**Lower Colorado River Water Quality Partnership**

## INTRODUCTION

The Colorado River is one of the most precious water sources in the West. The river begins high in the Rocky Mountains as small rivulets of pristine snowmelt that ultimately form a vast drainage basin traveling 1,400 miles through seven states, multiple Indian Nations, and portions of Northern Mexico. The river is a significant national resource, providing power and water to nearly 30 million people. In addition, more than 1.4 million acres of irrigated land throughout the Colorado River Basin produce about 15 percent of the nation's crops. Colorado River water also provides habitat for a diverse array of plant and animal species, along with providing extensive recreational opportunities throughout the basin.

The Central Arizona Project (CAP), the Metropolitan Water District of Southern California (MWD) and the Southern Nevada Water Authority (SNWA) are the primary urban municipal and industrial water delivery agencies along the Lower Colorado River. These water agencies have been long-standing partners on Colorado River management and issues and have joined together again to focus their efforts on the water quality challenges currently facing the River. The intent of this collaborative effort is to recognize the many successes, quantify the collaborative efforts made in the past, identify the challenges currently facing the River, and develop new initiatives to ensure the River can continue to serve the millions who rely on its existence.

CAP is a 336-mile long system of aqueducts, tunnels, pumping plants and pipelines and is the largest single source of renewable water supplies in the state of Arizona. Each year, CAP delivers about 1.5 million acre-feet of Colorado River water to cities, industries and farms in Pima, Pinal and Maricopa counties.

MWD is a consortium of 26 cities and water districts that provides drinking water to nearly 19 million people in parts of Los Angeles, Orange, San Diego, Riverside, San Bernardino and Ventura counties. The Colorado River is a principal water source for MWD’s 5,200 square-mile service area.

SNWA is a cooperative agency comprising representatives from the Big Bend Water District, the Clark County Water Reclamation District, the Las Vegas Valley Water District and the cities of Henderson, Boulder City, Las Vegas, and North Las Vegas. The SNWA manages the region’s water resources and develops solutions that will ensure adequate water supplies for the Las Vegas Valley. Southern Nevada gets nearly 90 percent of its water supply from the Colorado River.

These three agencies plan to formalize their partnership through a Memorandum of Understanding memorializing their continued commitment to effective management of water quality issues facing the Lower Colorado River.

## STATEMENT OF PURPOSE

The tremendous growth within the Lower Basin states (California, Arizona and Nevada) over the past thirty years has led to a need for increased focus on the future water supply from the river. The same is true of its quality.

Protecting the river's water quality is of paramount importance. Unlike river systems in the eastern U.S. that have many tributary waters, the Lower Colorado River has few tributaries with significant flows to mitigate water quality problems that may exist along the mainstem river. The existing drought and long-term impacts of climate change exacerbate this condition. While the Colorado River currently meets all applicable water quality standards, our challenge in an era of drought will be to protect and maintain that quality for all our users.

It is with this sense of purpose and urgency that the Central Arizona Project, Metropolitan Water District of Southern California and the Southern Nevada Water Authority have joined together to identify and implement proactive, collaborative solutions to address water quality issues facing the Colorado River.

## CURRENT CONDITIONS ON THE COLORADO RIVER AND WATER QUALITY ISSUES

The Colorado River provides a critical supply of municipal drinking water, agricultural irrigation water, water for wildlife habitat and water for recreation for the Lower Basin states. Protection of the Colorado River's water quality is vital to maintaining these beneficial uses. Like almost any surface water body, the river is subject to contaminants from a variety of sources. Over the years, a number of water quality issues and constituents of concern have been identified by Colorado River stakeholders that may pose an immediate or long-term threat to the river's water quality. These include salinity, selenium, nutrients (phosphorus and nitrate), bacteria/pathogens, endocrine disrupting compounds (EDCs)/pharmaceutical and personal care products (PPCPs), perchlorate, chromium VI, uranium, invasive species and climate change.

*Salinity:* The threat of increased salinity is a major concern in both the United States and Mexico. Salinity affects agricultural, municipal, and industrial water users. It is estimated that nearly 9 million tons of salt are washed into the Colorado River system annually. These salts are estimated to cause more than $376 million of quantified damages in the Lower Basin each year. Approximately half of the salt in the River is naturally occurring and half results from various human activities. In the early 1970s, the Colorado River Basin Salinity Control Program (Program) was established with the goal to reduce the basin's abundant salt supplies from moving into the Colorado River system. The Program partnered the federal government and the seven basin states to foster interstate cooperation on salinity issues. In addition, water quality standards for salinity were established. Through this process, projects such as funding on-farm efficiency to reduce agricultural drainage and building a well to capture and inject brine underground have been effective in achieving the goal by controlling more than 1.2 million tons of salt annually. As a result, the salinity concentrations at Imperial Dam are estimated to be 136 part per million lower today because of the Program's activities. The goal of the Program is to expand implementation to control an additional 800,000 tons of salt annually by 2020.

