LOAD REDUCTION TARGETS FOR THE ROCKY RIVER WATERSHED

Rocky River Watershed Action Plan
Appendix H
May 2006
Updated February 2010

This publication was prepared by the Northeast Ohio Areawide Coordinating Agency on behalf of the Rocky River Watershed Council. This publication was financed in part through a grant from the Ohio Environmental Protection Agency and the United States Environmental Protection Agency, under the provisions of Section 319(h) of the Clean Water Act.

Load Reduction Targets
For the Rocky River Watershed

Table of Contents

List of Tables

Load Reduction Targets
For the Rocky River Watershed

Abstract

This report summarizes the target load reductions in the Rocky River Watershed of Northeast Ohio. It includes a discussion of load reduction targets for the six segments subject to TMDL reductions. The report also identifies needed reductions in other portions of the watershed. This report is one of a series of analyses prepared for the Rocky River Watershed Action Plan through and Ohio 319 Grant 01(h) EPA-09.

Load Reduction Targets
For the Rocky River Watershed

Total Maximum Daily Load Recommendations

Summary of Causes and Sources: Six segments of the Rocky River are affected by the Total Maximum Daily Load (TMDL) allocations. These segments include the mainstem, Abram Creek, Baldwin Creek, and the Plum Creek near Olmsted Falls. The segments also include Baldwin Lake and Hinckley Lake. The following table reports the causes and sources of the water quality problems as identified in the TMDL report for each stream segment that is not meeting, or is only partially meeting, its aquatic use designations:

Segment	Causes	Sources
Mainstem (0.0 miles in full Attainment, 8.7 miles in Partial attainment and 3.37 miles in Nonattainment)	Nutrients Organic Enrichment Flow Alteration	Municipal Point Sources Marinas Combined Sewer Overflows Urban Runoff Hydromodification
Abram Creek (0.0 miles in full Attainment, 0.0 miles in Partial attainment and 3.7 miles in Nonattainment)	Ammonia Organic Enrichment	Municipal Point Sources Channelization Urban Runoff Hydromodification
Baldwin Creek (0.0 miles in full Attainment, 8.0 miles in Partial attainment and 0.0miles in Nonattainment)	Organic Enrichment Nutrients Habitat Alteration	Municipal Point Sources Urban Runoff Channelization Hydromodification Suburbanization Construction
Plum Creek at Olmsted Falls (0.0 miles in full Attainment, 0.0 miles in Partial attainment and 3.0 miles in Nonattainment)	Nutrients	Municipal Point Sources Urban Runoff Suburbanization

Segment	Causes	Sources
Baldwin Lake	Priority Organics Non-priority Organics Ammonia Chlorine Siltation Organic Enrichment/ Dissolved Oxygen	Municipal Point Sources Agriculture Urban Runoff Silviculture Non-industrial Permitted Sources
Hinckley Lake	Siltation Organic Enrichment/ Dissolved Oxygen Thermal Modification	Construction Urban Runoff Natural Sediment Loads

Ohio EPA has attempted to estimate the load reductions that are necessary to reclaim the stream segments identified in the TMDL Report as being in partial or nonattainment. They were able to provide quantitative estimates only for nutrient loadings. They were not able to quantify storm water runoff reductions or bacterial loadings. Accepted methodologies and detailed inputs are not readily available to accomplish this. This is particularly true when many source areas are pervasive throughout a watershed, such as urban lands and malfunctioning home sewage treatment systems. Where meaningful estimates of load reductions are possible, these are presented. In some cases where this information is not available, an alternative estimate of the level of reduction can be made. In other cases, it is necessary to simply begin initiating control efforts without clearly stated reduction targets.

In addition to the causes and sources identified in the TMDL and summarized in the table above, the Rocky River has a pronounced problem with elevated bacteria counts at sites throughout the watershed. The Ohio EPA 2002 Integrated Assessment Report states that 24 out of the 27 bacteria monitoring sites in their network on the Rocky River have a bacteria count that exceeds designated use criteria. The Rocky River and it primary tributaries are rated as “impaired” for recreational uses. As can be expected when bacteria violations are so widespread, a variety of source types contribute to the problems found in the Rocky River.

