INTEGRATED WATER RESOURCE CHARACTERIZATION AT A MUNICIPAL SCALE: COLCHESTER, VERMONT

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ABSTRACT

The Town of Colchester, Vermont is a lakeside community with approximately 6,000 onsite wastewater treatment systems. Colchester is using a town-wide integrated approach to water resource management with an interdisciplinary consulting team. The initial steps in this project were the characterization of decentralized wastewater infrastructure, stormwater infrastructure, water supply infrastructure, and available stream morphology data. Additionally, Colchester has been tracking summer *Escherichia coli* concentrations at public beaches for the past six years. This information is being used to inform further water resource evaluations, which include monitoring of phosphorus in surface water, microbial source tracking to identify *E. coli* host species using ribotyping, and a town-wide wastewater needs assessment. The initial data collection approach can be used by other communities who are looking to understand their water resources and water infrastructure in a systematic and organized fashion, thus enabling development of sustainable and integrated water resource management programs.

KEYWORDS: integrated water management, waste water, storm water, water supply, infrastructure mapping, water resource management, demonstration project, Vermont

INTRODUCTION AND BACKGROUND

Colchester, Vermont is a fast growing community just outside of Burlington, the state's largest city, and is itself the second most populated municipality in the state (Figure 1). Colchester faces continuing development pressure on its finite natural resources. The Town has 27 miles of shoreline, and shoreline development has been an important issue in Colchester's history.

Centralized wastewater service areas are limited with the majority of the community currently served by on-site wastewater disposal systems, including all of the communities' shoreline areas. There are approximately 5,300 onsite and shared systems throughout the community. The Town has conducted surface water quality testing in Malletts Bay for the last decade, and has documented reoccurring problems with coliform pollution of surface waters.

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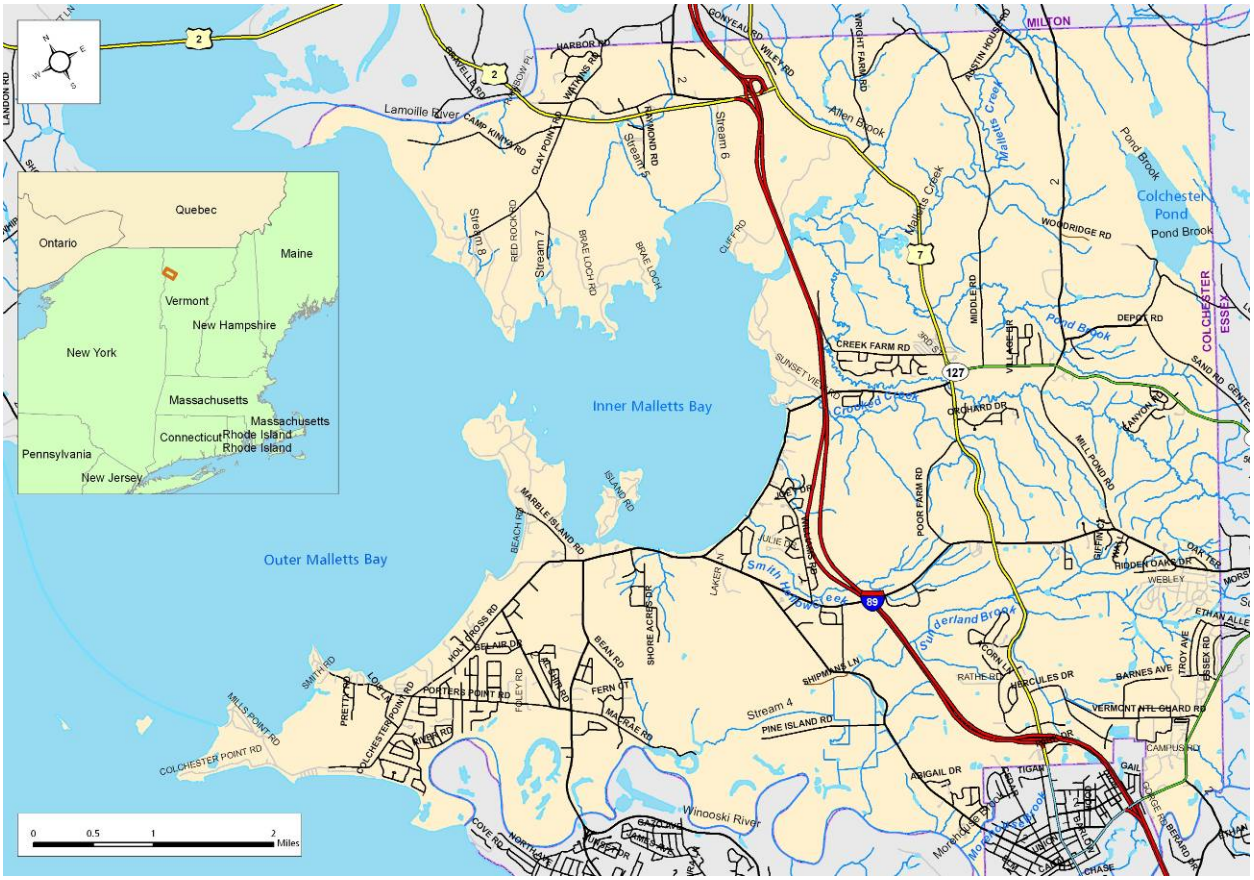

Figure 1. Location Map, Showing Roads, Streams, Ponds, and Lakes in Colchester.

Eight watersheds fully or partially within Colchester are currently listed as impaired on the Clean Water Act Section 303(d) list (Figure 2). With the exception of the Lamoille and Winooski rivers on the north and south boundaries of town, water quality impacts are mostly from within the town. Runoff into Malletts Bay comes primarily from small streams whose watersheds are largely within Colchester and from direct overland flow.