*Wastewater Constituents:* Treated wastewater discharges into the Colorado River add nutrients such as phosphorus and organic constituents including EDC/PPCPs. The largest wastewater discharge on the Colorado River is from Las Vegas, Nevada. The Las Vegas wastewater dischargers have implemented continuous phosphorus removal and have optimized their treatment processes to reduce phosphorus to approximately 50 percent of historic levels.

There are also many communities along the Colorado River that utilize septic tanks for wastewater disposal. These septic tanks have the potential to add nitrate, bacteria/pathogens, and EDCs/PPCPs to both adjacent groundwater supplies and to the river itself. Localized areas along the Colorado River have experienced elevated nitrate levels in their groundwater from septic tank contamination. There also have been increased concentrations of bacteria such as *E. coli* on beaches in the vicinity of these septic tanks. Many river communities have been required to install centralized wastewater treatment facilities at a large cost to their residents in order to help resolve these water quality concerns. Low concentrations of EDCs and PPCPs have been detected in the Colorado River system from wastewater discharges of all types. The human health and environmental effects of these compounds have yet to be completely ascertained, but these trace-level constituents appear to have greater implications for aquatic life than for human health.

*Industrial Contaminants:* Additional contaminants of concern in the Colorado River system include legacy contaminants due to past production, manufacturing, mining, and disposal practices. These include perchlorate, chromium VI, and uranium. The Nevada Division of Environmental Protection (NDEP) has worked effectively with the two perchlorate manufacturing companies in Henderson, Nevada, to reduce perchlorate loading to the Colorado River by over 90 percent. The concentration of perchlorate has fallen dramatically within the system in recent years despite decreased dilution.

At the same time, more than 1 billion gallons of chromium VI-contaminated groundwater located near Topock, Arizona, has migrated toward the Colorado River. A long-term remediation plan is currently being finalized. Interim measures taken have been effective and, thus far, no chromium VI has been detected in the Colorado River downstream of the Topock site. A chromium VI plume also has been found in Lake Havasu City, less than one mile from Lake Havasu. The State of Arizona is evaluating remediation alternatives for this contaminated groundwater.

A 16-million ton pile of uranium mill tailings was left along the banks of the Colorado River near Moab, Utah. There are concerns that these tailings may pose a water quality threat should a catastrophic flood event wash some of the tailings into the river. The United States Department of Energy began taking essential steps toward the removal and disposal of the tailings in 2009.

*Invasive Species:* Invasive species are a problem in the United States and throughout the world, causing significant environmental and economic damage. Losses have been estimated to add up to almost $120 billion per year in the United States alone. There are approximately 50,000 foreign species in the United States, and the number is increasing. Quagga mussels have invaded the entire lower Colorado River system and have the ability to plug pipes, intake structures, cooling lines, etc. Additionally, the mussels have the potential to concentrate pollutants in the river water and their waste products may create as much of a problem as the bio-fouling caused by the mussels themselves. The control of this invasive species has cost water utilities on the lower Colorado River millions of dollars, and these costs are expected to increase as these species spread throughout the river system.

One of the impacts quagga mussels can have is to increase water clarity, which surprisingly has adverse consequences. From below Davis Dam through Lake Havasu, this has led to unprecedented growth of invasive aquatic plants, including spiny naiad and Eurasian water milfoil. Proliferation of indigenous weed species also has increased, causing as many problems as invasive species. When the aquatic plants die, they detach from the bottom of the watercourses and can plug intake structures, further increasing maintenance costs for agencies.

A more comprehensive discussion of these water quality issues along the Lower Colorado River is included as an addendum to this discussion paper.

## A PROACTIVE PARTNERSHIP

Establishing a close collaboration among CAP, MWD, and SNWA represents a proactive opportunity to find creative local and regional solutions to the challenges facing the Colorado River. By working together, we believe we can recommend solutions that will safeguard the future well being of the Colorado River along with all those who rely on it.

