5. DEVELOPED/URBAN ZONE WITH DRAINAGE PROBLEMS

5.1 Analysis Methodology

5.1.1 Zone Determination

Earth Tech staff met with the City’s engineering and public works staff to identify the location of existing drainage problem areas. Nine (9) drainage problem areas were identified (Figure 1-1). The Developed/Urban Zone with Drainage Problems was delineated by the drainage basins that contribute to each drainage problem.

5.1.2 Hydrologic / Hydraulic Modeling

Data from the City’s storm sewer system maps, and topographic maps were then used to build an H/H model for assessment of the drainage system in each of the basins with drainage problems. The main purposes of the modeling were to confirm anecdotal evidence of drainage problems, and then determine what types of measures could be made to improve the drainage problems.

5.1.3 Drainage Improvement Alternatives Standard

In completing the H/H modeling, a “performance standard” was developed as a tool for determining the deficiency or adequacy of the existing drainage system and any proposed corrective measures. The standard used was referred to as the “10-year Standard”.

- “10-year Standard”: Modeling must indicate that the peak water surface elevation must not exceed 6-inches above the rim of a storm sewer manhole during a 10-year / 24-hour design storm. The 10-year / 24-hour design storm is described as 3.7 inches of rainfall occurring over a 24-hour duration. As typically used in Wisconsin, a 24-hour storm duration with a Type II distribution (see NRCS TR-55) was used. In the Type II distribution, most of the rainfall occurs in a sharp peak in the middle of the event.

Improvements that were evaluated included increasing the size of existing storm sewers, providing additional storm sewers, or providing stormwater detention/retention. Potential locations of improvements were based on best available geographic information. The analysis included sizing and development of costs for the proposed improvements.

5.2 Problem Area Analysis and Alternatives Development

Alternatives were developed for each area to mitigate the drainage problems. Those alternatives, along with cost estimates, are presented in the following sub-sections. The cost estimates for the alternatives were based on unit costs of the various items. Table 5-1 summarizes the unit costs used. These costs were also used in developing regional pond costs as described in Section 6.
## TABLE 5-1: UNIT PRICES FOR ITEMS USED IN CONSTRUCTION COST ESTIMATES

<table>
<thead>
<tr>
<th>Item</th>
<th>Item Description</th>
<th>Unit</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pond - Excavation/Grading/Disposal&lt;sup&gt;1&lt;/sup&gt;</td>
<td>CY</td>
<td>$6</td>
</tr>
<tr>
<td>2</td>
<td>Pond - Excavation/Grading/Disposal&lt;sup&gt;2&lt;/sup&gt;</td>
<td>CY</td>
<td>$8</td>
</tr>
<tr>
<td>3</td>
<td>Pond - Excavation/Grading/Disposal&lt;sup&gt;3&lt;/sup&gt;</td>
<td></td>
<td>$10</td>
</tr>
<tr>
<td>4</td>
<td>Pond - Clay Liner&lt;sup&gt;4&lt;/sup&gt;</td>
<td>SY</td>
<td>$2</td>
</tr>
<tr>
<td>5</td>
<td>Pond - Clay Liner&lt;sup&gt;5&lt;/sup&gt;</td>
<td>SY</td>
<td>$3</td>
</tr>
<tr>
<td>6</td>
<td>Pond - Landscaping/Restoration</td>
<td>SY</td>
<td>$4</td>
</tr>
<tr>
<td>7</td>
<td>18-inch RCP w/ land restore</td>
<td>LF</td>
<td>$120</td>
</tr>
<tr>
<td>8</td>
<td>18-inch RCP w/ restore</td>
<td>LF</td>
<td>$130</td>
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<tr>
<td>9</td>
<td>27-inch RCP w/ restore</td>
<td>LF</td>
<td>$145</td>
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<tr>
<td>10</td>
<td>30-inch RCP w/ restore</td>
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<td>36-inch RCP w/ restore</td>
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<tr>
<td>12</td>
<td>42-inch RCP w/ pave restore</td>
<td>LF</td>
<td>$170</td>
</tr>
<tr>
<td>13</td>
<td>48-inch RCP w/ restore</td>
<td>LF</td>
<td>$180</td>
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<tr>
<td>14</td>
<td>Erosion Control</td>
<td>LS</td>
<td>$2,000</td>
</tr>
<tr>
<td>15</td>
<td>Flow Constriction Structure (In Ex. Pipe)</td>
<td>LS</td>
<td>$2,500</td>
</tr>
<tr>
<td>16</td>
<td>Outlet Structure - New Pond&lt;sup&gt;6&lt;/sup&gt;</td>
<td>LS</td>
<td>$2,500 to $10,000</td>
</tr>
<tr>
<td>17</td>
<td>Outlet Structure - Ex. Pond</td>
<td>LS</td>
<td>$5,000</td>
</tr>
<tr>
<td>18</td>
<td>Pond - Erosion Control</td>
<td>LS</td>
<td>$8,000</td>
</tr>
<tr>
<td>19</td>
<td>Related Utility Adjustments&lt;sup&gt;7&lt;/sup&gt;</td>
<td>LS</td>
<td>$10,000 to $50,000</td>
</tr>
<tr>
<td>20</td>
<td>Estimated Land Cost</td>
<td>$/acre</td>
<td>$20,000</td>
</tr>
</tbody>
</table>

