Water Quality

A Half Century of Progress

Student volunteers install plants in a rain garden in Baltimore. Rain gardens reduce pollutants and the velocity of rainwater discharged from downspouts, sidewalks, and parking areas before it enters streams or storm drains. *Photo: USEPA*

EPA Alumni Association

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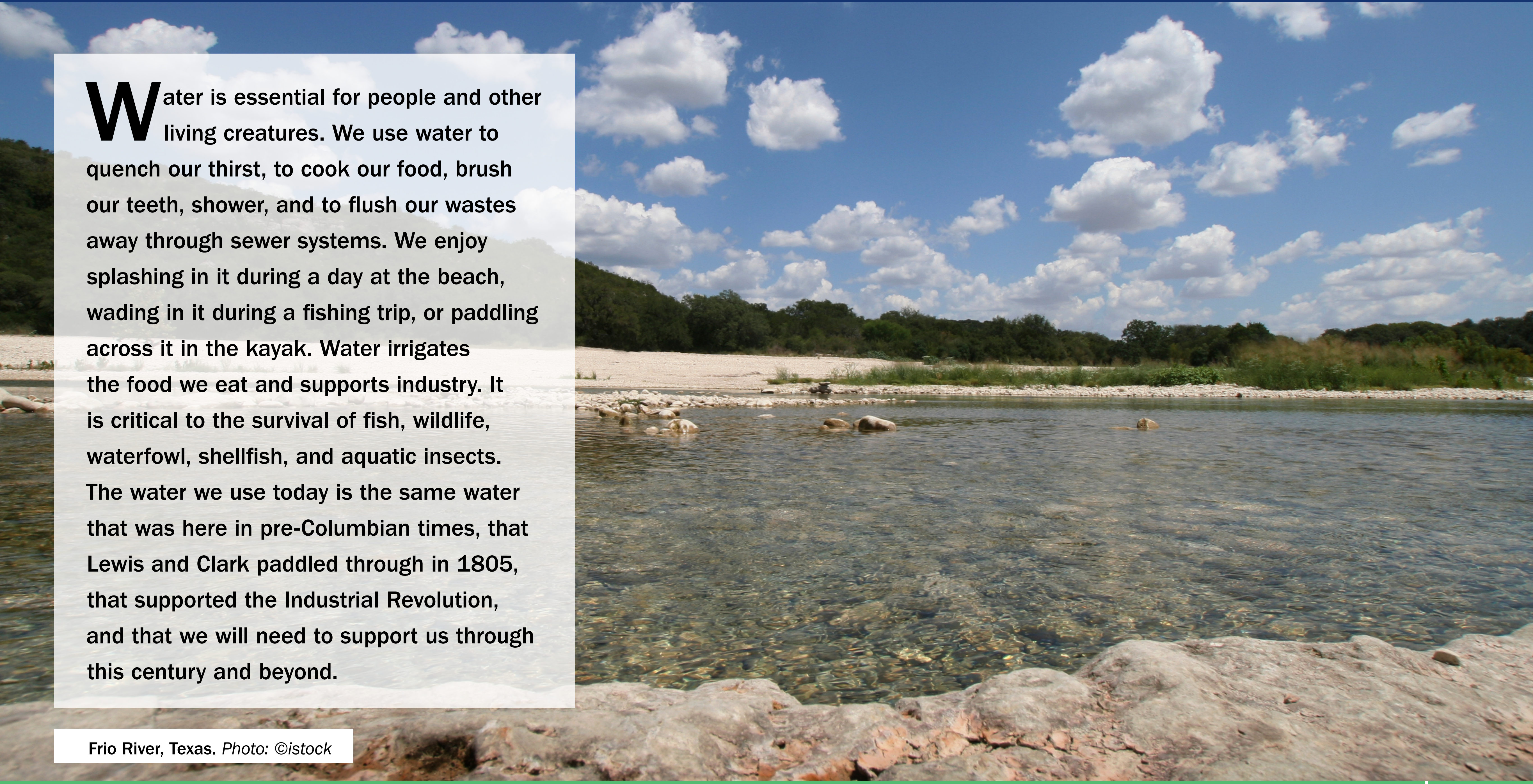
Preface

Former managers and staff of the U.S. Environmental Protection Agency (EPA) have formed an EPA Alumni Association (EPA AA). The Association has developed this and six other web-based environmental reports in support of our *Half Century of Progress* project. An integrated summary based on all of these reports, *Protecting the Environment: A Half Century of Progress*, is available on the Association website. The Association has developed these materials to inform high school and college students and other members of the public about the major environmental problems and issues encountered in the United States in the 1960s and 70s and the actions taken and progress made in mitigating these problems over the last half-century. We also want to highlight continuing and emerging environmental challenges we face today. We hope that, besides summarizing the history of U.S. environmental programs, these reports might inspire some students and others to consider careers in the environmental field.

A number of retired EPA program managers and subject matter experts worked together to produce the first editions of these reports in 2016. Additional experts have updated these documents in 2020 in recognition of the 50th anniversary of Earth Day and the creation of the EPA. This updated report has been reviewed by relevant members the EPA AA Board of Directors and other alumni. We welcome comments on this document, which you may provide at this EPA Alumni Association link.

The Association has also produced a *Teacher's Guide* to facilitate the use of these materials by educators interested in including the *Half Century of Progress* in high school and college curricula. The *Guide* contains data interpretation and other questions related to the report topics, with answers. It also includes activities that challenge students to learn more about environmental issues in their communities, web-based resources for additional activities, and three lesson plans related to the HCP materials. These plans were designed and tested by three AP Environmental Science Teachers. Teachers may request a copy here.



Water is essential for people and other living creatures. We use water to quench our thirst, to cook our food, brush our teeth, shower, and to flush our wastes away through sewer systems. We enjoy splashing in it during a day at the beach, wading in it during a fishing trip, or paddling across it in the kayak. Water irrigates the food we eat and supports industry. It is critical to the survival of fish, wildlife, waterfowl, shellfish, and aquatic insects. The water we use today is the same water that was here in pre-Columbian times, that Lewis and Clark paddled through in 1805, that supported the Industrial Revolution, and that we will need to support us through this century and beyond.

Frio River, Texas. *Photo: ©istock*

And yet, in the 1950s and 60s, America's rivers, lakes, estuaries, and wetlands were seriously polluted. In 1965 President Johnson declared the Potomac River at Washington, DC, to be a "national disgrace." Back then, the Georgetown Gap in the city's sewer system discharged 15 million gallons of raw sewage into the river every day.

The Potomac was not the only severely degraded waterbody. An August 1, 1969, article in *Time Magazine* read: "Some River! Chocolate brown, oily, bubbling with subsurface gases, it oozes rather than flows. Anyone who falls in the Cuyahoga does not drown, Cleveland's citizens joke grimly. He decays." In the 1950s and 60s, the Cuyahoga River at Cleveland occasionally caught on fire, as did other waterbodies. In the early 1970s, Lake Erie was declared "dead," due to massive algal blooms and oxygen-starved waters.

Early federal laws provided only limited authority and funds to deal with the serious insults to the nation's waters. The 1948 Federal Water Pollution Control Act emphasized that water pollution control was primarily the responsibility of the states. Interstate agreements were encouraged but not required. The federal role emphasized research and support for state programs. The law declared pollution of interstate waters to be a public nuisance subject to abatement through a federal enforcement action, but only when the pollution endangered the health or welfare of

Top: **Georgetown Gap Sewage Outfall.** *Photo: EPA Documerica Project.*
Bottom: **Cuyahoga River Fire.** *Photo: James Thompson, Cleveland Press Collection, Cleveland State University*

people in a state other than-where the pollution occurred. Also, the state where the pollution originated had to agree to control the pollution. Not surprisingly, few cases moved forward.

