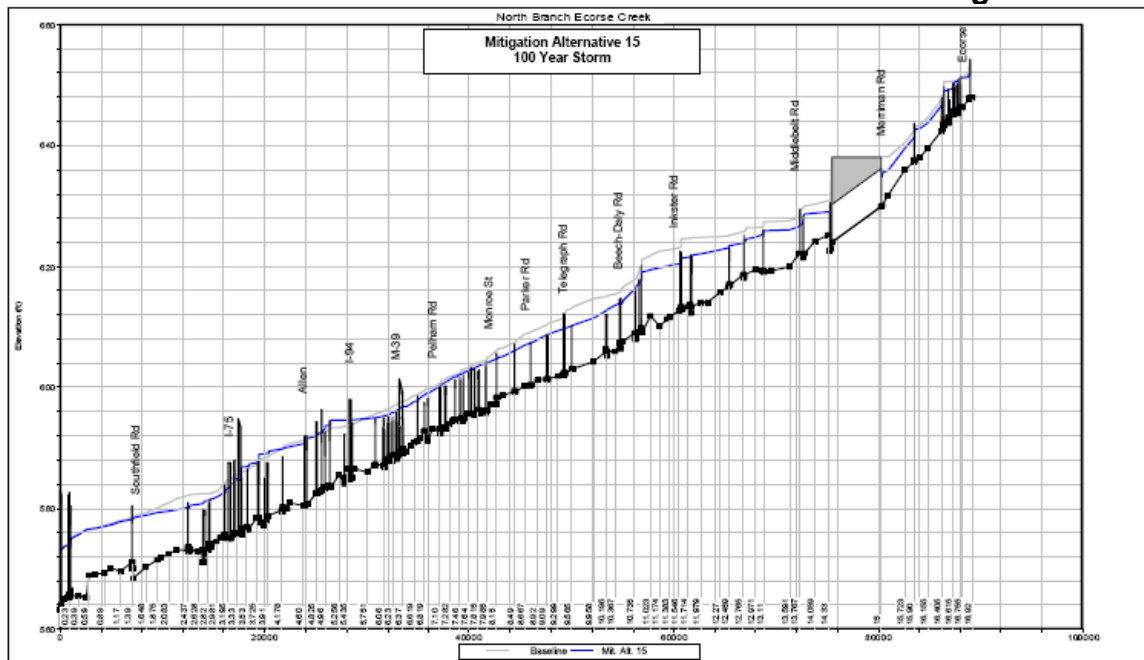


Figure 6-9
Comparison of Hydraulic Profiles along NBECD
For Baseline Conditions and Alternative 16 for 10 Year Design Storm

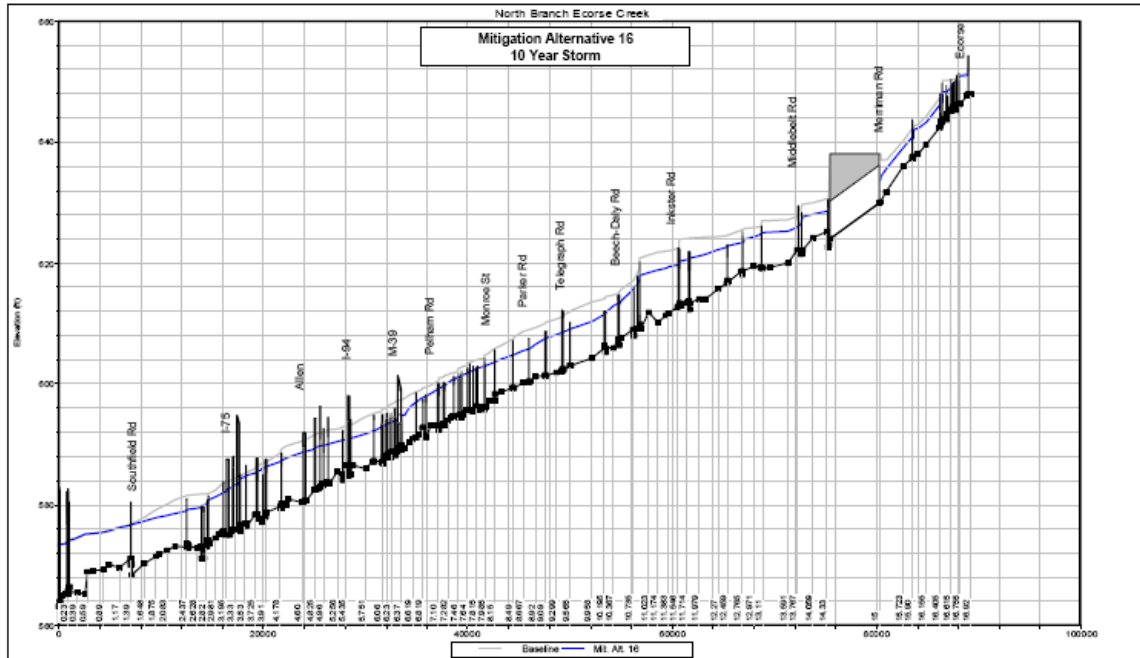


Figure 6-10
Comparison of Hydraulic Profiles along NBECD
For Baseline Conditions and Alternative 16 for 100 Year Design Storm

