Ipswich River Watershed

HUC - 0109001

Restoration of the Ipswich River Watershed – An Approach to Enhance the Use of Low-Impact Development Techniques and Conservation within Market-Based Trading Programs

Submitted for Funding under the EPA Watershed Initiative
January 15th, 2004

Contact:
Sara Cohen
Massachusetts Department of Conservation and Recreation
251 Causeway St., 7th floor, Boston, MA 02114
(617) 626-1374
sara.cohen@state.ma.us

Abstract

This proposal supports the Ipswich River Watershed Action Plan and represents collaborative effort between state and federal government, Ipswich River headwater communities, the private sector, and the Ipswich River Watershed Association. It consists of piloting and quantifying the benefit of low-impact stormwater filtration and recharge techniques and water conservation techniques, and quantifying their potential impact on a watershed-wide scale, through modeling. The collective benefit of the projects will be measured improvements in groundwater recharge and reduction in non-point source pollution and erosion within the Ipswich headwaters; calculated units of pollutant reduction and infiltration associated with specific technologies; calculated units of demand reduction associated with innovative conservation strategies; and quantification of potential benefits of various combinations of these techniques when modeled over large watershed areas. Such quantification will form the basis for local "water banks," and provide essential building blocks to enable regulators to employ incentive-based trading mechanisms within permitting programs.

CHARACTERIZATION OF THE IPSWICH WATERSHED AND WATERSHED PLANNING EFFORTS

Background - The Ipswich River winds 45 miles from Burlington, MA to the Atlantic Ocean, its 155 square-mile watershed encompassing all or part of 22 communities. The river has been an economic and ecological asset within northeastern Massachusetts since pre-colonial times, supporting productive fisheries and shellfish beds, and for over a hundred years, powering shipbuilders, tanneries, and textile mills. The watershed is a critical source of drinking water, providing water to over 330,000 residents and businesses in northeastern Massachusetts. The river itself is also an important recreational resource, and its estuary is part of the 17,000-acre Great Marsh ecosystem extending up the coast into New Hampshire.

Despite its value as a resource, the Ipswich, now classified by the Massachusetts Water Resources Commission as "highly stressed," was designated by American Rivers as the third most endangered river in the nation, due to extremely low flows and extended periods of no flow along much of the upper watershed. In three of the last five years, Ipswich flows were lower than any in the 45-year period of record. The river and groundwaters that feed it are pumped extensively for municipal water supply, and 80% of this water is exported out of the watershed, as drinking water or wastewater. At the same time, land-consumptive development has been increasing areas of impervious surface, which in turn increase overland flow and associated flooding and erosion, degrade water quality, and prevent natural recharge to the aquifers within the watershed. As a result of low flows and increased non-point source pollution, the river suffers from extremely low dissolved oxygen (DO), high temperatures, algal blooms, elevated nutrients, and pathogens. The entire length of the river, and many tributaries are listed as impaired on the Section 303(d) list under the Clean Water Act, for combinations of low DO, flow alteration, pathogens, suspended solids, and nutrients. Low and no-flow events and degraded water quality have led to repeated fish kills, and near full replacement of river-dependent fish species with species associated with ponds and still water. As one would expect, the Ipswich headwaters are the most impacted by flow alteration and the water quality problems associated with extreme low flow conditions.

Assessment and Planning - The Ipswich has been the focus of scientific research, extensive monitoring and assessment, and intensive modeling efforts, particularly by USGS. A precipitation-runoff model was developed and calibrated, using the Hydrologic Simulation Program--Fortran (HSPF), to analyze the effect of water withdrawals on aquatic habitat, water quality, and recreational use of the river. Also, an investigation of fish communities, habitat, and hydrologic conditions helped determine stream flows necessary to support fish habitat. These studies led to a comprehensive Watershed Action Plan, developed collaboratively between state and federal agencies, municipal government, local citizens and businesses, and scientists, under the organizing guidance of the Ipswich River Watershed Association (IRWA). The long-term goals of the Plan are to balance the water budget; restore water quality, biodiversity, and habitat within the watershed; improve access and balanced use of the river for human uses; and promote a shared responsibility among the watershed's stakeholders to protect water quality and sufficient flows throughout the watershed. The short-term goals address such restoration through the development of alternative water supplies, localized wastewater management, enhanced stormwater infiltration, demand reduction, and improved land use practices.

