The Lower Olentangy Watershed Action Plan in 2003

Strategies for Protecting and Improving Water Quality and Recreational Use of the Olentangy River and Tributary Streams in Delaware and Franklin Counties

Photograph by Ellie Nowels

Prepared by

FLOW

Friends of the Lower Olentangy Watershed (FLOW)

March 2005

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Strategies for Protecting & Improving Water Quality and Recreational Use of the Olentangy River and Tributary Streams in Delaware and Franklin Counties

Produced by:

FLOW

Explore. Discover. Understand.

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1.0 Introduction

The Friends of the Lower Olentangy Watershed (FLOW) is a non-profit, grassroots, citizen's organization dedicated to protecting and promoting the beneficial use of the Olentangy River and its resources. This Lower Olentangy Watershed Action Plan was developed with the input of citizens and stakeholders, and contains strategies and recommendations to improve or protect water quality by decreasing pollution and increasing the recreational value of the river. The Lower Olentangy River watershed includes the area of land that drains into the Olentangy River from the Delaware Dam just north of Delaware, OH to the confluence of the Olentangy River with the Scioto River in downtown Columbus, OH. FLOW's ultimate goal is to implement the strategies and recommendations contained in this watershed action plan.

1.1 FLOW and The Clean Water Act

The purpose of creating a watershed action plan is to meet the goals set forth in the Clean Water Act, which include having fishable, swimmable and drinkable streams. Growing public awareness and concern for controlling water pollution led to enactment of the Federal Water Pollution Control Act Amendments of 1972. As amended in 1977, this law became commonly known as the Clean Water Act. The Act establishes the basic structure for regulating discharges of pollutants into the waters of the United States, and gives the United States Environmental Protection Agency (U.S. EPA) the authority to implement pollution control programs such as setting wastewater standards for industry. The Act also makes it unlawful for any person to discharge any pollutant from a point source (e.g., pipe) into navigable waters, unless a permit is obtained under its provisions. Nonpoint source or diffuse sources of pollution are addressed under Section 319 of the Clean Water Act. Nonpoint source pollution is the leading cause of degradation to Ohio's waterways, including the Olentangy River and its tributaries. FLOW is funded in part through provisions in Section 319 of the Clean Water Act to address nonpoint source pollution by developing a watershed action plan.

It is important to note that the Lower Olentangy River Watershed is only a small portion of the entire Olentangy Watershed and that the entire watershed is in need of an action plan and coordination. The Upper Olentangy River Watershed from Delaware up to the headwaters in Crawford and Richland Counties is currently being evaluated for creation of a watershed plan by the Upper Olentangy Watershed Action Planning Team and is scheduled for completion by 2005. An entire Olentangy River Watershed stakeholder meeting was organized in August 2003 by

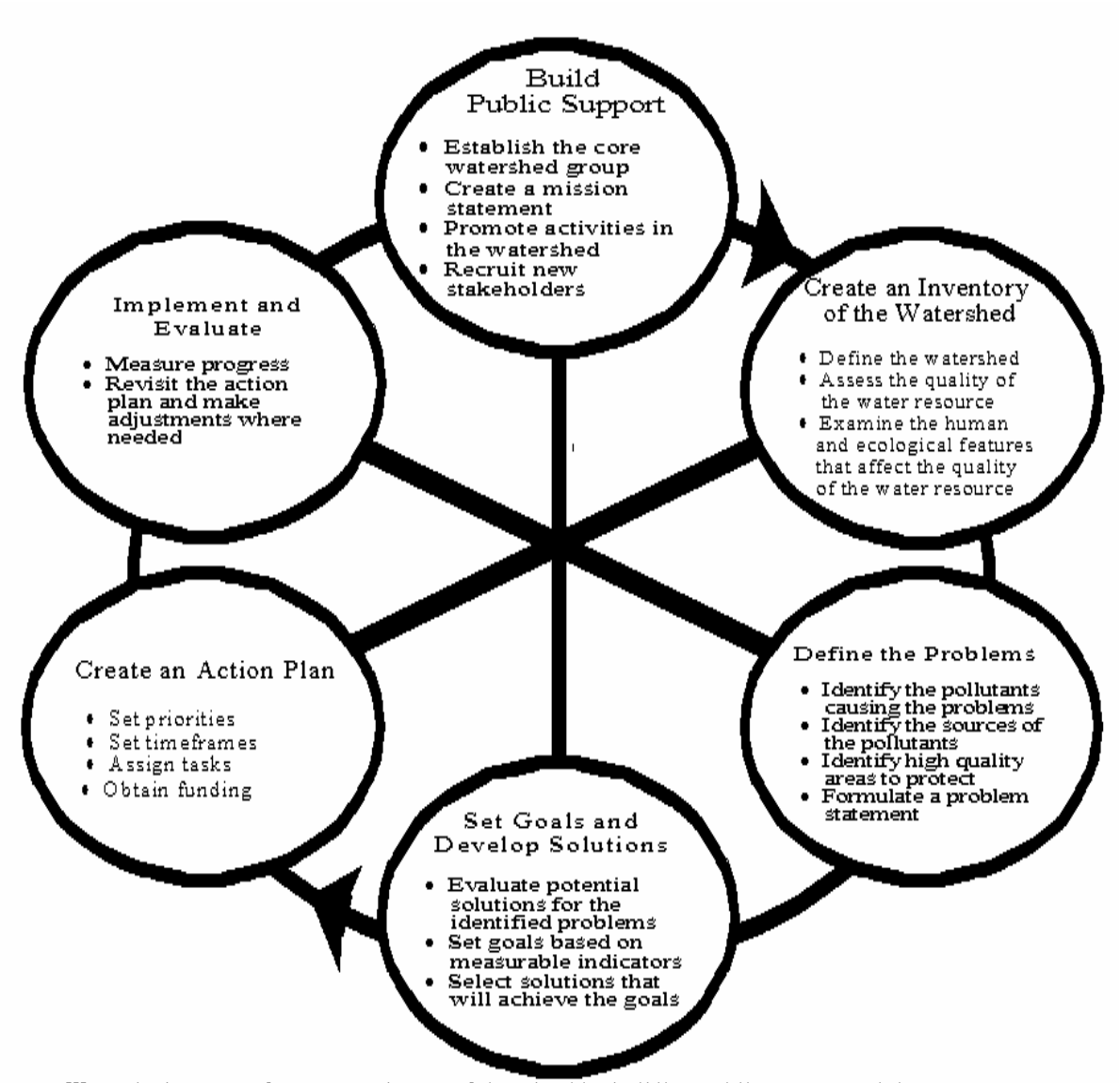
the Ohio EPA with the hope of extended coordination and communication in the future.

1.2 FLOW and the Watershed Action Planning Process

The first step in the watershed action planning process was to build public support by establishing a core watershed group, create a mission statement, promote activities in the watershed, develop relationships and recruit citizens and other stakeholders to participate (see Figure 1).

FLOW formed in August 1997 and a mission statement was adopted; FLOW's mission is to increase public awareness of the extensive environmental, recreational, and cultural resources of the Lower Olentangy River Watershed and to promote responsible policies and uses of the river. To date, FLOW has over 200 dues-paying members and is known within the watershed communities. FLOW has held monthly educational program meetings and regular service events such as tree plantings, cleanups, storm drain labeling and invasive plant removals. FLOW has formed a volunteer monitoring group that monitors eleven sites on the main stem of the Olentangy River and on one tributary, Bill Moose Run. FLOW has organized trainings on water quality monitoring, environmental education for teachers and reducing pollutants from homes. FLOW has also formed working relationships with the local jurisdictions and has assisted in providing comments and advice on plans and projects. The largest role FLOW plays in the community is education. FLOW also works to provide a forum for diverse interests to discuss issues concerning the river and its watershed.

FLOW is a 501 (c)(3) nonprofit organization with the IRS and the State of Ohio; it is governed by a set of by-laws and decisions are made by the Board of Directors through a majority vote, though consensus is sought. The Board of Directors consists of nine unpaid volunteer members elected by FLOW's dues-paying membership at an annual meeting. Board terms are three years in length and are staggered so that no more than one-third of the total board is replaced every year. Appendix A contains FLOW's by-laws and Appendix B contains FLOW's structural chart. FLOW has secured one full-time employee through the Ohio Department of Natural Resources (ODNR) Watershed Coordinator Grants program. FLOW's yearly budget is approximately $80,000, including program, personnel, and administrative costs. Their office is currently located in Clintonville.



Watershed groups often start at the top of the wheel by building public support and then move clockwise. A group is likely to travel around the wheel several times, with each cycle building upon the information and experience gained previously. The "spokes" connecting each step to the center illustrate that the process does not always proceed in one direction, and that the steps are interrelated. Information gained at one step may lead the group to move to another step in the process. For example, information gained during the inventory step may lead the group back to seeking new stakeholders.

Figure 1: Watershed Action Planning Process (Ohio EPA, 2001)

The second step of the watershed action planning process was to create a watershed inventory. The inventory is a compilation of the characteristics of the Lower Olentangy River and its tributary streams, as well as the features of the surrounding landscape that affect the quality of these critical water resources. The Lower Olentangy Watershed Inventory was completed in 2002 by the FLOW Inventory Committee, a dedicated group of volunteers who collected the data and wrote the inventory. The inventory describes hydrologic factors such as precipitation and stream flow; natural landscape features such as geology, topography, soils, and riparian habitats; and human influences such as population, land use, and human modification of these natural areas. Appendix C contains information on the demographics of the Lower Olentangy watershed. The inventory also includes a catalogue of the biological diversity and resources, both aquatic and terrestrial, which have been documented from the river and its watershed in addition to a breakdown of the Ohio Environmental Protection Agency's (Ohio EPA's) water quality monitoring in the mainstem and tributary streams. The inventory was printed on compact disc and distributed to over 300 stakeholders as well as being posted on FLOW's website. Comments on the draft were sought. The Lower Olentangy Watershed Inventory is contained in Appendix D. Section 2.1.2 provides a summary of the water quality data contained in the inventory.

The third step in the watershed action planning process was to define the problems, set goals, develop solutions and create an action plan to address the issues facing the watershed. The information found in the inventory report, in addition to newly collected information, was used to evaluate potential sources of water quality and biological habitat degradation. Potential actions were identified to address these impacted areas, as well as areas of high water and biological quality that may need additional protection. Working groups were formed to complete this third step in the watershed action planning process. The role of the working groups in the watershed action planning process is described in Section 1.3.

1.3 The Six Working Groups and the Watershed Action Plan

A focus meeting was held May 17, 2002 with fourteen stakeholder group representatives. The group laid out the significant issues facing the watershed, grouped them into categories and identified the overarching issues. The outcome of the focus meeting was the development of six working group topics:

- **Land Use** – focus on zoning and regulations affecting land use and comprehensive community plans;

- **Habitat & Recreation** – focus on the riparian corridor and in-stream habitat of the river and tributaries as well as recreation and increasing public access to the river;
- **Hydromodification** – focus on low-head dams, levees, bridge piers, channelization;
- **Stormwater & Construction** – focus on the engineering side of stormwater runoff for quality and quantity controls;
- **Human Health & Sanitation** – focus on septic tanks, sanitary sewer overflows (SSOs), combined sewer overflows (CSOs), wastewater treatment plants (WWTPs), contaminated sediments, and landfills; and
- **Education & Outreach –** focus on ways to educate the public about the Olentangy River, the watershed, and the Lower Olentangy Watershed Action Plan.

After the focus meeting, a planning meeting was held on May 30th 2002. Over 300 stakeholders were sent personal invitations to the meeting and the general public was invited through local newspaper announcements. The purpose of the meeting was to introduce participants to the watershed planning process, present the Inventory, and describe the process used to formulate the six working group topics. Over forty stakeholders attended this first planning meeting. The stakeholders then were encouraged to join one or more of the six working groups. The goal of each Working Group was two-fold: 1) To develop problem statements focused around the issue at hand related to increasing or protecting water quality and recreational uses, and 2) To develop goals, objectives and an activity timeline for solving the problems.

The six working groups met on a monthly basis. The meeting agendas, minutes and problem statements were open to the public via FLOW's website and over 800 people were invited to participate in each of the meetings via FLOW's monthly postcard announcement.

Using the Inventory and additional, newly collected information, the working groups identified potential sources of non-point source pollutants, high quality areas to protect, and areas that needed to be restored. The members also refined the problem and resource statements for their group. The participants then set goals and objectives, and assigned responsible parties / partners to carry out the objectives and meet the goals. They also identified potential funding sources indicators of success for the goals they set. The Working Groups had 10 months, by March 27th 2003, to complete their goal. Each Working Group's information was then compiled and published as the Lower Olentangy Watershed Action Plan. Sections 1.3.1 through 1.3.6 describe each of the six working groups in more detail.

1.3.1 The Land Use Working Group

The Land Use Working Group sought out participation from the Planning and Zoning staff for each of the multiple jurisdictions. Their strategy was to develop resource statements instead of problem statements in order to guide their efforts by the resources in need of protection as opposed to focusing on causes of impairment. They developed Resource Statements that included: Streamside Forests, Floodplains and Headwater Streams. They determined the spatial/political scale by which their recommendations would apply. This approach was used instead of a watershed blanket approach due to the political climate in the watershed. The jurisdictions weren't comfortable making recommendations or comments on other jurisdictions and felt that blanket recommendations would not be appropriate due to the varying levels of legal authority and will. Instead, the group evaluated what was currently being done and then developed general recommendations per their own political jurisdictions.

1.3.2 The Habitat and Recreation Working Group

The Habitat and Recreation Working Group sought out participation from recreation interests and in-stream habitat specialists. After convening, they realized they needed more data, so the first step was to organize a training and canoe survey to assess the condition of the in-stream and riparian habitat as well as recreational opportunities (existing or potential). After gaining this information for the Franklin County portion of the watershed, the group made recommendations and used aerial photographs (1"= 100') to reference the location of their recommendation. The aerial photographs were provided by Franklin County Engineers Office. The maps are located in the FLOW office and are available for public review. Recommendations for the Delaware County portion are still awaiting completion.

1.3.3 The Hydromodification Working Group

The Hydromodification Working Group used aerial photographs to determine locations of lowhead dams, past channelization/alteration, and bridge crossings. This group wrote three problem statements focused on Bridges, Levees, Lowhead Dams, Culverting and Channelization. They then made recommendations for each of these topics.

1.3.4 The Stormwater and Construction Working Group

The Stormwater and Construction Working Group began to focus on developing a model Phase II application for the multiple jurisdictions within the watershed, but

found this was a duplication of efforts currently underway in Franklin and Delaware Counties. They switched their emphasis to doing research on best management practices (BMPs) that treat for quality and quantity of stormwater and then made recommendations for undeveloped and developed (i.e., impacted) areas.

1.3.5 The Human Health and Sanitation Working Group

The Human Health and Sanitation Working Group focused on bacterial sources such as packaging plants and home septic / aeration systems in addition to looking at old landfills and areas where contaminated sediments were found.

1.3.6 The Education and Outreach Working Group

The Education and Outreach Working Group collected educational pamphlets and materials with regard to each source of impairment for future use. In addition, they made a matrix of environmental education providers and listed them in a matrix with contact information and programs offered and made recommendations on how to educate the public about the Lower Olentangy River Watershed.

1.4 The Purpose of the Watershed Action Plan

The final step in the watershed action planning process is to implement and evaluate the strategies contained in the plan. The purpose of the Lower Olentangy Watershed Action Plan is to help guide FLOW and other decision-making entities in the watershed to make policies, procedures and projects that will facilitate the goals and strategies for water quality protection and improvement that are laid out by the action plan. FLOW created this plan under the advisement, leadership and will of the working group participants. For FLOW, the goal at the end of the watershed action planning process was to have a consensus document to guide them in carrying out their mission.

The draft Watershed Action Plan was compiled and sent out for public comment in March 2003. Comments were received and the Watershed Action Plan was updated and resubmitted to the Working Group members as a final draft. Again, comments were received and the plan was updated, finalized and submitted to the Ohio EPA and ODNR for endorsement in November 2003. The plan was updated and resubmitted again in December 2003.

In January 2004, the Lower Olentangy Watershed Action Plan received conditional endorsement from the Ohio EPA and the ODNR. The plan was sent back to the

Working Group members during the summer and autumn of 2004 to discuss the comments received from the Ohio EPA and ODNR. The updated plan was resubmitted to the Ohio EPA and the ODNR for full endorsement consideration in March 2005. After endorsement, FLOW will put the Lower Olentangy Watershed Action Plan on a compact disc for distribution to membership, the Working Groups, local government officials, and other interested parties. FLOW will also make the Lower Olentangy Watershed Action Plan available in portable document format (pdf) on FLOW's website (www.olentangywatershed.org) for downloading. FLOW will make some printed copies of the Plan available in the FLOW office, at local libraries within the watershed, and to participating political jurisdictions that wish to have one. FLOW also plans to create and print copies of an Executive Summary of the Plan which will be available for distribution to the general public.

The Lower Olentangy Watershed Action Plan is intended to be a living document that will be updated over time as conditions in the watershed change and as the actions described in the Plan are implemented. As such, FLOW will evaluate the success of the actions being implemented and also review and update the Plan at a minimum of every five years from the date it is fully endorsed.

1.5 Document Organization

The Watershed Action Plan is divided into six sections based on the six working groups. Each section describes the working group's problem or resource statements, and their goals, objectives, and associated timelines. Potential sources of funding are also identified where possible.

1.6 Endorsement and Adoption

Through the planning and creation of the Watershed Action Plan, many watershed stakeholders, municipalities, and government entities were represented through the 6 working groups and individually. Entities represented include: Mid-Ohio Regional Planning Commisssion, Delaware County, Franklin County , City of Columbus, City of Powell, City of Worthington, City of Delaware, Liberty Township, Orange Township, Ohio State University, Delaware SWCD, Franklin SWCD, ODOT, ODNR, Ohio EPA, Ohio Department of Health, Olentangy Environmental Control Center, Sierra Club, Tributary Groups (including Friends Rush Run, Adena Brook Community, and Friends of Ravines), Olentangy Watershed Alliance and FLOW. These individuals, who represented various interests throughout the watershed, were responsible for the objectives and priorities outlined in the Recommendation Tables throughout this Action Plan. In so

doing, they expressed an interest and willingness on behalf of the stakeholders for implementation of these actions on one or more of the following levels:

- to participate in the watershed action planning and implementation process;
- to assist with research and information dissemination;
- to contribute pertinent and relevant information to the planning and implementation; and
- to commit involvement, action or resources as individuals or entities.

After the Action Plan has been fully endorsed by the Ohio EPA and ODNR, FLOW will seek stakeholder endorsement of the Plan, either through resolutions of support or adoption into local plans from active stakeholders including, but not limited to, those organizations listed above. In cases where full endorsement is not possible from all affected stakeholders, FLOW will work to secure various levels of support and collaboration on a case-by-case basis necessary to implement those items and sections of the Action Plan.

1.7 Implementation

FLOW has convened a steering committee to oversee implementation of the actions outlined in the Recommendation Tables. The steering committee is currently made up of the following stakeholder representatives: Mid-Ohio Regional Planning Commission, Franklin County, City of Columbus, Delaware County, Olentangy Environmental Control Center, Ohio Department of Health, Ohio EPA, ODNR, Ohio State University, Friends of Rush Run, and a couple of citizens at large. Additional representation will be sought from other groups as necessary. This group will meet 3-4 times per year to discuss the current status of action items in the WAP, prioritization of items during the current time frame, and identification of actions, resources and parties necessary for implementation to occur.

In addition, as a result of the work done by the Land Use group, a Government Forum will continue to meet several times per year. The purpose of this forum is to bring government leaders together to discuss implementation of recommendations made in the Action Plan.

1.8 Water Quality Monitoring Strategy

In order to assess water quality before and after any major implementation occurs, FLOW will consult with stakeholders and government agencies (e.g. Ohio EPA, ODNR) who have the necessary skills, facilities, qualifications and resources to conduct monitoring to pass rigorous scientific scrutiny. Water quality monitoring performed to assess the success of an implementation must be designed specifically to accommodate the goals and objectives of the implementation strategy. Where applicable, practicable, and funded, FLOW will consult with Ohio EPA for technical assistance in creating and implementing a water quality monitoring program.

1.9 Watershed Action Plan Summary

The recommendations within this plan are for the most part, based on water quality data collected by the Ohio EPA in 1999 and published in 2001. Table 1 in Section 2.0 is a summary of the data that was collected (please refer to the Inventory located in Appendix D which has a much more detailed data description). Most of the mainstem of the Olentangy River met the water quality standards, only two segments did not; above the 5th Ave Dam and at the confluence with the Scioto River. However, the entire River has been deemed "threatened" by the Ohio EPA due to the rapid development in Delaware County.

In contrast to the high water quality in the mainstem, the majority of the tributary streams monitored in 1999 were not meeting the water quality standards. It is the goal of FLOW and the Ohio EPA to have all segments of the Lower Olentangy Watershed meeting water quality standards by 2010.

It is important to note that 1999 was a drought year and it is likely that the effect of nearly every stressor within the basin was made more acute by significantly diminished stream flow. Monitoring for the TMDL is currently underway by the Ohio EPA and is expected to be published in 2005-2006. Data from this effort will be used to update the WAP after that time.

Items FLOW and watershed partner jurisdictions and agencies will focus on first are:

1. Protection of high quality areas (most of the mainstem especially in Delaware County) through Land Use and Stormwater Regulations and policies and through the purchase of riparian forests. First priorities are: Big Run

Preservation Park and Camp Lazarus conservation easement (see Appendix G for additional information).

2. Restoration of the mainstem through dam removal or dam modifications.
3. Restoration of the tributary streams through the "Backyard Conservation Program and Stormwater Reduction" education program. As well as stream restoration projects.
4. Home Sewage Treatment System maintenance education, inspections, upgrades or tie-ins to the sanitary system.
5. CSO / SSO reductions with efforts striving for elimination; Adena Brook Pilot Study to Reduce Inflow to the Sanitary System.
6. Development of a 32-mile Water Trail for boaters (including safety signage at lowhead dams and portage routes)
7. Local Stormwater post-construction BMP demonstration projects installed at OSU (parking lot bio-retention, bio-swale, green-roof) and monitor for effectiveness at pollutant removal.
8. Reduce littering and increase cleanup efforts
9. Control erosion and sedimentation from construction sites.

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2.0 The Land Use Working Group

The Land Use Working Group's strategy was to develop resource statements instead of problem statements in order for their efforts to be guided by the resources in need of protection as opposed to focusing on causes of impairment. The group sought out participation from the Planning and Zoning staff for each of the multiple jurisdictions. They determined the spatial/political scale by which their recommendations would apply. This approach was used instead of a watershed blanket approach due to the political climate in the watershed. The jurisdictions weren't comfortable making recommendations or comments on other jurisdictions and felt that blanket recommendations would not be appropriate due to the varying levels of legal authority and will. Instead, the group evaluated what was currently being done and then developed general recommendations per their own political jurisdictions.

The Resource Statements developed by the Land Use Working Group included: Streamside Forests, Floodplains and Headwater Streams. Because certain elements of the Land Use Working Group overlapped with the Habitat and Recreation Working Group, a general discussion of habitat is included in this section.

2.1 The Importance of Habitat

The Ohio EPA Division of Surface Water staff has demonstrated that habitat plays a major role in the occurrence and maintenance of viable populations of both fish and macro-invertebrates with habitat conditions largely being dependent on local geography and the nature and extent of man-made modifications of the aquatic environment (Rankin, 1995). The latter includes obvious features such a hydromodification of the stream, including dams, straightening of stream channels, and culvertization; as well as more subtle impacts such as the nature of stream substrates, bank stability, and the nature and condition of adjacent riparian areas (FLOW, 2003).

2.1.1 Measures of Physical Stream Habitat

Besides the use of chemical and biological criteria to assess water quality in Ohio's rivers and streams, Ohio EPA also has devised a measurement evaluating the condition and type of physical habitat characteristic of a particular stream segment. This measurement, termed the **Qualitative Habitat Evaluation Index (QHEI)**, is a numerical index based on visual estimates of stream habitat features. These include substrate quality, in-stream cover, channel morphology, riparian zone and bank

quality, pool and riffle quality, and stream gradient. The higher the total index score, the better the quality of the habitat along the studied stretch of the stream or river. High quality sections of rivers and streams in Ohio typically have QHEI scores in excess of 75. Streams with QHEI scores less than 45 generally cannot sustain a warm-water biota consistent with Warm-Water Habitat biological criteria (FLOW, 2003).

Recently the Ohio EPA developed a Primary Headwater Habitat Evaluation method to more accurately determine the health of small tributary headwater streams. This method was recently used on four headwater streams of Big Run (e.g., Lewis Center Tributary) and they scored as Class III, the highest classification.

Another important tool in measuring health of a stream is to look at stream morphology- the stability of the stream channel. In a healthy system a stream has access to its floodplain. No stream morphology data has been obtained on the Olentangy River or its tributary streams to date.