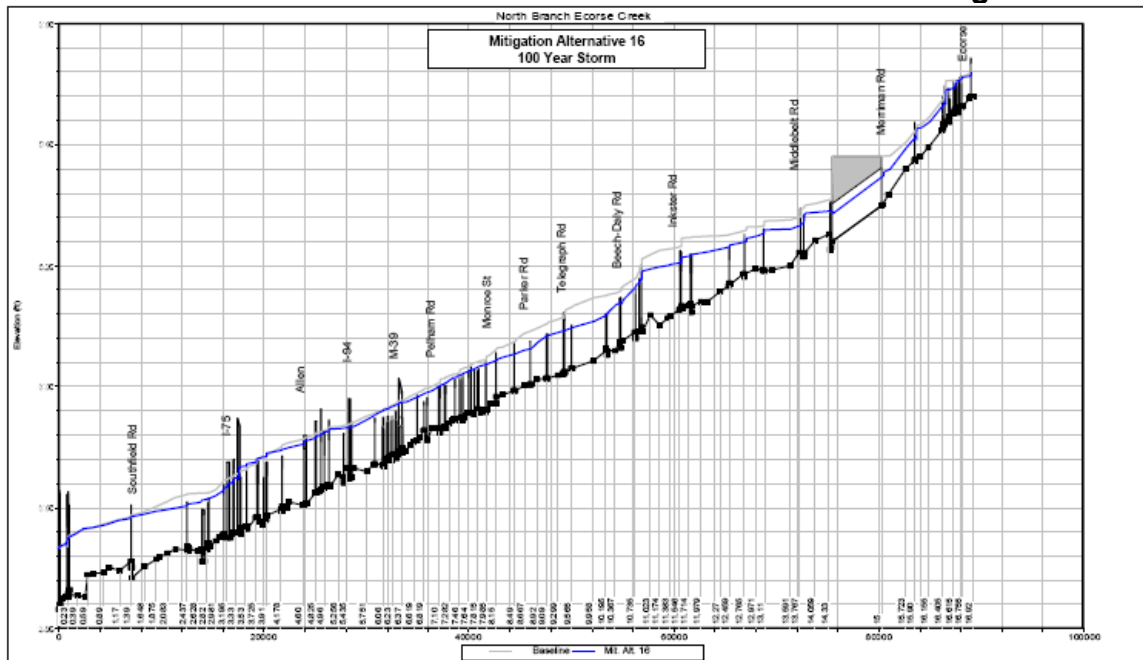


Figure 6-11
Comparison of Hydraulic Profiles along NBECD
For Baseline Conditions and Alternative 17 for 10 Year Design Storm

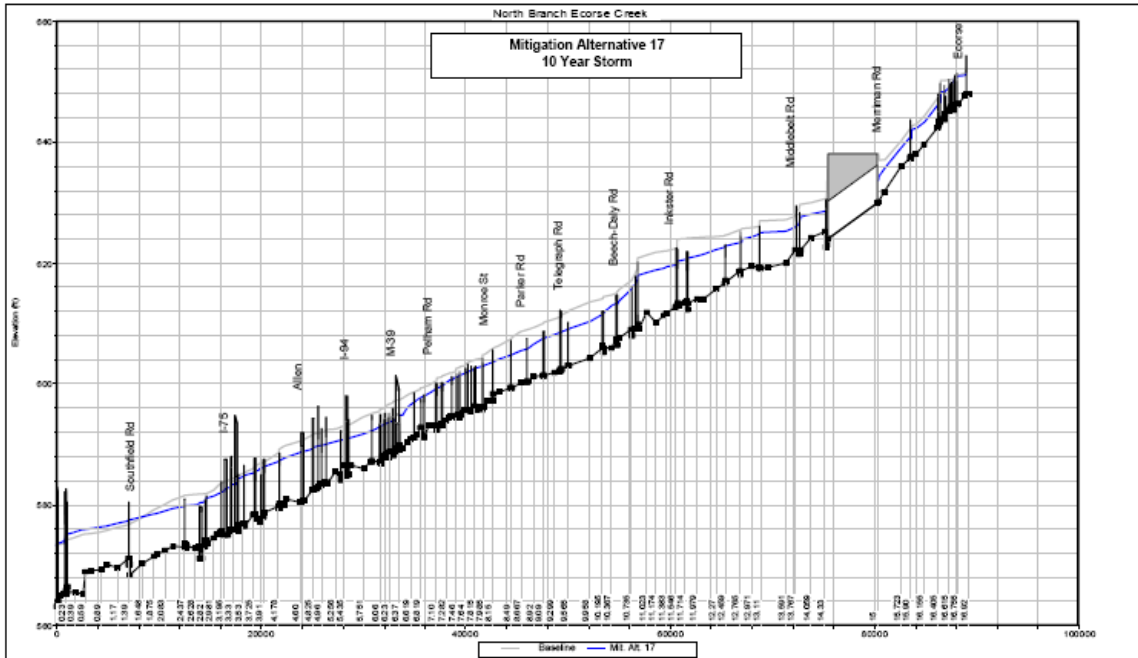
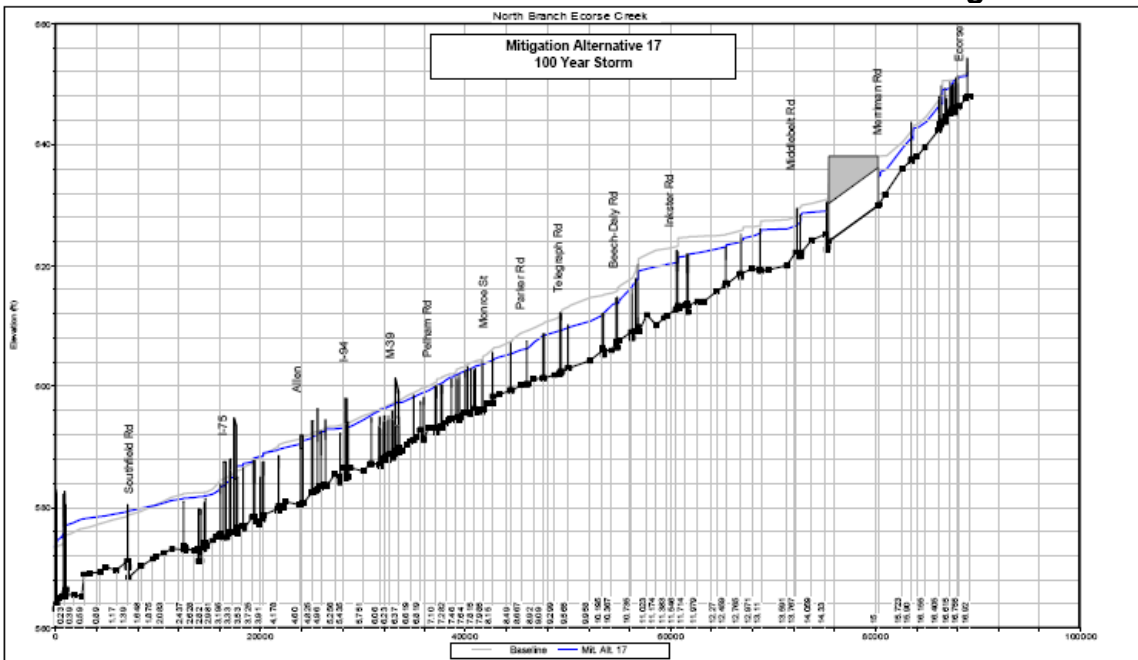