This proposal addresses the last three of these goals. Specifically, the project aims to ***implement*** and ***quantify*** the benefits of innovative low-impact development (LID) techniques for decreasing run-off and non-point source pollution while increasing infiltration to ground water; and ***implement*** and ***quantify*** the water savings of innovative conservation techniques. The project will also use the extensive modeling capabilities already developed for the watershed to simulate and quantify the potential restoration benefits of these practices extrapolated over larger areas of the watershed. Such quantification will establish the framework for a ***standardized water trading mechanism*** for those who use water from the Ipswich River Basin, and for those across the nation who require quantitative units of environmental benefit in order to institute market-based incentives for techniques that hold the most promise for watershed restoration. In addition, the techniques implemented and evaluated will be targeted within the headwaters of the Ipswich

and should effect measurable positive environmental improvement in this fragile and critical part of the ecosystem, within the timeframe of the project.

PROPOSED PROJECTS

Overview: The following projects represent broad collaborative effort between state and federal government, all the Ipswich River headwater communities, the private sector, and the Ipswich River Watershed Association. They consist of piloting and quantifying the benefit of low-cost stormwater natural filtration and recharge techniques and water conservation techniques, as well as quantifying their potential impact on a watershed-wide scale, through modeling. These projects will also answer critical questions about the potential for stormwater infiltration to impair groundwater quality. The collective benefit of the projects will be measured improvements in groundwater recharge within the study area portions of the headwaters; reduction in non-point source pollution and erosion within these areas; calculated units of pollutant reduction and infiltration associated with specific techniques; calculated units of demand reduction associated with innovative conservation strategies; and quantification of potential benefits of various combinations of these technologies and approaches when modeled over large watershed areas. The intention is that such quantification will form the basis for local "water bank" programs to balance water budgets, and lay the groundwork for state regulators to employ trading mechanisms within permitting programs, that allow cost-effective regional solutions to water quality and flow problems.

1. Low-Impact Development (LID) Implementation and Quantification of Impacts

Low-Impact Design – Project proponents will work with a developer and an LID specialist to include LID techniques in developing the housing units, parking areas, and commercial building within a mixed-use subdivision development in a headwater community. The units and parking lots will employ grading, rain gardens, reduced lawn areas, natural plantings, vegetated swales, reduced pavement, and rain barrels, to retain, naturally filter, and infiltrate stormwater on site. Project proponents will also work with local officials to establish an LID demonstration site on the grounds of a town hall within the watershed, using similar

techniques, and possibly the inclusion of a "green roof" demonstration. Effects on water quality and infiltration will be monitored and quantified, as described below, using conventionally designed buildings and landscapes in the vicinity for comparison. Specific subdivision proposals and two potential town halls have been identified for this project, and installation should be complete within two years and monitoring within three. Cost: $265,000 ($190,000 EPA, $75,000 Developer)

Parking Lot and Sidewalk Redevelopment – Within one headwater community, Porous pavement will be implemented and evaluated at a public library. Performance will be evaluated during all seasons, in addition to monitoring and quantifying effects on surface and groundwater quality and infiltration, as described below, using conventional parking areas for comparison. LID bioretention techniques will also be applied to a sidewalk adjacent to a sensitive stream corridor and evaluated for impacts to surface water quality. All implementation and monitoring will be complete within three years. Cost: $190,000 ($110,000 EPA, $80,000 town)

Roof Run-off Capture – This project will evaluate the effect of rain barrels on water quality and groundwater levels, in isolation of other LID techniques, when used throughout a neighborhood (~50 homes) to capture roof runoff for irrigation and infiltration. Infiltration and groundwater quality will be monitored, as described below, and water use patterns evaluated, in comparison to conventional roof runoff systems in nearby neighborhoods. Installation should be complete within one year and evaluation within three. Cost: $150,000 ($140,000 EPA, $10,000 town)