The Combined Sewer Overflows (CSOs) discharge mixed storm water/sanitary wastes when storm water inflow causes the capacity of the sewer to be exceeded. These discharges generally have very high bacteria counts associated with them with counts in the million range being not uncommon. Fortunately in the Rocky River, CSOs are confined to the lowest reaches of the River.

On the larger geographic scale, home sewage treatment systems (HSTSs) pose a more pronounced threat. The TMDL Report estimates that there are 16,500 HSTSs in the Rocky River Watershed. Estimates of failure rates for these systems vary widely, but rates ranging between 35 and 60% are typical. Failing systems do have a pronounced bacteria loading potential. System upgrades and replacements do occur in the watershed. On an average annual basis, an estimated 50 system replacements occur throughout the watershed. This translates into a 3,650pounds of BOD and 6,200 pounds of suspended solids if the replaced systems were in total failure. These gains are offset by the fact that as many as 5% of all systems in the watershed are expected to outlive their useful lives every year.

Non-human animals are also significant contributors to the bacterial loading in the watershed. These animals include household pets, livestock, and wild animals all of which are numerous in the watershed.

Ohio EPA points out in the TMDL report they rely on an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, biological response signatures to describe the cause and sources associated with observed impairments in local waterways. Thus the initial assignment of principal causes and sources of impairments identified in the TMDL do not represent a true "cause and effect" analysis, but rather represent links with known stressor and exposure indicators. The "Guide to the Causes and Sources of Water Quality Problems in the Rocky River Watershed" highlights some of the issues that experience tells us are operable in the Rocky River Watershed. The following discussion identifies the water quality problems that will be addressed through the Total Maximum Daily Load (TMDL) Process and established load reduction targets where appropriate. It also makes recommendations for water quality improvement strategies where target load reductions cannot be identified.

TMDL Required Reductions and Recommended Actions

Mainstem of the Rocky River

Nutrients: According to the TMDL Analysis for the Rocky River, Nitrogen loads need to be reduced by 46% in this segment. The load reduction needed (424,100 kg/yr) is larger than either the point or nonpoint inputs. Therefore, reductions are required from both components. Ohio EPA anticipates that nitrogen loads will be reduced in this segment over the next few years as a result of recent or planned activity by point source dischargers, though they do not have data to quantify the expected reductions.

The abandonment of eight treatment plants and the improvement of several of the remaining plants have resulted in a 30% reduction in loadings from 1992 to 1997. The City of Lakewood and the Northeast Ohio Regional Sewer District (NEORSD) are involved in projects to reduce the number and volume of combined sewer overflows to the lower river. The City of Lakewood is making improvements to its Wastewater

treatment Plant and its sanitary sewer system that are predicted to reduce the average number of plant bypass events from 84 per year to an estimated 10 (an 88% reduction). NEORSD is undertaking improvements that may reduce overflows from its CSOs by up to 25% over the next several years. Additional reductions are anticipated from nonpoint source initiatives in the watershed.

The phosphorus target applicable to the mainstem was being met in 1992. Phosphorus loadings had increased in 1997 to the point that a 28% reduction is now required. Ohio EPA has assigned this reduction to nonpoint source control programs as the point sources discharging to the segment already meet their limits and no improvements are planned or warranted at this time. The needed load reduction from nonpoint sources is 11,217 kg/yr.

Organic Enrichment/Dissolved Oxygen: Ohio EPA does not have enough information to establish a TMDL for this pollutant at this time. It appears that the cumulative effects of a high proportion of treated wastewater from multiple sources in the basin and the impacts associated with urban runoff and combined sewer overflows continue to limit full attainment in this segment. Ohio EPA is expecting that attainment goals will be met following the implementation of Phase II of the Storm Water Permits Program throughout the basin, implementation of the NPDES Permit for Cleveland Hopkins International Airport, implementation of combined sewer overflow controls by Lakewood and the Regional Sewer District, and other improvements in the upper watershed.