<sup>1</sup> Excavation/Grading/Disposal over 25,000 c.y.
<sup>2</sup> Excavation/Grading/Disposal over 2,500 c.y., under 25,000 c.y.
<sup>3</sup> Excavation/Grading/Disposal under 2,500 c.y.
<sup>4</sup> Clay Liner over 15,000 s.y.
<sup>5</sup> Clay Liner under 15,000 s.y.
<sup>6</sup> Varies depending on size and complexity of pond outlet structure.
<sup>7</sup> Varies depending on length of proposed sewer in existing road R/W.
ALTERNATIVE 3

Alternative 3 - Proposed 320' of 36" Storm Relief Sewer

Alternative 3 - Proposed 0.5 acre Storm/Conveyance Area

Figure 5-1

Drainage Problem (model)

Pipe Size < 24"
Pipe Size >= 24"
Alternative 1 - Relief Sewer
Alternative 2 - Relief Sewer
Alternative 3 - Relief Sewer
Proposed Pond

ALTERNATIVES 1 AND 2

Alternative 1 - Proposed 320' of 36" Relief Storm Sewer

Alternative 2 - Proposed 930' of 30" Relief Storm Sewer

Alternatives 1 and 2 - Proposed 0.5 acre Pond

Drainage Problem

City of Manitowoc, Wisconsin
83554 January 2006

Stormwater Management Plan Update

EarthTech

Figure 5-1

Drainage Problem

Area A
The following sub-sections describe the analysis and results for each problem area.

5.2.1 Drainage Problem A – Basin LR07 (Ash Avenue / Elder Drive)

There is anecdotal evidence of drainage problems at the intersection of Ash Avenue and Elder Drive. Based on a review of the topography, a low-point exists at this intersection which can create stormwater ponding. In addition, the drainage problem could be further aggravated by four other conditions. First is the potential that the 18-inch storm sewer in Ash Avenue has inadequate sewer capacity to drain the low point. Second is the commercial property 350 feet to the east. Although the commercial area drains to another storm sewer system in Johnston Drive, there is potential that, because of the significant impervious area, the storm sewer in the commercial area, and the storm sewer in Johnston Drive could both become overwhelmed during large rain events. If this were to happen, runoff would by-pass the storm sewer, would over top Johnston Drive and flow down Ash Avenue to the low point. Modeling indicates that this happens during the 10-year storm. Third, the low point is only five to six feet above the normal lake level / estuary level providing only minimal hydraulic grade to drain the low point. Lastly, this area has historically been located within the regional floodplain of the Little Manitowoc River. Based on review of the FEMA floodplain maps, the regional flood elevation of the Little Manitowoc River adjacent to this location is approximately 587.5 feet. The elevation of the low point in the road is over two feet lower at 585.3 feet.

During the 10-year design storm, the modeling indicated that the Ash Avenue / Elder Drive intersection would be completely inundated to a depth of around 1.6 feet. Several alternatives were considered, but only three met the 10-Year Standard (Figure 5-1).

Alternative 1 provides two main features. The first is a 0.5-acre detention pond at the commercial property located just northeast of the Ash Avenue/Johnston Drive intersection (upstream of the problem area). This would prevent runoff from flowing overland from Johnston Drive, west down Ash Avenue to the low point. The second feature would be the construction of 320 feet of 36-inch storm sewer from the low point south to Reed Avenue. Property would have to be purchased for the pond, and drainage easements would need to be obtained for the storm sewer. This alternative would lower the peak water depth during the 10-year design storm to around 0.3 feet above the rim of the manhole.

Alternative 2 also includes the previously mentioned 0.5-acre detention pond, and also 930 feet of 30-inch diameter relief sewer from the low point directly west to the Little Manitowoc River. Because there is potential that the stage of the Little Manitowoc River could influence the conveyance in the 30-inch relief sewer, a tail water elevation of 582 was assumed. If this alternative is considered in the future, further analysis of the impacts of tail water, and the floodplain of the Little Manitowoc River should be considered. This alternative would lower the peak water depth during the 10-year storm to 0.2 feet above the rim of the manhole.

Alternative 3 would include construction of 320 feet of 36-inch storm sewer from the low point, west to approximately 50 feet west of the Daisy Drive / Ash Avenue intersection. Then a 0.5 acre storage/conveyance area would be constructed from this location to the west and north to an existing wetlands complex adjacent to the river. The storm sewer would provide added conveyance capacity, and the storage/conveyance area would allow water to be day lighted, and be conveyed to the wetlands. This alternative would lower the peak water depth during the 10-year storm to 0.3 feet above the rim of the manhole.

Table 5-2 summarizes the peak water surface elevations (WSEs) during the 10-year event.
TABLE 5-2
PEAK WATER SURFACE ELEVATIONS
DRAINAGE PROBLEM AREA A

<table>
<thead>
<tr>
<th>Scenario</th>
<th>WSE at Ash Avenue / Elder Drive Intersection (Rim Elevation – 585.3)</th>
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</thead>
<tbody>
<tr>
<td>Existing</td>
<td>586.9</td>
</tr>
<tr>
<td>Alternative 1</td>
<td>585.6</td>
</tr>
<tr>
<td>Alternative 2</td>
<td>585.5</td>
</tr>
<tr>
<td>Alternative 3</td>
<td>585.6</td>
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</tbody>
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Tables 5-3A, 5-3B, and 5-3C summarize the design/construction cost estimates for the alternatives described above.