2.1.2 Current Stream Habitat Quality in the Lower Olentangy River

In 1999, Ohio EPA evaluated stream habitat [QHEI] at all stations studied along the main stem of the Lower Olentangy River from the Delaware Dam to the river's confluence with the Scioto River in Columbus. The river scored above the Warm-Water Habitat threshold [QHEI = 60] at all sites in Delaware County and at most sites in the northern portion of Franklin County above RM 5.0 (Ohio EPA, 2001). The highest habitat scores [QHEI > 75] were obtained at RM 27.9 at Hudson Road, upstream of the Delaware water plant and at RM 19.4 adjacent to the Hyatts Road Bridge along the Scenic River portion of the river, both in Delaware County. Habitat quality declines [QHEI < 60] in downstream portions of the river within the Columbus city limits. Some stretches of the river in this area are classified as "Modified Warm-Water Habitats" mainly due to the impacts of low-head dams and local channelization of the river. The lowest habitat score [QHEI = 29] occurred at RM 2.0, immediately upstream of the 5th Avenue dam and adjacent to the OSU campus. This stretch of the river has been slowed, straightened, broadened, and deepened, taking on the appearance of a stagnant, mud-bottom pond or lake rather than a free-flowing river. Table 1 contains a summary of the findings from the Ohio EPA's study. The Lower Olentangy Watershed Inventory (FLOW, 2003) in Appendix D contains a more comprehensive set of habitat and water quality data.

Table 1. Ohio EPA-Identified Attainment Status and Causes and Sources of Impairment (Ohio EPA, 2001), Page 1 of 5.

River Segment	River Mile[a][b]	Use[c]	Full Attainment	Partial Attainment	Non-attainment	Cause of Impairment[d]	Sources of Impairment
Main Road to US 23	32.0 to 22.3	WWH	12.4 (River Mile 32.0-19.60)				
Hyatts Rd. to OECC WWTP Mixing Zone	19.6 to 12.4	EWH	7.2 (River Mile 15.0-7.8)	4.6 (River Mile 19.6-15.0)		Due to slightly subpar fish scores below the EWH at Hyatts Rd. (Scored 44 Very Good vs. 48 Exceptional)	• Potentially from increased land development upstream causing stormwater runoff and sedimentation. • Potentially effluent of the Delaware WWTP • Potentially from the drought conditions during the 1999 field season.
Kenny Park to Henderson Rd.	7.8 to 6.8	WWH	2.3 (River Mile 7.8-5.5)				
E. North Broadway	5.5	MWH	1.5 (River Mile 5.5-4.0)				

Continued on the next page.

Table 1. Ohio EPA-Identified Attainment Status and Causes and Sources of Impairment (Ohio EPA, 2001), page 2 of 5.

River Segment	River Mile[(a)(b)]	Use[(c)]	Full Attainment	Partial Attainment	Non-attainment	Cause of Impairment[(d)]	Sources of Impairment
Dodridge Rd.	4.0 to 3.9	WWH		2.0 (River Mile 4.0-2.0)		• Due to subpar macroinvertebrate scores (Scored 26 Fair vs. 36 Good) • Habitat Alterations • Flow Alterations	From the urbanized character of the watershed, altered habitat (downstream of a dam) resulting in insufficient flow.
Upstream and Downstream of the 5th Avenue Dam	2.0 to 1.8	MWH		1.20 (River Mile 1.9-.70)	0.10 (River Mile 2.0-1.9)	• Upstream of the 5th Avenue Dam: not meeting due to extremely low habitat (QHEI 29) and macro-invertebrate scores (ICI 12) • Downstream of the 5th Avenue Dam: not meeting due to subpar macro-invertebrate scores (ICI 20)	• Upstream of the 5th Avenue Dam: from the impoundment, silty/mucky substrate, CSO/SSO discharges and contaminated sediment. • Downstream of the 5th Avenue Dam: from artificial substrates caused by the dam upstream.
Railroad Bridge	0.7 to 0.6	WWH		0.4 (River Mile .70-.30)		Due to subpar macroinvertebrate scores (ICI 28)	From slow current, limited habitat and urban impacts.

Continued on the next page.

Table 1. Ohio EPA-Identified Attainment Status and Causes and Sources of Impairment (Ohio EPA, 2001), page 3 of 5.

River Segment	River Mile[a], [b]	Use[c]	Full Attainment	Partial Attainment	Non-attainment	Cause of Impairment[d]	Sources of Impairment
Near Mouth	0.3 to 0.2	MWH			0.3 (River Mile .30-0.0)	Due to extremely low macroinvertebrate scores (ICI 12) and contaminated sediments	From the impoundment on the Scioto River, silty/mucky substrate, CSO/SSO discharges. Urban runoff.
Adena Brook	N/A	WWH			1.0	• Elevated nutrients, bacteria, and contaminated sediments (cadmium, copper, zinc). • Below WWH criteria for DO (low flow) • Flow alterations	• Urban runoff • Low flow (barely a trickle during drought) • SSOs • Food-grade oil spills • Impervious surfaces; past construction of buried sewer lines.
Turkey Run	N/A	WWH			0.7	• Poor fish (IBI 20) and poor macro-invertebrate scores • Elevated bacteria • Contaminated sediments (copper)	• Urban Runoff • Altered flow pattern • Septic • Golf Course
Rush Run	N/A	WWH			0.4	• Poor fish scores (IBI 28) • Extensive Channel Alteration (QHEI 48.5) • Nutrients causing algal blooms • Contaminated Sediments (aluminum, arsenic, barium, cadmium, copper)	• Urban Runoff • SSOs • Channel Alterations

Continued on the next page.

Table 1. Ohio EPA-Identified Attainment Status and Causes and Sources of Impairment (Ohio EPA, 2001), page 4 of 5.

River Segment	River Mile[a][b]	Use[c]	Full Attainment	Partial Attainment	Non-attainment	Cause of Impairment[d]	Sources of Impairment
Bartholomew Run	N/A	WWH			1.0	• Bank erosion; Fair ICI score • Suspended Solids and bacteria exceedences	• Urban Development
Delaware Run	N/A	WWH			1.2	• Poor macroinvertebrate and Fair fish scores (IBI 34, 30) • Channel modifications • Contaminated Sediments (aluminum, chlordane)	• Urban Runoff • Sewer line failures or Septic • Habitat Alterations
Horseshoe Run	N/A	WWH		0.3		• Fair macroinvertebrate rating • Below WWH criteria for DO (3.93 ppm) and *E. Coli* exceedences (685) and nutrient levels were moderately elevated.	• Potentially from the drought conditions during the 1999 field season. • Failing Septic/Fertilizer
Lewis Center Tributary (aka Big Run)	N/A	WWH		0.1		• Phosphorus levels were elevated. • Poor fish scores (IBI=32)	• Potentially from the drought conditions during the 1999 field season. • Failing Septic/Fertilizer

Continued on the next page.

Table 1. Ohio EPA-Identified Attainment Status and Causes and Sources of Impairment (Ohio EPA, 2001), page 5 of 5.

River Segment	River Mile[(a)(b)]	Use[(c)]	Full Attainment	Partial Attainment	Non-attainment	Cause of Impairment[(d)]	Sources of Impairment
Bill Moose Run	N/A	WWH			0.3	• Poor fish scores (IBI=30) and Fair macro-invertebrate scores (ICI). • Bacteria exceedences	•Urban Development •Failing Septic/SSOs
Linworth Run	N/A	WWH			0.9	• Subpar habitat (53.5) (intermittent)	•Urban Runoff •Flow alterations
Kempton Run	N/A	WWH			0.9	• Subpar habitat (54.5)-natural and poor fish score (IBI 22)	•Urban Runoff •Flow alterations

(a) The river mileage was determined by adding the known river segment miles to the beginning of the next river segment. Ohio EPA is lacking data for river segment miles in-between segments and has extrapolated the attainment status to the beginning of the next section.

(b) The tributaries to the main stem of the Olentangy River do not have river mile designations assigned to them and appear as Not Applicable (N/A).

(c) Aquatic Life Use designation criteria can be found in the Ohio Water Quality Standards (WQS); Ohio Administrative Code 3745-1.

MWH= Modified Warmwater Habitat – this aquatic use designation applies to streams and rives which have been subject to extensive, maintained, and essentially permanent hydromodifications such that the biocriteria for the WWH use are not attainable and where the activities have been sanctioned by state or federal law. The representative aquatic assemblages are generally composed of species tolerate of pollution and poor quality habitat.

WWH=Warmwater Habitat – this aquatic use designation defines the "typical" warmwater assemblage of aquatic organisms for Ohio rivers and streams. This use designation represents the principal restoration target for the majority of water resource management efforts in Ohio.

EWH=Exceptional Warmwater Habitat – this aquatic use designation is reserved for waters which support "unusual and exceptional" assemblages of aquatic organisms which are characterized by a high diversity of species, particularly those which are highly intolerant and/or rare, threatened, endangered, or species status (i.e., declining). This designation represents a protection goal for water resource management efforts dealing with Ohio's best water resources.

(d) Biological indices are used to measure and assess level of attainment or impairment:

IBI = Index of Biotic Integrity – measure of fish species diversity and species populations. Score range 0-60.

MIwb = Modified Index of Well Being – based on the performance of fish populations.

ICI = Invertebrate Community Index – based on measurements of the macroinvertebrate community. Score range 0-60.

QHEI = Qualitative Habitat Evaluation Index – is a measurement of the ability of the physical habitat to support biological communities. The threshold for WWH aquatic use designation is a QHEI score of 60+.

2.2 Resource Statement for Floodplains

Floodplains, which are open and accessible to floodwaters, serve a vital role in high quality stream ecosystems. Floodplains serve as natural, and very cost effective, storage areas for floodwaters that could otherwise put people and property in harms way. Floodplains dissipate energy out of the stream channel decreasing the erosive force of floodwaters on stream banks and slow floodwaters decreasing the impacts to downstream property. Floodplains provide areas for sediments and other non-point source pollutants to settle out of the water column providing very cost effective storm water treatment, especially when forested. Floodplains also provide areas for groundwater recharge.

In addition to the ecological attributes that floodplains possess, they can serve as outstanding recreational areas for rapidly urbanizing communities. Comparatively, floodplain property cost significantly less than upland areas making it much more desirable for public open space. Forested floodplains provide areas for hiking, fishing, biking, bird watching, picnicking and many other outdoor activities.

2.2.1 Current Floodplain Conditions in the Lower Olentangy Watershed

Land use in the Delaware County portion of the Olentangy River floodplain in 1994 consisted primarily of wooded acreage (39%) and agriculture or open space (37%) with only 3% classified as urban. In contrast, land use in the floodplain in Franklin County in 1998 was dominated by impervious urban areas (43%), wooded acreage (31%), and little agricultural or open space acreage (12%). The data shown in Table 2 is the most recent Land Use data available at this time for Delaware County (1994) and Franklin County(1998) (FLOW, 2003).

2.3 Resource Statement for Streamside Forests

Streamside forests (riparian buffer zones) are vital and inseparable components of a high quality stream ecosystem. Overhanging vegetation helps maintain consistent water temperature and provides leaf litter as a food source for the aquatic environment. Streamside forests filter out nitrogen, phosphorus, fine sediments, and other pollutants from surface water runoff before they can enter the stream network. Root structures from trees, shrubs, and grasses stabilize the stream bank and slow down flood velocities lessening the impact of flooding downstream. Streamside forests also provide habitat to diverse assemblages of terrestrial animals and are major flyways for migrating birds in Ohio. Streamside forests are also amenities to rapidly urbanizing communities, not only for the benefits of cleaner

water, but also as a recreational resource for bird watching, hiking, fishing, canoeing, etc.

As future development continues in the Olentangy Watershed, it will be crucial that streamside forests are protected in areas where they already exists, and restored in areas where they have been eliminated. In addition, streamside forests must be preserved/enhanced on the tributary streams of the Olentangy River as well as the main stem.

Table 2. Land Uses in the Lower Olentangy Watershed Floodplain.

Land Use[(a)]	Acreage in Delaware County	Acreage in Franklin County
Agriculture / Open Urban Areas	2,880.75	244.81
Non-forested Wetlands	365.00	21.51
Open Water	1,150.48	257.78
Shrub / Scrub	145.48	16.67
Unknown	0.46	0
Urban (impervious surfaces)	208.60	920.61
Wooded	3,036.68	663.91
Total Acreage	7,787.21	2,125.39

(a) Land Use Data Source: ODNR, REALM 1994 Land Use Inventory of Ohio (Delaware) and 1998 Franklin County land use/land cover, ODNR 1998 (Franklin County). 100 year flood boundary, Franklin Co FEMA Pilot Project Preliminary Data, FEMA, ODNR, 2001.

2.3.1 Current Streamside Forest Conditions in the Lower Olentangy River Watershed

The wooded acreage along the main stem of the Olentangy River's floodplain (i.e., streamside) consists of 3,036.68 acres in Delaware County and 663.91 acres in Franklin County. At this point in time, it is unknown what the forest conditions are for the tributary streams (FLOW, 2003).

Table 4 provides Streamside Forest and Floodplain Protection Recommendations. Table 5 provides Streamside Forest Restoration Recommendations.

2.4 Resource Statement for Headwater Tributary Streams

Headwater tributary streams are the small drainage ditches, swales, and small streams that are the origin of larger streams and rivers. Headwater tributary streams are very important to the water quality of the Olentangy River because the majority of the water within the main stem comes from these smaller streams. Consequently, these tributary headwater streams play a vital role in the health of the main stem. If headwater streams are preserved or restored they have the ability to capture and treat pollutants before they enter the Olentangy River, having a positive impact on water quality. On the other hand, if tributary-headwater streams are degraded or destroyed then they can contribute a significant amount of pollutants to the Olentangy River degrading water quality.

Many headwater tributary streams on the Olentangy River flow through deep, steep ravines containing large trees and in some cases the best remaining forest tracts in the Olentangy Watershed. These Ravines contain assemblages of wildflowers, amphibians, insects, mammals, and other wildlife. Due to their aesthetic nature they are areas under heavy urban encroachment for residential development. Urban encroachment upon these tributary ravines have caused significant water quality problems including excessive erosion due to increased storm water and deforestation resulting in instability of steep slopes and reduced filtration of nutrients and contaminants, and increases in nutrients and other contaminants from un- or under-treated storm water. The long-term health of the Olentangy River is directly dependent upon the preservation of the integrity of its tributary streams. Think of the tributary streams as veins in a human body. As veins become infected they negatively affect the rest of the body, and in some cases cause irreversible damage. Rivers and their tributary streams function in much the same manner.

2.4.1 Current Stream Habitat Quality of the Lower Olentangy Headwater Tributary Streams

Olentangy River tributary streams studied by Ohio EPA in 1999 had highly variable habitat scores. Habitat quality at or just above the WWH minimum [QHEI = 60] were recorded for Horseshoe Run, the upper reaches of Delaware Run, the Lewis Center tributary, all in Delaware County, and for Bill Moose Run in Franklin County (Ohio EPA, 2001). All of these streams had unmodified or recovered channels, pool depths > 40 cm, and abundant coarse-grained bottom sediments. All except Horseshoe Run were perennial with stream flow all year-round.

Habitat quality was more marginal [QHEI just below 60] for Kempton Run, Linworth Run, and the lower part of Adena Brook, all in Franklin County. Kempton Run has a very small drainage area and lacks a diversity of in-stream features. Linworth Run and the lower stretch of Adena Brook during the 1999 field summer season were bone-dry without even subsurface interstitial flow and were surrounded by an impervious urbanized landscape.

Habitat quality was judged to be poor [QHEI < 50] for studied portions near the mouth of Delaware Run in the city of Delaware [QHEI = 40], along the studied portion of Rush Run [QHEI = 48.5] in Worthington, and in the upper reaches of Adena Brook in Columbus [QHEI =43.5]. These studied stream courses were negatively impacted by significant hydromodifications (i.e. channelization) and by their surrounding impervious urban landscapes (FLOW, 2003).

Table 6 provides Headwater Stream Recommendations for Habitat Improvements.

2.5 Current Land Use Strategies in Place per Political Jurisdiction

2.5.1 Current Floodplain Regulations

2.5.1.1 City of Delaware. Fill permits are issued by the floodplain manager in the Planning Department (none have ever been issued). Typically permits only allow for surface parking; developers can be granted "conditional use" in the floodplain by the Board of Zoning Appeals. Zoning Code 1171.02.

2.5.1.2 City of Powell. To get a fill permit, you have to get permission from the Planning & Zoning Commission; they require proof of "beneficial purpose" and protection from erosion. No dredging is allowed unless appropriate state and federal permits are obtained. No structures or uses are allowed that will "adversely impact the efficiency of the floodplain or restrict its capacity". Fill permits require a public hearing, a request for a floodplain development permit goes before the Planning and Zoning Commission whose meetings are advertised and any resident within 250 feet of the development location is notified. Zoning Code 1145.26.

2.5.1.3 City of Worthington. Allows for only agriculture, forestry, non-commercial recreation, parks and public uses in the floodplain. Conditional uses must be non-commercial public services. Regulation only applies to the mainstem and is strictly enforced- a public process is required to obtain a variance through City Council. The City has established some minimum build elevations for tributaries. Zoning Code 1105.

2.5.1.4 City of Columbus. A developer must obtain a certificate of zoning clearance from the development regulation administrator prior to filling of the floodplain. There is no public process. Zoning Chapter 3305 (Ord. 635-87). Landfill is the only use that is prohibited in the floodplain Chapter 3385.10.

2.5.1.5 Delaware County. The Delaware County Regional Planning Commission is currently revising its subdivision regulations to limit subdivision within the floodplain.

2.5.1.6 Franklin County. Within the floodplain, flood protection shall be achieved by elevating buildings at least one foot above the base flood elevation. Non-residential structures may otherwise be flood-proofed (FCZR).

2.5.1.7 Orange Township. No structures are permitted within the floodplain. Fill cannot be deposited in the floodplain without permission of the BZA.

2.5.1.8 Berlin Township. Subtracts floodplains during calculations of net developable land.

2.5.2 Current Riparian Setbacks

2.5.2.1 City of Delaware. Currently, a required 120 foot buffer on either side of the main stem. The draft comprehensive plan calls for a 60 foot buffer on major tributaries and a 30 foot buffer on all other waterways; Delaware Run will likely have a smaller buffer because of existing development. Zoning Code 1150.06.

2.5.2.2 City of Powell. The Olentangy River Environmental Overlay requires a 120 foot setback from the main stem (no construction, no removal of vegetation or fill), requires no construction or removal of vegetation in the "regional floodplain" of the Olentangy River or its tributaries, requires that wooded ravines and tributaries remain natural- requiring conservation easements on private land or wilderness / natural preserve districts for public lands. Zoning Code 1143.29.

2.5.2.3 City of Worthington. No codified setbacks, however all development since the 1980's have required a 50 foot storm water easement along streams and scenic reserve easements along steep ravines.

2.5.2.4 Franklin County. 120 foot buffer and 25 foot transitional area for all major streams / rivers. (Subdivision Regulation 406).

2.5.2.5 ODNR Scenic Rivers. Recommends a minimum of a 120 foot setback on the main stem of the Olentangy Scenic River.

2.5.2.6 City of Columbus. It is an unwritten policy in the Parks & Recreation Department to get a 50 foot buffer on small streams and 120' on large rivers. The Storm Water Management Section has a written open watercourse policy

for a 50 foot buffer from the top of each bank of USGS blue-line streams and a 25 foot buffer for small streams.

2.5.3 Current Subdivision Regulation

2.5.3.1 City of Delaware. Requires a 10% parkland dedication for all residential development; they can negotiate parkland to be along the river. Zoning Code 1111.19.
2.5.3.2 Franklin County. See Section 2.5.2.4.
2.5.3.3 Delaware County. The Delaware County Regional Planning Commission is currently revising its subdivision regulations to limit subdivision within the floodplain.

2.5.4 Current Planned Residential/Unit Development (PUD/PRD)

2.5.4.1 City of Delaware. Requires an additional 10% - 30% open space dedication on top of the 10% parkland required in the subdivision code. Zoning Code 1135.04.
2.5.4.2 All Counties and Townships. The Ohio Revised Code gives counties and townships additional zoning authority (including zoning for general welfare) for Planned Unit Developments.

2.5.5 Current Greenways

2.5.5.1 City of Delaware. Parks & Recreation Department adopted a greenways plan; both the greenways plan and draft comprehensive plan call for "major greenways" along main stem and all tributaries.
2.5.5.2 City of Columbus. Riverfront Vision Plan recommends stabilize, maintain and selectively enhance the riparian corridor with particular attention to the vegetated steep banks along the river's edge and to enhance and maintain the natural bank along the river for wildlife habitat. The Columbus Comprehensive Plan calls for the protection of natural resources throughout the City (wetlands, natural habitats, river valleys and banks, natural drainage ways, forested areas and floodplains). The Comprehensive Plan also supports bicycle facilities, parks and Greenways. It supports the establishment of a greenways zoning overlay and a protective zoning overlay for ravines to tie them into the city's greenway system.

2.5.6 Current Easements

2.5.6.1 City of Delaware. Internal commitment (not codified) to obtain conservation easements along all waterways; policy of Parks & Recreation Department to pursue easements on all waterways.

2.5.6.2 City of Columbus. The Riverfront Vision Plan recommends the implementation of the environmental and public access provisions of the Riverfront Vision and Franklin County Greenways Plan to obtain conservation easements, right of way acquisition to extend the trail system, enable public access along and to the river's edge. Priority acquisition identified along the Olentangy: Westwater property, White Castle property. Columbus Comprehensive Plan calls for land acquisition to establish greenway systems including but not limited to fee simple purchase, mandatory dedication, easement purchase or donation, restrictive covenant.

2.5.6.3 ODNR Scenic Rivers Division. For the Olentangy State Scenic River (from the Delaware Dam to Wilson Bridge Road), it is a high priority to obtain easements along the mainstem of the river and along tributaries within 1,000 feet of the mainstem.

2.5.7 Current Tree Preservation

2.5.7.1 City of Delaware. Trees 6" or larger in caliper must be replaced 2 for 1 in all lots 1-acre or larger in size or a $250 fee is paid per removed tree, which is placed in the Tree Bank Fund for planting trees on public property. The 1-acre rule is currently being reviewed. Zoning Code 1168.

2.5.7.2 City of Powell. Destruction of trees is not allowed unless it meets criteria, destroyed trees need to be replaced on the same property and a $300 fine will be issued if trees are not replaced within one year of destruction. Zoning Code 1145.29 c,d.

2.5.7.3 City of Worthington. No codified tree preservation, however all new development / redevelopment requires a landscape plan that meets city standards and the developer can be fined if the landscape plan is not followed.

2.5.8 Current Planned Districts: Open Space

2.5.8.1 City of Powell. Protects all slopes greater than 6%, they must stay in their natural state. Zoning Code 1143.09 4D.

2.5.8.2 City of Columbus. Parkland dedication (Chapter 3318). Upon submission for rezoning of land in excess of one acre, the Recreation & Parks

Commission will determine if land or monetary donation will be required. The goal is to provide 5.5 acres of park for every one thousand residents.

2.5.8.3 Berlin Township. Subtracts floodplains, jurisdictional wetlands, slopes, bodies of water and utilities during calculation of net developable land. Open Space (20-40%) is based on the original zoning being overlaid. Un-buildable areas count for up to 50% of the requirement.

2.5.8.4 Orange Township. Single and multi-family developments- at least 20 % of the total gross acreage must be devoted to open space.

2.5.8.5 Liberty Township. To the maximum extent possible, all natural drainage courses shall be maintained. The comprehensive plan requires larger lot size (1 acre or more) below the 950' elevation.

2.5.8.6 Delaware Township. Requires fifteen thousands of an acre (.015) per 1 dwelling unit to be open space.

2.5.9 Current Redevelopment Plans

2.5.9.1 City of Worthington. The City is 98% built out. Many sites may redevelop in the next several years; the scenic reserve easements will be used to protect tributary streams.

2.5.9.2 City of Columbus.

2.5.9.2.1 River District between Neil & railroad tracks and west of tracks to the river 2 million sq ft commercial office space, 900,000 sq ft of commercial retail, 1,100 residential units.

2.5.9.2.2 Harrison West reach (Goodale to Second Ave)- redevelopment of existing use along the corridor, parkland and open space, AC Humko residential development.

2.5.9.2.3 The Olentangy River Road Urban Design Plan (Lane Ave to N. Broadway) was adopted by Columbus City Council on November 24, 2003.

