MEMORANDUM REPORT NO. 220

# SUPPLEMENTAL INFORMATION DEVELOPED FOR THE ROOT RIVER WATERSHED RESTORATION PLAN

This Memorandum Report is a supplement to SEWRPC CAPR No. 316, *A Restoration Plan for the Root River Watershed*

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

Special acknowledgement is due to Dr. Joseph E. Boxhorn, SEWRPC Senior Planner, and Mr. Aaron W. Owens, SEWRPC Planner, for their contributions to the conduct of this study and the preparation of this report.

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**NUMBER 220**

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Prepared by the

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# SUPPLEMENTAL INFORMATION DEVELOPED FOR THE ROOT RIVER WATERSHED RESTORATION PLAN

## BACKGROUND

The Root River watershed restoration plan (WRP) is a second-level plan for the management and restoration of water resources in the Root River watershed.[1] It was prepared in the context of the Southeastern Wisconsin Regional Planning Commission's (SEWRPC) regional water quality management plan update for the greater Milwaukee watersheds (RWQMPU).[2] The RWQMPU was prepared in coordination with, and largely incorporates, the Milwaukee Metropolitan Sewerage District's (MMSD) 2020 facilities plan.[3] The Root River WRP is designed to assist local units of government, State and Federal agencies, nongovernmental organizations, and private landowners in identifying actions that will restore and benefit the natural assets of the watershed.

Following its completion, SEWRPC submitted the Root River watershed restoration plan to the Wisconsin Department of Natural Resources (WDNR) and U.S. Environmental Protection Agency (USEPA) for review. The purpose of this review was to assess the consistency of the plan with a set of nine minimum elements of a watershed-based plan that USEPA considers critical for achieving improvements in water quality.[4] USEPA requires that these elements be addressed in watershed-based plans for threatened and impaired waters that are developed or implemented with funding made available through Section 319 of the Federal Clean Water Act.

As a result of this review, WDNR and USEPA asked for several clarifications regarding the Root River WRP.[5] The requested clarifications included 1) additional estimates of pollutant load reductions related to recommended streambank stabilization projects, 2) additional estimates of pollutant load reductions related to recommended grassed waterway projects, 3) quantification of management measures needed for animal agriculture facilities on private agricultural lands, and 4) development of estimates of the costs related to maintaining existing water quality monitoring stations, establishing 16 future water quality monitoring stations, and periodic collating and analyzing of monitoring data.

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[1] *SEWRPC Community Assistance Planning Report No. 316,* A Restoration Plan for the Root River Watershed, *July 2015.*

[2] *SEWRPC Planning Report No. 50,* A Regional Water Quality Management Plan Update for the Greater Milwaukee Watersheds, *December 2007.*

[3] *Milwaukee Metropolitan Sewerage District,* MMSD 2020 Facilities Plan, *June 2007.*

[4] *U.S. Environmental Protection Agency,* Handbook for Developing Watershed Plans to Restore and Protect Our Waters, *USEPA Publication EPA 841-B-008-002, March 2008.*

[5] *Andrew D. Craig, "Review Comments – Root River Wshed Plan consistency with EPA's 9 Key Elements – 12-01-2014," Electronic Mail Message to Michael G. Hahn, December 1, 2014; Thomas Davenport, "Evaluation of Responses to the WDNR and USEPA Request for Clarifications on the Root River Watershed Restoration Plan," Electronic Mail Message to Michael G. Hahn, December 29, 2014.*

This memorandum report presents the supplemental information for the Root River WRP specifically requested by the WDNR and USEPA. It provides additional quantification relative to implementing several specific recommendations. It should be noted that this report does not change or amend any plan recommendations as set forth in SEWRPC Community Assistance Planning Report No. 316 (CAPR No. 316).

A draft of this memorandum report was provided to the WDNR and USEPA for review. On April 21, 2015, the SEWRPC staff was notified by an electronic mail message from the WDNR that the information set forth in this report responded adequately to the supplemental information request from WDNR and USEPA and that USEPA had determined that the plan documented in SEWRPC CAPR No. 316, as supplemented by SEWRPC Memorandum Report No. 220, is consistent with the USEPA nine minimum elements of a watershed-based plan. Projects implemented using Federal funds provided under Section 319 of the Clean Water Act must directly implement a watershed-based plan that USEPA has determined to be consistent with the nine elements. In addition, implementing a plan that is consistent with the nine elements is a significant consideration in determining eligibility of projects for other Federal funding programs, such as the Great Lakes Restoration Initiative. Thus, the finding of consistency with the nine elements is a significant benefit to implementation of the plan in that it makes projects recommended under the plan eligible for Federal funding.

## STREAMBANK STABILIZATION

In their review comments, WDNR and USEPA requested clarification regarding streambank stabilization projects recommended in the Root River watershed restoration plan. The comments asked specifically for estimates of the pollutant load reductions that could be obtained from those streambank stabilization projects for which these reductions had not been quantified under the Root River WRP.

The Spreadsheet Tool for the Estimation of Pollutant Load (STEPL)[6] was used to estimate pollutant load reductions of total suspended solids (TSS) that could result from implementation of those streambank stabilization projects that were not quantified under the Root River WRP. To ensure that load reductions were estimated on a consistent basis, the STEPL model was also used to recalculate TSS load reductions for those streambank stabilization projects that were quantified in the plan. In addition, average annual pollutant load reductions of total phosphorus that could result from the implementation of the recommended streambank stabilization projects were estimated using the STEPL model. The STEPL model calculates pollutant loads for streambank erosion based on site-specific erosion length, height, lateral recession rate estimates, and soil textural class. A BMP efficiency rate of 0.90 was applied to the total load to account for any load that may not be captured by the recommended streambank stabilization project. Average annual pollutant load reductions for TSS and total phosphorus that would result from implementation of the streambank stabilization projects recommended in the Root River watershed restoration plan are presented in Table 1. These load reductions supersede the average annual load reduction estimates for TSS and total phosphorus reported in Tables 79 and 90 of the Root River watershed restoration plan.[7]

## GRASSED WATERWAYS

In their review comments, WDNR and USEPA requested clarification regarding grassed waterway projects recommended under the Root River WRP. The comments asked specifically for estimates of the pollutant load reductions that can be obtained from those grassed waterway projects for which reductions had not been quantified.

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[6] *Tetra Tech, Inc.,* Spreadsheet Tool for the Estimation of Pollutant Load, Version 4.2, *April 2013.*

[7] *SEWRPC Community Assistance Planning Report No. 316,* op. cit.