**TABLE 5-3A**
DESIGN/CONSTRUCTION COST ESTIMATE
DRAINAGE PROBLEM AREA A
ALTERNATIVE 1

<table>
<thead>
<tr>
<th>Item</th>
<th>Item Description</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>36-inch RCP w/ pave restore</td>
<td>LF</td>
<td>320</td>
<td>$160</td>
<td>$51,200</td>
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<tr>
<td>2</td>
<td>Related Utility Adjustments</td>
<td>LS</td>
<td>1</td>
<td>$10,000</td>
<td>$10,000</td>
</tr>
<tr>
<td>3</td>
<td>Excavation/Grading/Disposal</td>
<td>CY</td>
<td>8,000</td>
<td>$8</td>
<td>$64,000</td>
</tr>
<tr>
<td>4</td>
<td>Clay Liner</td>
<td>SY</td>
<td>2,400</td>
<td>$3</td>
<td>$7,200</td>
</tr>
<tr>
<td>5</td>
<td>Outlet Structure</td>
<td>LS</td>
<td>1</td>
<td>$5,000</td>
<td>$5,000</td>
</tr>
<tr>
<td>6</td>
<td>Erosion Control</td>
<td>LS</td>
<td>1</td>
<td>$5,000</td>
<td>$5,000</td>
</tr>
<tr>
<td>7</td>
<td>Landscaping/Restoration</td>
<td>SY</td>
<td>3,000</td>
<td>$4</td>
<td>$12,000</td>
</tr>
<tr>
<td>8</td>
<td>30-inch RCP w/ restore</td>
<td>LF</td>
<td>50</td>
<td>$150</td>
<td>$7,500</td>
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<tr>
<td></td>
<td>Total Construction Cost</td>
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<td></td>
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<tr>
<td></td>
<td>Land Acquisition</td>
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<tr>
<td></td>
<td>Total Cost</td>
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<td>$242,600</td>
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## TABLE 5-3B
### DESIGN/CONSTRUCTION COST ESTIMATE
#### DRAINAGE PROBLEM AREA A
##### ALTERNATIVE 2

<table>
<thead>
<tr>
<th>Item</th>
<th>Item Description</th>
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<th>Quantity</th>
<th>Unit Cost</th>
<th>Total</th>
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<td>$10,000</td>
</tr>
<tr>
<td>3</td>
<td>Excavation/Grading/Disposal</td>
<td>CY</td>
<td>8,000</td>
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<td>$64,000</td>
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<tr>
<td>4</td>
<td>Clay Liner</td>
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<td>$7,200</td>
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<td>Outlet Structure</td>
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<td>$5,000</td>
<td>$5,000</td>
</tr>
<tr>
<td>6</td>
<td>Erosion Control</td>
<td>LS</td>
<td>1</td>
<td>$5,000</td>
<td>$5,000</td>
</tr>
<tr>
<td>7</td>
<td>Landscaping/Restoration</td>
<td>SY</td>
<td>3,000</td>
<td>$4</td>
<td>$12,000</td>
</tr>
<tr>
<td>8</td>
<td>30-inch RCP w/ restore</td>
<td>LF</td>
<td>50</td>
<td>$150</td>
<td>$7,500</td>
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<p>| | | | | |</p>
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<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Total Construction Cost</td>
<td></td>
<td>$231,600</td>
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<tr>
<td>Land Acquisition</td>
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<td>Engineering</td>
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<td>20% Contingency</td>
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<td><strong>Total Cost</strong></td>
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<td><strong>$331,800</strong></td>
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</table>
Manitowoc Storm Sewers

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N. 11TH ST.

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### TABLE 5-3C
**DESIGN/CONSTRUCTION COST ESTIMATE**
**DRAINAGE PROBLEM AREA A**
**ALTERNATIVE 3**

<table>
<thead>
<tr>
<th>Item</th>
<th>Item Description</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>36-inch RCP w/ pave restore</td>
<td>LF</td>
<td>330</td>
<td>$160</td>
<td>$52,800</td>
</tr>
<tr>
<td>2</td>
<td>Related Utility Adjustments</td>
<td>LS</td>
<td>1</td>
<td>$10,000</td>
<td>$10,000</td>
</tr>
<tr>
<td>3</td>
<td>Excavation/Grading/Disposal</td>
<td>CY</td>
<td>4,500</td>
<td>$8</td>
<td>$36,000</td>
</tr>
<tr>
<td>4</td>
<td>Clay Liner</td>
<td>SY</td>
<td>1,300</td>
<td>$3</td>
<td>$3,900</td>
</tr>
<tr>
<td>5</td>
<td>Outlet Structure</td>
<td>LS</td>
<td>1</td>
<td>$2,500</td>
<td>$2,500</td>
</tr>
<tr>
<td>6</td>
<td>Erosion Control</td>
<td>LS</td>
<td>1</td>
<td>$5,000</td>
<td>$5,000</td>
</tr>
<tr>
<td>7</td>
<td>Landscaping/Restoration</td>
<td>SY</td>
<td>2,500</td>
<td>$4</td>
<td>$10,000</td>
</tr>
</tbody>
</table>

- **Total Construction Cost:** $120,200
- **Land Acquisition:** $6,000
- **Engineering:** $12,000
- **20% Contingency:** $27,600

**Total Cost:** $165,800

---

5.2.2 **Drainage Problem B – Basin LR03 (Waldo Blvd. – Between 11th and 12th Street)**

There is anecdotal evidence of drainage problems along Waldo Boulevard between 11th and 12th Street (Figure 5-2). Based on a review of the topography, a low-point exists at the intersection of Waldo Boulevard and 11th Street, which can create stormwater ponding. Modeling reflected ponding on Waldo Boulevard between 11th and 12th Street to a depth of approximately 0.6 feet during a 10-year event. There is also a low point on 12th Street approximately 200 feet north of Waldo Boulevard. Modeling indicated that the stormwater ponding at this low point may reach a depth of approximately 1.6 feet during a 10-year design storm event. A significant cause of this ponding is the stormwater flow in the storm sewer in Waldo Boulevard back-flowing up the storm sewer in 12th Street.