2.5.9.2.4 The Far North Plan (Powell Road on the north, I-270 on the south, Worthington Rd and I-71 on the east and Olentangy River on the west) calls for York Temple Country Club to maintain the golf course but support planned residential development if redevelopment opportunities arise. Pontifical College Josephinum supports future development compatible to existing development; special care should be taken to preserve and maintain the natural environment of the Olentangy River, Flint Ravine, and adjacent land. Camp Mary Orton- supports future development consistent with the Concept Plan of the Godman Guild Board of Trustees; preserve and maintain the natural environment to the greatest extent possible. The Far North Plan also

calls for bikeways, reserving public land along the Olentangy River, and to monitor and maintain the natural ravines and drainage ditches for storm water.

2.5.9.3 ***The Ohio State University.*** The Long Range Concept Plan for OSU calls for future development within the corridor should preserve its natural beauty; upgrade by reforestation and development of new pedestrian and bicycle paths. Identifies a Green Reserve of important open space resources to be protected and linked together (includes River corridor). It also restricts building development near the river.

2.5.10 Other Land Uses

2.5.10.1 ***City of Delaware.*** Draft Comprehensive Plan (2003) update calls for the removal of low head dams on the Olentangy River.

2.5.10.2 ***City of Columbus.*** Comprehensive Plan calls for the removal of low head dams wherever possible. It also recommends that a policy be adopted to state that storm sewers that carry urban runoff should not flow directly into rivers or tributaries without first being released into a rip-rapped channel or artificial wetland. In addition, it states that wherever City property abuts a river, mature woody vegetation should be maintained as a buffer.

2.6 Land Use Recommendations per Political Jurisdiction

2.6.1 Recommendations for Floodplains

2.6.1.1 ***City of Delaware.*** We recommend prohibition of all development in the 100 year floodplain with density transfer if not set aside as required open space.

2.6.1.2 ***City of Worthington.*** Establish floodplain regulations for the tributary streams for all new/redevelopment.

2.6.1.3 ***City of Columbus.*** All requests for floodplain fill permits should be subject to a public review process: City Council approval, press release and/or public or advisory group meetings.

2.6.1.4 ***All Jurisdictions.*** Develop more stringent floodplain regulations: do not allow filling of the floodplains if possible or develop a public involvement process for granting floodplain fill permits or variances**.**

Appendix E contains more information pertaining to floodplain protection.

2.6.2 Recommendations for Riparian Setbacks

2.6.2.1 ***City of Delaware***. We support the inclusion of the 60 ft setbacks on major tributaries and the 30 ft setbacks on other waterways in the comprehensive plan update currently underway. We support the codification of these setbacks as soon as possible.

2.6.2.2 ***City of Worthington.*** Codify required setbacks for redevelopment/new development along mainstem and tributaries.

2.6.2.3 ***Townships.*** Request that a riparian corridor overlay district be developed to contribute to the health, safety and morals of the residents in the townships.

2.6.2.4 ***Delaware County.*** Establish river and tributary setback requirements (See Franklin County examples under Current Riparian Setbacks 2.5.2).

2.6.2.5 ***City of Columbus.*** Follow the Comprehensive Plan and develop a greenways overlay and protective zoning overlay for ravines.

Appendix E contains background information on riparian setbacks. Appendix F contains information on conservation easements.

2.6.3 Recommendations for Tree Preservation

2.6.3.1 ***City of Worthington.*** Establish a tree preservation ordinance (see examples from the City of Delaware or Powell in Section 2.5.7).

2.6.3.2 ***City of Columbus.*** Establish a tree preservation ordinance (see examples from Delaware or Powell in Section 2.5.7). Dollars raised from tree preservation related fines be put towards re-vegetation efforts in natural areas, including riparian corridors.

2.6.4 Recommendations for Open Space Tools

2.6.4.1 ***City of Delaware.*** We recommend that the PRDs be pursued with all future developments to allow for the set-aside of a greater percentage of open space. We recommend that the set aside of open space be along riparian areas for parcels that include the mainstem or tributary stream as a City policy.

2.6.4.2 ***City of Columbus.*** Revise the Parkland Dedication Ordinance to state that riparian areas may not replace parkland dedication with cash donation; to negotiate the greatest protection. Recommend that dollars raised from cash donations to Parkland Dedication be placed in a fund for future acquisition of land and conservation easements preferably within the same 11 digit watershed, priority along streams. In addition, the ordinance should be

triggered not only for all rezoning requests, but also for all council variances-particularly when a more dense use is being proposed. Addition of a new "Whereas" clause in the ordinance stating setbacks for flood storage, wildlife habitat and low-impact recreation are preferable. Approve a written policy for setback widths.

2.6.4.3 ***All townships.*** Encourage the use of PUDs.

2.6.5 Recommendations for Redevelopment Plans

2.6.5.1 ***City of Worthington.*** Codify redevelopment standards along waterways to include scenic conservation easements, protection of floodplain, minimum setbacks, and protection of trees and natural vegetation; pursue parkland on redevelopment sites (e.g. Harding Hospital) whenever possible.

2.6.5.2 ***City of Columbus.*** We recommend that development standards for the Olentangy River Road Urban Design Plan protect and where able restore the natural resources of the riparian area. In addition, we recommend that a FLOW representative be involved in all future planning processes that may impact the Olentangy River and its tributary streams. We recommend that any transition of property from one use to another or any sale of public property be subject to a public review process (press release, meetings).

2.6.6 Recommendations for Other Land Uses

2.6.6.1 ***City of Delaware.*** We recommend the immediate re-naturalization of any riparian sites damaged by development, such as the Northside lot north of Hull Drive. We recommend the daylighting of culverted streams when able, such as Delaware Run.

2.6.6.2 ***City of Powell.*** We recommend the continuation of all existing protective zoning ordinances that impact the river and tributaries. We recommend the acquisition and preservation of available land that borders any portion of the main stem or tributaries of the Olentangy River.

2.6.6.3 ***City of Columbus.*** Recommend continuation of current efforts, including provisions under current plans, greenways program, multi-use trail programs and clean-up programs including obtaining easements or outright acquisition of riparian property.

2.6.6.4 ***FLOW.*** Continue education and outreach to property owners concerning appropriate treatment of riparian corridor, benefits to the river and property owners and engage in a periodic evaluation of the riparian corridor to bring attention to any potential land use issues that may impair the Olentangy River or its tributary streams.

Tables 3 through 7 contain recommendations from the Land Use Working Group for easement and acquisition areas, protection, restoration, and stabilization.

Table 3. List of Potential (Conservation) Easements and Acquisition Areas in Priority Order.

1. Establishment of **Big Run Preservation Park** (aka Lewis Center Tributary) is of highest priority. Cost is $3.95 million dollars; detailed proposal is located in Appendix G. The Ohio EPA DEFA through the WRRSP and City of Columbus loan is funding this Park in 2004. The proposed Big Run Preservation Park is located within Liberty Township, Delaware County, Ohio, north of Home Road, south of Hyatts Road, west of US 23, and east of Taggart Road. The proposed parkland is roughly 60 acres in size and contains approximately 8500 linear feet of streams which are a part of the Big Run Watershed, a high quality tributary of the Olentangy State Scenic River. The Big Run Tributary is less than five square miles and is one of two tributaries sampled by the OEPA in 1999 that were in attainment of their use designations. In June of 2003 Big Run and the four tributaries all qualified as Class III PHWH stream, the highest classification. The relative high quality of the Big Run Watershed is a direct result of its undeveloped nature. The Big Run Watershed is primarily old-growth woods and agricultural lands with the majority of the stream channels and floodplain in a natural state. There is currently residential and commercial development proposed within the watershed just east of the proposed parklands, and there will likely be additional development proposals in the future. With increased development within the watershed on the horizon, preservation of this large tract of undeveloped riparian forest becomes critical to the long-term preservation of Big Run as well as the Olentangy State Scenic River.
2. Protection of Camp Lazarus property through conservation easement. The property, owned by Simon Kenton Council of the Boy Scouts of America, is 227.75 acres in size and includes wonderful habitat such as one of the few remaining large upland forest ecosystems in southern Delaware County. The tributaries in this area lead to the "Scenic River" section of the Olentangy River, which is classified as "exceptional warm-water habitat". The section of the river along the Camp Lazarus property supports an excellent sport fishery and populations of special interest species, and provides an abundant supply of good quality water which is a significant source of drinking water for large portions of Delaware Co.

Continued on the next page.

Table 3. List of Potential (Conservation) Easements and Acquisition Areas in Priority Order, continued.

Continued from the previous page.

3. Seek conservation easements on riparian corridors throughout Delaware County due to ecological significance and development pressures. A list of parcels may be obtained from ODNR Scenic Rivers Division.
4. Seek purchase of the 42 acre parcel for parkland from OSU-Harding Hospital on Rush Run in Worthington.
5. Seek conservation easements from property owners adjacent to Worthington rugby field (Seabury Drive)
6. Seek conservation easements from property owners adjacent to Rush Run Park.
7. Seek purchase or easement of corridor just south of Como Park- owned by Olentangy Village; Casto Corp.
8. Seek easement extension of Anheuser Busch Park east of St. Rt. 315 between Bethel & Henderson Rds.; Install hiking trails and bird boxes.
9. Seek conservation easements from properties adjacent to Kenny Park and on the north bank of Bill Moose Run east to High Street.
10. Seek acquisition of easement along the Westwater property (Goodale St and Olentangy River Rd.)
11. Seek acquisition of easement along the White Castle property (south of the Westwater property).

Table 4. Streamside Forest and Floodplain Protection Recommendations.

The goal of the following tasks is to protect existing streamside forests and floodplains in order to protect water quality in the Lower Olentangy River watershed. As future development continues in the Olentangy Watershed, it will be crucial that these protective measures are in place to prevent urban encroachment and water quality degradation. The wooded acreage along the main stem of the Olentangy River's floodplain (aka streamside) consists of 3, 036.68 acres in Delaware County and 663.91 acres in Franklin County. The goal is to protect this wooded acreage in its entirety from encroachment through land use regulations, easements and/or purchase.						
Objectives (Tasks)	**Responsible Parties/ Partners**	**Costs**	**Funding Sources**	**Indicators of Success**	**Timeframe**	**River Segment**
Organize a government forum through quarterly lunch-n-learns to network and learn from other watershed communities and discuss implementation progress on the above "habitat recommendations per political jurisdiction."	FLOW will organize them. Multiple Jurisdictions participate.	$12,000	319 Grant Jurisdictions	Jurisdiction participation. 30% completion of recommendations by 2005.	Begin winter 2003	All
Protect streamside forests through fee-simple purchase or conservation easements (see Appendix F); potentially creating a land trust for the entire Olentangy Watershed.	ODNR Natural Areas & Preserves, Local Park Depts., Franklin Soil & Water Conservation District (FSWCD) Olentangy Watershed Alliance (OWA) FLOW	$7 million	• Water Resource & Restoration Program (WRRSP) • Mitigation $ • ODNR • Tax payers (levy) • Clean Ohio Fund • EPA 319 Grant	65 acres purchased and over 8,000 linear feet of streamside forest protected by 2005.	Begin winter 2003	Begin w/ Big Run Preserve. Park and Camp Lazarus purchase (see List potential acquisition areas)

Table 5. Streamside Forest Restoration Recommendations, page 1 of 4.

The goal of the following tasks is to restore streamside forests and floodplains in order to protect water quality in the Lower Olentangy River watershed. The non-wooded / agriculture or urban open space (grass) acreage along the main stem of the Olentangy River's floodplain (aka streamside) consists of 2, 880.75 acres in Delaware County and 244.81 acres in Franklin County and urban (impervious surfaces) acreage in the floodplain is 208.60 acres in Delaware County and 920.61 in Franklin County. The goal is to restore 10% of the streamside forest through redevelopment opportunities (110 acres) and re-vegetation programs (310 acres). The Habitat & Recreation group determined areas for re-vegetation through canoe surveys conducted in 2002 and aerial photograph review.

Objectives (Tasks)	Responsible Parties/ Partners	Costs	Funding Sources	Indicators of Success	Timeframe	River Segment
Reforest properties east of Pollock Rd, Delaware Co. Reforest properties north of Armstrong Rd, Delaware Co. Reforest properties north of the Panhandle Rd. Bridge, Delaware Co. Reforest property between Olentangy River Rd and Rt. 315 near Wilson Bridge Rd. Franklin Co. Plant wildflowers between on-ramps and clover leaf ramps from I-270 to Rt. 315. Establish no-mow zones.	Parks & Rec Depts. SWCDs FLOW Friends of the Ravines, Wild Ones, other community groups, Battelle Stream Team.	At least $100,000	• Ohio EPA 319 • Local nurseries • FLOW & other groups to provide volunteers. • Water Resource Restoration & Sponsorship Program (WRRSP) • Water Pollution Control Loan Fund (WPCLF) • Federal Highway Administration	# of trees planted / measure tree canopy coverage by aerial photos in ten year increments. 310 acres restored from open space to wooded.	2004-2015	See the Objective column.

Table 5. Streamside Forest Restoration Recommendations, page 2 of 4.

Chemical Abstracts- plant trees east of walkway. Along walkway plant native prairies and install bird boxes.						
Plant trees; establish a no mow zone through Whetstone Park's rivers edge						
Northmoor Park- plant trees and let plants grow through the retaining wall						
Como Park- plant trees along river edge						

Continued on the next page.

Table 5. Streamside Forest Restoration Recommendations, page 3 of 4.

Objectives (Tasks)	Responsible Parties/ Partners	Costs	Funding Sources	Indicators of Success	Timeframe	River Segment
<u>When redevelopment occurs:</u> 1. Establish a 40-100 foot setback from Union Cemetery to North Broadway when redevelopment occurs; re-grade to open floodplain and reforest. (See Columbus' Olentangy River Road Urban Design Plan). 2. Establish a 40-100 foot setback in the River District between Neil & railroad tracks and west of tracks to the river 2 million sq ft commercial office space, 900,000 sq ft of commercial retail, 1,100 residential units. 3. Establish a 40-100 foot setback in the Harrison West reach (Goodale to Second Ave)- redevelopment of existing use along the corridor, parkland / open space, AC Humko residential development.	City of Columbus Dev. Dept. and Parks. Developers	Unknown	Developers	110 acres restored from urban to open space or wooded when redevelopment occurs.	1& 2) 2004-2015 3) 2006	See Objective column.

Continued on the next page.

Table 5. Streamside Forest Restoration Recommendations, page 4 of 4.

Objectives (Tasks)	Responsible Parties/ Partners	Costs	Funding Sources	Indicators of Success	Timeframe	River Segment
Remove invasive plants from public lands (listed in priority order) 1. OSU Bottomland Wetland 2. Adena Brook Ravine 3. Rush Run Park 4. Tuttle Park 5. Any other opportunities that arise.	Local governments. FLOW, Friends of the Ravines (FOR) Wild Ones & other community groups. Dispatch. ODNR-Wildlife.	$10,000	Grants.	Tonnage of invasive plants removed.	2003- until complete	See Objectives column
Educate homeowners about invasive species and need for removal. Establish ordinance against planting invasive species of plants.						
Create wetlands to assimilate pollution (e.g. OSU Wetlands Research Park) Identify potential areas- one may be between the I-670 Spring Sandusky Bridge, 900 feet south of Goodale Ave.	Land owners. OSU-Dr. Mitsch	Unknown	Ohio EPA Mitigation	Wetland created.	2015	Within the last two miles of River.
Stabilize eroding banks using bio-engineering techniques (see Table 7)	Land owners ODNR	Site dependent	Ohio EPA 319	Bio-engineered techniques used vs. traditional hard engineering	When needed	Where needed

NOTE: Regarding log jams and stabilizing eroding stream banks, they should be assessed on a case by case basis. Log jams provide in-stream habitat for fish and stream banks erode naturally and enable natural channel migration. Regarding beaver damage, it needs to be assessed by ODNR Division of Wildlife. See Appendix H, Ohio Stream Management Guide, for more information.

Table 6. Headwater Stream Recommendations for Habitat Improvements, page 1 of 2.

The goal of the following objectives is to improve the habitat and water quality of the tributary streams; by improving habitat the streams ability to assimilate pollution will increase. None of the tributary streams sampled by the Ohio EPA in 1999 were meeting their WWH use designation (Ohio EPA, 2001). Loss of riparian vegetation and channelization have contributed to the non-attainment in the urbanized tributaries (Ohio EPA, 2001). More data on the tributaries is needed, specifically stream morphological data to determine potential restoration scenarios. The Hydromodification group decided to begin with Rush Run as it has the most potential for restoration of the three lowest QHEI scored tributaries (Adena Brook at Overbrook Drive; Delaware Run at Henry Street). The goal is to increase QHEI scores to 60. NOTE: The effect of nearly every stressor within the basin was likely made more acute by significantly diminished stream flow within the entire catchment (Ohio EPA, 2001). As classified by the Palmer Drought Severity Index, severe to extreme drought conditions were indicated for the period between July and October 1999 (ODNR, 1999).

Objectives	Responsible Parties/ Partners	Costs	Funding	Indicators of Success	Schedule	Targeted River Segment
Evaluate the stream morphology of the tributary streams.	ODNR-Soil & Water Franklin & Delaware SWCD	$3,500 match for time and use of equipment.	In-Kind	Completion of study with action recommendations.	2005-2008	Begin with Rush Run 2004, then Adena Brook 2005, Delaware Run 2006 then Linworth Run 2007.
Restore floodplain on tributary streams that have been channelized.	• Private Landowners • Local Gov't • Development Community • ODNR • OEPA	$30 / sq ft	• Mitigation Funds • 319 Grant Funds • Private Developers	Increased QHEI scores of the tributary streams to 60.	2006	Begin with Rush Run or as opportunities arise.

Table 6. Headwater Stream Recommendations for Habitat Improvements, page 2 of 2.

Objectives	Responsible Parties/ Partners	Costs	Funding	Indicators of Success	Schedule	Targeted River Segment
Daylight streams that currently run through underground conduits.	• City of Columbus • City of Worthington • City of Delaware • Development Community • OSU • Ohio Wesleyan University • ODNR • OEPA	Unknown	• Mitigation Funds • 319 Grant Funds • City Funds	Overall increase in water quality of tributary streams; QHEI of 60.	2007	Begin with Delaware Run or as opportunities arise.
Restore degraded tributary stream channels	• Private Landowners • ODNR • OEPA • Local Government • Col. Recr. & Parks • Development Community • Delaware and Franklin Co. SWCD's	$20- $40 / sq ft.	• Mitigation Funds • 319 Grant Funds • Private Developer • Clean Ohio Fund	Overall increase in water quality of tributary streams; QHEI of 60.	2004-ongoing	Begin with Glen Echo Restoration project, Rush Run or as opportunity arises.

Table 7. Recommended Bioengineering Techniques for Stabilizing Stream Banks, page 1 of 2.

BMP (with short description)	Maintenance Requirements	Site Specifics / Applicable Areas
Tree Kickers: Hardwood logs anchored to the stream bank on an outside curve and placed at an angle to "kick" stream flow away from the bank and toward the middle of the stream.	2+ people should inspect after high water events and make repairs if needed. Check the angle of the kickers and make adjustments, as well as cable tension around the kickers and around the trees it is anchored to.	Used to correct bank undercutting, where the crest of the cut bank is 5 ft or more above normal water levels.
Live Fascines: Long bundles or live woody vegetation buried in a stream bank in shallow trenches placed parallel to the flow of the stream.	Inspect after high water events during the 1st year, and annually afterwards. Remove accumulated debris and stabilize washouts ASAP.	Used to control erosion problems from over-bank run off, before gullies are formed, and to stabilize fairly long slopes. They are best applied on headwater streams or when placed above the line of bankfull discharge on larger streams.
Live Cribwalls: Wooden structure built into a streambank that is filled with rock, soil and willow cuttings.	Inspect after high water events during the 1st year, and annually afterwards. Check logs for proper alignment and no signs of rot to insure the stability of the cribwall. Willows should be replanted if there is a high mortality rate.	Reduce erosion and bank instability on the outside bends of stream with strong currents, where and when a stream has a steep bank and an unstable toe of slope, and where immediate protection from erosion is needed while vegetation is growing. Streams must be less than 75 ft wide.

Continued on the next page.

Table 7. Recommended Bioengineering Techniques for Stabilizing Stream Banks, page 2 of 2.

BMP (with short description)	Maintenance Requirements	Site Specifics / Applicable Areas
Streambank Vegetation: Woody vegetation planted along streams.	Inspect for disease, insect and wildlife damage and high water damage. Replant if necessary, protect vegetation from herbicide drift.	Best species and planting methods will depend upon the amount of bank erosion, stream size and planting location.
Deflectors: Spurs of rocks or logs that extend from the bank into the stream.	Inspect after high water events during the 1st year, and annually afterwards. The logs should be untreated hardwood. They should be placed in a trench cut into the channel bank so that ½ the log is buried and ½ projects into the channel. Trench should be backfilled and compacted. Voids in the rock should be filled with soil and aquatic vegetation should be planted.	Used in modified channels having uniform shape and little cover or in small streams with unstable banks.
Gravel Riffles: Gravel and cobble-sized stone arranged at distinct intervals in shallow streams. The riffles promote the formation of stable substrate in channels that have been modified or heavily impacted by development.	Inspect after high water events during the 1st year, and annually afterwards. Adjust riffles if there is evidence of erosion.	Used if coarse gravel substrate was an original characteristic of the stream, but has been removed – common in deepened, modified, or relocated channels. Could be caused by the enclosure of the upstream channels in a storm drain system. Best used in smaller streams.

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3.0 The Habitat and Recreation Working Group

The Habitat and Recreation Working Group sought out participation from recreation interests and in-stream habitat specialists. After convening, they realized they needed more data, so the first step was to organize a training and canoe survey to assess the condition of the in-stream and riparian habitat and recreational opportunities (existing or potential). After gaining this information for the Franklin County portion of the watershed, the group made recommendations and used aerial photographs (1"= 100') to reference the location of their recommendation. The aerial photographs were provided by Franklin County Engineers Office. The maps are located in the FLOW office and are available for public review. Recommendations for the Delaware County portion are still awaiting completion.

Table 8 contains the Habitat and Recreation Working Group's recommendations for the Watershed Action Plan.

Table 8. Habitat and Recreation Working Group Recommendations, page 1 of 4.

The goal of the following objectives is to increase the recreational safety and decrease impediments for boaters, waders and fisherman on the Olentangy River as well as providing access for these recreational uses. The goal of the WAP is to increase water quality and the recreational value of the Olentangy River and its tributary streams. FLOW strongly believes that when the community experiences the river and understands the resources it provides, they will be more inclined to become involved in its protection and restoration. Currently, community members have communicated with FLOW that lack of access and safety hazards due to lowhead dams are the reasons they do not utilize the River more. The Recreation & Habitat working group felt that lowhead dam location education via signage and maps as well as available access points were needed to assure the safety of recreational users.

Objectives	Responsible Parties/Partners	Costs	Funding	Indicators of Success	Schedule	River Segment
(see lowhead dam recommendations in the modification section as well) • Conduct an environmental impact/ feasibility study of the alteration of lowhead dams that harbor sewer lines; • Install boat chutes through lowhead dams that are unable to be removed (161 & N. Broadway ideal) • Install in-stream and bridge signage alerting boaters of lowhead dams, portage routes or chute locations. • Remove lowhead dams when able.	• Columbus Public Utilities. • Columbus Rec & Parks • FLOW, • ODNR Watercraft, Wildlife & Scenic Rivers, • Columbus Outdoor Pursuits	Study is 160,000 Dam removal is estimated at 120,000 per dam Signage costs are unknown	• 319 Grant • American Rivers Grant • ODNR-Watercraft Signage Grant • American Express Grant • ODNR Scenic Rivers License Plate Program	Dependent upon study - # of chutes / ladders installed.	Study complete by early 2006. All dams need signage by 2004.	161 Lowhead Dam, Broadmeadows and North Broadway Lowhead Dams are high priority for study or alteration. Signage should be on all lowhead dams (12 of them)

Continued on the next page.

Table 8. Habitat and Recreation Working Group Recommendations, page 2 of 4.

Objectives	Responsible Parties/Partners	Costs	Funding	Indicators of Success	Schedule	River Segment
1) Establish a Water Trail for canoe and kayakers. [Identify access points, get landowner permission, install access points and post signage for boat access. Design, produce and distribute a brochure detailing the recreational opts along the river]	FLOW City Recreation & Parks. Worthington ODNR Scenic Rivers	10-25,000	Columbus Rec & Parks Local outdoor sport companies Clintonville Fund / Columbus Fdn	• Establishment and advertisement of Water Trail. • Use of the Olentangy River water trail. • Number of brochures taken at events • Use of outdoor sensor system to record frequency of put-in at Highbanks Park	Priority after the lowhead dam signage is installed. 2004-2005	11 access locations have been identified; beginning at Highbanks Metro Park and ending at the Neil Ave Columbus Recreation & Parks Boat Ramp.
2) Rock-check dams: remove or alter them to aid navigation and improve riffle zones for aquatic biota's habitat. • Create a riffle play water area under the I-670 bridge interchange, south of the railroad bridge and north of Spring Street.	ODOT FLOW OSU ODNR Ohio EPA	unknown	In Kind support from agencies / organizations.	• Monitor the river before and after alteration; successful if ICI & IBI scores improve.	2006-2008 •Medium priority (dependent upon data collected- if rock-check dams causing impairments it will be a high priority) •Low priority for play water area.	• Rock-check dams (from I-270 to southern end of Antrim Park) • Play water area at I-670 Bridge.

