CHAPTER

# 7

# *Groundwater Quality Management Program*

## 7.1 INTRODUCTION

Water quality is an important component in the management of the water supply in the Tucson Active Management Area (AMA). The role of the Arizona Department of Water Resources (Department) in water quality relates to the impacts of water quality on available water supplies. Protecting and managing water quality maximizes the overall quantity of usable water. This chapter defines the Department's role and authority in groundwater quality management during the third management period and addresses water quality impacts on the management of water supplies in the Tucson AMA.

The Department's water quality responsibilities include enhancement of groundwater quality protection programs, assistance in the cleanup of contaminated areas, and assistance in matching water quality with the highest beneficial use. In the third management period, the Department will play a greater role in water quality issues because of increased responsibilities and funding for water quality management activities provided for in the 1997 Water Quality Assurance Revolving Fund (WQARF) Program reform legislation. Laws 1997, Ch. 287. Furthermore, the utilization of renewable supplies such as Central Arizona Project (CAP) water and effluent as well as the designation of end uses for remediated groundwater will play a larger role in water supply decisions during the third management period.

In general, groundwater in the Tucson AMA is of acceptable quality for most uses. Most of the groundwater resources meet federal and state drinking water standards, though contaminant levels exceed primary safe drinking water standards in a few areas. Groundwater withdrawals from wells within these identified areas have been discontinued or are in the process of being cleaned up through remedial activities. Other areas of known contamination that are not being remediated are monitored to ensure that contaminants do not spread.

In this chapter, the following topics are discussed in the order listed:

- Goals and Objectives
- Statutory Provisions
- Regulation of Groundwater Quality in Arizona
- Water Quality Assessment
- Third Management Plan Program Summary
- Future Directions

## 7.2 GOALS AND OBJECTIVES

The Department's goals and objectives for groundwater quality management for the third management period are complicated due to the Department's dual responsibilities to achieve reductions in withdrawals of groundwater and to facilitate remediation of contaminated groundwater by implementing incentives for the use of remediated groundwater. The WQARF reform legislation of 1997 creates several incentives for the use of remediated groundwater. In response to the fact that many sites with groundwater contamination have not been cleaned up, the Legislature mandated incentives for remediated groundwater use that could result in a significant increase in groundwater withdrawals. These incentives to use remediated groundwater present a unique groundwater management problem because they may be in conflict with an underlying objective of the Groundwater Code (Code), which is to "achieve reductions in withdrawals of groundwater" in order to attain the management goal of each AMA.

The Department recognizes that the goal of remediating contaminated groundwater is important and intends to facilitate such remediation by implementing incentives for remediated groundwater use. However, as the agency entrusted with the responsibility of managing and conserving Arizona's long-term water supplies, the Department also has the responsibility to ensure that the minimum amount of groundwater necessary to achieve remedial action objectives is pumped and to ensure that, where practicable, new groundwater uses are not created and groundwater supplies are conserved. While the Department believes that it is possible to both achieve reductions in withdrawals of groundwater and provide incentives for the use of remediated groundwater, it recognizes that there is a delicate balance between the two responsibilities that will involve coordinated efforts between the Arizona Department of Environmental Quality (ADEQ) and the Department to ensure that, on a case-by-case basis, no more groundwater is withdrawn than is necessary.

To implement its groundwater quality management challenge, the Department will "coordinate and confer" with ADEQ regarding "water plans, water resource planning, water management, wells, water rights and permits, and other appropriate provisions of [title 45] pertaining to remedial investigations, feasibility studies, site prioritization, selection of remedies and implementation of the [WQARF] program pursuant to title 49, chapter 2, article 5." Arizona Revised Statute (A.R.S.) § 45-105(B)(4)(c). A Memorandum of Understanding between the Department and ADEQ will be developed to address this cooperative effort.

The Department's goals and objectives for groundwater quality management for the third management period are as follows:

- to ensure that remediation of contaminated groundwater uses the least amount of groundwater necessary to facilitate the objectives of each remedial action project.

- to ensure that end uses of remediated groundwater minimize groundwater withdrawals and are consistent with the safe-yield goal.

- to ensure that water quality considerations affecting Department programs that extend beyond the scope of the WQARF program are also addressed in order to preserve groundwater quality and quantity. Some of these considerations include well construction and abandonment standards, well spacing, assured water supply, recharge, and groundwater withdrawal permits.

Pursuant to the WQARF Program, the Department will respond first to the highest ranked sites on the WQARF site registry. The Department's objectives are to ensure that remedial action projects are not an impediment to achieving the management goals for each AMA, and that cleanups are performed in a prudent and efficient manner from a water management perspective.

## 7.3 STATUTORY PROVISIONS

ADEQ is the agency primarily responsible for regulating water quality. The Department also has some limited responsibilities in this area. Statutory provisions pertaining to the Department's limited authority to regulate groundwater quality are discussed below.

The Code grants the Department authority to regulate groundwater. Under the Code, the Department has the following authority and responsibilities relating to water quality:

- "[T]he director may . . . [f]ormulate plans and develop programs for the practical and economical development, management, conservation and use of surface water, groundwater and the watersheds in this state, including the management of water quantity and quality." A.R.S. § 45-105(A)(1).

- "[T]he director may . . . [c]onduct feasibility studies and remedial investigations relating to groundwater quality and enter into contracts and cooperative agreements under § 104 of the comprehensive environmental response, compensation, and liability act [CERCLA] of 1980 (P.L. 96-510) to conduct such studies and investigations." A.R.S. § 45-105(A)(16).

- For the third management period, the director "shall, in cooperation with the department of environmental quality, include in each [management] plan an assessment of groundwater quality in the active management area and any proposed program for groundwater quality protection. Any such program shall be submitted to the Legislature for any necessary enabling legislation or coordination with existing programs of the department of environmental quality." A.R.S. § 45-566(A)(7).

- "[T]he director shall consult with the department of environmental quality on water quality considerations in developing and implementing management plans under this article." A.R.S. § 45-573.

The WQARF legislation, as revised in 1997, expands the Department's role in water quality management. The Department's responsibilities and authority under WQARF, which will be explained in greater detail later in this chapter, include the following:

- "[T]he director of water resources, in consultation with the director of environmental quality, may inspect wells for vertical cross-contamination of groundwater by hazardous substances and may take appropriate remedial actions to prevent or mitigate the cross-contamination. . . ." A.R.S. § 45-605(A).

- "[T]he director [of water resources] shall notify an applicant for a permit or a person who files a notice of intent to drill a new or replacement well if the location of the proposed well is within a subbasin where there is a site [with existing or future groundwater contamination presenting a risk of vertical cross-contamination by the well]." The director is also required to adopt rules relating to vertical cross-contamination and new or replacement wells. A.R.S. § 45-605(E).

- "[T]he director of environmental quality and the director of water resources shall coordinate their efforts to expedite remedial actions, including obtaining information pertinent to site investigations, remedial investigations, site management and beneficial use of remediated water." A.R.S. § 49-290.01(C).

- The director of water resources may waive permits, approvals or authorizations if they "unreasonably limit the completion of a remedial action." A.R.S. § 49-290.01(A). The director of water resources may also waive any regulatory requirement under Title 45 if the requirement conflicts with the selected remedy in a remedial action as long as the waiver does not "result in adverse impacts to other land and water users." A.R.S. § 49-290.01(D).

- "The department of water resources shall include in its management plans . . . provisions to encourage the beneficial use of groundwater that is withdrawn pursuant to approved remedial action projects. . . ." Laws 1997, Ch. 287, § 51. In order to encourage the beneficial use of remediated groundwater, "the department of water resources shall account for groundwater withdrawn pursuant to approved remedial action projects under CERCLA or Title 49, Arizona Revised Statutes, consistent with the accounting for surface water" for purposes of determining compliance with management plan conservation requirements. Laws 1997, Ch. 287, § 51(B).

- "For each calendar year until 2025, the use of up to an aggregate of sixty-five thousand acre-feet of groundwater withdrawn within all active management areas pursuant to approved remedial action

projects under CERCLA or Title 49, Arizona Revised Statutes, shall be considered consistent with the management goal of the active management area as prescribed in section 45-576, subsection I, paragraph 2, Arizona Revised Statutes." Additionally, in the third management period, 50 percent of the total volume of groundwater withdrawn pursuant to remedial action projects and in excess of the aggregate volume of 65,000 acre-feet shall be considered consistent with the management goal of the AMA. Laws 1997, Ch. 287, § 52.

- "The department of environmental quality and the department of water resources shall develop a method of sharing data, including cooperative data base development and integration between the departments, that will provide the departments with the information necessary to protect the resources of the state." Laws 1997, Ch. 287, § 53.

- "The directors of environmental quality and water resources shall enter into an agreement to coordinate the well inspection and remediation programs and to rank wells within an area of contamination according to each well's potential to act as a conduit to spread contamination and to determine the appropriate remedial action regarding the wells with a potential to act as a conduit, including well reconstruction, well abandonment or no action." Laws 1997, Ch. 287, § 54.

## 7.4 THE REGULATION OF GROUNDWATER QUALITY IN ARIZONA

To understand the Department's role in regulating groundwater quality, it is important to understand the broad framework of laws and programs impacting both groundwater and surface water quality. Since groundwater quantity and quality issues are so interrelated, ADEQ and the Department work together to prevent and mitigate groundwater quality and quantity problems. ADEQ has the lead role in protecting the state's groundwater and surface water quality, while the Department secondarily manages groundwater quality concerns. This section discusses the regulatory agencies responsible for administering laws impacting groundwater and surface water quality as well as the federal laws and state programs impacting groundwater and secondarily surface water quality.

### 7.4.1 Water Quality Regulatory Agencies

Water quality protection programs in Arizona are based on both federal and state law and are primarily administered by either ADEQ or the United States Environmental Protection Agency (EPA) Region IX. ADEQ has the responsibility to administer state water quality programs pursuant to state statutes and to administer federal water quality programs for which the EPA has delegated its authority to the state, sometimes referred to as state primacy. EPA has the responsibility to administer federal water quality programs pursuant to federal statutes, but may delegate its authority to states that demonstrate the ability to administer such programs.

ADEQ has authority pursuant to the Arizona Environmental Quality Act (EQA) of 1986 to set water quality standards and to regulate discharges that may impact the quality of groundwater by requiring dischargers to obtain Aquifer Protection Permits (APPs). ADEQ also has authority over remediation of contaminated groundwater under WQARF. ADEQ has authority under the Clean Water Act (CWA) to set Arizona's surface water quality standards and to certify that discharges subject to federal permits do not violate state water quality standards. Moreover, ADEQ has authority to regulate drinking water under the Safe Drinking Water Act (SDWA) and hazardous waste under the Resource Conservation and Recovery Act (RCRA).

EPA Region IX retains authority to administer the CWA National Pollutant Discharge Elimination System (NPDES) permits and the pretreatment program, while the United States Army Corps of Engineers, Los Angeles District, has authority to administer CWA permits for the discharge of dredge or fill materials in

Arizona's waters. EPA Region IX also has authority to require groundwater monitoring and remediation in accordance with CERCLA.

### 7.4.2 Federal Laws Impacting Groundwater Quality

The SDWA is the primary federal law regulating groundwater quality. In particular, it regulates drinking water from all sources including groundwater. The CWA, which regulates surface water, also impacts groundwater quality. CERCLA and RCRA impact groundwater management through the regulation of hazardous waste and sites contaminated by hazardous waste. Following is a brief overview of these federal laws and their impacts on the Department's water quality management.

#### 7.4.2.1 Safe Drinking Water Act

The SDWA was enacted in 1974 to regulate drinking water. ADEQ has been delegated authority by the EPA to implement the SDWA and "to ensure that all potable water distributed or sold to the public through public and semipublic water systems is free from unwholesome, poisonous, deleterious, or other foreign substances and filth or disease causing substances or organisms." A.R.S. § 49-351(A).

There are two types of standards set by the SDWA: national primary drinking water standards and national secondary drinking water standards. National primary drinking water standards may either be primary Maximum Contaminant Levels (MCLs) or Treatment Techniques (TT) requirements. Primary MCLs are the maximum permissible level of a constituent in a public water system and constitute the enforceable standard for safe drinking water. TT requirements set action levels for constituents such as lead and copper that cannot be directly detected or removed by water systems. National secondary drinking water regulations, referred to as secondary Maximum Contaminant Levels, set non-enforceable numeric standards for the aesthetic quality of water, such as taste, odor, or color. Water with contaminants above the secondary MCLs are not typically expected to cause health problems. ADEQ has adopted the EPA MCLs as state Drinking Water Standards and has the authority to adopt more stringent standards as well.

Although the Department does not directly regulate drinking water quality, the presence of contaminants that exceed federal and state standards impacts the regulation of municipal providers and poses significant water management issues for drinking water systems.

#### 7.4.2.2 Clean Water Act

The CWA, first passed in 1972, is the comprehensive federal statute regulating surface water quality. The CWA contains six major elements: (1) the NPDES permit program, which regulates discharges of pollutants by any person to the nation's waters and is designed to protect the chemical and biological integrity of the nation's waters, (2) technology-based effluent standards that apply to the quality of a facility discharge, (3) state ambient water quality standards, (4) dredge and fill permits designed to protect the physical and biological integrity of the nation's waters, (5) oil and hazardous substance spill liability, and (6) federal grant programs for improvement of municipal water treatment.

Under the NPDES permit program, all point source dischargers of pollutants into "waters of the United States" must obtain a permit. The jurisdictional reach of the CWA extends to "navigable waters" that are defined as "waters of the United States, including the territorial seas." 33 U.S.C. § 1362(7). EPA and the Corps define "waters of the United States" to include interstate waters; waters that are used, were used in the past, or may be susceptible to use in interstate or foreign commerce; waters the use, degradation, or destruction of which would or could affect interstate or foreign commerce; tributaries to such waters; the territorial sea and wetlands. 40 C.F.R. § 122.2; 33 C.F.R. § 328.3(a). A frequently cited definition of "waters of the United States" is:

> any waterway within the United States also including normally dry arroyos through which water may flow, where such water will ultimately end up in public waters such as a river or stream, tributary to a river or stream, lake, reservoir, bay, gulf, sea, or ocean within or adjacent to the United States. U.S. v. Phelps Dodge Corp., 391 F. Supp. 1181 (D. Ariz. 1975).

Based on this "tributary rule," the CWA has potential application to dry land that drains into a water of the United States. Additionally, EPA interprets waters of the United States to include wetlands, areas susceptible to use as habitat by migratory wildfowl, and areas where industries engaged in interstate commerce discharge. 44 Fed. Reg. 32854, 32858 (June 7, 1979); 51 Fed. Reg. 41206, 41217 (Nov. 13, 1986). "Point source" means:

> any discernible, confined, and discrete conveyance including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. 33 U.S.C. § 1362(11).

"Pollutant" includes dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste discharged into water. 33 U.S.C. § 1362(6). Based on the expansive definitions of "waters of the U.S.," "point source," and "pollutant," the jurisdictional reach of the CWA NPDES Program is quite broad. The EPA has also implemented a NPDES storm water permit program that regulates municipal and industrial runoff that eventually discharges to waters of the United States.

NPDES permits that allow discharges to canals or river systems as a result of remedial projects or by wastewater treatment facilities are important to the Department's overall water management strategy. As a result, the Department provides input on related reports and draft NPDES permits that may impact the water management activities in the state. Furthermore, non-point source contamination of groundwater by such substances as nitrate, sulfate, and dissolved solids can render large volumes of groundwater unusable for many purposes and pose serious water management problems. Therefore, the Department monitors statutory and programmatic developments as well as permits and reports related to non-point source discharges under the CWA.

The CWA also provides for area-wide long-range planning processes to mitigate water quality control problems in selected areas that result from urban and industrial wastewater. Because such planning processes include a comprehensive review of wastewater treatment and reuse options, the Department participates in this planning process and provides technical assistance to the local councils of government administering the plans.

#### 7.4.2.3 Comprehensive Environmental Response, Compensation and Liability Act

CERCLA and the Superfund Amendments and Reauthorization Act, commonly referred to as the federal Superfund program, authorize the investigation and remediation of groundwater contaminated by releases of hazardous substances. Groundwater remediation may be required to comply with primary MCL standards, although less stringent standards may be approved by EPA on a case-by-case basis through a technical waiver process. In Arizona, CERCLA establishes a comprehensive response program that is administered by ADEQ in cooperation with the EPA. The Department also plays an advisory role in this process.

Under Section 105 of CERCLA, the EPA is required to annually update the National Priority List (NPL) of Superfund sites. Sites are proposed for inclusion on the NPL after being assessed as to the release of

hazardous substances that threaten public health and the environment. Two significant components in the Superfund process are site investigation (Remedial Investigation) and evaluation of possible cleanup alternatives (Feasibility Study). During the Remedial Investigation, information is gathered to determine the general nature, extent, and sources of contamination at a site. Once the final cleanup plan has been selected, EPA formalizes this decision by signing a "Record of Decision" (ROD). The ROD also contains a Responsiveness Summary, which is EPA's response to public comments on the Remedial Investigation, Feasibility Study, and Proposed Plan. Design and actual cleanup activities (Remedial Design and Remedial Action) can then proceed.

The Department regularly participates in CERCLA Program activities, primarily for sites located within AMA boundaries. The Department's concern at CERCLA sites is that any groundwater withdrawn and remediated be put to reasonable and beneficial use. The Department participates on CERCLA technical committees and serves in an advisory capacity for monitoring and extraction well installation, source control projects, and permitting.