There is existing open space / depression that is part of the public school property at the northeast corner of the intersection of Waldo Boulevard / 11th Street. The main storm sewer line currently traverses this area, and is likely able to store excess stormwater. Two alternatives are proposed which both make use of this area. The alternatives consist of providing relief storm sewers from the two problem areas to the open space / depression area.
Alternative 1 provides 780 feet of 27-inch storm sewer from the low point in 12th Street (manhole LR3-125) east to manhole LR3-15 in the open space / depression. This requires that the sewer be installed between homes and in rear yards of several residences (Figure 5-2). This sewer would provide additional conveyance capacity from the low point on 12th Street. Alternative 1 also includes providing an additional 250 feet of 36-inch storm sewer from manhole LR3-347 in Waldo Boulevard to manhole LR3-15 in the open space / depression. This storm sewer would provide additional conveyance capacity from problem areas on Waldo Boulevard. With this alternative, the peak depths between 11th and 12th Street and at the low point on 12th Street were estimated to be 0.3 feet and 0.4 feet respectively.

Alternative 2 provides 620 feet of 30-inch storm sewer from the low point in 12th Street (manhole LR3-125) to Waldo Boulevard, and then east in Waldo to manhole LR3-347. Two-hundred fifty (250) feet of 36-inch storm sewer would then be constructed east/northeast from manhole LR3-347 in Waldo Boulevard to manhole LR3-15 in the open space/depression to manhole LR3-15 in the open space / depression. This system of relief sewers provided additional conveyance capacity from both of the problem areas to the open space / depression (Figure 5-2). With this alternative, the peak depths between 11th and 12th Street and at the low point on 12th Street were estimated to be 0.4 feet and 0.3 feet respectively.

Additionally, a flap-gate / back-flow preventer could be installed in the storm sewer in 12th Street to reduce back-flow from Waldo Boulevard to the low-point in 12th Street. Clogging and conveyance capacity reduction issues should be considered when using these. This was not integrated into either of the alternatives.

Tables 5-4A and 5-4B summarize the design/construction cost estimates for the alternatives described above.
### TABLE 5-4A
**DESIGN/CONSTRUCTION COST ESTIMATE**
**DRAINAGE PROBLEM AREA B**
**ALTERNATIVE 1**

<table>
<thead>
<tr>
<th>Item</th>
<th>Item Description</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<td>1</td>
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<td>36-inch RCP w/ restore</td>
<td>LF</td>
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<tr>
<td>3</td>
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<td>1</td>
<td>$10,000</td>
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**Total Construction Cost** $163,100

Additional Costs:
- Land Acquisition $4,000
- Engineering $20,400
- 20% Contingency $37,500

**Total Cost** $225,000
Manitowoc Storm Sewers
N. 5TH ST.
W AL D O B L V D.
RIVER CT.

Proposed 643' of 48” Relief Storm Sewer

Manhole LR3-4

Drainage Problem

Pipe Size < 24”
Pipe Size >= 24”
Alternative 1 - Relief Sewer

Figure 5-3
Drainage Problem
Area C
Stormwater Management Plan Update
City of Manitowoc, Wisconsin

© EarthTech
83554
January 2006
TABLE 5-4B
DESIGN/CONSTRUCTION COST ESTIMATE
DRAINAGE PROBLEM AREA B
ALTERNATIVE 2

<table>
<thead>
<tr>
<th>Item</th>
<th>Item Description</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30-inch RCP w/ restore</td>
<td>LF</td>
<td>620</td>
<td>$150</td>
<td>$93,000</td>
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<tr>
<td>2</td>
<td>36-inch RCP w/ restore</td>
<td>LF</td>
<td>250</td>
<td>$160</td>
<td>$40,000</td>
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<td>LS</td>
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Total Construction Cost $143,000

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<tr>
<td>Land Acquisition</td>
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<td>Engineering</td>
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<tr>
<td>20% Contingency</td>
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</table>

Total Cost $193,100

5.2.3 Drainage Problem C – Basin LR03 (Waldo Blvd. – Between 6th Street and Little Manitowoc River)

There is anecdotal evidence of drainage problems along Waldo Boulevard between 6th Street and the Little Manitowoc River. Based on a review of the topography, there is positive overland conveyance along this entire stretch of Waldo Boulevard, but modeling did confirm this anecdotal problem estimating between 0.5 to 1.0 feet of water accumulating along this section of Waldo Boulevard. The reason that this problem occurs is likely because the roadway is significantly lower than adjacent lands, it is the furthest downstream section of this relatively large drainage basin, and high tailwater conditions in the Little Manitowoc River may elevate the hydraulic grade line in the storm sewer.

To reduce ponding on the roadway, a relief storm sewer is proposed from manhole LR3-4 to a discharge point in the Little Manitowoc River. This relief sewer would provide additional conveyance capacity from the problem area to the river. The alternative would include 643 feet of 48-inch diameter relief sewer with pavement restoration (Figure 5-3). By providing this additional conveyance capacity, the 10-year standard is met by lowering the peak ponding depth to a depth of 0.4 feet or less.