Continued on the next page.

Table 8. Habitat and Recreation Working Group Recommendations, page 3 of 4.

Objectives	Responsible Parties/Partners	Costs	Funding	Indicators of Success	Schedule	River Segment
3) Improve access to the Olentangy Multi-Purpose Path (bike path)	•Local Rec & Parks Depts. •Planning Divisions •City of Columbus Rec & Parks	unknown	• USDOT: Transportation Equity Act (TEA-21) • Clean Ohio Funds • Local govmt.	When complete.	As opportunities arise.	• When the North Broadway bridge is replaced- install pedestrian lanes on bridge. • Connect the bike path from Union Cemetery to N. Broadway (west side of river). • Route bike path across Dodridge bridge to ARC Ind. Lot; bridge over swale and connect to bike path. • Install a stairway with bike roller at the end of North Street. • Install a pedestrian bridge (clear span- no piers) in the vicinity of Rosslyn Ave., Kanawha Ave., Broadmeadows Blvd., to connect to path to Antrim Park.
4) Educate bike path users or hikers or drivers on points of interest (historic, environmental etc).	Land owners Parks Depts. Historical Societies FLOW	unknown	Grants for signage and markers.	When complete	As opportunities arise.	•Union Cemetery "Resting place of famous xxx" signage. •Educational kiosk re: old Piatt Mill, benches and railing overlooking Dodridge Dam. •Kenny Park- install ecologically sensitive sign- e.g. 10% of fish are darters. •Whetstone Park- signage for Whetstone Island and for Adena Brook. •Historic marker Bill Moose at High St and Indianola.

Continued on the next page.

Table 8. Habitat and Recreation Working Group Recommendations, page 4 of 4.

Objectives	Responsible Parties/Partners	Costs	Funding	Indicators of Success	Schedule	River Segment
5) Increase awareness of parkland / publicly owned or managed land by installing signage; utilizing public lands.	Parks & Recreation Depts. FLO W & Community Groups.	unknown	Local Gov't	When complete	As opportunities arise.	• Install a sign on High Street directing to Kenny Park (behind Graceland). • Cleanup of Whestone Park's section of river. • Leave Gowdy Landfill Park as a wildlife area unless a community is identified for its use of ball fields etc. • All public land or easement areas should have signage indicating such. This could reduce impacts such as dumping, encroachment, tree cutting.
6) Produce a Green Map- detailing eco-tourism points of interest	Mid Ohio Regional Planning Commission (MORPC)	30,000	MORPC-Franklin Co Greenways. Solid Waste Authority of Central Ohio (SWACO)	Map completed	2004-2005	All

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4.0 The Hydromodification Working Group

The Hydromodification Working Group used aerial photographs to determine locations of lowhead dams, past channelization/alteration, and bridge crossings. This group wrote four problem statements focused levees, bridges, lowhead dams, and culverts. They then made recommendations for each of these topics. Sections 4.1 through 4.9 describe the outcome of the work this group did for the watershed action plan.

4.1 Altering the Natural Course of a River

Because rivers naturally flow back and forth over the landscape, altering a river's channel and riparian corridor greatly changes its dynamics, reducing biological diversity and water quality. These alterations are called hydromodification. In a study by the Ohio EPA, hydromodification was cited as the leading source of impairment to Ohio's rivers and streams. Hydromodification is a threat because it causes erosion, siltation and sedimentation. The soil that is supposed to be on the land is washed into the water, clouding it with suspended particles which can clog gills and filtering mechanisms of fish and aquatic organisms, reducing their ability to absorb DO from the surrounding water. Hydromodification often reduces the amount and types of habitat available to aquatic organisms. Siltation in particular smothers rocky substrates, filling in the interstitial spaces between the rocks that are used by many aquatic organisms for living and breeding.

4.2 Levees

Levees, or earthen embankments adjacent to a water body, border much of the lower Olentangy River. Levees were constructed to prevent floodwaters from inundating and damaging adjacent floodplain lands in order to make the lands more productive for development and agriculture. Although this may be a benefit to us, there are many negative consequences to constructing levees along streams. Levees increase water volumes and velocities within the stream channel. Streams consequently must readjust by increasing the channel capacity. This process causes down cutting and widening of the channel, severe instability, excessive erosion, and degraded in-stream habitat. Levees also decrease or eliminate overbank flooding into adjacent floodplain areas. Overbank flooding allows for energy to dissipate away from the stream channel and the subsequent deposition of sediments and other non-point source pollutants onto riparian areas, providing very cost effective treatment of

stormwater. Overbank flooding also provides nourishment to the riparian ecosystem and allows for groundwater recharge.

Levees have been historically maintained to ensure that they will hold back floodwaters. In many cases riparian areas within levees are neatly manicure lawns devoid of trees and other woody vegetation, eliminating all the benefits of streamside forests. Levees may also be armored with riprap to ensure that channel migration will not deplete the integrity of the levee, preventing the stream from migrating laterally.

4.3 Recommendations for Levees

Table 9 contains recommendations for levees.

4.4 Bridges

The purpose of this statement is to discuss and consider the impacts that bridge crossings have on the Olentangy River. Bridge crossings can have both a local environmental impact on the stream proper, as well as a secondary, more regional impact outside the confines of the river corridor. While most impacts resulting from bridges tend to be negative there are few positive impacts worthy of discussion. The impact of a bridge depends on the type of bridge, its' location and whether it has piers in the channel.

First we must consider the possible direct impacts of bridges on the hydrology of the river and the localized affects on the environment. In order to best discuss the impacts of bridges we must first understand the anatomy of bridges and that all bridges are not the same.

Bridges in general are composed of a superstructure, (the part the carries the traffic); piers, (the part that supports the superstructure out in the middle of the river); and the abutments, (the part that supports the superstructure at the ends of the bridge).

4.4.1 Superstructure Impacts

The traffic carrying part of the bridge is usually high above the water and has little or no apparent impact on the hydrology of the river. The superstructure may have an impact on the ecology of the river depending on the nature of the structure and the openness of the vegetation.

Table 9. Levee Recommendations.

The goal of the following objective is to increase the River's access to its floodplain. Nearly the entire 32 miles of the Lower Olentangy River has been levied on both sides. Most of the levees were installed before the Army Corps of Engineers flood control "Delaware Dam" was created. However, flooding remains a concern for development and agricultural areas. The levees should be looked at individually based on safety considerations, landowner permission and improvements to water quality. The Hydromodification working group determined that public parkland should be first sought for levee alteration. The group decided to specifically begin with the Highbanks MetroPark levee due to the high water quality present and its threatened state from increased development upstream. A good example of altering a levee in public parkland is the levee at the Olentangy River Wetlands Research Park* that was notched in three locations to allow the River to flood into its 13 acre floodplain.

Objective	Responsible Party/ Partners	Costs	Funding Source	Indicators of Success	Schedule	Targeted River Segment
Remove, notch or move back levees on public parklands and on private lands with landowner permission. Alteration of levees will only be performed after safety considerations have been met. Wetland restoration efforts where applicable.	MetroParks - for Highbanks Levees City of Columbus Recreation and Parks ODNR Private Landowners	$20,000 * (cost estimate based on above referenced example)	• Clean Water Act, • Section 319 Implementation Grant Funds • ODNR Scenic Rivers License Plate Funds • Mitigation Funds • EPA Supplemental Environmental Projects (SEP's) • WRRSP • WPCLF • U.S. Army Corps Engineers (USACE)	1. Sediment load reduction by 10% 2. Increased channel stability and decreased channel erosion using stream morphology monitoring methods 3. Increased QHEI in segments where levee alterations have been undertaken – need to be at or above 60. 4. Wetland restoration to category 2 or 3.	2005	Begin with Highbanks MetroPark levee (current QHEI = 65 full attainment of EWH, but threatened status due to development – Ohio EPA, 2001)

In some cases, the superstructure may provide shelter for various animals, although designers tend to want to discourage this from occurring for maintenance reasons.

The other aspect of the superstructure is that it can provide continuity of the canopy by providing a shady zone in an area that may lack adequate shade. (This is not true for most of the lower Olentangy). Bridges that are low to the water may have a more detrimental effect in that too much light is blocked. In these cases very little vegetation can grow under them creating the potential for erosion.

These are examples of secondary effects of bridges and not something that most designers consider in the design of the bridge.

4.4.2 Pier Impacts

Piers have the greatest impact on the hydrology of the river and the local in-stream environment. The impacts are as follows:

4.4.2.1 Scour. Scour is the erosion of riverbed around the pier that can destabilize the pier and cause structural problems for the bridge. Scour also impacts the riverbed by continually removing and depositing sediment around the pier foundations. This has a detrimental impact on the bottom dweller's habitat.

4.4.2.2 Turbidity. Turbidity occurs when the flow of water is interrupted causing localized changes in the velocity and direction of the water flow. Excess turbidity causes degradation to the free-swimming species that inhabit the stream and the plant life that depends on adequate sunlight for growth. Although this is not a significant impact, it contributes to the overall impact. The turbidity caused by piers during high water is not the same thing as riffle zones during normal flow periods. It must also be noted that piers can be designed to be fairly hydraulically efficient.

4.4.2.3 Sedimentation. Sedimentation occurs when the velocity of the water abruptly slows down and the stream no longer has the energy to retain sand and sediment suspended in the stream flow. Piers and abutments placed in the channel can be a constriction causing localized changes in flow velocities. On the upstream side of the bridge the water is backed up and temporarily pooled during a storm event. The flow accelerates through the constriction of the bridge and then slows down immediately down stream of the bridge as the floodway widens again. This reduction in flow velocity causes sand bars and islands to form immediately down stream of the bridge. It can also cause a shifting in direction of the flow, which could potentially cause erosion of

adjacent riverbanks. Piers and abutments can temporarily restrict the flow of water increasing its velocity as it passes under the bridge. This causes the streamflow water to back up and pool on the upstream side. This can create sand bars and islands immediately down stream of the bridge. It can also cause a shifting in direction of the flow, which could potentially cause erosion of adjacent riverbanks.

4.4.2.4 Debris. Piers situated in heavily wooded stream corridors are great debris catchers. The inadvertent snagging of a log or other debris can cause a host of problems for the bridge and stream. Logjams are a maintenance headache for the County (and any other bridge maintenance jurisdictions) and can cause high levels of stress on the pier. Logjams are a naturally occurring phenomenon and the streams correct the problem by channel realignment. In developed areas, such as the Olentangy River corridor, there is nowhere for the channel to relocate naturally. Flanked by housing, roads, levees and other forms of development, the river must be managed within its current confines.

4.4.2.5 Cost. In general, shorter spans with piers in the stream are more economical to construct than a bridge that spans the river, this is especially true for shallow rivers such as the Olentangy River. The environmental mitigation cost of pier placement in the channel is becoming more expensive, depending on the depth of water and width of the channel. Rivers similar to the Olentangy River, like Alum Creek and Big Walnut Creek, could be considered borderline cases. A bridge spanning the Olentangy River would likely cost more than two and a half times the cost of a standard bridge. As a rule, when bridges require the placement of piers in the water, they are designed to have the least possible impact on the hydrology of the stream, that is to say they are designed to cause a minimum of backwater (e.g., best bridge, short of spanning the entire water course, has the fewest number of piers, the shortest length and the smallest skew possible.) One misconception about bridges is their zone of influence on the stream. Whether it is backwater, scour, deposition or turbidity, for bridge piers in the Olentangy River the zone of impact is generally 400 feet or less.

Piers have the greatest impact on the stream and deserve the most attention. Our goal should be to work toward reducing the number of piers in the river, when bridge replacements present themselves, and develop designs for new bridges that have the least impact when piers in the channel cannot be avoided.

4.4.3 Stormwater Impacts

Many bridges have storm drains located on them that empty directly into the river or tributary streams. This results in runoff which can carry pollutants from the roadway into the watercourse below.

4.4.4 Abutment Impacts

Abutments, like piers are susceptible to scour when placed in, or at the edge of the waterway. Economics generally dictate the placement of the abutments, as the cost of a bridge increases geometrically as its span increases. There is a point at which the cost far exceeds the benefit of building the bridge, depending of the topography of the site.

In addition to scour, abutments can also affect the localized erosion potential and velocity of the stream much like that discussed concerning the piers, depending on their relative closeness to the main channel.

4.4.5 Construction Impacts

The short term affects of bridge construction are generally just that, yet they are still important to a fragile environment. Erosion control measures such as sediment basins, silt fences and other BMPs need to be employed and have become standard practice on most construction sites. The filtration of dewatering operations is becoming more common. Construction techniques that minimize the disturbance of the stream bottom and banks need to be explored and utilized where possible. Some construction activities are more detrimental than others. Each project must be evaluated on an individual basis to determine the best methods to employ. There are always trade-offs that must be weighed and considered, some are cost related and some are environmental. For example, the impact of a short but severe disturbance may be better than a lesser disturbance that lasts for months.

All aspects of design, construction and maintenance must be evaluated with respect to the monetary cost, the effects on the local environment, as well as the transportation system.

4.4.6 Regional Impacts of Bridge Crossings

Regional affects include economic and environmental impacts that extend beyond the area immediately surrounding the bridge. These regional impacts include, air

pollution, water pollution, economic costs and time. There are methods of determining all of these impacts and published statistics associated with them. One vehicle having to spend 5 minutes, or travel three miles out of the way to cross a stream may not seem like a big deal, but when multiplied by several thousand on a daily basis, it can be quite significant in terms of environmental impacts. Everything we do has an affect on the environment around us. Our charge, as responsible stewards of that environment, is to strive toward a win/win condition, where our civic needs are balanced with the needs of the environment. It is wishful thinking to expect everyone who is living along the banks of the Olentangy River to move out in order to maximize the benefits of an ideal riparian river corridor. It would also be impractical and even detrimental to remove all of the bridges that span the Olentangy. That doesn't mean we can't improve things, it just complicates them a little.

4.5 Recommendations for Bridges

So where do we go from here and what should we be doing to improve and preserve the environmental integrity of the Olentangy River watershed? Everyone must recognize the need for bridges and work with state and local officials to develop details and standards to design and build better, environmentally friendly bridges that have minimal impact of the quality of life for the flora and fauna of the corridor, as well as promote the quality of life for the people who live in the watershed. As existing bridges reach the end of their service life we have an opportunity to replace them with structures that serve to improve the environment and provide a high level of civic value to the citizens of our community. Currently there are 40 bridges (26 in Franklin County and 14 in Delaware County) over the Olentangy River. There are also many bridges over tributaries of the Olentangy River.

Table 10 contains recommendations for bridges.

4.6 Lowhead Dams

An example of hydromodification that greatly affects the health of the Olentangy River is the series of twelve low head dams that cross it (see Table 11). These structures have converted reaches of the Olentangy River from a stream system consisting of riffles, pools and runs to a lake system with fewer and more uniform habitat attributes. The reduction in available in-stream habitat has consequently reduced the number of organisms that inhabit impounded stream reaches. These structures also prevent fish and other organism from migrating up and down river.

Lowhead dams also decrease the ability of the Olentangy River to assimilate organic wastes from combined sewer overflows, urban runoff and wastewater treatment plant effluent. They increase the temperature of the water and decrease the amount of dissolved oxygen. Lowhead dams also eliminate the transport of bedload materials allowing only fine silts to move through the impounded segment. This not only has an effect on the impounded area but also has an effect directly downstream of the dam. Ohio EPA documented this effect downstream of the Dodridge Dam and the 5th Ave Dam.

In addition to the ecological impacts low head dams have on the Olentangy River they can also be extremely dangerous to canoeists, fisherman or waders due to the hydraulic jumps and eddy currents created on the downstream side of the dam structure. On the other hand, these dams provide an artificial pool depth to support canoeing and in the case of the 5th Ave Dam, OSU Crew Club's rowing year round. In addition, the Army Corps of Engineers operates the Delaware Dam which is a large earthen flood-control dam.

Recently, in the fall of 2002, ODNR Scenic Rivers Division, ODOT and the Civilian Conservation Corps removed the Dennison Dam, located north of Camp Lazarus and revealed a waterfall that had been under water for over 80 years.

4.7 Recommendations for Lowhead Dams

Tables 12, 13, 14 and 15 contain recommendations for lowhead dams in the scenic river segment of the Lower Olentangy River, lowhead dams that contain sewer lines, the 5th Avenue Dam, and the Delaware Dam, respectively.

4.8 Culverts

Culverts are drainage structures that convey water from an open watercourse under a road or driveway. They are not usually associated with an enclosed storm drainage system, but can be. Culverts are produced in a variety of sizes, shapes and materials. Culverts typically range in size from 12 inches to 72 inches in diameter. Culverts that have a span or opening size greater than 10 feet in diameter are considered bridges and are treated as such. Culverts that are part of a storm water management system are designed to function as an integral part of that system and should be addressed as part of that system. Because of its width and volume of flow, there are no culverts on the mainstem of the Olentangy River. However, all tributaries of the Olentangy River have had culverts placed on them.

Culverts may negatively impact the local ecology of the stream in which they have been installed. These structures tend to be smaller than the geometry of the stream channel and can cause constricted flows. This constriction causes sediment to be deposited at the inlet end and stream bank erosion at the outlet. Culverts may also prevent fish and other aquatic organisms from migrating upstream due to their length, steepness, or lack of water during low flow conditions.

4.9 Recommendations for Culverts

Table 16 contains recommendations for culverts.

Table 10. Bridge Recommendations.

The goal of the following objectives is to reduce the scour, turbidity and sedimentation of the Olentangy River caused by bridge piers. Though more costly, the benefits of less maintenance (debris removal; pier degradation) and improved water quality in many cases can be justified.

Objectives	Responsible Parties/Partners	Costs	Funding	Indicators of Success	Schedule	Targeted River Segment
• Wherever possible recommend spanning the river channel. • If spanning is not feasible, locate piers in such a way to minimize impact on the stream. • Bridge approaches should span the floodplain so as to maintain the natural floodplain as much as possible. • Develop standards that reduce the impacts bridges have on stream systems.	Delaware County Engineer Franklin County Engineer ODOT ODNR Columbus Rec & Parks	$ Two and a half times the cost of a piered bridge.	Same funding sources that are utilized by the County Engineers and ODOT FTEP (Federal Transp. Enhance. Program)	Monitor the 400 foot area around the replacement bridge before (with piers) and after (without) for the following parameters: 1. TSS / Turbidity 2. Stream morphology Show an improvement to meet the use designation.	As bridges are designed and constructed; the next bridge up for replacement is the Dodridge Street Bridge, Columbus by 2009.	Everywhere a new or replacement bridge is being proposed, especially within the Scenic River portion with EWH status & any other high quality (high WWH or EWH) segment.

Table 11. Locations of Lowhead Dams on the Lower Olentangy River.

Name of Dam	Location	Height / Purpose	Owner
Main Rd Dam	South of the Delaware Dam Delaware Co-"Scenic River"	4 ft. /	Private
Panhandle Road Dam	South of Panhandle Road Delaware Co.-"Scenic River"	4ft. /	½ Private, ½ ODOT
Central Ave. Dam	South of Central Ave. Delaware Co.-"Scenic River"	4ft. / For beautification	City of Delaware Rec & Parks Dept.
William Street Dam	South of William Street Delaware Co. –"Scenic River"	4 ft. / For beautification	City of Delaware Rec & Parks Dept.
Stratford Dam	North of St. Rt. 23 Bridge over the Olentangy River Delaware Co.-"Scenic River"	4 ft. /	Private
St. Rt. 23 Dam	North of St. Rt. 23 Bridge over the Olentangy River Delaware Co.-"Scenic River"	Eroding away.	Private
State Route 161 Dam	Lat: 40 05 06. Long: 83 01 50 Franklin County	6 ft. / Public Wastewater Treatment (harbor sewer lines)	City of Columbus- Division of Sewerage and Drainage
Broadmeadows Dam	Lat: 40 04 56. Long: 83 02 08 Franklin County	4 Ft. / Wastewater Treatment (harbor sewer lines)	City of Columbus- Division of Sewerage and Drainage
North Broadway Dam	Lat: 40 01 46; Long: 83 01 26 Franklin County	6 Ft./ Wastewater Treatment (harbor sewer lines)	City of Columbus- Division of Sewerage and Drainage
Union Cemetery Dam	Lat: 40 01 18; Long: 83 01 10 Franklin County	5.9 Ft./ Public Wastewater Treatment (harbor sewer lines)	City of Columbus- Division of Sewerage and Drainage
Dodridge Street Dam	Lat: 40 01 03; Long: 83 00 58 Franklin County	6.6 Ft. / Waste Retention-Sanitary Sewer Crossing (harbor sewer lines)	City of Columbus- Division of Sewerage and Drainage
Fifth Ave Dam	Lat: 39 59 20; Long: 83 01 29 Franklin County	8 Ft. / OSU	City of Columbus- Division of Sewerage and Drainage

City of Columbus dam information was obtained from ODNR's Dam Inventory Sheets. All other dam data was obtained by the Ohio Department of Natural Resources Division of Natural Areas and Preserves- Scenic River Section.

Table 12. Lowhead Dam Recommendations for the Scenic River Segment of the Lower Olentangy River

The goal of the following objectives is to improve the habitat and water quality of the impounded areas behind the twelve lowhead dams on the Lower Olentangy River to provide passage for fish migration and boaters. Two data reference sites exist from the Ohio EPA for behind the North Broadway Dam and the 5th Ave Dam. This data collected in 1999 shows low ICI (12) and QHEI (29.0) scores below the 5th Ave Dam and the North Broadway Dam (ICI: 22, QHEI: 44.0) (Ohio EPA, 2001). Per conversations with Ohio EPA staff this data can be extrapolated to other impounded areas of the Olentangy River. The goal is to improve the QHEI scores to 60.0 and ICI scores to 36.0 to meet a WWH use designation; at a very minimum the QHEI and ICI scores should meet the MWH use designation. A full-blown feasibility study is required for the lowhead dams within Franklin County portion of the Olentangy River; five of the six harbor sewer lines and the one that does not (the 5th Ave Dam) may have contaminated sediments behind it.

Objectives	Responsible Parties/Partners	Costs	Funding	Indicators of Success	Schedule	Targeted River Segment
If feasible and desirable, remove lowhead dams in the Scenic River portion.	• Dam owners • ODNR – Scenic River Division • Delaware County • City of Columbus • City of Delaware • OSU	Approx. $120,000 per dam removed. (general cost estimate from ODNR-DNAP)	• Mitigation Funds • 319 Grant Funds • Ohio Scenic Rivers License Plate Funds • City of Columbus • ODOT • WRRSP • WPCLF	QHEI scores to 60.0 ICI scores to 36.0 to meet WWH Higher IBI Overall Improvement in water quality	By 2010 remove four.	Dennison Dam removed fall 2002. Target possibilities include (if proved feasible and desired) in order of priority : 1. Panhandle Dam 2. Stratford Dam 3. Central Ave Dam 4. Williams St. Dam 5. Main Rd Dam 6. St. Rt. 23 Dam

Table 13. Lowhead Dam Recommendations for Dams that Harbor Sewer Lines.

The goal of the following objectives is to improve the habitat and water quality of the impounded areas behind the twelve lowhead dams on the Lower Olentangy River to provide passage for fish migration and boaters. Two data reference sites exist from the Ohio EPA for behind the North Broadway Dam and the 5th Ave Dam. This data collected in 1999 shows low ICI and QHEI scores below the 5th Ave Dam (ICI: 12, QHEI: 29.0) and the North Broadway Dam (ICI: 22, QHEI: 44.0) (Ohio EPA, 2001). Per conversations with Ohio EPA staff this data can be extrapolated to other impounded areas of the Olentangy River. The goal is to improve the QHEI scores to 60.0 and ICI scores to 36.0 to meet a WWH use designation; at a very minimum the QHEI and ICI scores should meet the MWH use designation. A full-blown feasibility study is required for the lowhead dams within Franklin County portion of the Olentangy River; five of the six harbor sewer lines and the one that does not (the 5th Ave Dam) may have contaminated sediments behind it. The 5th Ave Dam is a project in itself, listed separate from the other dam objectives.

