SEWRPC Staff Memorandum

CONTAMINANT LOADINGS TO THE EAST TROY POND WALWORTH COUNTY, WISCONSIN

October 10, 2007

East Troy Pond provides opportunities for water-based recreational to residents of the Village of East Troy and elsewhere within the Southeastern Wisconsin Region. Currently, these opportunities are primarily in the form of the Pond providing a visual amenity for the Village of East Troy and the small residential community located on the northern shores of the Pond. The southern shores are occupied by public open space lands to the southeast and by farmlands to the southwest. The Pond provides limited opportunities for use by recreational boaters, anglers, and other recreational users, in part because the Pond has been determined by the Wisconsin Department of Natural Resources (WDNR) to lack adequate public recreational boating access.

East Troy Pond is located on Honey Creek, within the Village of East Troy in Walworth County, approximately midway along the Creek from its point of origin at the Lauderdale Lakes in the Town of LaGrange in Walworth County and its confluence with the Illinois Fox River in the City of Burlington in Racine County. Sugar Creek joins with Honey Creek downstream of Honey Lake, approximately three miles upstream of the confluence.

The Honey Creek and Sugar Creek watershed was evaluated under the Chapter NR 120 priority watershed program that the WDNR conducted in this subbasin during 1994 through 1997.[1] East Troy Pond was included in this analysis as an element within the Troy Area Subwatershed. The analysis noted that the Pond was subjected to extensive anthropogenic disturbances, including contaminant inputs from both rural and urban sources of nonpoint pollution. Rural sources included pollutants generated from agricultural activities in the upstream watershed that included cropping and pasturing, and through prior disturbances to the channel that contributed to instream sediment movements. Urban sources included pollutants generated from urban and industrial sources that included stormwater runoff and discharges from the East Troy wastewater treatment plant and local industrial plants. This subwatershed and the upstream Upper Honey Creek subwatershed were identified as high priority areas for pollution reduction.

At the time of the Sugar-Honey Creeks Priority Watershed project, assessments by the WDNR suggested that about 15,000 tons of sediment were mobilized from an approximately 30,000 acre combined watershed, the majority of which—about 13,250 tons of sediment—were generated by about 20,000 acres of cropland, the balance being contributed by grasslands, woodlands, and urban areas. Urban lands were estimated to contribute about 525 tons of sediment, or about 3 percent of the total sediment load. In contrast, about 800 pounds of phosphorus, or about 60 percent of the total phosphorus load, were estimated to be contributed to the Creek from urban sources.

Based upon this evaluation, the WDNR recommended an overall reduction in sediment loading to the entire Honey Creek watershed from rural lands of about one-third. Phosphorus load reduction goals indicated a 30 percent reduction in phosphorus loads from urban and rural areas. These recommendations refined the recommended 25 percent pollution load reductions recommended in the regional water quality management plan.[2]

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[1]*See Wisconsin Department of Natural Resources Publication No. WT-478-97,* Nonpoint Source Control Plan for the Sugar-Honey Creeks Priority Watershed Project, *February 1997.*

[2]*See SEWRPC Memorandum Report No. 93,* A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report, *March 1995.*

NONPOINT SOURCE POLLUTANT LOADS

Pollutant loads to a lake are generated by various natural processes and human activities that take place in the area tributary to a lake.[3] These loads are transported to the lake through the atmosphere, across the land surface, and by way of inflowing streams. Pollutants transported by the atmosphere are deposited onto the surface of the lake as dry fallout and direct precipitation. Pollutants transported across the land surface enter the lake as direct runoff and, indirectly, as groundwater inflows, including drainage from onsite wastewater treatment systems. Pollutants transported by streams enter a lake as surface water inflows. In addition to identifiable or point source discharges from industries and wastewater treatment facilities, nonpoint source pollutants comprise the principal route by which contaminants enter a waterbody. Nonpoint sources of water pollution include urban sources, such as runoff from residential, commercial, transportation, construction, and recreational activities; and rural sources, such as runoff from agricultural lands and onsite sewage disposal systems.

Two analytical models were used to assess the magnitudes of the external pollutant loadings to East Troy Pond. Analyses were conducted using current, year 2000 land use data compiled by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) from digital orthophotography. The total tributary area upstream of East Troy Pond was estimated to be about 35,500 acres in areal extent. This area refines the drainage area used for the WDNR priority watershed project. The difference in the measured area may be attributed to the improved survey control available to accurately establish the scale of the latter, as opposed to the earlier, photographs, and differences in the scales of the photographs.