Low-Impact Municipal Ball Fields – 4 municipal ball fields will be redeveloped using LID techniques to minimize irrigation requirements and application of fertilizer and pesticides, and maximize infiltration. Techniques will include soil enhancement, the use of drought-resistant turf, and innovative irrigation controls. Two fields are already partially converted. Over the timeframe of the grant (3 years), the performance of partially converted, fully converted, and conventional fields will all be compared. Cost: $52,050 ($15,000 EPA, $37,050 town)

Non-point Source Mitigation of a Lake – Silver Lake in Wilmington is severely degraded from nutrients, sediment, and bacteria from the surrounding conventional stormwater system. A series of low-impact development techniques, including disconnection of flow paths, and infiltration and biological uptake through grass and vegetated swales, bioretention cells, and raingardens will be implemented to replace the conventional system and improve water quality and maximize infiltration. Using pre-implementation monitoring for a baseline, water quality improvements and infiltration volumes associated with the redevelopment will be quantified. Baseline monitoring, implementation, and short-term quantification will be complete within three years, long-term evaluation within five years. Cost: $290,000 ($190,000 EPA, $100,000 Wilmington)

Evaluation and Quantification – For each of the above projects, the impacts to groundwater quality will be determined through quality-assured sampling protocols for pollutants most relevant to the associated land uses (including: dissolved nutrients, fecal indicator bacteria, dissolved metals, and total petroleum hydrocarbons). Where appropriate, surface water quality and pollutant removal rates will be calculated (above, plus suspended solids). Total annual recharge rates associated with each infiltration technique will be quantified through monitoring of rainfall, soil moisture, continuous ground-water level data, and surface runoff flows. Quality and quantity impacts (milestones) will be evaluated against appropriate controls, as described above. USGS will oversee all the above efforts, and IRWA will provide volunteer and in-kind monitoring services in accordance with a plan developed by USGS. Cost: $613,000 ($300,000 EPA, $150,000 State, $150,000 USGS (not part of match), $10,000 IRWA, $3,000 volunteer)

2. Conservation Incentives and Quantification of Impacts

Reading Conservation Pilots – Reading, a headwater community, will implement and quantify the effect of two water conservation incentive programs: 1) rebates for low-flow toilets, high efficiency washing machines, and irrigation sensor systems; 2) free “retro-fittings” of low-flow shower heads, faucet aerators, and toilet dams, tailored to the customers’ needs. Program registration records and water bills will be used

to quantify the impact of each device or combination of devices on water use, using both pre-installation water bills and non-participant water bills as study controls. Installation (~200 homes per program) will be complete within two years and evaluation within three. Cost: $72,000 ($2,000 EPA, $70,000 town)

Innovative Technologies Irrigation Program – An innovative irrigation controller switch will be installed in 15 homes and 10 municipal park systems within Ipswich headwaters. Odd/even day watering bans will be waived to accommodate the systems. The switch receives continuous wireless transmitted data on solar radiation, temperature, relative humidity and wind and delivers optimum amounts of water, based on evapotranspiration needs of the landscape. The system has been predicted to reduce irrigation volumes by up to 50%. Average water savings from this system will be calculated in comparison to pre-installation use and concurrent use by comparable systems that use conventional technologies and that are subject to watering bans. Installation and evaluation will be complete within two years. Cost: $25,000 ($19,000 EPA, $6,000 AquaSave)

Meter Replacement/Monthly Billing – Topsfield will replace 500 conventional water meters with radio read water meters, bill this portion of its customer base monthly, and implement a progressive rate structure to encourage water conservation. Water use by customers billed monthly will be compared to those billed bi-annually, to quantify savings when customers can more directly correspond their water use with associated cost. Installation and evaluation will be complete within three years. Cost: $80,000 ($55,000 EPA, $25,000 Topsfield)

3. Model Enhancement to Predict Watershed-Scale Quality and Quantity Impact of Widespread Application of LID and Conservation Techniques