Objectives	Responsible Parties/ Partners	Costs	Funding	Indicators of Success	Schedule	Targeted River Segment
Where dam removal is not feasible or desirable investigate the means to modify structures to provide for fish ladders and boat chutes	City of Columbus: Div. Sewer & Drains Franklin County City of Worthington FLOW	$160,000 study needs completed (cost estimate from McLaughlin Engineering in Denver Co. used in 319 grant to the City of Columbus).	• Mitigation Funds • 319 Grant Funds (pending application submitted 03 by City of Columbus & FLOW) • American Rivers Restoration Grants. • ODNR- Division of Water Dam / Boat Safety • City of Columbus Recreation & Parks funds. • WRRSP • WPCLF	Increased diversity in fish and invertebrate species above and below impoundment	2010 modifications complete	Possibilities include (listed in priority order): 1. 161 Dam 2. Broadmeadows Dam 3. North Broadway Dam 4. Union Dam 5. Dodridge Dam 6. Scioto River Dam

Table 14. Lowhead Dam Recommendations for the 5th Avenue Dam.

The goal of the following objectives is to improve the habitat and water quality of the impounded areas behind the twelve lowhead dams on the Lower Olentangy River to provide passage for fish migration and boaters. Two data reference sites exist from the Ohio EPA for behind the North Broadway Dam and the 5th Ave Dam. This data collected in 1999 shows low ICI and QHEI scores below the 5th Ave Dam (ICI: 12, QHEI: 29.0) and the North Broadway Dam (ICI: 22, QHEI: 44.0) (Ohio EPA, 2001). Per conversations with Ohio EPA staff this data can be extrapolated to other impounded areas of the Olentangy River. The goal is to improve the QHEI scores to 60.0 and ICI scores to 36.0 to meet a WWH use designation; at a very minimum the QHEI and ICI scores should meet the MWH use designation. A full-blown feasibility study is required for the lowhead dams within Franklin County portion of the Olentangy River; five of the six harbor sewer lines and the one that does not (the 5th Ave Dam) may have contaminated sediments behind it. The 5th Ave Dam is a project in itself, listed separate from the other dam objectives and is of highest priority due the River segment not meeting the MWH use designation.

Objectives	Responsible Parties/ Partners	Costs	Funding	Indicators of Success	Schedule	Targeted River Segment
Refer to Army Corps of Engineers feasibility study scheduled for conception in 2003 and the recommendations from the City of Columbus 5th Ave Dam Advisory Team and OSU OTTER Project. No matter the outcome, consensus should be sought and alternative solutions to dam removal be developed to improve water quality if dam removal is not possible.	City of Columbus USACE OSU OSU Crew Club FLOW	Estimated at $2.4 million	• Clean Water Act 401 Mitigation Funds • 319 Grant Funds • USACE • City of Columbus • OSU • WRRSP • WPCLF	Overall improvement in water quality. At a minimum, meet Aquatic Use designation for MWH	2005 study complete. 2006 construction complete.	OSU Campus Section (2 miles from just south of Dodridge to 3rd Ave Bridge.

Table 15. Lowhead Dam Recommendations for the Delaware Dam.

The goal of the following objectives is to improve the potential affects from the Delaware Dam releases. The Delaware Dam is a bottom-release dam therefore; the Hydromodification group speculated that a large portion of sediment loading may be originating from above the Dam vs. below. A study to determine sediment transport is needed. In addition, members of the Hydromodification group were concerned with affects the release rates may have on fish and macroinvertebrate populations especially during periods of heavy rain.

Objectives	Responsible Parties/Partners	Costs	Funding	Indicators of Success	Schedule	Targeted River Segment
Conduct a sediment study, install monitors above Delaware Lake, below the Delaware Dam and downstream to Worthington.	• USGS • OEPA • ODNR • City of Delaware • City of Columbus • DelCo. Water • USACE	$200,000 (cost estimate from ODNR Scenic Rivers)	• USGS • OEPA • Scenic Rivers License Plate Funds • City of Delaware • DelCo. Water • USACE	After information is gathered, target efforts and programs to areas where sediment is coming from. Overall Reduction in sediment to the Olentangy River	2007	Above the Delaware Lake; Before and after the Dam gates and downstream sites (Delaware, Worthington and Scioto Confluence)
Stabilize Release Rates from the Delaware Lake Dam to mimic natural hydrology and rainfall (bell curve vs. spikes)	USACE USGS; ODNR, OEPA	$ In-Kind	USACE	Stable stream flows	2007	Dam

Table 16. Culvert Recommendations.

The goal of the following objectives is to minimize the alteration of the flow regime, channel morphology and disruption of aquatic organisms within tributaries to the Olentangy River caused by culverts.						
Objectives	**Responsible Parties/ Partners**	**Costs**	**Funding**	**Indicators of Success**	**Schedule**	**Targeted River Segment**
• When installing or replacing culverts, they should be designed to minimize the impact on the open channel habitat and preserve the character of the natural stream bottom. For larger sized culverts, the use of submerged inverts, or open bottomed structures are preferred and should be utilized where practical. Single cell openings are preferred over multiple cells. • All stream culverts shall be designed to allow natural movement of bedload to form a stable bed inside the culvert. For details on design requirements refer to Fish Passage Design at Road Culverts by the Washington Department of Fish and Wildlife, 1999. • Ensure sufficient water depth within the culvert during normal and low flow conditions. • Ensure proper installation to avoid scour pools at the downstream end of the culvert.	Delaware County Engineer Franklin County Engineer ODOT ODNR Columbus Rec and Parks		• Franklin County Engineer • Delaware County Engineer • ODOT • FHWA • Federal Transportation Enhancement Program (FTEP).	Success can be measured by the presence of certain bottom dwelling species and the absence of erosion or sedimentation. These measures can be determined quickly and economically without a lot of man power and costly testing.	As new culverts are installed or existing culverts are replaced.	To be determined

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5.0 Stormwater and Construction Working Group

The Stormwater and Construction Working Group began to focus on developing a model Phase II application for the multiple jurisdictions within the watershed, but found this was a duplication of efforts currently underway in Franklin and Delaware Counties. They switched their emphasis to doing research on best management practices (BMPs) that treat for quality and quantity of stormwater and then made recommendations for undeveloped and developed (i.e., impacted) areas.

5.1 Impacts of Stormwater Runoff

Urban and suburban development changes the landscape from vegetations such as trees, grasses and agricultural crops that absorb rainfall, to hard impervious surfaces such as roads, parking lots, rooftops and driveways. This causes rainfall to be deflected off the surface and become stormwater runoff. This runoff is directed into storm sewers which discharge into the river or tributary stream.

The Ohio EPA 1999 Technical Support Document identified sections of the Lower Olentangy Watershed most affected by stormwater runoff: the lower 4 miles of the river (78% impervious cover), the stretch of river within the City of Delaware and also in every tributary sampled except for Horseshoe Run and the Lewis Center Tributary which are threatened from future stormwater impacts due to rapid development rates.

A variety of stormwater management practices are available to minimize the impact of stormwater runoff on the receiving waters. However, these practices must be maintained to function efficiently and effectively.

Sections 5.1.1 to 5.1.7 describe problems that stormwater runoff causes to stream systems.

5.1.1 Degradation of Stream Channels

The increase in stormwater runoff is often too much for the natural drainage system to handle. As a result, stream banks and channels erode causing them to widen and deepen and become unstable. This also causes habitats within the channel to degrade (substrates become clogged disabling life to survive in the crevices, loss of

pool/riffle structures). This is particularly evident in Adena Brook; its function has been changed from a natural stream to one of storm water conveyance.

5.1.2 Declining Water Quality

Impervious surfaces accumulate pollutants such as nutrients, suspended solids, organic carbon, bacteria, hydrocarbons, trace metals, pesticides, chlorides, thermal impacts, trash and debris. During storm events, these pollutants quickly wash off and are delivered directly to local waterways. The first flush contains the most concentrated amounts of pollutants.

5.1.3 Diminishing Groundwater Recharge

The water that is deflected off impervious surfaces would under natural (pre-urbanized) conditions (especially in the Franklin County portion of the watershed), percolate into the ground and become stored as groundwater. This water would then slowly seep from the ground into the river or stream allowing a stable flow of water in the channel. Without this recharge, flow in the stream is reduced during low precipitation months.

5.1.4 Increased Flooding

Impervious surfaces and storm systems associated with urbanization often result in increased storm water runoff and a reduction in storm water travel time when compared to pre-urbanized conditions. These changes, if not adequately controlled, may result in increased flooding conditions in other areas of the watershed.

5.1.5 Sewage Overflows

In urban areas storm water, groundwater and stream water infiltration and inflow (I&I) can cause sanitary sewer and combined sewer overflows. In Delaware, this I&I is taken in by the Waste Water Treatment Plant and at times overwhelms the capacity of the facility. There are no known overflow relief points in Delaware's system, but I &I is evident due to the increased amount of influent to the plant during rain events.

5.1.6 Erosion and Sedimentation from Construction Sites

Construction is the most damaging phase of the development cycle for streams and aquatic life. Fine sediments can accumulate and clog spaces in between rocks where

macroinvertebrates, mussels and fish utilize these spaces for shelter, spawning and food gathering. Suspended solids can interrupt the ability for fish to locate their food.

5.1.7 Trash and Debris

Storm water carries trash and debris from local streets, commercial areas and parking lots. This can affect the aesthetic experience of our natural waterways and create apathetic perceptions for our natural areas among the public. In addition, trash and debris can pose a hazard for wildlife.

5.2 The Importance of Imperviousness

One of the main features associated with the urbanization of the watershed is the increase in "imperviousness", especially in the floodplain of the river. "Imperviousness" refers to the amount of hardened surfaces – surfaces that are impermeable to water and cause the water to be deflected off of these surfaces rather than soaking into the ground. Studies collected nationally by the Center for Watershed Protection show that imperviousness is a useful indicator with which to measure the impacts of development on streams.

The percentage of imperviousness or hard surfaces such as roads, parking lots, rooftops, and driveways in a watershed has a direct relationship with the amount of runoff. For example, the total runoff from a one-inch of rainfall from a one-acre meadow would fill a standard size office to a depth of about two feet. If that same acre were paved, runoff from a one-inch rainfall event would completely fill the office plus two additional offices adjacent to it. The peak discharge, velocity, and time of concentration of the rainfall event also exhibit a striking increase after a meadow is replaced with a parking lot.

In addition, an increase in imperviousness results in stream bank instability triggering stream bank erosion and habitat degradation. Recent research models developed in the Pacific Northwest suggest a threshold for urban stream stability exists at about 10% imperviousness (Booth, 1991; Booth and Reinelt, 1993). During their research, they found that sensitive streams (those meeting a warm water or exceptional warm water habitat use designation) had watershed imperviousness of 0-10%; while impacted streams (those only partially attaining their use designation) had watershed imperviousness of 11-25% and non-supporting streams had watershed imperviousness of 26-100%. Appendix I contains an article on the importance of imperviousness.

As indicated in Table 17, the percentage of imperviousness in the Lower Olentangy River increases dramatically as one goes downstream from the less-urbanized portion of the river near High Banks Metro Park and the Powell Road bridge (2.7%) to the river floodplain in Clintonville in the vicinity of Whetstone Park (49.5%), and to the increasingly more urbanized portion of the Olentangy River watershed within Columbus from the Dodridge Street bridge to the river's confluence with the Scioto River (78%). As suggested by the discussion presented in the previous paragraph, the 1999 "Biological and Water Quality Study of the Olentangy River and Selected Tributaries" (Ohio EPA, 2001) shows a distinctive inverse relationship between water quality in the river and increasing imperviousness in the watershed as one goes downstream from the I-270 bridge to the river's confluence within Franklin County.

It is evident, given the current explosive rate of population growth in southern Delaware County that land use across this portion of the watershed is changing at a rapid pace with development and the resulting urbanization of these former agricultural areas dramatically increasing the percent imperviousness in the Scenic River portion of the Olentangy River Watershed as we speak. It is to be anticipated that, barring any intervention to mitigate the effects of increasing imperviousness in this area, the current exceptional water quality along this stretch of the river in Delaware County will surely decline as its has in heavily-urbanized portions of Franklin County.

In 2002, the Delaware County Regional Planning Commission did an impervious surfaces analysis of existing development in the Olentangy Watershed from the City of Delaware south to the County line. They found that 2,488.61 acres of a total 28,590.75 acres is impervious cover (8.7%).

Table 17. Percentage of Imperviousness in the Lower Olentangy River at Select Locations

14 Digit Subwatershed	Location	% Imperviousness
05060001120010	Olentangy River below Horseshoe Run to below Delaware Run	11.7%
05060001120020	Olentangy River near Powell	2.7%
05060001120030	Olentangy River near Worthington	17.8%
05060001120040	Olentangy River near Worthington to gauging station at Henderson Road	41%
05060001120050	Olentangy River from gauging station at Henderson Rd to Dodridge Street	49.5%
0506000120060	Olentangy River from Dodridge Street to Scioto River	78.1%

5.3 Stormwater Runoff Recommendations

5.3.1 Recommended Stormwater Treatment for Undeveloped Sensitive Areas of the Olentangy Watershed

A major portion of the Lower Olentangy Watershed is primarily urban in nature which has and will continue to significantly impact the habitat, flow regime, and water quality of the lower Olentangy River. Southern Delaware County, all of Franklin County, the City of Powell and the City of Delaware all contribute significant amounts of urban storm water runoff into the river system. Sediments, nutrients, bacteria and heavy metals are the primary concerns.

The majority of the land remaining between the City of Powell and the City of Delaware and north of the City of Delaware to the Delaware Dam is undeveloped farmlands, old fields, natural areas, and large estates. In these areas the main stem of the Olentangy, its tributaries and surrounding wetlands have remained relatively intact. The large expanses of open areas, woodlands and agricultural fields allowed for a relatively stable flow regime. These open landscapes have contributed greatly to the Olentangy River exhibiting exceptional water quality throughout this stretch.

As more of these areas become developed and incorporated into the urban landscape, measures must be taken to reduce the impacts associated with urbanization. Storm water treatment in the undeveloped areas of the Olentangy River should entail the following levels of protection. **Existing, critical features should be preserved**. Critical features include woodlots, wetlands, floodplains, steep slopes, ravines and all tributaries (perennial, intermittent, and ephemeral). It is recommended that these features be places in conservation easements or permanently protected using other mechanisms (See Importance of Habitat Section Recommendations). These features contribute to maintaining a functional watershed ecosystem and flow regime as well as provide much under-valued storm water treatment by absorbing storm water before it reaches the receiving stream. Significant losses of storm water benefits occur as open channels are replaced with conduit or as channels with some natural attributes are shortened, bank heights increased or floodplain access reduced. These channel morphology modifications result in drainage systems having reduced functions in areas like groundwater recharge, assimilation of pollutants and attenuation of storm flows. This reduction in the ability to manage predevelopment loads of flow and sediments (and other materials) occurs at the same time that pollution loads, volume and energy are increasing with new land uses. Installing storm water facilities rarely mitigates

these impacts, for that reason they are best addressed by protection or rehabilitation measures in and along the stream system.

Storm water should be minimized. Smaller lot sizes, clustering of housing, narrower streets, and shared parking can all contribute to minimizing the amount of impervious surfaces produced from a development with the remaining areas designated as open spaces. Storm water should also be diverted away from impervious surfaces where practicable into vegetated areas and or by using other storm water BMPs. By minimizing the amount of storm water generated on-site the need for costly engineering solutions is reduced along with the negative downstream effects.

Stormwater should be treated for quantity and quality. At a minimum all storm water should be treated according to the Ohio Environmental Protection Agency (OEPA) National Pollutant Discharge Elimination System Permit (NPDES) requirements.
Concerns over storm water pollutants lifted from paved and developed areas bring the additional objective of water quality treatment to storm water management. Channel and stream erosion is also a ubiquitous problem in urbanizing streams. Besides damaging streamside property, it is also partially responsible for poorer habitat and water quality in urbanizing areas. Indications are that common detention strategies do not address these problems and in fact sediments from channel erosion often increase following development. Studies from Ohio, Maryland, Washington and Ontario indicate a need for managing commonly occurring storm events (e.g. 0.5 year – 5 year) to prevent these problems (Center for Watershed Protection Studies, 1998, 2000).

5.3.2 Practical Methods

5.3.2.1 Capture and treat storm water for post-construction pollutants. Capture and treat to the maximum extent practicable the first flush of storm water runoff volume. Different methods exist for accomplishing this, including those discussed in the American Society of Civil Engineers (ASCE, 1998) – Water Environment Federation Manuals of Engineering Practice #87 to simply providing extended detention. If nutrients are an issue, wet ponds, wetland treatment systems or additional measures may be required.

5.3.2.2 Provide extended detention of frequent storms. Provide extended detention of frequent storms in order to control the post-construction increase in bedload transport ability. "Effective discharge" storm events become more frequent following development and are rarely controlled by common storm

water detention strategies. The result is increased tractive force in channels. Indications are that capturing and providing extended detention for the runoff from the first 0.75 inches of rainfall will meet the objective of maintaining stream stability. This can likely be combined with the volume captured by first flush best management practices.

5.3.2.3 Provide detention for overbank flood protection and extreme flood protection. The intent is to minimize the impact of flood damage from infrequent (large) storm events and mimic the predevelopment flood conditions in receiving streams.

5.3.2.4 Encourage return of active floodplain along entrenched or incised channels. In channels that are degraded or incised this would mean removing earth or fill along the channel to provide greater floodplain access or providing grade control to down cutting channels. In newly designed channels, it would mean incorporating a multi-stage design in order to improve water quality, channel substrates and lower maintenance.

Tables 18 through 23 provide recommendations for stormwater runoff control.

Table 18. Stormwater Runoff Recommendations for Post-Construction BMPs Affecting Water Quality and Quantity.

The goal of the following objectives is to protect and restore the chemical, physical and biological integrity of the Olentangy River and tributary streams; none of the tributary streams sampled by the Ohio EPA in 1999 were meeting their WWH use designation and the mainstem of the River is considered threatened due to rapid development taking place in Delaware County (Ohio EPA, 2001). Urban runoff and altered flow regimes from imperviousness have contributed to the non-attainment in the urbanized tributaries and the lower 5 miles of the River (Ohio EPA, 2001). The Stormwater group decided to begin with undeveloped sensitive areas, Adena Brook, and the last 5 miles of the River to focus on Stormwater Regulations and use of water quality and quantity BMPs. The goal of these BMPs is to increase DO levels, reduce bacteria counts (see Human Health Section) and reduce nutrient loadings as well as reduce peak runoff rates. In general, storm water BMPs that treat for water quality have not been widely used in Ohio, especially Central Ohio; therefore creating local examples of storm water BMPs and monitoring their effectiveness at pollutant removal in our climate and soil conditions was an important objective for the Stormwater working group.

Objectives	Responsible Parties/Partners	Costs	Funding	Indicators of Success	Schedule	Targeted River Segment
Improve the implementation and determine the effectiveness of BMPs (see Table 23) to serve as a local example of these practices. Install demonstration BMPs. Follow the Rainwater Land Development Handbook to be published by the ODNR, Division of Soil and Water, with the next edition due in 2005.	Local governments, OSU, Developers	$100,000 (estimate from OSU FAE Dept.)	Developers, grants for demonstration projects; OSU	Number of listed BMPs implemented	2004-2005	OSU Campus and where opportunities arise.

Table 19. Stormwater Runoff Recommendations for Post-Construction BMPs.

The goal of the following objectives is to protect and restore the chemical, physical and biological integrity of the Olentangy River and tributary streams; none of the tributary streams sampled by the Ohio EPA in 1999 were meeting their WWH use designation and the mainstem of the River is considered threatened due to rapid development taking place in Delaware County (Ohio EPA, 2001). Urban runoff and altered flow regimes from imperviousness have contributed to the non-attainment in the urbanized tributaries and the lower 5 miles of the River (Ohio EPA, 2001). The Stormwater group decided to begin with undeveloped sensitive areas, Adena Brook, and the last 5 miles of the River to focus on Stormwater Regulations and use of water quality and quantity BMPs. The goal of these BMPs is to increase DO levels, reduce bacteria counts (see Human Health Section) and reduce nutrient loadings as well as reduce peak runoff rates. In general, storm water BMPs that treat for water quality have not been widely used in Ohio, especially Central Ohio; therefore creating local examples of storm water BMPs and monitoring their effectiveness at pollutant removal in our climate and soil conditions was an important objective for the Stormwater working group.

Objectives	Responsible Parties/Partners	Costs	Funding	Indicators of Success	Schedule	Targeted River Segment
Installation of BMPs to reduce quantity and quality of storm water on individual properties (rain gardens, rain barrels, dense vegetation) via Backyard Conservation & Storm water Reduction Program.	Local governments FLOW FSWCD FOR Adena Brook Community group	At least $20,000	Columbus Foundation / other grants. City of Columbus Local residents.	Measure flow rates; see decrease in peak discharges compared with rain gauge data.	2003-2033	Begin with Adena Brook and as opportunities arise.

Table 20. Stormwater Runoff Recommendations for Litter Reduction.

The goal of the following objectives is to improve the aesthetic experience of the Olentangy River and tributary streams as well as reduce the hazard for wildlife. The goal is to increase reduce litter loadings.

Stormwater carries trash and debris from local streets, commercial areas and parking lots. This can affect the aesthetic experience of our natural waterways and create apathetic perceptions for our natural areas among the public. In addition, trash and debris can pose a hazard for wildlife.

Objectives	Responsible Parties/Partners	Costs	Funding	Indicators of Success	Schedule	Targeted River Segment
Litter Reduction- Reinstitute Leaf collection; Include clean-up efforts as maintenance; Revitalize 'Stop Littering' programs; Develop street sweeping programs that target high traffic and environmentally sensitive areas; Release a "Dirty Dozen" report focusing on the most trash filled areas; When possible, incorporate a water quality device that captures floatables.	Local gov't; Organizations	unknown	Local gov't-could be part of storm water fees. Litter Prevention-ODNR and Local Parks & Health Depts.	Amount of leaves collected; number of cleanups held and reduction of garbage over time (measured in tons).	2004-2006	All

Table 21. Stormwater Runoff Recommendations for Erosion and Sedimentation Controls, page 1 of 2.

The goal of the following objectives is to protect and restore the physical, chemical and biological integrity of the Olentangy River and tributary streams; none of the tributary streams sampled by the Ohio EPA in 1999 were meeting their WWH use designation and the mainstem of the River is considered threatened due to rapid development taking place in Delaware County (Ohio EPA, 2001). Urban runoff and altered flow regimes from imperviousness have contributed to the non-attainment in the urbanized tributaries and the lower 5 miles of the River (Ohio EPA, 2001). Aside from post-construction water quality and quantity BMPs, the Stormwater working group thought controlling sedimentation from construction sites was important to the integrity of the resource. The goal is to control sedimentation.

To control sedimentation caused by construction sites, the group determined the need to specify the controls, thresholds (site sizes and appropriate practices) and timelines. Plan Review was an important component and includes a thorough review with sign off rejecting poor plans. Plans should incorporate the Ten Elements of an Effective Erosion and Sedimentation Control Plan outlined by the Center for Watershed Protection. Site Follow Up & Inspection- local jurisdictions should designate an inspector or increase inspector staff; develop an inspection tracking system, develop protocol for dealing with problem sites (prior to a problem). Enforcement- fines must cost more than implementing the practices and /or stop the work until practices installed and maintained. Be responsive. Increase amount of bonds with contractors that have had a history of repeated violations.

Objectives	Responsible Parties/ Partners	Costs	Funding	Indicators of Success	Schedule	Targeted River Segment
Identify ground recharge areas through resources available (map from ODNR) and promote infiltration recharge practices for development and redevelopment.	Local jurisdictions. Ohio EPA	unknown	Local governments (through stormwater fees).	Development and adoption of local erosion and sedimentation ordinances; number of plans reviewed and required revisions; number of enforcement cases when needed; development of a monitoring / inspection program	2004-2007	All jurisdictions covered under NPDES Phase I or Phase II, but especially those in Delaware County due to the rapid development.

Table 21. Stormwater Runoff Recommendations for Erosion and Sedimentation Controls, page 2 of 2.

Objectives	Responsible Parties/ Partners	Costs	Funding	Indicators of Success	Schedule	Targeted River Segment
Control erosion & sedimentation from construction sites, specifically with site follow up and inspections. Improve communications between Ohio EPA and FLOW of the permitted construction sites within the Lower Olentangy watershed. Ohio EPA staff will email FLOW monthly a list of sites and inspection status. This will enable FLOW to assist in citizen's visual monitoring that can be accomplished without entering onto sites. In order to enter a site, expressed permission from the property owner would be required. Any citizen's concerns about erosion and sedimentation would be passed onto local authorities.	Ohio EPA Local jurisdictions. FLOW	unknown	unknown	Number of active sites that have been inspected and followed up with if necessary.	2004	All, but especially those in Delaware County due to the rapid development and threatened state of the River.

Table 22. Stormwater Runoff Recommendations for Sewage Overflows, page 1 of 2.

