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Protecting Sources of Drinking Water

Selected Case Studies in Watershed Management

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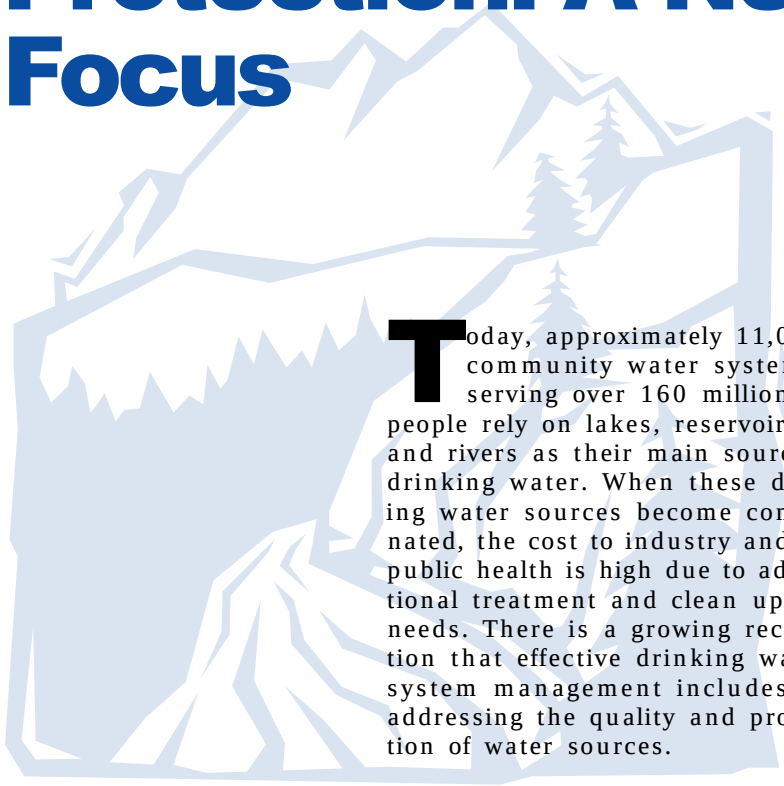
Foreword
Drinking Water Source Protection: A New National Focus



This document presents 17 drinking water utilities that are incorporating watershed management and protection as an integral part of their business of providing safe drinking water to their customers.

Today, approximately 11,000 community water systems serving over 160 million people rely on lakes, reservoirs, and rivers as their main sources of drinking water. When these drinking water sources become contaminated, the cost to industry and public health is high due to additional treatment and clean up needs. There is a growing recognition that effective drinking water system management includes addressing the quality and protection of water sources.

Drinking water source protection extends beyond controlling individual sources of contamination to address problems and solutions on a regional or watershed basis. Many states, tribes and local governments are already managing water quality programs with a watershed approach. However, drinking water programs heavily reliant on treatment technology to make water safe to drink, have not always been involved in these efforts to protect or restore water quality of lakes and rivers. This is beginning to change.

We have reached a crossroads where goals for safe drinking water are converging with the goals for clean water. Congress recognized this connection in passage of the Safe Drinking Water Act Amendments of 1996. The Amendments go beyond monitoring and treating contaminated water to emphasizing pollution prevention. They direct state drinking water agencies to examine the sources of drinking water as an additional layer of protection for our drinking water supplies. States are required to establish assessment programs to delineate drinking water source areas, complete inventories of all potentially significant contaminant sources, and determine the susceptibility of every public water system to contamination from these sources. These assessments will provide drinking water systems, states, and local communities with more understanding of the potential threats to each water supply, and help to target necessary protection measures.

The growing emphasis on drinking water source protection means that more water systems reliant on surface water will implement watershed management programs for the first time. There are numerous challenges to overcome through this process. Many water pollution problems are the result of diverse sources within a watershed, and their solutions rely on land and water resource management that is often beyond the control of a drinking water utility. These are difficult issues to effectively address without the involvement of multiple stakeholders including the general public.

Nonetheless, there are drinking water utilities across the country engaged in innovative and successful source water protection pro-

grams. Their solutions include developing partnerships between the water utility and local governments, working closely with local watershed councils, entering into land exchange agreements with land management agencies, and engaging with local farmers to implement best management practices aimed at protecting sources of drinking water.

This document presents case studies of 17 drinking water systems commited to extensive efforts to incorporate source water management and protection as an integral part of their business of providing safe drinking water to their customers. The authors provide snapshots of lessons learned in implementing four aspects of source water protection: partnerships, watershed assessment, watershed land use management, and land acquisition.

Though diverse in their watershed management experiences, there is a common thread among all of the water systems: the importance of cross-program coordination. The coordination of a drinking water utility's goals with local watershed management initiatives aimed at aquatic ecosystem restoration and protection can boost the effectiveness of program implementation for both priorities.

While no program can directly apply to another community's situation, some pieces of programs may help others to develop protection strategies. We hope that the experiences detailed here will prove useful to water system managers as they engage in efforts to protect their drinking water sources and become involved in local watershed management and protection programs.

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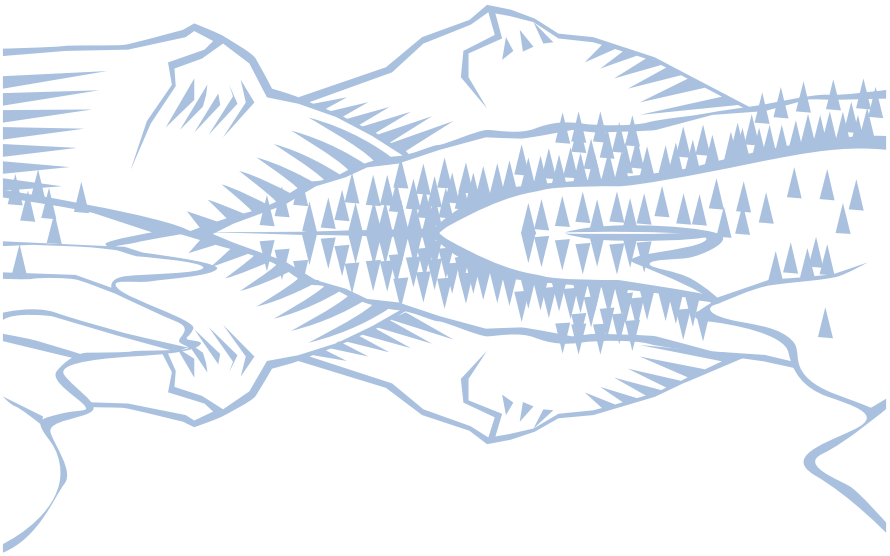

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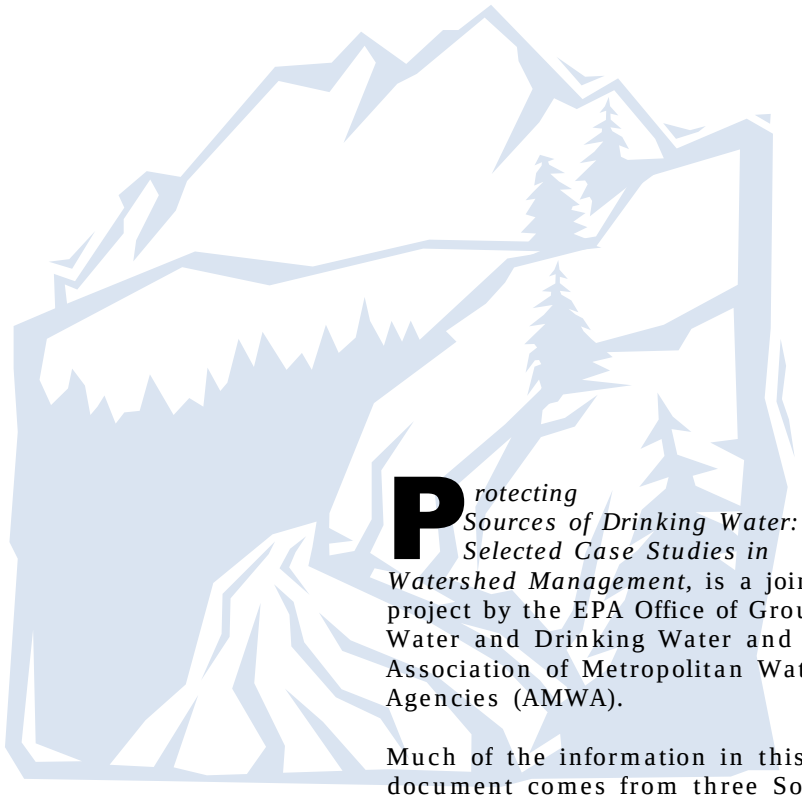

Protecting Sources of Drinking Water: Selected Case Studies in Watershed Management, is a joint project by the EPA Office of Ground Water and Drinking Water and the Association of Metropolitan Water Agencies (AMWA).

Much of the information in this document comes from three Source Water Protection Workshops attended by drinking water suppliers from across the country. The workshops were sponsored by EPA and AMWA. A list of participants is provided in Appendix A, along with program contacts around the country.

EPA and AMWA wish to thank the individuals and drinking water utilities who contributed case studies as a result of the workshops:

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The U.S. Environmental Protection Agency (EPA) Office of Ground Water and Drinking Water oversees the implementation of the Safe Drinking Water Act and coordinates with other programs that protect drinking water. To learn more about EPA's drinking water program, visit www.epa.gov/safewater, or call the Safe Drinking Water Hotline at (800) 426-4791.

Association of Metropolitan Water Agencies
The Association of Metropolitan Water Agencies, based in Washington, DC, is a nonprofit organization representing the nation's largest publicly owned drinking water providers. AMWA members collectively serve over 100 million people with clean, safe drinking water. For more information about AMWA, visit the association's web site at www.amwa-water.org, or call (202) 331-2820.

Chapter 1
Creating Partnerships

Instituting drinking water protection with a source water protection program involves balancing competing interests and conflicting demands within the watershed. This can be done through watershed planning committees, or simply by establishing good, long-term relationships among the partners, which encourages a level playing field for reconciling the community's needs.

To create a viable source water protection plan, all interested agencies and organizations must be identified and efforts must be made to resolve their competing missions.

The affected parties must share information effectively. Water utilities, local and state governments, watershed councils and grassroots organizations are among the players in watershed management strategies. By sharing information, formal or informal partnerships can be established.

Often, water systems must work with local, state and federal governments that have jurisdiction over watershed lands, but whose missions and institutional interests may be different than those of the water system. Such cases require a different form of partnership, one that acknowledges the legal mandates of all parties.

For example, when a drinking water system's source water lies almost entirely within a national park, the system's need to protect its source may conflict with the U.S. National Park Service's mission of promoting outdoor recreation. That was the situation facing one case study subject, the San Francisco Public Utilities Commission. They addressed these issues through a process of comprehensive stakeholder involvement and formal partnerships.

If a water utility demonstrates interest in the youth of the community, customers are more likely to accept watershed regulations and restrictions on land uses within a watershed. Watershed programs also help train a new generation of water-conscious consumers. Seattle Public Utilities invest in watershed and utility tours, classroom presentations, water experiments, and poster contests. They have heightened the awareness of watershed issues in the community and increased the stature of the utility among its customers.

Creating Partnerships with Groups and Individuals

Chester Water Authority

Chester, Pennsylvania

- Primary Source of Water: Octoraro Reservoir
- Watershed Area: 140 square miles
- Population Served: 200,000
- Treatment: Filtration, post-chlorination, fluorination, ammonia, activated carbon, potassium permanganate, post-lime
- Partners: Conservation Commissions, Farmers, Octoraro Watershed Association, Partners for Wildlife, Pennsylvania Fish and Boat Commission, Pennsylvania Department of Conservation and Natural Resources

To protect the water quality of its Octoraro Reservoir, the Chester Water Authority has forged a strong and lasting partnership with the Octoraro Watershed Association.

This partnership bridges the gap between the citizens who get their drinking water from the Octoraro Reservoir but do not live in the watershed, and the farmers and landowners who live in the watershed but do not get their drinking water from the Octoraro Reservoir.

The Octoraro Watershed Association was formed nearly 30 years ago by local property owners interested in protecting the watershed. Recognizing the potential of such an association, the Authority allied with it shortly after it was formed. Over the years, the Authority and the Association have jointly supported many education and outreach programs.

