

Bloomington
Airport South District

Storm Water Treatment Feasibility Study

Prepared for

City of Bloomington

Prepared by

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Executive Summary

1.0 Introduction/Study Goals

1.1 *Background*

The Airport South District (ASD), bounded by I-494 to the north, TH-77 (Cedar Avenue) to the west, and the Minnesota River to the east and south, is a portion of the City of Bloomington that is expected to see changes in land use over the next twenty years. It's estimated that approximately 272 acres will likely redevelop during this time, i.e., just under 38 percent of the total developable area within the District.

Runoff from the ASD ultimately discharges into Long Meadow Lake through four outfalls. Two of the outfalls, identified as 80th Street and Ceridian outfalls in this study, drain to the Lake through a variety of floodplain wetland complexes. A third outfall discharges to Hogback Pond. It takes runoff from a small area identified as the Adjoining Lands and a portion of Old Shakopee Road, as well as overflow from the area north of Old Shakopee Road, during large storm events via a flow splitting device. These three outfalls account for roughly 8 percent of the drainage area of the four outfalls to Long Meadow Lake, and 27 percent of the ASD. The last outfall, which discharges to Pond C, accounts for 92 percent of the drainage area of the four outfalls to Long Meadow Lake, including a drainage area west of TH 77.

The ASD comprises 29 percent (718 acres) of the total area from Bloomington discharging to the Lake through these four outfalls. The remaining 71 percent, almost 1,800 acres of mostly residential area west of TH 77 also discharges to the Lake via Pond C. This area is not expected to redevelop within the 20-year study period.

Long Meadow Lake lies within the floodplain of the Minnesota River and within the Minnesota Valley National Wildlife Refuge, managed by the U.S. Fish and Wildlife Service (USFWS). The Long Meadow Lake/marsh area is 1,188 acres in size (Table 3-4, Lower Minnesota River Watershed District (LMRWD) Water Management Plan, September, 1999), and is typically inundated for a period of weeks during normal springtime runoff conditions. Refuge staff have identified issues and concerns regarding potential water quality impacts to the Refuge from ASD storm water discharges, including: lack of 'above the bluff' storm water treatment ponds, low efficiency of treatment in Pond C, and past spills from industrial/commercial properties in ASD that had resulted in pollutant transport to Refuge water bodies via the City storm sewer.

1.2 *Study Goals*

City staff initiated this Feasibility Study to take a comprehensive look at the effectiveness of existing storm water treatment facilities and to assess future treatment demands and opportunities, in order to develop a strategy for maintaining and improving water quality level in discharges from ASD to the Refuge/Long Meadow Lake. This Feasibility Study builds on, but looks beyond the 2007 development conditions

studied during the ASD Alternative Urban Areawide Review (AUAR) process (conducted in 2001-2002), to address anticipated land use changes through year 2020. This Study also looks in greater detail at alternative strategies for addressing storm water quality, including on-site treatment, regional pond treatment and incorporation of other Best Management Practices (BMPs). In addition to this Feasibility Study, a separate review of commercial/industrial spill prevention practices was conducted to address Refuge concerns related to past spills, and recommendations were made for practices that the City and ASD property-owners could implement to prevent spills from being discharged to the City storm sewer system. Bloomington staff will be following up with commercial and industrial property owners within Airport South and the remainder of the City during 2002-2003 to review their facilities and discuss implementation of spill prevention plans and containment measurements.

The City of Bloomington retained SRF Consulting Group, Inc. and Montgomery Watson Harza to study the following in this Feasibility Study:

1. Evaluate the water quality changes within the ASD watersheds given a list of potential land use changes expected prior to the year 2020. Initial modeling assumptions for 2020 conditions include implementation of NURP-level treatment at all new development/redevelopment sites in ASD. This will allow assessment of whether adequate treatment can be provided by adding on-site ponding only, or if additional regional ponding capacity is also needed.
2. Evaluate the feasibility and cost effectiveness of constructing regional water quality treatment facilities to treat runoff at a number of potential sites within the ASD.
3. Evaluate the effectiveness of implementation of phosphorus reduction and street sweeping BMPs in ASD in reducing pollutant loadings to Long Meadow Lake.
4. Evaluate the impacts of the various proposed facilities and BMPs on the overall ASD loading to Long Meadow Lake.
5. Suggest potential combinations of regional water quality improvement measures that provide an effective, responsible approach to addressing water quality concerns and reducing the pollutant loading for the runoff flowing to Long Meadow Lake through the ASD.

The Feasibility Study's main purpose was to identify and evaluate the feasibility of measures that could be implemented to improve the quality of surface water discharges to Long Meadow Lake from ASD. As with the Airport South District AUAR storm water analyses, this Feasibility Study evaluated the impacts and improvements to water quality of the runoff discharging to the Lake via the four outfalls, and did not directly evaluate the improvements to the ecology to the Lake. This allows for comparison of existing and proposed conditions and potential improvements, but does not attempt to evaluate the impacts to the lake from other potential sources of sediment loading (e.g. from spring flooding).

2.0 Modeling Background/Data Sources

2.1 *Modeling Background*

The ASD is defined by I-494 to the north, TH 77 to the west, and the Minnesota River to the south and east. Previously, models have been developed for this area in order to determine the storm water runoff water quality. An Alternative Urban Areawide Review (AUAR) process was initiated for the ASD by the City of Bloomington to identify and document potential cumulative environmental impacts and infrastructure needs related to anticipated development and redevelopment in the ASD through year 2007. The modeling analyses performed for the AUAR provided a comparison of surface water quality for existing (2000) and post-AUAR (2007) development conditions in the ASD drainage areas to allow for assessment of potential cumulative surface water impacts. The water quality assessment conducted for the AUAR was a continuation of water quality studies conducted previously by Montgomery Watson Harza for the ASD.