In addition to our partnership, we plan to identify the numerous programs and organizations that are also working to maintain the integrity of the Colorado River. The next steps for this partnership may include efforts to:

- Inventory policy initiatives and identify funding opportunities for mitigation of water quality concerns.

- Coordinate water quality monitoring on the Colorado River among utilities along with state and federal agencies.
- Maintain an existing database of all water quality monitoring results on the Colorado River from Lake Mead to the Mexico border.
- Periodically hold science symposiums on water quality on the Colorado River.
- Support and maintain a water quality model of Lake Mead and the Colorado River that can be used by agencies to evaluate impacts of climate change, spills and emerging contaminants.

**Addendum: Colorado River Water Quality Issues**

Numerous efforts have been implemented throughout the Colorado River Basin and have been effective in protecting the water quality of the Colorado River. Despite these efforts, some constituents still threaten to adversely affect the river as a whole or may be resulting in localized deleterious effects. Continued vigilant efforts of key Colorado River stakeholders are critical to the preservation of the River's future water quality.

In the discussion paper, a number of water quality contaminants and issues of concern were identified as having the potential to negatively impact future Colorado River water quality. This section will address these and other Colorado River water quality issues in greater detail, along with describing some of the continued efforts necessary to ensure protection of the river. In addition, climate change, selenium, mercury, turbidity/suspended sediment, and stormwater will also be discussed in terms of their potential effects on the water quality of the lower Colorado River.

**Climate Change**

The onset of the drought in the Colorado River has heightened attention to the broader issue of long-term climate change, both within the Colorado River Basin and beyond. The United Nations Framework Convention on Climate Change defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods." Potential climate change impacts on the Colorado River are being investigated in the Colorado River Basin Water Supply and Demand Study being conducted by Reclamation and the Colorado River Basin states. Changes in timing and frequency of rainfall may impact the river's water quality and its treatability for drinking water supplies.

Water utilities across the country have convened to raise awareness of the impacts that climate change may have on municipal water agencies and regional water management. In 2008, some of the nation's largest water agencies partnered together to form the Water Utility Climate Alliance. This group works to improve research related to the impacts of climate change on water utilities and develop strategies for adapting to climate change. Additional research is needed to track and evaluate the potential influences of climate change and increased hydrologic variability.

**Salinity**

The Colorado River system is naturally saline. Nearly half of the salts in the Colorado River system are naturally occurring and originate from saline springs, erosion of saline geologic formations and runoff. Irrigation is the primary human-induced source of salinity contributions to the Colorado River, with reservoir evaporation and municipal and industrial sources making up the balance. The flow of the river dilutes these inputs and, depending upon the quantity of flow, salinity can be relatively diluted or concentrated. Climatic conditions directly affect the flow and, subsequently, the salinity concentrations in the Colorado River.

Present salt levels in the Colorado River system have few if any negative human health effects; however, during droughts, the United States Environmental Protection Agency (EPA) recommended secondary aesthetic water quality standard for sulfate can be exceeded. EPA's recommended secondary aesthetic standard for TDS is routinely exceeded under all lake elevations. The primary adverse effects of higher Colorado River salt concentrations are consumer economic impacts. Salinity-related damages can result from reduced agricultural crop yields, corrosion and plugging of pipes and water fixtures, additional treatment needed for industrial uses and processes, increased cost and difficulty of recycling water, and limitations for use in groundwater recharge and storage programs.

In 1972, the Colorado River Basin Salinity Control Forum (Forum) was created for interstate cooperation and information to comply with Section 303(a) and (b) of the Clean Water Act which is to develop water quality standards, including numeric salinity criteria and a basin-wide plan of implementation for salinity control. It is currently estimated that nearly 9 million tons of salt pass Hoover Dam each year. The Forum has set a 2030 target of 1.85 million tons per year of salt to be removed from the Colorado River system, an increase from the 1.08 tons currently being removed according to the Forum's *2008 Review of the Water Quality Standards for Salinity*. Continued funding to implement measures identified in the Salinity Control Program is critical to meeting the Forum's target and protect lower Colorado River uses.

**Selenium**

Selenium is an essential nutrient, but one that can be toxic in fish and wildlife in excessive concentrations and which has the ability to bioaccumulate. Bioaccumulation occurs when organisms of a lower trophic level ingest selenium and these organisms are consumed by organisms of a higher trophic level. This bioconcentration results in greater concentrations of selenium in those organisms higher in the food chain, which can result in deformities or even death.