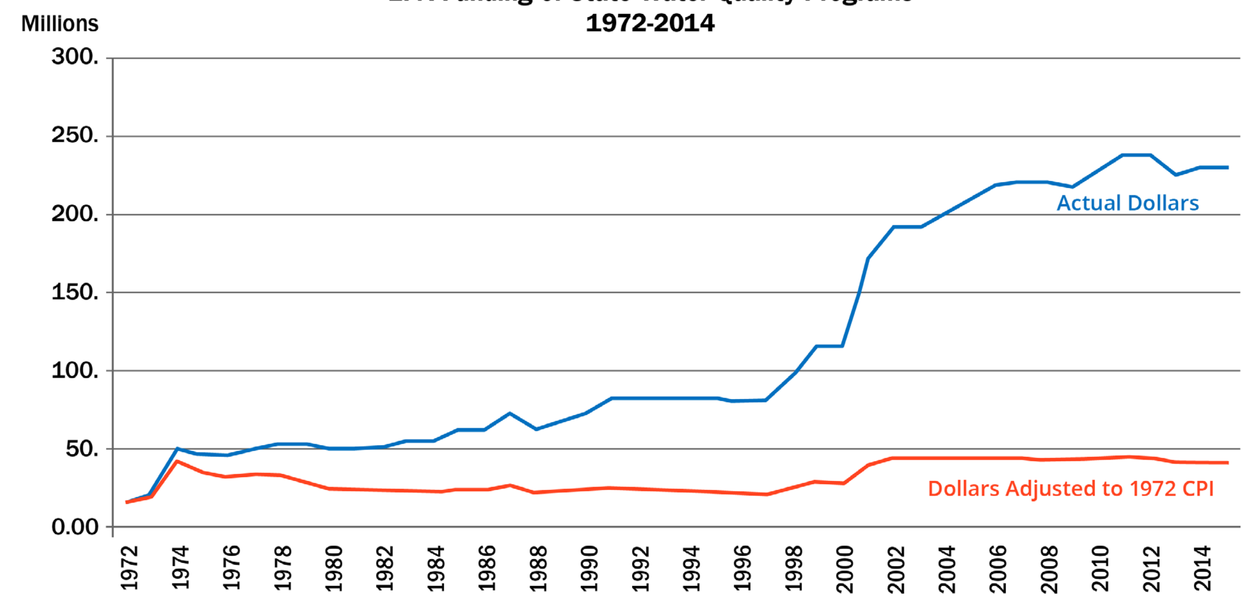
By the 1960s several states had integrated their water programs in a single department combining health, natural resources, and environmental functions. Additional states had initiated permit programs that placed pollution control requirements on industrial and municipal wastewater discharges. These programs were inconsistent across state lines. For example, two identical facilities on opposite sides of a river that happened to be in different states could have very different water pollution control requirements, or perhaps, none at all. This patchwork of state requirements with a very limited federal role led some industries to locate facilities in states with weaker environmental requirements that could be met at lower cost.


The Missouri River. *Photo: ©istock*

The Clean Water Act

Effective control of water quality degradation was brought about by the implementation of the Federal Water Pollution Control Act of 1972, otherwise known as the Clean Water Act (CWA). It was among several key pieces of legislation enacted soon after the Environmental Protection Agency (EPA) was created. The Act established a national water quality framework that was to be implemented by EPA in partnership with the states. It also established a number of fundamental precepts that continue to guide water quality programs: 1) to restore and maintain the chemical, physical, and biological integrity of the nation's waters; 2) to make unlawful the discharge of any pollutant from a point source unless authorized under the Act (a point source is typically a pipe, ditch, or other conveyance discharging pollutants); 3) to recognize, preserve, and protect the primary responsibilities of the states to prevent, reduce and eliminate pollution; and 4) to provide financial assistance to states and municipalities. The law authorized grants to states, territories, certain interstate agencies, and tribes to support their activities under the Clean Water Act.

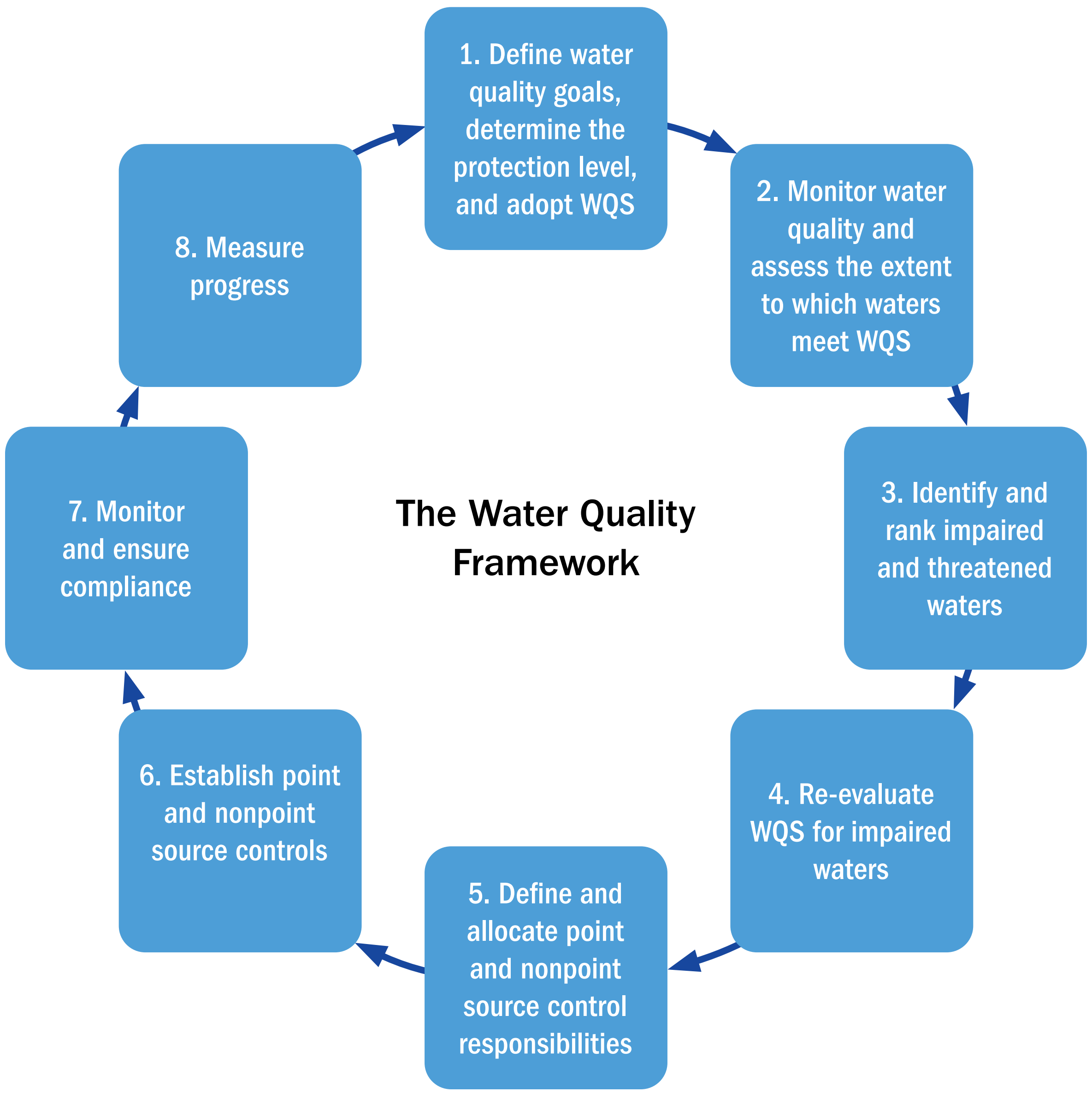
EPA Funding of State Water Quality Programs[a]
1972-2014



The Clean Water Act built on earlier federal water quality legislation and has itself been amended several times since 1972. In brief, the water quality framework in the statute includes:

- the states monitoring their waters and establishing Water Quality Standards (WQS) for all waterbodies (e.g. streams, rivers, lakes, estuaries);
- the requirement for all point sources to apply basic level of treatment to their discharges, based on an evaluation of available technology;
- assessment of whether waters meet standards and, if they do not—if they are "impaired"—development of a total maximum daily load (TMDL) is required.