The effects of the proposed ASD development were assessed using the P-8 Urban Catchment Model (W. Walker, Jr. 1998) previously developed for the study area in 1998. The model was updated to reflect current and proposed 2007 development conditions. These studies also incorporated modeling from the area west of TH 77 (Cedar Avenue) that drains to Pond C, including the drainage areas for Smith Pond and Wrights Pond. The Feasibility analyses build on the previous AUAR modeling to reflect 2020 development conditions.

2.2 *Background Data*

The following list includes the various sources utilized to provide the information required for the study.

- City of Bloomington storm sewer mapping
- 2-foot GIS contour mapping
- Mall of America Expansion – Met Center Site EIS (2000)
- Bloomington Airport South District Draft AUAR (2001)
- Field walks of each site
- Comprehensive Land Use information
- Discussions with City staff regarding potential land use changes
- Meeting with USFWS and stakeholders

2.3 *Other Resources*

The P-8 Urban Catchment Model vr. 2.2 (1998) was developed in the later 1980's by William Walker, Jr., utilizing information developed during the National Urban Runoff Program (NURP) studies in the later 1970's and early 1980's. P8 is a model to predict the generation and transport of storm water runoff pollutants in an urban watershed. This model is widely used for determining relative impacts of land use changes and best management practices on urban storm water quality.

The model incorporates modeling for the ASD as well as modeling developed for the area west of TH 77 which discharges to Long Meadow Lake through Pond C. Modeling for the area west of highway 77 was provided by City staff and was not changed or manipulated as a part of this study. It was, however, important to include this area in the modeling because it drains to Pond C, which is a device evaluated as a part of this study.

3.0 Existing Conditions

Storm water runoff from the study area currently enters Long Meadow Lake through one of four outfalls, as shown on Figure 3.1 and described in Section 1.1.

Storm water treatment currently takes place within four ponding areas, identified on Figure 3.1. These include two ponding areas below the bluff, Pond C and Hogback Pond, which operate as regional facilities. Pond C (located within Mn/DOT right-of-way and operated by the City) receives runoff from a large drainage area west of TH 77 in addition to runoff from the majority of ASD. Hogback Pond, located within the Minnesota Valley Refuge, receives water from the storm sewer that serves the Adjoining Lands parcel and overflow from the portion of the ASD north of Old Shakopee Road.

Two additional ponds are located within the developed areas of ASD: Pond 85 and Pond 30. Pond 85 serves a small parking area (presently developed as a park-and-ride near I-494, and Pond 30 serves the existing parking area on the Adjoining Lands parcel located east of the Mall of America.

The individual drainage areas that flow to Long Meadow Lake through the four outfalls are shown in Figure 3.2. Land uses and corresponding acreages within the areas for each outfall are shown in Table 3.1. The ASD comprises 29 percent of the total area draining to Long Meadow Lake through these outfalls, with the remaining 71 percent originating from the area west of TH 77 that drains to Pond C.

Figure 3.1 Airport South District Outfall Location Map

Figure 3.2 Smith/Wrights/Airport South Subwatersheds

**Table 3.1
Existing Drainage Area Characteristics**

| Outfall Location | Total Area (acres) | Impervious Area (acres) | Land Use (Percentage) | | |
|--------------------------------|--------------------|-------------------------|-----------------------|-------------------------|---------------------------------|
| | | | Commercial/Industrial | Low density Residential | Office/High Density Residential |
| 80th Street Outfall | 76 | 62 | 75% | - | 25% |
| Ceridian Outfall | 69 | 44 | 50% | 15% | 35% |
| Hogback Pond Outfall | 49 | 36 | 100% | | |
| Pond C Outfall – ASD | 524 | 370 | 70% | 20% | 10% |
| Total ASD | 718 | 512 | 71 % | 16 % | 13 % |
| Pond C Outfall – West of TH 77 | 1,796 | 800 | 15% | 80% | 5% |
| Totals | 2,514 | 1,312 | 31% | 62% | 7% |

As Table 3.1 illustrates, the majority of the existing drainage area to Long Meadow Lake is low density residential, primarily located west of TH 77. These residential areas are not expected to redevelop within the 20-year study period. In contrast, the majority of the ASD is higher density development in commercial/industrial and office/high density residential land uses, and 272 of the 718 acres of developed/developable land is anticipated to redevelop within 20 years.

4.0 Anticipated Land Use Changes/Hydrology

4.1 Changes in Land Use

The properties within ASD that are anticipated to change land use prior to 2020 are shown in Table 4.1.

The total area which will likely change land use from the existing conditions in 2001 to the year 2020 is 272 acres. This is just under 38 percent of the 718 acres of developable area of ASD, but represents only about 11 percent of the overall drainage area to Long Meadow Lake through the four outfalls.

**Table 4.1
2020 Redevelopment Areas**

| Location | Total Area (acres) | (2020) Impervious Area/Site (acres) | NURP Pond Surface Area Required (acres) | NURP Pond Permanent Pool Required (acre-feet) |
|---|--------------------|-------------------------------------|---|---|
| Met Center/ Thunderbird/Marriot ¹ | 87 | 54.2 | 3.9 | 13.6 |
| Adjoining Lands | 34.1 | 32.6 | 1.7 | 5.9 |
| Robert Muir | 12.3 | 11.8 | 0.7 | 2.1 |
| Health Partners | 44.7 | 31 | 1.5 ³ | 4.9 ³ |
| Kelley Property | 43 ² | 26.1 | 1.2 | 4.0 |
| VTC | 16.4 | 11.2 | 0.6 | 1.7 |
| Long Meadow Area | 4.5 | 3.1 | 0.2 | 0.5 |
| Total Area | 272 | 170 | 10 | 33 |
| Percent of ASD | 38% | | | |

¹ Areas/computations include all three sites.