#### 7.4.2.4 Resource Conservation and Recovery Act

The RCRA established a national hazardous waste management program in 1976. Under RCRA, hazardous waste permits are issued for the treatment, storage, and disposal of hazardous wastes. Individual permits issued to these facilities specify design, performance, and operational standards that include groundwater monitoring. Hazardous waste facilities also undergo a closure process once operations are reduced or terminated. Moreover, corrective action may be required at treatment, storage, and disposal facilities and may include groundwater monitoring.

ADEQ has been delegated authority for the implementation of RCRA requirements in Arizona. The Department's participation at RCRA sites is important for water management activities, particularly in regard to well siting, use permits, and end use issues.

### 7.4.3 ADEQ Groundwater Programs

The EQA (A.R.S. § 49-101, *et seq.*) established the ADEQ and created a strong and comprehensive water quality management structure. ADEQ's programs that protect groundwater resources include water quality assessments, groundwater monitoring, pollutant discharge monitoring, permitting activities, and remediation activities. The following are selected water quality protection programs that fall under the jurisdiction of ADEQ and have a direct impact on Department activities.

#### 7.4.3.1 Aquifer Water Quality Standards

Arizona's Aquifer Water Quality Standards (AWQSs) are the cornerstone of the state's groundwater protection program. Arizona has adopted the federal primary MCLs, established under SDWA, as numeric AWQSs. A.A.C. R18-11-406. These standards apply to aquifers that are classified and protected for drinking water use. Because all aquifers in Arizona are classified and protected for drinking water use, Arizona's AWQSs are enforceable water quality standards in all of Arizona's aquifers. A.R.S. § 49-224(B).

ADEQ may reclassify an aquifer within an AMA, upon consultation with the appropriate Groundwater Users Advisory Council and upon conducting a public hearing, for a projected use other than drinking water if the identified aquifer is hydrologically isolated from other aquifers or other portions of the same aquifer, water from the identified aquifer is not being used as drinking water, and the benefits to the public of the resulting water quality degradation outweigh the costs. A.R.S. § 49-224(c).

Arizona has also adopted narrative AWQSs to regulate pollutant discharges for which no numeric standards have been developed. Arizona's narrative AWQSs include the following: (1) a discharge shall not cause a pollutant to be present in an aquifer classified for a drinking-water-protected use in a concentration that endangers human health, (2) a discharge shall not cause or contribute to a violation of a surface water quality standard established for a navigable water of the state, and (3) a discharge shall not cause a pollutant to be present in an aquifer that impairs existing or reasonably foreseeable uses of water in an aquifer. A.A.C. R18-11-405.

### 7.4.3.2 Aquifer Protection Program

The most comprehensive ADEQ groundwater protection program is the Aquifer Protection Permit (APP) system, established by the EQA in 1986 and implemented by rule in 1989. An individual or general permit is required for any person who discharges or who owns or operates a facility that discharges a pollutant from a facility either directly into an aquifer or to the land surface or the vadose zone in such a manner that there is a reasonable probability that the pollutant will reach an aquifer. A.R.S. §§ 49-201(11) and 49-241. Discharging facilities that require either an individual or general permit to operate include: surface impoundments; solid waste disposal facilities; injection wells; land treatment facilities; facilities that add a pollutant to salt formations, dry well, underground cave or mine; mine tailings piles and ponds; mine leaching operations; large septic tank systems; effluent recharge projects; point source discharges to waters of the United States; sewage or sludge ponds; and wastewater treatment facilities. A.R.S. § 49-241(B). Classes or categories of facilities that are exempted from APP requirements are identified in A.R.S. § 49-250. General permits are issued by rule while individual permits must be applied for on a facility by facility basis.

APPs require a demonstration that AWQSs are maintained and the Best Available Demonstrated Control Technology (BADCT) is applied. For individual APPs, compliance with AWQSs is measured at a designated point of compliance. BADCT requirements ensure that the greatest degree of discharge reduction is achieved through an evaluation of site-specific engineering, environmental, and economic criteria.

APPs may require compliance with best management practices (BMPs). BMPs are typically site design techniques used to protect water quality. BMPs may be adopted to manage urban runoff, storm sewers, silvicultural activities, and septic tank systems. Agricultural general permits require compliance with BMPs for nitrogen fertilizer application and concentrated animal feeding operations. ADEQ is required to monitor compliance with established BMPs and to measure BMPs effectiveness.

Department staff receives and reviews all APPs for any impacts on Departmental programs and water management. In particular, the Department coordinates with ADEQ to review APP applications for potential harmful water quality impacts on groundwater conditions. Pursuant to A.A.C. R18-9-109, ADEQ advises the Department of each APP application received for a facility that is a recharge project or an underground storage and recovery project. One of the conditions for the issuance of an underground storage facility permit is that ADEQ must determine that the facility is not in a location that will result in pollutants being leached to the groundwater table so as to cause unreasonable harm. A.R.S. § 45-811.01(C). Facilities exempt from APP provisions may be required by the Department, in consultation with ADEQ, to meet other requirements to mitigate harmful water quality impacts to the aquifer.

### 7.4.3.3 Wellhead Protection Program

ADEQ's Wellhead Protection Program is an important supplement to the groundwater quality protection provided by the Department's well construction standards and well driller licensing programs. The Wellhead Protection Program fulfills federal requirements of Section 1428 of the SDWA by designating

Wellhead Protection Areas around public drinking water systems. The Wellhead Protection Program is a voluntary program that encourages the protection of all wells, not just public drinking water system wells. Local entities that have the authority to control land use and exercise other management options can also implement wellhead protection, therefore encouraging the creation of local programs.

#### 7.4.3.4 Reuse Permits

Reuse permits are issued to facilities that provide wastewater for reuse. A reuse permit specifies the amount of effluent to be reused and its chemical quality. ADEQ wastewater reuse rules (A.A.C. R18-9-701, *et seq.*) set the criteria for the use of treated effluent, or reclaimed water, for purposes such as agricultural irrigation, turf irrigation, and recharge. The current reuse rules prescribe numeric reclaimed water quality criteria and monitoring requirements for specific reuse applications. In general, these rules prescribe allowable limits for pH, total fecal coliform, turbidity, enteric viruses, and certain parasites. Reuse may be limited depending on the quality of source water and the intended use.

Wastewater reuse rules undergo periodic updating through ADEQ's rule-making process. The Department reviews any proposed changes to the wastewater reuse rules to ensure the protection of public health and groundwater supplies while maximizing the use of a significant renewable water supply. The Department evaluates effluent reuse permits issued by ADEQ and encourages the use of effluent where appropriate.

#### 7.4.3.5 Underground Storage Tanks

ADEQ'S Underground Storage Tank (UST) Program was developed to ensure the proper operation of USTs and to prevent and remediate releases. Under state regulation and RCRA amendments, the UST Program consists of notification requirements, technical standards for new and existing USTs, leak detection and closure criteria, corrective actions for remediation and financial responsibility demonstrations. Leaking USTs in a concentrated area can have detrimental impacts on groundwater quality and supplies.

The Department has the authority to issue poor quality groundwater withdrawal permits for water contaminated by USTs. The Department can provide guidance for UST site remediation projects to ensure the beneficial use of remediated water.

#### 7.4.3.6 Water Quality Assurance Revolving Fund

The WQARF Program, sometimes referred to as the state Superfund program, was created as part of the EQA. WQARF monies are used to protect the waters of the state against hazardous substances and may be used in conjunction with federal funds. Funds can be used for statewide water quality monitoring, health and risk assessment studies, and remediating hazardous substances that threaten the waters of the state. Mitigation of non-hazardous substances is also allowed under specified conditions. A.R.S. § 49-286. Each year, ADEQ develops a priority list of environmentally threatened sites that qualify for WQARF monies, based in part on the degree of risk to the environment and other available funding sources. Funds are used at those sites to mitigate existing contamination or to prevent further spread of pollutants that may threaten water supplies.

Some of the key legislative changes made in the 1997 WQARF reform package include: (1) establishment of a proportional share liability for cost allocation to responsible parties; (2) creation of a neutral party arbitration process, with incentives to encourage early settlements and disincentives to responsible parties who do not enroll in the neutral party arbitration process; (3) new ADEQ funding mechanisms designed to protect existing wells against migrating contamination from WQARF sites; (4) the creation of a comprehensive WQARF site registry, which consolidates a number of separate lists that were previously

used; the inclusion of petroleum releases in the WQARF Program under some circumstances; and (5) increased flexibility in the selection of groundwater remedies.

ADEQ follows a process for management and cleanup of WQARF sites that consists of site identification and characterization, site prioritization, remedy selection, identification of end uses, implementation and monitoring, and closure. The criteria used to evaluate response actions include practicability, risk, cost, and benefit. This process also includes a comparison of alternatives based on established statutory criteria, developing a Remedial Action Plan (RAP), obtaining public comment, and issuing a ROD. The Department will actively coordinate with ADEQ in the planning and implementation of groundwater cleanup actions under WQARF.

#### 7.4.3.7 Water Infrastructure Finance Authority

In 1989, the Arizona Legislature created the Wastewater Management Authority to administer funds granted to the state pursuant to the federal SDWA. These funds, which required a 20 percent state match, were loaned to wastewater treatment facilities for assistance in meeting the SDWA requirements. The ADEQ made loans for this purpose from monies in the ADEQ wastewater treatment revolving fund.

In 1997, this administrative body was amended by the Legislature and renamed the Water Infrastructure Finance Authority (WIFA). The authority of WIFA was expanded to make loans available to drinking water systems in addition to wastewater treatment systems for assistance in meeting requirements of the SDWA. The state funding source was also changed so that monies made available to these systems are now derived from the drinking water revolving fund. The Department participates on the advisory board that oversees WIFA and has an interest in the viability of water systems and SDWA compliance.

### 7.4.4 The Department's Programs Related to Groundwater Quality

The Department protects groundwater quality by considering groundwater quality issues in its permitting process and water quantity management programs. As a result of WQARF reform legislation of 1997, the Department has increased its responsibility in the program to coordinate and provide assistance to WQARF activities. Among other things, the bill provides for:

- annual funding for Department WQARF activities;
- database development and coordination with ADEQ;
- groundwater withdrawn pursuant to certain cleanups to be accounted for in the same manner as surface water for the purpose of determining compliance with conservation requirements;
- amendment of the Assured Water Supply Rules (AWS Rules);
- active involvement by the Department in all phases of site assessment, remediation, management, operation, and planning strategies;
- a WQARF Advisory Board on which the Department has a seat; and
- a well inspection program through which wells that are contributing to vertical cross-contamination of aquifers may be identified and modified.

The Department's existing permits and programs that involve groundwater quality issues, as well as its new programs for groundwater quality protection based on the WQARF legislation, are discussed in the following subsections.

#### 7.4.4.1 Poor Quality Groundwater Withdrawal Permits

Appropriate use of poor quality groundwater conserves the existing supply of potable groundwater. The Department issues poor quality groundwater withdrawal permits to allow the withdrawal of groundwater that, because of its quality, has no other beneficial use at the present time. A.R.S. § 45-516. Withdrawal

permits are issued by the Department, and the withdrawal must be consistent with the AMA management plan. Permits are usually issued in conjunction with CERCLA, WQARF, or leaking UST sites for pump and treat operations. To increase the appropriate uses of poor quality groundwater during the third management period, the Department will continue to encourage matching poor quality groundwater with beneficial uses within the AMA.

#### 7.4.4.2 Assured Water Supply Program

The Assured Water Supply Program (AWS Program) is a consumer protection program that ensures that new subdivisions have a secure supply of water with adequate quality for at least 100 years. The AWS Program is described in detail in Chapter 5, section 5.3.

In assessing the quality of a water supply pledged for assured water supply purposes, the Department works closely with ADEQ to determine whether the water supply meets ADEQ standards for the purposes for which the water is pledged. If the water is not of adequate quality, the applicant may need to find alternative water sources or to expend additional resources treating the water to meet the ADEQ standards.

#### 7.4.4.3 Underground Water Storage and Recovery

Underground water storage, also known as recharge, will play an important role in achieving the Tucson AMA's goal of safe-yield. The underground water storage program is administered by the Department and described in detail in Chapter 8, section 8.7.2. Permits must be obtained from the Department prior to undertaking recharge activities. The Department coordinates closely with ADEQ to ensure that underground water storage does not adversely impact existing aquifer water quality and does not cause movement of existing groundwater contamination. If effluent is stored underground, the applicant must obtain an APP from ADEQ, in addition to the underground storage permits required from the Department. CAP water that is recharged is exempt from the APP process.

#### 7.4.4.4 Well Spacing/Impact Analysis

A.R.S. § 45-598 and the Department's temporary Well Spacing and Well Impact Rules require well impact studies to evaluate the potential for new non-exempt wells and new withdrawals to damage land and other water users, particularly existing well operations. The Department conducts the impact studies for wells with a maximum discharge of 500 gallons per minute (gpm) or less. For wells with a maximum discharge rate exceeding 500 gpm, the permit applicant must submit a hydrological study of projected water level declines due to the operation of the proposed well. The study must also assess potential adverse impacts from the migration of poor quality groundwater. The well permit application may be denied if the Department determines the proposed well would cause an unreasonable and adverse impact on surrounding wells, additional regional land subsidence, or migration of poor quality groundwater. Wells that withdraw less than 35 gpm are currently exempt from these requirements.

#### 7.4.4.5 Well Construction and Abandonment Requirements and Licensing of Well Drillers

If wells are not constructed, sealed, or abandoned properly, they can act as conduits for contaminant flow from the surface to groundwater or between aquifers. The Department's rules governing well construction, abandonment, and driller licensing, set forth at A.A.C. R12-15-801, *et seq.*, are summarized below.

- Minimum well construction and abandonment requirements prevent entry of fluids at and near the surface and minimize the possibilities of migration and inadvertent withdrawal of poor quality groundwater. These requirements also prohibit the use of hazardous materials in the construction of wells.

- Installation, modification, abandonment, or repair of wells in Arizona must be performed by a driller licensed by the Department. The licensing procedure includes the administration of written examinations to test the applicant's knowledge of state regulations, hydrologic concepts, and well construction principles and practices.

- Disposal site restriction prevents the use of wells as disposal facilities for any material that may pollute groundwater.

- Special standards may be required by the Department if the minimum well construction requirements do not adequately protect the aquifer or other water users.

- Open wells must be capped with a water-tight steel plate.

- Except for monitor and piezometer wells, no well shall be drilled within 100 feet of any septic tank system, sewage disposal area, landfill, hazardous waste facility or storage area, or petroleum storage areas and tanks, unless authorized by the director.

Wells drilled prior to the enactment of the well construction rules (effective March 5, 1984) were not required to be constructed in accordance with minimum well construction standards. If a pre-rule well is replaced or modified, however, the new or modified well must meet the current well construction standards. See A.R.S. § 45-594.

### 7.4.4.6 The Department's Role in the WQARF Program

The Department's involvement in groundwater remediation has been redefined in the WQARF reform bill as a result of recommendations made by the Groundwater Task Force, which conducted an extensive series of stakeholder negotiations designed to expedite groundwater cleanup and groundwater quality management activities at remedial sites. Involvement in this development process was widespread and representative of a varied group of private and public interests.

#### 7.4.4.6.1 Department Activities in the WQARF Site Cleanup and Management Process

ADEQ's WQARF site cleanup and management process and the Department's role in that process are described in the following discussion.

Site Identification and Characterization

Existing WQARF sites have been identified and are being managed by ADEQ. Additional sites may be identified in the future based on a preliminary investigation by ADEQ to determine the potential risk to public health, welfare, or the environment. The Department will further assist ADEQ in this process by providing resource data that includes well location and pumpage records, water rights information, and any other appropriate data recorded by the Department.

Characterization of sites is important because the nature and extent of contamination must be understood before remedies can be selected and implemented. An important part of site characterization is an evaluation of how contamination impacts current and future groundwater uses. The Department's role may include such activities as site inspections and evaluations, review of investigations, field work such as well inspection and water quality sampling, identification of potential water management issues, and any other characterization as appropriate. Department computer models may be useful in characterizing groundwater flow patterns.

Site Prioritization

The results of the preliminary investigation will be used by ADEQ for site scoring using a method to be established in rules adopted by the ADEQ director. The completed preliminary investigation will be used by ADEQ to either make a determination of no further action on a site, or to prepare the site for inclusion on the Site Registry. In this latter case, a Site Registry report is prepared containing a description of the site, with its geographical boundaries indicated, and a score in accordance with the site scoring method to be established in rules and adopted by the ADEQ. The Department will assist ADEQ by sharing pertinent water resource information.

Remedy Selection

ADEQ has established a list of response actions to be considered when managing a site. Based on the potential impact on current and future water uses, remedial action options must be evaluated and a RAP developed. Each RAP is site-specific. The Department will assist in defining potential remedies to ensure the remedial approach is consistent with Department water management objectives and sound groundwater management practices that are publicly acceptable. The Department's level of assistance will vary based on the remedy selected. Possible remedies include:

- Plume Remediation

Plume remediation, or aquifer restoration, means achieving appropriate water quality standards for groundwater throughout the affected area. Source control and monitoring will likely be essential elements of this strategy. This remedy may be more effective for smaller plumes that can be remedied within reasonable time frames.

- Physical Containment

Physical containment refers to an approach that contains contaminants within defined boundaries. This strategy could consist of plume control and coordination of groundwater pumpage and recharge to ensure that contamination is confined within a defined area. Source control and monitoring are also likely elements of this strategy. Physical containment may be appropriate in cases where potable water supplies are threatened by contaminant migration and where containment is technically feasible, however, it may require extensive groundwater management to implement.