The TMDL identifies the reductions needed in pollutants causing the impairments and allocates the reductions to point and nonpoint sources. Reductions needed from point sources are incorporated into permits. The impaired water body should meet the water quality standards when the reductions specified by a TMDL are achieved. This framework for protecting and restoring waters is depicted below and described more fully below in the following narrative.



Water Quality Standards (WQS). The 1972 Act required states to establish standards for all intrastate waters and brought the existing interstate standards into the Clean Water Act framework. For the first time, all U.S. waters were covered by requirements for water quality.

A *Water Quality Standard* includes the identification of a designated use, for example, drinking water supply, swimming, fish habitat, agricultural or industrial use, etc. and the development of numerical and/or narrative criteria to support that use. Water quality criteria are typically scientifically derived numerical values developed to protect a use, such as:

- the level of dissolved oxygen necessary to support a healthy trout fishery;
- the maximum contamination of swimming areas by pathogens needed to avert infection or sickness;
- the maximum allowable level of specific pesticides in water to be used to supply drinking water.

Early standards focused on basic protection of drinking water supplies and fisheries, through criteria for dissolved oxygen, temperature, and acidity. Amendments to the Clean Water Act adopted in 1987 required criteria for toxic pollutants. EPA is now working with the states to develop their own biological criteria and criteria for nutrients based on eco-regional criteria developed by EPA. The current techniques for development and adoption of criteria are significantly more complex than earlier versions due to the increased availability of toxicity data, advancements in risk assessment methods, better methods to identify pollutants at extremely low levels, and availability of additional monitoring data.

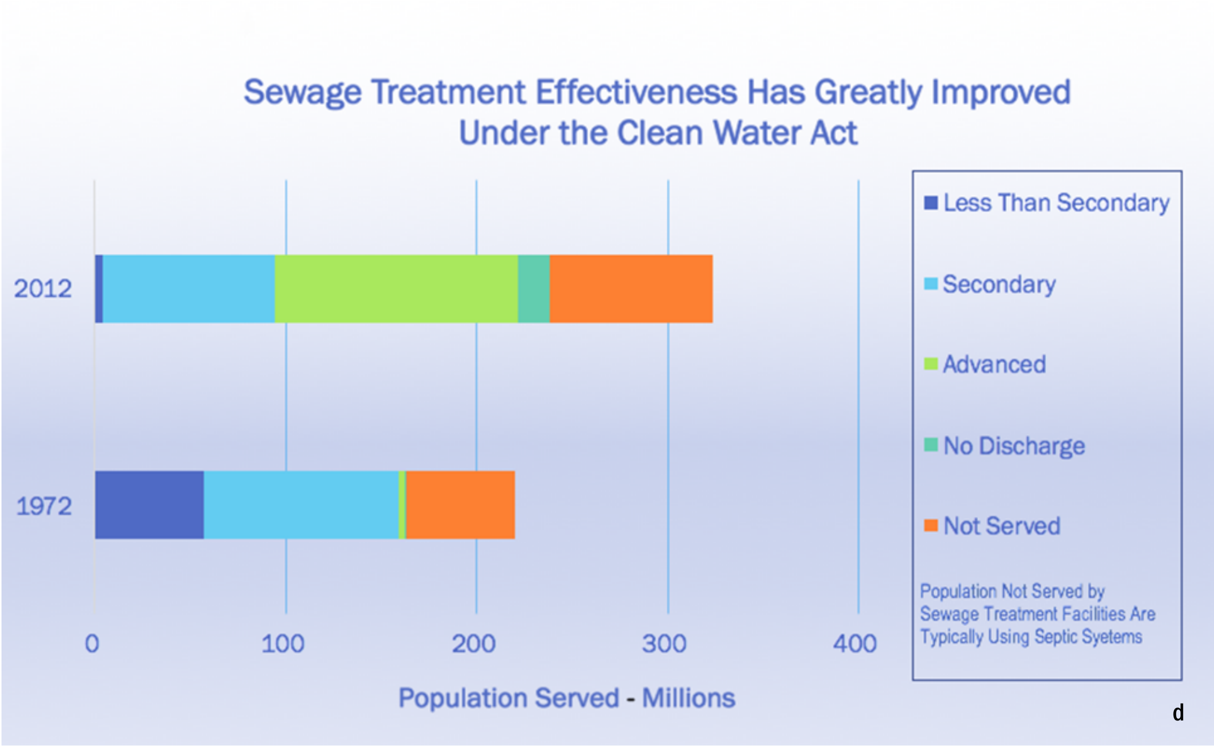
Point Sources. The Clean Water Act in 1972, for the first time, established federal jurisdiction over discharges from point sources into the nation's waters, which were subsequently prohibited unless authorized by a permit. The Act created a new EPA permit program, the National Pollutant Discharge Elimination System (NPDES) to implement and enforce the point source discharge requirements. The Act also authorized states, territories, and tribes to assume responsibility for this permit program if they agreed to meet EPA program requirements. Today, most states implement the permit program, subject to EPA oversight. Initially, the permit program was implemented in two phases.

The First Phase: The first round of pollution reductions implemented through permits was based on technology. The concept behind technology-based controls is that facilities within a category of dischargers—paper mills, for example—should provide treatment levels that represent the best available treatment determined to be affordable. The requirement applies to all facilities within that category nationwide. A mill in Pennsylvania has the same treatment technology requirements as a similar mill in Alabama or California.

Technology-based requirements for industries are established through EPA-developed *Effluent Guideline Limitations*. These guidelines are industry-specific regulations published by EPA based on comprehensive analysis of engineering and economic data for a particular industrial category. EPA has published 59 such guidelines that have resulted in removal of an estimated 700 billion pounds[1] of toxic pollutants annually from the nation's waters.[b]

The minimum technology-based requirement for municipal wastewater treatment plants is called *secondary treatment*. Secondary treatment removes 85% of the organic waste and suspended solids from domestic sewage. By contrast, primary treatment only removes about 30% of those pollutants. In 1972, with the U.S. population standing at 209 million, just under 70% of Americans were served by sewer systems and the wastewater of 62 million people—29% of the population—was treated to secondary standards. By January 2012, 14,748 publicly owned wastewater treatment works were serving 238.2 million Americans, with 94% of those people using facilities that provide secondary or even more advanced levels of treatment.[c]

1. Pollutants of different toxicities are "normalized" to be equivalent to the toxicity of a pound of copper in developing this value.



Essentially every city across the nation was a partner in implementing the treatment guidelines, along with the states and EPA, in planning, designing, and building the infrastructure needed to support these improvements in wastewater treatment.

The Second Phase: The second phase of the permitting process was to determine whether the technology-based limit would be adequate, taking into account all other sources of pollution entering a water body, to meet the Water Quality Standards. If not, limits are developed for pollutants based on the needs of that water body. The calculation of these water quality based limits uses available information on the condition of the water body, computer models, and effluent data on what is actually being discharged. Typically, water quality limits are set for oxygen demanding materials, suspended solids, pathogens, ammonia, metals, toxic organic chemicals, e.g. PCBs, and nutrients.

Other provisions of the permit program were included to address lingering problems with existing wastewater collection and treatment systems. As municipal sewer systems were built and expanded during the late nineteenth and the first half of the twentieth century, it was commonplace for industries to discharge untreated wastewater into the sewer system. These discharges often interfered with the treatment process, contaminated the biosolids (the byproduct of the treatment process), and made it unsuitable for reuse as a fertilizer product—or they passed through the treatment plant and contaminated the waters receiving the treated sewage. Amendments to the Clean Water Act adopted in 1977 required large municipalities and those with significant industrial users to establish an *Industrial Pretreatment Program* to treat or remove harmful wastes prior to discharge. Today over 1,500 cities are implementing a pretreatment program and work with local industry to remove tons of hazardous materials at the source before they enter municipal sewer systems.