The goal of the following objectives is to restore the chemical water quality of the Olentangy River and tributary streams from stormwater entering the sanitary system and causing sewage overflows (see also Human Health & Safety section); none of the tributary streams sampled by the Ohio EPA in 1999 were meeting their WWH use designation (Ohio EPA, 2001). The most frequent exceedences of Ohio Water Quality Standards in these streams were for fecal coliform and *E. coli* bacteria; symptomatic of sewage releases, commonly from CSOs and SSOs and failing household sewage disposal systems and package plants (see Human Health & Safety section for HSTS recommendations). Note: Poor water quality in these streams may also have been exacerbated by drought conditions that existed during the 1999 Ohio EPA field season. These drought conditions led to reduced or non-existent stream flow in these often-ephemeral waterways, possibly concentrating bacteria and nutrients in isolated stretches of the stream that still retained pooled water. Highly elevated levels of E. coli bacteria exceeding both Primary and Secondary Contact Recreation criterion (>575/100 mL) were found in all of the sampled tributaries. Urban runoff and altered flow regimes from imperviousness have contributed to the non-attainment in the urbanized tributaries and the lower 5 miles of the River (Ohio EPA, 2001). Reducing stormwater I&I (infiltration and inflow) to the sanitary system will reduce the occurrence of overflows. The goal is to increase DO levels, reduce bacteria counts and reduce nutrient loadings as well as reduce peak runoff rates. Use the Shaker Hts, Ohio study as an example.

Continued on the next page.

Table 22. Stormwater Runoff Recommendations for Sewage Overflows, page 2 of 2.

Objectives	Responsible Parties/Partners	Cost	Funding	Indicators of Success	Schedule	Targeted River Segment
• Reduce bacterial contamination and quantity of peak storm water entering Adena Brook- Conduct a pilot project to reduce storm water inflow to the sanitary system and storm water runoff into the creek. • Conduct monitoring to find foundation drains / downspouts connected into the sanitary system (part of Columbus Private Source I&I ID Pilot Project in Clintonville). • Begin a disconnect program – provide educational workshops (part of Backyard Conservation / Storm water Reduction Program) on downspout disconnects and diversion to BMPs such as rain gardens or rain barrels. • Provide a funding mechanism to purchase rain barrels etc. • Provide low interest loans to assist homeowners in disconnecting foundation drains. • Produce and distribute educational materials on decreasing pollutants in runoff and the importance of disconnection.	• City of Columbus Div. of Sewerage & Drainage • FLOW • Adena Brook Community • Ohio EPA • Clintonville Academy • Graham High School. • ODOT • Clintonville Area Commission	$60,000	•Ohio EPA 319 •Ohio EPA DEFA •T. Marzetti's Co. •City of Columbus •FLOW, area schools and the Adena Brook Community group. •Columbus Foundation	Conduct pre- and post-program monitoring of the creek; flow rates, SSO occurrences.	2004-2006 and as redevelop-ment occurs	Adena Brook (pilot)

Table 23. Recommended Structural Best Management Practices (BMPs) for Storm Water Management, page 1 of 7.

The following list of Best Management Practices (BMPs) is provided based on available information at the time of its development. It is recognized, however, that the development of storm water structural BMPs is an emerging science where advances in storm water treatment technology are ever changing. This list is provided as a guide only and is not meant to be exclusive of alternative storm water BMPs that could be used to benefit the Olentangy River watershed.

BMP (with short description)	Maintenance Requirements	Costs	$ Saved	Site Specifics/Applicable Areas
Bio-retention Areas- filter runoff stored in a shallow depression. Highly effective for removal of pollutants, especially metals.	Soil: Inspect & Repair Erosion- by visual observation on a monthly basis. Evaluate soil fertility cat ion exchange capacity (CEC) annually and replace soils when lost (every 5-10 years). This takes 1-2 days and costs $1-2,000 for a system that drains one acre. Mulch: Re-mulch as needed. Remove old mulch and replace once a year. Plants: Remove and replace all dead and diseased plants twice a year (spring and fall). Treat all diseased trees and shrubs as needed. Water plant materials for 14 consecutive days after the initial planting. Replace stakes after one year. Replace deficient stakes or wires as needed.	$3-$15 per square foot of bio-retention area	Reduction of storm drain pipe needed (e.g. Medical Office building in Prince George's Co. MD eliminated need for 570 feet of storm drain pipe due to bio-retention area and saved $24,000) Cost savings in Central Ohio are dependent upon specific site soil conditions	Good for commercial areas / parking lots and subdivisions. Soil Criteria: pH- 5.5-6.5 Organic Matter- 1,5-3.0% Magnesium 35 lbs/acre Phosphorus 100 lbs / acre Potassium 85 lbs / acre Soluble Salts < 500 ppm Vegetation: Use native plants (see OSU fact sheet on parking lot designs). Sizing: Bio-retention System should occupy 5-7% of the drainage basin. (example: for a 2 acre drainage area the system should be 1/10 of an acre).

Table 23. Recommended Structural Best Management Practices (BMPs) for Storm Water Management, page 2 of 7.

BMP (with short description)	Maintenance Requirements	Costs	$ Saved	Site Specifics/Applicable Areas
Rain Gardens- rainwater and snowfall are routed to the garden and filtered by plants and soils (micro-detention pond). Reduces the amount of runoff from rooftops, lawns, sidewalks and driveways.	Occasional weeding and replacement of dead and diseased plants (as with any landscaped area)	$200-$500 / lot	Reduction in costs associated with piping rooftop runoff to streets.	Relatively small area of plantings near the downspout of a building or paved area. Dig a shallow depression. Sand and / or gravel, soil and organic mulch are layered into the garden plot (if on-site filtration is poor). Then plant native hardy plants with deep root systems.
Bio, Grass and Vegetated Swales- reduce runoff velocity and increase infiltration. Compared to roadside ditches, they have a wider bottom, gentler slopes and denser vegetation.	Periodic removal of sediment build-up, mowing of turf and periodic inspections.	Very inexpensive. Maintenance costs unknown	For traditional conveyance systems (curb and gutter) it costs $40-$50 per running foot.	Use in areas along residential streets and highways. Design- good for smaller drainage areas with mildly sloping topography. Length is important but longitudinal slope and presence of check dams increases the pollutant removal capabilities.

Continued on the next page.

Table 23. Recommended Structural Best Management Practices (BMPs) for Storm Water Management, page 3 of 7.

BMP (with short description)	Maintenance Requirements	Costs	$ Saved	Site Specifics/Applicable Areas
Dry Swales- Engineered grass channels that provide treatment of storm water pollutants: 25 % more effective than grass swales at removing sediments, 40% more effective at removing phosphorus, 35% more effective at removing nitrogen and 40-60% more effective at removing metals.	Periodic removal of sediment build-up, mowing of turf and periodic inspections Replacement of the filter beds and periodic replacement of the top layer.	$15-$20 per running foot. Maintenance Costs Unknown.	For traditional conveyance systems (curb and gutter) it costs $40-$50 per running foot.	Use in areas along residential streets and highways. Design specs- good for smaller drainage areas with mildly sloping topography, housing density less than 4 dwelling units / acre. Design- layer of prepared sandy loam topped by dense turf. The treated runoff is collected in an under drain pipe system and discharged to receiving water. Designed to dewater a few hours after a storm.
Permeable Pavement- Reduces imperviousness, allows for infiltration of storm water – Soils in Central Ohio could preclude the use of such practices.	Annual high powered vacuuming of the area to remove sediments.	$2-$4 compared to asphalt at $0.50-$1.	May have cost reduction overall because of smaller storm water facilities needed.	Low-traffic areas such as sidewalks and parking lots.

Continued on the next page.

Table 23. Recommended Structural Best Management Practices (BMPs) for Storm Water Management, page 4 of 7.

BMP (with short description)	Maintenance Requirements	Costs	$ Saved	Site Specifics/Applicable Areas
Rain gutter Disconnects Redirecting rooftop runoff into grass swales, bio-retention areas, rain gardens or to store in rain barrels or cisterns instead of directly connecting to curb/gutter.	Dependant upon BMP chosen	$120 / rain barrel	Decrease costs of water bills to water lawns.	Great for decreasing CSO events in urban areas. Case study in Shaker Heights, OH. Transport water away from the foundation of the home.
Urban Forests/Tree Plantings Urban tree planting reduces storm water volume through the process of interception and absorption.	Leaf litter in impervious surface areas must be collected.	$125-$350 per 2.5" caliber. Tree for standard street tree planting costs.	Canton-Akron, OH expenses were $1.1 Billion worth of annual storm water and $8.3 million in air pollution remediation which was down from 1.4 Billion due to urban deforestation. (American Forests, 1999) Houston's forest save $1.4 Billion in storm water and $209 Million in air pollution while saving $26 million in heat and cooling and storing 37.5 Million Tons of Carbon (American Forests, 2000).	Street trees and parking lots islands prevent first flush. Residential and commercial lots that are highly forested intercept and absorb rainfall that become surface runoff. Local example: includes the older residential neighborhoods of Muirfield.

Continued on the next page.

Table 23. Recommended Structural Best Management Practices (BMPs) for Storm Water Management, page 5 of 7.

BMP (with short description)	Maintenance Requirements	Costs	$ Saved	Site Specifics/Applicable Areas
Urban Forests/Tree Plantings Urban tree planting reduces storm water volume through the process of interception and absorption.	Leaf litter in impervious surface areas must be collected.	$125-$350 per 2.5" caliber. Tree for standard street tree planting costs.	Canton-Akron, OH expenses were $1.1 Billion worth of annual storm water and $8.3 million in air pollution remediation which was down from 1.4 Billion due to urban deforestation. (American Forests, 1999) Houston's forest save $1.4 Billion in storm water and $209 Million in air pollution while saving $26 million in heat and cooling and storing 37.5 Million Tons of Carbon (American Forests, 2000).	Street trees and parking lots islands prevent first flush. Residential and commercial lots that are highly forested intercept and absorb rainfall that become surface runoff. Local example: includes the older residential neighborhoods of Muirfield.

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Table 23. Recommended Structural Best Management Practices (BMPs) for Storm Water Management, page 6 of 7.

BMP (with short description)	Maintenance Requirements	Costs	$ Saved	Site Specifics / Applicable Areas
Green Roofs Green roofs are 'roof surfaces that are entirely covered with a thin soil and vegetation layer.'(Scholz-Barth, 2001) which provide environmental services of storm water peak flow reduction and filtration, as well as atmospheric gas and temperature regulation. These are 'extensive' vegetated roof systems. Note: These are not roof gardens which require more construction and maintenance, and are designed to be inhabitable by the general public. Results vary based of local climatic conditions but runoff reduction is significant: A Three inch soil media planted receiving a 24 hr event of 3.35 inches will retain 50-60% of its volume (Miller, 2002)German studies showed an absorption rate of 75% of rain falling on a green roof and runoff reduction of up to 25% of normal levels in 2 inches of soil with 1 inch plantings. (NRCS, 2002).	The 'extensive green roof' consisting of < 4" of soil media and low ground covering vegetation, such as sedum requires little maintenance and no irrigation after establishment for approximately 30 yr life span.	Local ex: $35 s.f. Geauga County Ohio Parks and Rec. Building East Coast: $10-15 s.f. (Snodgrass, 2002) Toronto $21-$42 s.f. (Canadian dollars) (Peck, 1999) Costs are expected to drop as more projects are installed.	German Studies have shown the reduction of needs for storm water ponds, detention facilities and combined sanitary system replacement. Studies are being performed in Portland, Oregon on the feasibility comparisons for other BMPS reducing peak volumes in their combined sanitary system. It has been stated by some manufactures of the roofing membrane that these roofs outlast conventional roofs due to lack of ultraviolet light breaking down the membrane. Energy usage for air conditioning associated with the urban heat island effect have been shown to be reduced using green roofs in combination with other BMPs.	A green roofs weight varies based on manufacturer: weights range from 12 lbs s.f. dry wt. to 25 lbs s.f. wet wt. for a 3-4" green roof, which allows for construction on most existing structures. (Hydrotech, 2000; Miller, 2002)Green roofs up to a 45% slope have been installed. Local plant lists are available from manufactures, Penn State University, Michigan State University and the City of Chicago. Over a half a dozen companies service the Columbus area.

Table 23. Recommended Structural Best Management Practices (BMPs) for Storm Water Management, page 7 of 7.

BMP (with short description)	Maintenance Requirements	Costs	$ Saved	Site Specifics / Applicable Areas
Multi-Chamber Treatment Train- Designed for underground use- three chambers; inflow goes to an inlet/screening area then to a settling area then a filtration area. Substantial decrease of TSS and heavy metals.	varies	$10,000-20,000/ quarter acre of drainage area.	varies	Developed for stormwater hotspots (automotive repair and service areas, commercial parking lots, fueling stations, fleet storage areas, industrial rooftops, marinas, outdoor loading and unloading facilities, public works storage areas).
Oil & Grit Separators	Different product lines are available, follow product specifications.	varies	varies	Install in existing stormdrain grate industrial / commercial areas.
Sand Filters				Local example at OSU Hospital
Wet Ponds				
Stormwater Wetlands				

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6.0 Human Health and Sanitation Working Group

The Human Health and Sanitation Working Group focused on bacterial sources such as packaging plants and home septic/aeration systems in addition to looking at old landfills and areas where contaminated sediments were found.

6.1 Protecting Public Health and Safety

Summary Results of 1999 Ohio EPA Olentangy River Study [(excerpts from the Lower Olentangy Watershed Inventory, (FLOW 2003)].

6.1.1 Mainstem of the Lower Olentangy River

With regards to the chemical water quality of the mainstem of the river, Ohio EPA, based on their 1999 field study, judged the Lower Olentangy River to have generally good water quality (Ohio EPA, 2001). The only violations of Ohio Water Quality Standards consisted of excessive bacteria counts (above the Primary Contact Recreation criterion) from the river below the Delaware WWTP in the city of Delaware (RM 24.5) and in the lower reaches of the river within the Columbus city limits, including RM 5.5 adjacent to the east North Broadway bridge, RM 4.0 below the Dodridge Street dam, and at RM 0.6 below the Third Avenue bridge and above the river's confluence with the Scioto. Ohio EPA inferred these violations resulted from stormwater runoff, contributions from combined sewer overflows (CSOs) and faulty sanitary sewer lines concentrated in these urban areas (Ohio EPA, 2001). The violations may also be the result of failing household sewage treatment systems and package plants. Additional violations included exceedences of Aquatic Life Criteria for the pesticides Lindane and Dieldrin in the upper part of the Lower Olentangy River at RM 22.3 (U.S. Rt. 23 bridge).

Ohio EPA sampled sediments as well as water in the mainstem of the river in 1999. Sediments are often "sinks" for a variety of toxic chemicals that are often short-lived in the water column but persistent in bottom sediments. Especially persistent in sediments are *polycyclic aromatic hydrocarbons (PAHs)*, some pesticides (like DDT), *polychlorinated biphenyls (PCBs),* and some heavy metals (cadmium, chromium, lead). The PCBs and pesticides like DDT are not only persistent in sediments, but can bioaccumulate in tissues up the food chain, potentially leading to body burdens of

these chemicals in top-of-the-line predators like sport fish. Standards for aquatic and human exposures with regard to toxics in sediments are not well established. Ohio EPA has used guidelines established by the province of Ontario which establish a "Severe Effect Level" (SEL) for each chemical that indicates the level at which the chemical can be expected to have severe effects on bottom-dwelling organisms (Ohio EPA, 2001). Any chemical concentrations above the SEL guidelines are considered to be highly contaminated and likely to have significant adverse effects on measured ICI values.

Contaminated sediments were concentrated in urban portions of the river in Delaware and Columbus. The last couple of miles of the river upstream of its confluence in Columbus were the most severely impacted, having excessive levels of both heavy metals and organic compounds.

Ohio EPA detected a metals spike in river sediments at RM 22.3 at the U.S. Rt. 23 Bridge with highly elevated levels of aluminum, barium, and chromium (Ohio EPA, 2001). Ohio EPA speculated that possibly these high levels of metals might be the result of leachate derived from a former General Castings foundry sand disposal site upstream of the sample site. Curiously, these high metals levels in the sediment appear to have had no effect on benthic biotas in the areas as ICI scores for this locality were in the excellent range at 50.

High to extremely high metals levels (aluminum, barium, cadmium, chromium, copper, and zinc) and the PAHs fluoranthene, phenanthrene, and pyrene, plus lower levels of PCBs were detected in river sediments in the lower two miles of the river in Columbus (Ohio EPA, 2001). Ohio EPA suggested that these contaminants in the sediments along this stretch of the river were likely to be the result of a combination of factors, including run-off from city streets and highways, the former Gowdy Landfill near Goodale, and discharges from storm and sanitary sewer lines. Unlike the U.S. Rt. 23 bridge locality, ICI scores for this section of the river were poor to very poor. It is difficult to determine if this was the result of the toxics in the sediments or other effect of other human impacts on stream habitat along this stretch of the river. However, Ohio EPA gave QHEI scores of 61.5 and 65.5 for this stretch of the river, scores indicating a habitat that supported reasonably good bottom biotas elsewhere in the river.

6.1.2 Olentangy Tributary Streams

In contrast to the good to excellent chemical water quality documented for most of the Lower Olentangy River mainstem, the chemical water quality of many or most of the sampled tributary streams in Delaware and Franklin counties was judged to be only fair or poor (Ohio EPA, 2001). The most frequent exceedences of Ohio Water Quality Standards in these streams were for fecal coliform and *E. coli* bacteria; symptomatic of sewage releases, commonly from CSOs and SSOs and failing household sewage disposal systems and package plants. Poor water quality in these streams may also have been exacerbated by drought conditions that existed during the 1999 Ohio EPA field season. These drought conditions led to reduced or non-existent stream flow in these often-ephemeral waterways, possibly concentrating bacteria and nutrients in isolated stretches of the stream that still retained pooled water.

Highly elevated levels of E. coli bacteria exceeding both Primary and Secondary Contact Recreation criterion (>575/100 mL) were found in all of the sampled tributaries. Bacterial counts ranged from 570 to 6,800/100 mL. The highest levels of both E. coli and fecal coliform bacteria were detected near the mouth of Turkey Run [6,800 and 59,000 colonies/100 mL, respectively] in Columbus downstream of the OSU golf course. The pesticide Dieldrin was detected in Turkey Run surface water at concentrations exceeding the Ohio EPA Aquatic Life Criteria for this chemical.

Elevated levels of heavy metals were detected in sediments of several tributaries. In particular, high concentrations of aluminum, barium, and cadmium were detected in sediments in Rush Run in Worthington and cadmium and zinc in sediments in Adena Brook in Clintonville (Ohio EPA, 2001).

6.2 Combined and Sanitary Sewer Overflows

6.2.1 Combined Sewer Overflows (CSOs) Defined

In the past, sewer lines were constructed to collect both sanitary and industrial wastewater as well as rain water runoff. During dry weather, the combined sewers carry this water to wastewater treatment facilities. However, when it rains, the volume of water may exceed the capacity of the combined sewers and/or of the treatment plant. The sewer system is designed to have relief points due to lack of

capacity. These relief points allow combined wastewater to overflow untreated into the nearest stream or river which creates a combined sewer overflow, or CSO.

6.2.2 Sanitary Sewer Overflows (SSOs) Defined

SSOs originate from sewer lines that collect sanitary and industrial wastewater but unlike CSOs, stormwater is not intentionally directed into the pipes. The storm water causes the capacity of the sewer line to be exceeded and the sewage will "spill" over into a nearby storm line, street, basement or stream, creating a sanitary sewer overflow, or SSO.

6.2.3 Potential Problems with Sewer Systems

Because these systems can discharge untreated sanitary and industrial wastewater along with stormwater runoff, many different types of pollutants may be present. These pollutants can present a danger to the aquatic life that inhabits the receiving waters and to the health of people who use the waters for recreation. They can also deposit debris, litter or sediment that can result in unacceptable conditions due to visual aesthetics or odor problems.

Detections of elevated levels of *E. Coli* and Fecal Coliform bacteria in the mainstem of the lower Olentangy River within the city of Delaware and in the lower 5 miles of the river within the City of Columbus, as well as elevated bacteria in all of the tributaries sampled by Ohio EPA in 1999, indicate the impacts of the CSO and SSO s on water quality throughout the watershed (Ohio EPA, 2001). Important to note are the potentially failing home sewage disposal systems located within the watershed which are addressed in the next section.

Below are a series of tables highlighting the location of these sewer systems within the Lower Olentangy River Watershed.

Tables 24, 25, and 26 pertain only to the City of Columbus portion of the Lower Olentangy Watershed. The suburban areas of Franklin County do have sanitary sewer overflows (SSOs) and the Ohio EPA is looking at a way to deal with that.

Table 24. List of Regulators within Columbus Combined Sewer Collection System.

City of Columbus Reference Number	Location[(a)]	Jackson Pike Permit 4PF00000/Regulator#	Receiving Stream	Number of Overflows in 2000/2001	Volume in millions of gallons
98	First & Perry	(4PF00000)032	Olentangy River	8/6	1.72/ .96
102	Third & Perry	(4PF00000)027	Olentangy River	11/8	6.15/6.31
162	King Avenue	(4PF00000)007	Olentangy River	7/3	3.56/1.48
231	Regulator @OSU/Indianola Ave.	(4PF00000)006	Olentangy River	13/6	4.95/8.70
233	Tuttle Park @ Frambes	(4PF00000)031	Olentangy River	17/4	28.2/6.64
237	Frambes e/o Tuttle Park	(4PF00000)005	Olentangy River		
259	Hudson Street	(4PF00000)004	Olentangy River	10/5	3.45/.68

(a) These discharge points are near combined sewer regulators.

Data obtained from City of Columbus Regulator Overflow Summary Reports for Year 2000 and 2001.

Table 25. Combined Sanitary Sewer Overflows (CSOs) Without Regulators Located Within the City of Columbus Sanitary Collection System.

City of Columbus Reference Number	Location	NPDES Permit #	Receiving Stream
156*	Main Interceptor Sewer	4PF00000040	Olentangy River

* This site is to be removed from the permit and be recorded as an SSO.

Table 26. City of Columbus Sanitary Sewer Overflow (SSO) Relief Points Discharging to Storm Sewers, Basements, or Open Waterways, page 1 of 6.

City of Columbus Reference Number[a]	Relief Location	Type[c]	Discharge Location[d]	Estimated Date of Overflow[e]
103	MH[b] s/s of Third Ave., 290 ft. w/o Olentangy River Rd.	A	Olentangy River @ 36″ storm sewer s/o Third Ave.	
105	MH Third Ave. & Oxley (west)	A	Olentangy River @72″ storm sewer s/o Fifth Ave.	At least once between: 9/10-9/17/02; 9/17-9/23/02; 9/25-10/01/02; 11/5-11/15/02
107	MH f/o 814 W. Third Ave.	A	Olentangy River @ 36″ storm sewer s/o Third Ave.	At least once between: 7/30-8/6/02; 9/10-9/17/02; 9/17-9/23/02; 10/01-10/08/02
109	MH s/s of Third Ave., 490 ft. w/o Olentangy River Rd.	A	Olentangy River @ 36″ storm sewer s/o Third Ave.	At least once between: 10/1-10/08/02; 12/17-12/27/02
110	MH Third Ave. & Oxley (east)	A	Olentangy River @ 72″ storm sewer s/o Fifth Ave.	At least once between: 9/10-9/17/02; 9/17-9/23/02; 9/25-10/01/02; 11/5-11/15/02
111	MH s/s of Third Ave., 690 ft. w/o Olentangy River Rd.	A	Olentangy River @ 36″ storm sewer s/o Third Ave.	At least once between: 7/30-8/06/02; 9/10-9/17/02; 9/17-9/23/02; 9/25-10/01/02; 10/01-10/08/02; 11/4-11/11/02; 12/17-12-27/02
146	MH Third Ave. & Morning	A	Olentangy River @ 72″ storm sewer s/o Fifth Ave.	

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Table 26, City of Columbus Sanitary Sewer Overflow (SSO) Relief Points, page 2 of 6.

City of Columbus Reference Number[a]	Relief Location	Type[c]	Discharge Location[d]	Estimated Date of Overflow[e]
147	MH alley n/o King & w/o Starr Ave.	A	Olentangy River @ 60" storm sewer s/o King Ave.	
148	MH King Ave & alley w/o Virginia Ave.	A	Olentangy River @ 60" storm sewer s/o King Ave.	
149	MH Fifth Ave. & North Star	A	72" storm sewer s/o Fifth Ave.	
150	MH King Ave & North Star	A	Olentangy River s/o King Ave.	
151	MH Meadow Rd & Third Ave.	A	Olentangy River s/o Fifth Ave.	
154	MH Third Ave. & Virginia Ave.	A	Olentangy River s/o Fifth Ave.	At least once between: 11/5-11/15/02;
156[f]	MH in alley n/o Hill Ave, w/o Perry St.	A	Olentangy River alley n/o Hill	
157	MH Fifth Ave. & Eastview/Kenny	A	Olentangy River s/o Fifth Ave.	
263	MH Velma & the alley s/o Hudson	B	Olentangy River n/o Woody Hayes Dr.	At least once between: 9/9-9/17/02; 12/9-12/17/02
264	Howey & Maynard	A	Olentangy River n/o Woody Hayes Dr.	At least once between: 9/9-9/17/02
266	MH Howey & Briarwood	A	Glen Echo Ravine e/o I-71	At least once between: 11/4-11/13/02
267	MH Akola & alley w/o Atwood Terrace	A	Glen Echo Ravine e/o I-71	At least once between: 11/4-11/13/02
271	MH Azelda and alley n/o Hudson	B	Olentangy River n/o Woody Hayes Dr.	At least once between: 12/9-12/17/02

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Table 26, City of Columbus Sanitary Sewer Overflow (SSO) Relief Points, page 3 of 6.