Flow Alteration: Ohio EPA recognizes that projects that control storm water quantity and quality will greatly benefit the mainstem. Phase II of the Storm Water Permits Program offers one tool to accomplish this. The development of a strategy to create storm water retention and detention basins in the urban areas is another. Floodplain and stream corridor protection legislation can also help. Public education as to the need to mange storm water runoff and to protect the river corridor area also needed.

Bacteria: Ohio EPA has not established a target load reduction for this parameter. However, HSTSs have been identified by Ohio EPA in the 1999 Technical Support Document as a significant pollution source within the mainstem of the Rocky River. These loadings are largely generated in upstream segments. This segment is also affected by the CSO discharges from the systems of the Northeast Ohio Regional Sewer District and the City of Lakewood. The combination of tributary areas being heavily urbanized and an intense recreational use of the park system along the River by pet owners provide for a large potential of impacts from pet wastes. Wildlife teems in and around the Rocky River Reservation where there is a large population of deer and other animals. Horseback riding is another potential source of bacterial loading. All of these sources are in addition to loading from upstream areas.

CSO control improvements are programmed and will result in a reduction in the bacteria loadings to the Rocky River. All of the communities tributary to the mainstem are included in the Phase II Storm Water Permits Program. These communities will be required to increase their illicit discharge detection and elimination efforts and seek to minimize pollutant discharges in their storm water runoff. These control efforts, coupled

with a limited number of HSTSs that discharge directly to the mainstem, make further bacteria reduction initiatives in this segment a lower priority than upstream segments.

Abram Creek

Current estimated Total Nitrogen Load from nonpoint sources: 31,507 lbs/yr
Target nonpoint source Total Nitrogen Load: 25,853 lbs/yr
Recommended Total Nitrogen Load Reduction from nonpoint sources: 5654 lbs/yr

Current estimated Total Phosphorus Load from nonpoint sources: 5248 lbs/yr
Target nonpoint source Total Phosphorus Load: 3778 lbs/yr
Recommended Total Phosphorus Load Reduction from nonpoint sources: 1470 lbs/yr

Abram Creek is the most degraded tributary to the Rocky River. Habitat modifications, urban storm water impacts, septic system discharges, and point source discharge of pollutants have combined to seriously degrade the biological communities in the stream. Despite the abandonment of two wastewater treatment plants in the upper watershed in 1993, little recovery has been noted in the upper watershed where habitat is seriously degraded. The downstream portions of Abram Creek are severely impacted by discharges of storm water containing ammonia-nitrogen and glycols resulting from de-icing operations at the Cleveland Hopkins International Airport.

Urbanization of the watershed and the construction of the airport have resulted in the loss or reduction in size of the wetland complexes in the upper basin as well as channelization and re-routing of significant portions of the Creek. Many stretches are highly affected by fill material, particularly foundry sand. Portions have been culverted and a one mile stretch is about to be culverted to allow extension of the main runway at the airport. De-forestation of the watershed and the cumulative impacts of impervious surfaces have changed the hydrology of the stream significantly, resulting in lower base flows and higher peak flows associated with storm events. A dam spans the Creek just upstream from Cedar Point Road. All of these factors significantly limit the restoration potential of the stream in the upper watershed. They present a formidable challenge to restoration in the lower course, but there is a chance for restoration of this reach.

Ammonia: Ammonia-nitrogen loadings from the de-icing operations at the airport are being addressed under a consent agreement between the airport and Ohio EPA. A TMDL for ammonia will be developed following monitoring of the effects of the implementation of this agreement.

Organic Enrichment/Dissolved Oxygen: The glycols discharged from the airport have been the most significant cause of the organic enrichment noted in the lower portions of Abram Creek. The airport is implementing a glycol control program under an agreement with Ohio EPA. A TMDL for this parameter will be deferred until the results of this work have been determined.

Bacteria: There are approximately 200 home sewage treatment systems in the watershed. The Cuyahoga County Board of Health is currently working to eliminate

polluted discharges from these systems. This parameter can be de-listed when this effort is completed.