As a result of these factors, the Town has been active in developing plans to better manage water resources throughout the community and has taken concrete steps toward their preservation and improvement. The work to date has included the following:

- A comprehensive wastewater management plan identifying the preferred alternatives, both centralized and decentralized, for each wastewater management unit within the community.
- A comprehensive storm water management plan identifying all sub-watersheds within the community, their percentage of impervious surface and recommended BMPs.
- The design and installation of storm water outfall treatment structures designed to decrease sedimentation in Malletts Bay.
- The use of underdrain systems to lower the water table, thus enhancing performance of onsite wastewater systems and improving storm water management.
- A microbial source tracking study of sources of coliform pollution of surface waters.
- Annual tracking of surface water quality during the summer months.

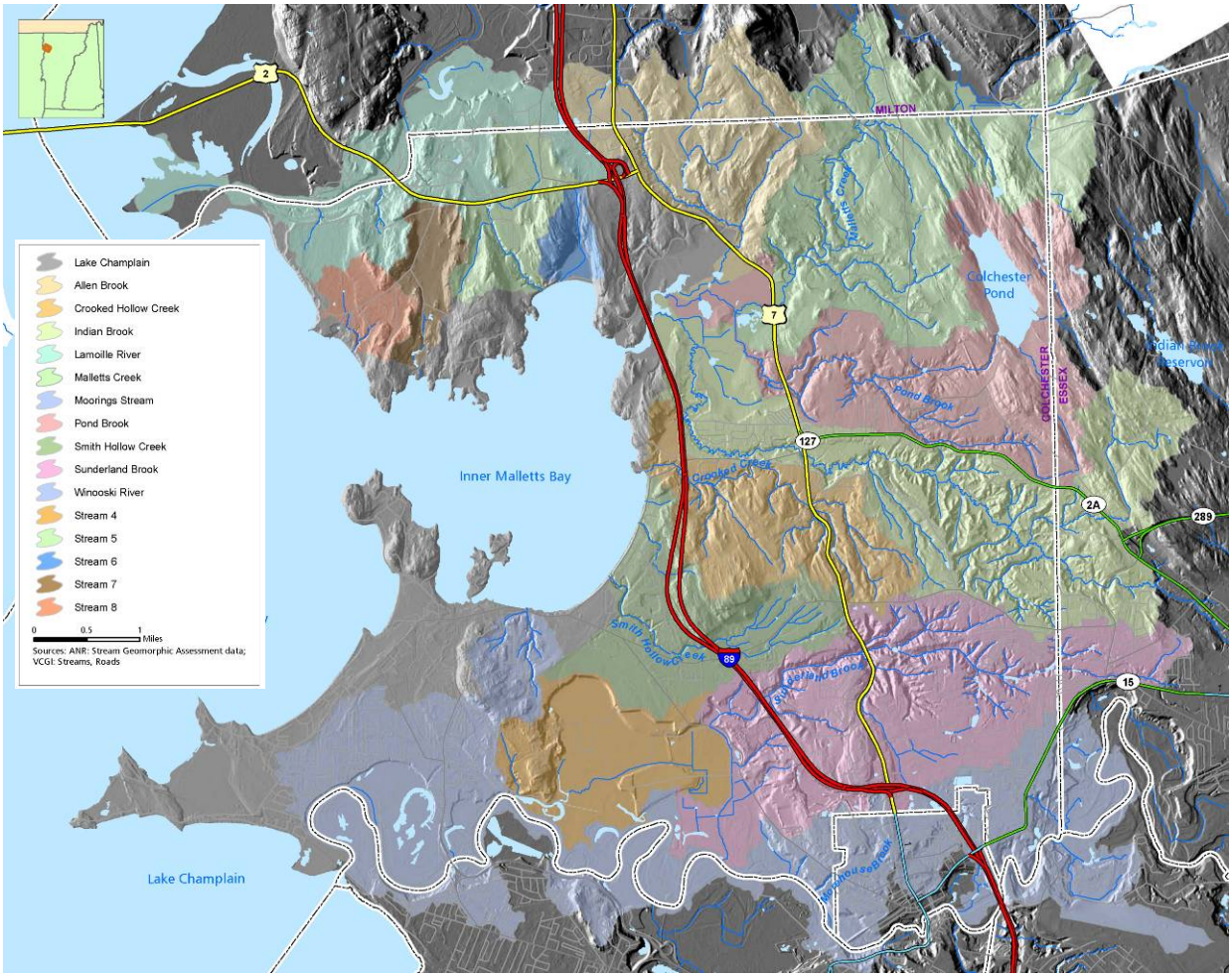

Figure 2. Watersheds with Land Area in Colchester.

- The development of a pilot onsite wastewater system inspection program for a lakeside neighborhood of 104 seasonal and year-round homes.
- Planning for decentralized wastewater management strategies for a new designated growth center by Interstate 89's Exit 17.

These past efforts serve as the building blocks for the Town's future management of natural resources. These efforts were brought together through the development of a Strategic Water Quality Plan, (SWQP) which was funded under a previous EPA Assistance Grant (No. X98144801-0), completed in 2003. The development of the SWQP links these past efforts to the Town's land use planning, as well as the development of technical design standards, policies, and regulations.

The SWQP also outlines recommendations, many of which have been incorporated into the Town's current efforts towards creating an Integrated Water Resources Management Plan (IWRMP). The development of an IWRMP is considered a critical step for the community and its water resources. The plan will capitalize on previous efforts and investments, and position the Town to better manage its water resources into the future.

The Town of Colchester secured a demonstration grant from the U.S. Environmental Protection Agency (EPA) for development of the IWRMP with a goal to improve the overall management of non-point source pollution control infrastructure, and that can be supported by the community at large. This plan has a technical component that includes the development of a sufficient knowledge base of the town's distributed infrastructure to support the creation of a comprehensive plan sufficient to address the community's needs and concerns, an educational component to convince the community that the plan is necessary, and finally the forging of a public private partnership, including a funding strategy to make the plan economically feasible. These three components are intricately linked and are therefore dependent of one another, and are all critical to the successful implementation of the Town's overall plan. A consultant team including Forcier Aldrich & Associates, Inc. of Essex Junction, Vermont, Stone Environmental, Inc. of Montpelier, Vermont, and Marketing Partners of Burlington, Vermont, with assistance from Keeping Track of Huntington, Vermont and the Jackson Estuarine Laboratory of the University of New Hampshire, was selected to assist the Town with implementing the grant workplan.