Nonpoint-source phosphorus, suspended solids, and urban-derived metals input to and output from East Troy Pond were estimated using unit area load-based models developed for use within the Southeastern Wisconsin Region, while phosphorus loads also were assessed using the Wisconsin Lake Model Spreadsheet (WILMS version 3.0).[4] Contaminant loads were estimated for base year 2000 land use conditions. No known point sources currently exist within this drainage area. Consequently, inflows to East Troy Pond is primarily through direct precipitation onto the Lake surface and runoff from the local tributary area, including the unnamed intermittent tributaries located along the southwestern and western shores of the Lake.

Phosphorus Loadings

Year 2000 land use data were used to estimate phosphorus loads to the Pond. Phosphorus has been identified as the factor generally limiting aquatic plant growth in waterbodies throughout Southeastern Wisconsin. Thus, excessive levels of phosphorus in the Pond are likely to result in conditions that interfere with the desired uses of the Pond.

The current loading rates were evaluated during the present study using the WILMS model. The estimated nutrient load to East Troy Pond based upon 2000 land use is set forth in Table 1. The estimated phosphorus budget for East Troy Pond, based on the WILMS analysis, is set forth in Table 1 for 2000 land use conditions. An annual total phosphorus load of between about 9,500 and 37,200 pounds, with a most likely total phosphorus

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[3] *Sven-Olof Ryding and Walter Rast,* The Control of Eutrophication of Lakes and Reservoirs, *Unesco Man and the Biosphere Series, Volume 1, Parthenon Press, Carnforth, 1988; Jeffrey A. Thornton, Walter Rast, Marjorie M. Holland, Geza Jolankai, and Sven-Olof Ryding,* The Assessment and Control of Nonpoint Source Pollution of Aquatic Ecosystems, *Unesco Man and the Biosphere Series, Volume 23, Parthenon Press, Carnforth, 1999.*

[4] *John C. Panuska and Jeff C. Kreider, Wisconsin Department of Natural Resources Publication No. PUBL-WR-363-94,* Wisconsin Lake Modeling Suite Program Documentation and User's Manual, Version 3.3 for Windows, *August 2002.*

Table 1

ESTIMATED EXTERNAL SOURCES OF PHOSPHORUS IN THE TOTAL AREA TRIBUTARY TO EAST TROY POND: 2000

Source	2000	
	Pounds[a]	Percentage[a]
Urban		
High-Density (commercial and industrial uses)	3,708	17
Medium-Density (multi-family and institutional uses)	79	<1
Low-Density (single-family and suburban-density residential uses)	145	<1
Recreational Lands	46	<1
Subtotal	3,978	19
Rural		
Mixed Agriculture	17,154	78
Landfill	233	1
Wetlands	92	<1
Woodlands	438	2
Water	2	<1
Subtotal	17,919	81
Total	21,897	100

[a]*Percentages estimated from WILMS model results.*

Source: SEWRPC.

loading of about 22,000 pounds, was estimated to be contributed to the Pond. With the implementation of the remedial measures set forth in the adopted regional water quality management and priority watershed plans, changes in the nutrient load to East Troy Pond may be anticipated. However, such changes were not evaluated during this analysis.

This load is considerably higher than that estimated during the WDNR priority watershed planning project, which suggested that the phosphorus load to East Troy Pond was about 1,500 pounds of phosphorus per year. Some differences in phosphorus load may be anticipated as a result of the specific drainage area utilized in the analysis. Differences may also be attributed to the fact that portions of the tributary area either drain to the Lauderdale Lakes or to Pleasant Lake, which is internally drained. In each case, a portion of the phosphorus load is retained in the lakes, thereby reducing the mass of phosphorus carried downstream by Honey Creek. Other differences reflect changing land use conditions within the tributary area since 1990 when the priority watershed study was conducted. Specifically, the area of urban lands contributing to the contaminant loadings to East Troy Pond has increased from about 3,000 acres in 1990 to about 5,000 acres in 2000, with concomitant changes in the loading rates.

In order to evaluate the validity of the estimated loads, the loads were used to forecast in-lake phosphorus concentrations on the basis of the relationships between phosphorus loading and in-lake phosphorus concentration developed by the Organization for Economic Cooperation and summarized by Ryding and Rast.[5] The estimated loads for 2000 land use conditions result in a likely in-lake phosphorus concentration of about 0.77 mg/l, which

[5] *Sven-Olof Ryding and Walter Rast,* op. cit.

compares relatively well with the mean observed phosphorus level of 0.70 mg/l reported from the Pond during 1982. Consequently, given this agreement between the forecast in-lake total phosphorus concentration and observed in-lake phosphorus concentration obtained using the most likely phosphorus loading estimate, and the good agreement between the two modeling approaches, it can be assumed that the models accurately represent the loads to the Pond.