² Does not include 17.1 acres that is assumed to be unbuildable.

³ Pond area and volume includes the total of a pond system taken from a proposed site plan.

For the initial modeling performed for this study it was assumed as these properties were redeveloped, water quality treatment measures were incorporated such that NURP levels of Total Suspended Solids (TSS) removal were attained (70-80 percent), to provide an estimate of the amount of treatment that could be anticipated by incorporating 'above the bluff treatment.' The ponding requirements shown in Table 4.1 describes a pond designed in accordance with the standards set in the City of Bloomington Water Management Plan (2001), which is consistent with standard design practices for the 'Walker' pond method. This method is consistent with the City's Storm water Management Plan as well as the LMRWD plan.

5.0 Potential Water Quality Treatment Sites/Site Evaluation

5.1 Selection of Water Quality Treatment Measures

There are many choices for water quality treatment measures for use on small sites, as identified in a number of recent publications (Protecting Water Quality in Urban Areas, MPCA 2000, Minnesota Urban Small Sites BMP Manual, Metropolitan Council, Barr Engineering, 2001). These include a plethora of aboveground and underground systems incorporating a variety of ponds, infiltration measures, and others. The appropriate choice of BMP is often connected with the physical site characteristics, site size and layout construction methods, target pollutant, short and long-term maintenance requirements and cost. This study assumed the use of on-site ponds (see

Table 4.1) as the means of providing treatment at each redevelopment site because they generally minimize the site area required for treatment. However, other on-site treatment methods such as infiltration basins could be utilized in addition to or in lieu of ponding to achieve the 70-80 percent target TSS removal levels.

While these various methods may be feasible means for providing on-site treatment at proposed redevelopment sites within the ASD, it is generally accepted that for a large regional treatment system, some type of ponding provides the most cost effective approach to providing a high level of pollutant removal. Wet detention ponds are relatively easy to construct, require a low level of maintenance, and can provide a high level of treatment of both soluble and particulate pollutants when sized properly. Therefore, this study analyzed the feasibility of using wet detention ponding for regional water quality treatment, in addition to studying the effectiveness of providing on-site ponding within the proposed redevelopment sites.

5.2 *Potential Regional Ponding Sites*

The ASD was reviewed from a hydrologic perspective to identify potential regional ponding sites to supplement and/or substitute for on-site ponding, as needed. The primary consideration in this process was the configuration of the existing conveyance systems and contributing drainage areas that discharge to Long Meadow Lake. Given the depth of the existing storm sewer (up to 15 feet below the ground surface) and its relationship to contributing drainage areas, as well as the physical characteristics of the ASD area (including bluff/ravine areas and intensively developed areas), the list of potential regional pond locations was narrowed to the sites shown on Figure 5.1.

Each of the sites identified was evaluated based on criteria in three main categories: Design/Effectiveness, Physical Feasibility, and Long Term Operation Issues. The criteria are listed in Table 5.1. Design criteria included initial analyses to determine the pond size required to treat the contributing drainage area (used as the basis for the physical feasibility evaluation) and, later, analysis of construction cost and treatment efficiency, measured in cost per pound of TSS removed. Physical feasibility included assessment of issues related to 'constructability' of a pond in each potential location (i.e., is there enough land available, are there environmental constraints, are there soil or topographic constraints, etc.) Long-term operation issues are not critical to assessing the physical feasibility, but are factors that should be considered in overall operation of a pond over time.