The Ipswich HSPF model described above received national recognition for its sophisticated treatment of all aspects of the hydrologic cycle in the Ipswich watershed. The model will be enhanced by adjusting land use to reflect water quantity and quality impacts from both the LID and conservation demonstration projects described above, to evaluate potential flow and water quality benefits when applied over larger

watershed areas, as well as when applied in different combinations. Model enhancement and watershed-scale evaluations will be completed within three years. Cost: $200,000 ($85,000 EPA, $75,000 State, $40,000 USGS (not part of match))

MONITORING AND EVALUATION

Monitoring and evaluation form the *key milestones* of this proposal, as the quantification of benefits associated with each demonstrated technology and conservation approach enable its inclusion in a market-based trading program. Each LID demonstration project and associated control site will include extensive onsite monitoring of groundwater levels, soil moisture, and groundwater quality, and targeted off-site monitoring of streamflow and water quality. Every conservation program will include monitoring of water use within the demonstration and control groups. Where described, pre-implementation conditions will form the baseline. LID projects will also be evaluated for mechanical and physical function (does water pool and does ice form on pervious pavement? do rain barrels function and infiltrate?) and potential contamination of groundwater. Project success will be measured by: complete installation of all demonstration projects and conservation programs; the quantification of pollutant removal rates, infiltration volumes, and conservation volumes associated with each demonstration; the quantification through modeling of such benefits when techniques are applied in various combinations across larger watershed areas; and actual improvement in streamflow levels and water quality within sub-basins of the Ipswich headwaters as a result of the demonstration projects, using pre-installation records and appropriate control sub-basins as baselines.

CONSISTENCY WITH EPA, OTHER FEDERAL, AND STATE PROGRAMS

Flow - The impact of depleted flows on water quality is a rising concern within Massachusetts and New England. EPA Region I has a policy to help states incorporate flow criteria into water quality standards. DEP's 2004-2005 Draft Performance Partnership Agreement with EPA specifically recognizes sufficient flows as a necessary parameter of clean water and healthy ecosystems. This project concertedly addresses flow as a critical parameter of, and influence on, water quality.

Market-Based Approach - The premise of pollutant and flow trading programs is the allowance of lower-cost substitution techniques, with equivalent environmental benefits, to constitute regulatory compliance. A primary obstacle to such programs is the inability to quantitatively compare environmental benefits of low-cost alternatives, due to lack of data. Such data would be provided by this project, enabling local, state, and federal programs to provide quantitative credit for using the above LID and conservation techniques in market-based trading schemes (e.g. as mitigation for water use from new development, as a substitute for higher-cost means of non-point source remediation, as means to reduce pollution concentrations through enhanced flows). Such data will directly support the goals of the Charles River Watershed Association's "Flow Trading and Water Banking Project," funded last year through the EPA Watershed Initiative.

Low Impact Development – This project will significantly advance the agenda of the Massachusetts LID Task Force, formed in partnership with EPA, to raise the visibility of, demonstrate the effectiveness of, and provide assistance for the implementation of LID.

Ipswich - The Ipswich River is classified as "highly stressed" by the Massachusetts Water Resources Commission and its restoration has been a high priority of EPA, which participated on the Ipswich Fisheries Task Force, of USGS, which has focused extensive efforts on modeling and assessment of the Ipswich for the purposes of restoration, and of the state, which funded the development of the Ipswich River Watershed Action Plan that this proposal directly supports.

PROJECT MANAGEMENT

The Department of Conservation and Recreation (DCR) is the lead organization for oversight, implementation, and fiscal management of all projects within this proposal. Within DCR, Mike Gildesgame, Director of the Office of Water Resources, will provide general fiscal and project management oversight. Vicki Gartland, Hydrologist, will oversee technical quality, budgeting, and scheduling of all projects. Gartland has 15 years of experience in technical and fiscal oversight of USGS cooperative studies, Massachusetts Watershed Initiative Studies, and Clean Lake studies. She leads the LID Task Force,