Baldwin Lake

Baldwin Lake needs to be sampled during the next scheduled watershed survey. Portions of the Lake are now being managed as a wetlands. Existing data on the Lake are outdated and incomplete. No target pollutant load reductions have been prepared for the Lake.

Hinckley Lake

Based on previous sampling, Ohio EPA has determined that the designated aquatic life and recreational uses for Hinckley lake were impaired due to an unbalanced fishery, high turbidity (low water clarity), and sedimentation. Ohio EPA further determined that the turbidity of the water limits the productivity of algae in the water column. Based on this determination, the nutrient concentrations in the Lake are not excessive, nor are they a cause of non-attainment of the water quality goals of the Lake.

No target load reductions for any parameters are available at this time. Hinckley Lake needs a comprehensive management plan that will be protective of the Lake's designated uses. Ohio EPA recommends an inventory and assessment of the sediment and nutrient loadings to the Lake.

Baldwin Creek
Current estimated Total Nitrogen Load: 114,197 lbs/yr
Target Total Nitrogen Load: 25,596 lbs/yr
Recommended Total Nitrogen Load Reduction: 88,601 lbs/yr

Current estimated Total Phosphorus Load: 4922 lbs/yr
Target Total Phosphorus Load: 3741 lbs/yr
Recommended Total Phosphorus Load Reduction: 1181 lbs/yr

Nutrients: Ohio EPA is of the opinion that it will be difficult to meet the nitrogen target in Baldwin Creek based on the last water chemistry sampling collection in 1992. Both of the treatment plants that discharge to the stream are meeting their current limits and have no planned upgrades scheduled. The recommended strategy is to reduce the nonpoint source contributions to the maximum extent feasible and to implement a variety of activities that will improve habitat conditions in the stream. Phosphorus load reductions will likewise have to come from nonpoint source reductions as the plants are also discharging below their permitted levels. Remediation of failing home sewage treatment systems in the watershed are called for.

Organic Enrichment/Dissolved Oxygen: More data is required to determine whether an organic enrichment problem continues to exist in Baldwin Creek. No action is

recommended at this time. Remediation of failing home sewage treatment systems in the watershed are called for.

Habitat alteration: The evaluation of the Qualitative Habitat Evaluation Index (QHEI) information collected by Ohio EPA and the Cuyahoga County Board of Health indicate that there is potential for habitat restoration in the stream. These actions are given a high priority.

Plum Creek near Olmsted Falls

Nutrients: The TMDL calls for a 32% loading reduction for nitrogen in Plum Creek. Two, small wastewater plants have been removed from the stream. The Lorain County Plum Creek plant is scheduled for improvements. Further reductions, if needed, will have to come from nonpoint source reductions.

Phosphorous loadings need to be reduced by 14%. The removal of the two wastewater treatment plants and the improvements at the Plum Creek Plant may be sufficient to meet this target. If not, nonpoint source loadings need to be addressed.

Reductions and Recommended Actions Beyond the TMDL

Ohio EPA has not established load reduction goals for those segments that are in attainment of their designated biological uses. However, recreational use impairments do exist in segments of the Rocky River that are not affected by the TMDL load reduction program. These segments include the East Branch, the West Branch, and the upper reaches of Plum Creek near Olmsted Falls. In addition, nonpoint source loadings of other parameters do potentially stress the system in these segments. With the advancing urbanization of these areas, it is prudent to address nonpoint source controls in these areas so as to help insure that the system does not become overstressed in the future. The following recommendations are provided as a means of addressing these impairments.

East Branch

Bacteria: Failing HSTSs in the lower East Branch Watershed in Cuyahoga County are a recognized contributor to the bacteria violations noted in the stream. The Cuyahoga County Health Department has prioritized the remediation of failing systems in areas of North Royalton where sanitary sewers are not expected in the foreseeable future. The lower East Branch is potentially affected by a series of recreational horse sites spread out along its course through North Royalton, Strongsville, Middleburg Heights and Berea.

Nutrients: the Medina Soil and Water Conservation District has targeted nutrient loadings to the upper East Branch in Granger and Hinckley Townships stemming from livestock waste washoff for loading reductions. Agricultural lands in Granger Township have also been identified as a priority for improved management.