**Table 1**

**REVISED SITE-SPECIFIC MANAGEMENT MEASURES FOR THE ROOT RIVER WATERSHED[a]**

| ID Number (from Table 79 in SEWRPC CAPR No. 316) | Management Action | Annual Pollutant Load Reduction | |
|---|---|---|---|
| | | TSS (pounds) | Total Phosphorus (pounds) |
| LRC-07[b] | Stream rehabilitation, naturalization, or bank stabilization project to address eroding streambanks. Remeandering of channelized reaches including addition of buffer and canopy cover. Bank erosion is estimated to be 60 feet in length and two feet in height | 1,200 | 0.4 |
| MRR-11[b] | Stream rehabilitation, naturalization, or bank stabilization project to address eroding streambanks. Could be done in conjunction with upcoming reconstruction of S. 76th Street. Total bank erosion is estimated at 300 feet with bank heights ranging from three to 12 feet | 58,000 | 16.3 |
| MRR-17[b] | Remove failing drop structures and perform stream rehabilitation, naturalization, or bank stabilization to address eroding streambanks. Bank erosion is estimated at 530 feet in length and five feet in height | 23,400 | 8.3 |
| RHD-01[b] | Stream rehabilitation, naturalization, or bank stabilization to address eroding streambanks. Two erosion sites both estimated to be 20 feet in length and four and one foot in height | 400 | 0.2 |
| RRC-01[b] | Stream rehabilitation, naturalization, or bank stabilization to address eroding banks on East Branch Root River Canal. Bank erosion is estimated to be 75 feet in length and three feet in height | 2,200 | 0.6 |
| RRC-05[b] | Stream rehabilitation, naturalization, or bank stabilization to address eroding banks on East Branch Root River Canal. Three erosion sites estimated at 30, 40, and 30 feet in length and two, two, and eight feet in height, respectively | 3,800 | 1.1 |
| RRC-06[b] | Stream rehabilitation, naturalization, or bank stabilization to address erosion along cliff on Raymond Creek. Bank erosion is estimated to be 30 feet in length and 10 feet in height | 9,800 | 2.5 |
| URR-05[b] | Streambank stabilization or rehabilitation project to address erosion and debris jams. Bank erosion is estimated to be 620 feet in length and 10 feet in height | 189,800 | 58.4 |
| URR-17[b] | Streambank stabilization or rehabilitation project to address erosion. Bank erosion estimated to be 300 feet in length and three feet in height | 9,000 | 2.8 |
| URR-19[b] | Stream rehabilitation, naturalization, or bank stabilization to address eroding streambanks. Bank erosion lengths are estimated to be 580 and 340 feet in length and three and four feet in height, respectively | 29,800 | 9.2 |
| URR-20[b] | Stream rehabilitation, naturalization, or bank stabilization to address eroding streambanks. Bank erosion length is estimated to be 375 feet in length and two feet in height | 7,800 | 2.1 |
| URR-21[b] | Stream rehabilitation, naturalization, or bank stabilization to address eroding streambanks. Bank erosion is estimated to be 960 feet in length and 2.5 feet in height | 23,200 | 7.2 |
| LRJ-04A | Bank stabilization to address bank erosion along 125 feet of Root River mainstem with an estimated average erosion height of two feet | 9,000 | 2.4 |
| AER-1 | Bank stabilization to address bank erosion along 1,070 feet of Root River mainstem with an estimated average erosion height of five feet | 119,400 | 33.7 |
| AER-2 | Bank stabilization to address bank erosion along 80 feet of Root River mainstem with an estimated average erosion height of six feet | 14,600 | 4.5 |
| AER-3 | Bank stabilization to address bank erosion along four sections of the Root River mainstem with lengths of 80, 85, 45, and 35 feet and respective estimated erosion heights of four, four, two, and four feet | 9,400 | 2.4 |
| AER-4 | Bank stabilization to address bank erosion along 625 feet of Root River mainstem with an estimated average erosion height of four feet (Note: the City is already in process of designing improvements in this area with construction planned in 2014) | 81,000 | 21.2 |

**Table 1 (continued)**

| ID Number (from Table 79 in SEWRPC CAPR No. 316) | Management Action | Annual Pollutant Load Reduction | |
|---|---|---|---|
| | | TSS (pounds) | Total Phosphorus (pounds) |
| AER-7 | Bank stabilization to address bank erosion along 500 feet of Root River mainstem with an estimated average erosion height of 14 feet | 73,800 | 19.3 |
| AER-8 | Bank stabilization to address bank erosion along 1,500 feet of Root River mainstem with an estimated average erosion height of 12 feet. This area has also been identified as an area to connect/expand the City's bike/pedestrian path and add park space. (Note: the City/ County are already in process of planning improvements in this area) | 189,600 | 49.6 |
| AER-9 | Bank stabilization to address four sections of moderate to high bank and ravine erosion on the Root River mainstem. Erosion section lengths are 150, 205, 60, and 80 feet in length with respective estimated average heights of six, six, eight, and eight feet (Note: the City is already in process of designing improvements in this area, with construction planned in 2014) | 33,000 | 9.7 |
| AER-10 | Bank stabilization to address three sections of bank erosion along the Root River mainstem. Erosion section lengths are 425, 390, and 38 feet each, with an estimated average height of six feet | 58,200 | 14.1 |
| MUS-E12 | Bank stabilization/protection to address erosion in close proximity to S. 124th Street. Bank erosion is estimated to be 60 feet in length and five feet in height | 9,800 | 2.5 |
| MUS-E14 | Bank stabilization/protection to address erosion in close proximity to S. 124th Street. Bank erosion is estimated to be 125 feet in length and three feet in height | 4,000 | 1.0 |
| MUS-E16 | Bank stabilization/protection to address erosion in close proximity to S. 124th Street. Bank erosion is estimated to be 180 feet in length and two feet in height | 3,800 | 1.0 |
| MUS-E30 | Bank stabilization/protection to address erosion in close proximity to S. Root River Parkway. Bank erosion is estimated to be 210 feet in length and two feet in height | 4,200 | 1.3 |
| MUS-E31 | Bank stabilization/protection to address erosion in close proximity to S. Root River Parkway. Bank erosion is estimated to be 285 feet in length and two feet in height | 5,600 | 1.7 |
| MUS-E33 | Bank stabilization/protection to address erosion in close proximity to S. Root River Parkway. Bank erosion is estimated to be 230 feet in length and three feet in height | 6,800 | 2.1 |
| MUS-E60 | Bank stabilization/protection to address erosion progressing toward Oak Leaf Trail bridge footings. Bank erosion is estimated to be 200 feet in length and five feet in height | 30,600 | 9.4 |
| MUS-E82 | Bank stabilization/protection to address erosion in close proximity to S. Root River Parkway. Bank erosion is estimated to be 100 feet in length and three feet in height | 3,000 | 0.9 |
| MUS-E96 | Bank stabilization/protection to address erosion in S. Root River Parkway. Bank erosion is estimated to be 430 feet in length and three feet in height | 13,600 | 3.6 |
| MUS-E106 | Bank stabilization/protection to address erosion in S. Root River Parkway. Bank erosion is estimated to be 315 feet in length and four feet in height | 12,600 | 3.9 |
| MUS-E116 | Bank stabilization/protection to address erosion in N. Root River Parkway. Bank erosion is estimated to be 200 feet in length and four feet in height | 8,400 | 2.2 |
| MUS-E140 | Bank stabilization/protection to address erosion in close proximity to Drexel Avenue and the Drexel Avenue culverts. Bank erosion is estimated to be 100 feet in length and two feet in height | 2,200 | 0.6 |
| MUS-E179 | Bank stabilization/protection to address erosion progressing toward STH 100. Bank erosion is estimated to be 150 feet in length and three feet in height | 13,800 | 4.2 |