Figure 6-12
Comparison of Hydraulic Profiles along NBECD
For Baseline Conditions and Alternative 17 for 100 Year Design Storm



Right-of-Way Acquisition

The NBECD is an established county drain in accordance with the Michigan Drain Code. In Michigan, county drains are initially established with a right-of-way for the purpose of maintaining and improving the drain. Typically, the originally established right-of-way of a drain is adequate to maintain or improve the drain. However, due to the magnitude of improvements required to mitigate flooding along the NBECD, acquisition of additional right-of-way is necessary. Acquisition of additional right-of-way includes either purchasing a strip of drain easement across a parcel of property or purchasing the entire property. This is referred to as easement acquisition or property acquisition, respectively.

The number of easements or properties that must be acquired has been estimated for each alternative. The estimate was developed using a parcel tax map provided by the WCDOE. The parcel map was provided as a GIS parcel layer that was developed by Wayne County and was last updated in 2000. This map was indicated as adequate for initial estimating. Prior to the implementation of a flood control project, a more detailed review of current properties along the NBECD is required.

The preliminary channel geometry and associated right-of-way needed to construct each improvement alternative was developed. Preliminary right-of-way maps were developed by drawing the required right-of-way limits onto the parcel tax maps. The number of properties encroached upon by the required right-of-way were counted. It was estimated, dependent upon the size and location of each property, whether acquisition of the entire property or of an easement across the property would be needed. This decision was based solely on providing adequate right-of-way to construct and maintain the improvements. The estimates were determined based on preliminary geometry and preliminary alignment of proposed improvements. The exact alignment and geometric configuration must correspond with the actual easements and properties that are acquired. Task 7 provides additional detail regarding right-of-way requirements.

The proposed improvements to the NBECD were divided into three categories including:

- Channel and crossing improvements
- Storm water detention improvements
- Tunnel improvements

The number of easements and property acquisition for type of improvements for each alternative is provided in the Table 6-4. The table shows the number properties impacted for each alternative.

**Table 6-4
Planning Level Estimates of Right-of-Way Acquisitions to Implement
NBECD Improvement Alternatives**

Alternative 14 – Greenway Intensive Alternative	Properties
Easement Acquisition for Channel Improvements	361 Parcels
Property Acquisition for Channel Improvements	430 Parcels
Property Acquisition for Tunnel	None
Property Acquisition for Detention Basins	13 Parcels
Alternative 15 – Stormwater Detention Intensive Alternative	Properties
Easement Acquisition for Channel Improvements	341 Parcels
Property Acquisition for Channel Improvements	397 Parcels
Property Acquisition for Tunnel	None
Property Acquisition for Detention Basins	259 Parcels
Alternative 16 – Tunnel to Rouge River	Properties
Easement Acquisition	612 Parcels
Property Acquisition for Channel Improvements	15 Parcels
Property Acquisition for Tunnel	50 Parcels
Property Acquisition for Detention Basins	13 Parcels
Alternative 17 – Tunnel to Lower NBECD	Properties
Easement Acquisition	621 Parcels
Property Acquisition for Channel Improvements	34 Parcels
Property Acquisition for Tunnel	60 Parcels
Property Acquisition for Detention Basins	13 Parcels

Planning Level Cost Estimates

The following paragraphs outline the basis in developing the planning level cost estimates for each alternative developed in Task 6. Estimates are for planning purposes only, intending to provide the magnitude of costs for comparison to other alternatives. Estimates were prepared using 2006 dollars. Planning leveling cost estimates were developed for each of the mitigation alternatives as shown in Table 6-5.

**Table 6-5
Planning Level Cost Estimates for
NBECB Mitigation Alternatives**

Alternative 14 – Greenway Alternative	
Channel Improvements	\$48 million
Drain Crossing Improvements.....	\$74 million
Storm Water Detention Facilities.....	\$11 million
Storm Water Tunnels	\$0 million
Right-of-Way Acquisition	\$44 million
Professional Services.....	\$31 million
Contingencies	\$21 million
Total Planning Level Estimate (2006 dollars)	\$229 million

Alternative 15 – Storm Water Detention Alternative	
Channel Improvements	\$42 million
Drain Crossing Improvements.....	\$38 million
Storm Water Detention Facilities.....	\$30 million
Storm Water Tunnels	\$0 million
Right-of-Way Acquisition	\$75 million
Professional Services.....	\$30 million
Contingencies	\$22 million
Total Planning Level Estimate (2006 dollars)	\$237 million

**Table 6-5 continued
Planning Level Cost Estimates for
NBECD Mitigation Alternatives**

Alternative 16 – Tunnel to Rouge River Alternative	
Channel Improvements	\$19 million
Drain Crossing Improvements.....	\$20 million
Storm Water Detention Facilities.....	\$11 million
Storm Water Tunnel	\$155 million
Rouge River Improvements	\$47 million
Right-of-Way Acquisition	\$11 million
Professional Services.....	\$54 million
Contingencies	\$32 million
Total Planning Level Estimate (2006 dollars)	\$349 million

Alternative 17 – Tunnel to Lower NBECD Alternative	
Channel Improvements	\$21 million
Drain Crossing Improvements.....	\$23 million
Storm Water Detention Facilities.....	\$11 million
Storm Water Tunnels	\$183 million
Right-of-Way Acquisition	\$16 million
Professional Services.....	\$51 million
Contingencies	\$30 million
Total Planning Level Estimate (2006 dollars)	\$335 million

The basis for cost estimating was completed using the following seven (7) categories:

- Channel Improvements
- Drain Crossing Improvements
- Storm Water Detention Facilities
- Storm Water Tunnels
- Right-of-Way Acquisition
- Professional Services
- Contingencies

The following paragraphs discuss the seven (7) categories itemized above and how planning level cost estimates for each alternative were developed.