PROJECT WORKPLAN

The IRWM workplan has three main components: inventory, assess, and recommend. The first component includes creating an inventory of the water resources within Colchester, along with land uses that can influence water quality (stormwater controls, on-site wastewater systems, land development, stream bank stabilization, etc.). Once the inventory work is completed, an assessment of quality of the water resources and how these various factors could impact water quality (both good and bad) will be undertaken. After the assessment is completed, recommendations will be prepared, as appropriate, for any land use and utility controls that should be considered for implementation by the Town of Colchester to help mitigate factors that cause harm to the Town's water resources. A brief outline of the scope of the original workplan, drawn from a project summary created early in the project for use by the general public, follows.

Inventory

The Town of Colchester has multiple sources of existing information on many parcels that will be compiled and consolidated into one database as an inventory of existing conditions. Information that resides with the Assessor's Office, Planning & Zoning Department, and Public Works Department will be combined on a parcel by parcel basis. The resulting inventory will contain information about land use (residential, commercial, etc.) and scale (number of bedrooms, number of employees, etc.), as well as information about potable water supply and wastewater treatment service. Stormwater collection, infiltration, and distribution systems throughout the Town will be mapped and confirmed to better understand how distributed stormwater systems collect and direct stormwater to waterways. The mapping will be created on a GIS/GPS platform for easy field reference in the future.

Some field investigation will be completed to more accurately map certain key features (precise location of a water supply well, location of a septic tank and leach field, etc.). The field work will also include the mapping of all streams and wetlands. When the inventory work is completed, the Town of Colchester will have an accurate portrayal of the land use features described above for each parcel.

Assess

With the completed inventory, the process of assessing current land use and the condition of water resources can begin. The assessment considers the impacts of both wastewater and stormwater practices on water resources.

The wastewater assessment will include an initial screening of all parcels in Colchester to determine which areas (if any) warrant a more detailed "needs assessment". Where a parcel relies on an on-site wastewater system, potential for the lot to support a functioning system under current rules will be assessed. This initial screening will utilize what's known about the parcel from the data compiled in the inventory to assess whether or not the lot would generally support a modern on-site system under current regulations. The integrated nature of the inventory will allow consideration of required setbacks between leachfields and stormwater infiltration features, which are usually very challenging to consider accurately at a screening level. As part of the initial screening, a build-out analysis will be completed to project the possible development impacts on vacant parcels, based on current zoning.

From this initial screening, parcels where it appears unlikely that the parcel could support a conventional on-site system will be selected for a more detailed "needs assessment". These parcels will receive a more detailed evaluation of their current on-site wastewater system and alternatives to provide improved treatment, whether with an innovative/alternative system onsite, off-site cluster system or other options. There will be a special focus on all properties near the shoreline of Malletts Bay. A similar study of distributed stormwater will also be completed to identify where stormwater management improvements could be implemented cost-effectively to reduce the adverse impacts of stormwater runoff on water resources.

Another unique aspect of the assessment phase is the microbial source tracking program. In conjunction with Dr. Steven Jones of the University of New Hampshire, water samples will be collected strategically throughout Colchester to first capture samples of *Escherichia coli* and then determine the source of the *E. coli* using DNA Ribotyping. The goal of this assessment piece is to determine if the predominant source of *E. coli* found along the shores·of Malletts Bay and some of the tributaries to the lake are human, animal or waterfowl. This information will help the Town gauge the impacts of current wastewater practices along the shores of Malletts Bay, as well as the range of stormwater impacts from tributaries.

Recommend

Armed with the inventory and assessment information, the project team and the Town will be able to identify areas for improvement in wastewater and stormwater management, as well as land use planning, to better protect water resources. Depending on the level of the needs as identified in the assessment, various levels of wastewater management will be considered, from a rather hands-off approach which may suit areas of low risk to a municipal utility to manage on-site systems in higher risk areas or even a centralized wastewater system for areas where wastewater needs cannot be met practically or cost-effectively by decentralized methods

A similar approach will be taken with distributed stormwater. Areas where improvements can be made to lessen the impacts of stormwater runoff to water resources will be identified. Strategies

for implementing improvements, whether through a stormwater utility, promoting best practices, restoration of stream bank erosion, etc., will be considered.

Public participation throughout the study is encouraged to both educate residents and gain their insight and opinion regarding possible approaches to improve water quality. Ultimately the project team's recommendations will lead to a community-wide discussion about what Colchester should do (if anything) to better protect water resources through municipal management of wastewater and stormwater systems, improvements to distributed infrastructure and/or revised land use planning and zoning. The ultimate decisions concerning action on the study recommendations will rest with the residents of Colchester.

Colchester's IRWM implementation process began in April 2009 with the finalizing of the workplan described above. The project's recommendations are expected in April 2012. A general timeline for the project is included below as Figure 3. The remainder of this paper will generally describe the work of the Inventory phase of the effort, which began in April 2009. The initial work to compile the inventory was completed in early 2010, though it will remain a dynamic dataset that will be updated throughout the remainder of the process.

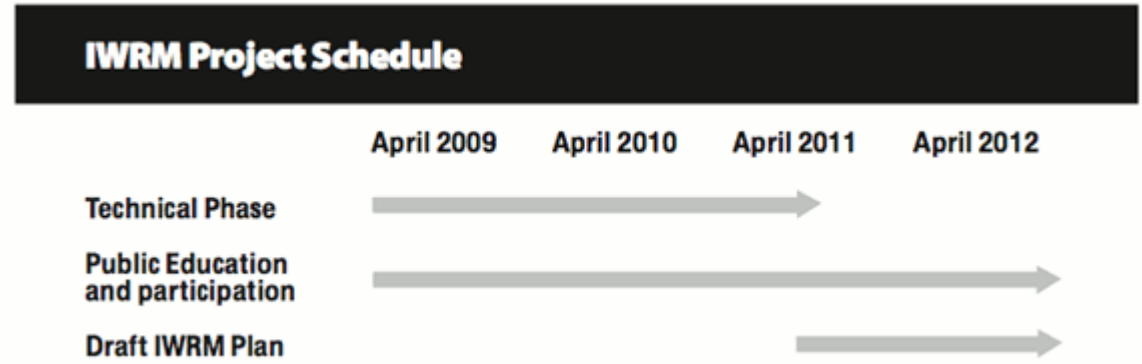

Figure 3. Grant Implementation Schedule as Presented on Project Website, colchesterwaters.net.