In recent years, the Authority has solidified its ongoing relationship with the Watershed Association by providing a meeting place and administrative support services.

Promoting Agricultural Best Management Practices

The Octoraro Watershed Association promotes streambank fencing, barnyard management, crop rotation, and the establishment of forested riparian buffers throughout the watershed. By visiting farms, grange halls, and other venues, the Association builds trust among the area's farmers, who are encouraged to adopt various best management practices (BMPs.)

The Association stresses that watershed protection BMPs are flexible and can be modified to meet the farmers' concerns. For example, the Association supports the installation of buffer strips that are narrower than textbooks recommend because farmers working small subsistence farms are concerned about losing the use of too much land.

One of the Octoraro Watershed Association's greatest challenges has been convincing farmers that BMPs will benefit them and the watershed. In a booth at a recent regional agricultural fair, the Association displayed "before and after" pictures of farms that had adopted BMPs. The Association also relies on success stories to spread the word among farmers.

Partnerships with Farmers: Overcoming Skepticism

The 140-square-mile Octoraro watershed is home to a large Amish community. An enthusiastic Amish farmer who recreated a wetland on his property with support from the Association and "Partners for Wildlife" has become an effective spokesman for BMPs. Citing erosion prevention, fishing, and other benefits, the farmer continues to build his own projects, and his experience is helping other Amish farm-

Citing erosion prevention, fishing, and other benefits, an enthusiastic Amish farmer continues to build his own projects. Other Amish farmers are becoming more receptive to watershed protection.

In the Upstate New York Watershed, the water utility has partnered with state regulatory agenices and helped to increase community awareness of environmental regulations within the watershed.

ers become more receptive to the association's watershed protection efforts.

Often, the Association helps willing farmers seek financial aid for their BMPs. They turn to local, state, and federal partners such as Conservation Commissions and the Pennsylvania Fish and Boat Commission's "Adopt a Stream" program for financial and technical assistance. The Partners for Wildlife also helps match proposals with funding sources. Recently, the Association received a matched grant with $20,000 from the Pennsylvania Department of Conservation and Natural Resources to fund a comprehensive watershed study.

Cross-Jurisdictional Cooperation: Utility and Government Partnership

Syracuse Water Department
Syracuse, New York

- Primary Source of Water: Skaneateles Lake
- Watershed Area: 73 square miles
- Population Served: 160,000
- Treatment: Chlorination, fluorination
- Partners: County Board of Health, Local Governments, New York State Department of Environmental Conservation

To protect Skaneateles Lake, the Syracuse Water Department (SWD) has negotiated agreements with local, county, and state authorities that have jurisdiction in the Upstate New York watershed. The water system participates in numerous governmental deliberations affecting the watershed's health and in return helps these governments meet their responsibilities.

State Environmental Department Partnership

The SWD and the New York State Department of Environmental Conservation (NYSDEC) have formed a symbiotic relationship: the water system helps the NYSDEC uncover watershed problems, while the state lets the utility review and comment on any shoreline disturbance permit that affects the lake. Rarely does the NYSDEC approve a permit within the watershed without consulting with the utility.

This arrangement began when SWD staff began reporting watershed violations they found during site visits to NYSDEC conservation officers. SWD staff are constantly in the watershed, while the NYSDEC cannot always patrol the watershed for violations. The SWD staff's knowledge of the watershed laws and regulations partnered with the state conservation department's regulatory mission helps watershed residents to know more about the regulations.

County Board of Health Partners

Perhaps SWD's closest working relationship is with the County Board of Health (BOH). The SWD has been designated as the Boards's official representative for observing required septic system percolation tests for septic systems. Any septic system violation found by SWD staff is reported to the BOH for enforcement, which may include a letter of violation, a hearing before the health commissioner, or a fine.

Additionally, most towns cannot approve a building permit without the Board of Health's agreement. The strong partnership between the water utility and the Board of Health has resulted in inclusion of SWD staff in the review of building permits to make sure that they are not in conflict with concerns for water quality.

Local Government Partners

The Skaneateles Lake watershed is located in three counties, seven towns, and one village. The Town of Skaneateles, which is closest to the SWD intakes, has the largest watershed population and the most potential for urban development. Prompted by town residents' concern that the lake's high water quality be maintained, Skaneateles recently rewrote its zoning laws authorizing the SWD to review applications for building permits, subdivision actions, and other zoning issues to ensure compliance with the SWD's Watershed Rules and Regulations. The SWD does not have authority to deny permits, but its recommendations to ensure compliance with the Watershed Rules must be incorporated in the zoning actions.

Skaneateles is the only community that has a formally codified agreement with the SWD; the utility's arrangements with other towns such as Niles, Scott, Sempronius, and Stafford are informal.

Turbidity Prompts Federal and State Cooperation

Salem Public Works Department
Salem, Oregon

- Primary Source of Water: North Santiam River
- Watershed Area: 600 square miles
- Population Served: 150,000
- Treatment: Slow sand filtration
- Partners: North Santiam Watershed Forum, Local Governments, U.S. Army Corp of Engineers, U.S. Bureau of Land Management, U.S. Forest Service

Strong partnerships are critical in the North Santiam Watershed because both public and private land management decisions affect water quality. Most of the 600 square mile North Santiam Watershed is public forest managed for timber and recreational use by the U.S. Forest Service, U.S. Bureau of Land Management (BLM), and Oregon Department of Forestry. The U.S. Army Corps of Engineers operates a reservoir for flood control, power, and recreation in the center of the watershed. There is also a small amount of private forest and farm land in six small communities.

Formalizing Partnerships

Persistent turbidity during two consecutive winters of high rainfall and flooding disrupted Salem's slow sand filtration, forcing the city to use alternate water sources, install temporary treatment systems, and curtail water use. The situation highlighted the importance of the city's source water and prompted the City of Salem Public Works Department and the U.S. Forest Service to negotiate an agreement on the management of Forest Service land in the city's watershed.

The Memorandum of Understanding (MOU) clarifies the management responsibilities and activities of Salem and the U.S. Forest Service to maintain high-quality water for the city's use. As a result, the U.S. Forest Service and Salem agreed upon a joint monitoring program in the watershed, and share equally the costs of operating ten sampling sites. Program details are available on the Internet at http://nwp71.nwp.usace.army.mil/NSRC/Main.html. This monitoring will provide critical information on the quality of the source water and target the areas most in need of management actions.

This monitoring program is already expanding to other parts of the watershed as more agreements are being negotiated with the Oregon Forestry Department, the Corps of Engineers, and BLM. These agreements will coordinate watershed protection efforts, clarify roles and

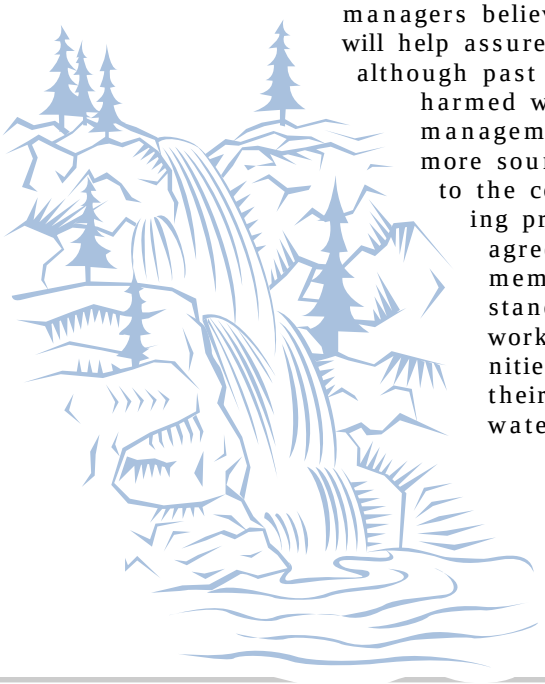
A partnership with the Forest Service has led to increased monitoring of the Santiam River - a task difficult to fund without joint cooperation.

Active participation in the North Santiam Watershed Forum has resulted in more agreement among community members as to the importance of drinking water protection.

responsibilities, and promote the parties' greater participation in management decisions affecting water quality.

Watershed Forum Partnership
Besides cooperating with public land managers, the Salem Public Works Department has been active in the North Santiam Watershed Forum, a voluntary watershed council established under Oregon law. The group represents such interests as timber production, agriculture, local enterprise, cities within the watershed or dependent on it, environmentalists, recreation, and local residents. It is guided by a 13-member interest-based steering committee with a mission to "provide opportunities for stakeholders to cooperate in promoting and sustaining the health of the watershed and its communities."

Salem City Partnership
Salem Public Works wants the North Santiam River to remain a high-quality water source. This has been the catalyst for cooperation in all of these efforts. Local communities joined in after realizing that cooperation can give them a greater voice in reducing potential local economic and ecological impacts. Public and private land managers believe that cooperation will help assure the public that, although past practices may have harmed water quality, new management practices are more sound. They are looking to the cooperative monitoring program and formal agreements such as the memorandum of understanding as a means to work with the communities so dependient on their lands for drinking water.



Landuse Planning Partnerships

San Francisco Public Utilities Commission
San Francisco, California

- Primary Sources of Water: Tuolumne River; Rattlesnake, and Moccasin Creeks (Hetch-Hetchy Watershed System)
- Watershed Area: 760 square miles
- Treatment: 3 reservoirs filtered, 3 reservoirs unfiltered
- Partners: California Department of Health Services, California Highway Patrol, Community Health Service District, County Planning and Environmental Health Organizations, Hetch-Hetchy Watershed Working Group, National Park Service, Regional Water Quality Control Board/Central Valley Region, U.S. Bureau of Land Management, U.S. Environmental Protection Agency

The San Francisco Public Utilities depends upon six reservoirs in the Hetch-Hetchy watershed system. Four of the reservoirs are in watersheds that include Yosemite National Park, the Stanislaus National Forest, and the National Forest System's Emigrant Wilderness.

As of 1998, three reservoirs are considered high-quality water sources. These reservoirs are exempt from filtration requirements under the condition that there are effective local controls on human activity that may have an adverse impact on the microbiological quality of the source water. Effective management is critical to maintaining water quality. To continue meeting the requirements of the Federal Safe Drinking Water Act Surface Water Treatment Rule and maintain the filtration avoidances, the San Francisco Public Utilities Commis-

sion (SFPUC) conducted a watershed sanitary survey and has developed a watershed management plan.

Stakeholder Involvement

The plan calls for a watershed working group to begin meeting periodically until the management plan is well underway. The philosophy of the Hetch-Hetchy Watershed Working Group is to include any potential stakeholder in the group. Informing un-interested parties is better than to risk excluding a potential stakeholder. The watershed working group has solicited input from the numerous stakeholders involved. The management plan's success depends on coordination between the key watershed partners and other agencies with watershed-related responsibilities. Some of the partners are agencies that administer the watershed lands: the National Park Service (NPS); U.S. Forest Service (USFS); and the U.S. Bureau of Land Management.

Recognizing the burden of coordinating the numerous partners and constituents affected by the working group's decisions, SFPUC provides staff to develop background information on technical issues, coordinate exchanges of information, and keep the watershed management plan's components on schedule.

The watershed workgroup will investigate such issues as the availability of funds, the amendment of the Stanislaus National Forest Land and Resources Management Plan to provide specific direction for the Emigrant Wilderness, the benefits and constraints of designating a watershed a "Sensitive Watershed," and an identification of "data gaps" within the watershed system.

Formal Partnerships with the National Park Service

The Raker Act of 1913 laid out certain recreational use guidelines. For example, building a fire and disposing of wastes are prohibited within 300 feet of a waterway, and contact recreation is banned.

However, the utility and the National Park Service. are working on a formal memorandum of understanding (MOU) because of the potentially competing missions of the utility and NPS. Protecting drinking water quality is foremost for SFPUC, while encouraging access and recreational use are goals of the NPS. Some potential conflicts involve horse corrals within the watershed, improperly functioning toilets in the park, and responsibility for water quality monitoring.

The current agreement has principles and stated objectives taken from other working documents including the NPS charter and SFPUC's planning document. The California Department of Health Services will give advice on the MOU during its final stages of preparation. The MOU will be a formal, signed agreement, enforceable at the State level.