Channel Improvements

Channel improvements consist of:

- Site clearing/debris management
 - Channel excavation/dredging including greenway excavation
 - Deposition and management of excess materials (spoils)
 - Soil erosion control/sediment control
 - Utility relocation/right-of-way enhancements
 - Environmental contamination and cleanup
-
- **Site Clearing/Debris Management** - Site clearing and debris management estimates were determined using a price per linear foot along the drain that must be cleared to implement improvements and then expressed as a lump sum amount. A range of \$10 to \$80 per foot of drain was used depending on the width of the drain and the magnitude of clearing required. Site clearing and debris management includes removal and disposal of trees, debris, obstructions, homes and structures in channel and right-of-way required to construct channel improvements.
 - **Channel Excavation/Dredging** - Channel excavation and dredging estimates were determined using a price per cubic yard of excavation to construct channel improvements and then converted to a unit price per foot. For mechanical excavation a price per cubic yard of \$3 to \$5 was used depending on the location and the magnitude of work. For hydraulic dredging, a price per cubic yard of \$5 was used.
 - **Deposition and Management of Excess Material (Spoil Management)** - Dredged and excavated material management estimates were determined using a price per cubic yard of excavated material and then converted to a unit price per foot. A price of \$1.75 for cubic yard was used if the excavated material is to be leveled along the

drain right-of-way and \$5 to \$10 per yard if the excavated material is to be hauled from the drain right-of-way. An additional fee of \$5 per cubic yard was added for land fill tipping fees for disposal of hauled material (this was obtained by contacting landfills in 2006). Discussion regarding soil contamination is provided later in this report.

- Soil Erosion Control and Sediment Control - Soil erosion control and sediment control measures were budgeted in the range of 15 to 27 percent of the total open channel construction cost depending on the location and the magnitude of work and then converted into a lump sum budget. Detailed analysis and design selection of specific methods and locations for soil erosion control and sediment control must yet be completed. For planning level cost estimating and budgeting, it was assumed the drain side slopes would be constructed to a 2 horizontal to 1 vertical side slope and would be vegetated. It was assumed that soils along the NBECD are sufficient to maintain the 2 horizontal to 1 vertical side slope since major bank sloughing and large scale erosion problems do not exist along the NBECD. The NBECD is relatively flat with a low water velocity.

The soil erosion control and sediment control estimate includes permanent and temporary (construction) measures. Permanent measures, intended to maintain drain and bank stability after construction, include:

- Placement of armor and erosion control textile along the drain at locations where higher water velocity will occur, such as bends and near crossings
- Placement of erosion control measures at points of concentrate flow, such as lateral storm water discharge points
- Grass seeding and mulching of the entire channel and right-of-way where construction occurs

Temporary construction measures include measures to adhere with Part 91 of Public Act 451 of 1994 and Wayne County Authorized Public Agency soil erosion control practices.

- Utility Relocation/Right-of-Way Enhancements - Utility conflicts requiring relocation of municipal infrastructure are expected. This includes relocation of infrastructure such as water mains, storm and sanitary sewers, and local roads. Conflicts requiring relocation of private utilities such as gas, phone, cable and others are also expected. Detailed review, design, and coordination with utility owners must be completed to identify specifics and extent required. A lump sum budget of \$2 million to \$4 million (depending on the mitigation alternative) for utility conflicts and relocations has been included in the planning level estimate although detailed analysis has not been completed. Also, planning level estimates did not consider enhancements that exceed what is required to provide flood protection along NBECD. Recreational enhancements or infrastructure capacity improvements that may be desired by specific municipalities must be coordinated between the WCDOE and municipalities.
- Environmental Contamination and Cleanup - Soil contamination is expected in some excavation areas along the NBECD. Four (4) sediment samples were obtained along the lower section of the NBECD and found to contain levels of contamination that would require disposal of spoils at a landfill or approved disposal site. The Task 4 report summarizes preliminary environmental reviews that were completed. Additional environmental analysis is required to determine extent of contamination and required remediation measures. An estimate of \$5 million to \$10 million for soil contamination has been included in the planning level estimate depending on the alternative.

Drain Crossing Improvements

Drain crossing improvements along the NBECD include work on bridges and culverts to improve flow capacity. Drain crossing improvements include:

- Replacement of bridges and culverts
- Removal of bridges and culverts
- Retrofitting/enhancements of existing bridges

Existing drain crossings identified as having inadequate flow capacity are proposed to be replaced or removed. Planning level cost estimates for bridge replacement were developed using the Michigan Department of Transportation's (MDOT) Bridge Repair Cost Estimate Worksheet (rev. 10/18/06), which can be found in Appendix D. The estimates were developed assuming the new bridge deck area to span the entire width proposed drain cross section. This calculation assumed that the existing road width, the number of traffic lanes and the road elevation would not change. The calculated area required to span the proposed channel was used to obtain replacement estimates from the MDOT worksheet. The estimates include removal of existing bridges and construction of new bridges and traffic control.

Planning level cost estimates for culvert replacement costs were calculated using unit prices per lineal foot obtained from pipe suppliers in 2006. A multiplication factor of three (3) was used. This was based on input from suppliers and recent projects to account for installation costs and then converted to a lump sum budget. The estimates include in-kind replacement of drive width and pavement type, removal of the existing culvert, and installation of the new culvert.