Figure 5.1 Airport South District Potential Regional Ponding Sites

**Table 5.1
Pond Feasibility Criteria**

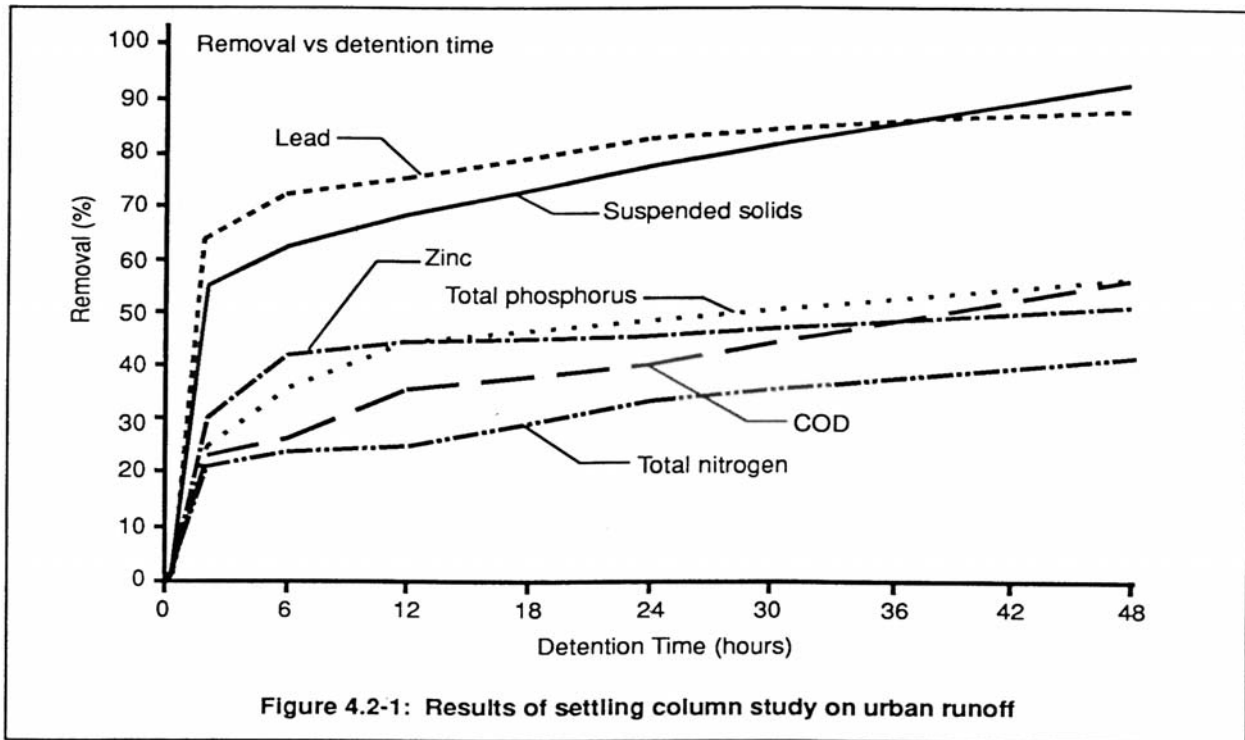
| |
|--|
| Design/Effectiveness |
| <ul style="list-style-type: none"> • Contributing Drainage Area (based on existing trunk storm sewer) • Proposed Normal Pool Depth/Surface Area • Potential Dead Pool/Active Pool Storage • Allowable Flood Elevation • Pollutant Removal (lbs./year) • Estimated Construction Costs |
| Physical Feasibility |
| <ul style="list-style-type: none"> • Physical Accessibility • Land Ownership • Proximity to Existing Storm Sewer (horizontal location and depth) • Soil Conditions • Constructability • Wetland Impacts • Permitting Requirements • Cultural Resources |
| Long Term Operation Issues |
| <ul style="list-style-type: none"> • Maintenance Access • Aesthetics • Maintenance Issues |

5.3 *Pond Treatment Effectiveness Criteria*

The current treatment standards in the Twin Cities metro area include providing ponding surface areas that are approximately 1 percent of the drainage area, given a permanent pool volume of runoff from the 2.5-inch storm event (Walker, 1987). Additional guidance in planning regional treatment is provided by Robert Pitt, who has studied pond sizing in terms of small storm events and found the ratio to vary between 0.8 for residential areas to 3.0 for totally paved areas (Pitt, 1998)

Storm water treatment devices designed according to NURP standards (MPCA criteria) will have long-term average phosphorus removal efficiencies of 47 percent to 68 percent for the Twin Cities area (W. Walker Jr., 1987). Detention ponds are designed to remove pollutants from surface waters as a result of physical settling and are most effective for controlling those pollutants typically associated with sediment particles, including lead, phosphorus and zinc. These pollutants attached to sediment particles exhibit settling characteristics similar to those of sediment as illustrated in Figure 5.2. Consequently, if removal efficiencies are reached for TSS, then appropriate removal efficiencies will typically be reached for the other constituents of concern. Therefore, TSS was used as an indicator of pond effectiveness.

Figure 5.2
Results of Settling Column Study on Urban Runoff



Source: OWML, 1983

Once the initial pond sizing was completed, a review of the physical feasibility of each potential pond location was conducted. This review indicated that there are physical barriers to providing regional ponding at some of the sites originally identified. First, existing outfalls at 80th Street and Ceridian have very limited drainage areas, and very limited undeveloped space for pond construction above the bluff. The only opportunity for water quality treatment exists within the redevelopment sites (i.e., Long Meadow Upper Pond). Second, the existing storm sewer system is typically quite deep to Hogback Pond or Pond C, which creates very deep regional ponding that require considerable property within areas on the bluff. Third, the ponding sites available deep enough to serve the storm sewer system (Ravine pond/Long Meadow Lower) have a variety of technical issues, including sidehill seeps that would change the effectiveness of settling in the basin, or resulted in other potential impacts (archeological, heavily wooded areas, etc.)

The physical feasibility matrices are found in Table A.1 in Appendix A. The matrices provide details of the factors evaluated for each of the regional ponding alternatives studied, and resulted in the conclusion that regional ponds at the 80th Street outfall and the Long Meadow Lower Pond sites were not feasible due to physical land constraints.

The remainders of the ponding sites were carried through the modeling processes to evaluate their overall effectiveness as a regional facility. These represent regional sites that would provide supplemental treatment for two of the four outfalls, and include those shown in Table 5.2.

**Table 5.2
Regional Pond Locations**

| Pond Location | Description | Outfall Location |
|----------------------|--|-------------------------|
| Pond C Expansion | Expand Pond C to the north within existing Mn/DOT right-of-way and physical constraints. Pond C is expanded by about 2.5 times in surface area and roughly 5 times in dead pool volume. | Pond C Outfall |
| Ravine Pond | Pond would be located in the ravine area along the access road to the Refuge. Direct drainage area would be from the Adjoining Lands and the outfall from Kelley Farms, which is currently directed to Hogback Pond. | Hogback Pond Outfall |
| West 77 pond | Pond sized to provide treatment for the untreated area currently flowing to Pond C from area W-3. | Pond C Outfall |

6.0 Water Quality Modeling

6.1 Methodology

The water quality studies performed for the Met Center EIS and the ASD AUAR provide the backdrop for the modeling effort contained within this study. The P-8 model developed for these documents was expanded to evaluate the regional facilities.