Extending to Other Partners

After the MOU with the National Park Service is complete, the utility will begin work on an MOU with the Forest Service regarding a potential future water supply on Forest Service land. The reservoir on USFS lands represents only a small portion of San Francisco's water supply and has been used

The philosophy of the Hetch-Hetchy Watershed Working Group is to include any potential stakeholder in the group. Informing uninterested parties is better than to risk leaving anyone out.

Approximately 10,000 students a year visit Seattle's source watershed to learn the connection between their drinking water and land use.

only twice for drinking water use during droughts. During those times, the Forest Service was very cooperative in restricting boats on the reservoir. However, a formal MOU will result in a common set of water quality standards intended to protect drinking water sources.

Local Involvement

A benefit to working at a local level and involving community members in assessment efforts is that it has increased public support of drinking water protection measures. Since many of the critical protection tools are under local control, particularly regarding landuse management, public support is important.

Educating Children About the Watershed

Seattle Public Utilities
Seattle, Washington

- Primary Source Watersheds: Cedar River Watershed, South Fork Tolt Watershed
- Watershed Areas: 90,495 acres (Cedar River), 13,390 acres (South Fork)
- Population Served: 1.2 million
- Treatment: Chlorinated, unfiltered
- Partners: Friends of the Cedar River Watershed, Seattle Schools

The educational program of the Seattle Public Utilities (SPU) focuses on fourth and fifth graders in the city's schools. The utility brings about 10,000 students a year in to the watershed, where for over 3 hours they participate in hands-on activities related to watersheds, the water cycle, wildlife, history, erosion, and forestry.

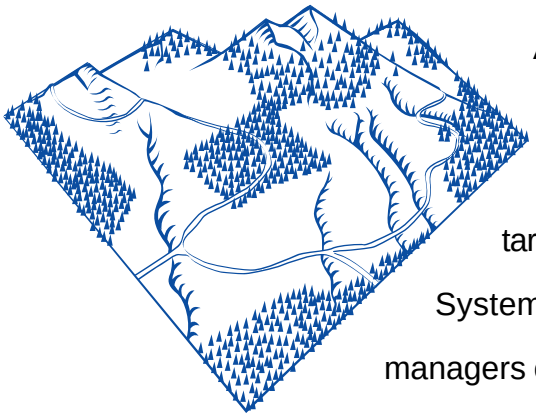
The utility also provides opportunities for middle and high school students to visit the South Fork Tolt Watershed. This program focuses on water quality, water treatment, and cooperative land management.

SPU hopes to expand its educational program and construct an educational center in the watershed in partnership with the nonprofit Friends of the Cedar River Watershed. They will be instrumental to gaining public support and raising funds.

Program Costs

Approximately $250,000 is spent annually on education and public programs. The Seattle Education and Public Programs section requires three full time staff, two naturalists and the public programs supervisor. This number is expected to increase to five full-time staff over the next few years.

Chapter 2
Watershed Assessment



An integral part of a strong watershed protection program is an assessment of the area. Watershed delineation and assessment will help identify potential problem areas and target protection efforts. Many utilities use Geographic Information Systems (GIS) to delineate their watersheds. Afterwards, local managers can use zoning maps to identify land use patterns within the watersheds and identify potential sources of contamination that pose threats to the drinking water supply.

A comprehensive monitoring plan also can help identify watershed problems. For example, a monitoring station that consistently detects elevated nitrate levels could be used to identify a local source of contamination.

Monitoring information can also demonstrate a project's success. A site that historically had elevated nitrate levels that shows a distinct decrease after an upstream farm implemented best management practices (BMPs), can convince community members and local governments that BMPs have tangible benefits.

The case studies of Boston, Portland, and Philadelphia describe the delineation, assessment, monitoring, and planning approaches that they have taken to develop watershed protection programs.

A comprehensive monitoring plan can help identify watershed problems or demonstrate a project's success.

Planning with Geographic Information Systems

Massachusetts Water Resources Authority
Boston, Massachusetts

- Primary Sources of Water: Quabbin and Wachusett Reservoirs
- Watershed Area: Quabbin, 187 square miles; Wachusett, 110 square miles
- Population Served: 1,932,000

The Massachusetts Water Resources Authority (MWRA) treats and distributes water from 3 surface sources to more than 2 million people in Boston and 45 neighboring communities. Another agency,

the Metropolitan District Commission (MDC), is responsible for managing and protecting the watersheds.

Watershed Mapping

Geographic Information Systems (GIS) help MWRA and MDC staff create maps and analyze data. For example, the agencies use GIS to identify pollution sources and prepare watershed protection plans; support the passage and implementation of watershed protection legislation; and target for purchase parcels of land important for watershed protection.

From 1988 to 1992, MWRA and MDC staff extensively studied the 400 square miles of watershed that provide water to the city—identifying, mapping, and ranking existing or potential pollution threats. Among them were septic systems, recreational activities, storm water runoff, logging, petroleum storage, and natural impacts such as erosion and animal populations. Based on this analysis, planners drew up watershed protection plans, which included recommendations for addressing current and future contamination sources.

Assessment to Legislation

In 1992, following six years of debate, the Massachusetts legislature passed the Watershed Protection Act. The intensive mapping effort aided passage of the Act by showing the relatively small size of the proposed buffers and the importance of protecting these areas, according to the MWRA's planning director.

The Act prohibits any land-disturbing or polluting activities, including most new construction, within 400 feet of drinking water reservoirs and 200 feet of tributaries and surface waters. It also restricts certain activities, such as the storing of harmful materials, in an area 200 to 400 feet from tributaries and surface waters, flood plains, over some aquifers, and within bordering vegetated wetlands.

GIS Benefits for Management

Mapping tools have also helped during implementation of regulations. For example, the MWRA gave a map to each watershed community showing the parcels of land affected by the regulations. The authority also used this information to inform the 5,000 to 6,000 owners of land within the buffer zones about the new restrictions. The notifications took several years, and the effort paid off in good relations with the communities and the affected property owners.

The MWRA, MDC, and other state agencies have used GIS to identify land that should be purchased to aid watershed protection and other activities. The software enables users to compare parcels based on specified characteristics and to rank land for which they have GIS data to identify "high value" lands for purchase. Such targeting is necessary because agencies often must meet the market prices offered by developers, and state funds for land acquisition are limited.

Mapping and assessment aided the passage of the Massachusetts Watershed Protection Act by showing the relatively small size of the proposed buffers and the importance of protecting these areas.

Monitoring Data to Support Protective Water Quality Standards

Portland Water Bureau
Portland, Oregon

- Primary Source of Water: Bull Run Watershed
- Watershed Area: 102 square mile drainage area above intake, 40 square miles of buffer lands
- Population Served: 800,000
- Treatment: Screened, disinfected, unfiltered

The Portland Water Bureau draws its water from the Bull Run River in the Mt. Hood National Forest. The watershed is administered by the U.S. Forest Service (USFS)

under several legal authorities including the Bull Run Management Act (P.L. 95-200) and the recently amended Oregon Resources Conservation Act, which tightly restricts timber harvesting in the watershed.

The Bull Run Management Act sets the production of pure, clean, raw, potable water as the principle federal management objective for the area. Specific water quality standards established under the Act are more stringent than the Forest Service's national standards. Consequently, the Forest Service must adopt standards specific to the Bull Run watershed that provide a greater level of protection.

Monitoring has led to better management and cut costs incurred from sediment entering the unfiltered water system during storm events.

Monitoring Responsibilities

The USFS, the Portland Water Bureau, and the U.S. Geologic Survey (USGS) share responsibility for sampling, data collection and analyses, and database management. The Portland Water Bureau pays for all lab analyses and shares equally with the USGS the costs of streamflow data collection and management. The USGS participates in the program because it furthers the survey's mission to collect streamflow and water quality data.

Monitoring Objectives

Monitoring is critical to unfiltered water systems, serving as an early warning of turbidity-producing events such as landslides and storm-induced erosion. By tracking turbidity levels during and after these events, facility operators can either divert heavily contaminated waters or temporarily switch to an alternative ground water source.

The key monitoring stations are at the mouths of five major sub-basins of the Bull Run River. Four are on major tributaries, and the fifth is where water from the river is diverted into water supply conduits. Some monitoring is done weekly, while some is automated and flow-based. Flow-based monitoring collects random samples; the probability of a sample being collected increases at higher flows.

Monitoring Objectives

Turbidity

- Anticipating, including the use of probability analysis, and tracking high-turbidity events.
- Determining source water turbidity compliance.
- Evaluating the potential for generating turbidity within the Bull Run reservoirs; tracking changes in turbidity with drawdown.

Demand and Supply

- Tracking the effects of management activities in order to modify current practices and to inform future management decisions.
- Tracking, forecasting, and improving the forecasts of seasonal supply.
- Monitoring the effects of releases from Bull Run Lake.
- Assessing Bull Run Lake safety (risk of overtopping).

Microbial Risks

- Assessing and improving understanding of microbial risks.
- Tracking and (limited) controlling of factors related to bacterial regrowth in the distribution system.

Other Water Quality Problems

- Tracking seasonal changes in factors that affect disinfection efficacy.
- Determining levels and trends in the concentration of disinfection byproduct precursors.
- Tracking seasonal changes in factors that affect corrosion control.
- Evaluating the potential for aesthetic water quality problems to develop.
- Detecting long-term shifts in water quality that could affect the quantity or quality of water delivered, or that could require treatment adjustments or other operational changes.

Abandoned Road Management

There are thousands of miles of roads within national forests that are in disrepair. In many cases, these are impacting on water quality. These roads are being prioritized for de-commissioning, which can mean anything from full restoration to merely planting trees to control erosion.

The Portland Water Bureau has installed temporary monitoring stations located above and below abandoned road management project locations in the Bullrun Watershed. The utility is collecting data to estimate the sediment loading from these management efforts to identify which decommissioning techniques have the least impacts on water quality as well as help quantify the extent to which abandoned roads that are neither maintained nor decommissioned impact upon the water quality.

Assessing Potential Contaminants: Monitoring and Modeling

Philadelphia Water Department
Philadelphia, Pennsylvania

- Primary Sources of Water: The Delaware River and Schuylkill River watersheds, which include nine local streams and several reservoirs.
- Watershed Area: The Delaware River and Schuylkill River watersheds are 13,000 and 1,892 square miles respectively
- Population Served: 1,500,000
- Treatment: Disinfection, filtration

The Philadelphia Water Department (PWD) participates in partnerships with state and federal studies of the Wissahickon Creek. A collaborative effort to develop an integrated environmental monitoring and data management system has led to a stronger understanding of the contaminant threats in the watershed.

The Wissahickon Creek Study: Linkages Between Land Use and Micro-Organisms

The Wissahickon Creek is an urban and suburban watershed which has seen significant development over the last quarter century. The land use changes have included the loss of almost all the agricultural land and increases in single and multiple family dwellings.

The 22-mile long creek currently has approximately 21 permitted discharge facilities, including 5 township or municipal wastewater treatment plants. Water quality, biological conditions, and sediment loads have not been adequately characterized.

To address these watershed health issues, the utility became involved in the Wissahickon Partnership. This group includes approximately 120 stakeholders commited to data collection to better understand the watershed.

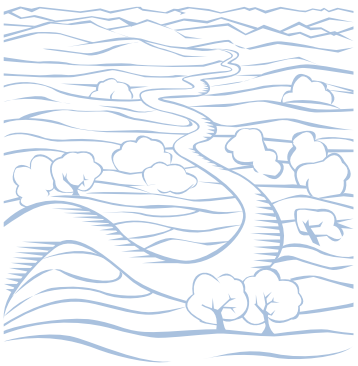
One partner is the Pennsylvania Department of Environmental Protection's (PADEP). The Department's Southeast Regional Office and Bureau of Labs began a Wissahickon Creek water quality study to determine the sources, occurrence, fate, and transport of the mirco-organisms *Giardia* and *Cryptosporidium* in the watershed.