In 2019, approximately 6,600 major point sources—those with flows over one million gallons per day—and another 792,000 municipal and industrial point sources are covered by either individual or general permits.[e] General permits can be issued to a class of similar dischargers. In some cases, the permitted source needs only to notify EPA or the state permitting agency that it is aware of and will comply with the terms of the general permit.

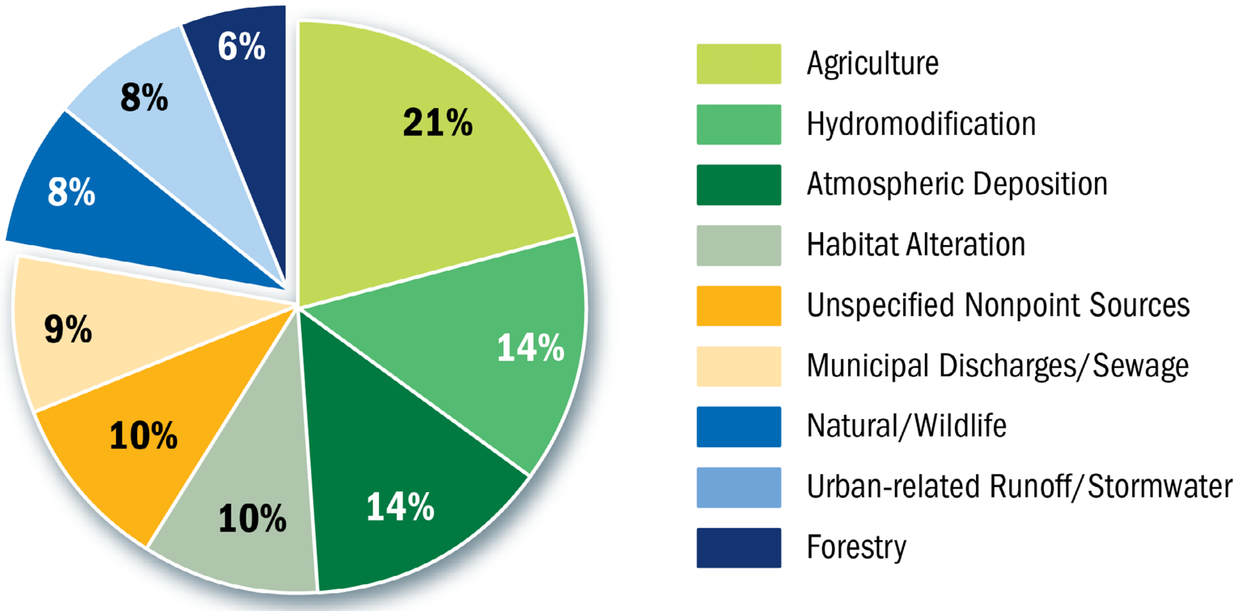
Very large categories of general permits include: discharges from vessels to control the introduction of invasive species (which cause billions of dollars of damage annually) and the application of aquatic plant pesticides in waters by some 360,000 applicators.

Implementation and enforcement of the NPDES permit program, and the continuous actions by the many thousands of dischargers to meet their pollution control requirements, are the backbone of Clean Water Act protections.

Monitoring, Assessment, and Listing. The Act also requires states to monitor and assess their waters regularly and to identify or list waters that are not meeting the Water Quality Standards. For each of these impaired waterbodies a total maximum daily load (TMDL, or pollutant budget) must be developed within a reasonable time—generally within 10–12 years. The TMDL assigns allowable pollutant loads based on the water quality criteria, and calculates the needed reductions for point sources and non-point sources so the Standards can be achieved.

During the early years of Clean Water Act implementation, the states focused on issuing permits and obtaining compliance with effluent guidelines and secondary treatment—the technology-based requirements. They developed very few TMDLs. Several lawsuits were brought by clean water advocacy groups to compel the development of TMDLs during the mid-1990s. To resolve these suits and avoid additional ones, the EPA placed emphasis on TMDL development. By 2019 over 75,000 TMDLs were completed, representing a significant step forward in the clean water program. These pollutant budget plans describe pollution reductions necessary to restore water quality and have highlighted the need for more effective control of non-point sources. States have reported to EPA that by 2017, 3,579 previously listed waters had been restored and met the criteria for all uses.[f]

Non-Point Sources. Pollution from runoff that is not discharged by a pipe or ditch or other "discrete conveyance" is called "non-point" source pollution, or polluted runoff. The primary cause of waters failing to meet standards for nutrients, sediments, and pathogens is pollution from non-point sources. These pollutants can be washed by rain and snowmelt from farm fields, pastures, suburban lawns, roofs, and parking lots in office parks and



Non-point Sources Are a Cause of Impairment of about 80% of Impaired River & Stream Miles

Nonpoint Source Pollution: Allowing cattle into streams introduces pollution from erosion, pathogens, and nutrients. *Photo: Dave Harp*

shopping centers to rivers, lakes, streams, wetlands, and coastal waters.[g]

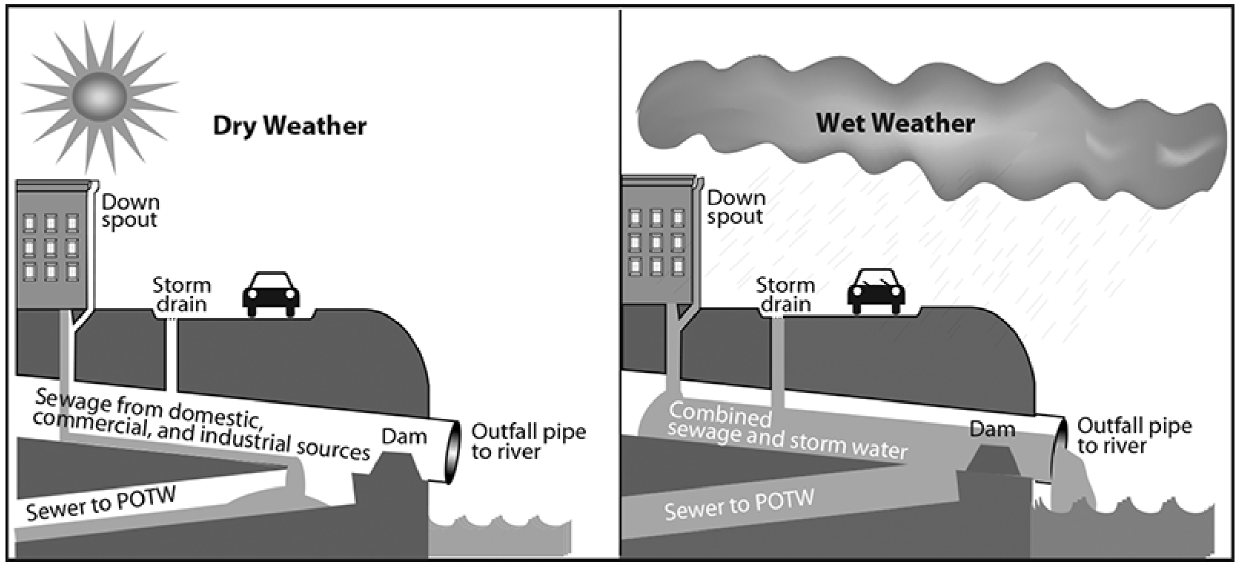
Clean Water Act permitting and control requirements do not apply to this runoff, but the Act recognizes non-point pollution as a component of the water quality challenge. Amendments to the Clean Water Act adopted in 1987 created a grant program which has transferred about $4 billion to states and tribes to support their efforts to reduce non-point source pollution. The US Department of Agriculture provides technical assistance and money to farmers for control of polluted runoff. The Clean Water Act does not authorize EPA to compel dischargers of non-point source pollution to abate their pollution. However, TMDLs for impaired waters do identify the needed reductions from non-point sources. These reductions are needed to address some major challenges across the nation. For example, large areas of harmful algal blooms that were detrimental to public health, fish, marine mammals, and economies in Lake Erie, the Gulf coast, and Florida's Atlantic coast appeared in 2017, 2018, and 2019. These outbreaks have drawn attention to the need for better control of nutrient runoff—primarily nitrogen and phosphorus—from agricultural lands and other sources. Partnerships between EPA and USDA have led to financing of more focused best management practices such as livestock fencing, stream buffers, use of cover crops, and treatment systems at the end of tile drains to limit nutrients entering waterbodies.