The primary source of this constituent is sedimentary rocks, which are generally seliniferous in the western United States. Water leaches selenium from these rocks and carries it into the watershed. Many of the tributaries in the Colorado River system exceed EPA's aquatic life beneficial use standard for selenium. Selenium enters the system in the same manner as salinity; therefore, efforts to reduce salinity will also reduce selenium.

**Nutrients**

There are numerous point and non-point source inputs of nutrients throughout the Colorado River system, which include wastewater treatment plants, landfills, wastewater lagoons, irrigated agriculture and septic tanks. Nitrate and phosphorus provide essential nutrients for phytoplankton and plants to grow. The amount of aquatic plants growing from below Davis Dam into Lake Havasu has increased greatly in recent years, coinciding with increased nutrient levels in the system. With increased population growth and urbanization in the Colorado River Basin, additional sources of nutrient loading into the Colorado River are likely unless effective source control measures are put in place.

*Phosphorus*

Phosphorus plays an important role in biological systems and is required in large quantities relative to its availability in nature. In most of the Colorado River system, phosphorus is the primary growth-regulating nutrient. In most portions of the system, its presence is limited. There are, however, localized areas in the river that receive high levels of phosphorus loading which can lead to excessive algal growth and blooms. When these algal blooms die and decompose, they can reduce dissolved oxygen concentrations in the water and result in fish kills. Algae decompose into organic carbon which can lead to harmful byproducts when disinfected for drinking water treatment. If the nutrient concentrations are high in the lower Colorado River, there is also the potential for toxic blue-green algal blooms. The toxins produced by the algae can impact fish and wildlife and drinking water supplies. Further, algal growth affects consumer acceptability of drinking water supplies by imparting undesirable tastes and odors, creates operational and maintenance challenges for water systems, and provides a food source for the proliferation of invasive species like quagga mussels.

*Nitrate*

Nitrogen-based compounds can exist in many forms, including nitrate, nitrite, organic nitrogen, and ammonia nitrogen. Nitrate is more commonly found in the environment than the other forms of nitrogen. Excessive levels of nitrate in drinking water can interfere with the blood's utilization of oxygen and has been shown to have the greatest impact on infants less than six months old. EPA has set standards for the amount of nitrate allowed in drinking water. The soil in the Colorado River system is a source of organic nitrogen; therefore, nitrate concentrations can be naturally found in Colorado River water. However, nitrate is not found at levels associated with adverse health effects.

Elevated drinking water concentrations of nitrate are normally found in groundwater systems due to septic tank contamination, agricultural practices, or industrial uses. Nitrate is easily dissolved and mobile in groundwater and therefore can be very difficult and costly to remove. There are communities along the lower Colorado River that have experienced localized elevated nitrate concentrations in their groundwater, largely due to the high densities of septic systems in these areas. As a result of these elevated nitrate levels, these smaller communities have been required to install centralized wastewater treatment systems at significant cost to their residents.

**Bacteria/Pathogens**

There are numerous bacteria, viruses, and parasites that can cause waterborne illness, such as *Salmonella*, *Shigella*, and *E.coli,* rotavirus and enterovirus, *Giardia* and *Cryptosporidium*. Pathogenic bacteria, viruses, and parasites normally exist in very low concentrations in water and are difficult to detect.

Based on analytical results, the concentration of bacteria, viruses, and parasites in the Colorado River system is low, except in some localized areas impacted by septic systems. The effluent from septic systems contains bacteria and pathogens, and these organisms have the potential to contaminate groundwater. Similar to the nitrate issues noted above, the communities along the lower Colorado River have also experienced localized elevated bacterial concentrations in their groundwater and downgradient surface waters. These communities have been required to install centralized wastewater treatment systems as a result of the adverse effects of septic systems.

**EDCs/ PPCPs**

Compounds that can alter the endocrine system of animals have been detected in water supplies around the world as the result of human activities and wastewater discharges. These substances are known as endocrine-disrupting compounds (EDCs) and—in sufficient concentrations—have been linked to a variety of adverse effects in both humans and wildlife, including hormone-dependent cancers, reproductive tract disorders, and reduction in reproductive fitness. Pharmaceutical compounds and their metabolites include antibiotics, heart medications, and anti-seizure medications. Trace levels of many pharmaceuticals have been detected in surface waters, a few of which have been detected in finished drinking water. Personal care products (PCPs) such as shampoos, antibacterial soaps, and perfumes, create another class of emerging contaminants that have been detected in surface and ground waters. Some pharmaceuticals and PCPs (collectively termed PPCPs) are highly persistent in the environment and can function as EDCs. Although these compounds have likely been present in surface waters for years, the scientific knowledge surrounding them is relatively new and continues to evolve.