INFRASTRUCTURE MAPPING AND INVENTORY

During the spring and summer of 2009, Stone conducted a desktop and field inventory effort of both public and private stormwater infrastructure (catch basins, culverts, piping, swales, detention basins and outfalls); septic system wastewater facilities; and private water supplies. Stone conducted the inventory based on the workplan and task-specific protocol; the EPA Demonstration Grant's project goals and objectives; an examination of existing information resources; consultant recommendation on essential inventory elements; and a cost-effective approach for building the inventory.

The infrastructure inventory includes the following components:

- Distributed waste water permits and systems
- Private water supply systems
- Storm water collection systems, including catch basins, culverts, piping, detention basins, and outfalls.

Storm Water Infrastructure

The storm water data inventory included comprehensive field data collection of both municipal and private (where permission was granted) stormwater infrastructure, as well as a review of stormwater discharge permits required by the Vermont Department of Environmental Conservation (DEC) and associated site plans. Additionally, site plans for developed areas within the town that were not associated with stormwater permits were reviewed.

The resulting databases developed include a geographic information system (GIS) inventory of stormwater structures, general locations of site plans with stormwater discharge permits, general locations of site plans without stormwater discharge permits, and locations of stormwater easements. All stormwater discharge permits, site plans, easement documents, and co-applicant maintenance agreements associated with properties within the Town of Colchester have been digitally catalogued and associated with a spatial location, where possible. These datasets can be used to maintain and manage stormwater infrastructure in the Town of Colchester.

The stormwater infrastructure inventory involved several phases of data collection, compilation, and review in order to construct as complete a dataset as possible. These phases included an initial computer desktop review of existing Chittenden County Regional Planning Commission (CCRPC) data, stormwater discharge permit and site plan review, field data collection, and a desktop quality control review following field data collection.

The final result of the stormwater data inventory is a geospatial database (geodatabase) of all stormwater structures and associated attributes, in the ArcGIS 9.3 personal geodatabase format. The geodatabase contains feature classes for stormwater infrastructure including outfalls, stormlines, stormwater structures, and retention ponds. Additionally, the geodatabase has permit and easement feature classes. These include point locations of stormwater permits as permitted by DEC, expired stormwater permits, site plans where no permit exists referred to as Unpermitted Site Plans, and stormwater easements. An example of the mapping completed for the stormwater data inventory is shown in Figure 4. Table 1 summarizes the geodatabase feature databases and associated feature classes compared with the original CCRPC data. All feature classes are in Vermont State Plane meters projection, NAD83. Table 2 contains a summary of the features inventories and their permit status.

Table 1. Stormwater Geodatabase Feature Datasets and Feature Classes

Feature Dataset	Feature Class	Description	2009 Count	CCRPC Count
Stormwater Structures (with topology)	Outfalls	Outfall point locations. Attributes of interest include discharge type, diameter, and condition.	279	130
	Stormlines	Stormline line features. Lines include stormlines, underdrains, infiltration pipes, culverts, and roof drains. Other attributes of interest include material type and diameter.	2,282	888
	Structures	Stormwater structure point locations. Structures include catch basins, dry wells, manholes, and clean outs. Other attributes of interest include discharge type and condition.	2,095	1,189
Stormwater Features	Retention Ponds	Retention pond polygons.	53	3
Permits and Easements	Stormwater Permits	Point locations of permitted stormwater discharge. Permits are managed by DEC under the Vermont Stormwater Program.	108	107
	Unpermitted Site Plans	Point locations of site plans with no stormwater permit under the Vermont Stormwater Program.	34	Not in dataset
	Stormwater Easements	Point locations of Town of Colchester stormwater easements.	22	Not in dataset

Table 2. Permitted and Non-Permitted Stormwater Structures Summary

Feature Class	Feature Type	Permitted	Percent of Count	Non-Permitted w/ Plan	Percent of Count	Non-Permitted w/o Plan	Percent of Count	Total Count
Outfalls		99	35%	7	3%	173	62%	279
Stormwater Structures		818	39%	134	6%	1143	55%	2,095
	Catch Basins	663	38%	112	6%	952	55%	1,727
	Dry Wells	36	26%	11	8%	92	66%	139
	Manholes	56	41%	8	6%	72	53%	136
	Other Structures	63	68%	3	3%	27	29%	93
Stormwater Lines		907	40%	130	6%	1245	55%	2,282
	Stormlines	743	37%	101	5%	1154	58%	1,998
	Culverts	78	48%	7	4%	76	47%	161
	Other Lines	86	70%	22	18%	15	12%	123
Retention Ponds		44	83%	0	0%	9	17%	53
Total Features		1853		272		2583		4,708

