EXECUTIVE SUMMARY
Kinnickinnic River Sediment-transport Planning Study

December 17, 2010

INTRODUCTION

The Kinnickinnic River Sediment-transport Planning Study that is the subject of this report was prepared for the Milwaukee Metropolitan Sewerage District (MMSD) by Tetra Tech, Inc. (dba Mussetter Engineering, Inc.) and our subconsultants DTM Consulting, Oneida Total Integrated Enterprises, and Mainstream Restoration. The MMSD project manager for this study was Mr. David Fowler, and Tetra Tech's project managers were Drs. Robert Mussetter, PE, and Michael Harvey, PG.

The objective of the Kinnickinnic River Sediment-transport Planning Study is to provide a supplementary planning tool to appropriate flood management, stabilization, and rehabilitation activities within the Kinnickinnic River watershed, primarily within the Milwaukee Metropolitan Sewerage District's (MMSD) jurisdiction. While extensive hydrologic and hydraulic analyses have been previously or are concurrently being conducted, an understanding of the sediment budget and sediment transport continuity within the watershed is also necessary to plan alterations to the channel and floodplain for improved flood conveyance and to rehabilitate aquatic habitat. This study contributes sediment transport and geomorphic analyses to provide comprehensive planning tools for MMSD that consider the impact of sediment transport and geomorphic character in addition to hydrologic conditions.

Specific objectives included:

1. Collect and evaluate relevant sediment and geomorphic data in the context of channel stability, flood management, and overall watershed management;

2. Identify existing problem areas and opportunities for improvement of watershed condition, to be integrated with flood management initiatives;

3. Provide a comprehensive database of geomorphic and sediment-transport characteristics to enable effective watershed management and decision making;

4. Provide guidance and prioritization of identified projects within MMSD jurisdiction; and

5. Provide training to MMSD staff for GIS tools developed for this project.

WORK PLAN

This sediment-transport study and its related investigations and output, accounted for all existing relevant information, existing watershed and channel condition, and state of the art GIS analyses and presentation formats.

Work performed included extensive field data collection of geomorphic parameters and channel geometry, categorization of channel reaches, and assessment of existing infrastructure (concrete channel liners, sewers outfalls and bridges). Field investigations and data collection established a framework for analyses, including sediment- and grain-size analysis, sediment-transport analysis, and evaluation of geomorphic trends within the study area. These analyses, supplemented by subsequent field review, facilitated the development of a priority listing of existing opportunities for river stabilization, rehabilitation, and enhancement.

Each component of the process was documented as a Technical Memorandum, listed subsequently, and included as an appendix to this Summary Report. All data and result are presented in the Summary Report in appropriate formats, including the report, a GIS database of maps, field data and photographs, and the Sediment-transport Analysis package.

The report is presented as a series of independent Technical Memoranda that were prepared during the course of the project, and include the following:

- Kinnickinnic River Sediment-transport Planning Study – Surveying (S)
- Kinnickinnic River Sediment-transport Planning Study – Hydrology (HY)
- Kinnickinnic River Sediment-transport Planning Study – Hydraulics (HA)
- Kinnickinnic River Sediment-transport Planning Study – Geomorphology (G)
- Kinnickinnic River Sediment-transport Planning Study – Sediment Transport (ST)
- Kinnickinnic River Sediment-transport Planning Study – Management Recommendations (MR)

Tables and figures cited in this Executive Summary are referenced to their respective Technical Memoranda. This study evaluated the existing and future (2020) conditions, respectively, for the Kinnickinnic River from its origin at S. 60th Street to the Kinnickinnic River arm of the Lake Michigan estuary immediately downstream of Chase Avenue (Figure HA.1). Also included in the study were the MMSD jurisdictional tributaries to the Kinnickinnic River, including Lyons Park Creek, 43rd Street Ditch, Wilson Park Creek, Villa Mann Creek, and Villa Mann Creek Tributary. A reconnaissance-level evaluate of several MMSD non-jurisdictional tributaries within the watershed, including Holmes Avenue Creek, Cherokee Park Creek, the Unnamed Tributary to Wilson Park Creek located within the Cities of Greendale and Milwaukee, respectively, and the two branches of Wilson Park Creek located east of Whitnall Avenue in the City of Cudahy, was also included to provide estimates of sediment yield to the jurisdictional channels (Figure HA.1).

Existing conditions in the report refer to physical conditions that were observed and measured during the field work that was carried out between April and May 2010 and the year 2007 hydrology, and future conditions are referenced to the year 2020 hydrology.

MANAGEMENT RECOMMENDATIONS (MR)

The primary problems identified within the Kinnickinnic River and tributaries by this sediment-transport planning study are:

1. Lack of hydraulic capacity (<100-year peak flow), primarily in the concrete-lined subreaches of the Kinnickinnic River between South 43rd Street and South 6th Avenue (KKR5-KKR9),

2. Eroding unlined channel segments in the Kinnickinnic River (KKR1-KKR4) and tributaries that both threaten streamside infrastructure and supply sediment to the downstream estuary of the Kinnickinnic River where it is deposited,

3. Failed and poor-condition, open-channel concrete lining, primarily in the Kinnickinnic River (KKR5-KKR9) that was constructed in the early 1960s and is coincident with the impaired hydraulic capacity, and

4. Sedimentation at the MMSD Flushing Tunnel outfall and impaired pumping capacity immediately downstream of Chase Avenue in the Lake Michigan estuary.