Table 5-5 summarizes the design/construction cost estimates for the alternative described above.
### TABLE 5-5
**DESIGN/CONSTRUCTION COST ESTIMATE**
**DRAINAGE PROBLEM AREA C**
**ALTERNATIVE 1**

<table>
<thead>
<tr>
<th>Item</th>
<th>Item Description</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<td>1</td>
<td>48-inch RCP w/ restore</td>
<td>LF</td>
<td>643</td>
<td>$180</td>
<td>$115,700</td>
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<td>Related Utility Adjustments</td>
<td>LS</td>
<td>1</td>
<td>$10,000</td>
<td>$10,000</td>
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</tbody>
</table>

**Total Construction Cost** $125,700

| Land Acquisition | $0   |
| Engineering      | $15,700 |
| 20% Contingency  | $28,300 |

**Total Cost** $169,700

---

5.2.4 **Drainage Problem D – Basin LR01 (Shorewood Blvd/Fenway Terrace)**

There is anecdotal evidence of drainage problems at the intersection of Shorewood Boulevard and Fenway Terrace. Modeling confirmed this problem estimating approximately 0.7 feet of water ponding at the intersection during a 10-year design storm event. This ponding is likely caused by topographic conditions at the intersection (very flat roadway grades) and inadequate sewer conveyance capacity downstream.

To reduce ponding on the roadway, two types of alternatives are considered. The first provides a relief sewer from the intersection of Shorewood Boulevard/Fenway Terrace (location where the 10-Year Standard is exceeded) to the intersection of Lawton Terrace/Fenway Terrace where there is additional storm sewer conveyance capacity.

Alternative 1 would include three-hundred thirty (330) feet of 30-inch diameter relief sewer. By providing this additional conveyance capacity, the 10-Year Standard is met by lowering the peak ponding depth to 0.4 feet (Figure 5-4). Alternative 2 involves utilizing an existing depression near the drainage problem. The depression is located approximately 200 feet northeast of the intersection of Shorewood Boulevard and Fenway Terrace. There is currently a 12-inch storm sewer the drains the depression. This pipe connects into the main storm sewer system in the walkway between the Pine Street / 5th Street intersection and the Shorewood Boulevard/Fenway Terrace intersection.
By installing a flow restrictor in the 27-inch storm sewer (under the walkway), and installing an additional 18-inch storm sewer pipe just upstream of the restrictor to the depression, additional stormwater is allowed to be detained in the depression. Alternative 2 would include:

- Utilizing existing 0.5 acre depression
- 83 feet of 18-inch diameter relief sewer with landscape restoration
- Installing a 15-inch diameter flow restrictor in the existing 27-inch diameter storm sewer

By providing these measures, the 10-year standard is met by lowering the peak ponding depth to -1.1 feet (i.e. 1.1 feet below the rim elevation).

Table 5-6 summarizes the peak water surface elevations (WSEs) during the 10-year event.

### TABLE 5-6

<table>
<thead>
<tr>
<th>Scenario</th>
<th>WSE at Shorewood/Fenway intersection (Rim 590.0)</th>
<th>WSE in Existing Depression (586.5 bottom)</th>
<th>WSE at Lawton/Fenway Intersection (Rim 589.6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing</td>
<td>590.7</td>
<td>588.3</td>
<td>588.8</td>
</tr>
<tr>
<td>Relief Sewer</td>
<td>590.4</td>
<td>588.3</td>
<td>589.5</td>
</tr>
<tr>
<td>Enhance Ex. Depression</td>
<td>588.9</td>
<td>589.3</td>
<td>587.7</td>
</tr>
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</table>

Tables 5-7A, and 5-7B summarize the design/construction cost estimates for the alternatives described above.
### TABLE 5-7A
**DESIGN/CONSTRUCTION COST ESTIMATE**
**DRAINAGE PROBLEM AREA D**
**ALTERNATIVE 1**

<table>
<thead>
<tr>
<th>Item</th>
<th>Item Description</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30-inch RCP w/ pave restore</td>
<td>LF</td>
<td>330</td>
<td>$150</td>
<td>$49,500</td>
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<td>3</td>
<td>Related Utility Adjustments</td>
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**Total Construction Cost** $59,500

<table>
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<tr>
<td>Engineering</td>
<td>$8,900</td>
</tr>
<tr>
<td>20% Contingency</td>
<td>$13,700</td>
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</tbody>
</table>

**Total Cost** $82,100
TABLE 5-7B
DESIGN/CONSTRUCTION COST ESTIMATE
DRAINAGE PROBLEM AREA D
ALTERNATIVE 2

<table>
<thead>
<tr>
<th>Item</th>
<th>Item Description</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Excavation/Grading/Disposal</td>
<td>CY</td>
<td>100</td>
<td>$10</td>
<td>$1,000</td>
</tr>
<tr>
<td>2</td>
<td>Constriction Structure</td>
<td>LS</td>
<td>1</td>
<td>$2,500</td>
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<tr>
<td>3</td>
<td>Erosion Control</td>
<td>LS</td>
<td>1</td>
<td>$2,000</td>
<td>$2,000</td>
</tr>
<tr>
<td>4</td>
<td>Landscaping/Restoration</td>
<td>SY</td>
<td>200</td>
<td>$4</td>
<td>$800</td>
</tr>
<tr>
<td>5</td>
<td>18-inch RCP w/ land restore</td>
<td>LF</td>
<td>85</td>
<td>$120</td>
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</table>

Total Construction Cost $16,500

Land Acquisition $10,000
Engineering $4,100
20% Contingency $6,100

Total Cost $36,700
Alternative 1 - Proposed 2.8 acre Pond

Alternative 1 - 2.8 acre Pond

Alternative 1 - 725' of 42" Storm Sewer

Alternative 1 & 2 - 370' of 18" Storm Sewer

Alternative 2 - 3,300' of 27" Storm Sewer
5.2.5 Drainage Problem E– Basin R22 (36th Street / Custer Street)

There is anecdotal evidence of drainage problems between 35th and 37th Streets along Custer Street, and the 3800 block of Marshall Street. Modeling also indicated drainage problems at these locations. Stormwater from this area primarily is collected in the storm sewer in Custer Street and flows east ultimately to the Manitowoc River. There is however a flow spilt in the storm sewer manhole located at the intersection of Macarthur Drive and Custer Street. Part of the flow drains north in Macarthur (ultimately to the Manitowoc River) and the difference remains in the Custer Street storm sewer.