- Controlled Migration

This strategy aims to control but not necessarily contain contaminant migration. Source control and monitoring are likely elements of this strategy. Control of contaminants can include control and/or coordination of pumpage that affects contaminant migration and any other measures taken to control contaminant migration. Controlled migration may be appropriate for larger plumes that cannot be practically remediated or contained.

- Source Control

Source control is a reduction of continuing contaminant sources such as soil contamination or areas of high concentrations of Volatile Organic Compounds (VOCs) or other contaminants. Dense non-aqueous phase liquids (DNAPLs), which are contaminants (such as VOCs) of such high concentrations that they are not dissolved in groundwater but exist as free phase liquids, are an example of contaminant sources. Source control is a remedial action that often results in the highest volume of contaminants removed per unit cost.

This strategy employs controlling the pollutant at the source to ensure that aquifer contamination does not migrate due to uncontrolled contaminant releases. Monitoring is a likely component of this strategy. Source control can include, but is not limited to, the remediation of sorbed or free-phase contaminants, pumpage of groundwater to contain or control significant sources of contaminants, and the removal of contributing contaminant sources.

- Monitoring

Monitoring water quality conditions, instead of implementing actual cleanup activities, can be a remedy applied to sites with low risk to human health or the environment. Monitoring sites is also an important part of many remediation plans to assess the extent of contamination and the effectiveness of remedial activities. Computer groundwater models may be used to predict contaminant movement, to monitor well locations, and to develop contingency plans for more aggressive remedies, if necessary.

- No Action

This alternative consists of taking no action at a site. The site is not monitored nor are any remedial actions performed. This strategy is normally included as a baseline condition for comparison purposes in a remedial investigation feasibility study, but may be a viable alternative in limited cases. Generally, this alternative would only be chosen for sites that are geographically isolated from populated areas, do not pose a significant threat to drinking water supplies, or would be used for comparative purposes to other sites.

Identification of Beneficial End Uses

The Department is committed to the beneficial use of groundwater withdrawn and treated at WQARF sites, along with other areas that have degraded groundwater quality. The Department will assist ADEQ with the identification and facilitation of designated end uses for remedial projects. These end uses should be consistent with those determined for existing sites as well as the development of new end uses to match the intended use.

Implementation and Monitoring

The implementation and monitoring phase of a site activity includes construction, startup, monitoring, operation and maintenance, and any other appropriate activities. The Department will assist ADEQ in this phase through the following activities where appropriate: field work, review of groundwater analyses, pertinent groundwater and assured water supply accounting, and any other appropriate activities.

Site Closure

ADEQ must certify that site goals have been attained in order to discontinue cleanup activities. Department staff will assist in evaluation of sites and certification of site closure. The Department may need to identify alternative water sources to replace remediated water when sites are closed.

### 7.4.4.6.2 The Department Policies for WQARF Site Cleanup and Management

In general, site cleanup plans should be consistent with the management goal of the AMA in which the site is located. A.R.S. §§ 49-282.06(F) and 45-105(B)(4)(c). Therefore, the Department will implement policies during the third management period for the management and cleanup of remedial sites in cooperation with ADEQ. These policies will ensure that AMA goals are addressed when remedial actions are planned. The Department supports proposed remedial projects when they are appropriate, but believes

that RAPs must make sense from a groundwater management perspective. The principles that will be used to formulate these policies are described below.

Water should be used consistent with water allocation concepts in Title 45

This policy requires that entities using water withdrawn pursuant to cleanups, whether under CERCLA, WQARF, RCRA, voluntary, or other sites possess appropriate authorities for the use of groundwater (such as permits or water rights).

The Department supports source control cleanups to protect water sources

Source control, which controls pollution at its source, can be the most cost effective and practicable approach to cleanups. Source control projects to protect wells that are threatened by contaminant migration are generally supported by the Department. Pollution prevention is also a significant component of mitigating contaminant migration.

Any groundwater withdrawn must be put to reasonable and beneficial use

Reasonable and beneficial use of groundwater is a policy that applies to all groundwater remediation efforts. Any withdrawals of 100 acre-feet or less per year may qualify for de minimis status and be exempted from beneficial use requirements, but the Department will evaluate de minimis exemptions from this policy on a case-by-case basis. In the case of leaking UST sites, the Department generally exempts sites that annually pump less than 10 to 15 acre-feet. The de minimus policy also facilitates the handling of small volumes of water pumped for the collection of groundwater sampling.

Contaminated groundwater represents a resource that has future importance

Contaminated groundwater is a resource that may be used for both potable and nonpotable uses. Potable uses must meet state and federal standards that regulate public consumption of drinking water. ADEQ and the Department of Health Services intend to develop end use standards for non-potable uses that, if implemented, will make large volumes of contaminated groundwater usable for specific purposes. The Department will cooperate in the development of nonpotable end use standards and will develop policies for appropriate end uses based on the new standards.

Containment remedies that involve massive groundwater withdrawals to achieve regional groundwater flow control are generally inappropriate and will not be supported by the Department

In some cases, massive groundwater withdrawals of uncontaminated or only slightly contaminated water may be considered to control migration of contaminant plumes or for other purposes. In general, the Department considers these kinds of proposed remedies to be wasteful of groundwater and not cost-effective.

#### 7.4.4.6.3 Statutory Mandates for the Department's Involvement in the WQARF Program

The 1997 WQARF reform legislation mandates that the Department implement certain water quality programs and provides for expanded Department involvement in water quality management. New Department programs and responsibilities based on the 1997 WQARF reform legislation include the following:

Remediated Groundwater Incentives

The WQARF reform legislation of 1997 directs the Department to include in the management plans developed pursuant to A.R.S. § 45-566 (the Third Management Plans) provisions to encourage the beneficial use of groundwater that is withdrawn pursuant to approved remedial action projects under CERCLA or Title 49, Arizona Revised Statutes. Laws 1997, Ch. 287, § 51(A).

- Remediated Groundwater Incentive for Conservation Requirement Accounting

In order to encourage the beneficial use of remediated groundwater, the Legislature specifically mandated:

> In determining compliance with applicable conservation requirements adopted pursuant to sections 45-566, 45-567 and 45-568, Arizona Revised Statutes, the department of water resources shall account for groundwater withdrawn pursuant to approved remedial action projects under CERCLA or Title 49, Arizona Revised Statutes, consistent with the accounting for surface water.

Laws 1997, Ch. 287, § 51(B).

- Remediated Groundwater Incentive for Assured Water Supply Accounting

In addition, the WQARF reform legislation of 1997 directs the Department to consider specified amounts of groundwater withdrawn pursuant to approved remedial action projects as consistent with the management goal of the active management area from which it is withdrawn for purposes of the Department's AWS Program. Laws 1997, Ch. 287, § 52. The Legislature mandated that:

> For each calendar year until 2025, the use of up to an aggregate of sixty-five thousand acre-feet of groundwater withdrawn within all active management areas pursuant to approved remedial action projects under CERCLA or Title 49, Arizona Revised Statutes, shall be considered consistent with the management goal of the active management area.

Laws 1997, Ch. 287, § 52(A).

Once the aggregate volume of 65,000 acre-feet of remediated groundwater use by all users in all active management areas is reached in a year, the use of an additional amount of remediated groundwater is consistent with the management goal of the active management area based on a sliding scale. In the third management period, fifty percent of the total volume withdrawn in excess of the 65,000 acre-feet will be consistent with the management goal. Laws 1997, Ch. 287, § 52(B). By the year 2025, the remediated groundwater incentive for assured water supply accounting decreases to zero.

A municipal provider must apply for a remediated groundwater accounting for an assured water supply determination prior to January 1, 2010. The amount of groundwater determined to be consistent with the management goal cannot exceed the amount that the municipal provider is legally obligated to withdraw or use and does not extend beyond 2025. Laws 1997, Ch. 287, § 52(C).

Annual groundwater withdrawals of 250 acre-feet or less that are withdrawn pursuant to an approved remedial action project shall not be debited against the water provider's assured water supply mined groundwater account and shall not be subject to a replenishment obligation. The water provider must notify the Department of its compliance with the exemption. Annual withdrawals of 250 acre-feet or less of remediated groundwater will not count against the 65,000 acre-feet per year total volume. Laws 1997, Ch. 287, § 52(E).

- Coordination with ADEQ in Evaluating Proposed Remedial Actions

Pursuant to A.R.S. § 45-105(B)(4)(c), the Department is required to actively coordinate and confer with ADEQ in evaluating proposed remedial actions to provide ADEQ with information regarding water resource considerations. The Department will coordinate and confer with ADEQ prior to ADEQ's approval or denial of a proposed remedial action project. Once a remedial action project is approved by ADEQ or the EPA pursuant to CERCLA or Title 49, Arizona Revised Statutes, the Department will account for remediated groundwater in accordance with Laws 1997, Ch. 287, §§ 51 and 52. Among other things, the Department will consider the following factors relating to proposed remedial actions in its recommendations to ADEQ:

- Volume of remediated groundwater to be withdrawn

The Department will encourage remedial actions that use the least amount of groundwater necessary to facilitate a project's remedial goal and will discourage remedial actions that are not prudent and efficient from a groundwater management perspective.

- End uses to which remediated groundwater will be put

The Department will encourage end uses that minimize groundwater withdrawals and that are consistent with the safe-yield goal because they will result in no change in groundwater storage. Where remediated groundwater cannot be practicably or cost effectively re-injected or recharged, the Department will encourage replacing existing groundwater uses with remediated groundwater and preventing new permanent uses that would not have occurred without the incentive to use remediated groundwater and that would continue to rely on groundwater after the remediated groundwater is no longer available.

While individualized circumstances will be evaluated on a case-by-case basis, generally, the Department's beneficial end use preferences are the following, listed in order from most to least preferred based on impacts to the AMAs management goal and the amount of groundwater in storage:

Neutral to local aquifer

a. Re-inject or recharge in the same local area.
b. Replace existing groundwater uses in same local area.

Neutral to groundwater basin

c. Re-inject or recharge in the same AMA.
d. Replace existing groundwater uses in the same AMA.

Reduce groundwater in storage

e. Replace existing non-groundwater use in the same AMA.
f. Beneficial uses of water for new purposes.
g. Artificial wetlands or artificial lakes.
h. Dispose to the sewer (unless the resulting effluent is re-injected, recharged or replaces an existing groundwater use).

- Achievement of maximum beneficial use of waters and viability of proposed remedial action

Remedial actions must assure the protection of public health and welfare and the environment; to the extent practicable, provide for the control, management or cleanup of hazardous substances so as to allow the maximum beneficial use of the waters of the state; and be reasonable, necessary, cost-effective and technically feasible. A.R.S. § 49-282.06(A).

- Consistency with Title 45

Groundwater withdrawn pursuant to an approved remedial action must be withdrawn and used consistent with Title 45, Arizona Revised Statutes.

Well Inspection, Modification, or Replacement

The Department is required by the 1997 WQARF legislation to develop rules for well inspections. An evaluation of the extent of the cross-contamination problems will be performed by the Department in cooperation with ADEQ and other stakeholders.

Construction of New Wells In and Near WQARF Sites

The 1997 WQARF legislation mandates that the Department ensure that new or replacement wells located in areas of known groundwater contamination are constructed in such a manner that cross-contamination does not occur. Department staff will screen Notices of Intent to Drill that are submitted to help ensure that wells are properly constructed. The Department will establish policies and procedures to implement this directive, including procedures to effectively communicate with well owners and drillers.

Abandonment of Wells In and Near WQARF Sites

Department staff will review and evaluate Notices of Intent to Abandon to ensure that abandonment of wells is done in accordance with Department rules and that potential for cross-contamination is minimized.

## 7.5 WATER QUALITY ASSESSMENT

A water quality assessment must be included in management plans pursuant to the Code. The assessment provides an overview of water quality concerns in the Tucson AMA. The following sections discuss the assessment goals and objectives, water quality of renewable and groundwater supplies, constituents of concern in the Tucson AMA and their impact on water management, and specific contamination areas in the Tucson AMA.

### 7.5.1 Assessment Goals and Objectives

The primary goal of the Third Management Plan Water Quality Assessment is to provide a general evaluation of groundwater and surface water quality conditions in the Tucson AMA and to identify the interface of water quality concerns with the regional water supply. The impact of water quality on water resource management has become more important in recent years due to such factors as stringent water quality standards, conjunctive use of water supplies, groundwater management at remediation sites, and increasing levels of public concern.

The municipal, agricultural, and industrial sectors have distinctive demand patterns and water quality requirements. For example, state law prohibits direct use of treated effluent for potable use, but treated effluent is used for turf irrigation, agricultural irrigation, cooling towers, and groundwater recharge. Water high in total dissolved solids (TDS) may be inappropriate for agricultural irrigation, but may be usable for some industrial applications. Water high in nitrate could provide a suitable end use for agriculture, but does not meet potable standards. During the third management period the Department will evaluate matching water quality characteristics with appropriate end uses while ensuring compliance with applicable laws and rules for each end use.

### 7.5.2 Renewable Water Supplies

The primary renewable water supplies available for use in the Tucson AMA are CAP water and effluent. Other than imported CAP water, the volume of natural surface water supplies in the Tucson AMA available for direct use is small. The quality of these waters is discussed in the following sections.

#### 7.5.2.1 Central Arizona Project Water

The largest surface water supply available in the Tucson AMA is CAP water, which is diverted and conveyed from the Colorado River primarily in an open canal. The direct delivery of CAP water for municipal water supply has been met with much controversy in the Tucson AMA. The City of Tucson, the largest municipal CAP subcontractor in the state, has been faced with many obstacles in their attempt to utilize their CAP allocation. The utilization of CAP water as a direct supply for drinking water has been an issue since the City began delivery of treated CAP water in November 1992. Customer complaints of colored water, corrosion, bad taste and odor, and other problems led to the Mayor and Council's decision to discontinue deliveries of treated CAP water. Since then, many of the causes for these water quality problems have been identified and control methods are being developed. Some of these problems were caused by changes in pH, pressure fluctuations, hydraulic flow reversals, and the deteriorated condition of part of the existing water distribution system.

Disinfectants are used in public water supplies to avoid outbreaks of water-borne diseases and pathogens such as giardia and cryptosporidium. Scientists currently believe that the health risks of these diseases far outweigh the risk associated with disinfection by-products. However, research is being done to evaluate issues related to disinfection by-products.

There has been considerable controversy concerning the potential harmful health effects of disinfection by-products associated with surface water treatment, especially trihalomethanes (THMs). THMs, including chloroform, are known cancer-causing agents in animals and are produced as a by-product when chlorine disinfectants are used in source water containing naturally occurring organic matter.

The EPA published new federal regulations in December 1998 for disinfectants, disinfectant by-products, and microbial contaminants. The phase in of these new standards will regulate water constituents such as haloacetic acids and individual THMs. This action may affect water supply management decisions and create additional issues regarding the treatment and direct use of CAP water.

A combination of ozone and chloramine was chosen by the City of Tucson for CAP water treatment because it produces fewer THMs compared to chlorine, the disinfectant used by most water treatment facilities. Ozone is used to kill all viruses and bacteria in a single "shock" treatment. Ozone does not leave any residuals. Chloramine is a combination of chlorine and ammonia and is added in the final stages of treatment as a residual disinfectant to keep microorganisms from growing in the distribution system. For the Hayden-Udall CAP water treatment plant, the City set a disinfectant by-product standard of 20 micrograms per liter (µg/l) THMs as compared to the current EPA standard of 100 µg/l. The EPA has promulgated the Stage 1 Disinfectants/Disinfection By-products Rule in December 1998, which are more stringent than the current standards. Compliance dates for these rules begin three to five years after promulgation depending on the type of water system being regulated.

Many CAP water use alternatives have been recommended and include blending treated CAP water with groundwater, enhanced treatment of CAP water using membrane filtration, and implementing larger-scale recharge programs. Levels of TDS in CAP water range from about 650 to 750 milligrams per liter (mg/l), which is typically higher than TDS found in groundwater currently being pumped in most locations of the Tucson AMA. These and other alternatives raise significant technical and economic issues that will continue to be studied.

### 7.5.2.2 Effluent

Effluent is defined by A.R.S. § 45-101(4) as "water that has been collected in a sanitary sewer for subsequent treatment in a facility that is regulated pursuant to A.R.S. §§ 49-361 and 49-362. Such water remains effluent until it acquires the characteristics of groundwater or surface water." Sanitary sewers are comprised of any pipe or other enclosed conduit that carries any waterborne human wastes from residential, commercial, and industrial facilities. A.R.S. § 45-101(8).

Effluent treated at municipal wastewater treatment plants is a significant source of renewable water supply in the Tucson AMA. Although not suitable for human consumption without advanced treatment, effluent is suitable for turf irrigation, agricultural irrigation, sand and gravel washing, and several other industrial applications.

There are currently two wastewater treatment facilities that discharge effluent into the Santa Cruz River within the Tucson AMA boundaries. These facilities are the Roger Road Wastewater Treatment Facility and Ina Road Water Pollution Control Facility and are operated by the Pima County Wastewater Department. Segments of the Santa Cruz River downstream from the effluent discharges have perennial or continuous flows as a result of these discharges. Wastewater discharges to waters of the United States require an NPDES permit and an APP to ensure that water quality standards are being met.

Secondary effluent, which is treated to NPDES permit standards, usually contains TDS, nitrate, sulfate, metals, and bacteria at concentrations higher than those present in public water supply systems with groundwater sources. A portion of the secondary effluent is treated to a higher standard by filtering and disinfection and is directly delivered for non-potable uses in the Tucson AMA. Wastewater reuse rules are developed by ADEQ and establish parameters for wastewater reuse options.