Microbial Research

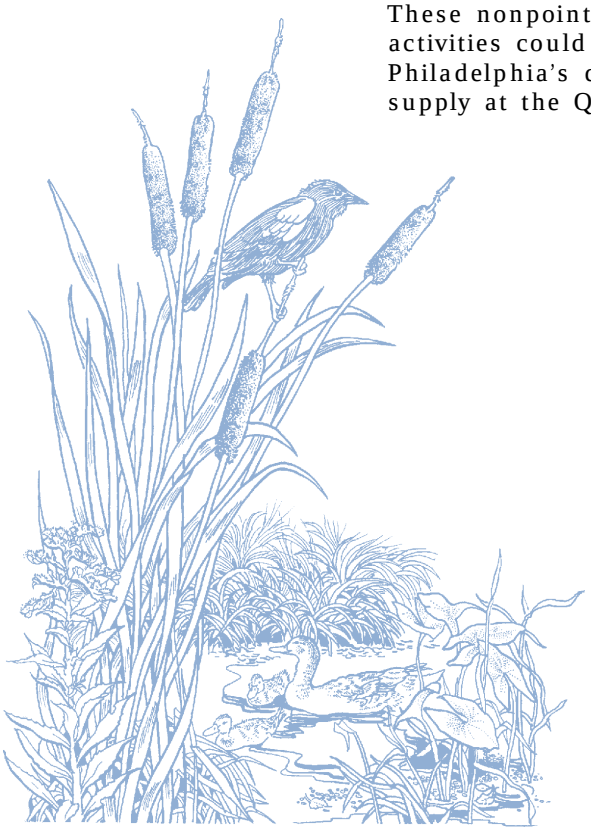
Cryptosporidium and *Giardia*, are of great concern to the drinking water industry because they can cause serious gastrointestinal disease. More information about the occurrence and removal of these micro-organisms from sources of drinking water is crucial.

The results of the Wissahickon Creek study complement a growing

Monitoring results are helping to support de-commissioning of abandoned roads that are significantly impacting water quality.



The results of a Wissahickon Creek water shed assessment complemented a growing body of research suggesting that wastewater is a constant and significant source of *Cryptosporidium* and *Giardia* in a watershed.



body of research suggesting that wastewater is a constant and significant source of *Cryptosporidium* and *Giardia* in a watershed and can contribute detectable amounts of the protozoa to the water column during stable flow periods.

The original 1996-1997 Pennsylvania study focused on contribution of *Giardia* and *Cryptosporidium* by point sources, such as wastewater treatment plants, under stable flow conditions. To provide a better understanding of protozoa contribution, fate, and transport, research in 1998 and 1999 will measure the contributions of the Schuylkill River and Wissahickon Creek to *giardia* and *cryptosporidium* occurrence at the drinking water facility intake.

Total Maximum Daily Loads

The state of Pennsylvania selected the Wissahickon Creek as a pilot site to be the first watershed in Pennsylvania to develop a Total Maximum Daily Load (TMDL) that includes nonpoint source controls. These nonpoint source watershed activities could potentially impact Philadelphia's drinking water supply at the Queen Lane Water Treatment Plant. Accurate TMDL modeling will help to identify some of the pressing threats to the drinking water supply.

Watershed Modelling

Lending to the watershed study, the National Institute for Environmental Renewal (NIER) is developing a watershed model for the Wissahickon Creek. NEIR hopes the model will address the watershed's myriad of water quality problems, as well as help quantify the geomorphology and hydrology of the watershed. This includes an inventory of storm water discharge pipes, obstructions, channelization features, and nonpoint sources of pollution.

Chapter 3
Land Use in Watersheds: Rural, Urban, and Natural Resource Management

No matter where the source of drinking water, challenges arise concerning the predominant land uses in the area. Rural, urban, forested and/or farmed lands present different challenges.

Utilities whose water sources are in a forested area usually must contend with logging, erosion, and timber management. Systems whose sources are in rural or suburban areas may need to deal with septic systems, agricultural run-off and erosion, or recreational uses such as swimming, hiking, and mountain biking. Utilities that have water sources in urban areas need to address issues such as storm water drainage, run-off from pavement, and increasing development.

This chapter looks at agricultural land use, urban storm water management, septic systems and waste management, and habitat conservation. The solutions range from simple, creative ideas that other systems can easily adopt, to capital-intensive projects which require significant funding commitments. The most useful solution for any drinking water system will depend on many factors, including the particular land use issues it faces and the intensity of the threats posed to the system's source water.

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Agricultural Land Use Issues

Water systems in primarily agricultural areas face a host of issues different from those that confront their urban counterparts. Nonpoint source pollution from irrigated and nonirrigated crops, feedlots, and animal waste management areas can threaten drinking water sources. Other agricultural activities such as the application of fertilizer or pesticides can introduce nutrients, pathogens, and toxic chemicals into drinking water. Tillage practices can contribute to erosion, which can lead to problems with surface water turbidity.

Contaminant source management is one means to reduce agricultural nonpoint source pollution. Some of the case studies in this chapter show how utilities have implemented best management practices (BMPs) to deal with pollution and erosion, or have

developed ways of involving and educating the farming community in source water protection.

Storm Water Management

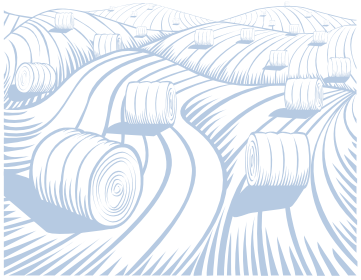
Systems whose water sources are in or near urban areas are challenged by storm water runoff. Runoff from impermeable surfaces such as concrete and pavement, may be contaminated with various chemicals, including oil and grease from motor vehicles and related sources, as well as pesticides and herbicides applied to lawns and landscaping.

Waste Management

Where septic systems are the primary method of treating sanitary waste, water systems have the added concern of leaking or improperly functioning septic tanks. Poorly maintained septic systems can contaminate ground water and surface water with nutrients, chemicals, and pathogens.

Habitat Conservation

The mission of a drinking water utility is to provide clean, potable water to its customers. This goal often overlaps with other public interests such as the restoration or conservation of habitat for fish and wildlife. Frequently, what is good for habitat preservation is also good for source water protection.



Agricultural Land Use Management

Department of Environmental Protection
New York City, New York

- Primary Sources of Water: Croton Watershed; Catskill and Delaware Watershed (includes 19 reservoirs)
- Watershed Area: 1,969 square miles
- Population Served: 9,000,000 (includes some upstate communities in addition to New York City)
- Treatment: Croton: Chlorinated, filtered (scheduled); Catskill/Delaware: Chlorinated, disinfected, unfiltered

New York is one of the most densely populated cities on the planet, and its drinking water comes from miles away in a rural setting of forests, farms, and hamlets. Agriculture, especially dairy and livestock operations, may be a significant source of microbial pathogens, nutrients, and other surface water pollutants. Managing agricultural runoff is crucial to the city's watershed protection program.

Farmers Lead Council

To promote the use of agricultural best management practices (BMPs), the New York City Department of Environmental Protection (DEP) funds the voluntary Watershed Agricultural Program.

Founded in 1993, this progam is administered by a not-for-profit Watershed Agricultural Council of farmers. The leadership provided by this council has been key to gaining the acceptance of farmers who have long mistrusted DEP.

The council determines how funds will be spent and reviews and approves whole farm plans. Whole farm plans are prepared by local teams made up of staff from the county Soil and Water Conserva-

Founded in 1993, the voluntary Watershed Agricultural Program involves stakeholders in organizing, implementing, and managing the agricultural program in the watershed.

tion District, Cooperative Extension Service, and the federal Natural Resources Conservation Service. Farmers play a major role because local acceptance of the recommended practices is crucial to the plan's success.

The water utility has committed $35.2 million to support the program from 1995 to 1999. Among the activities funded are whole farm planning, design, and engineering; implementation and construction of BMPs; program management, administration, and outreach; and research and technical support for the farmers. By 1997, 287 out of 350 eligible farms in the Croton Watershed signed on to the program. Of these, 155 completed whole farm plans and signed implementation agreements.

Establishing an independent Watershed Agricultural Council as the program's central administrative agent was important to gaining acceptance from the farm community.

The Multiple Management BMP Approach

Whole Farm Planning takes a "multiple management approach to best management practice planning and implementation.

Examples of three barriers are:

1. **Pollutant Source Controls**. Herd health maintenance, improvements in sanitation and calf housing, soil sampling, management of grass or hay production to reduce the need for excess fertilizer, and Integrated Pest Management to reduce pesticide use.

2. **Landscape Controls**. Barnyard improvements, manure storage, scheduled and direct spreading of manure, and composting to control the application of animal waste to the land.

3. **Stream Corridor Controls**. Streambank stabilization, stream crossings, animal watering systems, and vegetated buffers to keep animals out of watercourses and to slow and reduce the transport of pollutants into watercourses.

Best Management Plans

The Croton Watershed spreads across many jurisdiction and water quality is affected by multiple land uses ranging from agriculture to urban stormwater runoff. At the start, institutional cooperation across county lines and coordination among federal, state, and local agricultural agencies was weak.

For example, historically there were few ties between the Soil and Water Conservation Districts and the Cooperative Extension Service offices. The former traditionally worked with farmers on implementing U.S. Department of Agriculture conservation practices, while the latter focused on agronomic issues such as maximizing productivity and crop yields. Now, staff from both agencies help farmers develop whole farm plans, using the Conservation District staff's knowledge of BMPs and the Cooperative Extension Service's expertise in assessing the impact of BMPs on a farm's economic viability.

The economic advantages of BMPs and whole farm planning are more apparent as the program evolves. Most of the BMPs conserve farm resources while protecting New York's source of drinking water. More efficient use of fertilizer reduces costs and nutrient concentrations in water. Similarly, improved sanitary conditions for livestock reduces disease in the animals, which saves costs and reduces pathogen levels, thus protecting waterways.

Monitoring projects are underway to measure the program's impact on water quality in the watershed. The results will be used to calibrate individual, farm-specific models of water quality impacts.

The Interface of Agricultural, Urban and Wildlife Needs

Contra Costa Water District Concord, California

- Primary Sources of Water: Sacramento and San Joaquin Rivers
- Watershed Area: 18,500 acres (Los Vaqueros Reservoir only)
- Population Served: 400,000

The northern California Contra Costa Water District (CCWD) supplies water to over 400,000 people in Contra Costa County. The sources of the drinking water come from the Central Valley, including the Sacramento and San Joaquin River watershed.

Regulatory Process Involvement

To address source water protection, the Contra Costa Water District incorporated a Water Resources Group into the organization's planning department. This group is active in Central Valley source water protection, participating in hearings of the Central Valley Regional Water Quality Control Board, which issues National Pollutant Discharge Elimination System permits. CCWD also participates in the National Environmental Policy Act and California Environmental Quality Act public comment process to address industrial and municipal wastewater discharges.

Pollutant Discharge Reduction

Also, working with other stakeholders, CCWD has sought to reduce agricultural drainage and to minimize pollutant loads from abandoned mines in those areas affecting source water. The utility has worked on numerous programs ranging from incentives for the mitigation of agricultural drainage discharges, pilot studies to treat agricultural drainage before discharge into the Delta, mine drainage remediation, and land retirement.

Voluntary Management: Grasslands Bypass Channel Project

High concentrations of naturally occurring selennium in ecologically sensitive waters has been a problem in the region for some time. Agricultural drainage channels are one source of the sellenium loading. An attempt to address the problem was to construct the San Luis Drain, a concrete channel to divert agricultural irrigation discharges from sensitive areas. However, the Bureau of Reclamation halted construction when it was found that the new discharge area was being negatively impacted.

A compromise was reached, which allows farmers to use part of the constructed San Luis Drain to divert selenium-rich water from the ecologically sensitive Grassland Wildlife Refuge. In exchange for this right, the farmers accept selenium load limits on their discharges under a Waste Discharge Requirement. These permits have resulted in lower selenium loadings to the San Joaquin River, one of the sources of drinking water for Contra Costa County.

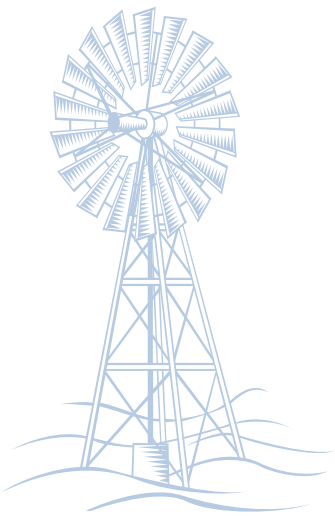
Based on the monitoring results for the first two years and the significant measures taken by the farmers to reduce the quantity of selenium in their disharges, the terms of the 1996 Bypass Use Agreement have been extended until 2001.