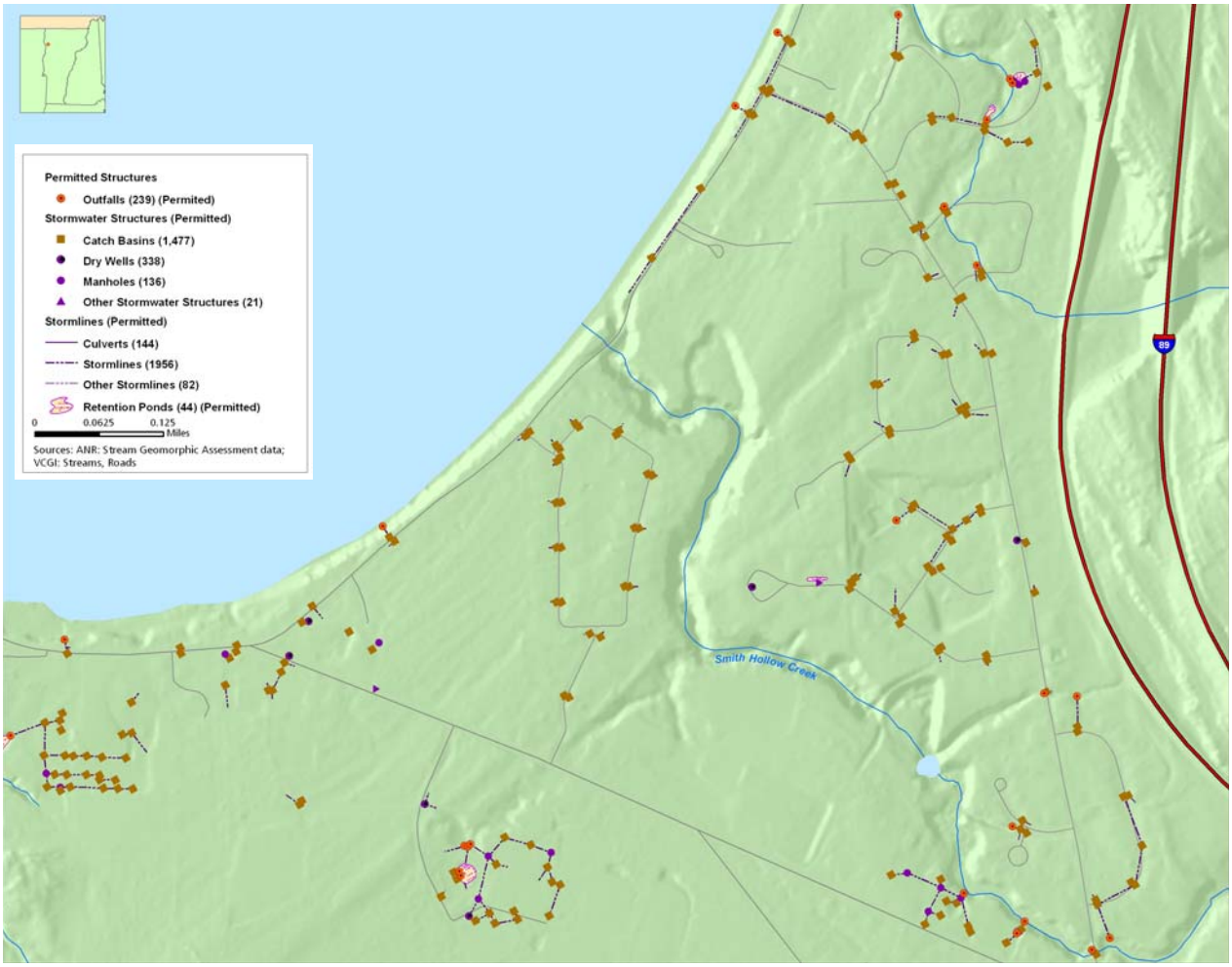

Figure 4. Example of Mapping Results from the Storm Water Infrastructure Data Inventory (detail along the Inner Malletts Bay Shoreline).

Waste Water Infrastructure

The waste water and private water infrastructure inventories consisted of four efforts: collection, assessment, and integration (as feasible) of multiple town and State of Vermont databases and paper records; creation of GIS and field data collection applications; field inventory of private water wells; and a data inventory quality control effort. The Town of Colchester and the State of Vermont both maintain sources of information relevant to the waste water and water supply inventory and which will be useful in the assessment processes. The data sources and their relevance are briefly described in Table 3.

Table 3. Existing Sources of Waste Water System and Water Supply Data

Data Source	Description	Total Records
Assessor's Database	Parcel ID-specific information about property use; zoning; water, waste water, and other utilities; structure dimensions, residential structure age, residential design flow basis data	6,949
Planning and Zoning Permits Database	Dates and numbers of septic and building permits issued under Town-administered programs, recorded by parcel ID; reason for permit recorded in some instances	6,047
ACS Land Records Database	Scanned land records and associated documents that are intended to run with the land, including stormwater, wastewater, and water supply permits and related easements; indexed by parcel ID	620
Canon imageWARE Document Management System	Scanned Town-issued septic and building permits and related documents, including large-format plans in some cases; proprietary database indexed by parcel ID	3,271
Paper Files: Plan Sheets and File Cabinets	Historic building and wastewater permits, subdivision records, planning and zoning permits, correspondence; generally indexed by parcel ID	350+ linear feet
Vermont DEC GIS Datasets	Public water supply locations and wellhead protection areas, approximate locations for some private water supplies	n/a
Vermont DEC Regional Office Permit Database	Web-based database of permits, documents, and other information related to state-level permitting activities, primarily Act 250 (land use) and the Wastewater System and Potable Water Supply Rules (small-scale onsite systems); indexed by permit number and owner; linked to parcel ID during inventory phase where possible	1,758
Water District Service Areas and Use Records	Boundaries of municipal water service areas in GIS; confirmed on parcel basis during inventory phase	n/a
Centralized Sewer Service Areas	Boundaries of municipal sewer collection areas in GIS; confirmed on parcel basis during inventory phase	n/a

The town has relatively comprehensive, but often overlapping, sources of information about both centralized and decentralized waste water and water supply infrastructure. A three-step effort was completed to develop the inventory of parcel-based data regarding this infrastructure:

1. Inventory and organize existing information. The existing electronic datasets described above were standardized and linked by parcel ID where feasible to develop an initial inventory of core information.
2. Limited file review to fill inventory gaps. When the wastewater systems inventory began, priorities were set for paper file review in the following order: parcels in the Lakeshore Drive area, then commercial parcels and parcels served by cluster systems for which no electronic documentation was available, then lots of less than 0.5 acres in size served by onsite OWTS and water supply wells. As the inventory effort progressed, it became clear that paper file review, if any, would be best conducted once the initial planning level needs assessment was complete and priority areas were more clearly and completely identified.
3. Field location of private water supply wells, with particular attention to parcels where no electronic information currently exists regarding wastewater or water supply infrastructure. (See the following section for details on this effort.)