Wet Weather Challenges. Traditional wastewater point sources were the focus of water quality programs through the mid-1980s. As progress was made with both municipal and industrial sources, attention turned to pollutants from wet weather sources, including combined sewer overflows (CSOs) and municipal separate storm sewer system discharges.

The sewer systems in nearly 800 U.S. cities include combined sewers. Combined sewers are designed to collect both wastewater and stormwater and transport that flow to treatment plants. When the plant capacity is exceeded, during rain storms or snowmelt, the additional flow of untreated sewage and stormwater is sometimes discharged without proper treatment. A typical combined sewer system will discharge untreated sewage (an overflow) to local waterways every time there is measurable rainfall, which can be 70 to 80 times per year with total overflows up to a billion gallons or more.

In 1994, EPA issued a Combined Sewer Overflow Policy which called for the control of overflows through a phased approach, ultimately leading to the requirement that Water Quality Standards be met even during wet weather. By 2018, 742 permits containing abatement requirements for combined sewers had been issued, including 703 with long-term control plans, and 173 systems had separated their collection systems for stormwater and sewage. The control of combined sewer overflows has required major capital construction programs in many communities.[h]

Amendments to the Clean Water Act adopted in 1987 clarified that stormwater—which is collected by drains and pipes in a separate storm sewer system—must be managed under the NPDES clean water permit program. Large municipal systems (population >100,000) and selected industrial sources were required to be permitted in the mid-1990s, and permits for smaller systems were required by 2003. Most stormwater permits are based on systems of best management practices that are reviewed and improved with each five-year permit. Recent advancements focus on retaining stormwater on-site, and filtering it through wetlands and other vegetation before discharge to streams or using vegetation to encourage the water to be absorbed into the ground or evaporated. This suite of techniques is often called "green infrastructure." These approaches hold great promise for controlling storm water more economically, and are being incorporated into many local programs. Currently, approximately 7,000 municipal, 90,000 industrial, and 121,000 construction



Combined Sewer System.
Report to Congress: Impacts and Control of CSOs and SSOs, USEPA, 2004

Two early adopters of Combined Sewer Overflow control programs were the Metropolitan Water Reclamation District of Greater Chicago and the Milwaukee Metropolitan Sewer District. Both districts used systems of large (20 to 30 foot diameter) tunnels to collect and store excess flow that is then pumped back through the treatment plant once the rain-induced flow subsides. The results have been dramatic. In Milwaukee, overflows into the river system near lakefront beaches averaged 8.5 billion gallons per year in the two years before the system came on-line, compared with 1.1 billion per year over the last ten years. Many cities including Washington DC, St. Louis, Philadelphia, and Cleveland are in various stages of implementing their CSO control programs.

stormwater permits are in place, providing a management framework for reducing pollutants from stormwater before it enter local waterways.

Financial Assistance. Prior to the 1972 Clean Water Act, federal grants were available for up to 55% of the costs of construction of municipal wastewater treatment plants. By 1971, the annual funding level for these grants had reached $1 billion. The CWA included significant new funding through the Construction Grants Program. Up to 75% of project costs were eligible for grants, and $18 billion was made available during an early three-year period. Over the 19 years of the program (1972–1990), federal grants of $53 billion, together with state and local matching support, funded over $80 billion in municipal treatment works.

In 1987, Congress replaced the Construction Grants program with a *State Revolving Fund* (SRF) Program. In this program, EPA provides grants to the states—which contribute a 20% match—to support a fund in each State that provides loans to municipalities for wastewater infrastructure at below-market interest rates. EPA capitalization grants to the state SRFs, together with the state match and leveraged funds, has resulted in more than $133 billion in funded projects. Nearly 28,000 assistance agreements to small communities have been made, financing $31.4 billion in facilities serving fewer than 10,000 people. SRFs have provided considerable cost savings to communities by offering an average interest rate of 1.5% compared to the prevailing market rate of 4.0%.[i]

Wilmington Delaware's wastewater treatment facility received a $36 million Clean Water Act loan (largest in the program at the time) to construct a renewable energy and biosolids facility for its treatment plant. This new facility captures previously flared-off methane gas from the plant and gas from a nearby landfill and uses it to generate four megawatts of electricity, supplying 90% of the treatment facility's electricity needs. These reductions in electricity and along with savings in solid waste disposal costs are estimated to save the City $16.7 million over 20 years.

This project also sponsored a $3.4 million Clean Water Act loan for the permanent conservation of 22 acres of wetlands in the historic Southbridge region. This sponsored project was funded with the savings realized from the reduced total project loan interest rate resulting in zero additional cost to customers. This has led to an application from the City for an additional $15.2 million CWSRF loan to remediate the wetlands for flood control and stormwater management for the nearby Southbridge community.[k]

The *Water Infrastructure Finance and Innovation Act* (WIFIA) of 2014 provides another mechanism for wastewater and drinking water financial support to communities. As of July 2019, EPA had issued loans totaling over $2 billion in WIFIA credit assistance to help finance over $5 billion for water infrastructure projects and create over 6,000 jobs. The WIFIA program has an active pipeline of pending applications and projects that will lead to billions of dollars invested in additional construction and create thousands of jobs, remove pollution, improve water quality, and protect human health.[j]

The Clean Water Act municipal construction assistance programs have been a resounding success. Construction Grants, SRF and WIFIA loans and individually earmarked grant projects have funded—with the highest levels of financial and management integrity—approximately $190 billion in municipal wastewater infrastructure in thousands of communities across the nation, accelerating the pace of clean water restoration and protection. This assistance supported wet-weather control projects in Chicago and Milwaukee and the nutrient treatment projects around the Great Lakes which led, by the 1990s, to the restoration of Lake Erie to be a world class walleye fishery.[2] In Washington DC, daily sewage overflows have been eliminated and the largest advanced wastewater treatment facility in the world has been constructed, removing nitrogen and phosphorus to the limit of technology, and restoring the Potomac River, which now hosts national bass tournaments. These and many other significant and visible improvements around the country have resulted from Clean Water Act financial assistance programs.

Wetlands. For much of U.S. history, wetlands—swamps, fens, bogs, potholes, marshes and seasonally saturated or flooded areas—were considered worthless at best and disease-ridden nuisances at worst. They were drained or filled for agricultural production and for development. Indeed, farmers were encouraged by federal subsidies to convert wetlands to crop production. By the 1950s, half the nation's historic wetlands had been destroyed,

Green River, Wyoming wetlands. *Photo: Dave Kimble, US Fish and Wildlife Service, Mountain-Prairie*

leaving several large states, including California, with less than 10% of their original wetlands.[i] With that destruction came a realization that wetlands were valuable habitat for fish,ducks, and other migratory waterfowl. In addition, wetlands reduce the more severe effects of flooding and storm surges, and provide other valuable services to society and nature. As scientists and naturalists began to document these benefits, federal policy began to shift.

The 1972 Clean Water Act provided that "dredged or fill material" should be regulated somewhat differently than other pollutants.

2. Pollutants of different toxicities are "normalized" to be equivalent to the toxicity of a pound of copper in developing this value.

The Army Corps of Engineers was directed to issue or deny permits for placement of dredged or fill material into "waters of the United States," under guidelines issued by EPA. EPA can veto any permits inconsistent with those guidelines. While states could mange this program, only two have done so, due in part to the costs of operating the program. However, many States play key roles by regulating dredged or fill material under programs recognized by general permits issued by the Corps. Discharges from normal, ongoing agricultural activities were exempted.