City of Columbus Reference Number[a]	Relief Location	Type[c]	Discharge Location[d]	Estimated Date of Overflow[e]
274	MH Republic & Ontario	A	Glen Echo Ravine e/o I-71	At least once between: 11/4-11/13/02
275	MH Hamilton & alley n/o Duxberry	B	Olentangy River n/o Woody Hayes Dr.	At least once between: 9/9-9/17/02; 11/04-11/13/02; 12/9-12/15/02; 12/23-12/30/02
276	MH Criarwood & alley w/o McGuffy	A	Glen Echo Ravine e/o I-71	
279				
284	MH n/o Pacemont at Olentangy River	A	Olentangy River n/o Pacemont	
285	MH Midgard & alley e/o Indianola	A	Walhalla Ravine	At least once between: 7/22-8/1/02
288	MH e/o Olentangy St. & Indianola	A	Glen Echo Ravine & Indianola	At least once between: 7/22-8/1/02; 9/9-9/16/02; 11/4-11/13/02
291	MH Osceola & alley s/o Weber Rd.	A	Glen Echo Ravine e/o I-71	
301	MH Alamo & alley w/o Osceola	A	Glen Echo Ravine e/o I-71	
303	MH Akola & alley e/o Homecroft	A	Glen Echo Ravine e/o I-71	
304	MH Alamo & alley w/o Pontiac	A	Glen Echo Ravine e/o I-71	
308	MH Minnesota & Hamilton	A	Glen Echo Ravine e/o I-71	At least once between 11/4-11/13/02
310	McGuffey & Aberdeen	A	Olentangy River e/o I-71	At least once between 11/4-11/13/02

Continued on the next page.

Table 26, City of Columbus Sanitary Sewer Overflow (SSO) Relief Points, page 4 of 6.

City of Columbus Reference Number[a]	Relief Location	Type[c]	Discharge Location[d]	Estimated Date of Overflow[e]
323	MH Webster Pk & Olentangy Blvd	A	Ditch s/s Webster Park w/o Olentangy Blvd	
326	MH Olentangy Blvd & Montrose Way	A	Olentangy River w/o relief	
328	Como & High St.	A	Olentangy River at Como	At least once between: 7/22-8/1/02; 9/9-9/16/02' 9/16-9/23/02; 9/23-9/30/02
329	MH e/s Indianola & alley E.N.Broadway Ave.	A	Walhalla Ravine & Walhalla/Diana	At least once between: 9/9-9/16/02
330	MH Pauline & Atwood Terrace	A	Overbrook Ravine e/o Indianola Ave.	At least once between: 9/9-9/17/02
335	Whetstone Park of Roses	B	Adena Brook/Indian Spring Run	
337	MH Richards & Granden	A	Olentangy River n/o W.N.Broadway Ave	At least once between: 7/22-8/01/02; 9/9-9/16/02; 9/16-9/23/02; 9/23-9/30/02;
338	MH Northridge & Atwood Terrace	A	Overbrook Ravine e/o Indianola	At least once between: 9/9-9/17/02; 11/4-11/13/02
346	MH w/o Rustic Pl & Olentangy Blvd	A	Olentangy River w/o relief	At least once between: 7/22-8/01/02; 9/9-9/16/02; 9/16-9/23/02; 9/23-9/30/02; 11/04-11/13/02; 12/16-12/23/02
349	MH Alley s/o Schreyer Place	B	Adena Brook/Indian Spring Run, w/o High, s/o Croswell	At least once between 9/9-9/16/02; 9/16-9/23/02; 11/04-11/13/02

Table 26, City of Columbus Sanitary Sewer Overflow (SSO) Relief Points, page 5 of 6.

City of Columbus Reference Number[a]	Relief Location	Type[c]	Discharge Location[d]	Estimated Date of Overflow[e]
350	MH Wetmore and alley e/o High St.	B	Ditch e/o Rustic Bridge and s/o Beechwold Blvd.	At least once between 7/22-8/01/02; 11/04-11/13/02.
351	MH w/o Olentangy Blvd & n/o Royal Forest	A	Olentangy River w/o relief	At least once between 7/22-8/01/02
352	MH n/s Weisheimer and Starrett	A	Olentangy River w/o relief	
360	MH s/o Rathbone & e/o Dalawanda	A	Ditch s/o Rathbone & Delawanda	
368	MH alley e/o High St. & s/o Lincoln	A	Rush Run r/o 126 Sharon Springs	
380	MH Lexington & alley n/o Hudson	B	Olentangy River n/o Woody Hayes Dr.	At least once between 9/9-9/17/02; 11/04-11/13/02
381	MH Maynard & Velma	A	Olentangy River n/o Woody Hayes Dr.	At least once between 9/9-9/17/02; 09/30-10/07/02; 11/04-11/13/02
576	MH f/o 320 Kanawha	D	Olentangy River at Kanawha	At least once between 7/22-08/01/02; 08/05-08/12/02; 08/12-08/19/02; 09/09-09/16/02; 09/16-09/23/02; 09/23-09/30/02; 09/30-10/07/02; 11/04-11/13/02; 12/16-12/23/02

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Table 26, City of Columbus Sanitary Sewer Overflow (SSO) Relief Points, page 6 of 6.

City of Columbus Reference Number[a]	Relief Location	Type[c]	Discharge Location[d]	Estimated Date of Overflow[e]
873	MH SR315 northbound off ramp to Henderson	A	Olentangy River e/o manhole	
898	MH California & High St.	A	Olentangy River s/o Sunset & Tulane	

(a) Reference number refers to the numbering system used by the city to track the SSOs in the collection system.
(b) MH = manhole.
(c) Type: A=Discharge occurs when a manhole fills to a certain elevation. B=Discharge occurs when sewage flows over a weir. C=Discharge occurs when a pump station wet well fills to a certain elevation. D=Discharge occurs when the sewer line fills to a certain level.
(d) n/o, north of; s/o, south of; e/o, east of; w/o, west of; n/s, north side; r/o, rear of; f/o, front of.
(e) Data obtained by the City of Columbus as per the Ohio EPA consent order that states "Columbus shall report all SSOs from its sewers and from its maintenance contract areas monthly". The sites in Grandview, Upper Arlington, Riverlea and Worthington are not required to be reported on. The volume is unknown and all incidents were caused by wet weather.
(f) SSO and CSO.

Reference for Table 26: City of Columbus Division of Sewerage & Drainage; Ohio EPA Biological and Water Quality Study of the Middle Scioto River and Alum Creek 1999: Franklin, Delaware, Morrow, and Pickaway Counties, Ohio. Division of Surface Water, Ecological Assessment Unit, Columbus.

6.3 Current Efforts and Recommendations to Stop SSOs and Reduce CSOs in the City of Columbus

As part of Columbus' wastewater treatment plant permit renewal process with the OEPA, the CSO Long Term Control Plan for Columbus will be updated. It should coincide with the System Evaluation & Capacity Assurance Plan project (SECAP) laid out in the consent decree; target completion date of July, 2005. Included in the work to be done the next few years is a CSO Alternative Analysis to explore ways to reduce CSOs, biological studies of the rivers, and more water quality modeling will be done to ascertain the impact they have on water quality. Reducing Infiltration & Inflow (I/I) is something that will move along separately as part of the Capacity, Management, Operations and Maintenance (CMOM) efforts and is more related to SSOs but the combined system can have some benefits from it because it's all part of the same system. For example, reducing I/I in Clintonville can help reduce the amount of flow coming into the Olentangy-Scioto Interceptor Sewer (OSIS); however, rain can still enter the combined system but at least during a major storm event when it causes an overflow, the sewage is diluted.

Table 27 contains recommendations from the Human Health and Sanitation Working Group for CSOs and SSOs.

6.4 Home Sewage Treatment and Disposal Systems

The Ohio EPA has documented excessive bacteria counts above Primary Contact Recreation standard for portions of the Lower Olentangy River main stem while many or most of the tributaries have violated the Secondary Contact Recreation standards for *E.coli* bacteria. One of the sources causing these excessive bacteria counts is from household sewage treatment and disposal systems (HSTDS). The contents and bacteria from HSTDS can make their way to our surface waters in the following ways: 1) the direct discharge of untreated wastewater (due to inadequate technology or faulty systems) into our drainage ways, ditches, tributaries, and streams; 2) the illicit interconnection of HSTDS with storm sewers or farm drains; and 3) urban or rural runoff (due to faulty leaching fields, saturated soils, or plugged up leach beds) containing untreated HSTDS wastewater; and 4) leaking septic tanks or leach fields discharging into highly permeable bedrock near streams.

Table 27. Human Health and Safety CSO and SSO Recommendations, page 1 of 3.

The goal of the following objectives is to restore the chemical water quality of the Olentangy River and tributary streams from sewage overflows (see also Stormwater section Sewage Overflow Recommendations); none of the tributary streams sampled by the Ohio EPA in 1999 were meeting their WWH use designation (Ohio EPA, 2001). The most frequent exceedences of Ohio Water Quality Standards in these streams were for fecal coliform and *E. coli* bacteria; symptomatic of sewage releases, commonly from CSOs and SSOs and failing household sewage disposal systems and package plants (see Human Health & Safety section for HSTS recommendations). Note: Poor water quality in these streams may also have been exacerbated by drought conditions that existed during the 1999 Ohio EPA field season. These drought conditions led to reduced or non-existent stream flow in these often-ephemeral waterways, possibly concentrating bacteria and nutrients in isolated stretches of the stream that still retained pooled water. Highly elevated levels of E. coli bacteria exceeding both Primary and Secondary Contact Recreation criterion (>575/100 mL) were found in all of the sampled tributaries. The goal is to increase DO levels, reduce bacteria counts and reduce nutrient loadings as well as reduce peak runoff rates. Use the Shaker Hts, Ohio study as an example.

Objectives	Responsible Parties/ Partners	Costs	Funding	Indicators of Success	Schedule	Targeted River Segment
Educate the public on why sanitary overflows must stop. Give presentations to community groups. Design and distribute an educational brochure. Educate the public on why reducing CSO's is important. Stress that their rainwater is getting into the combined sewer system that can also cause backed up basements and discharges of sewage into the Olentangy River & Tributaries (Part of the Backyard Conservation & Stormwater Reduction Program).	FLOW with support of local governments.	$10,000	EPA 319	# of public meeting presentations and # of brochures distributed.	2004-2005	Rustic Pl and Olentangy Blvd. and Third Ave. Sewer Service Community.

Continued on the next page.

Table 27. Human Health and Safety CSO and SSO Recommendations, page 2 of 3.

Objectives	Responsible Parties/ Partners	Costs	Funding	Indicators of Success	Schedule	Targeted River Segment
Find out which homes have sump pumps, foundation drains or downspouts illegally connected into the sanitary system.	Local governments Columbus DOSD	unknown	Local governments	# of homes disconnected from sanitary system	2003-2004	Clintonville I&I pilot in Adena Brook sub-watershed
Develop a financial assistance program to separate the above inflow points and divert the stormwater to lawns- rain gardens, vegetated swales or other BMP. Do follow up inspections.	Local governments	$200-$500 / home	Ohio EPA 319/ DEFA	# of home involved in the program.	2004	Clintonville I&I pilot in Adena Brook sub-watershed
Monitor flow volume, rate of occurrence at each SSO and CSO to be stopped. Only the CSO's are to be monitored for frequency and volume, plus sample for TSS (total suspended solids).	Local governments	unknown	Local governments	For all objectives above, the indicator of success is the decrease in volume and rate of occurrence over time.	ongoing	For every CSO/SSO location

Continued on the next page.

Table 27. Human Health and Safety CSO and SSO Recommendations, page 3 of 3.

Objectives	Responsible Parties/ Partners	Costs	Funding	Indicators of Success	Schedule	Targeted River Segment
Develop a reporting system to alert residents of impacts, location and frequency of sanitary sewer overflows. (1. signage at overflow points; 2. post frequency, bacteria counts and volume data to website; 3. notification covered in local papers)	Local governments City of Columbus	unknown	Local governments City of Columbus	Signs posted at overflow points; Data posted daily to a publicly assessable website; Notification in local papers.	Completed in 2003. Reporting should continue on an ongoing basis.	For every CSO/SSO location

*Concentrate efforts above on areas where most frequent overflow occurrences were observed (Kanawha SSO, Rustic Place & Olentangy Blvd SSO, Third & Morning St. SSO, Third Ave. 690′ SSO, Frambes Rd CSO).
The Kanawha SSO may be eliminated in 2007-2008 by the Franklin County Sanitary Engineer's Office and the City of Columbus.

6.4.1 Home Sewage Treatment and Disposal Systems Defined

Home Sewage Treatment and Disposal Systems are designed to treat and dispose of all of the wastewater from individual homes. They can be divided into three main types.

6.4.1.1 On-lot septic and leach systems. On-lot septic and leach systems, also know as traditional deep trench soil absorption systems, are built to discharge the effluent to the surrounding soil, where it is naturally filtered by biological processes. Septic and leach fields use on-lot soil absorption as treatment and final disposal, therefore reducing the chance of any potential health risk migrating off site. Since on-lot systems are set up to be self-contained, there should be no discharge of effluent off the lot. The effluent from an on-lot system should not reach ground water or surface water if it is properly sited and meets current sewage disposal regulations as mandated by the local health department.

6.4.1.2 Off-lot aeration treatment units. Off-lot aeration treatment units (ATUs) are built to treat household waste and discharge the treated effluent off-site to a receiving stream or other discharge point(s) such as storm sewers, ditches or tributaries. By design, aerator units pose a greater risk to public health and watershed health because they discharge treated effluent off site. Because ATU systems that employ older technology lack chlorination devices or include chlorination devices that are not properly maintained, they can transfer contaminated effluent off-site. Table 28 shows the number of ATUs in the watershed.

6.4.1.3 Soil absorption and discharging systems. Soil absorption and discharging systems that meet the most current treatment and disposal technology are probably the most effective of the HSTDS options. Some of these systems can significantly reduce bacterial and viral loads (compared to traditional systems). Newer ATUs can reduce bacteria and other pollutants because they include chlorination devices, built-in non by-pass filtration units, attached growth processes, and improved engineering and design. Some designs reduce bacteria without chlorination. Newer discharging attached-growth media filter systems using peat, sand, and synthetic fibers can significantly reduce pollution loading and some designs reduce bacteria and viruses without chlorination. Newer soil absorption systems based upon drip irrigation technology or above ground mounding of the filter material reduce pollutant loading to acceptable levels prior to even reaching the original ground surface.

Table 28. Aeration Treatment Units (Off-Lot) in the Lower Olentangy Watershed.

Jurisdiction	# of Semi-public ATUs (off-lot)	# of Private ATUs	Total number of ATUs
Franklin County (includes Columbus)	11	230	241
Delaware County	141	Undetermined	Undetermined
All Jurisdictions	152		

Source: Franklin County Health Department and Delaware County Health District

6.4.2 Potential Problems with Home Sewage Treatment Disposal Systems

A number of factors can cause failure of a HSTDS and lead to untreated sewage entering the tributaries and mainstem in the watershed. Failing HSTDS contribute suspended solids, BOD, and a bacteria load that will disturb the natural and desired stream environment and impact public health.

6.4.2.1 On-lot systems. Septic and leach systems rely on an aerobic soil environment to treat and disperse effluent from the septic tank. Even though these on-lot systems may appear to "function", many systems installed prior to the adoption of local sewage disposal regulations are releasing contaminants and causing water quality problems. Septic systems fail due to 1) improper siting in non-absorbent soil, 2) systems being too small for the volume of wastewater being treated, 3) improper construction, 4) aging system, 5) lack of maintenance causing leach field to be plugged with solids, 6) wet weather periods causing high water tables, which reduces the treatment and dispersion capacity of the soil. When septic and leach systems fail, a breakthrough of untreated waste reaches the surface of the ground where it becomes run-off. The best option for a failing on-lot system is to connect the home sewage system to a sanitary sewer where the effluent will be transported to a sewage treatment plant. The next best option is to install a new soil-absorption system that meets current codes. When this is not possible, the final option is to upgrade the HSTDS to an off-lot discharging system (aeration or other technology) meeting or exceeding water quality requirements. In some cases, landowners have illegally connected their septic and leach systems to storm sewers or farm drains as a way to deal with a failing on-lot system. This is

illegal and should never be done as it allows untreated effluent to reach water sources.

6.4.2.2 Off-lot systems. ATUs require constant maintenance to operate correctly. They rely on motors to force air into the ATU which enables bacteria in the unit to decompose sewage aerobically. The "digested" or treated waste is then further clarified or sometimes chlorinated before being discharged into a stream, ditch or other outlet point. There are still many ATUs in Franklin and Delaware County that are over 30 years old, as most of the ATUs were installed in the 1970's. Some ATUs, especially the older ones, do not remove bacteria from the discharged effluent due to the way the systems were designed. Newer ATUs, especially ones with built in chlorinators and attached-growth filters, are designed to remove more bacteria as long as they are maintained properly.

6.4.3 Current Conditions for Home Sewage Treatment Disposal Systems

Table 29 summarizes the information in Sections 6.4.3.1 to 6.4.3.4.

6.4.3.1 Franklin County. In the year 2000, there were approximately 4,000 aeration systems operation permits, and 450 semi-public operation permits in Franklin County outside of Columbus. There are an estimated 14,000 soil based disposal systems. The Franklin County Map of Septic and Sewer Sites within the Olentangy River Watershed can be found in Appendix J.

6.4.3.2 Delaware County. There are approximately 17,000 household sewage disposal systems installed within Delaware County. Of those there are approximately 5,000 aeration systems and 10% of those are inspected annually. The ration of discharging systems to total HSTS in Delaware County is 0.29. The ratio of soil-based systems to the total HSTS is 0.70. In 2002, there were 323 semi-public operation permits issued in Delaware County. Annually 50% of these systems are inspected, and in 2002, 181 semi-public sewage systems were inspected. The Delaware General Health District (DGHD) does not issue operation permits to household sewage systems at this time. In 2002, a summer intern inspected approximately 23 household sewage system impacting the Olentangy Watershed, starting at Delaware Reservoir and heading south to the corner of SR23 and Hudson Road. The Delaware County Map of HSTS located within the Olentangy River Watershed can be found in Appendix K.1. Appendix K.2 contains an action table for addressing HSTS, which was compiled by the DGHD as part of the Delaware County HSTS 2004 plan.

6.4.3.3 City of Columbus. There are 911 on-lot HSTS, and 149 off-lot aeration systems installed in City of Columbus. There are a total of 110 semi-public on-

lot sewage systems and 43 semi-public aeration sewage systems installed in the City of Columbus.

6.4.3.4 City of Worthington. In the city of Worthington, there are 82 HSTS. All of these systems are inspected annually. The ratio of discharging to total HSTS in the City of Columbus is 0.14. The ratio of soil-based systems to the total HSTS is 0.86.

6.4.4 Pockets of Concentrated HSTS in Franklin and Delaware Counties

While most of the Olentangy River watershed in Franklin County lies within urbanized sewered areas, there are 9 pockets of developed land that remain unsewered, as shown in Table 30. One of these pockets has been designated a Water Quality Partnership area (along with 12 other locations in Franklin county but outside the Olentangy watershed) by the governmental agencies who want to convert these areas to permanent sanitary sewers without annexation. These areas rely heavily on HSTDS, such as septic/leach fields and Aeration Treatment Units (ATUs).

In Delaware County, a package plant serving a manufactured home park on SR 23 South is not functioning properly. Subdivisions with failing HSTS include the Wren/Carriage Lane Subdivision and the North/South Parkway subdivision along SR 23. Appendix K.3 contains a list of priority areas that DGHS has identified throughout all of Delaware County.

6.4.5 Current Federal, State and Local Efforts to Relieve or Eliminate HSTDS Contamination

6.4.5.1 Federal efforts. The USEPA requires that all storm water collection systems in jurisdictions of a certain population size obtain a National Pollution Discharge Elimination System (NPDES) Permit for storm water discharged into surface waters of the state. All of the jurisdictions in the Lower Olentangy watershed are required to have these permits and to implement their requirements. The intent of this national program is to eliminate pollution from storm sewers that could impact watershed health. These permits were issued for five years and permit requirements have to be met by 2007 unless otherwise given exemptions by the OEPA. One of the main requirements of the permit is to identify and eliminate illicit discharges like HSTDS connections to storm sewers or farm tile. When ATUs discharge contaminated effluent to storm drains, this is a violation of the NPDES Phase II permits. By reducing contaminated effluent discharges from ATUs and other non-point source

pollution to storm water, local jurisdictions make progress toward compliance of their NPDES Phase II permits and the community meets objectives set forth in this Watershed Action Plan.

6.4.5.2 State efforts. Under the current Ohio Administrative Code (OAC), when public sewage treatment systems are not available, soil absorption on-lot systems are mandated as long as the lot meets site criteria (lot size, soil type, slope, bedrock, water table). If the site does not meet the state's siting criteria, then discharging systems such as ATUs are permitted.

Under the OAC passed in 1977, ATUs are regulated for Biological Oxygen Demand (BOD) to 20 mg/L and Suspended Solids (SS) to 40 mg/L. While they are not regulated for bacteria, public health officials are pushing for bacteria standards and hope to achieve that by 2006 or 2007.

Newer aeration systems can reduce bacteria if they include a chlorination device that is properly maintained or if they utilize some new alternative technology. Because the OAC does not cover the newest treatment technology (and possibly the most effective-to-date), residents must go to their local or state Board of Health for a variance allowing them to install the new sewage treatment technology. In other words, current regulations discourage the use of more efficient HSTDS. The OAC needs to be updated to include standards for bacteria discharge, update the BOD and SS standards, define limits as to where an ATU can be discharged and facilitate the use of more effective HSTDS technology.

6.4.5.3 Local efforts. Currently Local Health Departments may, under the current Ohio Revised Code inspect (for operational status) all known semi-public soil absorption and off-lot discharging systems (serving greater than a three-family dwelling and under 25,000 gpd) on a frequency determined by the OEPA depending on the size and type of system. The Franklin County Health Department (under contract with the Ohio EPA) has been able to inspect all semi-public on an annual basis. Franklin County is also currently inspecting all off-lot discharging private systems (1-3 family dwelling) on an annual basis.

Semi-public and private failing ATU systems are brought into mechanical compliance, although this doesn't always ensure that ATUs are meeting current wastewater quality standards. Mechanical repairs such as fixing the motor improve aeration to decompose the sewage – but inadequate chlorination and older designs can still allow bacteria, BOD, and SS to escape into the environment. In Franklin County, the mechanical failure rate for ATUs has consistently been between 15-25% of the approximately 4,000 inspected every year (ranging in age from 1-30 years old), which is similar to statewide failure rates. Even though the failure rate may depend on the system model or age, that has not been specifically determined as of this time.

Table 29. Home Sewage Treatment and Disposal Systems in the Lower Olentangy Watershed, Franklin County and Delaware County.

	Lower Olentangy Watershed		Franklin County Total	Franklin County			Delaware County Total
	Franklin County	*Delaware County*		*Outside Columbus*	*Inside Columbus*	*Worthington*	
Total HSTS	Unknown	1,587	19,060 +	18,000+/-	1,060	82	17,000
Discharging %			17%		14%		29%
Aeration systems ATU's w/operating permits	241		4,149	4,000	149		5,000
Aeration systems not yet identified	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Semi-public Aeration systems ATU's (<25,000gal/day) w/operating permits	11	141	603	450	153		323
Private ATU's (1,2,3 family)	230	Unknown					
On-lot Soil-based (septic) Disposal systems			14,911	14,000	911		±11,900
Ratio of soil-based systems to HSTS			80%		86%		70%

Source: Franklin County Health Department and Delaware County General Health District

Table 30. Franklin County Pockets of Township Land that Remain Unsewered.