A single inventory geodatabase and ArcMap project was used to collect, store, analyze, and report information regarding distributed waste water infrastructure in Colchester. Where applicable and whenever possible, this information was linked to individual lots by account number. At a minimum, all accounts contain parcel-specific information sufficient to conduct a town-wide, planning level needs assessment. The waste water data inventory includes:

- Basic property information from the Assessor's database (owner, address/location, use, zoning, design flow basis, structure square footages)
- Permit history as available from Planning and Zoning database
- Digitized private water supply locations
- Supplemental electronic permit history and scanned design drawings, perc test results, soils information from VTDEC permits (and from ACS and imageWARE where available) (linked by permit number or account number as appropriate in geodatabase)
- Scanned permits, plans, and as-built drawings from Town paper files (linked by account number in geodatabase)

With the exception of the southeast corner of Town, most properties are served by individual onsite systems or relatively small-scale shared systems with soil-based dispersal (Figure 5). Of the approximately 6,250 parcels in Town, about 80% are served by waste water treatment infrastructure that is completely contained on the parcel where water is used. Nearly 240 parcels contain some form of shared or cluster waste water treatment system. Shared systems in Colchester range from relatively small and simple (such as two single-family condominiums sharing a leachfield on common land surrounding the condos) to more complex (such as 6,499-gpd cluster systems with STEP tanks, textile filters, and large, shared off-site pressurized dispersal systems). In addition, about 220 parcels are served by centralized sewer; these parcels are located in the densely developed southeast corner of Town, and in a few designated areas along the Route 7 north-south corridor (Figure 5). About 710 parcels, or 11% of the properties in Town, are not developed and currently have no wastewater infrastructure. The results of the waste water system permit and infrastructure inventory are also summarized by system type in Table 4.

Table 4. Summary of Type of Waste Water Treatment Infrastructure by Parcel.

Type of Wastewater Treatment	Total Parcels Served
Onsite	5078
Shared System Collection	185
Shared System Dispersal	52
Sewer	222
None (undeveloped)	713
TOTAL	6250

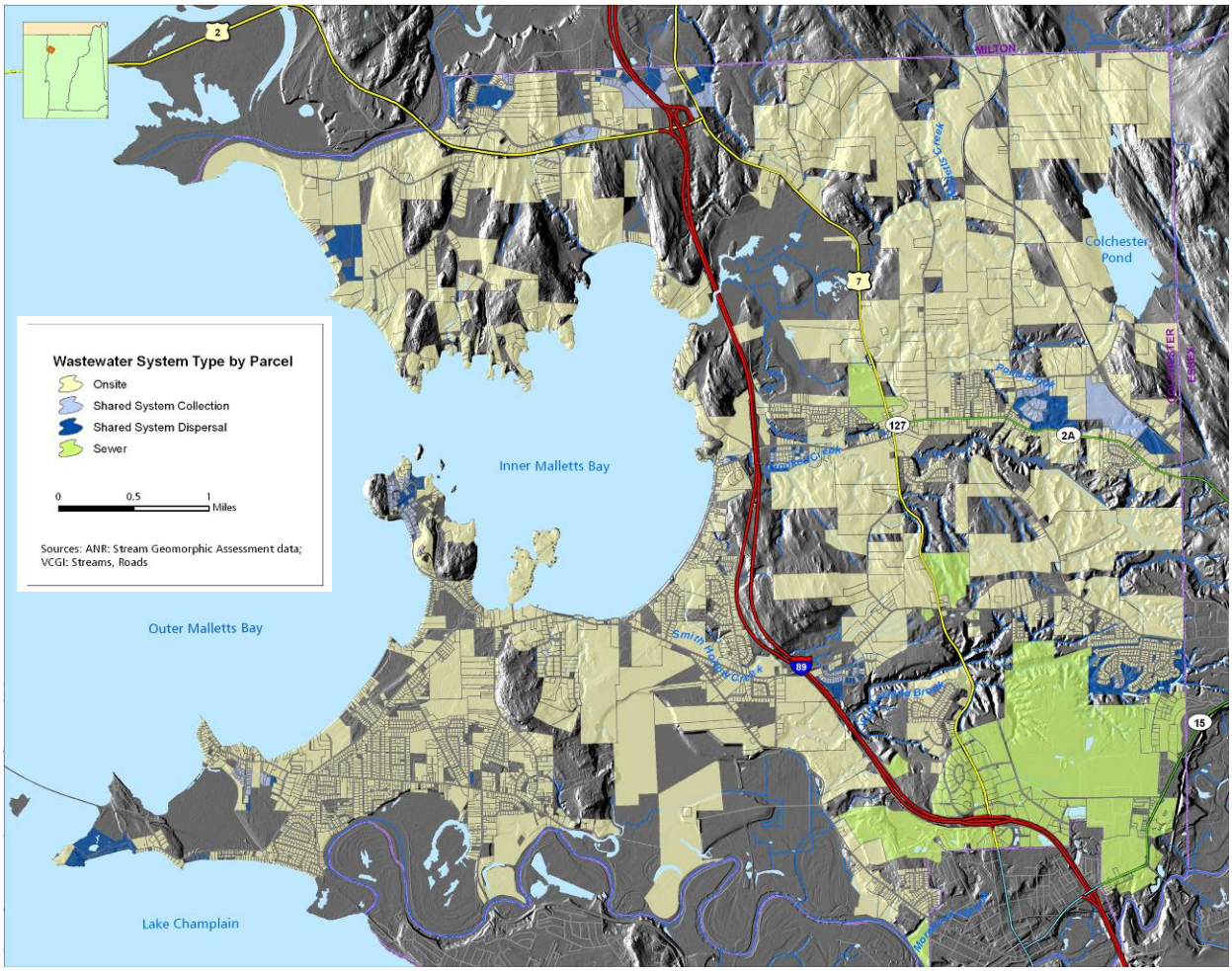

Figure 5. Map of Town-Wide Waste Water Treatment Infrastructure Inventory Results.