Healey Creek:
Current estimated Total Nitrogen Load from nonpoint sources: 16,678 lbs/yr
Target nonpoint source Total Nitrogen Load: 12,593 lbs/yr
Recommended Total Nitrogen Load Reduction from nonpoint sources: 4085 lbs/yr

Current estimated Total Phosphorus Load from nonpoint sources: 2872 lbs/yr
Target nonpoint source Total Phosphorus Load: 1841 lbs/yr
Recommended Total Phosphorus Load Reduction from nonpoint sources: 1031 lbs/yr

West Branch

Bacteria: The West Branch of the Rocky River has similar bacteria problems to those in the East Branch. The most pronounced problems occur in the lower courses Columbia Township, Olmsted Township, Olmsted Falls and North Olmsted. Failing HSTSs in Columbia Township, Olmsted Township, and North Olmsted are the priority for remediation. The concentration of recreational horse sites in the Olmsted Falls area makes this area a priority for encouraging increased animal waste management practices.

Nutrients: the Medina Soil and Water Conservation District has targeted nutrient loadings to the upper West Branch in Medina, York, and Liverpool Townships stemming from livestock waste washoff for loading reductions. Agricultural lands in York and Liverpool Townships have also been identified as a priority for improved management.

Upper West Branch
Current estimated Total Nitrogen Load: 25,931 lbs/yr
Target nonpoint source Total Nitrogen Load: 20,681lbs/yr
Recommended Total Nitrogen Load Reduction: 5250 lbs/yr

Plum Creek near Olmsted Falls

Bacteria: The upper reaches of Plum Creek in Columbia Township have numerous older HSTSs that are in need of repair or replacement. The Lorain County General Health District has identified this area as a priority action area.

Load Reductions from Phase II of the Storm Water Permits Program Activities Affecting the Rocky River Watershed

Urbanized communities in the Rocky River Watershed are initiating enhanced storm water management programs as the result of the Phase II storm Water Permits Program. These activities have been designed to reduce pollutant loadings and storm water runoff impacts associated with municipal operations to the maximum extent practicable. While the maximum extent practicable criterion is not a quantitative measure of expected load reductions, qualitative statements can be useful in determining the potential impact that the Phase II program may have on the watershed.

A major initiative that watershed communities have committed to is the implementation of regulations designed to minimize the impacts of new development on local streams. This applies to sediment and other contaminant releases during the construction phase. It also applies to the quality and quantity of water running over the completed development. While these activities will not decrease impacts from existing development in the watershed, it will minimize any new impacts.

The Phase II initiative will result in improvements on many urbanized lands as they become redeveloped in future years. The control of urban runoff impacts from redeveloped lands is often not as effective as controls on newly developing lands due to space and cost considerations. However, a target has been set to reduce redevelopment impacts by 50% in the long run.

Communities will be implementing improved good housekeeping and pollution minimization practices for all municipal operations that have the potential to generate storm water runoff impacts. For programs such as road salt spreading, sewer system maintenance, landscaping operations, and vehicle maintenance activities, communities will engage in accelerated training of their employees in proper and safe procedures designed to minimize impacts from these activities. In those communities that already excel at pollution prevention, there will be little reduction in pollutant loadings to the Rocky River. In those communities where such practices as not as advanced, one can expect a slight improvement. An estimate of an overall reduction of 10% has been suggested as an objective from this initiative. This value appears low but it is indicative of the fact that most communities recognize that the discharge of pollutants resulting from their operations costs them in wasted materials. Many pollution prevention activities are also undertaken as a result of efforts to safely handle hazardous materials for the protection of the employees.