It can be further estimated, using the two models, that about 18,000 pounds per year, or about 80 percent of the total loading, was contributed by runoff from rural lands and about 4,000 pounds per year, or about 20 percent, was contributed by runoff from urban lands. Phosphorus release from the lake bottom sediments, or internal loading, which may also contribute phosphorus to the Pond, can be assumed to be negligible given the good agreement between predicted and observed phosphorus concentrations.

Sediment Loadings

The estimated sediment budget for East Troy Pond under year 2000 land use conditions is shown in Table 2. An annual sediment load of about 5,665 tons of sediment was estimated to be contributed to the Pond. Of the likely annual sediment load, it was estimated that about 5,405 tons per year, or 95 percent of the total loading, was contributed by runoff from agricultural lands, with the balance being contributed from urban lands and by direct precipitation onto the Pond surface. In contrast to the estimated phosphorus load to the Pond, this estimated sediment loading rate is significantly less than that estimated during the WDNR priority watershed project. In part, this reduction is likely to be due to changing land uses—from active agricultural uses to less intensive uses of the lands in the tributary area.

Urban Heavy Metals Loadings

Urbanization brings with it increased use of metals and other materials that contribute pollutants to aquatic systems.[6] Table 2 sets forth the estimated loadings of copper, zinc, and cadmium likely to be contributed to East Troy Pond from urban development surrounding the Pond. Metals loadings to East Troy Pond were not estimated during the previous WDNR study. Nevertheless, it can be anticipated that metals loads are increasing in proportion to the area of land within the drainage basin that is being converted to urban land uses.

The majority of the metals entering East Troy Pond are likely to become associated with sediment particles,[7] and encapsulated into the bottom sediments of the Pond. The heavy metal concentrations likely to be observed in the Pond as a consequence of these loads, under current conditions, would be expected to be within the guidelines established for the protection of fish and aquatic life.[8] The estimated heavy metal budget for East Troy Pond, under year 2000 land use conditions, is shown in Table 2. About 26 pounds of copper, 230 pounds of zinc, and 1 pound of cadmium were estimated to be contributed annually to East Troy Pond from urban lands.

IN-LAKE SINKS

Of the annual total phosphorus load entering East Troy Pond, it is estimated, on the basis of water loading rate,[9] that 10 percent of the total phosphorus load, or about 2,000 pounds of phosphorus, is retained within the Pond.

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[6] *Jeffrey A. Thornton,* et al., op. cit.

[7] *Werner Stumm and James J. Morgan,* Aquatic Chemistry: An Introduction Emphasizing Chemical Equilibria in Natural Waters, *Wiley-Interscience, New York, 1970.*

[8] *Frits van der Leeden, Fred L. Troise and David Keith Todd,* The Water Encyclopaedia, Second Edition, *Lewis Publishers, 1990.*

[9] *Sven-Olof Ryding and Walter Rast,* op. cit.

Table 2

ESTIMATED CONTAMINANT LOADS FROM THE TOTAL AREA TRIBUTARY TO EAST TROY POND: 2000

Land Use	2000				
	Area (acres)	Sediment (pounds)	Copper (pounds)	Zinc (pounds)	Cadmium (pounds)
Residential	1,647	34,290	0.54	3.78	0.00
Commercial	37	29,008	8.14	55.13	0.37
Industrial	42	31,584	9.24	62.58	0.42
Communications, Transportation, and Utilities	2,729	25,925	0.00	0.00	0.00
Governmental	115	58,765	8.05	92.0	0.00
Recreational	172	4,128	0.00	0.00	0.00
Water	1,035	194,580	0.00	0.00	0.00
Wetlands and Woodlands	5,472	20,246	0.00	0.00	0.00
Landfill	263	118,350	0.00	0.00	0.00
Agricultural	24,030	10,813,500	0.00	0.00	0.00
Total	35,542	11,330,377	25.97	229.69	0.79

Source: SEWRPC.

This mass of phosphorus is either used by the biomass within the Pond or deposited in the lake sediments. The balance of the phosphorus entering the Pond is transported downstream. To this end, the relatively small volume of the impoundment relative to the area of the upstream drainage basin is beneficial in that the through flow of water is such that algal growth is discouraged and many of the symptoms of nutrient enrichment are moderated by the rapid throughput of water. A water residence time in excess of the 0.02 years estimated for East Troy Pond is required for algae to have sufficient time to reproduce within the Pond.[10]

RECOMMENDED RESPONSES

Nonpoint Source Pollution Abatement

Based upon the foregoing analysis, ongoing implementation of the measures recommended in the regional water quality management plan, as refined in the adopted priority watershed plan, is recommended.[11] These measures include actions designed to reduce sediment and other pollutant loads carried by Honey Creek. To this end, ongoing implementation of construction site erosion control programs, including inspection oversight of existing and future construction, is recommended. Likewise, ongoing implementation and continued maintenance of rural nonpoint source pollution control measures, including the application of agricultural best management practices such as manure management and cropping practices, is recommended.