EDCs and PPCPs have been detected at very low (parts per trillion) concentrations in the lower Colorado River system. Most are not regulated by the EPA. They generally are difficult to remove through conventional wastewater treatment methods and, consequently, are highly persistent in the environment in extremely low concentrations. Advanced drinking water treatment systems such as ozonation have proven effective at destroying many of these compounds. No known human health effects have been determined for EDCs and PPCPs at concentrations found in the Colorado River, but these compounds continue to receive significant media attention and can affect the public's confidence in drinking water supplies. Scientific research continues to be conducted to better understand the occurrence and potential effects of these emerging compounds.

**Perchlorate**

Perchlorate is an oxidizer found in solid rocket fuel, munitions, and fireworks. In sufficient concentrations, it has the ability to interfere with the thyroid function of sensitive sub-populations such as pregnant women and children. Perchlorate was produced in the Las Vegas Valley for 50 years. Before environmental regulations were instituted in the early 1970s, improper disposal practices at two chemical manufacturing facilities allowed perchlorate to contaminate the local groundwater, which has seeped into Las Vegas Wash, Lake Mead, and the lower Colorado River.

Although perchlorate concentrations in Lake Mead and the lower Colorado River have decreased dramatically in recent years due to remediation performed under the oversight of the Nevada Division of Environmental Protection, long-term funding for perchlorate remediation may be in jeopardy. The company responsible for one-third of the funding for perchlorate remediation filed for bankruptcy in 2009; the bankruptcy settlement resulted in the establishment of an environmental trust to help fund continued remedial efforts. Other funding mechanisms are also necessary in the future to support the long-term remediation of the site.

## Metals

All surface waters contain metals that stem from both human activities and natural sources. Dissolved concentrations of metal ions are generally low, and the solubility of metals in surface waters is predominantly controlled by the water chemistry and other environmental factors. Metals that have received attention for its potential to threaten the water quality of the Colorado River include chromium VI, uranium, and mercury.

### *Chromium VI*

Chromium is a naturally occurring element found in rocks, soil, plants, and animals. Chromium VI is a toxic form of chromium that has several industrial uses in electroplating, textile manufacturing, dyes and pigments, wood preservation, and as an anti-corrosion agent. It is known to cause lung cancer in humans when inhaled, while the health effects from ingestion continue to be researched.

A significant groundwater plume contaminated with chromium VI is adjacent to the Colorado River near Topock, Arizona. This plume exists as a result of past disposal practices of chromium VI as an anti-corrosive agent used at a gas compressor station along the river. Interim measures, including pumping and treating water from the leading edge of the plume, have been implemented to protect the river. A long-term groundwater cleanup remedy has been defined, and the final cleanup plan is being finalized by the lead oversight agencies, the California Department of Toxic Substances Control and the United States Department of Interior. Chromium VI has also been found in the groundwater in Lake Havasu City. A metal plating facility discharged waste containing chromium VI into a septic system approximately one mile from Lake Havasu. Expeditious implementation of groundwater cleanup from all sources will help ensure protection of the Colorado River from chromium VI contamination.

### *Uranium*

Uranium is a radioactive metal associated with significant health effects. It is considered by EPA to be a proven kidney toxicant and is regulated in drinking water. Also, as uranium can concentrate in specific locations in the body, risk of bone and liver cancer and blood diseases are increased. Uranium can be naturally present in the environment in soil, rock, and water, and is also introduced through human activities such as mining and other industrial uses.

Through previous efforts to process uranium for national defense programs and fuel for nuclear power plants, approximately 16 million tons of uranium mill tailings were left along the banks of the Colorado River near Moab, Utah. Due to its proximity to the Colorado River, there is a potential for tailings to enter the river as a result of a catastrophic flood event or other natural disaster. In 2009, the United States Department of Energy began moving the tailings to an engineered disposal cell approximately 30 miles north of the mill tailings site. Through 2010, nearly 3 million tons of tailings have been removed; however, significant funding is still needed in order to continue this progress and to remediate the area's groundwater to ensure future protection of the Colorado River. Another uranium-related threat exists further downstream along the Colorado River in areas proximate to Grand Canyon National Park. There has been a significant increase in recent years in uranium mining claims in this area (as well as throughout the western United States) due to renewed worldwide interests in nuclear energy. Without close oversight and regulation, mining activities can pose a water quality threat to the Colorado River.