Communities will be surveying their storm water outfalls on a regular basis under the Phase II Program. The primary objective is to identify and eliminate any illicit discharges from their system. These discharges can include cross-connections between sanitary and storm sewers, illegal dumps or spills, and failing HSTS effluent. Communities are already involved in the elimination of illicit discharges whenever such problems are encountered. The Phase II initiative will increase the frequency that they look for problems with the expectation that more illicit discharges will be identified and removed. In most cases, the illicit discharges that do occur are transitory in nature, otherwise they would have been identified and would have been addressed already. Therefore, increased surveillance can be expected to result in further decreases in these discharges. Older, more heavily urbanized areas will probably benefit more than newly developed areas with tighter systems and installation regulations. Arriving at an estimate of the total amount of loading reductions that will accrue due to the Phase II initiative is speculative, but a 5-10% reduction is certainly in the realm of possibility.

The Rocky River Work Group arrived at an estimate that up to 10% of all developing lands may abut a riparian corridor. A large percentage of these lands would be expected to materially affect riparian vegetation. This expectation is partially due to observed

behavior on existing developments. It is also affected by the fact that many more headwater areas are going to be developed in the Rocky River Watershed in the future. The lower courses of the watershed have been extensively developed in the past. Avoidance of large streams and rivers because of flood risks was common in this watershed. Now that development has shifted to headwater areas where flooding has a very low risk, more infringement might be predicted. Rocky River communities have embraced the NOACA Regional Storm Water Task Force's recommended storm water management program that includes an initiative to provide for mandatory riparian setbacks from all streams including headwater streams. If one assumes that 20% of the buildable land in the Rocky River Watershed will be developed in the next 20 years, and that 10% of this land affects riparian areas, 2% of the riparian corridor along the streams of the watershed will be preserved. This figure may not sound like much, but there is easily 1,000 stream miles in the entire watershed when headwater streams that meet Ohio EPA criteria are accounted for.

Potential Nutrient Load Reductions from an Intensive Land Treatment Program

The Rocky River Total Maximum Daily Load (TMDL) Project has established the need to reduce nitrogen loading in the watershed by 934,980 pounds per year and phosphorus loadings by 24,730 pounds per year. Both of these targets need to be met largely through nonpoint source controls. Nutrient loadings from agricultural operations are generally much higher on an acre-by-acre basis than all other land use types. However, agricultural lands are far removed from the segments of the Rocky River that have a documented nutrient-loading problem. Land based controls, when applied over the entire watershed, can account for a load reduction of 549,926 pounds per year of nitrogen (See below for details.) This is would account for almost 60% of the needed load reduction. However, these controls would cost an estimated $1,000 per acre treated, or $100 million when applied to all non-open space lands in the watershed. This level of treatment would also materially reduce the phosphorus loading by some undetermined amount. Improvements in the performance of HSTSs would result in additional nutrient load reductions.

Several states in USEPA's Region V have pooled their resources to create a series of tools that allow the estimation of pollutant load reduction estimates for a wide variety of nonpoint source controls. These tools have been converted into Excel spreadsheets that are available on the Ohio Department of Natural Resources (ODNR) website at:

http://www.dnr.state.oh.us/soilandwater/docs/loadreduction/Ohio_v1.2.xls

A companion document is available that provides guidance for the use of many of the load reduction estimation tools. This document is available at:

http://www.dnr.state.oh.us/soilandwater/docs/loadreduction/MI_poll_man.pdf

NOACA used the spreadsheets to evaluate potential total nitrogen load reductions from a series of land uses. Table 2 shows the estimated load reductions for all of the nonpoint

source controls that have a reduction estimation tool that quantifies total nitrogen loadings. Each entry in the table represents the annual load reduction in pounds from one acre of treated land.

As noted in Table 2, practices that rely on infiltration of storm water into the ground have a limited applicability in Northeast Ohio. The clayey soils absorb water very slowly. Infiltration devices tend to become overloaded too quickly and too often. Unfortunately, infiltration practices do possess some of the best loading reduction numbers of all BMPs where they can be suitably employed.