In addition, the placement and maintenance of streambank buffers, including vegetated buffers along the edge of the Pond for a distance of about 20 feet from the water's edge as recommended in the State turf maintenance guidelines, is recommended as a basis for moderating the direct impacts of nutrients in lawn runoff on the Pond.[12]

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[10]Ibid.

[11]*Wisconsin Department of Natural Resources Publication No. WT-478-97*, op. cit.

[12]*U.S. Geological Survey Water-Resources Investigations Report No. 02-4130,* Effects of Lawn Fertilizer on Nutrient Concentration in Runoff from Lakeshore Lawns, Lauderdale Lakes, Wisconsin, *July 2002; see also, Wisconsin Department of Natural Resources Technical Standard No. 1100,* Turf Nutrient Management, *January 2006.*

Consideration of the promulgation of a turf management ordinance, limiting the application of fertilizers containing phosphorus or compost-based products containing more than 3 percent phosphorus in urban areas, is recommended.

Stormwater Management

While many of the agricultural intrusions into the stream corridor have been eliminated, pursuant to the recommendation set forth in these plans, the management of urban stormwater runoff remains an issue of concern, and the control of urban stormwater is recommended. Currently, at least one municipal storm drain discharges directly to the Pond. Consideration should be given to modifying this discharge so as to minimize the flow of particulates into the Pond. Implementation of stormwater management practices consistent with the current requirements of Chapter NR 151 of the *Wisconsin Administrative Code* is recommended. Alternatively, use of inline treatment technologies, such as the implementation of vortex separators, could be considered as a means of minimizing particulate loads to the Pond from urban lands served by stormwater conveyance systems, where available land area is a constraint on the use of detention or retention basins. Control of particulates also can contribute to the reduction of nutrient loads to the Pond, as some nutrients are adsorbed to sediment particles and therefore are removed in the settling or separation process.

Management of Sediments within the Dam Basin

Beyond the contaminant loads currently being delivered to East Troy Pond, the issue of managing the loads already delivered to, and deposited in, the Pond continues to be an issue of concern, regardless of the decision to retain or abandon the dam that forms the Pond. In both cases, stabilization and management of the accumulated sediments, especially, are issues that should be addressed. Specifically, the implementation of the land management measures set forth in the adopted regional and priority watershed plans is endorsed. These measures should be implemented regardless of the status of the dam.

Should the dam be retained and maintained, consideration of the removal of accumulated sediments within the impoundment should include an evaluation of potential benefit to the downstream river course of the interception of sediment loads from the upstream watershed.[13]

Conversely, should the dam be removed, consideration of the removal of accumulated sediment within the former impoundment should include the beneficial impact of such removal on the downstream segments of Honey Creek. Such an impact is the likely result of stream down cutting through the accumulated flocculent sediments following removal of the dam structure, [14] and the deposition of such eroded materials within stream and wetland habitat areas downstream of the impoundment. Should removal of the dam creating East Troy Pond be

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[13]*For the purposes of this discussion, the term "former impoundment" is used to describe the land area underlying the impounded waters that form the East Troy Pond. Because the dam has altered the hydrodynamics of the previously existing stream, sediments that are carried by Honey Creek have been deposited on the bed of the Pond. Portions of this sediment load, generated from within the watershed, have been deposited on the bed of the Pond, altering the physical geometry of the basin and potentially modifying the morphometry of the stream channel that pre-dated the construction of the dam and creation of the Pond. As these sediments have accumulated, the ability of the Pond to retain additional sediment has diminished as the volume of the Pond has decreased over time. Restoration of this volume by removal of historic sediment accumulations would restore the ability of the Pond to capture and retain portions of this sediment load, thereby minimizing the impact of the deposition of this sediment in downstream reaches of Honey Creek.*

[14]*M.W. Doyle, E.H. Stanley, and J.M. Harbor, "Channel Adjustments Following Two Dam Removals in Wisconsin,"* Water Resources Research, *Volume 39, Number 1, 2003.*

contemplated, restoration of the pre-impoundment stream course is strongly recommended as a mechanism to limit the transfer downstream of significant quantities of sediment eroded from the former impoundment, prior to the removal being effected.

In either case, the removal and/or stabilization of sediments within the lake basin could provide positive benefit to the downstream stream reaches of Honey Creek and protection of downstream riverine habitat.

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