Constructed wetlands can be developed to further enhance the treatment of effluent and to pretreat water prior to recharge or reuse. Vegetation and microbial activity in wetlands along with filtration of effluent through the vadose zone (soil aquifer treatment) improves the quality of water containing high concentrations of nitrate and organic carbon. Constructed wetlands are occasionally used as a treatment for lower quality surface waters and agricultural return flows. Wetland projects are also being evaluated to determine their effectiveness as an enhanced TT to bring effluent discharges into compliance with potentially more stringent NPDES permit requirements. In addition to improving water quality, wetlands enhance wildlife habitat and serve as an educational and recreational resource for the community.

### 7.5.2.3 Surface Water Other Than CAP Water

Most streams in the Tucson AMA are ephemeral or intermittent. Because in-stream channel flows are typically short-term and occur in response to runoff from precipitation events, the direct use of surface water is limited. The surface water supplies other than CAP are an important source of natural aquifer recharge in the Tucson AMA. Although relatively few surface water quality samples have been taken, water from this source often contains bacteria, parasites, and/or viruses. Municipal and industrial storm water runoff may also contribute to surface water contamination. In order to address contaminants in storm water runoff, the NPDES storm water program was developed to specifically control the amount of storm water pollutant discharges to waters of the United States.

### 7.5.3 Groundwater Supplies

Groundwater is one of the most important sources of water in Arizona. Most of the groundwater supplies in the Tucson AMA are of acceptable quality for most uses. However, some groundwater areas have been degraded as a result of contamination.

The introduction of contaminants into aquifer systems degrades groundwater quality and threatens public health and the environment. Contaminants can migrate into areas of potable groundwater supplies due to groundwater pumping or regional groundwater flow patterns. Many areas of the Tucson AMA are projected to remain dependent on groundwater pumping, thereby potentially causing migration of contaminants. The Department's role in managing potential contaminant migration is through involvement in site-specific and non site-specific water quality management.

Groundwater that has been degraded has limited beneficial uses due to chemical, biological, or radiological contamination and may have high treatment and delivery costs associated with its use. Despite these limitations, the Department considers poor quality groundwater to be a valuable resource for future water management and encourages appropriate uses of this water supply. Matching the highest beneficial use with poor quality groundwater is an important aspect of water management. Frequently, poor quality groundwater is remediated and re-injected into the aquifer because it is not economically feasible to convey the treated water to another location for a higher beneficial use.

The Central Arizona Groundwater Replenishment District, the Arizona Water Banking Authority (AWBA), and other entities are actively pursuing recharge of excess CAP water within the Phoenix, Pinal, and Tucson AMAs. The impacts of CAP water recharge on existing groundwater quality are not fully understood at this time. Recognizing that there may be groundwater quality impacts resulting from surface water recharge, the EPA requires states to develop a rule for groundwater under the influence of surface water. ADEQ has proposed a rule (A.A.C. R18-11-405), currently under public review, which would require that groundwater under the direct influence of surface water withdrawn from recharge facilities undergo more extensive treatment than groundwater. These filtering and disinfection requirements are cost factors for the development and operation of underground water storage facilities. See Chapter 8, section 8.3.4, for further discussion of recharge water quality issues.

### 7.5.4 Groundwater Constituents and Their Impacts on Water Quality Management

The management of water resources requires an understanding of how water quality impacts aquifer conditions and potential uses. Drinking water quality regulations are developed to ensure that the intended use will not have harmful impacts on human health. The Department and ADEQ evaluate water quality based on ADEQ's numeric and narrative AWQSs as well as EPA's primary and secondary MCLs, commonly expressed as mg/l or µg/l. Appendix 7A provides a detailed list of the primary MCLs for VOCs, pesticides, inorganic metals, radiochemicals regulated under the Arizona Drinking Water Rules, and other selected contaminants. Appendix 7A also includes a brief description of the potential human health effects and sources of these contaminants in drinking water. Appendix 7B lists the secondary MCLs for selected contaminants. Secondary MCLs are non-enforceable aesthetic standards.

The following sections briefly describe the impact of selected constituents on groundwater management and public health. ADEQ's Arizona Water Quality Assessment was used as a reference for descriptions of the limitations on uses, present and planned remedial activities, and potential uses of poor quality groundwater for each constituent. Other sources used in the presentation of contaminant concentrations include the Department's Second Management Plan for the Tucson AMA, CAP water quality reports prepared by the Central Arizona Water Conservation District, Groundwater Reclamation Project Reports prepare for Air Force Plant Number 44 (AFP 44), and data contained in the 1994 Pima Association of Government's State of the Region Water Quality Report.

For most constituents, a corresponding map is provided that displays available water quality data for well locations sampled in the Tucson AMA since 1990. Well sites that produced test results within drinking water quality standards and in exceedance of current drinking water quality standards are displayed for each selected constituent. If multiple samples were taken at a monitor site, the most recent sample analyzed since 1990 is displayed.

The groundwater quality maps are the result of an interagency effort between the Department and the ADEQ. An interagency team retrieved and analyzed data from a variety of sources including the Department's Registry of Groundwater Rights and Groundwater Site Inventory databases, the ADEQ Groundwater Quality database, and a number of WQARF site project reports.

Other ADEQ databases, such as the Underground Storage Tank and Drinking Water Quality databases, were not used because they could not be integrated with the Department's databases. Consequently, the groundwater quality maps depicted in this section were made from the information that was available and compatible with the Department's well identification system.

The groundwater quality maps provide a general overview of water quality conditions within the AMA. These maps are provided for informational purposes and should not be referenced for site-specific groundwater quality conditions. Other reports that are published by the ADEQ and other sources may contain additional data that are not reflected on these maps.

### 7.5.4.1 Nitrate

Nitrates are salts formed from nitrogen compounds and are one of the most common groundwater contaminants detected in Arizona. Low nitrate concentrations in groundwater may originate from natural sources such as organic acids. Elevated nitrate levels are generally attributed to current and historic industrial sources, wastewater treatment plants, septic tanks and leach fields, agricultural fertilizers, and animal impoundments such as stockyards.

The primary MCL for nitrate can be expressed in two different ways. When nitrate is expressed as a concentration of nitrogen (N) in water, the primary MCL is 10 mg/l and it is termed nitrate-nitrogen. When nitrate is expressed as a concentration of nitrate ($NO_3$) in water, the primary MCL is 45 mg/l and is termed simply "nitrate." The primary MCLs of 10 mg/l of nitrate-nitrogen and 45 mg/l of nitrate are equivalent. Water containing high levels of nitrate cannot be delivered as a drinking water supply unless it is equal to or reduced below the primary MCL of 10 mg/l for nitrate-nitrogen. Adults can tolerate high levels of nitrate, although water containing more than several hundred mg/l of nitrate-nitrogen can cause gastrointestinal irritation. Water that contains nitrate in concentrations in excess of the primary MCL can be harmful to infants. Nitrate may also be harmful to livestock at levels exceeding several thousand mg/l.

Nitrate stimulates plant growth and is typically regarded as a desirable constituent for most agricultural and irrigated turf applications. For this reason, effluent is often sought as a source of irrigation water. Nitrogen fertilizer application rates may be reduced or eliminated if irrigation water contains elevated nitrate levels.

Figure 7-1 displays selected nitrate groundwater sample test data from sources as described in section 7.5.4. In the Tucson AMA, nitrate concentrations above the EPA primary MCL of 10 mg/l of nitrate-nitrogen (equivalent to 45 mg/l of nitrate) can be found in localized areas along the Santa Cruz River near Green Valley, Sahuarita, and northwest of Marana. In the Upper Santa Cruz Valley Subbasin, nitrate concentrations are lowest in aquifers underlying undeveloped desert. In the Avra Valley Subbasin, nitrate concentrations are lowest in the southern portion, in aquifers underlying undeveloped desert. Nitrate concentrations are highest in the northern portion of the subbasin along the Brawley Wash.

### 7.5.4.2 Sulfate

Sulfate can occur as a natural inorganic constituent of groundwater that originates from the natural dissolution of minerals in aquifers. Elevated concentrations can result from the leaching of industrial wastes and agricultural fertilizers. High sulfate concentrations are often found in aquifers underlying current or historic agricultural lands, mining areas, and areas of natural mineralization.

Figure 7-2 shows some of the locations of elevated sulfate conditions in the Tucson AMA, based on data collected as described in Section 7.5.4. Elevated sulfate levels, (which are not displayed), have also been detected in groundwater west of the Santa Cruz River near Green Valley where copper mine operations and natural mineralization occurs. The sulfate level for raw CAP water typically averages 242 mg/l, whereas the average groundwater concentration in the AMA is 48 mg/l.

The EPA has not established a primary MCL for sulfate. The EPA is scheduled to complete studies of the human health effects of sulfate and to decide whether to establish a drinking water MCL in August 2002. The secondary MCL for sulfate is 250 mg/l.

Elevated sulfate concentrations in drinking water supplies can cause problems due to taste and laxative effects and can lead to scale formation in evaporative cooling systems. The diverse nature of industrial water quality requirements creates specific needs for different industries. Some industries require very low sulfate levels while others can use water with elevated sulfate levels. High sulfate concentrations in groundwater do not commonly limit agricultural water use.

#### 7.5.4.3 Total Dissolved Solids

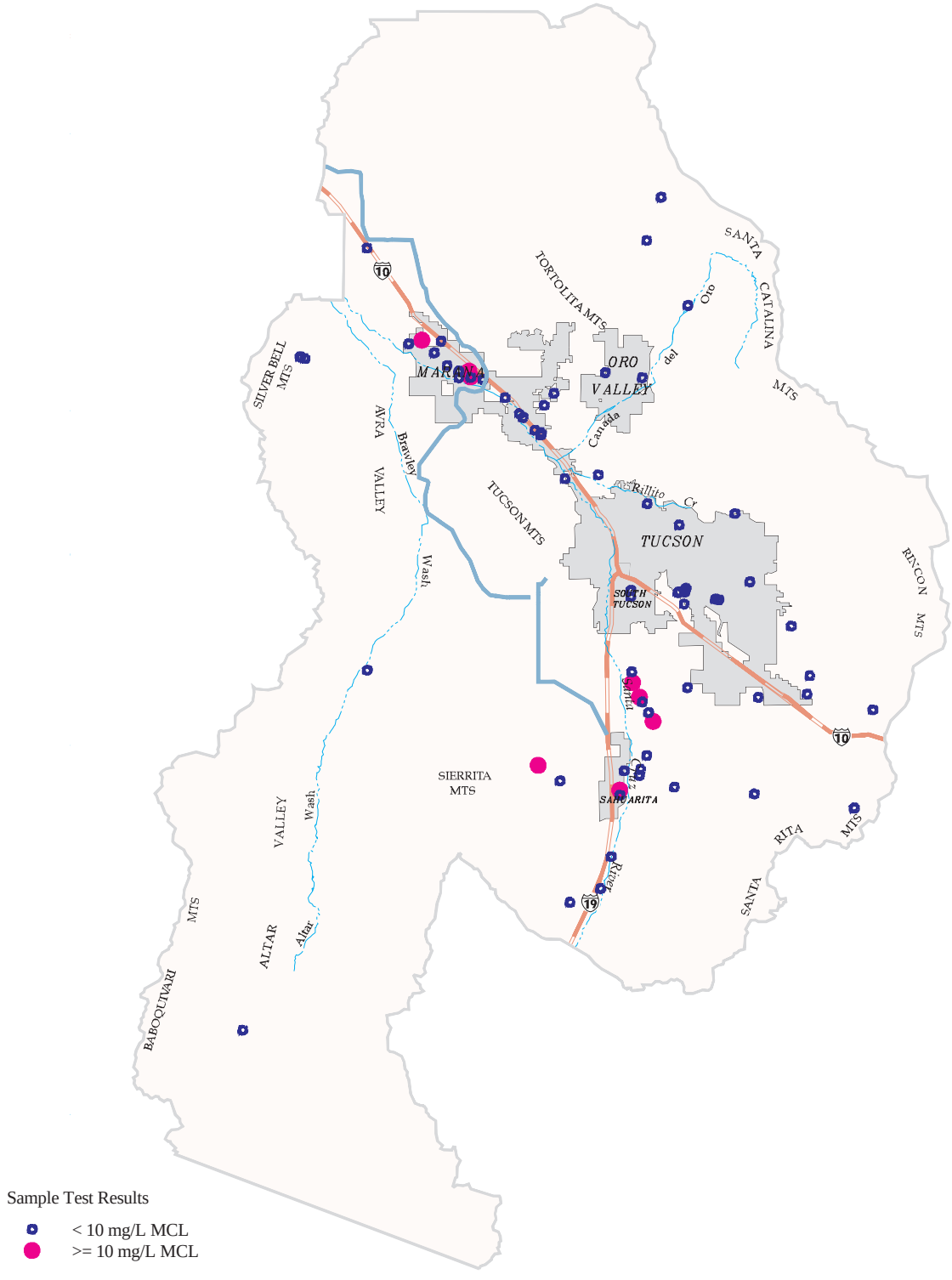
TDS content is a measure of the dissolved minerals present in water and is a general indication of inorganic water quality. Components of TDS include inorganic compounds such as calcium, magnesium, sodium, potassium, sulfate, bicarbonate, chloride, and silica. In most areas, the primary components of TDS are derived naturally as groundwater dissolves minerals present in aquifers. TDS concentrations can also be elevated by agriculture, industry, and wastewater treatment facility discharges.

The EPA has established a secondary MCL of 500 mg/l for TDS. High TDS concentrations, which result in scaling and mineral accumulation, can have an adverse economic impact on water distribution systems and household plumbing and appliances. Though no permanent harmful effects have been observed from drinking high TDS water, some people may find the taste of this water to be less desirable than lower TDS water.

TDS concentrations in the Tucson AMA are depicted in Figure 7-3. TDS levels up to 2,500 mg/l have been detected in groundwater near Green Valley and the mines and levels up to 600 mg/l have been detected downstream of agricultural activities in the northern portion of the Avra Valley Subbasin along Brawley Wash. The TDS content of most groundwater in the Tucson AMA is below or near the secondary MCL. TDS concentrations in the groundwater currently being withdrawn typically ranges from 200 mg/l to about 500 mg/l. Such concentrations present little restriction in the use of the potable groundwater supplies.

TDS concentrations in CAP water imported into the Tucson AMA range from about 650 to 750 mg/l. This has become an issue in the Tucson AMA because the concentration of TDS in CAP water is higher than the concentration detected in much of the current groundwater supply. As discussed in Chapter 8, there is concern about the potential impacts of CAP water on existing groundwater quality due to aquifer recharge and underground storage of CAP water.

The concentration of TDS that limits water use varies widely among industries. High TDS water is a primary concern of a few industries (such as the semiconductor industry) that require water so pure they must treat almost any source water to obtain the necessary quality. Other industries, such as sand and gravel operations, can use water with very high TDS concentrations. The application of water containing high concentrations of TDS on turf facilities can impact turf quality and clog irrigation sprinkler heads if proper management techniques are not followed.