headed the Science and Data subcommittee of the Ipswich River Management Council, including managing several USGS studies of the Ipswich River Basin, and actively assisted in developing the Ipswich River Watershed Action Plan. Sara Cohen, Water Resources Specialist, will serve as Project Lead and EPA liaison, completing administrative workplan and reports, and coordinating project implementation and technical decision-making among all project partners. As Charles River Team Leader under the Massachusetts Watershed Initiative, and interim chair of the Ipswich River Management Council, Cohen has led collaborative teams of state and federal agencies, municipal government, and private and non-profit groups in the establishment of watershed priorities and restoration strategies, and in the implementation and coordination of projects addressing water quality, habitat protection, and citizen stewardship. Dr. Peter Weiskel, Program Officer for USGS in Massachusetts and Rhode Island, will ensure technical quality of all monitoring and sampling protocols, analysis, and enhancements and applications of the HSPF model. Kerry Mackin, IRWA Executive Director, will coordinate the outreach program described below. She has extensive outreach and project management experience, and led the multi-stakeholder development of the Ipswich River Watershed Action Plan. Each municipal project will have fiscal and department oversight by the appropriate municipal director. Cost of program administration: $48,000 (State match)

OUTREACH

Municipal and Legislature Outreach – IRWA will develop outreach tools to inform decision-makers and citizens in the Ipswich about key watershed goals and ongoing efforts, including projects under this proposal (Brochures on balancing the region's water budget to sustain habitat, water supplies, and the economy; PowerPoint presentations summarizing the USGS findings and the Watershed Action Plan; fact sheets and website on various management options, including those demonstrated through this grant, with the streamflow and water quality benefits associated with each). IRWA will also coordinate a series of workshops and forums for municipal elected officials, planning boards, and departments of public works, using materials developed above, and work with interested towns to develop local water resources working

groups and identify local priority actions, obstacles to implementation, and resources needed. Lastly, IRWA will organize an educational forum for legislative leaders in the Ipswich Watershed, using materials developed above, emphasizing implications for state and local budgets. All the above will be implemented within 3 years. Cost: $100,000 ($75,000 EPA, $25,000 IRWA)

LID Manual and Website – The LID Task Force will develop a user-friendly website for use by municipal officials, developers, planners, landscape architects, and citizens, providing a helpful overview of LID, answers to frequently asked questions, cost information, and links to detailed reference documents. Project will be complete within one year. Cost: $15,000 (State match)

Citizen Stewardship – Local residents and homeowners will be educated about the LID implementation projects demonstrated in their neighborhoods and encouraged to volunteer in the sampling and monitoring of the projects under USGS supervision, to become better informed about each technique and develop stewardship principles. (No substantial additional cost)

Technique Evaluations – The quantification of water quality, infiltration, and conservation benefits and any impacts to groundwater quality associated with the above techniques and programs will be published in a user-friendly manner, with full descriptions of site conditions, to assist in wide-spread application (or modification, where conditions vary) in market-based trading programs within Massachusetts and nationally. Cost: $35,000 USGS (not part of match)

BUDGET

The total budget for the above projects is $2,135,050. The grant would provide $1,181,000, which represents 55% of the total project cost. Non-Federal project partners would provide $729,050 towards these efforts, which represents 34% of the total project cost (project "match"). The U.S. Geological Survey would provide the remaining $225,000, which represents 11% of the total project cost.

See attached budget for details.