Los Vaqueros Reservoir Project

CCWD owns approximately 18,500 acres surrounding the Los Vaqueros Reservoir, newly constructed in 1998. The district is negotiating land management agreements with the owners of the remaining land

Agricultural drainage management has led to reductions of sellenium-laden discharge to the San Joaquin river.

Grazing management instituted to protect water quality also provides habitat for wildlife such as the San Joaquin Kit Fox.



affecting the reservoir to protect the water quality.

In May 1997, the CCWD Board of Directors adopted a Watershed Management Program to address environmental, contractual, and public safety requirements and to guide land management activities asosciated with the Los Vaqueros Reservoir. One component of the management plan involves agriculture and grazing.

Grazing Management

The agriculture program allows for a moderate amount of managed grazing inside the reservoir watershed. CCWD manages and enforce the grazing requirements on their land. Grazing and farming is allowed where biological resource commitments and fire management needs are critical and the potential risks of water quality degradation are low. For example, CCWD is committed to maintaining the habitat of the San Joaquin kit fox; properly managed grazing will provide habitat for the fox's prey.

Phase I of the agriculture program specifies nine grazing leases, encompassing approximately 11,000 acres. Most of these areas have been grazed by ranchers for hundreds of years. The program consolidates and re-configures the leases to minimize impacts to environmental resources and reservoir water quality. Fencing along all major tributaries of the reservoir keeps cattle out of the water and provides a vegetative buffer between the grazed areas and the tributaries.

The effects of the program's first phase on water quality and environmental resources will be closely monitored. A program to monitor water quality for bacteriological, nutrient, inorganic, and organic parameters began in 1997 at five key locations. The findings of the water quality monitoring may lead to legal changes in grazing within the watershed.

Partnerships for Modeling

CCWD is a partner in the Bay-Delta Modeling Forum, a statewide, nonprofit, nonpartisan consensus-building organization. CCWD staff have served as officers on the steering and technical committees.

The forum's mission is to increase the usefulness of modeling for analyzing water-related problems in the San Francisco Bay, the Sacramento-San Joaquin Valley, and the Central Valley system. The forum maintains a modeling clearinghouse and assists in mediating technical disputes and provides educational opportunities.

Although the modeling forum has yet to hold any workshops specifically on source water protection, its workshops on the modeling of flow and transport in the Delta help to provide a better general understanding of the relationship between discharges and water quality at urban intakes.

Control of Land Use in the Drinking Water Source Area

Los Angeles Department of Water and Power
Los Angeles, California

- Primary Sources of Water: Owens River/ Mono Basin and Open Distribution Reservoirs
- Watershed Area: about 2.2 million acres
- Population Served: 3.7 million
- Treatment: Chlorinated, aerated

Among the diverse components of its water supply and delivery system, the City of Los Angeles has two components of the system that pose unique water quality challenges: the Eastern Sierra watershed, comprised of the Owens Valley and Mono Basin watersheds, and in-City open distribution reservoirs. The Eastern Sierra watershed furnishes raw water

from mountain snowmelt and natural springs. The open distribution reservoirs in the city are uncovered reservoirs that contain finished water, but are subject to on-site water quality degradation.

Eastern Sierra Watershed

Approximately 2.2 million acres of Eastern Sierra watershed supplies the city of Los Angeles with water. The U.S. Forest Service, U.S. Bureau of Land Management and the Los Angeles Department of Water and Power (LADWP) own 98 percent of this land. Of this, the LADWP owns 314,000 acres, primarily on the Owens Valley floor. The LADWP leases 260,000 acres to citizens for such diverse uses as ranching, commercial ventures and recreation.

Ranch Leases

Ranch leases comprise 247,000 acres of the Eastern Sierra land leased out by the LADWP. Of that, 2,200 acres are under cultivation with alfalfa, 20,000 acres are irrigated pasturelands, and the remainder is used for dry grazing. Most LADWP ranch lessees also have permits with the U.S. Forest Service or U.S. Bureau of Land Management for livestock grazing. The LADWP lease is considered the rancher's "base property." Without it, a rancher cannot obtain a federal permit.

Lease policies are set forth in the *Range Management Guidelines for DWP Leased Lands,* and are designed to protect the City's watershed and water quality. In addition, individual Ranch Management Plans are being prepared jointly with each of the lessees. Ranchers serve as the land stewards of the watershed, and the LADWP ensures that their ranching practices are compatible with the LADWP's objectives. Department staff conduct informal, routine inspections to ensure the guidelines' requirements are satisfied. Vegetation, livestock use, and water quality are monitored regularly.

Users of the leased land must follow range management guidelines that require all livestock, salts, and supplements for animals to be kept away from water sources and riparian zones. They are required to consult with LADWP prior to initiation of water diversions, and they must adhere to irrigation practices that minimize runoff, return flows, and erosion. The county agricultural commissioner administers pesticide and herbicide use permits. A farm advisor from the University of California and a Federal Soil Conservation Service representative periodically consult with the lessees on crop production and range management issues.

Commercial Leases

Typically 5 years in duration, commercial leases affect business and commercial town properties in the area. Urban expansion on these lands conforms to Inyo County's General Plan. This includes a land use policy to manage the ground water basins to ensure water quality and quantity for beneficial uses. The county wastewater policy follows the Uniform Plumbing Code or the Regional Board Guidelines for the proper installation of septic tank systems.

Recreation

Activities in un-developed watershed areas in the Owens Valley and Mono Basin are considered to have minimal impacts on surface water quality. Signs indicating private property and prohibiting overnight camping are clearly posted throughout the city-owned lands. Motor boats are allowed on two reservoirs. Monitoring for the gasoline additive Methyl Tert-Butyl Ether (MTBE) has been conducted at these locations, however none was detected. Waste receptacles, portable toilets and regular patrolling of the reservoir perimeters help protect water quality.

Of the 314,000 acres of watershed owned by the utility, 230,000 acres are under land management control through leases to farmers or ranchers.

Restricting public access has made it easier to identify or trace potential sources of contamination in the source watershed.

Land use management by the Los Angeles Department of Water and Power has allowed multiple use of the natural resources to continue while minimizing threats to public health.

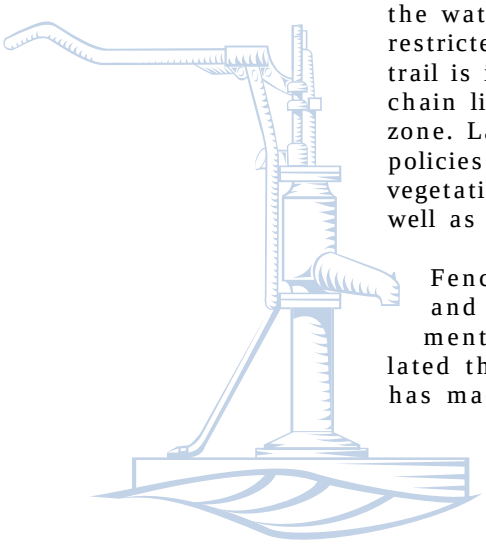
Open Distribution Reservoirs

LADWP is one of the few utilities that have open distribution reservoirs to hold treated water. Four of the LADWP's 10 open reservoirs are influenced by surface runoff and, therefore, are subject to the Surface Water Treatment Rule. LADWP's source protection program for these four large distribution reservoirs formally began in 1989. LADWP will continue operating the reservoirs under a compliance agreement with the California Department of Health Services (DHS) until treatment facilities are built. The reservoirs store almost 8 billion gallons, and their watersheds total 1,683 acres, mostly LADWP property.

Although the treated water in the reservoirs is chlorinated at each reservoir outlet, the California DHS designates the reservoirs as raw source waters and has directed the LADWP to develop a monitoring program and watershed management practices accordingly. LADWP leaves undeveloped the land in the watershed it owns at each reservoir, and has monitoring programs at the reservoirs similar to a raw source water monitoring program.

Restricted Access

Except for a jogging trail on one of the watersheds, all access is restricted to the public. The jogging trail is isolated from the water by a chain link fence and a small buffer zone. Land use restrictions include policies on the management of vegetation, soil, and erosion, as well as on the use of pesticides.



Fences between the watersheds and most nearby land developments have significantly isolated the reservoirs. This situation has made it easier to identify or trace potential sources of contamination. LADWP has implemented remote systems to monitor the reservoirs for indications of potential water quality problems such as algae blooms.

Proactive Planning for Urban Growth

Metropolitan Water District of Southern California

Primary Sources of Water: California State Water Project and the Colorado River

Watershed Area: Lake Matthews, 39 square miles; Colorado River Basin, 150,000 square miles; California State Water Project, 42,000 square miles

Population served: 16 million

Treatment: filtered, disinfected

Developed in cooperation with representatives of the local county, the Flood Control and Conservation District, landowners, and a residential developer, the Metropolitan Water District developed a drainage management plan. This plan aims to mitigate the impacts that development of the surrounding watershed has on reservoir water quality. Although the Lake Matthews Watershed and Colorado River Basin are sparsely populated, they lie in the path of expanding growth. Urbanization of the watershed is expected to increase loadings of heavy metals, pathogens, sediments, oil, and grease.

The first phase of the drainage management plan focuses on the Lake Mathews reservoir. Lake Mathews is an 180,000 acre terminal reservoir for imported Colorado River water. The surrounding 39-square-mile watershed is drained by Cajalco Creek, which feeds into Lake Matthews.

One key element of the Lake Matthews management strategy is to use a series of wetlands to help "cleanse" water from first-flush and nuisance flows as well as to provide wildlife habitat. Next, the water would flow into a constructed water quality pond to provide a first-flush diversion facility, and then into a sediment basin to capture bed load

sediment before it enters Lake Matthews. Lastly, there are plans to construct a dam and detention basin designed to regulate 100-year peak flood flows from Cajalco Creek.

Multiple Challenges Require New Tools

Salt Lake City Corporation, Department of Public Utilities

Salt Lake City, Utah

- Primary Source of Water: Wasatch Canyons
- Watershed Area: 95 square miles (Provo River Watershed is 500,000 acres)
- Population Served: 400,000
- Treatment: Disinfected, filtered

The Salt Lake City economy is booming and development is unprecedented. Recreational tourism and changing land use practices, construction of new homes and exapnsion of urban areas, is affecting water quality and impacting public drinking water supplies.

Increased use is giving rise to more coliform bacteria in canyon streams. Although well within acceptable limits, the increased coliform counts indicate a degradation of water quality, raising concerns over the future of the ecosystem.

This is why Salt Lake City invests in source water protection. Drinking water source protection is essential to the multi-barrier approach to water quality. The ability to provide high quality drinking water depends on the protection of raw water. Not only is this protection essential, it is the most cost-effective barrier to waterborne disease.

History of Drinking Water Source Protection

Salt Lake City's watershed protection efforts date back to the early 1900's. Sanitary surveys, watershed ordinances and canyon patrols have been used by the city since 1911 to protect the quality of its drinking water. Federal legislation (Public Law 199) was passed by Congress in 1914 requiring the U.S. Forest Service to manage the federal lands within the Provo River watershed cooperatively with Salt Lake City to protect the drinking water supply from pollution. Various court decrees have adjudicated the water rights in the Salt Lake valley.

Additionally, Salt Lake City has numerous exchange agreements with farmers who hold the early water rights to the waters flowing from the Wasatch Canyon watershed. Under these exchange agreements, the city provides the farmers with water stored in Utah Lake in exchange for high-quality mountain water for the city's drinking water. The exchanges are mutually beneficial to the city and the farmers. The city needs the higher quality water for municipal drinking water, while the farmers need a more dependable water supply to mature their crops during the late growing season and during droughts.

Salt Lake City, under state law, has extraterritorial jurisdiction to protect its watersheds and water supply. Under this state authority, ordinances have been passed and enforced by the city to manage the watershed lands that are not municipally owned. It regulates uses in the surrounding canyons including Little and Big Cottonwood, City Creek, and Parley. Hiking and camping are allowed, but overnight campers must stay 200 feet from any water source. In watershed areas, the city prohibits dogs, horses, and grazing, and it does not allow septic systems.

Economic development poses challenges to drinking water source protection.

Drinking water source protection is essential to the multibarrier approach to water quality.

Seeking public input on changes to the master plan, the utility organized a series of meetings and publicized them on the Internet, public access television, in newspapers, and in fliers.