Based on the modeling, it appeared that one of the major causes of drainage problems in this area is the lack of positive flow paths overland and in storm sewers to create adequate conveyance for the stormwater runoff. Two types of alternatives were considered (Figure 5-5).

Alternative 1 is a combination of added storm sewer along with providing stormwater detention in available open land. The most feasible location for a detention pond is a section of open land on the south side of the 3200 block of Custer Street. Modeling indicated that providing a detention pond (covering approximately 2.8 acres) along with additional storm sewer to convey runoff to the pond, would improve drainage conditions that would meet the 10-Year Standard. A summary of the features is as follows:

- 2.8 acre Pond (bottom pond area – 65,000 sf, pond area @ 5 feet – 109,000 sf)
- 725 feet of 42-inch storm sewer from the 35th Street / Custer Street intersection to the pond
- 200 feet of 30-inch storm sewer from the Custer Street storm sewer to the pond
- 370 feet of 18-inch storm sewer from the 3800 block of Marshall Street to the 3800 block of Custer Street

Alternative 2 consists solely of the construction of relief sewers to convey the stormwater. Because the existing sewers have relatively flat slopes, it would be recommended that relief sewers be constructed to the river. If the relief sewer would be constructed only a portion of the way, and then connected into existing sewers, there is potential that it would create new drainage problems downstream. The shortest route for a relief sewer would be to follow the existing sewer in Macarthur Drive north to the river. This would require approximately 4,400 feet of 27-inch storm sewer and 370 feet of 24-inch storm sewer.

Tables 5-8A, and 5-8B summarize the design/construction cost estimates for the alternatives described above.
### TABLE 5-8A
DESIGN/CONSTRUCTION COST ESTIMATE
DRAINAGE PROBLEM AREA E
ALTERNATIVE 1

<table>
<thead>
<tr>
<th>Item</th>
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<th>Total</th>
</tr>
</thead>
<tbody>
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<td>1</td>
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<td>CY</td>
<td>25,000</td>
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<td>Clay Liner</td>
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<td>3</td>
<td>Outlet Structure</td>
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<td>$4</td>
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<td>$130</td>
<td>$48,100</td>
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<tr>
<td>7</td>
<td>30-inch RCP w/ pave restore</td>
<td>LF</td>
<td>200</td>
<td>$150</td>
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<td>8</td>
<td>42-inch RCP w/ pave restore</td>
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<td>Engineering</td>
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<td>20% Contingency</td>
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<td>$705,100</td>
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Figure 5-6
Drainage Problem
Area F
Stormwater Management Plan Update
City of Manitowoc, Wisconsin

83554 January 2006
TABLE 5-7B
DESIGN/CONSTRUCTION COST ESTIMATE
DRAINAGE PROBLEM AREA E
ALTERNATIVE 2

<table>
<thead>
<tr>
<th>Item</th>
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<th>Total</th>
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<td>$130</td>
<td>$48,100</td>
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<td></td>
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<td>$837,700</td>
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</table>

5.2.6 Drainage Problem F – Basin L14 (30th Street / Division Street)

There is anecdotal evidence of drainage problems along 30th Street, adjacent to Court Street. Modeling indicated problems at this location and additionally at the intersections of 31st and Court, and 30th and Division. Modeling also indicated potential problems downstream directly east of the intersection of 30th and Court, where the storm sewer crosses under the railroad track. Therefore, alternatives consisting of adding conveyance were not considered because of potentially creating, or worsening problems downstream.

Based on the modeling, it appeared that stormwater back flows up 30th Street from Division Street to Court Street in pipes L3133 and L3132 aggravating the drainage problem at the 30th Street / Court Street intersection. To reduce ponding on roadways, a detention pond is proposed on open land northeast of the 30th Street / Division Street intersection. Modeling indicated that providing a 0.5 acre detention pond (bottom pond area – 9,000 sf, pond area @ 8 feet – 25,000 sf), would improve drainage in order to meet the 10-Year Standard (Figure 5-6).

Additional conveyance may be needed directly from 30th Street to the proposed pond to convey street flow from Division Street flowing north on 30th Street. This could be accomplished with a curb-cut in 30th Street to the pond, or additional storm sewers to the pond.

Modeling also indicated potential drainage problems along Division Street between 35th and 31st Streets, but no anecdotal evidence of problems at this location is known.
ALTERNATIVE 3

- Proposed 1,580' of 24" of Relief Storm Sewer
- Proposed Inlet/Outlet Pipe
- Proposed 1.3 acre Pond

ALTERNATIVES 1 AND 2

- Proposed 1,580' of 54" of Relief Storm Sewer
- Proposed Inlet/Outlet Pipe
- Proposed 2.2 acre Pond

Drainage Problem
Pipe Size < 24"
Pipe Size >= 24"
Existing Pond
Alternative 1 - Relief Sewer
Alternative 3 - Relief Sewer

Figure 5-7
Drainage Problem
Area G
Stormwater Management Plan Update
City of Manitowoc, Wisconsin
83554 January 2006
Table 5-9 summarizes the design/construction cost estimates for the alternative described above.