Water Supply Infrastructure

The project team conducted an initial computer desktop review of existing data. Based on that review, an approach for conducting a field inventory of private potable water supplies was developed. During and following the field inventory, quality control checks were completed. The water supply inventory was completed primarily in support analyses of onsite waste water treatment capacity. Vermont's *Wastewater System and Potable Water Supply Rules* have specific requirements for horizontal isolation distances between water supply wells and onsite waste water treatment systems, so understanding the geographic locations of individual and small shared water supplies is a particularly important piece of the overall water infrastructure picture on an individual property. The water supply sources identified during the inventory included drilled wells, springs, and Lake Champlain (both as the supply for individual camps and as the main supply of municipal water).

Of the approximately 750 properties with private water supplies in the town, the project team was able to obtain permission to field-locate 284 private water supplies. These private water supplies support 483 properties. Four of the water supplies located during the inventory were shared drilled wells which were permitted as Non-Transient Community (NTC) Water Supplies; these wells serve a total of 75 properties. Table 5 provides a summary of the type of water supply

serving each developed property in the town, both those located during the field inventory and areas in which municipal water service was confirmed during the desktop inventory. Figure 6 shows potable water service type by parcel for the entire Town, along with the locations of private and NTC water supplies where mapped during the field inventory, and the boundaries of the service areas for municipal water supply.

Table 5. Summary of Type of Water Supply by Parcel.

Type of Water Supply	Total Parcels Served
Individual Drilled and Shallow Wells	1
Individual Drilled Well	563
Individual Shallow Well/Spring	27
Lake Water	47
Municipal	4765
None (no water supply; undeveloped or primitive camp)	743
Shared Drilled Well	102
Shared Shallow Well/Spring	2
TOTAL	6250

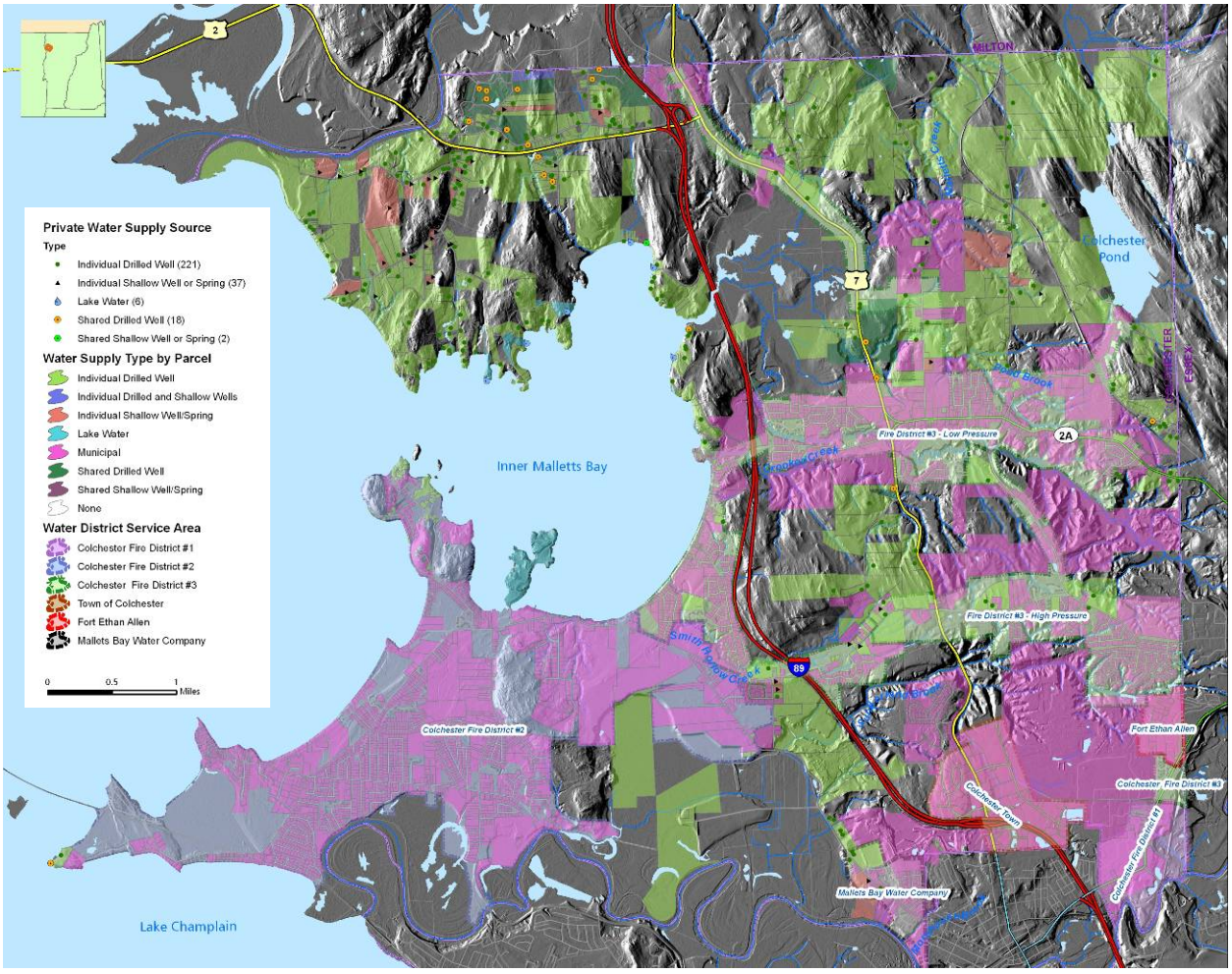

Figure 6. Map of Town-Wide Potable Water Supply Inventory Results.

WATER RESOURCES INVENTORY AND WATER QUALITY RESEARCH

In addition to the detailed information gathered in the infrastructure inventory efforts described above, the project team developed an inventory of basic water resources data throughout Colchester, based on review and understanding of existing data sources. The water resources mapping and inventory includes the following components:

- Wetlands mapping;
- Stream mapping and watershed delineation;
- Stream conditions assessment;
- Known aquifer and wellhead protection mapping; and
- Soil conditions mapping.