1.1. Hydraulic Capacity

In general, the concrete-lined subreaches of the Kinnickinnic River and its tributaries will convey the 100-year peak flow, except in those segments immediately upstream of bridges and underground culverts that create upstream backwater (Table MR.3.1). While the identified bridges can be replaced, it would be more difficult and expensive to replace the tunnel segments.

1.2. Failed- and Poor-condition Concrete Lining

The condition of the concrete within the open-channel segments of the Kinnickinnic River and tributaries were evaluated during the field inspection (Table MR. 3.2). As expected, the Poor (about 18,260 LF) and Failed (about 3,000 LF) segments are located in the oldest sections of constructed channel. Given the coincidence between the poor state of the concrete and the impaired hydraulic capacity, the most appropriate remedy appears to be replacement of the concrete lining. Successful replacement could be achieved with a compound channel, sized to convey the 1-percent peak design flow without eroding, including a low-flow, rock-lined channel sized to convey about the 0.1-percent mean daily exceedence flow, with appropriate vertical and lateral variability to provide fish passage and resting areas. Typical sections were developed for three locations along the Kinnickinnic River with a low-flow channel geometry that would convey the 0.1-percent mean daily exceedence flow (consistent with the approximate conveyance of the existing berms), and to provide 1 foot of freeboard at the 100-year peak discharge (Figures MR.3.2a through MR.3.2c).

1.3. Eroding Channels

Ongoing bed and bank erosion of the unlined subreaches of the Kinnickinnic River and its tributaries has the potential to adversely affect adjacent infrastructure (roads, houses, utilities), and will provide sediment that ultimately will be transported to and deposited in the vicinity of MMSD's Flushing Tunnel outfall downstream of Chase Avenue.

1.3.1. Infrastructure Risk

Because most of the unlined channel segments have incised to a greater or lesser degree, the height of the banks has increased commensurately. The highest risk to channel margin infrastructure occurs where the infrastructure is within two channel widths of the eroding bank, medium risk occurs where the infrastructure is between two and three channel widths of the eroding bank, and the lowest risk is where the infrastructure is beyond three channel widths of the eroding bank. Because of the level of risk, the High-priority sites should be stabilized and the Medium-priority sites should be monitored, and re-rated as necessary over time. Longer-term monitoring of the Low-priority sites is also recommended.

1.3.2. Sediment Reduction

Sedimentation in the vicinity of the MMSD Flushing Tunnel outfall downstream of Chase Avenue originates from erosion of the unlined channel segments within the watershed and from watershed-derived erosion. Approximately 14,000 yd^3/yr of sediment is deposited annually in the estuary, and approximately 3,700 yd^3/yr of the total is derived from bank erosion (Table MR.3.1). Stabilization of all the currently eroding banks in the unlined reaches would reduce the downstream sedimentation by about 26 percent and stabilization of the eroding channel beds would reduce downstream sedimentation by a further 20 percent.

1.3.3. Vertical Stabilization

Because of the presence of the relatively erosion-resistant, consolidated till in the beds of the unlined channels, rates of channel degradation are low (0.05-0.1 ft/yr). However, continued bed degradation will continue to produce sediment (approximately 2115 yd^3/yr) that is transported downstream to the estuary, and if unchecked, will eventually accelerate the rate of bank erosion as bank heights increase.

1.4. Damaged Bank Protection

The effectiveness and integrity of existing bank protection on the Kinnickinnic River were evaluated during the field inspection (Table MR.3.5, Figure MR.3.11). Damage and failure at all of the identified sites is the result of both local scour and general degradation of the bed. The sites continue to provide erosion protection even though they are damaged or have failed structurally. Because they were constructed during the Works Project Administration (WPA) era, they may have historical significance that could complicate their removal and replacement, and therefore, it is recommended that they be monitored and only be replaced if the monitoring indicates that they no longer provide bank protection. Dumped rock bank protection exists along the banks of Lyons Park Creek within Lyons Park (Subreach LPC2). The rock is effective in preventing bank erosion where it has remained in place, but there have been numerous localized failures that reduce the effectiveness and locally accelerate erosion by diverting flows into the banks. Removal of the existing rock and replacement with a combined rock toe-upper-bank bioengineered bank protection is recommended. The replaced protection will provide both effective bank stabilization and will improve stream corridor aesthetics.

1.5. Flushing Tunnel Sedimentation

Although the annual rate of sedimentation in the Kinnickinnic River arm of the estuary downstream of Chase Avenue is currently lower than it was historically (14,000 yd^3/yr vs 21,000 yd^3/yr), the existing sedimentation is affecting the pumping capacity of MMSD's Flushing Tunnel. The existing sedimentation problem is two-pronged. The impact of the annual sediment supply from the upstream watershed and channel erosion is exacerbated by the presence of gravels and cobbles that are derived from ongoing erosion of the terraces immediately upstream. A combination of dredging of the existing sediments and reduction in the supply of sediment from upstream is recommended. Stabilization of the unlined sections of channel will reduce the annual sediment supply by about 43 percent, and elimination of the source of coarser, bar-armoring sediments will likely increase the mobility of the remainder of the sediment supply, reducing the likelihood of sedimentation in the vicinity of the pumps. Replacement of the concrete lining with rock lining in the Kinnickinnic River is also likely to reduce the volume of sediment that is delivered to the head of the estuary due to deposition on, and within, the rock lining.