**Table 1 (continued)**

| ID Number (from Table 79 in SEWRPC CAPR No. 316) | Management Action | Annual Pollutant Load Reduction | |
|---|---|---|---|
| | | TSS (pounds) | Total Phosphorus (pounds) |
| MUS-E208 | Bank stabilization/protection to address erosion in close proximity to the Oakwood Road crossing. Bank erosion is estimated to be 120 feet in length and two feet in height | 7,400 | 2.3 |
| MUS-E224 | Bank stabilization/protection to address erosion in close proximity to an electrical utility tower. Bank erosion is estimated to be 100 feet in length and two feet in height | 2,000 | 0.6 |
| MUS-E226 | Bank stabilization/protection to address erosion in close proximity to 60th Street. Bank erosion is estimated to be 140 feet in length and two feet in height | 2,800 | 0.9 |
| MUS-E266 | Bank stabilization/protection to address erosion in close proximity to mobile home in Franklin Mobile Estates. Bank erosion is estimated to be 40 feet in length and two feet in height | 2,400 | 0.7 |
| MUS-E267 | Bank stabilization/protection to address erosion in close proximity to mobile home in Franklin Mobile Estates. Bank erosion is estimated to be 40 feet in length and two feet in height | 800 | 0.2 |
| RPC-HE1, 2 | Bank stabilization to address severe erosion along 65 feet and 80 feet of Hoods Creek. Erosion heights are estimated at seven feet and nine feet, respectively. Place fence along embankment to reduce dog access | 47,600 | 12.4 |
| RPC-HE4 | Bank stabilization to address bank erosion along 120 feet of Hoods Creek. Average erosion height is estimated to be four feet | 15,600 | 4.1 |
| RPC-HE6, 7, 8, 9 | Bank stabilization to address erosion of 30, 120, 100, and 45 feet in length along Hoods Creek. Erosion heights are estimated to be three, four, 3.5, and five feet, respectively | 16,800 | 4.4 |
| RPC-HE12 | Bank stabilization to address bank erosion along about 50 feet of Hoods Creek. Removal of old bridge footings should be considered to prevent continued scour. Average erosion height is estimated to be five feet | 8,200 | 2.1 |
| RPC-HE14 | Bank stabilization to address severe bank erosion along about 120 feet of Hoods Creek. Removal of old bridge footings should be considered to prevent continued scour. Average erosion height is estimated to be nine feet | 43,800 | 11.5 |
| RPC-HE22 | Bank stabilization to address bank erosion along 175 feet of Hoods Creek in close proximity to the Hoods Creek Road crossing. Average erosion height is estimated to be three feet | 17,000 | 4.5 |
| RPC-HE23, 24 | Bank stabilization to address bank erosion along 40 feet of Hoods Creek in close proximity to the Hoods Creek Road crossing with an erosion height estimated at four feet; bank stabilization to address bank erosion along 80 feet of Hoods Creek, with an estimated average erosion height of 3.5 feet | 4,600 | 1.2 |
| RPC-HE25 | Bank stabilization to address bank erosion along 200 feet of Hoods Creek in close proximity to the Hoods Creek Road crossing. Average erosion height is estimated to be 3.5 feet | 7,400 | 1.9 |
| RPC-HE26, 27, 28a, 29, 30 | Bank stabilization to address erosion along Hoods Creek of 300, 250, 50, 40, and 200 feet. Average erosion heights are estimated to be seven, four, six, six, and six feet, respectively. Site HE26 has a high priority due to its proximity to a private driveway crossing; Site HE30 has a high priority due to its proximity to a private dam | 134,200 | 35.8 |
| RPC-HE31, 32, 33 | Bank stabilization to address bank erosion along Hoods Creek of 40, 125, and 60 feet in length, respectively. Average erosion heights are estimated to be six, 5.5, and 10 feet, respectively | 49,400 | 12.9 |
| RPC-HE36 | Bank stabilization to address bank erosion along 90 feet of Hoods Creek. Average erosion height is estimated to be nine feet. Erosion is in close proximity to stormwater detention basin outflow channel located on Jamestown Limited property | 26,200 | 6.9 |

**Table 1 (continued)**

| ID Number (from Table 79 in SEWRPC CAPR No. 316) | Management Action | Annual Pollutant Load Reduction | |
|---|---|---|---|
| | | TSS (pounds) | Total Phosphorus (pounds) |
| RPC-HE39 | Bank stabilization to address bank erosion along 100 feet of Hoods Creek. Average erosion height is estimated to be six feet. Erosion is in close proximity to a residential garage | 19,400 | 5.1 |
| RPC-HE40, 41, 42, 43, 44, 46 | Bank stabilization to address erosion along Hoods Creek of 50, 100, 150, 75, 45, and 100 feet, respectively. Average erosion heights are estimated to be three, four, 3.5, six, five, and four feet, respectively | 45,400 | 11.9 |
| RPC-HE52 | Bank stabilization to address bank erosion along 100 feet of Hoods Creek. Average erosion height is estimated to be six feet. Erosion is in close proximity to a stormwater outlet and Airline Road | 6,400 | 2.0 |
| RPC-HE54, 55, 56, 57, 58,59, 60, 61, 62 | Bank stabilization to address bank erosion along Hoods Creek of 75, 150, 100, 40, 80, 50, 100, 75, and 50 feet, respectively. Average erosion heights are estimated to be 3.5, four, four, four, six, four, five, three, and 3.5 feet, respectively | 83,600 | 30.5 |
| RPC-HE63 | Bank stabilization to address bank erosion along 60 feet of Hoods Creek. Average erosion height is estimated to be five feet | 9,200 | 2.8 |
| RPCHE67, 69 | Bank stabilization to address bank erosion along 250 feet, and 60 feet of Hoods Creek, respectively. Average erosion heights are estimated to be 3.5 feet, and 15 feet, respectively | 61,200 | 18.8 |
| RPC-HE73 | Bank stabilization to address bank erosion along 60 feet of Hoods Creek. Average erosion height is estimated to be 15 feet | 34,400 | 10.6 |
| RPC-HE76 | Bank stabilization to address bank erosion along 30 feet of Hoods Creek. Average erosion height is estimated to be 12 feet | 11,000 | 3.4 |
| RPC-HE77, 78, 79 | Bank stabilization to address bank erosion along 25, 20, and 25 feet of Hoods Creek, respectively. Average erosion heights are estimated to be six, eight, and 10 feet, respectively. Could be combined with projects aimed at remeandering channelized stream reaches, address tile drainage, and reconnecting the stream to a constructed floodplain bench in areas of severe incision in agricultural areas (see LRC-02) | 17,000 | 5.3 |
| RPC-HE80 | Bank stabilization to address bank erosion along 100 feet of Hoods Creek. Average erosion height is estimated to be nine feet | 27,600 | 8.5 |
| RPC-HE81 | Bank stabilization to address bank erosion along 75 feet of Hoods Creek. Average erosion height is estimated to be 12 feet. Could be combined with projects aimed at remeandering channelized stream reaches, address tile drainage, and reconnecting the stream to a constructed floodplain bench in areas of severe incision in agricultural areas (see LRC-02) | 27,600 | 8.5 |
| RPC-RE2 | Bank stabilization to address bank erosion along 60 feet of the mainstem of the Root River. Average erosion height is estimated to be six feet | 11,600 | 3.1 |
| RPC-RE5 | Bank stabilization to address bank erosion along 50 feet of the mainstem of the Root River. Average erosion height is estimated to be four feet | 6,200 | 1.9 |
| RPC-RE 8 | Bank stabilization to address bank erosion along 70 feet of the mainstem of the Root River in Johnson Park. Average erosion height is estimated to be four feet | 9,000 | 2.4 |
| RPC-RE12 | Bank stabilization to address bank erosion along 600 feet of the mainstem of the Root River. Average erosion height is estimated to be four feet. Adjust mowing protocol to leave unmowed area along streambank. Add designated fishing area | 23,800 | 7.4 |
| RPC-RE13 | Bank stabilization to address bank erosion along 500 feet of the mainstem of the Root River. Average erosion height is estimated to be six feet | 91,800 | 28.3 |