In most cases, pre-existing spatial data were updated and adapted to support the Town's resource protection goals. The information from this task and the infrastructure inventory task will help identify those priority areas within the town that are at the highest risk and warrant further targeted investigation in the later assessment tasks.

One of the primary objectives of the demonstration grant is to continue and enhance an ongoing bacteriological/microbial source tracking water quality sampling program. The continuation of this program will enable better understanding of the sources of bacterial contamination of surface water and incorporate this enhanced understanding into water resource management decision-making.

From 2000 to 2002, the University of New Hampshire (UNH) completed a microbial source tracking (MST) study in two watersheds in the Town of Colchester adjacent to Lake Champlain (Jones, 2002a). Ribotyping profile analyses performed on isolates of *E. coli* from water and feces samples collected in August 2000 revealed a range of wildlife, domestic animals and humans as apparent sources of bacterial contamination. That study was one of the first MST studies in northern New England, and it provided useful information on study design and the need for a large database of known source species to provide for more conclusive results.

The demonstration grant includes an enhanced Microbial Source Tracking (MST) program using DNA Ribotyping to determine the sources of *E. coli* contamination in Malletts Bay, and to assist in determining the best approach to managing water resources in this area. The ribotyping methods are detailed in Jones (2002b) and Jones and Bryant (2004). A baseline of microbial source data will be established to measure the effectiveness of water resource management initiatives. In the first year of this effort, a Quality Assurance Project Plan (QAPP) was developed, field training in scat identification and sample collection was initiated, and several sampling events for both 'knowns' (scat or septic tank samples) and 'unknowns' (grab samples of water from streams and shoreline areas of Malletts Bay) were completed. Analysis and assessment of the 2009 results is ongoing, as is the 2010 sampling program.

PUBLIC INPUT SHAPES THE PROCESS

A notable change was made from the grant's original workplan as a result of public input gathered during early presentations of the project approach. Initially, the water resources inventory contained significant resources to confirm existing geomorphic assessments of stream channels in Colchester, with particular attention to several internal drainages to Malletts Bay

which had not been previously assessed using the Phase 1 and Phase 2 stream geomorphic assessment protocols established by the Vermont Department of Environmental Conservation. At an early public meeting, however, residents strongly questioned the demonstration project's lack of resources directed towards collecting water quality information for streams, particularly with regard to phosphorus—the limiting nutrient in Lake Champlain and Malletts Bay. The Town responded to this input by directing the project team to shift resources to allow the collection of stream water quality data, particularly ambient phosphorus concentration data.

The objectives of the new phosphorus survey task is to identify subwatersheds in Colchester drained by streams with relatively high phosphorus concentrations (hot spots) and assess the relative contributions of phosphorus among differing land uses (e.g., agricultural, forested, impervious cover, commercial, residential with wastewater collection, residential with onsite wastewater treatment). Locating "hot spots" with elevated phosphorus concentrations will enable Colchester to target these areas for implementation of improved management practices, including possible stormwater retrofits. Describing relationships between phosphorus levels and land use will enable Colchester to focus management efforts on certain land classes. Site selection and field sampling efforts are ongoing for this task, with initial results expected in the fall of 2010.

2010 FIELD SEASON AND BEYOND

The microbial source tracking and water quality data collection efforts will continue through the 2010 field season. The project team is also beginning to shift to the 'assessment' phase, particularly with regard to distributed wastewater treatment infrastructure. A screening-level, Town-wide assessment of wastewater treatment limitations on a parcel basis is currently nearing completion, part of which is an assessment of failure rates (and potentially modes of failure) for distributed wastewater treatment infrastructure. The results of theses assessments will allow the prioritization of site-by-site confirmations of wastewater treatment infrastructure, to be completed in the fall of 2010.

CONCLUSIONS

In the first year of implementing Colchester's Integrated Water Resource Management planning efforts, a significant inventory of information related to water resources, infrastructure, and land use was compiled. The processes and methods used to characterize the Town's distributed infrastructure may be useful to other communities with significant and overlapping sources of infrastructure data. The information that was collected is now being used both in outreach efforts and in screening-level and detailed site assessments of distributed infrastructure. More information about the demonstration project, including status updates, public meeting videos, maps, and related documentation, can be found on the project website http://www.colchesterwaters.net.

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LITERATURE CITED

Forcier, Aldrich & Associates, Inc. 1997. Town of Colchester Wastewater Master Planning Part II: Town-Wide Wastewater Facilities Planning Update. Report prepared for the town of Colchester by Forcier, Aldrich & Associates Inc., September 1997.

Jones, Stephen H. 2002a. Microbial source tracking in Vermont using *Escherichia coli* ribotyping. Final report to the US EPA Section 104(b)3. US EPA Region 1, Boston MA.

Jones, S.H. 2002b. QA Plan for the Jackson Estuarine Laboratory Microbiology Lab. USEPA approved: 2002.

Jones, S.H. and T. Bryant. 2004. Standard procedure for detection of total coliforms, fecal coliforms, *Escherichia coli* and enterococci from environmental samples. Jackson Estuarine Laboratory, University of New Hampshire, Durham, NH.

Stone Environmental, Inc. 2003. Colchester Strategic Water Quality Plan. Report prepared for the Town of Colchester by Stone Environmental, Inc., August 25, 2003.

Stone Environmental, Inc. 2010. Distributed Infrastructure Inventory, Integrated Water Resources Management Program: Task 1 Interim Report, Town Of Colchester, Vermont. Project ID 05-1694-G, submitted February 2010.

Town of Colchester, Vermont. 2005. Application for Integrated Water Resources Management Grant. October 21, 2005.

Town of Colchester, Vermont. 2010. ColchesterWaters.Net: Information on Colchester's Integrated Water Resource Management Project. Project website accessed at http://www.colchesterwaters.net on August 6, 2010.