EPA guidelines called for denial of permits if individually or cumulatively they would cause unacceptable degradation of waters of the United States. Additionally, permits should not be issued if there is a practical alternative that does not adversely affect waters. Permit holders must minimize impacts of their projects on aquatic resources. Restoration or creation of wetlands or other waters is typically required to offset any losses that can't be avoided. Controversy developed as the CWA was implemented, and extended the Corps' traditional role of regulating structures and discharges that could pose hazards to navigation. In response, Congress considered legislation to restrict the waters to which the Clean Water Act program would apply. However, rather than restricting the geographic scope of the Clean Water Act, Congress provided, in 1977, for states to "assume" or manage the permit program for dredged or fill material and also authorized general permits for multiple discharges for similar kinds of activities.

Agricultural Policy Change & National Wetlands Policy Forum. In 1985, agricultural policy regarding wetlands also shifted to recognize the value of these special areas. *Swampbuster* provisions of the 1985 Farm Bill provided that farmers and ranchers would be ineligible for farm program benefits if they converted undisturbed wetlands to agricultural use. In 1988, a non-partisan, diverse group of leaders from agriculture, state and local government, environmental groups and other organizations was convened by the Conservation Foundation at EPA's behest. This *National Wetlands Policy Forum* issued a report[m] which called for a variety of program and policy actions by federal, state and private interests to achieve "no net loss of wetlands" in the short term and a long-term goal to increase the quality and quantity of the Nation's wetlands resource base.

Many of the forum recommendations were implemented. The US Department of Agriculture implemented several programs to restore tens of thousands of acres of previously converted wetlands. A significant decline in the rate of wetlands loss followed. From an annual net rate of loss of nearly 300,000 acres per year in the 1970s and 1980s, the loss rate fell to less than 60,000 acres per year in the 1980s and1990s. Moreover, the nation realized a net increase of wetlands in the period 1998-2004. From 2004-2009, the loss of wetlands overall was not statistically significant, but the rate of loss for one subset of wetlands, coastal marshes, grew at a significant rate.[n]

States and Tribes. As noted at the outset, the CWA established a partnership between EPA and the states in the implementation of key programs. The states have the lead in:

- establishing Water Quality Standards;
- monitoring and assessing waters;
- developing TMDLs;
- implementing non-point source programs; and
- managing the construction grant and SRF programs.

In addition, 46 states have been authorized to implement the NPDES permit program and two states issue dredged or fill material permits in place of the Corps. The state partnership role is supported through annual program grants that in 2018 totaled $229.3 million.

The 1987 Clean Water Act Amendments provided that tribes could be treated in the same manner as states for most programs. Recognized tribes receive annual program grants and, to date, EPA has approved WQS submitted by 40 tribal governments. Where a tribe has not been approved, EPA implements Clean Water Act programs on tribal lands. To date, no tribe has been authorized to implement the NPDES program.

Other Programs. This report has focused on the core water quality programs and their accomplishments. In addition, a number of other programs have made significant contributions to protecting public health and the environment in supporting the mission of restoring and maintaining the nations waters. These include:

- ***Geographic Programs:*** Water is a uniquely local resource. Geographic programs focused on a particular water resource that is valued by the public have successfully focused resources, tools, and public attention. Geographic focus areas/programs include: Chesapeake Bay Program, Great Lakes Program, National Estuary Program (includes 28 estuaries nationally), Gulf of Mexico Program, Urban Waters Program, and Everglades restoration.
- ***Citizen Involvement in Monitoring and Restoration Efforts:*** In addition to personal efforts to practice water conservation, establish rain gardens and other runoff-reducing practices, organized citizen groups provide valuable data on water quality and aquatic biodiversity through citizen monitoring. There are also numerous examples of citizen participation in cleanup and restoration efforts. For example, high sediment oxygen demand in a reservoir behind a dam contributed to low dissolved oxygen (DO) levels in Michigan's Thornapple River. A 27-mile reach of the river was added to the state's list of impaired waters due to low dissolved oxygen. The Barry Conservation District removed the dam. Michigan Department of Environmental Quality staff, supported by Clean Water Act funding, directed a mussel relocation project before the dam was removed. In one

day, volunteers helped DEQ and Barry Conservation District staff move a total of 1,295 mussels, representing 11 species, from the area immediately below the dam to a stable river reach downstream. Soon after the dam was removed, the river regained a more natural width, depth, and flow rate. DO concentrations increased to a level that met Michigan's water quality standards.[o]

Volunteers relocate mussels on the Thornapple River. *Photos: Joanne Barnard, Barry Conservation District*

- ***Fish Advisories:*** Through the 1980s, advice provided to consumers regarding contaminants in fish was largely based on outdated analytical methods. Beginning in the early 1990s work by EPA, in consultation with the states, has resulted in protocols for sampling and testing fish tissues and for assessing and managing risk that are in use today by the states. Health advisories provide information to recreational anglers, subsistence fishers, and Native Americans regarding what fish to eat, in what amount and frequency and how to prepare caught fish for the table. These groups are better informed and protected today as a result.

- ***Ocean Dumping and Vessel Discharges:*** Radioactive wastes, solid waste, and biosolids (sewage sludge) were all routinely transported from the U.S. and dumped in ocean waters until those practices were outlawed over time. When discharged in marine waters, dredged material from deepening ports and marinas is subject to permits issued by the US Army Corps of Engineers in conformance with EPA Guidelines at sites designated by EPA to minimize adverse effects on marine ecosystems. EPA and the Corps are encouraging the beneficial reuse of dredged material, including in habitat restoration. Discharges from vessel operations and other discharges to ocean waters are also subject to special requirements.

- ***On-Site Sewage Systems:*** More than 20% of U.S. housing stock is served by on-site wastewater (septic tank) systems. These backyard systems have often received little thought or attention. The EPA *On-Site Systems Program* has worked with the states, academia, and industry representatives to improve the technical design, maintenance, and management of existing and new on-site systems. A series of design manuals, a management handbook, and an ongoing collaborative of 18 partner organizations have increased the overall level of available quality information and continuing professional focus on this issue, which is critical to the protection of local groundwater and surface water.[p]

- ***Beach Program:*** A family day at the beach on a day following a rain event used to pose unrecognized public health risks. The Beach Program has successfully brought together the states, local beach resource managers, and EPA to better assess the risk of contaminated stormwater or wastewater overflows and the exposure of the beach going public. Better sampling, analytical methods, and communication tools now allow beach managers to make better and more timely decisions on whether to open or close their beaches and to better inform the public about beaches with a history of overflow related contamination.

- ***WaterSense:*** A 2014 General Accountability Office report surveying state water managers found that 40 states anticipate non-drought related water shortages over the next 10 years.[q] The WaterSense Program is a voluntary public information effort that gives consumers reliable information regarding products, practices, and fixtures that save water without sacrificing performance. Since it launched in 2006, the WaterSense Program has saved 3.4 trillion gallons of water—725 billion gallons in 2018, alone. It has saved consumers $84.2 billion in water and energy costs. In addition, the program has helped reduce the amount of energy needed to heat, pump, and treat water by 462 billion kilowatt hours—enough to supply a year's worth of power to 44.4 million homes.[r]

Future Challenges

In the four decades since the passage of the CWA there has been remarkable progress in restoring and protecting our nation's waters. As the U.S. population grew by 116 million (57%), every American city expanded and upgraded its wastewater infrastructure and industry made significant investment in improving its water quality and water quantity footprint. The burning rivers, odors, floatable nuisance issues, daily sewage overflows, and large-scale fish kills are, for the most part, in the past. However, lingering challenges from the past along with a number of emerging issues threaten our water environment today.