Anyone caught polluting the city's drinking water supply, regardless of land ownership, may be fined.

New Challenges

Salt Lake City Public Utilities is updating its 1988 watershed master plan to reflect increasing recreational use and development of the watershed, which pose challenges to the watershed's protection. There is limited unappropriated water available in the watershed, and there are growing development pressures. For instance, Little Cottonwood Canyon has two world-class ski resorts, and 9,000 cars travel into the canyon each winter day.

Private landowners in the watershed do not automatically own the rights to water on their sites. Most canyon water rights are owned by Salt Lake City, either by title or through exchange agreements. Developers interested in watershed property must obtain water rights to build. Subject to certain restrictions, water sales agreements can be made with Salt Lake City for water from springs located on the watershed property. Because of this policy, the city is involved with several law suits over water rights issues.

Seeking public input on changes to the master plan, the utility organized a series of meetings and publicized them on the Internet, public access television, in newspapers, and by distributing fliers. The utility also established a management issues group which solicits input from stakeholders including the Salt Lake City Council, the City/County Health Department, the County Sheriff's Department, which patrols the watershed, and the U.S. Forest Service. The group wants to know each party's priorities for watershed protection and management.

The utility also has hired an environmental consulting firm to examine the issues and help prepare a new master plan.

These developments come during a time of governmental belt-tightening. Budgets have been cut at all levels of government. However, despite limited resources, the utility continues to partner with land management and public health agencies to address drinking water source protection.

Managing Urban Storm Water

Massachusetts Water Resources Authority
Boston, Massachusetts

- Primary Sources of Water: Quabbin and Wachusett Reservoirs
- Watershed Area: Quabbin: 187 square miles: Wachusett: 110 square miles
- Population Served: 1,932,000

Drinking water source quality is often adversely affected by storm water runoff. After a large rainfall, contaminant concentrations increase significantly, further stressing drinking water treatment facilities. Although the Massachusetts Water Resources Authority does not regulate storm water releases from construction sites, The Metropolitan District Commission (MDC) Division of Watershed Management works with petitioners to review all plans for the design and construction of storm water and erosion control projects. These control projects are required under the state's Watershed Protection Act as well as the Wetlands Protection Act.

Review Authority

The Massachusetts Watershed Protection Act requires division review of all proposed alterations in watershed areas that are within 400 feet of designated tributaries, wetlands, and flood plains. Proposals submitted to local conservation commissions are reviewed by division staff for water quality concerns during and after construction. Following their review,

staff advise the commissions of their findings.

During 1997, MDC division personnel reviewed 98 applications with an eye toward erosion and sediment control and water-quality issues. Each project's design ultimately conformed to watershed protection regulations and met stipulated water quality standards.

Additionally, annual watershed sanitary surveys help MDC staff identify areas of concern. Once a specific threat to human health is identified, the MDC works with the responsible party to mitigate the situation. Several projects with the state highway department began in this way.

Watershed Approach to Storm Water Management

Besides these ongoing activities, the MDC has hired an environmental engineering firm to prepare an in-depth storm water management plan for the entire watershed. Once completed, the plan will include a series of pollutant-loading analyses at the sub-basin level and recommended best management practices (BMPs). The Massachusetts Water Resources Authority and MDC plan to conduct workshops to help municipalities implement the BMPs, and may provide technical and financial assistance.

Community Ordinance Revision

The MDC Watershed Division also provides technical assistance to communities to help establish or revise erosion and sediment control bylaws and regulations, site plan bylaws, and subdivision regulations. Division staff are working with one community to develop model subdivision regulations for use with other communities. These regulations are intended to foster a more progressive approach that includes concerns for water quality.

Urban Land Use: Solutions to Address Drinking Water and Natural Habitat

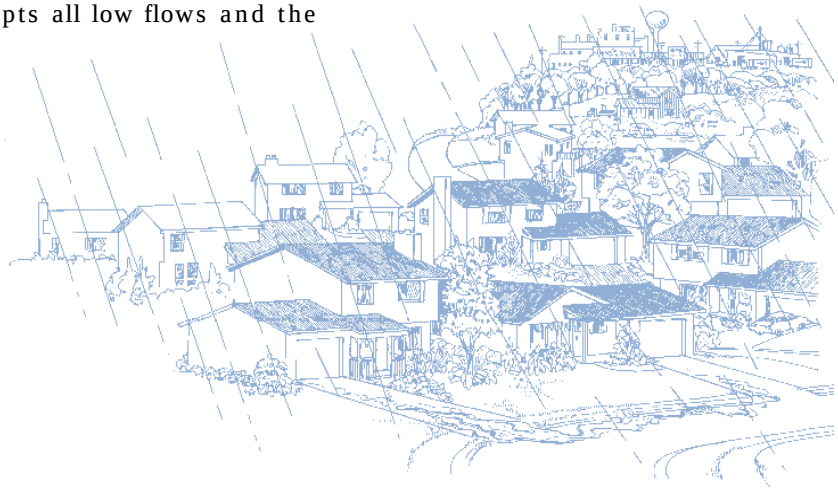
Sweetwater Authority
Chula Vista, California

- Primary Sources of Water: Colorado River, California State Project water, Sweetwater River, ground water
- Watershed Area: 182 square miles (reservoir watershed)
- Population Served: 165,000
- Treatment: Reverse osmosis for brackish water/runoff treatment (planned)

In 1977, increasing urbanization of the Sweetwater River Watershed led the California Department of Health Services to express concern about potential impacts of urban storm runoff on water quality in the Sweetwater Reservoir. To deal with these impacts, the Sweetwater Authority, a municipal water supplier, constructed an Urban Runoff Diversion System (URDS) at the reservoir to protect the surface water supply from the impacts of new development.

The first phase of the diversion system, completed in 1991, intercepts all low flows and the

Model subdivision regulations are intended to foster a more progressive approach to managing growth in watersheds.



Since 1991, the Urban Runoff Distribution System has kept 3,300 tons of salt out of the reservoir.

first flush runoff from the watershed. Thus far, the system prevented the addition of 3,300 tons of salt to the reservoir and has reduced loading from minerals, nutrients, pathogens, and coliform.

The second phase, now under construction, will complete the water protection barrier. Ultimately, the diverted runoff that seeps into the lower ground water basin will be treated in a plant currently under construction. This will provide a new water resource for the community.

Comprehensive Funding Approach

Phase one of the project cost $6.5 million, and Phase two will cost $7.0 million. Water revenue bonds, government grants, and development fees financed the construction. Funding sources included Title XVI grants from the U.S. Bureau of Reclamation, which are available to water projects that use reclaimed water. The water utility also received grants under section 205(j) of the Clean Water Act, specifically alloted for innovative construction projects to treat waste water.

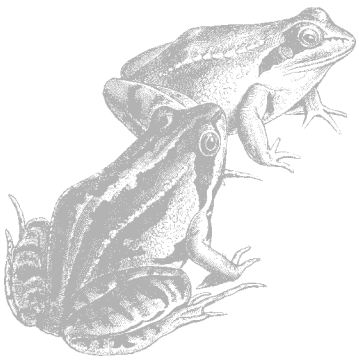
The local development fees resulted from a cost-sharing agreement between the Sweetwater Authority and San Diego County. The agreement allows the authority to impose a fee on development permits in the watershed's middle basin to recover the costs of controlling runoff from new development, estimated at 60 percent of the total project cost. The fee of $300 per equivalent dwelling units, in 1984 dollars, is assessed on 2.9 dwelling units per acre for commercial and other non-residential uses. The authority is negotiating with the county to expand the fee program to recover the costs associated with mitigating the impacts of urbanization.

Habitat Management Program Controls Weeds & Predators

The Sweetwater Authority developed a program to manage 140 acres of endangered species habitat affected by the Urban Runoff Diversion System and reservoir operations. The program includes monitoring, re-vegetation, invasive weed eradication, and predator removal programs coordinated with the U.S. Fish and Wildlife Service and the California Department of Fish and Game.

The authority re-designed portions of the diversion system to minimize or avoid impacts to environmentally sensitive areas. The current design protects the Sweetwater Reservoir from the effects of new development and urbanization while protecting habitat.

Previously, the plan called for a low-flow barrier 2 miles upstream of the reservoir, several miles of diversion pipes, and three upstream ponds. However, some of the property targeted for construction was identified as sensitive habitat, so the authority eliminated the upstream ponds and added a larger downstream pipe and an additional downstream pond. Although the new design handles a smaller volume of storm water, the authority judged the compromise adequate to balance environmental impacts.



Vegetation Management

Periods of drought significantly reduce water levels in the reservoir fed by the Sweetwater River. During these periods, vegetation grows in sections of the reservoir and woodland habitats develop. Later, as the water level rises, this vegetation becomes inundated, and rotting plants cause water quality problems. To avoid such problems, the vegetation must be removed.

Although these areas can reduce water quality, the developing habitats may also become home to the least Bell's vireo, a small songbird listed federally as an endangered species. To minimize impacts on the species, the Sweetwater Authority and the U.S. Fish and Wildlife Service agreed to "rotate" the suitable habitat out of the reservoir and into an old sand pit upstream, which can be revegetated and is contiguous with similar habitat. Habitat acreage is not reduced because vegetation is not removed from the reservoir until new habitat is "qualified" upstream.

The program has been very successful, and the endangered songbird has occupied the new habitat more quickly than expected. The authority manages 140 acres of riparian woodland under this revegetation effort. The program also has enabled the authority and the Fish and Wildlife Service to meet their goals through a coordinated effort.

Septic System Management

Portland Water District
Portland, Maine

- Primary Source of Water: Sebago Lake
- Watershed Area: 450 square miles
- Population Served: 160,000
- Treatment: Ozonated, chlorinated, unfiltered

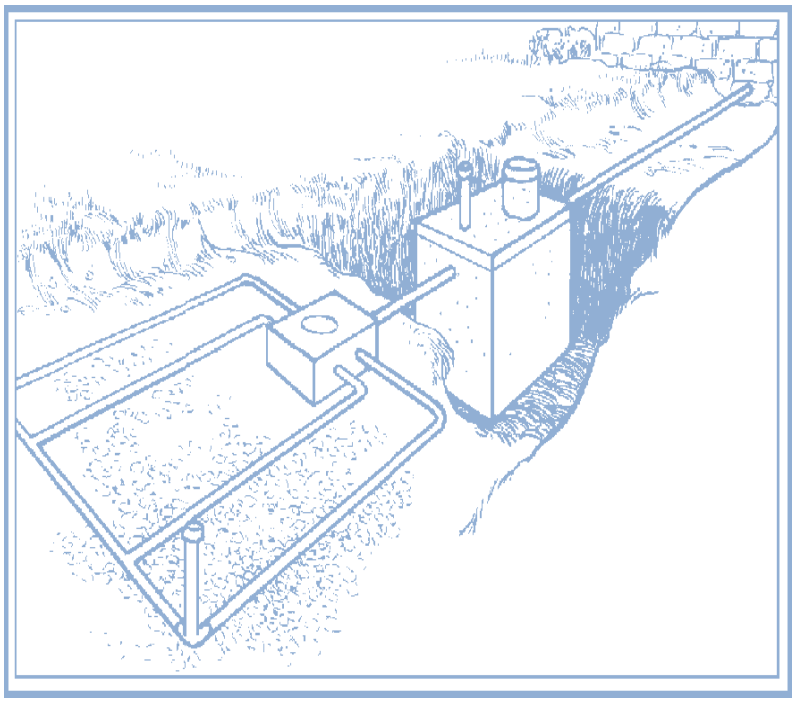
Seasonal residential development is a major threat to Sebago Lake, the Portland Water District's primary source. About 3,000 cottages are within 200 feet of the lake, along the lake shore and on several islands. To mitigate the effects of individual septic systems, the district relies on various controls including charter legislation that created the district in 1912, the state's shoreland zoning regulations and plumbing code, local zoning ordinances, and agreements with private landowners.

Under the district's charter legislation, septic systems must have a permit if they are within 200 feet of the high water mark of the lake. Water District staff are required to perform inspections of the systems. They also may inspect septic systems that are up to 1,000 feet from the lake's tributaries.