As with the ASD AUAR, the 2.5-inch type II single event storm was used to evaluate the system. This is consistent with the design required for NURP ponds that would be found within the various redevelopment sites. The P-8 modeling performed for the Met Center Site EIS (May 18, 2000) evaluated the impact and effectiveness of three rainfall scenarios of the redevelopment and mitigation respectively. In all cases the large, single event resulted in removal efficiencies 15-25 percent lower than for the normal rainfall year. Since the modeling was completed for a much larger design storm this analysis provides a conservative approach for the evaluation of the devices on an annual basis.

The average annual storm in Minneapolis is approximately 0.34 inches in magnitude. It is likely that the devices will actually perform much better under the majority of storm events likely to occur. The particle class used for the analysis was the 50th percentile class derived from the National Urban Runoff Program. The model also includes data for the area west of 77 provided by City staff as it affects the functioning of Pond C.

6.1.1 Storm Water Treatment Scenarios Modeling

A number of scenarios were assembled to evaluate the effectiveness of the overall system efficiency (i.e., the combined effect of all assumed treatment facilities on the discharge to Long Meadow Lake), as well as the individual components. The baseline condition included NURP ponding within all of the redevelopment areas as a means of assessing the ability of treatment at new development sites to provide adequate treatment (i.e. without additional regional ponding capacity). The model evaluates the treatment components both individually and as a system, which provides the opportunity to observe how each component contributes to the overall protection of Long Meadow Lake.

The four potential regional pond facilities listed in Table 5.2 were incorporated – along with other ponding/BMP strategies – in combinations to create eight treatment scenarios (see Table 6.1) that were modeled for overall effectiveness in TSS removal. Most of the scenarios focus on evaluation of options that address the area draining to the Pond C outfall, given that Pond C provides treatment for the majority of the drainage area. It should also be noted that although the 80th Street and Ceridian outfalls do not have regional ponding facilities, onsite NURP ponds are included on redeveloped properties within these subwatersheds for the Baseline condition.

**Table 6.1
2020 Model Scenarios**

| | |
|---|---|
| 1 2020 Baseline Conditions | NURP-level treatment ponds constructed on all new development properties. This model is the baseline for the remaining 2020 model scenarios. |
| 2 Pond C Expansion | Maximized the expansion of Pond C to the north within existing Mn/DOT right-of-way and physical constraints. Pond C is expanded by about 2.5 times in surface area and roughly 5 times in dead pool volume. |
| 3 Ravine Pond | Routed overflow from the splitter through a pond in the ravine area. Direct drainage area is from the Adjoining Lands and the outfall from Kelley property, which currently flows to Hogback Pond. |
| 4 Wrights Lake and Smith Pond bypass | Bypassed the Wrights Lake and Smith Pond outlets directly to Long Meadow Lake. Model intended to test effectiveness of removing hydrologic loading from Pond C. |
| 5 West 77 pond | Routed watershed W-3 (currently untreated) through a NURP pond and then into Pond C. |
| 6 West 77 area through a NURP pond with Pond C expansion | Routed all of the area west of 77 through the W77 pond, including the outlet of Wrights Lake and watershed W-3. Outlets directly to Long Meadow Lake, reducing hydraulic loading on Pond C. Pond C expansion treats ASD water only. |
| 7 Wrights Lake NURP pond with Pond C expansion | Routed the outlet of Wrights Lake through a W77 pond, then directly to Long Meadow Lake. Area W-3 flows to Pond C. |
| 8 2020 combo of TP ban, street sweeping, Pond C expansion | This model is intended to demonstrate the effectiveness of additional housekeeping measures, compared to Scenario 2. |

6.2 Analysis Results

6.2.1 Existing Conditions

The existing systems include storm water treatment at Hogback Pond and Pond C, as well as two ponds currently within the ASD (Pond 30 and Pond 85). The model results for these ponds in the current condition are shown in Table 6.2. The results show that the Smith Pond/Wrights Lake and Pond C treatment systems are below the 70 percent removal threshold.

**TABLE 6.2
DEVICE REMOVAL EFFICIENCIES FOR TOTAL SUSPENDED SOLIDS
2000 CONDITIONS**

| Pond | Runoff Volume (ac-ft) | TSS input load (lb) | TSS output load (lb) | TSS removed (lb) | Percent (%) Reduction TSS | Percent (%) Reduction TP |
|--|-----------------------|---------------------|----------------------|------------------|---------------------------|--------------------------|
| Existing Treatment Ponds (Regional and Site Specific) | | | | | | |
| Pond 30 | 4.9 | 615 | 121 | 494 | 80 | 35 |
| Pond 85 | 2.1 | 318 | 98 | 219 | 69 | 29 |
| Hogback Pond | 34 | 3,816 | 722 | 3,077 | 80 | 34 |
| Pond C | 220 | 19,027 | 10,176 | 8,852 | 47 | 12 |
| Smith Pond | 63.2 | 7,961 | 2,890 | 5,071 | 64 | 21 |
| Wrights Lake | 119 | 10,126 | 6,017 | 4,109 | 41 | 9 |

6.2.2 On-Site Development Ponds

The effectiveness of on-site treatment devices within the redevelopment sites assumed for modeling Scenarios 1-8 are shown in Table 6.3. Each new device provides a removal efficiency of 70-80 percent, at or above minimum NURP requirements for a Type II storm event.