Sample Test Results

- < 10 mg/L MCL
- >= 10 mg/L MCL

- Tucson AMA
- Incorporated Areas
- Roads and Highways
- Rivers and Streams
- CAP Canal

Figure 7- 1

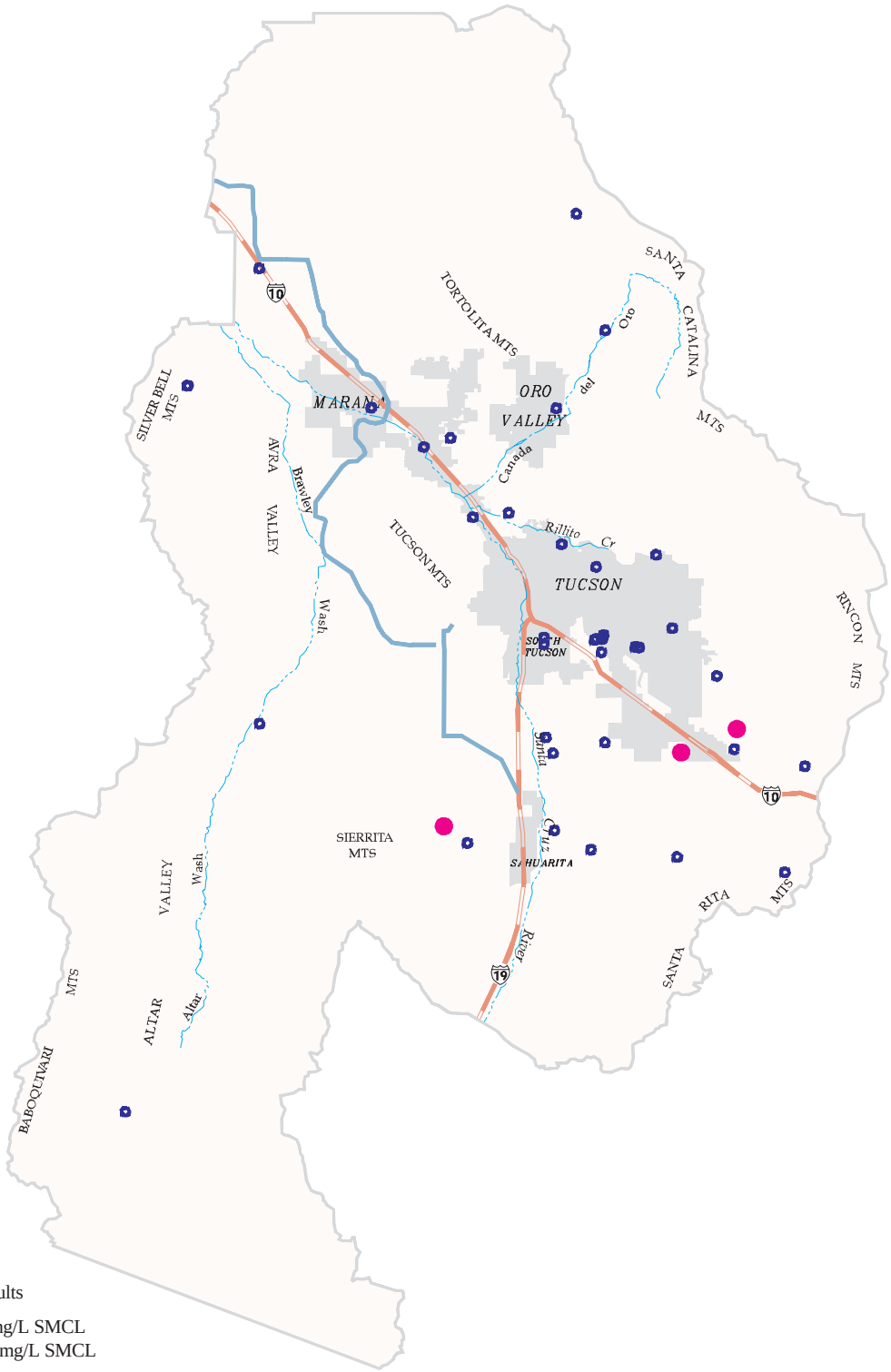
## Water Quality Sample Test Results
## Nitrate Nitrogen and Nitrite Plus Nitrate

0 3 6 9 12
Miles

North

ORIGINAL SOURCE

Arizona Dept of Environmental Quality:
Water Quality Database
Selected Well Locations and Water Quality
Samples since 1990




Sample Test Results

- < 250 mg/L SMCL
- >= 250 mg/L SMCL

- Tucson AMA
- Incorporated Areas
- Streets and Highways
- Rivers and Streams
- CAP Canal

Figure 7- 2

# Water Quality Sample Test Results

## Sulfate

0 3 6 9 12
Miles

North

ORIGINAL SOURCE

Arizona Dept of Environmental Quality:
Water Quality Database
Selected Well Locations and Water Quality Samples since 1990

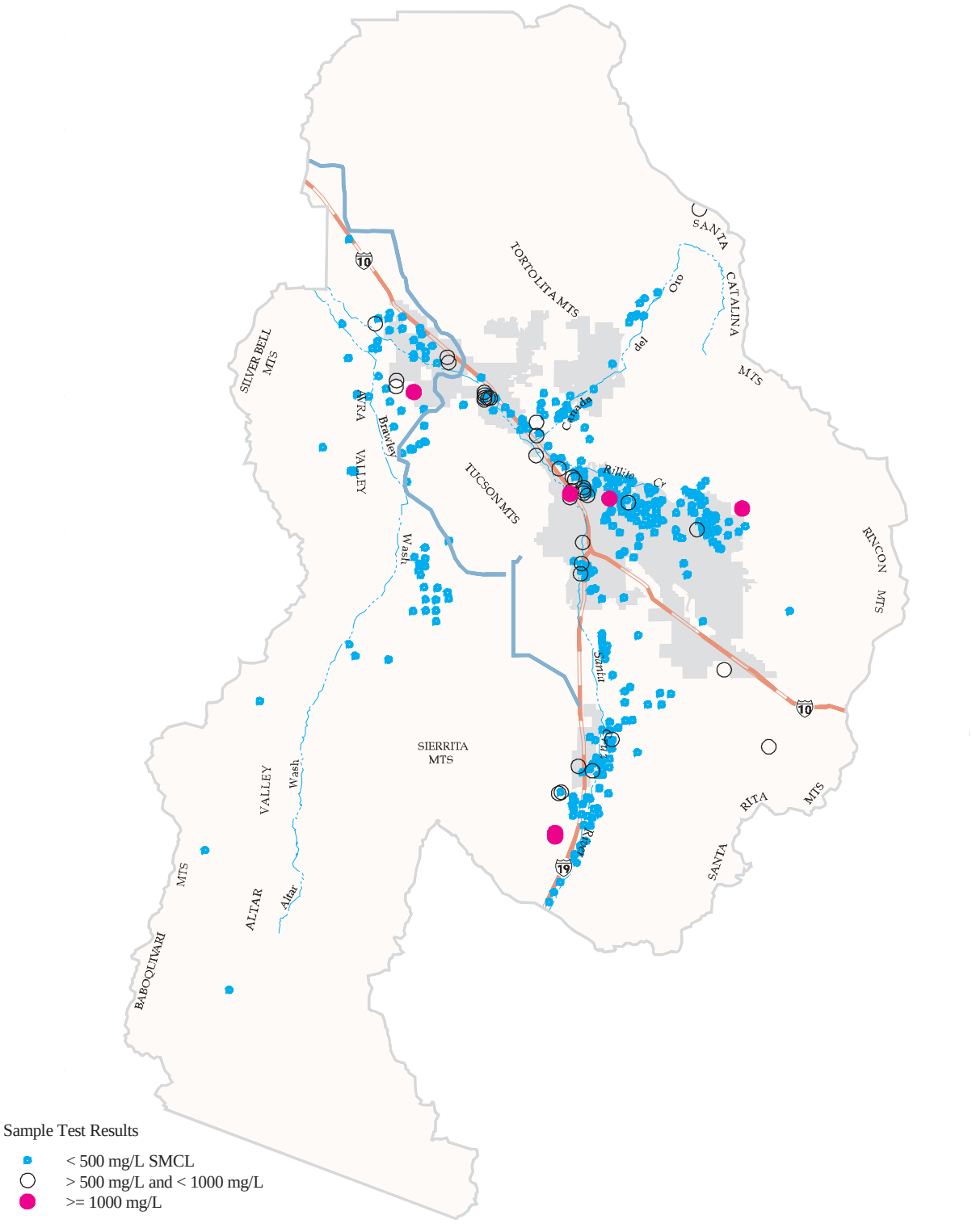



Figure 7- 3

## Water Quality Sample Test Results
## Total Dissolved Solids

ORIGINAL SOURCE

Arizona Department of Water Resources:
GWSI Well Locations
Selected Water Quality Samples since 1990

Calculated from Specific Conductivity

### 7.5.4.4 Metals

The EPA has designated 13 priority pollutant metals and has established primary MCLs for nine of the metals that occur in drinking water: antimony, arsenic, barium, beryllium, cadmium, chromium, mercury, selenium, and thallium. The primary MCL for nickel has recently been remanded for further review by the EPA. The EPA promulgated primary MCL goals and National Primary Drinking Water Rules for lead and copper in June of 1991. High concentrations of metals in groundwater are typically associated with industrial wastes. Some metals naturally occur in groundwater, depending on the geology of the aquifer and the geochemical equilibrium between aquifer materials and groundwater.

Most metals detected from groundwater samples in the Tucson AMA are naturally occurring and found in low concentrations. Figure 7-4 summarizes metal concentrations in the Tucson AMA based on the ADEQ Groundwater Quality Database as described in section 7.5.4. A few metals have been detected in groundwater samples associated with industrial waste disposal sites, airports, and mining areas. Silver, cadmium, chromium, lead, and selenium are present in high concentrations in the upper Santa Cruz Valley Subbasin in several isolated areas. Chromium above the primary MCL has been detected in the vicinity of the Tucson Airport and the Raytheon (formerly Hughes) Aircraft facility and has been decreasing with ongoing remedial activity. Concentrations of metals in exceedence of the primary MCLs have also been found in groundwater samples from a few wells in areas along the Santa Cruz River in the northern portion of the Santa Cruz Valley Subbasin.

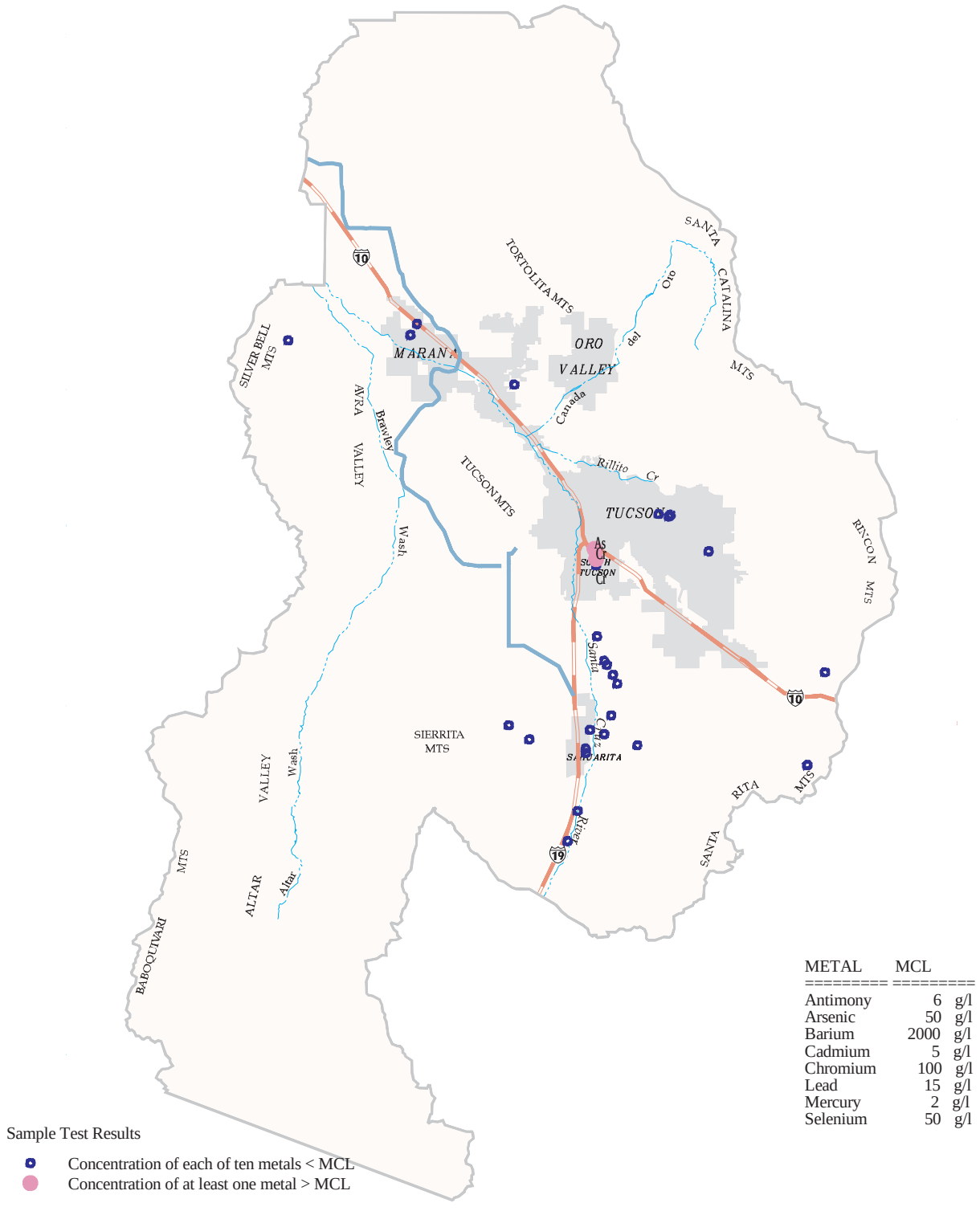
The health effects associated with exposure to metals vary depending on the constituent and concentrations. Some metals such as selenium and chromium are known to be essential for human nutrition and are beneficial in certain concentrations. Others, such as lead, have no known beneficial effects on human or animal development and are harmful in high concentrations. Limitations on industrial and agricultural use of water with high concentrations of metals varies considerably depending on the contaminant and the associated use.

### 7.5.4.5 Volatile Organic Compounds

VOCs, such as trichloroethylene (TCE) and tetrachloroethylene (PCE), are chemicals that evaporate easily but do not readily dissolve in water. Other common VOCs include acetone, vinyl chloride, 1,2-dichloroethane, benzene, 1,1-dichloroethylene, 1,1-dichloroethane, chloroform, toluene, and methylene chloride. VOCs are present in or are used for the manufacturing of many substances including degreasers, solvents, plastics, paint, varnish, finish removers, detergent, medicine, and gasoline. When found in groundwater, VOCs are usually associated with industrial areas, landfills, and other sites used for the improper disposal of chemicals.

Older landfills that were developed in gravel pits and other unsuitable sites are more likely to have leachate and VOC migration problems than modern landfills that are properly sited, constructed, operated, and closed. It is generally accepted that the transport of VOCs associated with older landfills is primarily caused by the downward percolation of leachate through the vadose zone to groundwater. However, recent work performed by the City of Tucson's Office of Environmental Management indicates that in arid landfills vapor transport of VOCs to groundwater also occurs. Continued research on this condition will be necessary to understand VOC transport and for determining appropriate remedial strategies.

VOC contamination has been found near the CERCLA and WQARF sites in the Tucson AMA. The largest area of known VOC contamination is located at the Tucson International Airport Area (TIAA) CERCLA site south of Tucson. This area is described further in section 7.5.5.7. Figure 7-5 displays VOC concentrations within the Tucson AMA.




| METAL | MCL |
|---|---|
| Antimony | 6 g/l |
| Arsenic | 50 g/l |
| Barium | 2000 g/l |
| Cadmium | 5 g/l |
| Chromium | 100 g/l |
| Lead | 15 g/l |
| Mercury | 2 g/l |
| Selenium | 50 g/l |

Sample Test Results

- Concentration of each of ten metals < MCL
- Concentration of at least one metal > MCL

- Tucson AMA
- Incorporated Areas
- Streets and Highways
- Rivers and Streams
- CAP Canal

Figure 7- 4

# Water Quality Sample Test Results

## Metals

0 3 6 9 12 Miles

North

ORIGINAL SOURCE

Arizona Dept of Environmental Quality: Water Quality Database

Selected Well Locations and Water Quality Samples Since 1990

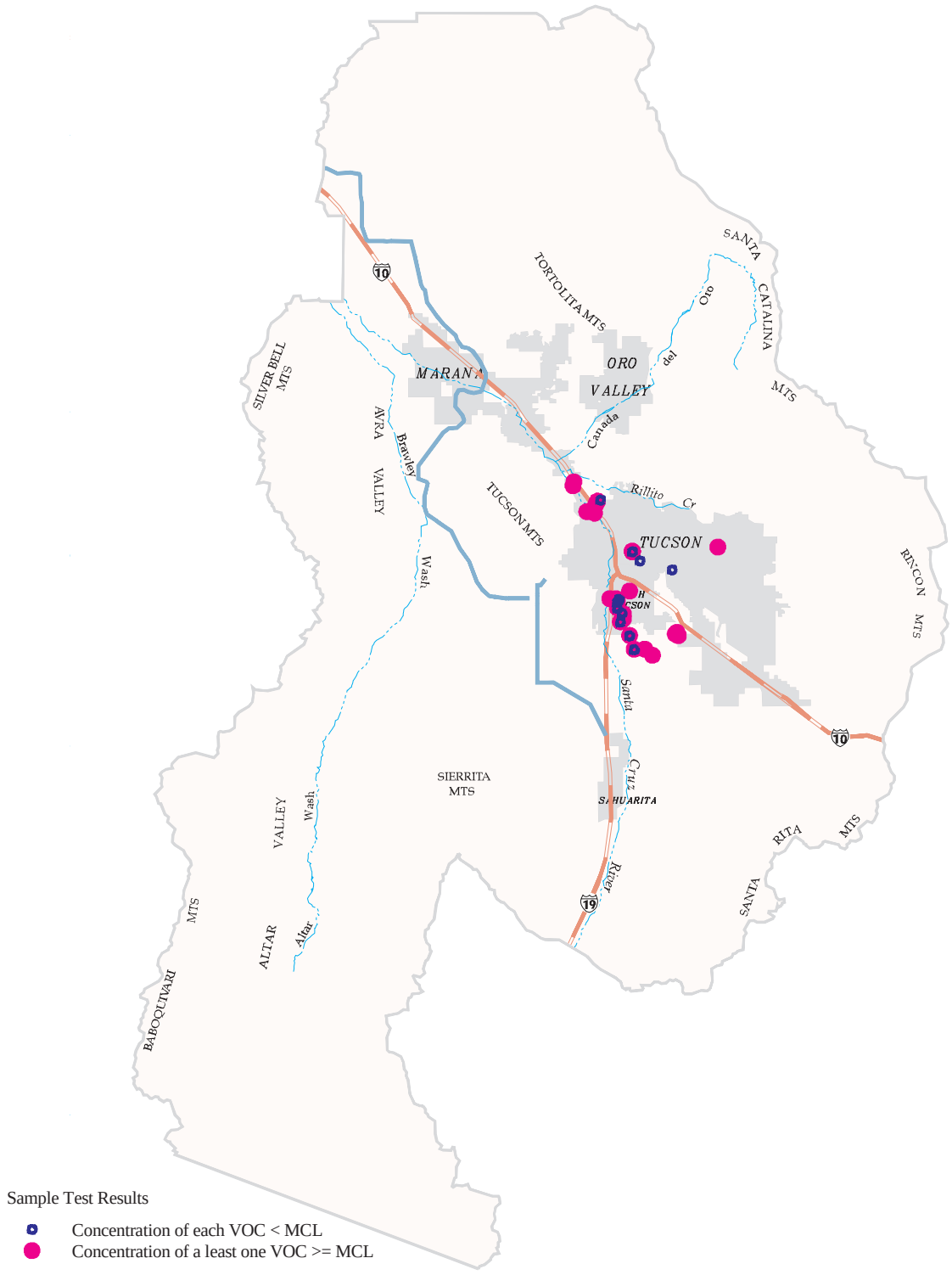



Figure 7- 5

## Water Quality Sample Test Results
## Volatile Organic Compounds

ORIGINAL SOURCE

Arizona Department of Water Resources:
Registered Well Locations

Arizona Dept of Environmental Quality:
Water Quality Database
Selected water quality samples since 1990

Health effects associated with VOCs in drinking water are complex and vary with the types of compounds and concentrations present. Some VOCs, such as TCE, are suspected human carcinogens while others have been associated with damage to internal organs. Drinking water supplies that exceed primary MCLs for VOCs must be treated prior to use.