In order to translate the potential load reductions shown in Table 1 into estimates of what might be obtained from an aggressive nonpoint source program in the Rocky River, some simplifying assumptions have to be made. Not all BMPs are equally applicable on all land areas, even areas dedicated to the same land use. A "typical" load reduction was assigned to each land use in Table 1 to account for the variation in BMP selection likely to be encountered. Commercial areas were assigned a reduction rate of 6 pounds/acre/year. Industrial and Transportation lands were given a rate of 4 pounds/acre/year. Institutional lands and Multi-family were assigned a rate of 3 pounds/acre/year respectively. Residential lands have a 2 pounds/acre/year rate. Agricultural loading reductions were generated with the use of grass filter strips on all land in production. This represents a rate of 10 pounds/acre/year. Multiplying the typical rate for each land use by the number of corresponding acres in the watershed gives a picture of the results to be gained by treating all developed lands in the watershed with one BMP. These results are shown in Table 3 first for the entire watershed and then for select subbasin areas.

Table 2

Urban Runoff BMPs

Total Nitrogen Load Reductions in lbs/acre treated/year

Land Use	Vegetated Filter Strips	Grass Swales	Wetland Detention	Dry Detention	WQ Inlets	Infiltration Basin*	Infiltration Trench*	Porous Pavement*	Concrete Grid Pavement*	Sand Filter/Infiltration basin	WQ Inlet/Sand Filter	Oil/Grit Seperator	Wet Pond
Commercial	8	2	4	6	4	13	12	18	19	7	7	1	7
Industrial	6	1	3	4	3	8	8	12	13	5	5	1	5
Institutional	4	1	2	3	2	7	6	9	10	4	4	1	4
Transportation	5	1	3	4	3	8	7	11	12	5	5	1	5
Multi-family	4	1	2	3	2	7	6	9	10	4	4	1	4
Residential	2	1	1	2	1	4	3	5	5	2	2	0	2
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0
Vacant	0	0	0	0	0	1	1	1	1	0	0	0	0
Open Space	0	0	0	0	0	1	1	1	1	0	0	0	0

Nitrogen load reduction estimates are not available for the following urban BMPs: Extended wet detention Settling basins Sand filters Weekly street sweeping

* These BMPs have a very limited applicability in Northeast Ohio due to climatic and soil limitations.

Table 3. Individual watershed Load Reduction Values

Rocky River Watershed
Total Nitrogen Load Reductions
From Intensive Land Treatment

Land Use	Typical Reduction (lbs/acre/year)	Sq. Mi.	Load Reduction (lbs/year)
Commercial	6	7.91	30,374
Industrial	4	3.76	9,626
Institutional	3	4.18	8,026
Transportation	4	4.22	10,803
Residential	2	77.32	98,970
Agriculture	10	61.27	392,128
Open Space	0	134.04	0
Total	N/A	292.70	549,926

Mainstem Rocky River Watershed
Total Nitrogen Load Reductions
From Intensive Land Treatment

Land Use	Typical Reduction (lbs/acre/year)	Sq. Mi.	Load Reduction (lbs/year)
Commercial	6	0.93	3,571
Industrial	4	0.04	102
Institutional	3	1.74	3,341
Transportation	4	0.75	1,920
Residential	2	7.06	9,037
Agriculture	10	0.09	576
Open Space	0	4.39	0
Total	N/A	15.00	18,547

Table 3 (continued)

Abram Creek Watershed
Total Nitrogen Load Reductions
From Intensive Land Treatment

Land Use	Typical Reduction (lbs/acre/year)	Sq. Mi.	Load Reduction (lbs/year)
Commercial	6	1.43	5,491
Industrial	4	1.06	2,714
Institutional	3	0.47	902
Transportation	4	0.32	819
Residential	2	3.69	4,723
Agriculture	10	0.14	896
Open Space	0	3.00	0
Total	N/A	10.11	15,546

East Branch Rocky River Watershed
Total Nitrogen Load Reductions
From Intensive Land Treatment

Land Use	Typical Reduction (lbs/acre/year)	Sq. Mi.	Load Reduction (lbs/year)
Commercial	6	1.10	4,224
Industrial	4	0.41	1,050
Institutional	3	0.54	1,037
Transportation	4	1.22	3,123
Residential	2	17.65	22,592
Agriculture	10	6.13	39,232
Open Space	0	39.62	0
Total	N/A	66.67	71,258