**Table 1 (continued)**

| ID Number (from Table 79 in SEWRPC CAPR No. 316) | Management Action | Annual Pollutant Load Reduction | |
|---|---|---|---|
| | | TSS (pounds) | Total Phosphorus (pounds) |
| RPC-RE15 | Bank stabilization and extension of existing rock toe downstream to address bank erosion along 50 feet of the mainstem of the Root River. Average erosion height is estimated to be 12 feet | 19,400 | 5.1 |
| RPC-RE18 | Bank stabilization to address bank erosion along 245 feet of the mainstem of the Root River. Average erosion height is estimated to be five feet | 37,400 | 11.5 |
| RPC-RE20 | Bank stabilization to address bank erosion along 240 feet of the mainstem of the Root River. Average erosion height is estimated to be five feet | 36,800 | 11.3 |
| RPC-RE21 | Bank stabilization to address bank erosion along 150 feet of the mainstem of the Root River. Average erosion height is estimated to be five feet | 23,000 | 7.1 |
| RPC-RE24 | Bank stabilization to address bank erosion along 590 feet of the mainstem of the Root River. Average erosion height is estimated to be five feet | 90,200 | 27.8 |
| RPC-RE34 | Bank stabilization to address bank erosion along 740 feet of the mainstem of the Root River. Average erosion height is estimated to be four feet | 92,400 | 27.0 |
| RPC-RE36, 37 | Bank stabilization to address bank erosion along 20 feet and 160 feet of the mainstem of the Root River. Average erosion heights are estimated to be eight feet and seven feet, respectively | 39,400 | 12.0 |
| RPC-RE38, 39, 40, 41, 42 | Bank stabilization to address bank erosion along 400, 80, 80, 100, and 120 feet of the mainstem of the Root River. Average erosion heights are estimated to be five, six, four, six, and five feet, respectively | 110,400 | 33.9 |
| RPC-RE43, 44 | Bank stabilization to address bank erosion along 80 feet and 200 feet of the mainstem of the Root River. Average erosion height is estimated to be six feet for both sites | 51,400 | 15.8 |
| RPC-RE45, 46, 47, 48 | Bank stabilization to address bank erosion along 80, 200, 240, and 160 feet of the mainstem of the Root River. Average erosion heights are estimated to be five, 10, five, and five feet, respectively | 111,800 | 32.7 |
| RPC-RE49, 50, 51, 52, 53, 54, 55 | Bank stabilization to address bank erosion along 80, 80, 520, 130, 300, 200, and 240 feet of the mainstem of the Root River. Average erosion heights are estimated to be four, four, six, four, five, five, and five feet, respectively | 240,200 | 72.0 |
| RPC-RE56 | Bank stabilization to address bank erosion along 50 feet of the mainstem of the Root River. Erosion is within one stream width of a residential structure. Average erosion height is estimated to be four feet | 2,200 | 0.6 |
| RPC-RE57, 58, 59 | Bank stabilization to address bank erosion along 75, 100, and 290 feet of the mainstem of the Root River. Average erosion heights are estimated to be five, four, and four feet, respectively | 20,400 | 5.3 |
| RPC-RE60 | Bank stabilization to address bank erosion along 50 feet of the mainstem of the Root River. Erosion is located at an outlet of a pond. Average erosion height is estimated to be five feet | 8,200 | 2.1 |
| RPC-RE61, 62 | Bank stabilization to address bank erosion along 75 feet and 130 feet of the mainstem of the Root River. Average erosion heights are estimated to be seven feet and five feet, respectively | 26,600 | 5.9 |
| RPC-RE64, 65 | Bank stabilization to address bank erosion along 170 and 80 feet of the mainstem of the Root River. Average erosion heights are estimated to be seven feet and six feet, respectively | 54,200 | 14.2 |
| RPC-RE66, 67, 68, 71, 72, 73 | Bank stabilization to address bank erosion along 150, 880, 50, 200, 100, and 200 feet of the mainstem of the Root River. Average erosion heights are estimated to be 10, seven, 10, four, five, and four feet, respectively | 306,400 | 87.0 |

**Table 1 (continued)**

| ID Number (from Table 79 in SEWRPC CAPR No. 316) | Management Action | Annual Pollutant Load Reduction | |
|---|---|---|---|
| | | TSS (pounds) | Total Phosphorus (pounds) |
| RPC-RE69, 70 | Bank stabilization to address bank erosion along 425 feet and 300 feet of the mainstem of the Root River. Average erosion height is estimated to be seven feet and eight feet, respectively | 120,800 | 32.3 |
| RCL-02 | Installation of agricultural BMPs including: grade stabilization structure 78 feet long; subsurface drain 1,542 feet long; grassed waterway 1,354 feet long; two underground outlets, 1,165 feet and 440 feet long; and three water and sediment control basins | 200,184 | 61.6 |
| RCL-03 | Installation of agricultural BMPs including: grassed waterway 392 feet long and two lined waterway outlets 20 feet and 16 feet long | 11,843 | 2.7 |
| RCL-04 | Installation of agricultural BMPs including: four grassed waterways 1,450, 900, 1,945, and 520 feet long; five subsurface drains 1,314, 1,340, 930, 529, and 1,844 feet long; and an underground outlet 76 feet long | 411,430 | 126.7 |
| RCL-05 | Installation of agricultural BMPs including: three grassed waterways 1,116, 347, and 480 feet long; and one lined waterway outlet | 222,963 | 68.7 |
| RCL-06 | Installation of agricultural BMPs including: one 1,138-foot-long grassed waterway; and one 1,138-foot-long subsurface drain | 156,134 | 48.1 |
| RCL-07 | Installation of one 650-foot-long grassed waterway | 33,841 | 10.4 |
| RCL-08 | Streambank protection structures to address erosion along 165-foot and 75-foot sections of the West Branch Root River Canal with respective estimated average erosion heights of eight and four feet | 79,600 | 24.5 |
| RCL-09 | Installation of agricultural BMPs including: one 1,050-feet-long grassed waterway; and one 1,050-foot-long subsurface drain | 144,060 | 44.4 |