Several drain crossings are proposed for removal without replacement. Planning level cost estimates provided for these, which consist of local roads or unused private crossings, assumed that crossings would be removed and road/drive as exists would dead end at the crossing. Once again, the estimates to remove the bridges or culverts were based upon the MDOT Bridge Repair Cost Estimate Worksheet (rev. 10/18/06).

Some existing drain crossings have adequate flow capacity. The specific work required at each of these drain crossings is yet to be determined. A budget for retrofitting and enhancements of the crossing was included in the planning level estimates for:

- Sediment removal from crossings
- Adjustments of crossing approaches
- Underpinning of crossing foundation

Storm Water Detention Facilities

The storm water detention facility improvements include:

- Excavation of open storm water detention basin
 - Spoil management
 - Inlet and outlet control structures
 - Site clearing
 - Utility conflicts
 - Soil erosion/site restoration measures
-
- Excavating Open Storm Water Detention - Planning level cost estimates for excavation of detention basins were determined using a price range of \$3 per cubic yard of excavation to provide required detention volume. Conceptual site plans for each potential detention facility are provided in Task 5. The conceptual plans were used to estimate cubic yards of excavation required.
 - Spoil Management - Spoil management included either: hauling of spoils, or leveling the spoils on-site. Each site was individually evaluated to estimate either hauling or on-site leveling. This depended primarily if the land area of each site was sufficient to level spoils. For sites where hauling of spoils was assumed, it was estimated that spoils were not contaminated, unless sites were identified to have contamination as determined in Task 4.

Storm water inlet control structures were assumed to be reinforced earthen overflow structures of sufficient length to allow gravity overflow into basins during high flow conditions. Details of each structure must yet be completed. Two types of outlet control structures were considered: gravity outlet and pumped outlet. Most storm water detention basins were assumed to have a gravity outlet structure that allowed the basin to dewater through a concrete structure and piping directed to the NBECD. Dewatering pumping stations would allow the basins that are deeper than the drain bottom to be dewatered once the storm event has passed and the flood levels have decreased. Dry basins are required in the vicinity of Detroit Metro Airport for air traffic safety. Budgets for inlet and outlet control structures were included in the planning level cost estimates.

Site clearing estimates for each alternative were determined using a price per acre of acreage to be cleared and then expressed as a lump sum amount. A range of \$7,500 to \$13,500 per acre was used depending on site characteristics. A large range exists as some sites are open fields, some are wooded, and some are currently residential neighborhoods. Sites would be required to be completely cleared to allow for construction of storm water facilities.

Utility conflicts requiring relocation of municipal infrastructure at some detention sites are expected. This includes relocation of infrastructure such as water mains, storm and sanitary sewers, and local roads. Conflicts requiring relocation of private utilities such as gas, phone, cable, and others are also expected. Detailed review, design, and coordination with utility owners must be completed to identify specifics and extent required. An estimate for utility conflicts and relocations has been included in the planning level estimate on a site by site basis.

Soil erosion control and site restoration measures, at detention sites includes permanent and temporary (construction) measures. Permanent measures, intended to maintain bank stability after construction, include:

- Placement of armor and erosion control textile at locations where higher water velocity will occur, such as inlet and outlet structures
- Grass seeding and mulching of entire sites
- Economical site features such as driveways, top soil grading, and fencing of site

Temporary construction measures include measures to adhere to Part 91 of Public Act 451 of 1994 and the Wayne County Authorized Public Agency soil erosion control practices.

Storm Water Tunnels

The estimates for tunnel construction were primarily based on unit prices and quantities presented in the Task 4 report prepared by NTH Consultants, Ltd. (NTH). Planning level estimates provided in Task 4 were supplemented with estimates for site restoration and tunnel inlet and outlet structures.

Right-of-Way Acquisition

Additional right-of-way must be acquired to construct and maintain a flood mitigation project. Preliminary estimates of the number of properties and easements that must be required were developed for three categories needed to construct:

- Channel and crossing improvements
- Storm water detention facilities
- Tunnel improvements that extend outside of the current NBECD right-of-way

This evaluation was completed by overlaying proposed improvements (and associated right-of-way requirements) onto aerial photography and the Wayne County GIS parcel layer dated 2000 to complete a count. Final design alignments must be coordinated and a detailed review of current property ownership must be completed prior to determining the exact level of property acquisition. Based on available parcel data, individual parcels affected by project alternatives were sorted into three (3) classifications being:

- Parcels requiring additional easement

- Vacant parcels
- Existing developed parcels with a house/building that must be purchased

For channel improvements and tunnel improvements, flat purchase prices for acquisition per parcel were developed for each classification. The initial prices are assumed to be:

- \$5,000 to obtain an easement (with purchasing entire property);
- \$15,000 to obtain a vacant lot sized parcel; and
- \$130,000 to obtain a lot size parcel containing a house/structure.

For parcels that are currently owned by a municipality or governmental agency, no acquisition cost was estimated.

Appraisals of individual sites were not completed as part of the flood control study. Prices were developed with input of the WCDOE and upon review of home sale prices in areas where the majority of properties acquisition is required. For storm water detention sites where large parcels and tracts of land are required, acquisition prices were estimated to range between \$25,000 and \$100,000 per acre depending on site location. Property and easement acquisition is discussed in detail in Task 7.

Professional Services

Professional services for engineering design, construction oversight, legal fees, and assistance with property acquisition have been estimated to be 20 percent of the construction cost.

Project Contingencies

The Michigan Drain Code requires a minimum contingency of 10 percent of the total project cost. A contingency of 10 percent of total estimated cost was used in the planning level cost estimates.

Financing

Financing costs are not included in the planning level cost estimates. Depending on method and time frame of financing, interest and other costs associated with the project financing will be incurred. It is recommended that the WCDOE will consult with a municipal financing expert on this matter.

Selection of Recommended Flood Mitigation Alternative

In accordance with the Michigan Drain Code, the County Drain Commissioner is responsible for determining the scope of drainage improvements that are petitioned for and ordered necessary by a Board of Determination. This is the case for the NBECD. To determine the scope of improvements for the NBECD, the Wayne County Drain Commissioner initiated this flood control study to provide a recommendation for the scope of drain improvements. The Wayne County Drain Commissioner also requested the formation of Technical and Policy Committees to provide input on local acceptability of various alternatives of a project scope. The Technical and Policy Committee members and roles are outlined in the Task 4 report.