Baldwin Creek Watershed
Total Nitrogen Load Reductions
From Intensive Land Treatment

Land Use	Typical Reduction (lbs/acre/year)	Sq. Mi.	Load Reduction (lbs/year)
Commercial	6	0.41	1,574
Industrial	4	0.03	77
Institutional	3	0.03	58
Transportation	4	0.22	563
Residential	2	4.96	6,349
Agriculture	10	0.13	832
Open Space	0	4.15	0
Total	N/A	9.93	9,453

West Branch Rocky River Watershed
Total Nitrogen Load Reductions
From Intensive Land Treatment

Land Use	Typical Reduction (lbs/acre/year)	Sq. Mi.	Load Reduction (lbs/year)
Commercial	6	2.15	8,256
Industrial	4	1.49	3,814
Institutional	3	0.59	1,133
Transportation	4	0.38	973
Residential	2	23.67	30,298
Agriculture	10	23.65	151,360
Open Space	0	41.77	0
Total	N/A	93.70	195,834

Table 3 (continued)

Plum Creek at Olmsted Watershed
Total Nitrogen Load Reductions
From Intensive Land Treatment

Land Use	Typical Reduction (lbs/acre/year)	Sq. Mi.	Load Reduction (lbs/year)
Commercial	6	0.24	922
Industrial	4	0.04	102
Institutional	3	0.12	230
Transportation	4	0.08	205
Residential	2	3.55	4,544
Agriculture	10	7.38	47,232
Open Space	0	6.23	0
Total	N/A	17.64	53,235

Mallet Creek Watershed
Total Nitrogen Load Reductions
From Intensive Land Treatment

Land Use	Typical Reduction (lbs/acre/year)	Sq. Mi.	Load Reduction (lbs/year)
Commercial	6	0.13	499
Industrial	4	0.00	0
Institutional	3	0.09	173
Transportation	4	0.00	0
Residential	2	2.38	3,046
Agriculture	10	8.87	56,768
Open Space	0	6.60	0
Total	N/A	18.07	60,486

South Branch Rocky River Watershed
Total Nitrogen Load Reductions
From Intensive Land Treatment

Land Use	Typical Reduction (lbs/acre/year)	Sq. Mi.	Load Reduction (lbs/year)
Commercial	6	0.96	3,686
Industrial	4	0.22	563
Institutional	3	0.21	403
Transportation	4	0.36	922
Residential	2	5.27	6,746
Agriculture	10	5.61	35,904
Open Space	0	10.16	0
Total	N/A	22.79	48,224

North Branch Rocky River Watershed
Total Nitrogen Load Reductions
From Intensive Land Treatment

Land Use	Typical Reduction (lbs/acre/year)	Sq. Mi.	Load Reduction (lbs/year)
Commercial	6	0.12	461
Industrial	4	0.00	0
Institutional	3	0.03	58
Transportation	4	0.32	819
Residential	2	1.84	2,355
Agriculture	10	2.35	15,040
Open Space	0	5.24	0
Total	N/A	9.90	18,733

Table 3 (continued)

Granger Ditch Watershed
Total Nitrogen Load Reductions
From Intensive Land Treatment

Land Use	Typical Reduction (lbs/acre/year)	Sq. Mi.	Load Reduction (lbs/year)
Commercial	6	0.07	269
Industrial	4	0.05	128
Institutional	3	0.07	134
Transportation	4	0.22	563
Residential	2	2.79	3,571
Agriculture	10	4.69	30,016
Open Space	0	7.23	0
Total	N/A	15.12	34,682

Plum Creek at Brunswick Watershed
Total Nitrogen Load Reductions
From Intensive Land Treatment

Land Use	Typical Reduction (lbs/acre/year)	Sq. Mi.	Load Reduction (lbs/year)
Commercial	6	0.32	1,229
Industrial	4	0.42	1,075
Institutional	3	0.29	557
Transportation	4	0.35	896
Residential	2	4.20	5,376
Agriculture	10	1.88	12,032
Open Space	0	5.36	0
Total	N/A	12.82	21,165