**TABLE 6.3
DEVICE REMOVAL EFFICIENCIES FOR TOTAL SUSPENDED SOLIDS
REDEVELOPMENT SITES**

| Pond | Runoff Volume (ac-ft) | TSS input load (lb) | TSS output load (lb) | TSS removed (lb) | Percent (%) Reduction TSS | Percent (%) Reduction TP |
|--|-----------------------|---------------------|----------------------|------------------|---------------------------|--------------------------|
| Airport South District 2020 Redevelopment On-Site Ponds | | | | | | |
| Met Center/ Thunderbird/ Marriott | 15 | 1,850 | 444 | 1,406 | 76 | 31 |
| Adjoining Lands | 5.3 | 666 | 140 | 525 | 79 | 34 |
| Health Partners | 7.0 | 1,142 | 328 | 815 | 71 | 33 |
| Muir Pond | 2.3 | 318 | 80 | 238 | 75 | 33 |
| Kelley Ponds | 5.5 | 691 | 202 | 490 | 71 | 28 |
| VTC | 2.2 | 280 | 72 | 208 | 74 | 30 |
| LMA | 0.6 | 78 | 20 | 58 | 74 | 30 |

6.2.3 Results of Regional Ponding Combinations

The scenarios described in Table 6.1 were modeled to evaluate the effectiveness of each scenario combination on the total loading from the four outfalls to Long Meadow Lake. Results of these model runs are shown in Table 6.4.

**TABLE 6.4
DEVICE REMOVAL EFFICIENCIES FOR TOTAL SUSPENDED SOLIDS (TSS)
2020 Scenarios**

| Treatment Scenario | Runoff Volume (ac-ft) | TSS input load (lb) | TSS output load (lb) | TSS removed (lb) | Percent (%) Reduction TSS | Percent (%) Reduction TP |
|--|-----------------------|---------------------|----------------------|------------------|---------------------------|--------------------------|
| 1 2020 Baseline | 296 | 38,097 | 13,363 | 24,737 | 65 | 24 |
| 2 Pond C Expansion | 296 | 38,097 | 11,117 | 26,981 | 71 | 29 |
| 3 Ravine Pond | 296 | 38,097 | 13,161 | 24,936 | 65 | 24 |
| 4 Wrights/Smith Lake bypass | 296 | 38,097 | 14,369 | 23,728 | 62 | 22 |
| 5 West 77 pond | 296 | 38,097 | 10,944 | 27,152 | 71 | 30 |
| 6 West 77 area through NURP pond w/ Pond C expansion | 296 | 38,097 | 8,310 | 29,787 | 78 | 35 |
| 7 Smith/Wright's Lake NURP pond w/Pond C expansion | 296 | 38,097 | 8,834 | 29,263 | 77 | 34 |
| 8 2020 Combo-w/Pond C Expansion | 296 | 38,097 | 11,176 | 26,905 | 71 | 28 |

A review of the results provides the following comments.

- Ponding scenario 1 includes ponding within all of the redevelopment areas. The addition of NURP ponding within all of the development areas expected to redevelop within the next twenty years does not bring the overall system removal efficiency to within the 70 percent minimum TSS removal NURP treatment goal (only 65 percent TSS removal is achieved in Scenario 1).
- Expanding Pond C, shown in Scenario 2, in conjunction with the development ponding, removes 71 percent of the TSS load to Long Meadow Lake, within the range of NURP guidelines.
- Construction of Ravine Pond (Scenario 3) does not contribute appreciably to TSS removal in the system (compare to Scenario 1).
- Scenario 4 was included to evaluate the impact of removing hydraulic loading from Pond C by routing Smith/Wrights (treated) discharges directly to Long Meadow Lake, not through Pond C. While Pond C performs at higher removal rate, the overall system still operates at a lower efficiency than Scenario 1 because Smith/Wrights do not treat to NURP standards and Pond C still does not meet NURP standards.
- Scenario 5 – construction of a pond to treat Watershed W-3 (currently untreated see Figure 3.2) prior to discharge to Pond C – improves system performance (compare to Scenario 1) to meet minimum NURP standards, but it is not substantially better than construction of Pond C expansion alone (Scenario 2).
- Pond C expansion combined with construction of additional ponding west of TH 77 (Scenario 6) provides additional system improvement (77 percent removal), compared to Pond C expansion alone.
- The model does not reflect any appreciable difference instituting the street sweeping/phosphorus ban measures in Scenario 8 (compare to Scenario 2).

6.2.4 Analysis of Scenarios Without Redevelopment Treatment at Select Properties

Comments from MAC staff on the Airport South District Draft AUAR document expressed concern about locating storm water ponding above the bluff, where it might encourage waterfowl thus increasing the risk of bird/aircraft conflicts. To address this concern, and also as a means of evaluating the relative effectiveness of on-site treatment compared to regional treatment, two additional sub-scenarios were analyzed:

- A. Assume no ponding within the runway safety zone, i.e., removing ponding from Kelley and Adjoining Lands.

- B. Removal of ponding within the Met Center, Thunderbird and Marriott sites in addition to the Kelley and Adjoining Lands parcels.

The model alternatives re-run with these two sub-alternatives included Scenarios 1, 2, and 6. Results are shown in Table 6.5.