[a]*This table provides additional and revised quantification for selected management measures listed in Table 79 of SEWRPC Community Assistance Planning Report No. 316 (CAPR No. 316),* A Restoration Plan for the Root River Watershed, *July 2014. The annual pollutant load reductions provided in this table supersede load reductions reported in Table 79 and Table 90 of the aforementioned report.*

[b]*Capital costs and annual operations and maintenance costs, respectively, for the specified bank stabilization projects not included in Table 79 of CAPR No. 316 are estimated as follows: LRC-07, $19,800 and $1,200; MRR-11, $99,000 and $5,900; MRR-17, $174,900 and $10,500; RHD-01, $6,600 and $400; RRC-01, $24,750 and $1,500; RRC-05, $33,000 and $1,980; RRC-06, $9,900 and $600; URR-05, $204,600 and $12,300; URR-17, $99,000 and $5,900; URR-19, $303,600 and $18,200; URR-20, $123,750 and $7,400; URR-21, $316,800 and $19,000.*

*Source: SEWRPC.*

The STEPL model was used to estimate the pollutant load reductions that could be achieved if the grassed waterway projects recommended in Table 79 of the Root River watershed restoration plan[8] were implemented. The STEPL model calculates pollutant loads for gullies formed on agricultural fields based on the top width and bottom width of the gully, the depth of the gully, the length of the gully, the estimated number of years required to form the gully, and the soil textural class of the field in which the gully is located. A BMP efficiency rate of 0.70 was applied to the total load to account for any load that may not be captured by the installed grassed waterway. Due to the nature of agricultural field gully erosion, it was assumed that only 70 percent of the remaining load would be actually delivered to the receiving waterbody. Pollutant load reduction estimates for TSS and total phosphorus are provided for grassed waterway projects RCL-02 through RCL-07, and RCL-09 in Table 1.

[8]Ibid.

## ANIMAL AGRICULTURE

In their review comments, WDNR and USEPA requested clarification regarding management measures related to animal agriculture in the Root River watershed restoration plan. The comments asked specifically for quantification of several items related to animal agriculture, including:

- The number of animal agriculture operations located within the watershed,
- The estimated average herd size per operation,
- The management measures related to animal agriculture needed in the watershed, and
- The estimated reduction in pollutant loading resulting from implementation of these management measures.

The number of animal agriculture operations in the watershed and the average herd size were estimated using data from the 2012 national agricultural census.[9,10] The national agricultural census presents data on the numbers of animal agriculture operations and animals within each county. To derive estimates of the number of animal agriculture operations and animals in the watershed, a proration factor was calculated for each county. This factor was calculated by dividing the area of the Root River watershed located within the county by the area of the county. The number of agriculture operations raising each type of animal in the portion of the Root River watershed located in the county was estimated by multiplying the number of agriculture operations in the county raising that type of animal by the proration factor. The estimate was rounded to the nearest whole number. For each type of animal, the average herd size per animal agriculture operation was estimated by dividing the total number of animals in the county by the number of agriculture operations in the county raising that type of animal. Table 2 shows the estimated number of agricultural operations raising different farm animals in the Root River watershed.

Two methods were used to assess the reasonableness of these estimates. First, the estimated number of dairy farms in the watershed was compared to milk producer license data from the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP). The DATCP license data indicated that in 2014, there were 11 licensed dairy operations wholly located within the Root River watershed and two licensed dairy operations partially located in the watershed. This agreed well with the estimate of 12 dairy operations that was made using the data from the national agricultural census (see Table 2). Second, Racine County Land Conservation Division staff was consulted regarding reasonableness of the estimates. With two exceptions they found that the estimates derived from the national agricultural census data were representative of the Racine County portion of the Root River watershed. The number of horse operations and the average herd size at horse operations were the exceptions. County staff indicated that the estimates derived from the national agricultural census, 48 operations with an average herd size of seven animals per operations, underestimate the number of horse operations and the average herd size in the portion of the watershed located within Racine County. Given

[9] *U.S. Department of Agriculture National Agricultural Statistics Service,* 2012 Census of Agriculture: Wisconsin State and County Data, *Volume 1, Geographic Area Series Part 49, Publication AC-12-A-49, May 2014.*

[10] *Specific data were not available regarding the number of animal agriculture operations in the Root River watershed and the average sizes of the animal herds at these operations. As shown below, based on review by the Racine County Land Conservationist and comparison with watershed-specific dairy license data provided by Wisconsin Department of Agriculture, Trade & Consumer Protection, these estimates were found to be reasonable.*

**Table 2**

**ESTIMATED NUMBER OF ANIMAL AGRICULTURE OPERATIONS AND HERD SIZES IN THE ROOT RIVER WATERSHED: 2012**

| | Animal Operations in County | Watershed Area in the County (acres) | County Area (acres) | Proration Factor[a] | Estimated Animal Operations in Watershed[b] | Animals in County | Estimated Average Herd Size[c] |
|---|---|---|---|---|---|---|---|
| Kenosha County | | | | | | | |
| Horses | 99 | 1,762.8 | 178,202.0 | 0.0099 | 1 | 912 | 9 |
| Milwaukee County | | | | | | | |
| Layers (chickens) | 10 | 36,930.2 | 155,349.0 | 0.2377 | 2 | 409 | 41 |
| Racine County | | | | | | | |
| Beef Cattle | 55 | 79,352.1 | 217,969.0 | 0.3641 | 20 | 754 | 14 |
| Dairy Cattle | 32 | 79,352.1 | 217,969.0 | 0.3641 | 12 | 3,246 | 101 |
| Hogs/Pigs | 19 | 79,352.1 | 217,969.0 | 0.3641 | 7 | 1,108 | 121 |
| Sheep/Lambs | 27 | 79,352.1 | 217,969.0 | 0.3641 | 10 | 382 | 15 |
| Horses | 133 | 79,352.1 | 217,969.0 | 0.3641 | 60[d] | 956 | 10[d] |
| Layers (chickens) | 59 | 79,352.1 | 217,969.0 | 0.3641 | 21 | 2,616 | 44 |
| Pullets (chickens) | 7 | 79,352.1 | 217,969.0 | 0.3641 | 3 | 568 | 81 |
| Broilers (chickens) | 22 | 79,352.1 | 217,969.0 | 0.3641 | 8 | 2,063 | 94 |
| Waukesha County | | | | | | | |
| Beef Cattle | 58 | 8,438.9 | 371,558.0 | 0.0227 | 1 | 581 | 10 |
| Horses | 172 | 8,438.9 | 371,558.0 | 0.0227 | 4 | 1,887 | 11 |
| Layers (chickens) | 67 | 8,438.9 | 371,558.0 | 0.0227 | 2 | 2,419 | 36 |