The use of water containing VOCs for industrial and agricultural applications must be examined on an individual basis. Treatment processes for the removal of VOCs must be adequate to meet the intended use of the remediated water. Air quality regulations also need to be considered prior to the use of water contaminated with VOCs.

### 7.5.4.6 Petroleum Hydrocarbons

This class of contaminants includes non-halogenated hydrocarbons such as benzene, toluene, ethylbenzene, and xylenes, which are ingredients of gasoline and other fuels. These constituents are incorporated into the VOC concentrations in Figure 7-5. Primary MCLs have been established for the main ingredients in gasoline and other fuels.

Leaking underground fuel storage tanks and distribution systems are a common source of groundwater contamination by petroleum hydrocarbons. According to ADEQ, there are over 5,700 reported leaking UST systems in Arizona. Many of these leaking USTs have been investigated and remediated.

Contaminants from leaking USTs in the Tucson AMA are usually detected in the soil area above the aquifer and only a small percentage of these sites have caused groundwater contamination. Furthermore, petroleum hydrocarbons in groundwater may naturally reduce over time depending on the physical, chemical, and microbiological conditions in the aquifer.

In 1998, there were 445 registered active UST facilities in Pima County. Many other UST facilities have been closed. ADEQ's database for Pima County indicates that, of these 445 sites, there are approximately 312 open investigation cases of reported releases from UST systems. Most of these reported release sites are located within the Tucson AMA. Many of the reported releases have been discovered during closure or upgrade of older UST systems. The risk of groundwater contamination from UST system releases will decrease significantly as UST systems come into compliance with federal regulations for system construction, inventory monitoring, and leak detection, and as the older systems are closed.

As of 1996, there were 37 leaking UST sites identified as contributing to groundwater contamination in the Tucson AMA. Most of these leaking systems are associated with gasoline stations and with commercial and industrial sites. The sites identified have varying degrees of groundwater contamination and are in various stages of remediation.

### 7.5.4.7 Pesticides

Pesticides are synthetic and natural organic chemicals that are used as insecticides, rodenticides, and herbicides. Pesticides may be detected in groundwater underlying areas irrigated for agriculture and turf grass. Municipal water providers were required by the SDWA to begin quarterly testing for pesticides in 1994 for a period of one year. Testing for pesticides is repeated every three years. This process has shown minimal pesticide detections, and to date, pesticide contamination of groundwater has not been a major concern in the Tucson AMA. Although pesticide sampling has been limited, better analysis of the occurrences of pesticides in groundwater will be made as more data becomes available. Many pesticides have low mobility and are usually contained near the ground surface of soil profiles.

The health effects of pesticide exposure in water are varied and complex, depending on both the pesticide's inert and active ingredients and reaction with substances contained in the water. The presence of pesticides can restrict some industrial and agricultural water uses such as animal-based industries and vegetable production because elevated concentrations of pesticides may bioaccumulate (accumulate in living tissue) as they are passed through the food chain.

#### 7.5.4.8 Fluoride

Fluorides are compounds found in rocks and soil and some industrial waste products. Fluorides are used primarily in manufacturing and as a drinking water additive for the prevention of tooth decay. Fluoride occurs naturally in groundwater; however, the acceptability of water containing fluoride for domestic or municipal use depends on the concentration level.

The average fluoride level in Tucson area groundwater is about 0.4 mg/l and in CAP water it is about 0.3 mg/l. Fluoride concentrations in the Tucson AMA are shown in Figure 7-6. An optimal fluoride concentration of 0.8 mg/l in drinking water is recommended for the prevention of tooth decay. However, elevated concentrations can cause mottling of teeth and skeletal effects. Fluoride is not currently added to Tucson area water supplies. The EPA primary MCL for fluoride is 4.0 mg/l and the recommended secondary MCL is 2.0 mg/l to prevent mottling of teeth.

#### 7.5.4.9 Radiochemicals

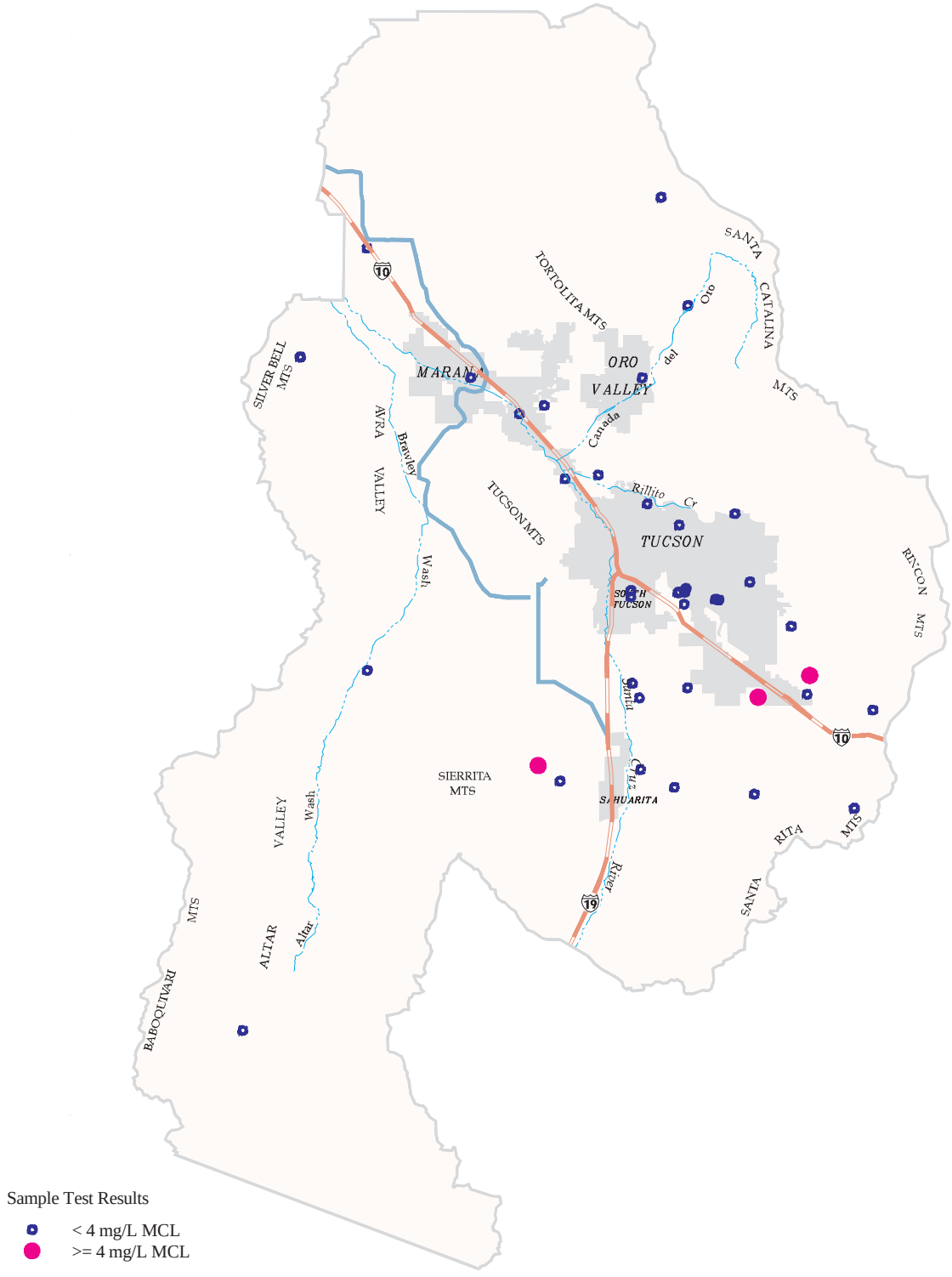
Radioactive elements such as uranium, radon, and radium occur naturally in soil and water at locations throughout Arizona. The federally proposed primary MCL for radon is 300 picocuries per liter, but radon in groundwater is not regulated at this time. The EPA is currently collecting data on radon occurrences and conducting a health effects study prior to promulgating a radon standard for drinking water. Inhalation of radon may be harmful when it is released to the air from a contaminated water source. The primary concern when using radon-contaminated water is to ensure that emissions are below air quality standards when processes such as cooling towers, construction aggregate washing, and sprinkler irrigation are used.

Radon occurrences in the Tucson AMA are primarily a result of naturally occurring uranium-rich lacustrine limestone deposits. In areas south of Tucson, radon at 200 to 1800 picocuries per liter have been detected in 87 wells according to ADEQ. Ranges from 500 to 1400 picocuries per liter has been detected in the central Tucson groundwater basin. Since regional data were not available for radiochemicals, groundwater quality maps depicting these concentrations were not produced for this chapter.

### 7.5.5 Specific Contamination Areas

This section contains a description of some of the specific groundwater contamination areas that have been identified in the Tucson AMA. Unless otherwise indicated, each of these sites are listed on the WQARF Priority List or the NPL. Figure 7-7 shows WQARF, CERCLA, or Department of Defense remedial site boundaries located within the Tucson AMA. It should be noted that the areas shown on this map are the designated site boundaries and do not necessarily indicate the extent of groundwater contamination.

WQARF sites throughout the state have been scored based on criteria developed by ADEQ. In the Tucson AMA, the El Camino del Cerro area, Miracle Mile Interchange area (including Silverbell Jail Annex), Park-Euclid site (Mission Linen), and the Broadway-Pantano site have each been ranked in the top ten sites statewide. The scores assigned to WQARF sites may change as more site-specific information becomes available and is evaluated by ADEQ. A summary of individual remedial sites in the Tucson AMA is




Sample Test Results

- < 4 mg/L MCL
- >= 4 mg/L MCL

- Tucson AMA
- Incorporated Areas
- Streets and Highways
- Rivers and Streams
- CAP Canal

Figure 7- 6

## Water Quality Sample Test Results
## Fluoride

0 3 6 9 12
Miles

North

ORIGINAL SOURCE

Arizona Dept of Environmental Quality:
Water Quality Database
Selected Well Locations and Water Quality
Samples since 1990

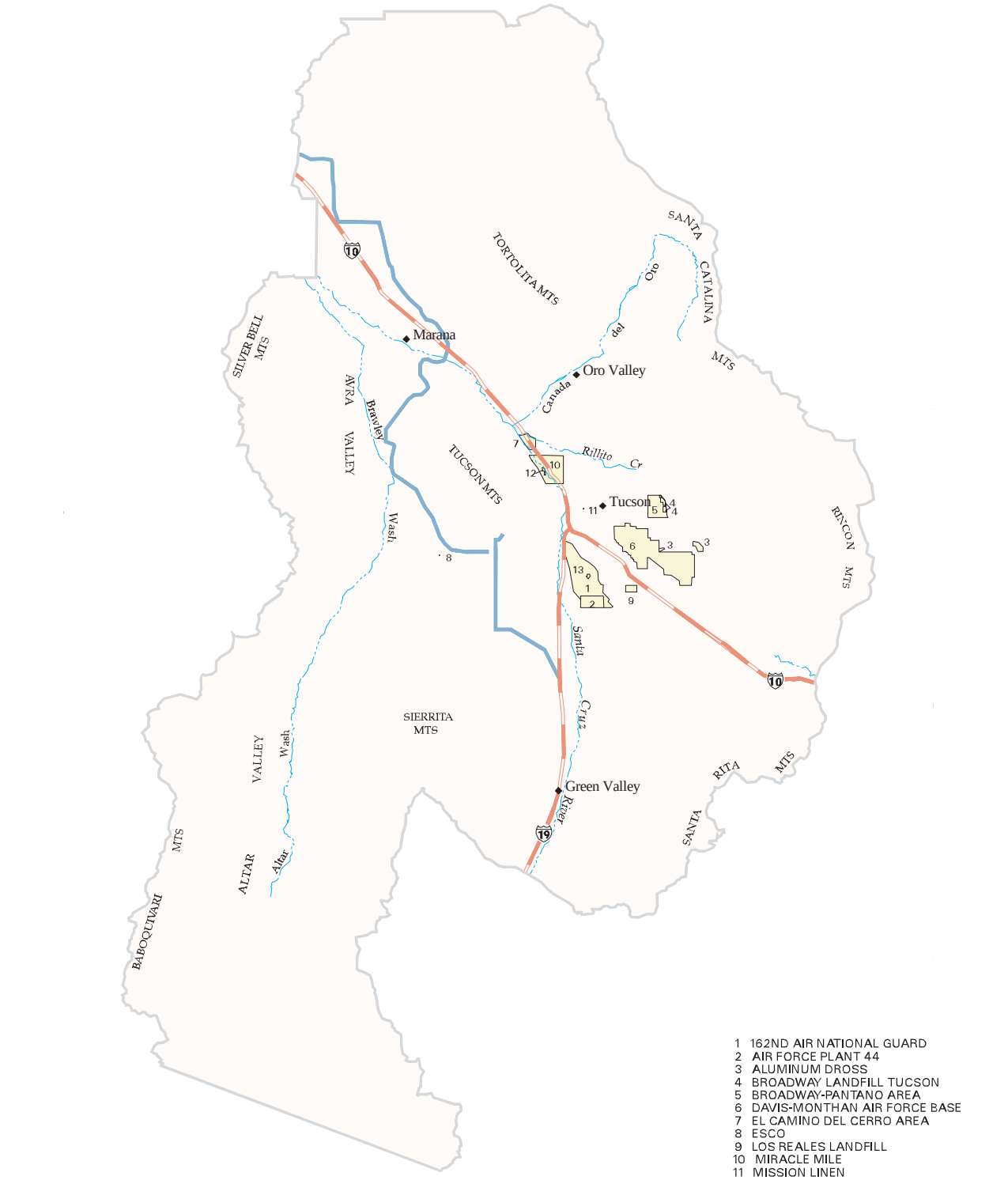



Figure 7- 7

## Selected Water Quality Study Areas

ORIGINAL SOURCE

Arizona Dept of Environmental Quality

provided below. Information on the description and status of remedial sites was obtained from ADEQ's Southern Regional Office, City of Tucson's Office of Environmental Management, Davis-Monthan Air Force Base's Management Action Plan, and the Pima Association of Government's 1994 State of the Region Water Quality Report.

### 7.5.5.1 El Camino Del Cerro Area

The El Camino del Cerro Study Area is located in northwest Tucson between the Santa Cruz River on the west, Shannon Road on the east, the Rillito River on the north, and El Camino del Cerro Road on the south. The El Camino del Cerro Study Area Landfill occupies approximately 20 acres of land located on the southwest corner of the study area. This site was placed on the WQARF Priority List on May 23, 1995.

VOC contamination has been detected in several wells used for domestic, commercial, industrial, and public drinking water supplies. These wells are located north and northeast of the site and are no longer used for drinking water supplies. Approximately 23 different VOCs and several trace metals have been detected in groundwater around the site. Pima County has been conducting groundwater monitoring in the El Camino del Cerro Study Area for VOCs, trace metals, and general minerals. Eight of the 25 wells sampled in January of 1998 indicated VOC levels above the primary MCL. PCE was detected as high as 160 µg/l and TCE as high as 85 µg/l. The primary MCLs for PCE and TCE are each 5 µg/l.

In addition to groundwater sampling, data are being collected within the El Camino del Cerro Study Area from soil vapor sampling probes and will be used to evaluate potential contamination sources and remedial actions.

### 7.5.5.2 Miracle Mile Interchange Area/Silverbell Jail Annex Landfill

The Pima County Health Department discovered VOCs in groundwater near the Miracle Mile/Interstate 10 interchange during the fall of 1983. The southern boundary of the VOC contamination is just south of Miracle Mile Road and the northern limit is slightly over two miles to the northwest (downgradient), near Wetmore Road. In the vicinity of Prince Road, the east-west width of the contamination is approximately two miles. ADEQ is monitoring this site quarterly and as of the third quarter of 1996, results indicated that VOCs and metals were present above the primary MCLs in several wells. The highest detected contamination was TCE at 17 µg/l, and chromium at 200 µg/l. The primary MCL for TCE is 5 µg/l and is 100 µg/l for chromium. The Miracle Mile site was placed on the WQARF Priority List on November 13, 1987.

Inorganic groundwater quality in the Miracle Mile interchange area is apparently naturally poor. High TDS, sulfate, and chloride concentrations have been present at least since the 1920s. The area also has had an elevated nitrate zone since the 1950s.