When a landowner applies for a town plumbing permit to install or modify a septic system, the local health department informs the Water District, which will issue its own permit. The district relies on the state plumbing code for its minimum requirements for septic system design and installation. Depending on soil conditions, the district may impose even stricter requirements. Local wastewater disposal regulations also may impose more stringent criteria for system siting. District staff conduct inspections during and after construction, and regularly once the system goes into operation. Recently, district inspectors have focused their attention toward reseeding construction sites to prevent erosion.

If the district and a town learn of a malfunctioning or failed septic system, the town usually takes the lead on resolving the situation. Although the district and towns have legal authority to act, the towns have handled these situations well in the past, and there has been no need for enforcement by the district.

Septic systems must have a permit if they are within 200 feet of the high water mark of Sebago Lake



Drops in Coliform concentrations have corresponded with increases in Croton Watershed citizens self-reporting of septic system integrity.

Wastewater Management

Department of Environmental Protection
New York, New York

- Primary Sources of Water: Croton Watershed; the Catskill and Delaware Watershed (includes 19 reservoirs)
- Watershed Area: 1,969 square miles
- Population Served: 9,000,000 (includes some upstream communities)
- Treatment: Croton: Chlorinated, filtered (scheduled); Catskill/Delaware: Chlorinated, disinfected, unfiltered

The New York City Department of Environmental Protection (DEP), is providing more than $350 million to fund septic systems and wastewater management projects in the Croton and Catskills-Delaware watersheds.

To meet the standards and requirements set by the City's new rules and regulations, New York City is upgrading all of their wastewater treatment plants to state-of-the-art tertiary treatment facilities, at a cost of more than $200 million. Other wastewater treatment plants in the Croton watershed and the Catskills and Delaware River watershed are also being upgraded with assistance from the New York DEP, budgeted at almost $80 million.

Some other wastewater and septic initiatives include:

- A New Infrastructure Program to finance wastewater treatment facilities, community septics, and septic management districts.
- A Sewer Extension Program to address failing or potentially failing septic systems.
- A Septic System Rehabilitation and Replacement Program.
- A program for alternative design septic systems.
- A Water Quality Program in certain watershed counties for county-based wastewater/septic system initiatives.
- Funding for studies to assess the feasibility of sewage diversion to outside of one of the watershed systems.

In the Catskill and Delaware River Watershed, DEP is partnered with the Catskill Watershed Corporation (CWC). The CWC is a local non-profit established to administer the 1997 Watershed Agreement between DEP and the state. Similarly, in the Croton Watershed, the DEP is working with county governments to develop program rules and priorities for regional source water protection initiatives.

Septic Systems Regulation

Onondaga County Water Authority
Syracuse, New York

- Primary Source of Water: Otisco Lake
- Watershed Area: 44 square miles
- Population Served: 70,000
- Treatment: filtered

Because each residence in the Onondaga County watershed has its own septic system, their maintenance is a primary watershed protection activity. The state health commissioner has mandated that the Onondaga County Water Authority carry out the inspection program of septic systems. The authority and the county health department also review designs for new septic systems and for changes to existing systems.

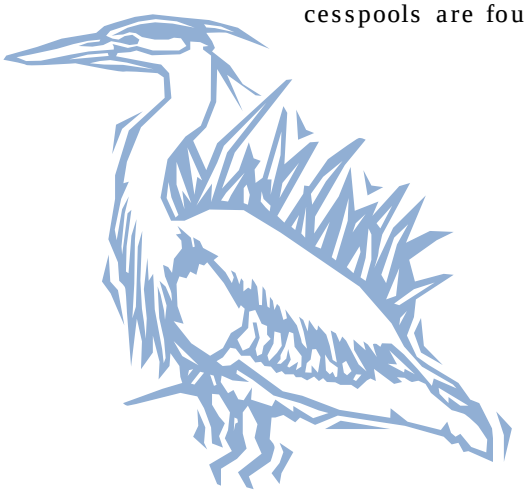
Every summer, authority staff conduct a door-to-door survey of all residences in the watershed to update their information and

inspect each septic system. They also perform dye tests at one-third of the residences located directly on Otisco lake so that all the residences are covered once every 3 years.

Watershed violations, such as a positive dye test or a soggy spot in a leach field, are handled initially by the water authority. The resident has 14 days to fix the problem. The authority cannot provide financial assistance, but usually recommends that residents hire a contractor to address the situation.

If a violation persists for more than 14 days, the county health department takes over enforcement under authority of the Onondaga Sanitary Code. First, the department sends a letter notifying the homeowner of the sanitary code violation. The letters warns that, if the problem is not fixed within a specified time period, the homeowner will be called before the health commissioner, who has the power to impose a fine or order the homeowner to take any steps that are deemed necessary to fix the problem.

Performing regular dye tests helps the authority ensure that all the septic systems near its source water are in good working order. The program also gives the authority a high profile among landowners, which works to its benefit.



Replacing Septic Systems Throughout the Watershed with Sewers

Massachusetts Water Resources Authority
Boston, Massachusetts

- Primary Sources of Water: Quabbin and Wachusett Reservoirs
- Watershed Area: Quabbin: 187 square miles: Wachusett: 110 square miles
- Population Served: 1,932,000

The Massachusetts Water Resources Authority is funding the installation of sewers to replace 40 percent of the septic systems in its Wachusett watershed at a cost of $58 million. Data on the remaining 7,000 systems are compiled in a database.

To better manage the monitoring of these systems, the Metropolitan District Commission (MDC) funded the development of model by-laws for regional wastewater management districts. Independent of municipal government, these districts would provide an overall management structure for regular inspection and maintenance of septic systems. MDC is funding a pilot region to the north of the Wachusett reservoir, where older cesspools are found.

The City of Seattle is working towards establishing an ecological reserve on over 60% of the land that it operates.

Habitat Management Protects Endangered Species and Drinking Water

Seattle Public Utilities
Seattle, Washington

- Primary Sources of Water: Cedar River Watershed and the South Fork Tolt Watershed
- Watershed Area: 90,495 acres (Cedar River), 13,390 acres (South Fork)
- Population Served: 1.2 million
- Treatment: Chlorinated, unfiltered

To protect and preserve the endangered and threatened species in its Cedar River Watershed, while maintaining stringent water quality standards, Seattle developed a Habitat Conservation Plan. The city recently distributed a "Proposed Agreement in Principle" in which Seattle commits to:

- Establish an ecological reserve on about 64 percent of the land it owns and operates.
- Develop a program to manage the commercial harvest of timber on lands not part of the ecological reserve. The program will be operated according to principles that exceed fisheries and wildlife protection standards.
- Create facilities for salmon and steelhead trout to pass the Landsburg Diversion Dam.
- Rebuild sockeye salmon habitat and build a hatchery downstream of the dam.
- Implement an in-stream flow program in the lower Cedar River.
- Design a comprehensive research and monitoring program that will verify the plan's implementation, evaluate its effectiveness, and provide information on species of concern.

The purpose of the proposed agreement is to provide a basis for negotiations among local, state, federal, and tribal agencies.

Plant Grant Programs Provide Citizen Incentives for Source Water Protection

Portland Water District
Portland, Maine

- Primary Source of Water: Sebago Lake
- Watershed Area: 450 square miles
- Population Served: 160,000
- Treatment: Ozonated, chlorinated, unfiltered

In an effort to move beyond traditional regulation and involve more lakeside residents in watershed protection efforts, the Portland Water District instituted three innovative programs. These programs promotes habitat restoration and water quality protection, and have been very popular with property owners.

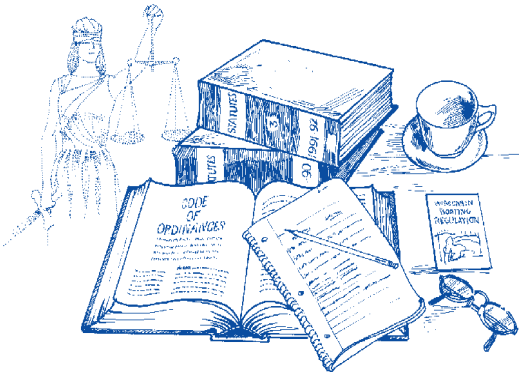
Plant Grant Program
Since 1995, the Plant Grant Program provides $200 matching grants to Sebago Lake-shore property owners who buy plants and establish buffers to control existing erosion. Several nurseries supplied over 665 recommended shrubs, ground cover, and trees compatible with lake-side erosion control efforts and provided technical assistance to participating residents. The Water District has distribute $5400 in grants since 1995, and plans to continue this program, including monitoring the level of success of the lakeside plantings.

Master Gardener Program
The Master Gardener Program, begun in 1997, partners lakeside landowners with knowledgeable staff from the Maine Cooperative Extension Service. A master gardener visits a shoreline home site and teaches the owner environmental gardening techniques.

Camp Grant Program
Another restoration effort, the Camp Grant Program, provides technical assistance and grant funds to incorporate education and erosion remediation at lakeside camp sites. The district has donated about $6,700 to buy supplies for control measures at severely eroded shoreline camps; these efforts markedly improved conditions.

Gardening and lakeside planting have increased citizen awareness of drinking water protection issues with minimum costs.

Chapter 4
Land Acquisition



One way to solve the problem of competing land uses within a watershed is to acquire all the land surrounding a water source. Rather than negotiate with individual land owners, the system buys the land surrounding a surface water source. This solution is simple, yet often difficult to implement.

For example, the Portland Water District in Portland, Maine encountered difficulties in administering its land acquisition plan because much of the land that the utility wished to purchase was in a single town.

The Salt Lake City Public Utilities Department can purchase land only at its appraised value, which puts the utility at a disadvantage when competing with developers, who are free to pay more.

New York City's Department of Environmental Protection, must consult and partner with multiple local governments to manage the acquired lands.

Despite these obstacles, land acquisition has turned out to be a critical part of protecting the water source, since ownership means more control over landuse.

Land Aquisition to Control Uses of the Watershed

Seattle Public Utilities
Seattle, Washington

- Primary Sources of Water: Cedar River Watershed and the South Fork Tolt Watershed
- Watershed Area: 90,495 acres (Cedar River), 13,390 acres (South Fork)
- Population Served: 1.2 million
- Treatment: Chlorinated, unfiltered

To control the use of land within its watersheds, the Seattle Public Utilities (SPU) has made land acquisition a top priority in the Cedar River and South Fork Tolt watersheds, which are the primary sources of Seattle's drinking water. The utility owns 99.9 percent of the Cedar River Watershed and 70 percent of the South Fork Tolt Watershed. Land acquisition is funded with revenues from customers.

Seattle Public Utilities and the U.S. Forest Service began exchanging land in 1962. This land exchange arrangement was formalized with passage of the Cedar River Watershed Act of 1992.

The law directs the U.S. Forest Service to exchange critical Cedar River Watershed lands to the Seattle Public Utilities and places deed restrictions on the property prohibiting the City of Seattle from reselling, harvesting timber from, or developing (other than for routine maintenance) the parcels in question. These restrictions were instrumental to reducing the land's value, enabling SPU to afford the property through exchange of other parcels it owned worth approximately $8 million. Without the restrictions, the land was valued at nearly $100 million.

This latest exchange brings the utility's total acquisition in the Cedar River Watershed over the last 100 years, to 99.9 percent of the land.

South Fork Watershed: 70 Percent of Lands Acquired

The other area critical to Seattle's drinking water supply is the South Fork Watershed. Working with private industry, the utility completed a land exchange with the Weyerhauser Company for some SPU holdings in the North Fork Tolt basin. These properties had once been logged and are now in various stages of young second-growth forest.

This land exchange consolidates the holdings of Seattle Public Utility and Weyerhauser in the North and South Fork Watersheds, thus improving the management of these lands. Although the utility's land is surrounded by Weyerhauser property, a signed agreement shows the support of Weyerhauser to protect water quality in the watershed.

The remaining eastern end of the South Fork Tolt is old-growth timber owned by the U.S. Forest Service. No logging is taking place in this federally-owned area, since there is an awareness of its value to the drinking water supply of Seattle.

Third Parties Aid Land Acquisition

Salt Lake City Corporation, Department of Public Utilities

Salt Lake City, Utah

- Primary Source of Water: Wasatch Canyons
- Watershed Area: 185 square miles (Provo River Watershed is 500,000 acres)
- Population Served: 400,000
- Treatment: Disinfected, filtered

Since the adoption of a master watershed management plan in 1988, the Salt Lake City Public Utilities has funded land acquisitions with a monthly fee of $0.25 per water connection. The result has been spending of $1,154,000 to buy 1,000 acres of watershed land.