As outlined in previous chapters of this flood control study, many alternatives and mitigation measures were considered and evaluated. These efforts culminated in the development of the four (4) comprehensive flood mitigation alternatives that are outlined in this Task 6. One of the four (4) alternatives is to be the recommended flood mitigation alternative. To assist in selecting the recommendation, a scoring system was developed as a basis for completing a comparative evaluation of alternatives and having the Technical and Policy Committees rank the alternatives. The scoring system considered many factors from cost to property acquisition to construction disruption. A total of 19 factors were developed, with assistance of the Technical and Policy Committees, and placed into three primary categories being:

- Long-term impacts
- Short-term impacts
- Acceptability by grant and regulatory agencies

The following is a summary of factors that were used to score the flood mitigation alternatives.

Long Term Impacts

Long term impacts are considered those to remain in effect after the construction of a flood control project. Long term impacts can be positive or negative. For example, flood reduction is a considered long term positive impact whereas the project cost is considered a long term negative impact.

Eleven factors were selected for comparing the long term impacts of each alternative. These factors were developed with input from the Technical and Policy Committees. Each factor was assigned a score ranging between positive and negative five (5 to -5). Factors that were considered positive impacts were assigned positive number and factors that were considered negative impacts were assigned a negative number. The following provides a summary of each factor and basis for assigning a score for each.

- Capital Cost – This includes a comparison of the planning level cost estimates as provided in this Task 6. Lower cost alternatives were assigned a higher score.
- Habitat and Conservation – This includes a comparison of the potential for environmental habitat and conservation enhancements associated with each alternative. The primary factor considered was the establishment of buffer zones along the creek corridor. Alternatives that provide larger buffer zone areas along the creek corridor would provide more natural features and vegetation in an undeveloped corridor and were assigned a higher score.
- Health and Safety – This includes a comparison of the public health and safety enhancements of each alternative. Since the flooding of public streets hinders local emergency services, the primary factor considered for this comparison is the reduction the flood water depth and duration of flooding on public road right-of-way.

Alternatives that provide the more reduction in flood depth and flood duration in public roads were assigned a higher score.

- Archeological – This considers possible disruption of archeological or historical sites. A preliminary review of potential impacts was completed as part of Task 4. Potential negative impacts to historical and archeological sites were identified based on a preliminary review completed in Task 4. Alternatives that have lesser impacted sites were assigned a higher score.
- Life Cycle Costs – The life cycle cost for each of the alternatives was estimated. They were based on a 50-year period which considered operation and maintenance costs, infrastructure replacement cost, and probable flood damage costs. Some alternatives do not include complete infrastructure replacement, for example, bridges not being replaced as part of the initial capital improvement project. The alternatives having lower life cycle costs were assigned a higher score.
- Loss of Tax Base – This considered the loss of tax base as a result of property acquisition. The number of property acquisitions of taxable properties was estimated for each alternative. The alternatives that have a larger number were assigned a lower score.
- Permanent Traffic Changes – This considered the number of bridges that are proposed for removal with each alternative, as bridge removal will result in permanent traffic changes. Alternatives with a higher number of bridge removals were assigned a lower score.
- Private Property Impact – This considers a comparison of the estimated acquisitions for each alternative. Alternatives with the largest magnitude of acquisition were assigned a lower score. The scoring considered a comparison of the number of easement acquisitions verses the number of property acquisitions. Alternatives that

have a proportionally larger number of property acquisitions were scored lower than alternatives that had a proportionally larger number of easement acquisitions. In general, easement acquisition is considered to have a lesser impact on private property when compared to property acquisition.

- Reduction in Flooding – This considers a comparison of the land area flooded with and without the implementation of the flood mitigation alternatives for the 10 year and 100 year return frequencies. Flood maps that show the extent of predicted flooding for baseline conditions and for each alternative were compared. The land area flooded for baseline conditions and the land area flooded for each alternative were calculated. Alternatives that are predicted to reduce the most area of flooding were assigned a higher score.
- Soil Erosion – This considered long term potential for stream bank erosion along the NBECD. This considers a comparison of predicted water velocity, channel improvement geometry and ability to provide channel alignment that is least subject to bank erosion. Alternatives that were estimated to be least susceptible to long term bank erosion problems were assigned a higher score.
- Water Quality – The primary consideration for water quality is comparison in the reduction of flooding on public road right-of-way. Street flooding contributes to the overloading of sanitary sewer systems, which is related to basement flooding and sewage overflows. These items were identified locally to be primary water quality concerns. Alternatives that provide the more reduction in street flooding were assigned a higher score.

Short Term Impacts

Short term impacts are considered those to be in effect during the construction phase of a flood control project. Short term impacts are considered to be negative as they reflect the inconveniences that will occur during the construction of the project.

Six (6) factors were selected for comparing the short term impacts of each alternative. These factors were developed with input from the Technical and Policy Committees. Each factor was assigned a score ranging between zero and negative five (0 to -5). The following provides a summary of each factor and basis for assigning score for each.

- **Business and Property Impacts** – These consider temporary disruption to businesses, private properties and recreational areas during construction. This was compared by estimating the number of parcels (not to be acquired) adjacent to proposed construction areas for each alternative. The alternatives that have construction adjacent to the most number of properties were assigned a lower score.
- **Construction Duration** – This considers the estimated duration of construction activities for each alternative. Alternatives that are expected to have longer construction time frames were assigned a lower score.
- **Dust/Odors** – This considers the anticipated dust and odor that could be an inconvenience to residents during construction. This considered the length of channel improvements, tunneling mining pits, and the number of proposed detention basins in each alternative. Alternatives that are expected to generate more orders and dust were assigned a lower ranking.
- **Noise** – This considers the anticipated noise nuisance during construction. This considered the length of channel improvements, tunneling mining pits, and the number of proposed detention basins in each alternative. Alternatives that are expected to generate more noise were assigned a lower ranking.
- **Traffic** – This considers the estimated traffic disruptions during construction. This compared the number of drain crossings being improved and the tunnel mining pits for each alternative. Alternatives that are expected to have a worst impact on traffic were assigned a lower ranking.