Number*	Name	Jurisdiction	Planning Status	Conversion to Permanent Sanitary Sewers
1	Mt. Air	Perry/Sharon Townships	Identified	No plans exist for this area
2	Flint	Sharon Township	Identified	No plans exist for this area
3	Olentangy River Road N. of SR 270	Sharon Township	Identified	No plans exist for this area
4	Linworth	Perry Township	Identified	No plans exist for this area
5	McVey Blvd. area, Greenvale, Brookdown	Perry Township	Identified	No plans exist for this area
6	Kanawha, Rosslyn, Westview, Fenway area	Sharon Township	Planned	On Franklin County's list of 13 Water Quality Partnership (WQP) areas to be sewered under old contract with Columbus.
7	Sharon Hill area	Sharon Township	Identified	No plans exist for this area
8	Cook Road area	Clinton Township	Identified	No plans exist for the area
9	Chambers Road area	Clinton Township	Identified	No plans exist for the area

*Not listed by priority

6.4.6 Recommendations for Home Sewage Treatment and Disposal Systems

To prevent further pollution of the watershed by HSTDS, a long-term planning and implementation effort is needed to either:

1) make centralized sewer services available (as much as possible) in lieu of on-lot or off-lot HSTD systems;
2) connect failed HSTDS to sanitary sewers;

3) if connection to sanitary sewers is not possible in the near future, upgrade old ATU's to new ATU or HSTS technology with the permission of the ODH and the OEPA; or
4) repair the on-lot HSTDS with the newest technology to keep the effluent on-lot in a soil absorption (septic) system.

State and local rules need to be revised to be more comprehensive, incorporating new treatment & disposal technologies, and more stringent discharge requirements. Otherwise, local health departments, residents and developers lack the authority to approve newer, more effective technology for local residents and developers.

All existing and new HSTDS will need to be inspected and maintained on a regular basis. To support such action steps, local and state rules will need to be amended.

Tables 31 and 32 summarize the Human Health and Sanitation Working Group's recommendations for HSTDS in the Lower Olentangy Watershed.

6.5 Contaminated Sediments

Overall, there are not any areas of grave concern. The recommendation from the Ohio EPA Central District Office Surface Water staff, is to leave the sediments undisturbed or stabilize with vegetation in areas of highly or extremely elevated levels of contamination, which are identified below. Data is from the Watershed Inventory located in Appendix D and is summarized in Table 33.

6.6 Landfills

There are three known landfill sites within the Lower Olentangy Watershed that are situated in close proximity to the main stem of the river. These include: the Cherry Street sanitary landfill in the City of Delaware, a landfill used for low-level radioactive waste on the grounds of the Fawcett Center on The Ohio State University Campus in Columbus, and an old refuse landfill adjacent to the Olentangy River Road Extension south of Third Avenue and North of Goodale Boulevard in Columbus. Each of these landfills is closed and no longer receives waste materials.

Table 31. Recommendations for Home Sewage Treatment Systems and Point Source Discharges (package plants).

The goal of the following objectives is to restore the chemical water quality of the Olentangy River and tributary streams from Home Sewage Treatment Systems (HSTS); none of the tributary streams sampled by the Ohio EPA in 1999 were meeting their WWH use designation (Ohio EPA, 2001). The most frequent exceedences of Ohio Water Quality Standards in these streams were for fecal coliform and E. coli bacteria; symptomatic of sewage releases, commonly from CSOs and SSOs and failing household sewage disposal systems and package plants (see Human Health & Safety & Stormwater sections for CSO / SSO recommendations). Note: Poor water quality in these streams may also have been exacerbated by drought conditions that existed during the 1999 Ohio EPA field season. These drought conditions led to reduced or non-existent stream flow in these often-ephemeral waterways, possibly concentrating bacteria and nutrients in isolated stretches of the stream that still retained pooled water. Highly elevated levels of E. coli bacteria exceeding both Primary and Secondary Contact Recreation criterion (>575/100 mL) were found in all of the sampled tributaries. The goal is to increase DO levels, reduce bacteria counts and reduce nutrient loadings.

Objectives	Responsible Parties/Partners	Costs	Funding	Indicators of Success	Schedule	River Segment
Identification of all home aeration and septic systems / unsewered communities within the Olentangy Watershed. Assess known inventories of approved systems (GIS mapping, inspection reports)	Delaware Co. General Health District (DGHD) Franklin Co. Board of Health (FCBH) Columbus Health Dept.	None	None	Geographical inventory of all known home aeration systems within the watershed	Completed. GIS maps will be provided by December 2005 along with all known on-lot HSTS systems (septic tanks).	All

Table 31, Recommendations for Home Sewage Treatment Systems and Point Source Discharges, page 2 of 2.

Objectives	Responsible Parties/Partners	Costs	Funding	Indicators of Success	Schedule	River Segment
Elimination of 10% of all home aeration system discharges within the Olentangy Watershed	• DGHD • FCBH • Columbus Health Dept. • Delaware Co. Engineer • Franklin Co. Engineer • City of Columbus • Ohio EPA	Unknown	319 Grant Program Linked Deposit Program with Ohio EPA Local Source	• Identify alternative non-discharging system or availability of centralized sewer systems • Improved permitting of systems to improve operation and maintenance • Improve frequency of inspections	2007	All impacted by HSTDS
Evaluate the feasibility of providing centralized sewer service to these areas; Identify if human health or water quality impacts warrant abandonment of existing systems and connection to a centralized system. Perform water quality sampling to document unsanitary conditions if necessary.	• Ohio EPA • DGHD • FCBH • Columbus Health Dept. • Delaware Co. Engineer • Franklin Co. Engineer • City of Columbus	To be determined by 2007	• Ohio Public Works Comm: SCIP – State Capital Imprvmnt Program - Issue 2 • Franklin Co. Community & Economic Dev. Dept. • OhioEPA - Div. Environmental and Financial Assistance	Elimination of on-site systems in high density areas through the connection to centralized sewer systems	To be determined by 2007	• Mount Air – ambient sampling in 2003 • Kanawha and Rosslyn Rds. - sewer service will be provided when engineering and funding issues are resolved.

Table 32. Recommendations for Home Sewage Treatment Systems, page 1 of 3.

The goal of the following objectives is to restore the chemical water quality of the Olentangy River and tributary streams from Home Sewage Treatment Systems (HSTS); none of the tributary streams sampled by the Ohio EPA in 1999 were meeting their WWH use designation (Ohio EPA, 2001). The most frequent exceedences of Ohio Water Quality Standards in these streams were for fecal coliform and E. coli bacteria; symptomatic of sewage releases, commonly from CSOs and SSOs and failing household sewage disposal systems and package plants (see Human Health & Safety & Stormwater sections for CSO & SSO recommendations). Note: Poor water quality in these streams may also have been exacerbated by drought conditions that existed during the 1999 Ohio EPA field season. These drought conditions led to reduced or non-existent stream flow in these often-ephemeral waterways, possibly concentrating bacteria and nutrients in isolated stretches of the stream that still retained pooled water. Highly elevated levels of E. coli bacteria exceeding both Primary and Secondary Contact Recreation criterion (>575/100 mL) were found in all of the sampled tributaries. The goal is to increase DO levels, reduce bacteria counts and reduce nutrient loadings.

Objectives	Responsible Parties/Partners	Costs	Funding	Indicators of Success	Schedule	River Segment
Sampling of discharging systems for fecal coliform, TSS and BOD, to assess the impact of the HSTS on watershed health. Compare sampling data to OEPA stream water quality data. Use sampling data to prioritize HSTDS for repair, replacement or upgrade.	Franklin Co. Board of Health (FCBH) Columbus Health Dept Delaware County General Health District (DGHD)	Unknown	EPA 319	Sampling results	2005 - 2007	All affected segments

Continued on the next page.

Table 32. Recommendations for Home Sewage Treatment Systems, page 2 of 3.

Objectives	Responsible Parties/Partners	Costs	Funding	Indicators of Success	Schedule	River Segment
• Identification of all permitted (NPDES) and unpermitted public semi-public point source discharges within the Olentangy Watershed; • Review inventory of point source discharges in Ohio EPA database and FLOW Inventory document, 2003	DGHD Ohio EPA	None	None	Inventory of all permitted and un-permitted facilities has been updated and completed. See Table 26 in the Inventory (FLOW, 2003)	Completed.	All affected segments
• Evaluate the feasibility of eliminating semipublic point discharges through connection to a centralized treatment system provided by Delaware Co., City of Delaware or City of Columbus; • Estimate proximity of nearest centralized sewer system • Evaluate feasibility of connection under present condition • Identify potential impediments to connection (e.g. annexation, easements, access) • Estimate time frame associated with future availability of centralized sewers	Ohio EPA Delaware Co. Engineer Franklin Co. Engineer City of Columbus City of Delaware	Cost of connection to centralized system	Point source discharger through the payment of tap fees and the construction of laterals	Elimination of point source discharges from public, semi-public and commercial facilities.	2005-2008	All affected segments

Continued on the next page.

Table 32. Recommendations for Home Sewage Treatment Systems, page 3 of 3.

Objectives	Responsible Parties/Partners	Costs	Funding	Indicators of Success	Schedule	River Segment
Provide HSTDS owner education on how these systems affect watershed health	FCBH DGHD	Unknown	319, OEPA OEEF grant funds	Documentation of materials and presentations	2005-2007	All affected segments
Strengthen HSTDS operation maintenance inspection policies and regulations. Promote policies supporting the use of advanced HSTDS.	FCBH DGHD	Unknown	Local health department (LHD) funds	Documentation of policies and regulations	2005 - 2007	All affected segments

Table 33. Contaminated Sediments.

Location of highly or extremely elevated levels of contaminated sediments	**Description**	**Possible Sources**	**Recommendation**
RM 22.30 (U.S. 23)	Metals- Aluminum, Barium, Chromium	Foundry sand disposal site at the General Castings Corp. and the Cherry Street Landfill.	Further consultation with experts is needed to determine strategy.
R.M. 1.80 (downstream of 5th Ave Dam)	Metals- Aluminum, Zinc Polycyclic aromatic hydrocarbons- Chrysene, Fluoranthene, Phenanthrene, Pyrene (all above the Severe Effect Level = a level at which pronounced disturbance of the sediment-dwelling community can be expected).	Stormwater runoff, CSO's and air deposition. PAHs are found in petroleum tars used for roads and roofing.	Further consultation with experts is needed to determine strategy.
RM 0.60 (near mouth)	Metals-Aluminum, Barium, Cadmium, Chromium, Copper & Zinc.	Gowdy Landfill, stormwater runoff, CSOs and air deposition.	Further consultation with experts is needed to determine strategy.
Horseshoe Run	Metals- Aluminum	unknown	Further consultation with experts is needed to determine strategy.
Delaware Run	Metals- Aluminum Pesticides & PCBs- Chlordane	Chlordane was used to kill termites.	Further consultation with experts is needed to determine strategy.
Rush Run	Metals- Aluminum, Arsenic, Barium, Cadmium, Copper.	Arsenic is used in pesticides, cadmium is used in plating, copper is used in lakes to control algae.	Further consultation with experts is needed to determine strategy.
Adena Brook	Metals- Zinc, Cadmium, Copper	Algaecide	Further consultation with experts is needed to determine strategy.
Turkey Run	Metals- Copper	Algaecide	Further consultation with experts is needed to determine strategy.

6.6.1 Cherry Street Landfill

The Cherry Street Landfill is a 15-acre site east of Cherry Street and fronting the Olentangy River at the south end of the City of Delaware. The site was operated by the City of Delaware as a solid waste landfill from 1951 to 1975 accepting household, commercial and industrial solid wastes. Landfill operations ceased in 1975 and the site was covered and graded. The current wastewater treatment plant, a recycling center and the city maintenance garage are all situated on top of the former landfill. Explosive levels of methane gas have been detected routinely across the property. Ohio EPA reported leachate seeps discharging low levels of chemical (organics like ethyl benzene, xylene and various polycyclic aromatic hydrocarbons plus the metals arsenic, iron and lead) into the river along the east bank of the landfill site in the early 1990's. The property continues to be monitored by OEPA and the Delaware City-County Combined Health District. Actions have been taken to correct erosion of the cover, correct subsidence problems and provide additional monitoring of methane gas. No landfill liner exists, and no regular ground water or leachate monitoring is done as these landfill closure requirements post-date the closure of the landfill site.

6.6.2 OSU Low-Level Radioactive Waste Site

This refuse dump was operated by The Ohio State University on the west bank of the Olentangy River just north of Lane Avenue and east of Olentangy River Road on ground immediately adjacent to the river. The site received low-level radioactive waste during the 1950's and early 1960's. The Fawcett Center was later built on and extends over much of the actual fill. The OSU Office of Environmental Health and Safety has done extensive sampling and monitoring of the site as recently as 2001. Identifiable levels of metals (copper, chromium, nickel, lead and mercury), volatile organic and semi-volatile organic compounds were found but most were at acceptable or near non-detection levels. Sampling done at the site does not indicate identifiable levels of any of these contaminants moving off of the site through groundwater or leachate.

6.6.3 Gowdy Landfill

The old Gowdy Landfill site is adjacent to the Olentangy River Road south of Third Avenue and north of Goodale Boulevard. This landfill site was operated and closed before any solid waste management regulation. The site received both construction debris and mixed municipal waste. The site has been covered but the surface was left irregular allowing surface water and precipitation to collect on the site. No

regular monitoring occurs, although OEPA has done some assessment of the site. Little information is available to fully characterize the waste at the site or monitoring information to determine if leachate or contaminated groundwater is moving out of the sight. Other known sources of contamination affecting sediments and water quality in this portion of the Olentangy River, close to the confluence with the Scioto River, make it difficult to distinguish any effect the landfill might be having on water quality. In 1998-1999 a large quantity of waste was removed from the site to allow the construction of the Olentangy River Road Extension as a part of the larger Spring/Sandusky Street interchange reconstruction. The Columbus Riverfront Vision recommends the property be redeveloped into an active recreation facility with athletic fields and court games.

6.6.4 Recommendations for Landfills

Recommendation #1: Continue existing inspection, sampling and monitoring to document the type and extent of groundwater and leachate contamination that may be moving out of the landfill site and its effect on water quality.

Recommendation #2: Continue existing site management and assessment to minimize water infiltration into the site (cover and fill maintenance, correction of subsidence, surface grading, erosion prevention, establishment of vegetative cover) and containment of contamination on site.

Recommendation #3: Identify funds or resources to upgrade assessment, monitoring and site management activities where they currently don't exist.

Recommendation #4: Continue research to identify other landfills in the watershed (there may be one located at Battelle Memorial).

6.7 Point Sources

The Lower Olentangy Watershed Action Plan encourages all jurisdictions and facilities with National Pollution Discharge Elimination System (NPDES) Permits with Ohio EPA to comply with the permit in accordance with the Clean Water Act. We encourage open discussions with facilities and periodic review of compliance status by the Ohio EPA.

There are two major (flows >1.0 mgd) wastewater treatment plants in the Lower Olentangy River Watershed: 1) the City of Delaware (this facility has been renamed the Upper Olentangy Water Reclamation Center) plant, and 2) the Delaware County

plant (Olentangy Environmental Control Center). The Recommendation for these WWTP (beyond complying with their permit requirements) is to include year-round treatment for recreational uses. The Ohio Revised Code (3745-1-07 B.4) currently states the "recreational use designations are in effect only during the recreation season, which is the period from May first to October fifteenth." The Olentangy River is used year-round by kayakers, canoeists, fisherman, educational institutions and the OSU rowing club.

Besides these two wastewater treatment plants, there are 27 other permitted wastewater dischargers scattered throughout the Lower Olentangy River Watershed. These include a variety of public and private facilities including Shroyer's Mobile Home Park off US Rt. 23 north of Delaware, the Worthington Arms Mobile Home Park, (this facility abandoned their plant and connected to the City of Delaware system), Marzetti's in Clintonville (note: Marzetti's only has a stormwater permit. It does not have a permit to discharge process wastewater), The Ohio State University, the Battelle Memorial Institute near the 5th Avenue bridge, and the Timken Corporation on the west side of Cleveland Avenue (Ohio EPA, NPDES Permit List, Jan. 2001). Again, the recommendation for these NPDES holders is to comply with the Ohio EPA permit requirements.

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7.0 Education and Outreach Working Group

The Education and Outreach Working Group collected educational pamphlets and materials with regard to each source of impairment for future use. In addition, they made a matrix of environmental education providers and listed them in a matrix with contact information and programs offered and made recommendations on how to educate the public about the Lower Olentangy River Watershed. Appendix L contains the matrix of the environmental education providers.

7.1 The Importance of Education

Central Ohio's most precious natural resources are its rivers, ravines and the greenway corridors along them. In order to protect these community resources, residents of the watershed community must be aware they exist, appreciate the delicacy of the river's ecological system and be informed of ways to become personally involved in protection efforts. One important way to get the community connected to the river and tributary streams is to provide access and recreational opportunities. We strongly believe that when the community experiences the river and understands the resources it provides, they will be more inclined to become involved in its protection and restoration.

7.2 Summary Findings of the National Geographic Society's River Poll

The National Geographic Society conducted a River Poll in June 2001 by Penn, Schoen & Berland Associates of Washington D.C. The statistical significance of the results are ±4.4% at the 95th confidence interval level. The major findings of the study are:

1. Environmental issues are important to Americans and protecting and conserving rivers is a priority. Americans are concerned about the health of our rivers and express an interest in becoming involved in river conservation.
2. Americans have a low "River IQ": They lack the basic knowledge about rivers. They fail to appreciate that they are part of a larger interrelated system in which their actions have negative effects, and they are unaware of the extent to which our rivers are in danger.
3. Americans cite lack of time, information and awareness of the problem as the major reasons they are not more personally involved in protecting and conserving rivers. Americans are willing to get involved to protect fish and

wildlife to ensure that we have clean drinking water. They view their involvement as a way to educate children about the importance of the environment.

Appendix M contains the National Geographic Society River Poll. Table 34 contains the Education and Outreach Working Group's recommendations for the Lower Olentangy Watershed.

Table 34. Education and Involvement Recommendations, page 1 of 6.

The goal of the following objectives is to promote ongoing collaboration about the watershed between educational organizations and communicate ongoing progress, educate the public, and increase public involvement. In general, the public lacks basic knowledge about rivers. They fail to appreciate that they are part of a larger interrelated system in which their actions have negative effects. They are unaware of the extent to which our rivers are endangered. Americans cite lack of time, information and awareness of the problem as the major reasons they are not more personally involved in protecting and conserving rivers. However, Americans are willing to get involved to protect fish and wildlife and to ensure that we have clean drinking water. They view their involvement as a way to educate children about the importance of the environment.

The goal of the WAP is to improve water quality, riparian corridor, habitat, and the recreational value of the Olentangy River and its tributary streams. The Education and Outreach Working Group contacted 28 central Ohio environmental entities and introduced the Lower Olentangy Action Plan. The working group developed an Educational Resource Matrix which contains the contact information, names of projects, target audience, and objectives of each of the environmental entities. Appendix L contains this matrix.

Objectives	Responsible Parties/Partners	Costs	Funding	Indicators of Success	Schedule	River Segment
1) Create and distribute an educational resource matrix of information pertaining to water quality, environmental education, and stewardship of the Olentangy River. (Appendix L contains the matrix.)	Franklin SWCD, Delaware SWCD, local land owners, ODNR, OSU CampUShed, Ohio State Extension, The Columbus Zoo, Delaware DGHD, FLOW members	None	In-kind service provided by FSWCD for duplicate copies.	Effective use of the document and regular updates with each educational provider.	Completed	n/a

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Table 34. Education and Involvement Recommendations, page 2 of 6.

Objectives	Responsible Parties/Partners	Costs	Funding	Indicators of Success	Schedule	River Segment
2) Organize obtained educational materials pertaining to each of the FLOW Working Groups, including Hydromodification, Stormwater, Education and Outreach, Human Health and Sanitation, Land Use, and Riparian Habitat and Recreation. Folders will contain brochures, pamphlets, facts sheets, etc. which will be a source of reference on how various aspects of the Lower Olentangy Watershed Action Plan will proceed.	All FLOW Working Groups From the WAP: Hydromodification Habitat Land Use Storm water Health & Safety	None	In-kind services from committee members.	Utilization of the folders by the public to learn about the Watershed Plan process and resources available.	Basic information completed. Will be continued as action plan items are completed and revised.	n/a
3) Plan a media bus tour with site visits along the Olentangy River highlighting attributes and impairments identified in the WAP as well as plans and progress to achieve the goals and objectives set forth in this document. Invitees will include local and suburban newspapers, radio and TV media.	FSWCD, DSWCD, FLOW, ODNR O.S.U. Columbus Rec & Parks Columbus DOSD DelCo. OECC	1,200	Partners Grants (OEEF, etc)	Success will be measured by publication in 2 newspapers, promotion by 1 radio and 1 TV station. Attendance	April 2005 (depends on when we can secure funding).	All

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Table 34. Education and Involvement Recommendations, page 3 of 6.

Objectives	Responsible Parties/ Partners	Costs	Funding	Indicators of Success	Schedule	River Segment
4) FLOW bus placards placed on the rear of 14 COTA buses for the duration of 4 months to advertise the FLOW website and be a new means of outreach.	FLOW	6000	319 Grant ? Other Grants: OEEF, etc. ?	Increase visibility of FLOW. Increase in membership Increase in website hits.	Ad campaign ran June- Sept 2003 resulted in over 5,800 web hits. Future ad campaigns would depend on funding	COTA service area
5) Robbie the Rainbow Darter (river education) Road Show will begin in April at elementary schools in the Olentangy Watershed. Robbie will make appearances at civic events (RoseFest, etc.) to educate the public on a variety of water quality issues.	FLOW, OEPA, FSWCD, DSWCD COSI	5000	OEEF grant	Increase presentation of Robbie at local schools in the years following 2003 and beginning of 2004.	Debut April 2003 in schools	All

Continued on the next page.

Table 34. Education and Involvement Recommendations, page 4 of 6.

Objectives	Responsible Parties/ Partners	Costs	Funding	Indicators of Success	Schedule	River Segment
6) Create a Public Service Announcement (PSA) slide to be aired on local government channel. The slide will be identical to the COTA bus placard. May also be used in print media as a source of outreach.	FLOW	unknown	unknown OEEF	Increased visibility of FLOW. Increased membership. Increased hits to website. Increased meeting attendance (sign in sheet asks how they heard about FLOW)	June 2004	n/a
7) Develop a series of presentations for community groups, local governments, schools, etc, concerning the six Working Group's issues and an overall presentation of the Action Plan.	FLOW, Education and Outreach Working Group	none	In-kind	Presentation to be followed by question and answer period. Conduct survey to evaluate effectiveness of the presentation.	April 2003 Ongoing	n/a
8) Pilot the FSWCD / NRCS Backyard Conservation Program with the addition of Stormwater management techniques for urban / suburban property owners.	FLOW FSWCD NRCS Friends of the Ravines Wildlife groups Adena Brook Community	$20,000	Columbus Foundation; other grants and in-kind services	Number of participants Survey results from participants	2004	Advertise to the entire Franklin County portion of the Olentangy watershed with emphasis in the Adena Brook watershed and Clintonville.

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Table 34. Education and Involvement Recommendations, page 5 of 6.

Objectives	Responsible Parties/ Partners	Costs	Funding	Indicators of Success	Schedule	River Segment
9) Continue to encourage volunteer monitoring efforts;	FLOW SWCDs Schools ODNR-DNAP OSU	5,000	Grants: OEFF, ODNR, Foundations	Each site monitored at least twice per year with yearly findings posted to the website.	ongoing	FLOW and ODNR have at least 15 sites on the mainstem of the River.
10) Increase awareness of stormdrain connection to rivers and streams; label them with "Do Not Dump; Drains To River" markers and distribute explanatory flyers.	• FLOW – Helgrammite Science Cmtte • Community Tributary groups • SWCDs • Schools • MORPC- labels • DOSD - labels	Dependant on # ($1.60 per drain)	Local Govts Utilities Grants: OEFF, ODNR, Foundations	Entire watershed labeled- one per street should be sufficient	ongoing	All
11) Increase public participation in reporting illegal discharges; develop or advertise currently established community hotlines.	Local Govt (public utilities; SWACO; health depts.) EPA – DERR Franklin Co. Sheriff Env. Enforcement Nail-A-Dumper	unknown	Local Govts -Public Utilities	1. Hotline Established 2. # of calls received 3. # of situations that were addressed due to this reporting mechanism	Ongoing (Columbus is 645-STREAM; Delaware getting hotline in 2004)	All

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Table 34. Education and Involvement Recommendations, page 6 of 6.

Objectives	Responsible Parties/ Partners	Costs	Funding	Indicators of Success	Schedule	River Segment
12) Name tributaries that are currently unnamed or undesignated on the County Engineers Maps and USGS Board of Geographic Names. Inquire with residents if the streams are already locally named. If not, hold a contest to name the stream Work with the County Engineers offices to designate names on maps. Work with Transportation divisions to install signage at roadway crossings. Conduct a cleanup on Beechwold Ravine and at mouth to River.	Friends of the Ravines, FLOW, Historical Societies, MORPC-Franklin County Greenways Program Future Delaware County Greenways or PACE group.	unknown	MORPC Grant for Signage.	# of streams named and identified with signs	2004 – Ongoing	All tributaries

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