*Mercury*

Mercury is a naturally occurring element that can be mobilized in the environment through excavation and mining/ore processing, and can be aerosolized by incineration, coal fired power plants, cement and lime kilns, smelters, and pulp and paper mills. Mercury bioaccumulates and can be toxic when inhaled, ingested, or absorbed through the skin. In humans, mercury can cause developmental defects in fetuses as well as kidney and nervous system damage.

The most common source of mercury contamination in the Colorado River is mining and aerial deposition. Some of the tributaries in the Colorado River system are listed as impaired due to the mercury concentration of the water. Some of the tributaries in the lower Colorado River system are also impaired due to mercury concentrations in fish tissue. Efforts to cap abandoned mines and reduce the aerial distribution of mercury will reduce the mercury concentrations in the Colorado River system.

## Invasive Species

Invasive species are non-native plants or animals that adversely affect the systems they invade economically, environmentally, and ecologically. In most cases an invasive species can out-compete native species for resources such as nutrients, light, physical space, food, or water. Some species were introduced into the environment intentionally, while others have been introduced unintentionally and expanded on their own. If these invasive species evolved in environments with competition or predation and these stressors are removed, the new environment may allow them to proliferate quickly.

The Colorado River system, due to its proximity to large population centers, is susceptible to the introduction of invasive species. Recreational boat users can spread zebra and quagga mussels, New Zealand mud snails, and numerous aquatic plants. Many times invasive terrestrial plants are introduced in urbanized areas for use in landscaping and spread to other areas where they choke out the native vegetation.

Currently, some of the invasive species in the lower Colorado River system include tamarisk, cheat grass, Russian olive, quagga mussels, spiny naiad, Eurasian water milfoil, and New Zealand mud snails. Continued funding for research and development, as well as implementation of control measures, is critical for effective management of these invasive species in the lower Colorado River system.

**Turbidity/Suspended Sediment**

Turbidity is a surrogate measure for estimating the amount of suspended particles in water. These particles can be either organic (algae and other biological matter) or inorganic (sands and silt). Water can contain inorganic suspended solids consisting of particles of many different sizes. While some inorganic suspended material will be large enough and heavy enough to settle rapidly, other very small particles will settle very slowly or not at all.

Turbidity in lakes and rivers may be caused by the growth of phytoplankton or human urbanization activities that disturb land, storm events, agriculture, or certain industries such as quarrying and mining. High turbidity levels are undesirable for drinking water systems because these particles can mask the presence of microorganisms and interfere with their disinfection at treatment plants. Elevated turbidity/suspended sediment concentrations have also been shown to have adverse effects on fish and states have adopted standards to protect fish populations. Recreational uses may also be impacted by turbidity due to the reduced aesthetic enjoyment of murky water and the inability to see submerged hazards.

Due to the highly erodible soils and low plant coverage in the arid west, suspended sediments are difficult to control in the Colorado River system. Turbidity is elevated at the tributary inflows into the Colorado River due to storm events washing large quantities of sediment into the river from rural or urbanized areas and the re-suspension of deposited sediment with changing lake elevation at the various deltas formed at the tributary inflows. Contaminants from sediment may be released during the re-suspension of particles. However, with the exception of the tributary inflow locations, the water in the Colorado River has very little suspended sediment because the large dams within the system have slowed the water's flow significantly and reduced the amount of sediment sent down the river.

**Stormwater**

Even in their natural state, the soils of the Southwest are not conducive to water retention. However, the natural vegetation and topsoil are often changed in developed areas to make way for buildings, roads, and other urban infrastructure and agriculture. These changes, and the introduction of constructed drainage networks, alter the hydrology of the local area such that the receiving water in an altered watershed experiences different runoff flow regimes. Many of the problems with stormwater are associated with the loss of the water-retaining function of the soil and vegetation in the landscape. In storm events, the water is no longer retained, but rather flows into receiving waters such as tributaries to the Colorado River, or the river itself. This stormwater can carry numerous contaminants such as sediment, bacteria/pathogens, nutrients, metals, TDS, pesticides, herbicides, and other organic compounds.

EPA issued final regulations in 1990 establishing a process for stormwater permit applications, a requirement for a municipal stormwater management plans, and a permitting strategy for stormwater discharges associated with industrial activities. The stormwater permitting requirements have helped communities in the Colorado River system reduce contaminant loads and peak volume flows from rain events. Due to the total volume of water in the Colorado River system, rain events play a minor role in overall water quality, but localized impacts can be seen.