**TABLE 5-9**  
**DESIGN/CONSTRUCTION COST ESTIMATE**  
**DRAINAGE PROBLEM AREA F**  
**ALTERNATIVE 1**

<table>
<thead>
<tr>
<th>Item</th>
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<th>Total</th>
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<td>1</td>
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<td>$32,000</td>
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<td>Clay Liner</td>
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<td>3</td>
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<td>$5,000</td>
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<tr>
<td>4</td>
<td>Erosion Control</td>
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<tr>
<td>5</td>
<td>Landscaping/Restoration</td>
<td>SY</td>
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<td>$8,000</td>
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<td><strong>Total Cost</strong></td>
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5.2.7 Drainage Problem G – Basin L14 (Dewey St. and the railroad overpass)

There is anecdotal evidence of drainage problems at the low point in Dewey Street at the location of the railroad overpass (approximately the 2700 block of Dewey Street). The drainage problem is likely caused by the low point in the roadway due to the railroad overpass along with low gradient of the Dewey Street storm sewer draining this area. The upstream drainage area (approximately 700 acres) is experiencing significant and rapid development. Although there are some stormwater detention facilities upstream, modeling indicated that they are not adequate to prevent ponding at the low point in the roadway. Modeling indicated that even if the outflow from the existing detention pond, located just west of the 35th/Dewey Street intersection, was reduced to zero flow, there still would be significant ponding at the roadway’s low point.

Several alternatives were considered and analyzed, but only three are considered (Figure 5-7). Alternative 1 is the construction of relief sewers to convey the stormwater away from the low point and enhancing the existing detention capacity of the pond located just west of the 35th/Dewey Street by installing a staged outlet structure. Based on review of the existing storm sewer system, a relief sewer would need to be constructed from the low point at the railroad crossing to the intersection of Dewey Street and 23rd Street. From this point, the existing system in Dewey Street downstream of 23rd Street has additional capacity from
additional pipes and additional slope in pipes. Installing an additional 54-inch relief storm sewer reduced the depth at the low point from 4.3 feet to 1.4 feet, but this still exceeds the 10-year standard. Although modeling did not indicate any downstream problems with this alternative, downstream flows and water surface elevations do increase. Therefore, care should be taken in selecting this alternative, because of the potential that this could create drainage problems downstream.

Alternative 2 is a combination of stormwater detention in available open land, and enhanced flow restrictions in the existing detention system. The most feasible location for a detention pond is the southwest corner of Dewey Street and 30th Street, but other open parcels may be considered, including the parcel north of the Manitowoc Public Utility Land (northwest of the road low point). Modeling indicated that providing a detention pond (approximately 2.2 acres in size excavated to a depth of approximately 20 feet), along with a 15-inch diameter flow restriction in existing pipe #2035 (currently a 42-inch diameter pipe), and installing a staged outlet structure in the existing detention pond located just west of the 35th/Dewey Street intersection would improve drainage to the 10-Year Standard. A summary of the features is as follows:

- 2.2 acre Pond (bottom pond area – 22,000 sf, pond area @ 20 feet – 96,000 sf)
- 15-inch diameter flow restriction in existing pipe #2035
- Staged outlet structure in the existing detention pond located just west of the 35th/Dewey Street intersection

Alternative 3 is a combination of the first two alternatives. Because the proposed pond in alternative two would require significant earthwork, alternative three includes a stormwater pond at this location, but would be reduced in size, and a relief storm sewer constructed from the low point at the railroad crossing to the intersection of Dewey Street and 23rd Street. It would also include an 18-inch diameter flow restriction in existing pipe #2035 (currently a 42-inch diameter pipe), and installing a staged outlet structure in the existing detention pond located just west of the 35th/Dewey Street intersection. The proposed detention pond would require excavation depths of approximately 20 feet. A summary of the features is as follows:

- 1.3 acre Pond (bottom pond area – 6,500 sf, pond area @ 20 feet – 58,000 sf)
- 18-inch diameter flow restriction in existing pipe #2036
- Staged outlet structure in the existing detention pond located just west of the 35th/Dewey Street intersection
- 1,580 feet of 24-inch diameter storm sewer from low point to 23rd Street
Table 5-10 summarizes the peak water surface elevations (WSEs) during the 10-year event.

### TABLE 5-10
**PEAK WATER SURFACE ELEVATIONS**
**DRAINAGE PROBLEM AREA G**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>WSE at Roadway Low Point (Rim Elevation 635.2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing</td>
<td>639.5</td>
</tr>
<tr>
<td>Zero flow from Ex. Pond</td>
<td>639.5</td>
</tr>
<tr>
<td>Alternative 1</td>
<td>636.6</td>
</tr>
<tr>
<td>Alternative 2</td>
<td>635.7</td>
</tr>
<tr>
<td>Alternative 3</td>
<td>635.5</td>
</tr>
</tbody>
</table>

Tables 5-11A, 5-11B, and 5-11C summarize the design/construction cost estimates for the alternatives described above.