[a] *Calculated by dividing the watershed area in the County by the area of the County.*

[b] *Estimated by multiplying the reported number of animal operations in the County by the proration factor and rounding to the nearest whole number.*

[c] *Estimated by dividing the reported number of animals in the County by the reported number of animal operations raising that animal in the County.*

[d] *As estimated by the Racine County Conservationist.*

*Source: National Agricultural Statistics Service, Racine County Land Conservation Division, and SEWRPC.*

that the national agricultural census defines a farm as "any place from which $1,000 or more of agricultural products were produced and sold, or normally would have been sold, during the census year,"[11] it is likely that agricultural census results underestimate the number of small farms with horses in the four counties partially located within the Root River watershed. To account for this likely underestimate, Table 2 shows estimates provided by the Racine County Land Conservation Division of 60 horse operations with an average herd size of 10 animals per operation.

It should be noted that the estimated number of animal agriculture operations given in Table 2 represents an overestimate of the actual number of animal operations in the watershed, but not an overestimation of the herd sizes or of the aggregate total phosphorus loads from animal operations. The overestimate of the number of operations occurs because Table 2 does not account for individual operations raising more than one type of animal (e.g., an operation raising both dairy and beef cattle); however the aggregate load is not affected because it is based on the estimated number of animals. The national agricultural census does not provide data on the number of animal agriculture operations raising multiple types of animals. The Racine County Land Conservation Division staff estimated that there are currently about 100 animal operations in the portion of the Root River watershed located in Racine County, as opposed to the 141 given in Table 2. Based on this, the number of animal agriculture operations in the portion of the Root River watershed located in Racine County is estimated at 100.[12] Because the estimated number of animal operations in the portions of the watershed located in Kenosha, Milwaukee, and Waukesha Counties is small, these estimates were not adjusted to account for agriculture operations raising more than one type of animal.

Table 3 shows the estimated annual amount of manure generated by the animal agriculture operations in the watershed. The per animal manure production rates in the table were taken from the Wisconsin manure quantity estimation worksheet,[13] a planning tool made available to farmers by DATCP. The production rates in the worksheet are taken from a review by the Midwest Plan Service.[14] The following assumptions were made to estimate the annual quantity of manure generated at individual animal agriculture operations and the total annual quantity of manure generated within the watershed:

- Beef cattle consisted of beef cows weighing 1,000 pounds,
- Dairy cattle consisted of lactating cows weighing 1,400 pounds,
- Hogs and pigs consisted of gestating sows weighing 275 pounds,
- Sheep and lambs consisted of sheep weighing 100 pounds,
- Horses consisted of horses weighing 1,000 pounds,
- Layers consisted of chickens weighing four pounds,
- Broilers consisted of chickens weighing two pounds, and
- Pullets consisted of chickens weighing two pounds.

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[11] Ibid.

[12] *Estimates related to the number of animal operations requiring manure storage and the cost of such storage per farm, as described below, were based on there being 100 operations within Racine County.*

[13] *Wisconsin Department of Agriculture, Trade and Consumer Protections, "Wisconsin Manure Quantity Estimation Worksheet," September 1, 2003.*

[14] *Midwest Plan Service*, Manure Characteristics, *Section 1, Publication Number MWPS-18, 2000.*

**Table 3**

**ESTIMATED ANNUAL MASS OF MANURE AND PHOSPHORUS PRODUCED AT ANIMAL AGRICULTURE OPERATIONS IN THE ROOT RIVER WATERSHED: 2012**

| | Estimated Animal Operations in Watershed | Estimated Average Herd Size | Manure Production Rate (pounds per animal per day) | Average Annual Manure Production (pounds per operation) | Manure Phosphorus Content (pounds P per ton manure) | Average Annual Phosphorus Production (pounds P per operation) | Total Annual Phosphorus Production (pounds P per county) |
|---|---|---|---|---|---|---|---|
| Kenosha County | | | | | | | |
| Horses | 1 | 9 | 50.00 | 164,250 | 2.6 | 214 | 214 |
| Milwaukee County | | | | | | | |
| Layers (chickens) | 2 | 41 | 0.26 | 3,891 | 19.2 | 37 | 74 |
| Racine County | | | | | | | |
| Beef Cattle | 20 | 14 | 63.00 | 321,930 | 3.5 | 563 | 11,260 |
| Dairy Cattle | 12 | 101 | 148.00 | 5,456,020 | 1.7 | 4,638 | 55,656 |
| Hogs/Pigs | 7 | 121 | 7.50 | 331,238 | 5.7 | 944 | 6,608 |
| Sheep/Lambs | 10 | 15 | 4.00 | 21,900 | 3.9 | 43 | 430 |
| Horses | 60 | 10 | 50.00 | 182,500 | 2.6 | 237 | 14,220 |
| Layers (chickens) | 21 | 44 | 0.26 | 4,176 | 19.2 | 40 | 840 |
| Pullets (chickens) | 3 | 81 | 0.18 | 5,322 | 19.2 | 51 | 153 |
| Broilers (chickens) | 8 | 94 | 0.18 | 6,176 | 19.2 | 59 | 472 |
| Waukesha County | | | | | | | |
| Beef Cattle | 1 | 10 | 63.00 | 229,950 | 3.5 | 402 | 402 |
| Horses | 4 | 11 | 50.00 | 200,750 | 2.6 | 261 | 1,044 |
| Layers (chickens) | 2 | 36 | 0.26 | 3,416 | 19.2 | 33 | 66 |
| Total | - - | - - | - - | - - | - - | - - | 91,439 |

*Source: National Agricultural Statistics Service, University of Wisconsin-Extension, and SEWRPC.*

Table 3 also shows the estimated mass of phosphorus contained in the estimated annual amount of manure generated by the animal agriculture operations in the watershed. Typical phosphorus content of different manures was taken from a University of Wisconsin-Extension guidance document for nutrient application on croplands.[15] Based upon the data in Table 3, the annual amount of manure produced by animal agriculture operations located within the Root River watershed is estimated at 533,453 tons. This manure is estimated as containing 91,439 pounds of phosphorus.

It should be noted that not all of the phosphorus that is contained in manure applied to agricultural fields is lost to surface waters. The fraction of applied phosphorus lost to surface waters varies depending upon soil types, application rates, soil slopes, field history, crops grown, degree of incorporation of the manure into the soil, and weather conditions following applications. In studies examining a variety of systems, the percentage of phosphorus in manure applied to agricultural lands that was lost to surface waters ranged from less than 1 percent to about 20 percent.[16] Given that much of the agricultural land in the Root River is drained by tile drainage, it is likely that a relatively large percentage of the phosphorus contained in manure applied to agricultural lands is lost to surface waters. Thus, it was assumed that, in the absence of adequate containment and storage, 15 percent of phosphorus contained in manure applied to agricultural lands in the Root River watershed is lost to surface waters.