SECTION A – BUDGET SUMMARY

Watershed Project, Activity or Work Plan Element	EPA Watershed Initiative	Non-Federal (Match)	USGS (not part of match)	Total
LID Demonstration Projects				
1. Landscape LID Techniques (Residential, Mixed-Use, and Municipal Town Hall)	$190,000	$75,000 (Triton Construction)*	--	$265,000
2. Porous Pavement in Library Parking Lot	$110,000	$50,000 (Wilmington)*	--	$160,000
3. LID Sidewalk Renovation	--	$30,000 (Wilmington)*	--	$30,000
4. Roof Runoff Rain Barrel Program	$140,000	$10,000 (Wilmington – in-kind services)*	--	$150,000
5. LID Ball Fields	$15,000	$37,050 (North Reading - $22,650 plus $14,400 in-kind)*	--	$52,050
6. LID Lake Remediation	$190,000	$100,000 (Wilmington)*	--	$290,000
Monitoring and Evaluation				
7. USGS Monitoring and Evaluation (sensor and gage installation, monitoring, sampling, analysis)	$290,000	$150,000 (State Cooperative Program)*	$150,000	$590,000
8. IRWA and Volunteer Monitoring Services	$10,000	$13,000 ($10,000 IRWA; $3,000 in-kind volunteer labor)*	--	$23,000
Conservation Programs				
9. Reading Rebate & Retrofit ConservationPrograms	$2,000	$70,000 (Reading)*	--	$72,000
10. Irrigation Control Switch Demonstration Program in Reading* and Wilmington*	$19,000	$6,000 (AquaSave)*	--	$25,000
11. Meter Replacement and Monthly Billing	$55,000	$25,000 (Topsfield)*	--	$80,000
Watershed Model Enhancement and Application				
12. HSPF modeling of watershed scale impacts of all the above	$85,000	$75,000 (State Cooperative Program)*	$40,000	$200,000
Outreach				
13. Municipal and Legislature Outreach Program	$75,000	$25,000 (IRWA)*	--	$100,000
14. LID Website Development	--	$15,000 (State in-kind technical services)*	--	$15,000
15. Publication of Technology Evaluations and all Modeling	--	--	$35,000	$35,000
Project Administration				
16. Grant Oversight and Administration	--	$48,000 (State in-kind services)*	--	$48,000
TOTAL	**$1,181,000**	**$729,050**	**$225,000**	**$2,135,050**
% of Total	**(55%)** Requested Funds	**(34%)** Non-Federal Match	**(11%)** Additional Match	**(100%)**

* See Attached Letter of Support for Reference

SECTION B – BUDGET CATEGORIES

	Watershed Project, Activity or Work Plan Element								Total
Budget Categories	(1) Landscape LID	(2) Porous Pavement	(3) LID Sidewalk	(4) Rain Barrels	(5) LID Ball Fields	(6) Lake Remediation	(7) Monitor / Evaluation USGS	(8) Monitoring IRWA	
a. Personnel				$10,000					$10,000
b. Fringe Benefits									
c. Travel									
d. Equipment				$90,000			$100,000		$190,000
e. Supplies		$80,000	$10,000		$29,250		$20,000	$2,000	$141,250
f. Contractual	$190,000			$50,000	$8,400	$290,000	$290,000	$18,000	$846,400
g. Construction	$75,000	$80,000	$20,000		$14,400		$180,000		$369,400
h. Other								$3,000 volunteer labor	$3,000
i. Total Direct Charges (a-h)									
j. Indirect Charges									
TOTALS	$265,000	$160,000	$30,000	$150,000	$52,050	$290,000	$590,000	$23,000	$1,560,050

	Watershed Project, Activity or Work Plan Element								Total	Totals from Columns Above	Total by Category
Budget Categories	(9) Reading Water Conservation	(10) Irrigation Controllers	(11) Meter and Billing Program	(12) Modeling	(13) Municipal and Leg. Outreach	(14) LID Website	(15) Results Publication	(16) Program Administration			
a. Personnel					$25,000	$15,000		$45,000	$85,000	$10,000	$95,000
b. Fringe Benefits								$1,500	$1,500		$1,500
c. Travel								$1,500	$1,500		$1,500
d. Equipment		$6,000	$65,000	$13,000					$84,000	$190,000	$274,000
e. Supplies	$35,000						$5,000		$40,000	$141,250	$181,250
f. Contractual	$37,000	$19,000	$15,000	$187,000	$75,000		$30,000		$363,000	$846,400	$1,209,400
g. Construction										$369,400	$369,400
h. Other										$3,000	$3,000
i. Total Direct Charges (a-h)											
j. Indirect Charges											
TOTALS	$72,000	$25,000	$80,000	$200,000	$100,000	$15,000	$35,000	$48,000	$575,000	$1,560,050	$2,135,050