There are eight identified possible contamination sources in the southern plume area including six industrial sites and two landfills. The Silverbell Jail Annex landfill was owned and operated by the City of Tucson between 1966 and 1977. The landfill appears to have contributed to VOC contamination of the groundwater. Another landfill was operated by the University of Arizona at the Agricultural Center on the east side of the Santa Cruz River and is a potential source of PCE and freons found in groundwater. The Miracle Mile contamination has affected two public-supply wells serving mobile home parks. Groundwater samples taken in this area in November, 1997, had concentrations of PCE as high as 16 µg/l and TCE at 13 µg/l. No other wells tested detected levels above the primary MCLs for PCE and TCE. Benzene and chromium above the primary MCL have each been detected in the study area.

The City of Tucson has completed a pilot study on the effectiveness of a vertical circulation well for the removal of chlorinated hydrocarbons in the groundwater at the Silverbell Jail Annex. This method eliminates the need to pump the contaminated groundwater to the surface for treatment and disposal, thereby preventing unnecessary groundwater depletion. This process is currently being reviewed to determine if a vertical circulation system should be implemented in place of the pump and treat system originally proposed in the 1995 RAP.

### 7.5.5.3 Tucson Urban Study Area

Groundwater investigations by the Arizona Department of Transportation and ADEQ in the vicinity of downtown Tucson have produced evidence of wide-spread petroleum contamination and VOC contamination in some wells. Diesel fuel was found in 1964 during the drilling of two Tucson Water wells just north of the downtown area. There is concern that some of the existing wells could be providing a conduit between the perched and regional aquifers creating a pathway for contaminant migration. Additional assessment and investigation work needs to be completed to determine the extent of the contamination.

Diesel fuel is the most widespread contaminant in the Downtown area and appears to be generally confined to the perched aquifer. However, diesel has been found in the regional aquifer at the Mission Linen dry-cleaning facility and in three Tucson Water wells. ADEQ has indicated that Southern Pacific Transportation Company (presently owned by Union Pacific) is a likely source of the diesel contamination. Other sources include the Continental Trailways bus station, which was reported to have a leaking UST.

Chlorinated VOCs such as TCE and PCE are present in more localized areas. The highest concentrations of chlorinated VOCs in the regional aquifer were found in a well at Mission Linen. Concentrations of PCE were reported up to 11,000 µg/l. Benzene, trichloroethane (TCA), and other VOCs were also detected. The extent of contamination is still under investigation. PCE has been detected in the deeper aquifer and new monitoring wells indicate concentrations of PCE up to 630 µg/l and lower levels of TCE and dichloroethylene (DCE) in the uppermost regional aquifer.

Other areas noted to have groundwater contamination include gasoline in the perched groundwater and soils near the Yellow Cab facility (411 N. 5th Avenue) and benzene, toluene, and ethylbenzene detected from two monitor wells in the perched aquifer downgradient from the former Continental Trailways bus station (5th and Broadway).

### 7.5.5.4 Broadway - Pantano Study Area

The Broadway Landfill area is located on the City of Tucson's east side, north and south of Broadway Boulevard at Kolb Road. The Broadway Landfill was operated between 1959 and 1974 as a municipal sanitary landfill and is now closed. VOCs were detected in the groundwater in 1983. Analysis of groundwater samples collected at this site and downgradient of the landfill has detected concentrations of PCE and TCE.

In June 1995, the City of Tucson began monthly water quality monitoring in this area. In December, 1997, and January, 1998, TCE and PCE levels were detected above the 5 µg/l primary MCL in several of the area's wells. A Remedial Investigation to characterize the landfill and investigate potential sources of groundwater contamination in the vicinity of the Broadway North Landfill has been completed. Field investigation activities included a soil gas survey, soil borings, and the installation of three permanent deep soil vapor probes. Three groundwater monitoring wells were also installed and equipped with deep soil gas vapor probes. The final report identifies the landfill as a source of groundwater contamination and gas phase transport as the mechanism by which the VOCs moved from the landfill downward 325 feet to the regional aquifer.

### 7.5.5.5 Los Reales Landfill

Los Reales Landfill, owned and operated by the City of Tucson, is an active municipal sanitary landfill consisting of approximately 320 acres in southeast Tucson. The landfill site has been in operation since the early 1970s. Approximately five acres in the southeast corner of the landfill were designated for hazardous waste disposal from 1977 to 1980. The hazardous waste area has been closed, leveled, and fenced in.

Analyses of water samples collected from monitor wells installed at the site as part of the remedial investigation detected several VOCs including PCE, TCE, dichloroethane, DCE, methylene chloride, and dichlorodifluoromethane (freon-12). PCE and TCE concentrations from these test sites have exceeded the primary MCLs for drinking water standards. Groundwater quality samples taken in 1997 from downgradient monitor wells (located northwest of the landfill) contained PCE concentrations as high as 30.8 µg/l and TCE at 14 µg/l. Water samples taken from upgradient wells have not had detectable levels of VOCs.

Studies conducted by the City of Tucson have indicated that the contamination at the landfill site exists primarily in the upper portion of the aquifer. The City's Conceptual Design Plan for the landfill remediation was approved by ADEQ in September, 1997. The preferred remedial alternative is to pump, treat, and re-inject the treated water upgradient of the Los Reales Landfill. The final plan design is scheduled to be submitted to ADEQ in 1998.

No public-supply wells have been impacted by this plume. However, wells supplying drinking water to the Town and Country Mobile Home Park and the Ray Water Company are located 1.5 miles downgradient from the landfill.

### 7.5.5.6 Price Service Center

The City of Tucson's Thomas O. Price Service Center is located south of downtown Tucson, near the intersection of Park Avenue and Ajo Way. Petroleum-related contamination of soil and groundwater has been detected at this site where gasoline and diesel fuel were stored in 23 USTs. Employees at the facility discovered leaks in the storage system in 1989, and the tanks were emptied. The City refilled six of the tanks in 1991 but emptied them again when a tank was punctured and leaked about 8,000 gallons of diesel fuel. All of the tanks were removed in October of 1992.

The soil and shallow groundwater were sampled by the City in the fall of 1992. Contaminants found included benzene, toluene, and xylene, which are all common gasoline constituents. Benzene was detected in concentrations as high as 30,000 µg/l in one of the shallow monitoring wells containing fuel. The area of soil contamination is approximately 400 by 600 feet.

Numerous soil borings and monitor wells have been installed at this site. A corrective action plan has been submitted by the City to ADEQ addressing soil contamination and plans will be submitted to address shallow and deep groundwater contamination.

### 7.5.5.7 Tucson International Airport Area

The TIAA CERCLA site is the only federal Superfund site in the Tucson AMA. The TIAA consists of a number of major project areas with groundwater contamination, particularly VOCs. Groundwater contamination in the TIAA is characterized as one major plume and two smaller plumes. The major plume is more than four miles long and one-half mile wide and extends from the United States AFP 44 facility to slightly north of Irvington Road. The plume is oriented along the groundwater flow gradient to the north-

northwest. The two smaller plumes are located east of the major plume north of the Tucson International Airport. Both of these plumes are less than one-half mile in diameter and length.

The regional aquifer in the area is divided into an upper zone and a lower zone separated by a 100 to 160-foot thick clay aquitard that impedes the flow of water between the two zones. The aquitard pinches out in the northwest, resulting in an undivided regional aquifer. Most of the contamination in the major plume is within the upper zone of the regional aquifer, although in the northwest area of the plume the contamination has spread beyond the edge of the clay aquitard and into the undivided regional aquifer. The two smaller plumes are primarily confined to the upper zone of the regional aquifer. Soil contamination is present in both areas.

TCE is the major detected contaminant in the plumes and other contaminants include 1,1-dichloroethylene; chloroform; benzene; xylene; and chromium. TCE has been detected in the main aquifer in concentrations as high as 2,700 µg/l near the AFP 44 site and 350 µg/l in the portion of the plume at the Tucson International Airport (north of Los Reales Road). In a 1992 Wellhead Protection study done by the Pima Association of Governments, 15 public-supply wells were identified as either closed or requiring treatment due to TCE contamination.

#### 7.5.5.7.1 Tucson Airport Remediation Project

The Tucson Airport Remediation Project plume is being remediated through a pump-and-treat system that began operation in September of 1994. The 5,800 gallon per minute facility removes TCE from the water and distributes the treated water to the City of Tucson water system where it is blended with other groundwater supplies and delivered to Tucson's west side and downtown areas. This treatment process has been very effective, with no detections of TCE in the blended water supply since the City of Tucson began delivering remediated water to customers. Although the Water Consumer Protection Act of 1995 precludes delivery of this water for potable purposes, no alternative use has been identified that is acceptable to all parties and consistent with the federal ROD required for this CERCLA site.

#### 7.5.5.7.2 United States Air Force Plant 44 (Raytheon Aircraft Corporation)

The AFP 44 is located within the boundaries of the TIAA CERCLA site and is a subsite of the TIAA Superfund Site. AFP 44, which was operated by the Hughes Aircraft Corporation until 1997 and is currently operated by the Raytheon Aircraft Corporation, is a Department of Defense Installation Restoration Program (IRP) site. The groundwater investigation and ongoing groundwater cleanup are regulated under CERCLA. The RCRA Program has the regulatory lead in the soils investigation and remedial design for soil cleanup activities at the site. The EPA, in coordination with the ADEQ and the Department has initiated a Federal Facilities Agreement for AFP 44 to consolidate the regulatory requirements for soil and groundwater remediation.

Groundwater contamination was first detected in 1981 when the EPA conducted a preliminary investigation of groundwater conditions underlying AFP 44 that revealed elevated levels of several VOCs, including TCE. It is suspected that groundwater contamination by VOCs was present in this area as early as the 1950s as a result of historical waste management and disposal practices. The investigation revealed that the perched zone, which is located above and separated from the regional aquifer, contained levels of chromium, manganese, arsenic, iron, zinc, TCA, TCE, and DCE that were above background levels and in general above applicable EPA primary drinking water standards. The upper zone of the regional aquifer contained similar levels of these constituents. However, manganese, arsenic, and zinc concentrations did not exceed drinking water standards.

The remediation process used at AFP 44 is a "pump and treat" method followed by injection of the treated water back into the aquifer. The project includes a reclamation well field, a treatment plant, and a

monitoring program. The reclamation well field consists of 20 upper zone extraction wells, four lower zone extraction wells, and 19 injection (recharge) wells. Water is pumped from the extraction wells in the center of the plume and transported to the treatment plant, where metals and organics are removed using an air stripping process. When elevated chromium levels were detected in groundwater samples, the water was treated by ion exchange prior to going to the air strippers to remove the chromium. The ion exchange system was placed on standby in November, 1994 because chromium concentrations in all of the extraction wells were below the primary MCL of 0.1 mg/l. The treated water is recharged by well injection to the aquifer along the margins of the plume.

A Dual Phase Extraction (DPE) project began in August 1994. The DPE system is used with the groundwater pump-and-treat system to enhance the groundwater remediation program. The DPE system uses a vapor extraction blower unit to pull air under vacuum from the casing of a pumping, groundwater extraction well. The vacuum causes VOC's present in the soils just above the water table and in the dewatering section of the aquifer to evaporate and be removed with the air stream.

#### 7.5.5.7.3 Arizona Air National Guard

The Arizona Air National Guard is currently treating a small groundwater plume at its Tucson facility. This site, also known as the 162nd Tactical Fighter Group, is a Department of Defense Facility. The plume has affected the facility's well. Groundwater sampled from this well was detected to have 14 µg/l TCE and a private well just off-site to the north was sampled at 7 µg/l TCE. A groundwater pump, treat, and re-injection system has been operating at this site since the spring of 1997.

#### 7.5.5.7.4 Burr-Brown

The Burr-Brown site is located north of the airport and includes the property owned by Burr-Brown, an area immediately adjacent to the Burr-Brown property, and the area between the northern boundary of the property and Valencia Road. Groundwater extraction and treatment at the facility began in 1992 and uses air stripping technology. TCE contaminated groundwater is extracted at about 40 gpm and treated. The treated water is used at the facility for irrigation and industrial uses.

#### 7.5.5.7.5 West-Cap

The former West-Cap of Arizona facility is located near the Burr-Brown site northeast of the Tucson Airport in an industrial and commercial area at 2204 East Elvira Road. Elevated levels of TCE and PCE were detected from an off-site source during groundwater monitoring efforts at the Burr-Brown and Arizona Air National Guard facilities. EPA investigations determined that the off-site source is from the former West-Cap of Arizona facility. Contaminant migration will be controlled through groundwater extraction at the West-Cap site. Current remedial plans include the installation of one extraction well and two monitoring wells. The extracted groundwater will be connected to the groundwater treatment plant at the Burr-Brown facility. Groundwater monitoring and investigations will continue at this site to determine the extent of contamination.

#### 7.5.5.7.6 Soils Restoration Program

The Soils Restoration Program is ongoing at six IRP sites within AFP 44. Soil Vapor Extraction (SVE) is being used at three of these sites to remove VOCs in the soils. Soil excavation techniques are being used at the other three sites to remove heavy metal contaminants, which are disposed off-site at a RCRA landfill.

### 7.5.5.8 Davis-Monthan Air Force Base

Davis-Monthan Air Force Base began its IRP investigations and site assessments in the early 1980s. As a result, 47 sites at the base were identified as areas of concern. Subsequent investigations have indicated that many of these sites have no confirmed contamination or have been evaluated and determined to be of no significant threat to humans or the environment. Some of these sites may be revisited prior to ADEQ granting final site closure. Current concerns have been narrowed to approximately four activities that are described in more detail below.

Long-term monitoring is being conducted to confirm that there are no significant groundwater quality problems associated with various sites within the base. Monitor wells located in proximity to sites that are under a "no action status" are also being closely monitored.

A jet fuel leak was detected at the J3 Pumphouse (Site 35) in March 1985 and the pipe leak was repaired in June of that year. Nine groundwater monitoring wells were installed and sampled. Levels of petroleum compounds in excess of the federal primary MCLs were detected in water samples collected from two of these wells. The groundwater level in this area is about 300 feet below land surface and both the soil and groundwater have been contaminated by the fuel. In 1990, the groundwater contamination extended approximately 60 feet to the northeast of the leak. The contamination has not affected public supply wells. Remedial activities are operating at Site 35 and includes the operation of a groundwater treatment system, an SVE system, and bioventing. Long-term operation of this remedial site is expected.

The Site 1 Landfill, which was used from the early 1940s to 1976, covers approximately 17 acres in a 35-foot deep pit. The landfill was used for the disposal of household garbage, metals, cars and aircraft, thinners, solvents, pesticides, and other items. The pit was filled to about 20 feet below grade and covered with soil. The remedial plan for this site is to cap the landfill to prevent leaching.

Site 47, referred to as the DRMO (Defense Reutilization and Marketing Office) yard consists of two waste pits and a french drain. The waste pits contain approximately 100 cubic yards of contaminated soil, waste and ash and the french drain contains approximately 50 cubic yards. It is believed that the wastes at this site were from aircraft recycling. An Interim Removal Action to cap the waste in place was completed in August of 1997. No further remedial action is expected at this site.

## 7.6 THIRD MANAGEMENT PLAN PROGRAM SUMMARY

Most groundwater supplies in the Tucson AMA are of acceptable quality for most uses. However, human activity and natural processes have resulted in the degradation of groundwater quality in some areas to the extent that it is unusable for many purposes. The extent and type of contamination varies by location and land use activities. In general, contaminated groundwater in the Tucson AMA is caused by human activity. VOCs are a predominant contaminant in the Tucson AMA and limit the direct use of some groundwater. Remedial processes are used to treat VOC contaminated water to drinking water quality standards making this water available for either current or future direct potable use. Water supplies contaminated with other constituents must also be properly treated prior to use for drinking water supplies. Beneficial end uses of lower quality water can be identified but must be economically feasible.

As WQARF activities progress, addressing water management issues such as available supply and reuse options will become essential to ensure a long-term water supply of adequate quality. The ability to recognize specific groundwater management requirements for contaminated and degraded aquifer conditions will also become increasingly important as the demand for water increases.

During the first and second management periods, ADEQ emphasized pump and treat remedies to cleanup poor quality groundwater in aquifers within the AMA. Success was limited, however, due to lengthy

periods of litigation that have restricted actual cleanup activities. With the advent of the WQARF reform package of 1997, a new approach emphasizing incentives to cleanup and flexibility in the selection of remedies was developed to improve the likelihood that sites will actually be remediated.

The 1997 WQARF reform legislation creates an incentive for the use of groundwater withdrawn in accordance with approved remedial action projects pursuant to Title 49, Arizona Revised Statutes, or CERCLA. It provides that such groundwater must be accounted for consistent with accounting procedures used for surface water conservation requirements and that the use of certain volumes of such groundwater is consistent with achievement of the management goal of the AMA until the year 2025. During the third management period, the Department will amend its AWS Rules to conform to these provisions. Additionally, permanent rules regarding well spacing and impact will be promulgated by the Department during the third management period. The Department also intends to integrate water quality concerns more fully into its underground water storage programs.

During the third management period, the Department intends to enact and implement the provisions outlined in this chapter. This commitment will encompass the new provisions and activities summarized below.

- An ongoing groundwater quality assessment in cooperation with ADEQ will assist with the evaluation of existing rules and provisions and provide better data to the public.

- Integration of groundwater quality management into recharge planning and permitting, and development of incentives to use remediated groundwater where appropriate.

- Formal permit coordination with ADEQ to cooperate on both Title 45 and Title 49 permits. Basin-wide or non-site-specific tracking and coordination of all permits will provide both agencies with a more complete picture of contaminant distribution, groundwater withdrawals, and releases to groundwater and surface water on a basin-scale perspective.