Under its present system, utility staff identify and recommend to an advisory board priority properties for acquisition. The board, composed of city and county residents appointed by the mayor of Salt Lake City, decides whether to go ahead with the purchase.

The utility is at a disadvantage when competing with land developers because the utility can purchase property based only on the land's appraised value. Often, the utility cannot compete with a developer's offer because the price is too high. To get around this problem, the utility works with environmental groups who are not required to buy the land at the

Using a monthly fee of $0.25 per water connection, the Salt Lake City Public Utilities has bought 1,000 acres of critical watershed land.

An advisory board of city and county residents, appointed by Salt Lake City's mayor, decides whether to purchase land as recommended by water system staff.

Fair market value will be paid for all land, and DEP will pay property taxes on the land it buys.

appraised value. They purchase land for placement in private land trusts.

Another disadvantage is that the utility can bid only on land offered to it by the landowner. Utility staff would like to be able to seek out land for purchase. When revising the master plan, the utility hopes to change these rules.

Land exchanges for reasons other than protecting the natural resources within the watershed are a potential concern for supporters of watershed protection. To further assure that these types of transactions don't impact the drinking water supply, the utility, working with city officials, passed a resolution recommending the US Forest service -a major land manager in the watershed - refrain from selling watershed land to private parties. This action hopefully will help lead to further protection of drinking water sources.

Land Acquisition Program Targets High Priority Parcels

New York City Department of Environmental Protection
New York, New York

- Primary Source of Water: Croton Watershed, Catskill/Delaware Watershed (includes 19 reservoirs)
- Watershed Area: 1,969 square miles
- Population Served: 9,000,000 (includes towns along the distribution lines)
- Treatment: Croton: Chlorinated, filtered (scheduled); Catskill/Delaware: Chlorinated, disinfected, unfiltered

New York City's water utility, the Department of Environmental Protection (DEP), has embarked on a 10-year program of land acquisition within its watersheds.

DEP has committed $250 million to acquire property associated with in the Catskill and Delaware River supply systems. The Catskill and Delaware branches of the system, which spread over 1,600 square miles west of the Hudson River, provides 90 percent of New York City's water. An additional $10 million has been set aside for the same purpose in the Croton Watershed, which lies east of the Hudson. The state will provide an additional $7.5 million to supplement the Croton Watershed land acquisition effort.

Each watershed has been divided into priority areas, based on natural features and proximity to reservoirs, intakes, and DEP's distribution system. These priorities determine the geographic focus for acquisitions. Fair market value is paid for all land, and DEP pays property taxes on the land.

As part of a 1997 Watershed Agreement, DEP has a 10-year water supply permit from the New York State Department of Environmental Conservation (NYSDEC). The permit enables DEP to acquire, through purchase or conservation easements, undeveloped land near reservoirs, wetlands, and watercourses, as well as land possessing other water-quality-sensitive features.

No land will be taken by eminent domain. The Watershed Agreement allows towns and villages to exclude certain parcels from acquisition. Communities west of the Hudson River may exclude specified amounts of land in certain hamlets and up to 50 acres of land for continued commercial and industrial use in certain priority areas.

Throughout the two watersheds, DEP will consult with the community in which the parcel is located and will provide up to $20,000 to each town to support the local review process. Any disputes will be referred to the NYSDEC for resolution.

Land Acquisition Requires Small Town's Cooperation

Portland Water District
Portland, Maine

- Primary Source of Water: Sebago Lake
- Watershed Area: 450 square miles
- Population Served: 160,000
- Treatment: Ozonated, chlorinated, unfiltered

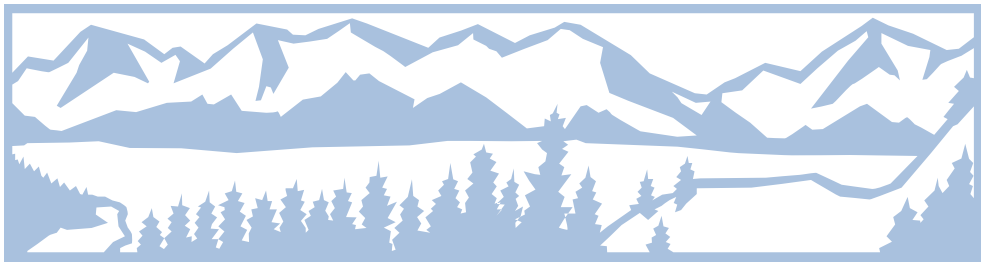
The Portland Water District, small in relative size to other utilities involved in watershed acquisition, has made significant use of this management tool. Even with limited resources and staff, in 1997, the utility spent $600,000 to establish a buffer zone by purchasing land within 1,000 feet of the shoreline of Sebago Lake and its tributaries. The district purchased 5 properties, at market value, from willing sellers.

The money for the district's land acquisition program comes from 1993 legislation allowing water utilities to set aside up to 5 percent of the prior year's revenues for drinking water source protection.

Thus far, all of the district's purchases have been made in the town of Standish, Maine. This prompted community concerns about reduced tax revenues and the perceived threat that the district would buy all village land, since the village center is within 1,000 feet of Sebago Lake.

To allay community concerns, correct mis-apprehensions, and promote communication, a committee of town selectmen and utility trustees was formed. The team helps to assure that everyone's interests are addressed while protecting the town's drinking water supply.

In 1997, the utility spent $600,000 to buy land within 1,000 feet of the shoreline of Sebago Lake and its tributaries.



Appendix A
Source Water Protection Workshop Participants

Southwest Source Water Protection Workshop

Participants in the Southwest Source Water Protection Workshop, held in Tempe, Arizona, were:

Ed Archuleta
General Manager
El Paso Water Utilities, Texas

Judy Bloom
U.S. EPA Region 9

Dennis Bostad
Water Quality Director
Sweetwater Authority, California

John Robert Carman
Metropolitan Water District of Salt Lake City, Utah

Brad Cross
Texas Natural Resource Conservation Commission

Richard A. Denton
Contra Costa Water District, California

Barbara Gastian
Albuquerque Public Works Department, New Mexico

Mike Gritzuk
Director
Phoenix Water Services Department, Arizona

Michael Johnson
Southern Nevada Water Authority

Charlie Jordan
Public Affairs Director
Denver Water Department, Colorado

Tim Kacerek
Central Arizona Project

Michele Kempel
City of Nogales, Arizona

Karl Kolhoff
Assistant Utilities Manager
Mesa, Arizona

Mary Ann Mann
Metropolitan Water District of Southern California

Tom McCann
Central Arizona Project

Brendan Murphy
National Rural Water Association

Reed Oberndorfer
Central Utah Water Conservation District

Ken Orton
National Rural Water Association

Pankaj Parehk
Los Angeles Department of Water and Power, California

Dan Pedersen
American Water Works Association

Florence Reynolds
Salt Lake City Public Utilities Department, Utah

Glenn Singley
Northern District Engineer
Los Angeles Department of Water and Power, California

Moncef Tihami
Arizona Department of Environmental Quality

Gary Ullinskey
Phoenix Water Services Department, Arizona

Northwest Source Water Protection Workshop

Participants in the Northwest Source Water Protection Workshop held in Portland, Oregon, were:

Dan Bradley
General Manager
South Fork Water Board, Oregon

Bill Brookes
U.S. Bureau of Land Management

Bill Carr
United Water Idaho

Dave Clark
Director
State of Washington Drinking Water Division

Sue Doroff
RiverNetwork, Riverlands Conservancy Director

Suzanne Flagor
Seattle Public Utilities, Washington

Alan W. Fletcher
Clackamas River Water, Oregon

Bob Groncznack
City of Olympia Water Utilities, Washington

Maryann Helferty
U.S. EPA Region 10

Ron Hunsinger
East Bay Municipal Utility District, California

David Jennings
State of Washington Department of Health

Bob Jones
Medford Water Commission, Oregon

Dave Leland
State of Oregon Drinking Water Program Manager

Steve Leonard
San Francisco Public Utilities, California

Bob Lewis
Deputy Director
National Association of Water Companies

Dan Lowell
City of Everett Water Department, Washington

Patty Mallett
San Francisco Public Utilities, California

Frank Mauldin
Public Works Director
City of Salem, Oregon

Alan Medak
City of Tacoma Water Division, Washington

Joe Meek
State of Montana Department of Environmental Quality

Bruce Niss
Portland Water Bureau, Oregon

Tom Ortman
U.S. Forest Service

Tina Schweickert
City of Salem Public Works, Oregon

Janet Senior
Portland Water Bureau, Oregon

Sheree Stewart
State of Oregon Department of Environmental Quality

Ty Wick
General Manager
Spokane County Water District No. 3, Washington

Howard Woods
State of Idaho Division of Environmental Quality

Northeast Source Water Protection Workshop

Participants of the Northeast Source Water Protection Workshop, held in New York City, were:

Phillippe Boissonneault
Portland Water District, Maine

Tom Curtis
Natural Resources Group Director
National Governors' Association

Stephen Estes-Smargiassi
Massachusetts Water Resources Authority

Patrick Fasano
Chester Water Authority, Pennsylvania

Stephen Gould
U.S. EPA Region 2

Ed Holland
Orange Water and Sewer Authority, North Carolina

Barker Hamill
Chief
State of New Jersey Bureau of Safe Drinking Water

John Hroncich
United Water Resources
Harrington Park, New Jersey

Dale Long
U.S. EPA Region 3

Preston Luitweiler
Philadelphia Suburban Water Company, Pennsylvania

Joseph McGinn
Metropolitan District Commission
Boston, Massachusetts

Mark Murphy
Onondaga County Water Authority, New York

Howard Neukrug
Director of Planning & Technical Services
Philadelphia Water Department, Pennsylvania

John Przepiora
Commissioner
Syracuse Department of Water, New York

Richard Rafanovic
General Manager and Chief Engineer
Providence, Rhode Island

Philip Rossa
Passaic Valley Water Commission, New Jersey

Anne Seeley
Section Chief, Drinking Water Quality Planning
New York City Department of Environmental Protection, New York

Workshop Organizers

The workshops were sponsored by AMWA and co-managed with EPA's Jeff Cohen. Facilitators for the workshops were Clayton Creager (Tempe and Portland) and the Cadmus Group, Inc.'s Laurie Potter (New York City). The consultant for the workshops was Dr. Chi Ho Sham.

Appendix B
Source Water on the Web

U.S. EPA Office of Ground Water and Drinking Water
www.epa.gov/safewater/protect.html
Provides information to facilitate the protection of source water resources.

Nonpoint Source Control (U.S. EPA)
www.epa.gov/OWOW/NPS/index.html
Features highlights of Clean Water Act and Coastal NPS programs and includes a list of enforceable state mechanisms for NPS control.

Watershed Management Program (U.S. EPA)
www.epa.gov/OWOW/NPS/wtrshd.html
Includes dozens of links and information for people interested in protecting their watersheds.

Clean Water Action Plan
www.cleanwater.gov
Describes the Clinton Administration's new effort to address nonpoint source pollution problems.

Association of Metropolitan Water Agencies
www.amwa-water.org/
Provides background on the provisions of the Safe Drinking Water Act that apply to source water protection as well as links to other resources.

Natural Resources Conservation Service (USDA)
www.nrcs.usda.gov
Provides information to help people conserve, improve, and sustain our natural resources and environment.

Agriculture Research Service (USDA) and the University of Maryland
www.nal.usda.gov/wqic
A large site with many databases and articles on the relationship between agriculture and water quality.

U.S. Geological Survey
http://water.usgs.gov/index.html
Contains links to just about everything the USGS is doing in water, including a great site with real-time water flow data from thousands of stations.

Surf Your Watershed (U.S. EPA)
www.epa.gov/surf
Describes watershed conditions in over 2,000 watersheds nationwide.

RiverNetwork
www.rivernetwork.org
Contains information for local watershed protection groups.

Watershed Academy (U.S. EPA)
www.epa.gov/OWOW/watershed/wacademy/fund.html
Lists sources of federal funding to support various watershed protection projects and local watershed projects.

Watershed Lessons Learned
www.epa.gov/OWOW/lessons
Describes the Top 10 lessons learned by watershed practitioners working on watershed protection plans and other watershed work, and provides real-world examples to illustrate each lesson.