- Utility Service Disruption – This considers the estimated temporary utility disruption during construction. This considered the length of channel improvements, length of tunnel, and the number of proposed detention basins in each alternative. Alternatives that are expected to have the most utility service disruptions were assigned a lower ranking.

Acceptability by Grant and Regulatory Agencies

Two factors were selected for acceptability. The goal of this was to anticipate state and federal grants and regulatory acceptability. These factors were developed with input from the Technical and Policy Committees. A scoring scale of five to zero (5 to 0) for positive impacts and zero to negative five (0 to -5) for negative impacts was assigned to each factor. A score of five (5) represents the greatest relative positive impact and a score of negative five (-5) represents the greatest relative negative impact.

- Grant Agencies – Grant agencies were considered those that could provide additional state or federal money, to supplement local funding in accordance with Michigan Drain Code, to assist with the implementation of a flood control project. The agencies initially considered were the Michigan Department of Environmental Quality (MDEQ), the United States Army Corps of Engineers (USACE) and the Federal Emergency Management Agency (FEMA). Alternatives were weighted and ranked higher based on project scopes that are more probable to meet eligibility for these agencies to provide grant funding.
- Regulatory Agencies – Each of the alternatives are subject to state and federal regulations and permit requirements. These requirements are outlined in the Task 4 report. Alternatives were weighted and ranked higher based on project scopes which are more probable to meet permit and regulatory guidelines and thus be easier to expedite permits with state and federal agencies.

The scores of each factor described above are shown in Table 6-6.

**Table 6-6
Evaluation Factors and Comparatives Scores for the
NBECD Comprehensive Flood Mitigation Alternatives**

Long Term Impacts		Alt 14 Greenway	Alt 15 Storm Water Detention	Alt 16 Tunnel to Rouge River	Alt 17 Tunnel to Lower NBECD
1	Historical / Archeological	0.0	0.0	0.0	0.0
2	Capital Costs	-3.2	-3.3	-5.0	-4.8
3	Habitat and Conservation	5.0	4.6	2.9	1.2
4	Health and Safety	5.0	5.0	5.0	5.0
5	Life Cycle Costs	-0.8	-1.0	-1.1	-1.1
6	Loss of Tax Base	-0.2	-0.3	0.0	0.0
7	Permanent Traffic Changes	-0.9	-0.9	-0.6	-0.6
8	Private Property Impact	-2.2	-3.1	-1.3	-1.3
9	Reduction in Flooding	5.0	5.0	5.0	5.0
10	Soil Erosion	2.6	2.2	2.4	2.1
11	Water Quality	3.3	3.3	3.3	3.3
Short Term Impacts					
12	Construction Duration	-1.4	-1.8	-2.5	-2.5
13	Dust/Odors	-1.5	-1.5	-1.6	-1.6
14	Noise	-1.4	-1.4	-1.7	-1.6
15	Business and Property Impact	-2.8	-2.7	-4.9	-5.0
16	Traffic	-1.2	-1.0	-1.9	-2.0
17	Utility Service Disruptions	-1.6	-1.2	-1.3	-1.4
Acceptability					
18	Acceptability by Grant Agencies	3.0	3.0	0.5	1.0
19	Acceptability by Regulatory Agencies	2.5	3.0	0.5	2.0

After presenting the evaluation factors to the Technical and Policy Committees, the members were asked to prioritize the evaluation factors by assigning a weight to each factor on behalf of their municipality or agency. Table 6-7 is the Evaluation Criteria Weighting Sheet that was provided to each committee member.

**Table 6-7
Evaluation Criteria Weighting Sheet provided to
Committee Members for Ranking NBECD Flood Mitigation Alternatives**

Long Term Evaluation Criteria		Weight
1	Historical / Archeological	
2	Capital Costs	
3	Habitat and Conservation	
4	Health and Safety	
5	Life Cycle Costs	
6	Loss of Tax Base	
7	Permanent Traffic Changes	
8	Private Property Impact	
9	Reduction in Flooding	
10	Soil Erosion	
11	Water Quality	
Short Term Evaluation Criteria		
12	Construction Duration	
13	Dust/Odors	
14	Noise	
15	Business and Property Impact	
16	Traffic	
17	Utility Services Disruptions	
Other Evaluation Criteria		
18	Acceptability by Grant Agencies	
19	Acceptability by Regulatory Agencies	
Sum of Evaluation Criteria Weight		100%

The weight assigned by each municipality/agency was multiplied by a vested interest factor. The vested interest factors were proportioned amongst municipality/agency

based on the current at-large cost share percentage of each municipality/agency and on the number of properties in each municipality that are subject to special assessments for the NBECD. The objective of the vested interest factor is to give higher weight to municipalities for which higher percentages of the project cost would be collected. The exact breakdown of apportionments for the project cost are not determined at this point and will not be known until the final project scope and assessments of benefits derived is completed and the vested interest factors are just an estimation. The MDOT factor considers only at-large since MDOT does not represent private property owners.

The sum of the vested interest factors must equal 100 percent. The percentage of the at-large cost sum is 27.4 percent. The remaining percentage was pro-rated to the municipalities based on the number of private properties within the NBECD Drainage District. Two municipalities, Lincoln Park and Ecorse, did not return the Evaluation Criteria Weighting Sheet. The vested interest of these municipalities was distributed proportionally amongst others to equal 100 percent. Table 6-8 shows the final factors that were used.