**TABLE 6.5
DEVICE REMOVAL EFFICIENCIES FOR TOTAL SUSPENDED SOLIDS (TSS)
2020 SCENARIOS WITHOUT NURP PONDING WITHIN SPECIFIC DEVELOPMENT
AREAS**

| Ponding Scenario | Runoff Volume (ac-ft) | TSS input load (lb) | TSS output load (lb) | TSS removed (lb) | Percent (%) Reduction TSS | Percent (%) Reduction TP |
|--|-----------------------|---------------------|----------------------|------------------|---------------------------|--------------------------|
| 2020 SCENARIOS WITHOUT NURP PONDING AT ADJOINING LANDS/KELLEY | | | | | | |
| 1A 2020 Baseline | 296 | 38,097 | 13,499 | 24,598 | 65 | 24 |
| 2A Pond C Expansion | 296 | 38,097 | 11,254 | 26,843 | 70 | 28 |
| 6A West 77 through W77 Pond w/Pond C expansion | 296 | 38,097 | 8,448 | 29,649 | 78 | 34 |
| 2020 SCENARIOS WITHOUT NURP PONDING AT Adjoining Lands/Kelley/Met Center/Thunderbird/Marriott | | | | | | |
| 1B 2020 Baseline | 296 | 38,097 | 13,780 | 24,317 | 64 | 23 |
| 2B Pond C Expansion | 296 | 38,097 | 11,498 | 26,599 | 70 | 28 |
| 6B West 77 through W77 Pond w/Pond C expansion | 296 | 38,097 | 8,651 | 29,446 | 77 | 34 |

When compared to the original runs of Scenarios 1, 2 and 6 in Table 6.3, these new scenarios indicate that the TSS and phosphorus removal efficiency of the system has very little change when ponding is removed from the specified areas. The ponding within the Adjoining Lands and Kelley parcels, noted as ponding scenario alternative A, resulted in an additional 137 pounds of TSS removed per year for all scenarios. Also removing ponding from the Met Center, Thunderbird and Marriott sites results in an increase in loading of 340 to 420 pounds per year compared to the original scenarios 1, 2 and 6. In each sub-alternative (2A/2B and 6A/6B), the addition of a regional facility (Pond C expansion or W77 pond) provides an overall system that falls within the NURP guidelines, even if the on-site ponds are not constructed at these sites.

6.2.5 Comparison of Ponding Approaches

Using the Design/Effectiveness criteria established in Section 5, each of the 8 model scenarios was evaluated based on effectiveness and cost. The results are shown Table 6.6.

**TABLE 6.6
MODEL SCENARIO COMPARISON**

| Ponding Scenario | Description | Additional TSS removed (lb) ¹ | Approximate Costs ² | Cost Per Pound of TSS Removed ³ | Percent Reduction TSS (%) |
|--|--|--|--------------------------------|--|---------------------------|
| | 2000 Existing conditions | - | - | - | 62 |
| 2020 SCENARIOS WITH NURP PONDING AT ALL DEVELOPMENT SITES | | | | | |
| 1 | 2020 Baseline | 817 | \$14.7 million | \$1,200 | 65 |
| 2 | Pond C Expansion | 3,061 | \$19.8 million | \$431 | 71 |
| 3 | Ravine Pond | 1,016 | \$16 million | \$1,050 | 65 |
| 4 | Wrights Lake /Smith Pond bypass | -192 | \$14.7 million | N/A | 62 |
| 5 | West 77 pond | 3,232 | \$29 million | \$598 | 71 |
| 6 | West 77 area through NURP pond w/ Pond C expansion | 5,867 | \$35 million | \$398 | 78 |
| 7 | Smith/Wrights Lake NURP pond w/Pond C expansion | 5,343 | \$35 million | \$437 | 77 |
| 8 | 2020 Combo-w/Pond C Expansion | 2,985 | \$19.8 million | \$442 | 71 |
| 2020 SCENARIOS WITHOUT NURP PONDING AT ADJOINING LANDS/KELLEY | | | | | |
| 1A | 2020 Baseline | 678 | \$10.4 million | \$1,023 | 65 |
| 2A | Pond C Expansion | 2,923 | \$15.4 million | \$351 | 70 |
| 6A | West 77 through W77 Pond w/ Pond C expansion | 5,729 | 29.5 million | \$343 | 78 |
| 2020 SCENARIOS WITHOUT NURP PONDING AT Adjoining Lands/Kelley/Met Center/Thunderbird/Marriott | | | | | |
| 1B | 2020 Baseline | 397 | \$4.8 million | \$806 | 64 |
| 2B | Pond C Expansion | 2,679 | \$9.8 million | \$244 | 70 |
| 6B | West 77 through W77 Pond w/ Pond C expansion | 5,526 | \$24 million | \$290 | 77 |

¹ Additional TSS removal is computed by normalizing the existing 2000 drainage area to the 2020 condition, then subtracting the TSS removed from each model scenario.

² Costs include applicable construction and land costs. The 2020 Baseline costs included in the scenario costs. The Ravine Pond and Pond C expansion are both within existing public right-of-way, and therefore do not include land cost. Land costs for the development ponds assumed at \$25/sf.

³ Per pound costs are computed based on a 15-year design life.

A number of observations can be drawn from the data in Table 6.6.

- Regional ponding provides the most cost effective removal of TSS.
- The expansion of the Pond C is a common link between all of the scenarios that provide the lowest cost per pound of TSS removed (scenarios 2,6,7, and 8).
- While providing treatment for the untreated watershed W-3 (scenario 5) accomplishes similar levels of treatment as expanding pond C, it does so at almost 1.5 times the cost.
- Adding a pond west of TH 77 is cost effective in terms of treatment, when the pond provides additional treatment for the Wrights Lake outfall in addition to watershed W-3. Scenario 6 (Pond expansion plus a pond west of TH 77) has the lowest cost per pound of TSS removed, however, it costs nearly twice as much as the next closest alternative (Scenario 2 – Pond C expansion), which also meets the minimum treatment criteria (70% TSS removal).
- The 'B' alternative provides the least cost per pound of removal for all of the scenarios studied, due to elimination of the need to pay a high cost for land needed to construct ponding in Scenarios 2 and 6.

7.0 Conclusions

A number of general conclusions can be drawn from reviewing the results of the modeling analyses and the other implementation considerations.