- Evaluation of the need for additional incentives to withdraw and use remediated groundwater in an effort to match quality with beneficial use. This evaluation will include groundwater that may be contaminated with hazardous, non-hazardous, and naturally occurring substances. Incentives may involve amendments to Title 45, Arizona Revised Statutes, Department rules and policies, or a modification of the management plans.

- The Department and ADEQ will develop and enter into Memorandums of Understanding, as necessary, to establish, among other things, the division of responsibilities for the implementation of the reformed WQARF Program, development of common scopes of work for WQARF sites and other groundwater contamination sites, and database development and exchange.

The Department's Water Quality Section, which was established with funding provided by the 1997 WQARF reform legislation, will allow the Department to strengthen its commitment to work closely with ADEQ to resolve groundwater quantity and quality issues throughout Arizona. The Department's Water Quality Section will provide support to the Tucson AMA on issues related to WQARF cleanup activities.

Other remedial activities and management action plans such as those associated with Superfund sites will continue to include the Department's direct involvement. This will ensure that remedial activities meet the Department's water management objectives and are consistent with the AMA's safe-yield goal.

## 7.7 FUTURE DIRECTIONS

The Department's long-range plans for groundwater quality management will focus on two areas: (1) evaluation of groundwater quality issues on a site and non-site-specific level to understand the impact of broader groundwater quality issues on water resource management; and (2) preservation of AMA management goals and interests while implementing incentives to use remediated groundwater.

### 7.7.1 Non-Site-Specific Water Quality Management

Non-site-specific groundwater quality management refers to groundwater quality management activities that may occur in general areas located outside of an identified WQARF or CERCLA boundary. To address and mitigate dispersed contamination over large areas, a broader management strategy is needed. Areas that may need more intensive management can include those where public or private supply wells have been or may be affected by contamination. For instance, areas that are in the vicinity of major population centers or agricultural areas can be affected by contamination, especially if large volumes of groundwater are pumped, creating cones of depression.

Issues related to changes in groundwater levels will be monitored during the third management period to reduce the possibility of degrading aquifer conditions. Managing rising water levels in areas of known landfills or other areas that have suspended contaminants in the vadose zone (e.g. leaking USTs), will mitigate the potential of contaminant migration. Aquifers experiencing declining groundwater levels also need to be monitored for impacts on aquifer water quality. In addition, proper planning will ensure that the impacts of groundwater recharge projects do not contribute to the degradation of aquifer conditions.

The concept of groundwater quality management on a non-site-specific scale will be developed to enhance water management activities in critical areas. The identification of source groundwater quality and the development of area-specific plans to match water quality with the intended use will become an important aspect in the third management period. The Department intends to study the development of area-specific plans that could employ a combination of strategies to evaluate and mitigate the effects of contamination in critical areas. These plans should be developed in coordination with ADEQ and with affected stakeholders. Any contaminant management on a non-site-specific scale will be voluntary and will not affect rights to groundwater, well ownership, delivery responsibilities, or existing permits.

### 7.7.2 Preservation of AMA Management Goals

The WQARF reform package of 1997 was designed to encourage the remediation of groundwater that has limited or no use due to contamination. Pump and treat groundwater remediation activities are anticipated to increase substantially during the third management period as a result of the remediated groundwater use incentives provided in the WQARF reform package. As a result, previously unavailable sources of groundwater from contaminated areas may be put to beneficial use.

Remediated groundwater withdrawals associated with WQARF, CERCLA, Department of Defense, RCRA, and voluntary site cleanups are expected to increase. Estimates of annual remediated groundwater withdrawals, provided by ADEQ and its contractors for existing remedial sites within the Tucson AMA range from about 14,000 acre-feet to approximately 23,000 acre-feet. Such withdrawals may occur as part of aquifer restoration or plume containment. These estimates merely represent preliminary projections based on data from only a portion of the existing sites within the Tucson AMA. These estimates may be conservative due to the potential detection of unknown sites and because remedial activities on known contaminated areas are in different stages of development.

In the third management period, the Department will monitor water levels, subsidence, and effects on local water providers at remedial project sites in areas of intensive pumping. While the Department supports the

remediation of contaminated groundwater, it also seeks to preserve the management goal of safe-yield in the Tucson AMA. Water quality management is a lengthy process that is expected to continue far beyond the scope of the third management period. Continued remedial activities over the long-term will likely result in considerable volumes of groundwater being pumped, treated, and subsequently used.

The net effect of continued remediated groundwater withdrawals could result in a substantial increase in the overall volume of groundwater used within the Tucson AMA. Proper water quantity and water quality management will be required to ensure that groundwater use created as a result of remedial projects does not negatively impact the goal of safe-yield in the Tucson AMA. Remediated groundwater is not a renewable water supply and therefore must be managed as a diminishing resource. Consequently, the Department will seek to preserve the intent of the Code and the AMA management goals while cooperating with EPA, ADEQ, and other water resource agencies to promote groundwater quality management.

## APPENDIX 7A
## DRINKING WATER STANDARDS AND HEALTH EFFECTS
## TUCSON ACTIVE MANAGEMENT AREA

| Contaminant | Primary MCL (mg/l)[1] | Potential Health Effects from Ingestion of Water | Sources of Contaminant in Drinking Water |
|---|---|---|---|
| **Inorganics** | | | |
| Antimony | 0.006 | Cancer | Fire retardants, ceramics, electronics, fireworks, solder |
| Arsenic | 0.05 | Skin, nervous system toxicity | Natural deposits; smelters, glass, electronics waste |
| Asbestos | 7.0 MFL[2] | Cancer | Natural deposits, asbestos cement in water systems |
| Barium | 2.0 | Circulatory system effects | Natural deposits, pigments, epoxy sealants, spent coal |
| Beryllium | 0.004 | Bone, lung damage | Electrical, aerospace, defense industries |
| Cadmium | 0.005 | Kidney effects | Galvanized pipe corrosion; natural deposits, batteries, paints |
| Chromium (total) | 0.1 | Liver, kidney, circulatory disorders | Natural deposits; mining, electroplating, pigments |
| Cyanide (as free cyanide) | 0.2 | Thyroid, nervous system damage | Electroplating, steel, plastics, mining, fertilizer |
| Fluoride[3] | 4.0 | Skeletal and dental fluorosis | Natural deposits; fertilizer, aluminum industries |
| Mercury | 0.002 | Kidney, nervous system disorders | Crop runoff; natural deposits; batteries, electrical switches |
| Nickel | Remanded | Gastrointestinal distress, skin irritation, respiratory congestion | Food, water, and metal alloys |
| Nitrate (as N) | 10.0 | Methemoglobulinemia | Animal waste, fertilizer, sewage, natural deposits, septic tanks |
| Nitrite (as N) | 1.0 | Methemoglobulinemia | Same as nitrate; rapidly converted to nitrate |
| Total nitrate/nitrite | 10.0 | Same as nitrate | Same as nitrate |
| Selenium | 0.05 | Liver Damage | Natural deposits; mining, smelting, coal/oil combustion |
| Thallium | 0.002 | Kidney, liver, brain, intestinal | Electronics, drugs, alloys, glass |

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## TUCSON ACTIVE MANAGEMENT AREA

| Contaminant | Primary MCL (mg/l)[1] | Potential Health Effects from Ingestion of Water | Sources of Contaminant in Drinking Water |
|---|---|---|---|
| **Volatile Organic Chemicals** | | | |
| Benzene | 0.005 | Cancer | Some foods; gas, drugs, paint, pesticides, plastic industries |
| Carbon tetrachloride | 0.005 | Cancer | Solvents and degradation by-products |
| ortho-Dichlorobenzene | 0.6 | Liver, kidney, blood cell damage | Paints, dyes, engine cleaning compounds, chemical wastes |
| para-Dichlorobenzene | 0.075 | Cancer | Room and water deodorants, and mothballs |
| 1,2-Dichloroethane | 0.005 | Cancer | Leaded gasoline, fumigants, paints |
| 1,1-Dichloroethylene | 0.007 | Cancer | Plastics, dyes, perfumes, paints |
| cis-1,2-Dichloroethylene | 0.07 | Liver, kidney, nervous, circulatory | Waste industrial extraction solvents |
| trans-1,2-Dichloroethylene | 0.1 | Liver, kidney, nervous, circulatory | Waste industrial extraction solvents |
| Dichloromethane | 0.005 | Cancer | Paint stripper, metal degreaser, propellant, extraction |
| 1,2-Dichloropropane | 0.005 | Liver, kidney effects; cancer | Soil fumigant; waste industrial solvents |
| Ethylbenzene | 0.7 | Liver, kidney, nervous system | Gasoline; insecticides; chemical manufacturing wastes |
| Monochlorobenzene | 0.1 | Nervous system and liver effects | Waste solvent from metal degreasing process |
| Styrene | 0.1 | Liver, nervous system damage | Plastics, rubber, resin, drug industries; landfill leachate |
| Tetrachloroethylene | 0.005 | Cancer | Improper disposal of dry cleaning and other solvents |
| Toluene | 1.0 | Liver, kidney, nervous, circulatory | Manufacturing and solvent operations, gasoline additive |
| 1,2,4-Trichlorobenzene | 0.07 | Liver, kidney damage | Herbicide production, dye carrier |
| 1,1,1-Trichloroethane | 0.2 | Liver, nervous system effects | Adhesives, aerosols, textiles, paints, inks, metal degreasers |
| 1,1,2-Trichloroethane | 0.005 | Kidney, liver, nervous system | Solvent in rubber, other organic products; chemical production wastes |
| Trichloroethlylene | 0.005 | Cancer | Textiles, adhesives, and metal degreasers |

## APPENDIX 7A
## DRINKING WATER STANDARDS AND HEALTH EFFECTS
## TUCSON ACTIVE MANAGEMENT AREA

| Contaminant | Primary MCL (mg/l)[1] | Potential Health Effects from Ingestion of Water | Sources of Contaminant in Drinking Water |
|---|---|---|---|
| Vinyl chloride | 0.002 | Cancer | May leach from PVC pipe; formed by solvent breakdown |
| Xylenes (total) | 10.0 | Liver, kidney, nervous system | By-product of gasoline refining; paints, inks, detergents |
| **Synthetic Organic Chemicals** | | | |
| Alachlor | 0.002 | Cancer | Runoff from herbicides applied to crops |
| Atrazine | 0.003 | Mammary gland tumors | Runoff from herbicides used on crops and non-cropland |
| Benzo(a)pyrene | 0.0002 | Cancer | Fossil fuels, burning organic matter, coal tar coatings, volcanics |
| Carbofuran | 0.04 | Nervous, reproductive system effects | Soil fumigant; some area restrictions apply |
| Chlordane | 0.002 | Cancer | Leaching from soil treatment for termites |
| 2,4-D | 0.07 | Liver and kidney damage | Runoff from herbicides applied to crops, rangelands, and lawns |
| Dalapon | 0.2 | Liver and kidney effects | Herbicide on orchards, crops, lawns, road/railways |
| Dibromochloropropane | 0.0002 | Cancer | soil fumigant |
| Di(2-ethylhexyl)adipate | 0.4 | Decreased body weight | Synthetic rubber, food packaging, cosmetics |
| Di(2-ethylhexyl)phthalate | 0.006 | Cancer | PVC and other plastics |
| Dinoseb | 0.007 | Thyroid, reproductive organ damage | Runoff of herbicide from crop and non-crop applications |
| Diquat | 0.02 | Liver, kidney, eye effects | Runoff of herbicide on land and aquatic weeds |
| Endothall | 0.1 | Liver, kidney, gastrointestinal | Herbicide on crops, land/aquatic weeds; rapidly degraded |
| Endrin | 0.002 | Liver, kidney, heart damage | Pesticide on insects, rodents, birds; restricted since 1980 |
| Ethylene dibromide | 0.00005 | Cancer | Leaded gasoline additives; leaching of soil fumigant |
| Glyphosate | 0.7 | Liver, kidney damage | Herbicide on grasses, weeds, brush |
| Heptachlor | 0.0004 | Cancer | Leaching of insecticide for termites and very few crops |
| Heptachlor epoxide | 0.0002 | Cancer | Biodegradation of heptachlor |
| Hexachlorobenzene | 0.001 | Cancer | Pesticide production waste by-product |

## APPENDIX 7A
## DRINKING WATER STANDARDS AND HEALTH EFFECTS
## TUCSON ACTIVE MANAGEMENT AREA

| Contaminant | Primary MCL (mg/l)[1] | Potential Health Effects from Ingestion of Water | Sources of Contaminant in Drinking Water |
|---|---|---|---|
| Hexachlorocyclopentadiene | 0.05 | Kidney, stomach damage | Pesticide production intermediate |
| Lindane | 0.0002 | Liver, kidney, nervous, immune circulatory | Insecticide on cattle, lumber, gardens; restricted in 1983 |
| Methoxychlor | 0.04 | Growth, liver, kidney, nerve effects | Insecticide for fruits, vegetables, alfalfa, livestock, pets |
| Oxamyl (Vydate) | 0.2 | Kidney damage | Insecticide on apples, potatoes, tomatoes |
| Pentachlorophenol | 0.001 | Cancer, liver and kidney effects | Wood preservatives, herbicide, cooling tower wastes |
| Picloram | 0.5 | Kidney, liver damage | Herbicide on grass sod, some crops, aquatic algae |
| Polychlorinated biphenyls | 0.0005 | Cancer | Coolant oils from electrical transformers; plasticizers |
| Simazine | 0.004 | Cancer | Herbicide on grass sod, some crops, aquatic algae |
| 2,3,7,8-TCDD (Dioxin) | $3 \times 10^{-8}$ | Cancer | Chemical production by-product; impurity in herbicides |
| Toxaphene | 0.003 | Cancer | Insecticide on cattle, cotton, soybeans; canceled in 1982 |
| 2,4,5-TP (Silvex) | 0.05 | Liver and kidney damage | Herbicide on crops, right-of-way, golf courses; canceled in 1983 |
| **Radionuclides** | | | |
| Combined Radium-226 and Radium-228 | 5 pCi/l[4] | Bone Cancer | Natural deposits |
| Gross Alpha[5] | 15 pCi/l | Cancer | Decay or radionuclides in natural deposits |
| Gross beta | 4 mrem/yr[6] | Cancer | Decay of radionuclides in natural and man-made deposits |
| Radon-222 (Proposed) | 300 pCi/l | Cancer | Natural sources |
| Uranium (Proposed) | 20 µg/l[7] | Cancer | Natural sources |

## APPENDIX 7A
## DRINKING WATER STANDARDS AND HEALTH EFFECTS
## TUCSON ACTIVE MANAGEMENT AREA

| Contaminant | Primary MCL (mg/l)[1] | Potential Health Effects from Ingestion of Water | Sources of Contaminant in Drinking Water |
|---|---|---|---|
| **Microbiology** | | | |
| Giardia lamblia | TT[8] | Gastroenteric disease | Human and animal fecal waste |
| Legionella | TT | Legionnaire's disease | Indigenous to natural waters; can grow in water heating systems |
| Standard Plate Count | TT | Indicates water quality, effectiveness of treatment | |
| Total Coliform | [9] | Indicates gastroenteric pathogens | Human and animal fecal waste |
| Turbidity | [9] | Interferes with disinfection, filtration | Soil runoff |
| Viruses | TT | Gastroenteric disease | Human and animal fecal waste |
| Total Trihalomethanes | 0.1 | Cancer | Drinking water chlorination by-products |

[1] mg/l = milligrams per liter (all MCLs are in mg/l unless otherwise indicated)
[2] "MFL" means million fibers per liter greater than ten microns
[3] The MCL for fluoride applies to community water systems only
[4] pCi/l = picocuries per liter (30pCi/l is equivalent to 20 µg/l)
[5] Gross particle activity, including Radium-226 but excluding Radon and Uranium
[6] mrem/yr = millirem per year, see ADEQ, Drinking Water Rules source (1) for more information
[7] µg/l = micrograms per liter
[8] Treatment Technology (refer to source (1) for more information)
[9] Refer to source (1) for more information

Sources:

1. Arizona Department of Environmental Quality, Arizona Drinking Water Rules, April 28, 1995
2. United States Environmental Protection Agency, Office of Water 4304, EPA 822-B-96-002, October 1996
3. United States Environmental Protection Agency, National Primary Drinking Water Regulations, Appendix A: National Primary Drinking Water Standards (Modified 1/14/98)

## APPENDIX 7B
## SECONDARY DRINKING WATER STANDARDS[1]
## TUCSON ACTIVE MANAGEMENT AREA

| Constituents | SMCLs (mg/l)[2] |
|---|---|
| Aluminum | 0.05 to 0.2 |
| Chloride | 250 |
| Color | 15 color units |
| Copper | 1.0 |
| Corrosivity | non-corrosive |
| Fluoride | 2.0 |
| Foaming agents | 0.5 |
| Iron | 0.3 |
| Manganese | 0.05 |
| Odor | 3 threshold odor numbers |
| pH | 6.5 - 8.5 |
| Silver | 0.1 |
| Sulfate | 250 |
| Total dissolved solids | 500 |
| Zinc | 5 |

[1] Secondary Drinking Water Standards are unenforceable federal guidelines regarding taste, odor, color and certain other non-aesthetic effects of drinking water. States may adopt their own enforceable regulations governing these concerns.

[2] Secondary Maximum Contaminant Levels (SMCLs) units are in milligrams per liter (mg/l) unless otherwise indicated.

Source:
United States Environmental Protection Agency, Office of Water 4304, EPA 822-B-96-002, October 1996.