The Racine County Land Conservation Division estimates that about 17 percent of the animal agriculture operations in the portion of the Root River watershed that is located in Racine County have adequate manure containment and storage to enable the operations to spread manure on fields twice annually during periods when the ground would not be frozen prior to spring planting and after summer and fall harvest. Based on this, it is estimated that manure storage facilities should be installed at 83 animal operations in the portions of the Root River watershed in Racine County. Similar estimates were not available for animal agriculture operations located in portions of the watershed in Kenosha, Milwaukee, and Waukesha Counties; however, only a small number of animal agriculture operations are estimated to be present in these portions of the watershed. Given that only 0 percent to 4 percent of the cropland in these counties is covered by nutrient management plans,[17] it is likely that few of these operations have adequate manure containment and storage. Based on this, it was assumed that none of the operations in these three counties currently have adequate manure storage and containment. Manure storage facilities should be installed at one animal agriculture operation in the portion of the watershed located in Kenosha County, two animal agriculture operations in the portion of the watershed located in Milwaukee County, and seven animal agriculture operations in the portion of the watershed located in Waukesha County.

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[15]*Carrie A.M. Laboski and John B. Peters,* Nutrient Application Guidelines for Field, Vegetable, and Fruit Crops in Wisconsin, *University of Wisconsin-Extension Publication No. A2809, 2012.*

[16]*Daniel G. Galone, "Calibration of Paired Basins Prior to Streambank Fencing of Land,"* Journal of Environmental Quality, *Volume 28, pages 1,853-1,863, 1999; G. C. Heathman, A.N. Sharpley, S.J. Smith, and J.S. Robinson, "Land Application of Poultry Litter and Water Quality in Oklahoma, U.S.A.,"* Fertilizer Research, *Volume 40, pages 165-173, 1995; P.S. Hooda, A.C. Edwards, H.A. Anderson, and A. Miller, "A Review of Water Quality Concerns in Livestock Farming Areas,"* The Science of the Total Environment, *Volume 250, pages 143-167, 2000; William E. Jokela and Michael D. Casler, "Transport of Phosphorus and Nitrogen in Surface Runoff in a Corn Silage System: Paired Watershed Methodology and Calibration Period Results,"* Canadian Journal of Soil Science, *Volume 91, pages 479-491, 2011; Antonio P. Mallarino, Mazhar Ul Haq, Matthew J. Helmers, and Ryan Rusk, "Crop Yields and Phosphorus Loss with Surface Runoff as Affected by Tillage Systems and Phosphorus Sources,"* Iowa State Research Farm Progress Reports, *Paper 415, 2009; and Joann K. Whalen and Chi Chang, "Phosphorus Accumulation in Cultivated Soils from Long-Term Annual Applications of Cattle Feedlot Manure,"* Journal of Environmental Quality, *Volume 30, pages 229-237, 2001.*

[17]*Wisconsin Department of Agriculture, Trade and Consumer Protection,* Wisconsin Nutrient Management Update & Quality Assurance Team Review of 2014's Nutrient Management Plans, *November 2014.*

**Table 4**

**ESTIMATED ANNUAL MANURE AND PHOSPHORUS PRODUCTION AT THE "TYPICAL" ANIMAL AGRICULTURE OPERATION IN THE RACINE COUNTY PORTION OF THE ROOT RIVER WATERSHED**

| Animal | Herd Size | Daily Manure Production (pounds per animal) | Annual Manure Production (tons) | Manure Phosphorus Content (pounds per ton) | Annual Phosphorus Production (pounds) |
|---|---|---|---|---|---|
| Beef Cattle | 2.80 | 63.00 | 32.2 | 3.5 | 113 |
| Dairy Cattle | 12.12 | 115.00 | 254.4 | 1.7 | 432 |
| Hogs/Pigs | 8.47 | 7.50 | 11.6 | 5.7 | 66 |
| Sheep/Lambs | 1.50 | 4.00 | 1.1 | 3.9 | 4 |
| Horses | 6.00 | 50.00 | 55.0 | 2.6 | 142 |
| Layers (chickens) | 9.24 | 0.26 | 0.4 | 19.2 | 8 |
| Pullets (chickens) | 2.43 | 0.18 | <0.1 | 19.2 | 2 |
| Broilers (chickens) | 7.52 | 0.18 | 0.5 | 19.2 | 5 |
| Total | 50.08 | - - | 355.2 | - - | 772 |

*Source: SEWRPC.*

For the portions of the watershed located in Kenosha, Milwaukee, and Waukesha Counties, the estimates of the numbers and types of animal agriculture operations shown in Table 3 were used for the purposes of estimating the number of operations requiring manure storage and the pollutant load reductions that would result from installing such storage. Because the estimated number of animal agriculture operations in Racine County was adjusted to account for some operations rearing more than one type of animal, a profile was created of the "typical" animal agriculture operation in the portion of the watershed located in Racine County. This typical operation was developed by dividing the estimated number of each type of agricultural animal in this portion of the watershed by the estimated number of animal operations in this portion of the watershed. The characteristics of this "typical" operation are shown in Table 4. On an annual basis, such an operation would produce about 355 tons of manure containing about 772 pounds of phosphorus. This "typical" operation was used for the purposes of estimating the number of animal agriculture operations requiring manure storage, the amount of storage needed, and the pollutant load reductions that would result from installing such storage.

It was the best professional judgment of the Racine County Land Conservation Division staff that provision of adequate manure containment and storage would enable the animal agriculture operations to spread manure on fields twice annually during periods when the ground would not be frozen prior to spring planting and after summer and fall harvest and that this would result in reducing the amount of phosphorus applied in manure that enters surface waters by about 80 percent when compared to operations without this practice. This estimate was used to estimate the pollutant load reductions that would result from provision of manure storage capacity at animal agriculture operations in the Root River watershed.