- The majority of untreated runoff from above the bluff comes from the drainage area west of TH 77. 71 percent of the total drainage area within the study area (1,796 acres) originates west of TH 77. Of this area, 606 acres discharge untreated to Pond C, while the Smith-Wrights Ponding system reduces the TSS loading by only 40 percent prior to discharging to Pond C.
- Pond Scenario 2, the expansion of Pond C, provides a level of treatment within the range of the NURP guidelines for total loading from the area. The expansion of Pond C, in conjunction with the NURP level of treatment within the 2020 redevelopment areas, results in TSS reduction of 71 percent. This level of treatment is within the range found in typical NURP basin design.
- Pond C gains additional benefits from a separate outfall to Long Meadow Lake for the area west of TH 77. Model Scenario #6 provides treatment of all of the storm water west of TH 77, including area W-3, and provides a separate outfall to Long Meadow Lake. With an expansion to Pond C, the normal pool surface area is approximately 1.5 percent of the contributing drainage area, which is within the guidelines for effective pond treatment for the mix of residential and commercial area.

- The greatest reduction in overall loading to Long Meadow Lake occurs with additional treatment of storm water discharging from Wrights Lake/Smith Pond to pond W77 with the expansion of Pond C. Pond W77, in addition to Smith Pond and Wrights Pond, provides pond surface area equaling roughly 1.7 percent of the upstream drainage area. The modeling results, 77-78 percent overall removal efficiency, are within the range of treatment reported in the various research documents available on pond effectiveness.
- The addition of on-site NURP level treatment (70-80 percent reduction in TSS) at redevelopment sites provides minor reductions in overall system TSS removal. The study scenarios include a comparison of redevelopment with and without NURP level treatment within each site (Sub-alternatives A and B). The 70-80 percent reduction in TSS at the Adjoining Lands and Kelley sites result in a removal of 1,015 pounds of TSS for the individual sites. However, the resulting reduction in loading to the Long Meadow Lake is 139 pounds, or about 14 percent of that removed at the sites.
- Regional ponding appears to provide the most cost effective approach to overall TSS and TP removal. A comparison of estimated cost per pound of TSS removal for the various treatment scenarios studied indicates that Sub-alternatives A and B (that assume fewer on-site ponding areas, compared to Scenarios 1, 2 and 6) result in lower cost per pound removal of TSS with only minor changes in efficiency. For example, the cost of TSS removal for Scenario 2 (Pond C expansion) drops 18 percent from Scenario 2 to Scenario 2A, with a less than 1 percent drop in removal efficiency. The cost decrease between Scenario 2B vs. Scenario 2 is 43 percent, also with only a 1 percent decrease in efficiency of TSS removal.

8.0 Recommendations

8.1 Recommendations

The following recommendations are based on the conclusions stated above.

- Pursue design and permitting of the expansion of Pond C.

The Pond C expansion can provide a substantial benefit for the water quality of storm water entering Long Meadow Lake from the study area, as it provides treatment of 92 percent of the total ASD study area. It also brings overall removal for the ASD and the area west of TH 77 within the NURP TSS removal gridlines (70 percent removal).

Construction access, right-of-way, and existing soils data will be critical to the design and construction. Soil borings for the skimmer structure installed in 2000 indicated the excavated soils to be granular in nature, which may reduce the construction costs.

- Pursue ponding locations for the drainage area west of TH 77, and/or the expansion of Wrights Lake, if redevelopment occurs in this area in the future.

The cost of purchasing right-of-way for a regional ponding facility west of TH 77 makes a proposed regional pond cost prohibitive. While this area is not expected to redevelop in the near term, a pond providing additional treatment of this area would provide a substantial increase in sediment and phosphorus removal.

- If no regional ponding facilities are available for a subwatershed (i.e., 80th Street and Ceridian outfall areas), then on-site treatment ponds (or equivalent treatment facilities) should be incorporated into all new development/redevelopment projects within the subwatershed.
- Incorporate rate control and primary treatment measures as a minimum treatment at all redevelopment areas within subwatersheds served by regional ponds.

While the analysis reveals that on-site ponding within the proposed re-development areas has a relatively small impact on overall water quality (compared to the regional ponding improvements identified above), long term maintenance costs of the regional facilities would be lessened by removing sediment nearer the source through the use of primary treatment measures such as grit chambers and 'floatables' removal devices. While the sediment that is easily removed does not carry the bulk of the pollutant loading, it does create the largest volume of material. Removing a large percent of this material at the source may double the expected maintenance schedule for the ponding areas, as well as allow them to operate at higher efficiencies for a longer period of time.

- Encourage low impact development (LID) management practices be incorporated for treatment in redevelopment areas where appropriate.

LID practices include a variety of methods to provide on-site infiltration. Appropriate LID practices may include infiltration trenches, rain gardens, green roofs, treatment trains, and many other practices that promote infiltration such as wetland restoration. While it is difficult to establish these practices in the larger commercial and industrial settings found within the ASD, it may be possible to incorporate them into an office campus setting, or the redevelopment of small sites.

- To reduce the potential for pollutant overloading from accidental spills from commercial and industrial properties within ASD, City staff should continue to work with commercial/industrial property owners within ASD and the remainder of the City in implementation of spill prevention plans and containment procedures.

8.2 *Agency Coordination/Partnerships*

We anticipate the following coordination will be required to implement the recommendations.

- Expansion of Pond C takes place within existing Mn/DOT right-of-way, and will likely require coordination with them for the proposed expansion.
- USFWS for potential construction and maintenance access to expand Pond C.
- Business owner's cooperation with City staff will be required for spill prevention implementation.