Climate. The first reaction of many is that climate change is an air/atmospheric issue. It is true that many of the controls will focus on power generation, fuel choices, and carbon dioxide management. As our climate continues to change, however, many of the significant impacts will be on water resources. Extended drought will have ecological effects on aquatic communities. More severe rainfall and flooding will have scouring effects on streams, accelerate sediment and nutrient runoff into local waters and exceed the design capacity of combined sewer and storm sewer control systems. Rising sea levels will change the salinity along our coastlines and affect biological communities as well as threaten wastewater infrastructure in many coastal communities. Ocean warming and acidification will degrade coral reefs and affect fisheries and recreational resources. The water treatment infrastructure which has brought about improvements in the nation's waters was designed for a pre-climate change world. Changes in precipitation patterns likely will affect the performance of many facilities and some may be subject to severe damage and destruction as sea levels rise and the frequency and intensity of storms change. A comprehensive strategy to adapt to climate change and mitigate its effects on water infrastructure, like treatments plants, will be critical for years to come.

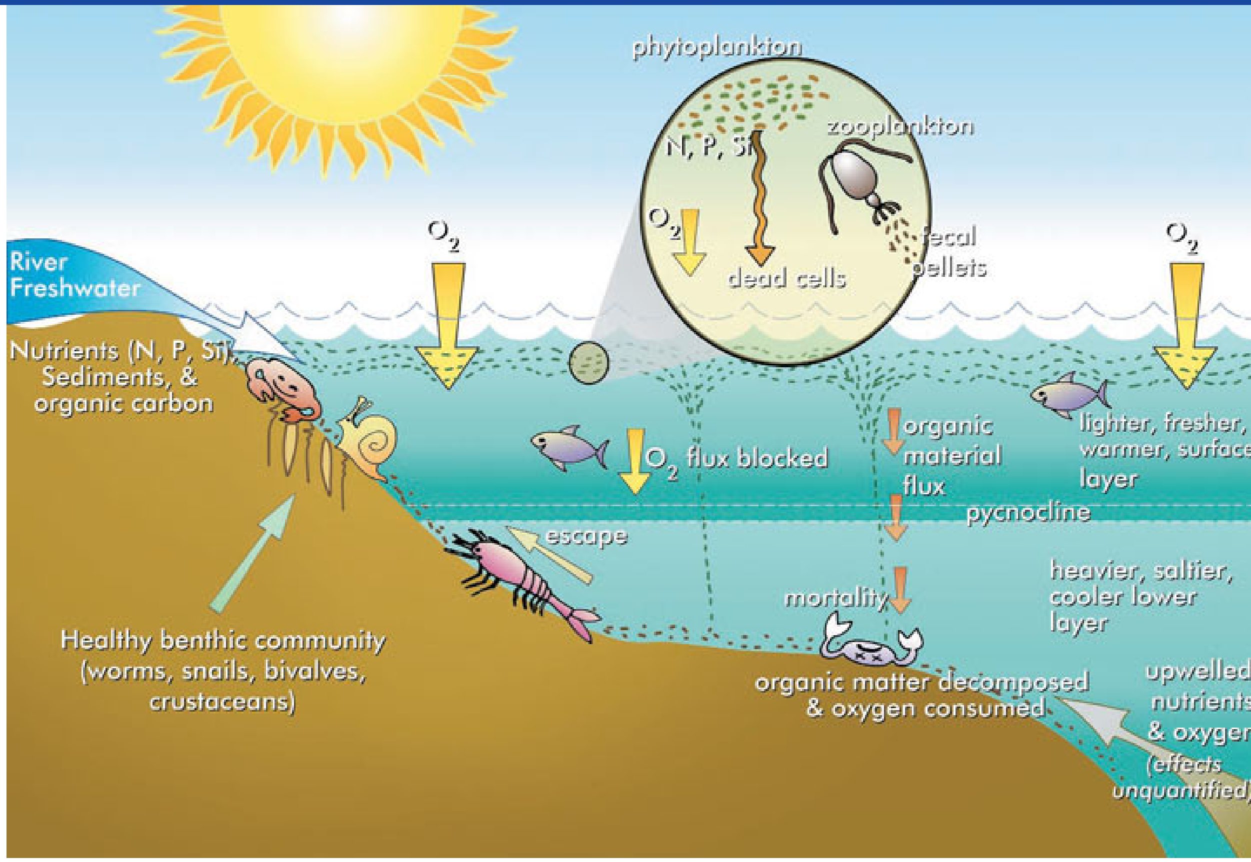
Scope of Clean Water Act Protections. While several efforts in Congress to curb wetlands protection were unsuccessful in the 1990s, significant uncertainty has been introduced into the CWA regulatory protections for some wetlands, small streams, and isolated ponds as a result of recent Supreme Court decisions. In 2001, the Supreme Court held that use of wetlands by migratory birds was not, by itself, a sufficient basis to establish that wetlands were subject to Clean Water Act protections. In 2006, a Michigan developer appealed his conviction for filling wetlands on a property he wished to develop on the grounds that they were not subject to regulation under the CWA because they were separated from traditionally navigable waters by a man-made berm. Notwithstanding unified state and executive branch arguments against further restricting the geographic scope of the Act, a majority of the Supreme Court agreed with the developer. The Court disagreed, however, on what would be a sufficient

Prairie potholes are isolated freshwater wetlands which may be temporarily or permanently wet found in the Upper Midwest. The area is home to more than 50% of North American migratory waterfowl. *Photo: US Fish and Wildlife Service*

"nexus" to navigable waters for a permit to be required. A 2015 regulation issued by EPA and the Corps to clarify this issue was challenged by several states and private interests and partially enjoined, and in 2019 a more restrictive definition was proposed. There is a high probability that any future rule making will again be litigated. It is important to note that aquatic resources which are determined not to be waters of the U.S. are not just exempted from the Act's dredge and fill provisions in section 404 of the Act, but will not be protected by other provisions either.

Wetlands. The most recent National Wetlands Inventory indicates that losses have again outpaced gains, though by a small margin. Uncertainty over the geographic scope of the Clean Water Act is one factor. Additionally, incentives for farmers to restore and protect wetlands provided by the Farm Bill are no longer as strong as they once were.

Nutrients. Excess nutrients, principally phosphorus and nitrogen, have proven to be one of the most pressing challenges to reaching clean water goals. Nutrients "fertilize" algae in the lakes, rivers, and estuaries and cause water to become cloudy. Reduced light penetration from this cloudiness shades out plants living on the bottom of lakes and estuaries. Loss of these plants reduces nursery and shelter areas for fish and shellfish. Some algae, referred to as red tides or brown tides, are toxic to fish and cause breathing difficulties for some people. In addition, when algae die off, their decomposition uses up oxygen in the water—resulting in hypoxia, or "dead zones," and fish kills. These effects have been a worsening problem over the last decade with no remedy in sight. A TMDL was completed for the Chesapeake Bay in 2010 that calls for a 25% reduction in nitrogen and a 24% reduction in phosphorus across the watershed. This is a monumental undertaking to restore the nation's most productive estuary that will take a focused effort by all sectors for decades to come. More than one-third of the Nation's 102 estuaries are identified as eutrophic, a condition of high nutrient concentration that often causes large swings in dissolved oxygen concentration and algal population. The anoxic (dead) zone in the Gulf of Mexico was



Processes contributing to formation of a low oxygen (hypoxic) zone in the Gulf of Mexico.
Source: www.epa.gov/ms-htf/hypoxia-101

recently measured at 7,900 square miles, the size of the states of Connecticut and Delaware combined, and has been on an increasing trend line. These impairments are damaging to water dwelling organism, human recreational opportunities, and property values. Furthermore, they affect the quality of our drinking water sources, making it more difficult and costly to treat them to safe levels. Drinking water problems can be significant—for example, the drinking water intake for the City of Toledo was closed for several days in 2014 due to a massive algal bloom in the Lake Erie's West Basin.