Table 5 presents the estimated number of animal agricultural operations requiring provision of manure storage facilities, the required manure storage capacity needed by these operations to provide storage of manure for six months, and the estimated reduction in total phosphorus loads that would result from providing such storage.[18]

[18]*The estimation of the potential load reductions from providing six months of manure storage was made assuming that the storage would most effectively be used to avoid winter spreading on frozen ground over an approximately six-month period. Thus, half of the annual amount of manure available for spreading was used to estimate the load reductions. The provision of six months of storage would also enable spreading to be strategically accomplished to avoid rainy periods during the other six months of the year, but any reduction in delivered load due to that approach would be highly dependent upon the occurrence of rain and would be difficult to estimate. Thus, no reduction was claimed for the ability to better time spreading in the warmer months of the year.*

**Table 5**

**ADDITIONAL MANURE STORAGE CAPACITY RECOMMENDED TO PROVIDE SIX MONTHS MANURE STORAGE FOR THE ROOT RIVER WATERSHED**

| Animal Operations | Animal Agriculture Operations | Manure Storage Capacity (tons per operation) | Estimated Annual Phosphorus Load Reduction (pounds per operation) | Total Manure Storage Capacity (tons) | Estimated Total Annual Phosphorus Load Reduction (pounds) |
|---|---|---|---|---|---|
| Kenosha County | | | | | |
| Horses | 1 | 41[a] | 12.4 | 41 | 12.4 |
| Milwaukee County | | | | | |
| Layers (chickens) | 2 | 1[b] | 2.2 | 2 | 4.5 |
| Racine County | | | | | |
| "Typical" Animal Operation[c] | 83 | 178[c] | 46.3 | 14,774 | 3,842.9 |
| Waukesha County | | | | | |
| Beef Cattle | 1 | 58[d] | 24.1 | 58 | 24.1 |
| Horses | 4 | 50[d] | 15.7 | 200 | 62.8 |
| Layers (chickens) | 2 | 1[d] | 2.0 | 2 | 4.0 |
| Total | 93 | - - | - - | 15,077 | 3,950.6 |

NOTE: Costs of providing manure storage vary based upon the method of containment. According to inflation adjusted estimates provided by the University of Wisconsin-Extension, typical costs for providing storage for the manure produced by one dairy cow range from about $182 for a lined manure pit to $1,820 for above ground liquid storage tanks. This is the equivalent of the storage cost per ton of manure ranging between $13.48 and $134.80.

[a]*Based on the above "note," capital costs for providing manure storage to the single horse operation in the portion of the Root River watershed located in Kenosha County are estimated to range between $553 and $5,530.*

[b]*Based on the above "note," capital costs for providing manure storage to the two layer operations in the portions of the Root River watershed located in Milwaukee County are estimated to range between $28 and $280.*

[c]*Based on the above "note," capital costs for providing manure storage to 83 typical animal operations requiring manure storage in the portion of the Root River watershed located in Racine County are estimated to range between $199,200 and $1,992,000.*

[d]*Based on the above "note," capital costs for providing manure storage to the seven animal operations in the portions of the Root River watershed located in Waukesha County are estimated to range between $3,500 and $35,000.*

*Source: SEWRPC.*

The table indicates that such storage should be provided at one animal agriculture operation in the portion of the watershed located in Kenosha County, two animal agriculture operations in the portion of the watershed located in Milwaukee County, 83 animal agriculture operations in the portion of the watershed located in Racine County, and seven animal agriculture operations in the portion of the watershed located in Waukesha County. The total storage capacity needed is estimated to be 15,077 tons of manure. It is estimated that provision of this capacity would reduce annual contributions of total phosphorus to surface waters of the Root River watershed by about 7,900 pounds.

## WATER QUALITY MONITORING

In their review comments, WDNR and USEPA requested clarification regarding costs related to the water quality monitoring component of the Root River watershed restoration plan. The comments asked specifically for clarifications regarding the following recommendations:

- The costs of maintaining the existing water quality monitoring stations,
- The costs of establishing 16 additional water quality monitoring stations, and
- The costs of periodically collating and analyzing the water quality monitoring data.

The cost of maintaining the existing water quality monitoring network was estimated based upon consultations with the agencies conducting monitoring during development of the Root River WRP. Because these are existing stations, no capital costs are associated with maintaining the existing monitoring network in the Root River watershed. The annual operation and maintenance costs for these stations is estimated to be $236,130. Table 6 presents estimated costs attributable to each element of the existing monitoring network. Note that the cost estimate associated with biological monitoring conducted by the WDNR is based upon the assumption that this monitoring will be conducted once every four years.

The costs of the recommended expansion of water quality monitoring in the Root River watershed were estimated based upon consultations with the agencies that are anticipated to participate in this expansion. The capital costs associated with the expansion are estimated to be $200,450. These costs are largely associated with establishing two continuous monitoring (real-time) stations. Annual operation and maintenance costs associated with the recommended expansion of the monitoring network are estimated to be $180,110. Table 6 presents estimated costs attributable to each element of the expanded monitoring network. These cost estimates are based upon the assumption that monitoring at the additional stream stations and expanded monitoring at Quarry Lake will be conducted by the City of Racine Health Department and that monitoring at the additional lake stations will be conducted through the Wisconsin Citizen Lake Monitoring Program.

The cost of the recommended collation and analysis of monitoring data is estimated at $36,000, which is anticipated to be incurred once every 10 years.

**Table 6**

**CAPITAL AND ANNUAL OPERATIONS AND MAINTENANCE COSTS ASSOCIATED WITH THE WATER QUALITY MONITORING RECOMMENDATIONS OF THE ROOT RIVER WATERSHED RESTORATION PLAN**

| Recommendation | Capital Cost (dollars) | Annual Operation and Maintenance Cost (dollars) |
|---|---|---|
| Costs to Maintain Existing Monitoring System | | |
| Existing USGS Stream Gauges (four gauges) | - - | $ 46,400 |
| MMSD Root River Survey (six sampling stations) | - - | 38,000 |
| MMSD/USGS Toxicity Testing and Biological Monitoring (two stations) | - - | 6,200[a] |
| City of Racine Health Department Monitoring (18 stations) | - - | 152,000 |
| Quarry Lake Beach Bacteria Monitoring | - - | 6,400 |
| WDNR Biological Monitoring | - - | 2,500[b] |
| WDNR Water Chemistry Monitoring (one station) | - - | 4,500 |
| UWEX Water Action Volunteers Monitoring (four stations) | - - | 40 |
| Wisconsin Citizen Lake Monitoring Network Monitoring (one station) | - - | 90 |
| Subtotal | 0 | $256,130 |
| Costs to Expand Monitoring System | | |
| Establishing Additional Stream Monitoring Stations (16 stations) | - - | 90,100[c] |
| Establishing Continuous Monitoring Stations (two stations) | $200,000 | 89,200 |
| Establishing Lake Monitoring Stations (eight stations) | 400[d] | 720[d] |
| Expansion of Monitoring at Quarry Lake (one station) | 50[e] | 90[e] |
| Subtotal | $200,450 | $180,110 |
| Total | $200,450 | $436,240 |

[a]*The cost of this monitoring is about $18,600 for a season of monitoring. The cost listed assumes monitoring is conducted every third year.*

[b]*The cost of this monitoring is $10,000 for a season of monitoring. The cost listed assumes monitoring is conducted every fourth year.*

[c]*Cost is based on the assumption that monitoring at these stations will be conducted by the City of Racine Health Department.*

[d]*Cost is based on the assumption that monitoring at these stations will be conducted through the Wisconsin Citizen Lake Monitoring Network.*

[e]*Cost is based on the assumption that monitoring at this station will be conducted by the City of Racine Health Department.*

*Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, University of Wisconsin-Extension, City of Racine Health Department, and SEWRPC.*