**Table 6-8
Vested Interest Factors for Ranking NBECD Flood Mitigation Alternatives**

Municipality or Agency	Private Property Factor	Municipal At-Large Factor	Total Vested Factor	Adjusted Vested Interest Factor (without Ecorse and Lincoln Park)
Allen Park	7.3	2.8	10.1	13.7
Dearborn Heights	5.3	6.8	12.1	16.4
Ecorse	4.3	2.0	6.2	0.0
Inkster	1.0	0.9	1.8	2.5
Lincoln Park	16.3	3.8	20.2	0.0
Melvindale	0.1	0.1	0.2	0.3
Romulus	2.4	2.6	5.0	6.8
Taylor	34.9	2.3	37.1	50.4
Westland	1.1	1.1	2.2	3.0
MDOT	0	5.2	5.2	7.0
Total	72.6	27.4	100	100

Table 6-9 shows the weight given to each of the evaluation factors by each municipality and the final weight given to each evaluation factor.

**Table 6-9
 NBECD Evaluation Criteria Priority by Community
 and Overall Criteria Weight**

Evaluation Criteria		Final Criteria Weight	Allen Park Priority	Dearborn Heights Priority	Ecorse Priority	Inkster Priority	Lincoln Park Priority	Melvindale Priority	Romulus Priority	Taylor Priority	Westland Priority	MDOT Priority
1	Archeological	0.55	0	1	0	5	0	0	4	0	0	0
2	Capital Costs	33.75	15	40	0	11	0	100	4	31	50	100
3	Habitat and Conservation	1.22	0	2	0	5	0	0	4	1	0	0
4	Health and Safety	1.73	0	2	0	5	0	0	4	2	0	0
5	Life Cycle Costs	3.81	0	5	0	9	0	0	10	3	20	0
6	Loss of Tax Base	7.72	35	10	0	2	0	0	4	2	0	0
7	Permanent Traffic Changes	1.50	0	4	0	3	0	0	4	1	0	0
8	Private Property Impact	6.68	15	10	0	3	0	0	4	5	5	0
9	Reduction in Flooding	18.65	20	10	0	9	0	0	10	26	10	0
10	Soil Erosion	1.08	0	1	0	6	0	0	4	1	0	0
11	Water Quality	2.35	0	2	0	10	0	0	4	3	0	0
12	Construction Duration	1.03	0	1	0	4	0	0	4	1	0	0
13	Dust/Odors	1.01	0	1	0	3	0	0	4	1	0	0
14	Noise	1.01	0	1	0	3	0	0	4	1	0	0
15	Private Property Impact	1.46	0	1	0	5	0	0	10	1	0	0
16	Traffic	0.99	0	1	0	2	0	0	4	1	0	0
17	Utility Services	3.19	0	2	0	3	0	0	4	5	0	0
18	Acceptability for Grant Agencies	8.05	10	3	0	8	0	0	10	10	10	0
19	Acceptability for Regulatory	4.20	5	3	0	4	0	0	4	5	5	0
Sum of Evaluation Criteria Weight		100	100	100	0	100	0	100	100	100	100	100

The score of the evaluation criteria per mitigation alternative was multiplied by the overall criteria weight to determine the final score and ranking of the flood mitigation alternatives. Table 6-10 shows the scoring of each of the alternatives.

**Table 6-10
Scoring of NBECD Flood Mitigation Alternatives**

Long Term Evaluation Criteria		Weight	Alt 14 Greenway	Alt 15 Storm Water Detention	Alt 16 Tunnel to Rouge River	Alt 17 Tunnel to NBECD
1	Historical / Archeological	0.55	0.00	0.00	0.00	0.00
2	Capital Costs	33.75	-108.00	-111.37	-168.75	-162.00
3	Habitat and Conservation	1.22	6.11	5.62	3.54	1.47
4	Health and Safety	1.73	8.63	8.63	8.63	8.63
5	Life Cycle Costs	3.81	-3.01	-3.85	-4.27	-4.23
6	Loss of Tax Base	7.72	-1.54	-2.32	0.00	0.00
7	Permanent Traffic Changes	1.50	-1.35	-1.35	-0.90	-0.90
8	Private Property Impact	6.68	-14.77	-20.79	-8.35	-8.89
9	Reduction in Flooding	18.65	93.23	93.23	93.23	93.23
10	Soil Erosion	1.08	2.77	2.40	2.58	2.30
11	Water Quality	2.35	7.88	7.88	7.88	7.88
Short Term Evaluation Criteria						
12	Construction Duration	1.03	-1.42	-1.84	-2.59	-2.53
13	Dust/Odors	1.01	-1.55	-1.51	-1.65	-1.58
14	Noise	1.01	-1.42	-1.44	-1.72	-1.66
15	Business and Property Impact	1.46	-4.10	-3.88	-7.17	-7.32
16	Traffic	0.99	-1.17	-1.02	-1.89	-1.99
17	Utility Service Disruptions	3.19	-4.95	-3.92	-4.14	-4.52
Other Evaluation Criteria						
18	Acceptability by Grant Agencies	8.05	20.13	24.16	4.03	16.11
19	Acceptability by Regulatory Agencies	4.20	12.61	12.61	2.10	4.20
TOTAL		100	8.08	1.26	-79.45	-61.82

Table 6-11 shows the ranking of the flood mitigation alternatives by municipality.

**Table 6-11
Ranking of NBECD Flood Mitigation Alternatives by Municipalities**

Municipality or Agency	Alt 14 Greenway	Alt 15 Storm Water Detention	Alt 16 Tunnel to Rouge River	Alt 17 Tunnel to NBECD
Allen Park	1	2	4	3
Dearborn Heights	1	2	4	3
Ecorse	-	-	-	-
Inkster	1	2	4	3
Lincoln Park	-	-	-	-
Melvindale	1	2	4	3
Romulus	1	2	4	3
Taylor	1	2	4	3
Westland	1	2	4	3
MDOT	1	2	4	3
Combined Ranking	1	2	4	3

Conclusion

With consideration of the ranking by the municipalities and with the input from the Wayne County Drain Commissioner and the flood control study consultant team, the recommendation of this flood control study is to implement a “greenway” flood mitigation alternative.

The “greenway” Alternative 14 will be developed in detail as the recommended flood control project in the Task 7 report.