The nutrient challenge is significant. Over 12 million tons of nitrogen and 4 million tons of phosphorus fertilizers are used in the U.S. each year.[s] In addition, the animal agriculture industry produces 1 billion tons of manure annually, much of which is applied to crops as organic fertilizer. Air emissions from fossil fuel combustion cause a fall-out of nitrogen to waterbodies and watersheds This atmospheric deposition is estimated to account for 21% of the nitrogen load to the Chesapeake Bay. The diversity and scale of these sources is daunting. A high percentage of the nutrient pollution loads in most watersheds is from non-point sources over which little Federal authority exists. New science, tools, and approaches are needed to tackle this challenge.[t]

Energy Development. The U.S. is becoming more independent of foreign sources of energy and scarce metals. The overall economic benefits of domestic production will continue to encourage the expansion of the mining and oil and gas sectors. Many of the Effluent Guidelines that address these sectors are dated and do not address current extraction techniques or technologies. Examples include the use of mountaintop removal practices for coal mining and hydraulic fracturing (fracking) for natural gas extraction. These practices produce large volumes of wastewater high in total dissolved solids, are often in remote locations, and have been documented to have adverse effects on aquatic communities. The pressure to pursue these resources will continue. Better management approaches and technologies are needed. In addition, large pipeline projects, which may cross thousands of waterbodies along their routes, are being developed to carry fracked gas and liquids to markets and export terminals.

Emerging Contaminants. The focus of CWA programs in the 1970s through the 1990s was organic wastes, along with a suite of toxic compounds. These challenges continue. However, the current and future lists of pollutants of concern will also include pharmaceuticals and personal care products along with the range of nano-materials being introduced into society, our waste streams, and our waters. Improved analytical methods, risk assessment techniques, and management approaches are needed to protect ecological systems as well as sources of drinking water.

A lavender-colored pipeline carrying nonpotable water in a dual piping system in Mountain View, California. *Photo: Grendelkhan, CC BY-SA 3.0*

Infrastructure. Remarkable progress in the planning, design, and construction of municipal wastewater infrastructure has occurred over the last 40 years. This infrastructure inventory, largely owned and maintained by local governments, is valued in the trillions of dollars. As that infrastructure ages, its upkeep and replacement is straining local budgets. The 2008 Clean Watersheds Needs Survey documented $298 billion in capital needs, and a 2017 American Society of Civil Engineers report graded the condition of the Nation's wastewater infrastructure a D+ with a capital funding gap through 2025 estimated at $105 billion.[u]

New tools, including total asset management models, allow utilities to better inventory their current networks of pipes, pumps, and plant assets and to schedule critical maintenance and replacement investments. The use of these tools often results in a need for increased funding. Those needs compete with other public safety, education, and transportation demands on local budgets. A strategy on how the local, state, and federal sectors will work to maintain and improve as necessary the service provided by municipal wastewater infrastructure is critical to water quality protection and sustaining healthy local economies.

Economic Tools. The endpoint of many of the nation's environmental laws is human health protection. The analytical tools and models used in health protection decision-making are generally well established.

However, the CWA goals related to the chemical, physical, and biological integrity of the nation's waters do not benefit from the same generally accepted, robust, analytical tools. It is important, therefore, to sharpen the types of economic analyses to be used for water regulations including acceptance of the ecosystem benefit approach for this purpose.

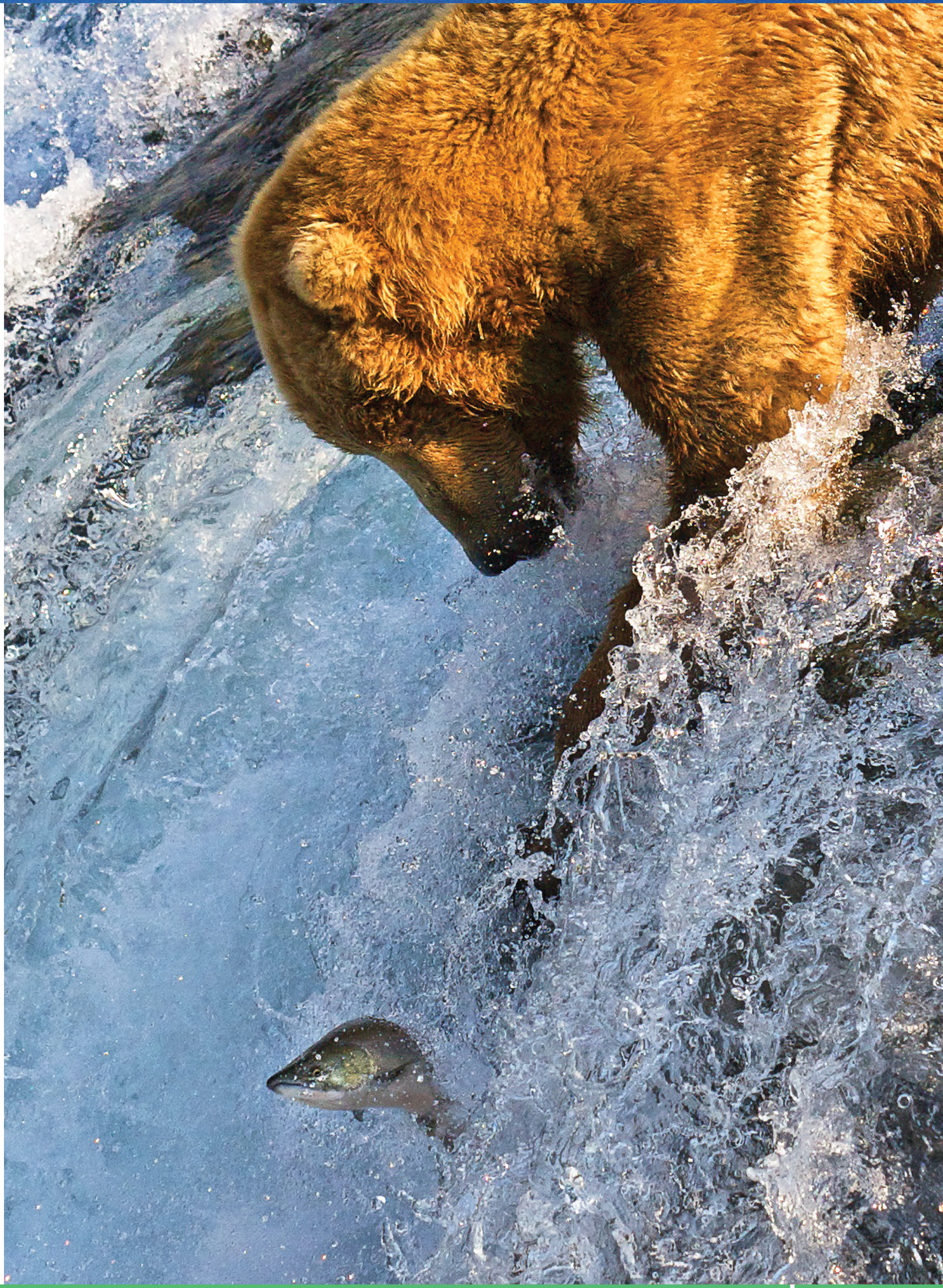
Conclusion

On November 2, 1971, Senator Edmund Muskie urged his colleagues to adopt the Clean Water Act with these stirring words:

> "This country once was famous for its rivers. In songs and poems and stories, Americans gloried in the now quiet, now roaring reaches of the river waters. A vigorous people, following their rivers to the oceans and beyond, built along the riverbanks a strong and productive economy.
>
> But today, the rivers of this country serve as little more than sewers to the seas. Wastes from cities and towns, from farms and forests, from mining and manufacturing, foul the streams, poison the estuaries, threaten the life of the ocean depths. The danger to health, the environmental damage, the economic loss can be anywhere".[v]

Much has been accomplished in the restoration and protection of the nation's waters since then. As the U.S. population grows and the economy evolves, infrastructure ages, the climate changes, and new challenges are testing EPA and its state and tribal partners in implementing the Clean Water Act. The resolve and commitment to restore and maintain the chemical, physical, and biological integrity of the Nation's waters must be maintained as we face these challenges with creativity and innovation.

The urgency of protecting America's water resources continues.



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