### TABLE 5-11A
**DESIGN/CONSTRUCTION COST ESTIMATE**
**DRAINAGE PROBLEM AREA G**
**ALTERNATIVE 1**

<table>
<thead>
<tr>
<th>Item</th>
<th>Item Description</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>54-inch RCP w/ pave restore</td>
<td>LF</td>
<td>1,580</td>
<td>$190</td>
<td>$300,200</td>
</tr>
<tr>
<td>3</td>
<td>Related Utility Adjustments</td>
<td>LS</td>
<td>1</td>
<td>$25,000</td>
<td>$25,000</td>
</tr>
</tbody>
</table>

**Total Construction Cost** $325,200

| Land Acquisition | $0 |
| Engineering      | $32,500 |
| 20% Contingency  | $71,500 |
| **Total Cost**   | **$429,200** |
### TABLE 5-11B
DESIGN/CONSTRUCTION COST ESTIMATE
DRAINAGE PROBLEM AREA G
ALTERNATIVE 2

<table>
<thead>
<tr>
<th>Item</th>
<th>Item Description</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Excavation/Grading/Disposal</td>
<td>CY</td>
<td>42,750</td>
<td>$8</td>
<td>$342,000</td>
</tr>
<tr>
<td>2</td>
<td>Clay Liner</td>
<td>SY</td>
<td>2,900</td>
<td>$3</td>
<td>$8,700</td>
</tr>
<tr>
<td>3</td>
<td>Constriction Structure</td>
<td>LS</td>
<td>1</td>
<td>$2,500</td>
<td>$2,500</td>
</tr>
<tr>
<td>4</td>
<td>Erosion Control</td>
<td>LS</td>
<td>1</td>
<td>$8,000</td>
<td>$8,000</td>
</tr>
<tr>
<td>5</td>
<td>Landscaping/Restoration</td>
<td>SY</td>
<td>7,000</td>
<td>$4</td>
<td>$28,000</td>
</tr>
<tr>
<td>6</td>
<td>48-inch RCP w/ restore</td>
<td>LF</td>
<td>150</td>
<td>$180</td>
<td>$27,000</td>
</tr>
<tr>
<td>7</td>
<td>Outlet Structure - Ex. Pond</td>
<td>LS</td>
<td>1</td>
<td>$5,000</td>
<td>$5,000</td>
</tr>
</tbody>
</table>

Total Construction Cost: $421,200

Land Acquisition: $44,000
Engineering: $42,100
20% Contingency: $101,500

Total Cost: $608,800
### TABLE 5-11C
DESIGN/CONSTRUCTION COST ESTIMATE
DRAINAGE PROBLEM AREA G
ALTERNATIVE 3

<table>
<thead>
<tr>
<th>Item</th>
<th>Item Description</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Excavation/Grading/Disposal</td>
<td>CY</td>
<td>23,875</td>
<td>$8</td>
<td>$191,000</td>
</tr>
<tr>
<td>2</td>
<td>Clay Liner</td>
<td>SY</td>
<td>1,500</td>
<td>$3</td>
<td>$4,500</td>
</tr>
<tr>
<td>3</td>
<td>Constriction Structure</td>
<td>LS</td>
<td>1</td>
<td>$2,500</td>
<td>$2,500</td>
</tr>
<tr>
<td>4</td>
<td>Erosion Control</td>
<td>LS</td>
<td>1</td>
<td>$8,000</td>
<td>$8,000</td>
</tr>
<tr>
<td>5</td>
<td>Landscaping/Restoration</td>
<td>SY</td>
<td>7,000</td>
<td>$4</td>
<td>$28,000</td>
</tr>
<tr>
<td>6</td>
<td>48-inch RCP w/ restore</td>
<td>LF</td>
<td>150</td>
<td>$180</td>
<td>$27,000</td>
</tr>
<tr>
<td>7</td>
<td>24-inch RCP w/ pave restore</td>
<td>LF</td>
<td>1,580</td>
<td>$140</td>
<td>$221,200</td>
</tr>
<tr>
<td>8</td>
<td>Related Utility Adjustments</td>
<td>LS</td>
<td>1</td>
<td>$25,000</td>
<td>$25,000</td>
</tr>
<tr>
<td>9</td>
<td>Outlet Structure - Ex. Pond</td>
<td>LS</td>
<td>1</td>
<td>$5,000</td>
<td>$5,000</td>
</tr>
</tbody>
</table>

Total Construction Cost: $512,200

Land Acquisition: $30,000

Engineering: $51,200

20% Contingency: $118,700

Total Cost: $712,100

5.2.8 Drainage Problem H – Basin L14 (Expo Drive / Calumet Avenue)

There is anecdotal evidence of drainage problems along Calumet Avenue near its intersection with Expo Drive. Modeling did not indicate that the 10-Year Standard was exceeded. However, the model did indicate some (less than 6-inches in depth) ponding of stormwater on roadways adjacent to manhole L14-460. Modeling indicated that providing a storm sewer crossing under Calumet Avenue (from manhole L14-460 to L14-558) would improve this drainage problem. Because the problem does not violate the 10-Year Standard, no formal alternative is proposed.

5.2.9 Drainage Problem I – Basin SC (Northeast Corner of Calumet Ave. / Silver St. Intersection)

There is anecdotal evidence of drainage problems along Silver Creek just upstream of the Calumet Avenue crossing. The investigation showed that there is a considerable watershed of over 10,000 acres contributing to this area. The vast majority is outside the planning area of this project. Because there is no
evidence that the problem violates the 10-Year Standard, and the contributing area is outside the study area, no formal alternative is proposed. However, continued stormwater management practices, by following the City’s stormwater ordinance are recommended. In addition, adequate setbacks from floodways and flood fringes are also recommended.