Groundwater Protection In Arizona: An Assessment of Groundwater Quality and the Effectiveness of Groundwater Programs

Arizona Department of Environmental Quality

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Office of Water Quality
Groundwater Hydrology Section

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The Arizona Department of Environmental Quality shall preserve, protect and enhance the environment and public health, and shall be a leader in the development of public policy to maintain and improve the quality of Arizona's air, land and water resources.

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EXECUTIVE SUMMARY

As required by A.R.S. §49-249, this document reports on levels of pollutants in Arizona's aquifers and the effectiveness of groundwater protection programs established in Title 49, Chapter 2 of the Arizona Revised Statutes.

Groundwater quality is a major concern because groundwater is the principal source for public water supply in Arizona. Groundwater quality data collected by the Arizona Department of Environmental Quality and other agencies show that groundwater throughout the state generally meets drinking water standards. Despite this finding, many groundwater quality problems have been identified, due to both human-caused contamination and pollutants present at naturally elevated levels.

Major pollutant sources in Arizona include agricultural activities, wastes from industries, leaking underground storage tanks, septic tanks, landfills, mining, and wastewater treatment plants. A total of 150 groundwater quality problems, many located in the Phoenix and Tucson metropolitan areas, are denoted on nine regional maps of Arizona (see Appendix).

Pollutants detected in groundwater include volatile organic compounds (typically industrial solvents), nitrate, sulfate, dissolved solids, metals, pesticides, petroleum hydrocarbons (usually gasoline or diesel), radiochemicals, and bacteria. Although groundwater contamination is a serious problem, it is stressed that the quality of water delivered in public supplies is strictly regulated and monitored to meet federal and state standards set to protect public health.

Title 49 established broad authorities for managing and protecting groundwater quality and remediating point and non-point sources of pollution. The explicit goal of the statute is to preserve and protect groundwater quality for all present and reasonably foreseeable future uses. This report describes the major milestones achieved by programs established under Title 49, Chapter 2.

The Aquifer Protection Permit Program (APP), with its reliance on Best Available Demonstrated Control Technology (BADCT) and Best Management Practices (BMPs), and the Water Quality Assurance Revolving Fund (WQARF) are the key groundwater protection and groundwater cleanup programs, respectively, established in Chapter 2. Other Chapter 2 programs include Aquifer Boundaries and Water Quality Standards, Drywells, Pesticides, Nonpoint Source, Compliance, and Ambient Monitoring and Database. In total, these programs have demonstrably prevented new discharges to groundwater while ushering in cleanup of existing contamination sites. It is emphasized that most existing contamination sites are due to discharges that had occurred prior to the establishment of the Title 49 programs.

Arizona's groundwater protection programs are highly regarded by many states and agencies, including the U.S. Environmental Protection Agency, as comprising one of the most comprehensive approaches in the nation. The Arizona Department of Environmental Quality continues to work in partnership with the public, the regulated community, EPA and other agencies to improve groundwater protection efforts.

I. INTRODUCTION

This report is submitted in accordance with A.R.S. §49-249, which requires the Director of the Arizona Department of Environmental Quality (ADEQ) to report every five years to the Governor, the President of the Senate, and the Speaker of the House of Representatives, on levels of pollutants in Arizona's aquifers and the effectiveness of groundwater protection programs described in Title 49, Chapter 2 of the Arizona Revised Statues. This report assesses levels of pollutants in aquifers and describes the effectiveness of groundwater protection programs at controlling or reducing pollution in aquifers.

In Arizona, both water quantity and quality are critical to the viability of our state. Groundwater quality is a major concern because groundwater is the principal source of public water supplies in Arizona, providing approximately 60 percent of drinking water supplies, and is an important component of our river and wetland environments (Wilson, 1991). In 1985, groundwater accounted for 48 percent of the total supply of 7.21 million acre-feet (Solley, et al., 1988). About 74 percent of the water pumped was used for agriculture and the remainder was used for public supply, industrial, domestic, and other purposes (Wilson, 1991). The availability of suitable quality and quantity of water has influenced the development of cities and croplands in Arizona. Rapid population growth has increasingly resulted in cropland retirement and conversion of agricultural water supplies to urban drinking water uses.

Arizona's groundwater has long been subject to pressures of overdraft and waste disposal. In 1980, the enactment of the Groundwater Management Act (GMA), which established the Arizona Department of Water Resources (ADWR), set in motion a comprehensive 45-year effort to eliminate overdraft, and to manage groundwater as a public resource, including consideration of water quality in planning for sustained yield of groundwater.

At the inception of the GMA, state legislation mandating groundwater quality protection was limited. However, the Arizona Department of Health Services (ADHS), in 1981, initiated development of a state program to protect groundwater quality. ADHS adopted narrative groundwater quality standards in 1983 and the Groundwater Quality Protection Permit program in 1984. Enactment of environmental legislation followed, culminating in the Environmental Quality Act of 1986 (EQA), which established the Arizona Department of Environmental Quality. The EQA put into place a strong and comprehensive groundwater quality management program in Arizona. As in the 1980s, protection of groundwater remains a major issue in this decade.

II. SUMMARY OF GROUNDWATER QUALITY AND LEVELS OF POLLUTANTS IN AQUIFERS

ADEQ has adopted the 50 groundwater basin boundaries delineated by ADWR (**FIGURE 1**). These basins were designated on the basis of physiography, surface drainage patterns, subsurface geology, and aquifer characteristics. As specified in the GMA, four of the basins were designated Active Management Areas (AMAs): Phoenix AMA, Tucson AMA, Prescott AMA, and Pinal AMA. These basins contain the largest population centers, the greatest amount of irrigated acreage, and the highest density of industry. Due to concern about groundwater overdraft, the AMAs are highly regulated with regard to groundwater pumping, water use, irrigation efficiency and conservation requirements. The 50 groundwater basins, including the AMAs, have been grouped by ADWR into nine planning regions reflecting similarities in water supply, water use, and other water-resource management factors. Much of the state's groundwater data is organized around the nine planning regions and the groundwater basins which constitute them.

Principal Aquifers and Groundwater Quality

Principal aquifers in Arizona are composed of unconsolidated sediments (alluvial aquifers), consolidated sedimentary strata (sandstone and limestone aquifers), and crystalline rocks of igneous and metamorphic origin (fractured bedrock aquifers). These aquifers are located within the three physiographic provinces of Arizona: the Plateau Uplands Province, the Central Highlands Province, and the Basin and Range Province (**FIGURE 1**). The potential sources of pollution and the susceptibility of these aquifers to pollution vary depending on aquifer type and physiographic province.

The Plateau Uplands Province in the northeastern 40 percent of the state is underlain by extensive consolidated sedimentary rock formations. Most of the groundwater is withdrawn from these strata, although localized alluvial aquifers also provide supplies. While groundwater may be found near land surface, it generally occurs at a depth of more than 1,000 feet in the consolidated sedimentary rocks.

The Central Highlands Province, covering 15 percent of the state, provides a geologic and physiographic transition from the Plateau Uplands to the Basin and Range Lowlands. The Mogollon Rim marks the northern boundary of this province. Aquifers in this province are varied, including alluvial aquifers occupying relatively small basins, aquifers in consolidated sedimentary rocks, and fractured aquifers in hard rocks. Much of the surface water flow within Arizona originates in the Central Highlands Province. The streams and rivers within this province are often fed by groundwater along parts of their length.

The desert Basin and Range Lowlands Province constitutes 45 percent of the state's

FIGURE 1 - ARIZONA GROUNDWATER BASINS AND PLANNING REGIONS

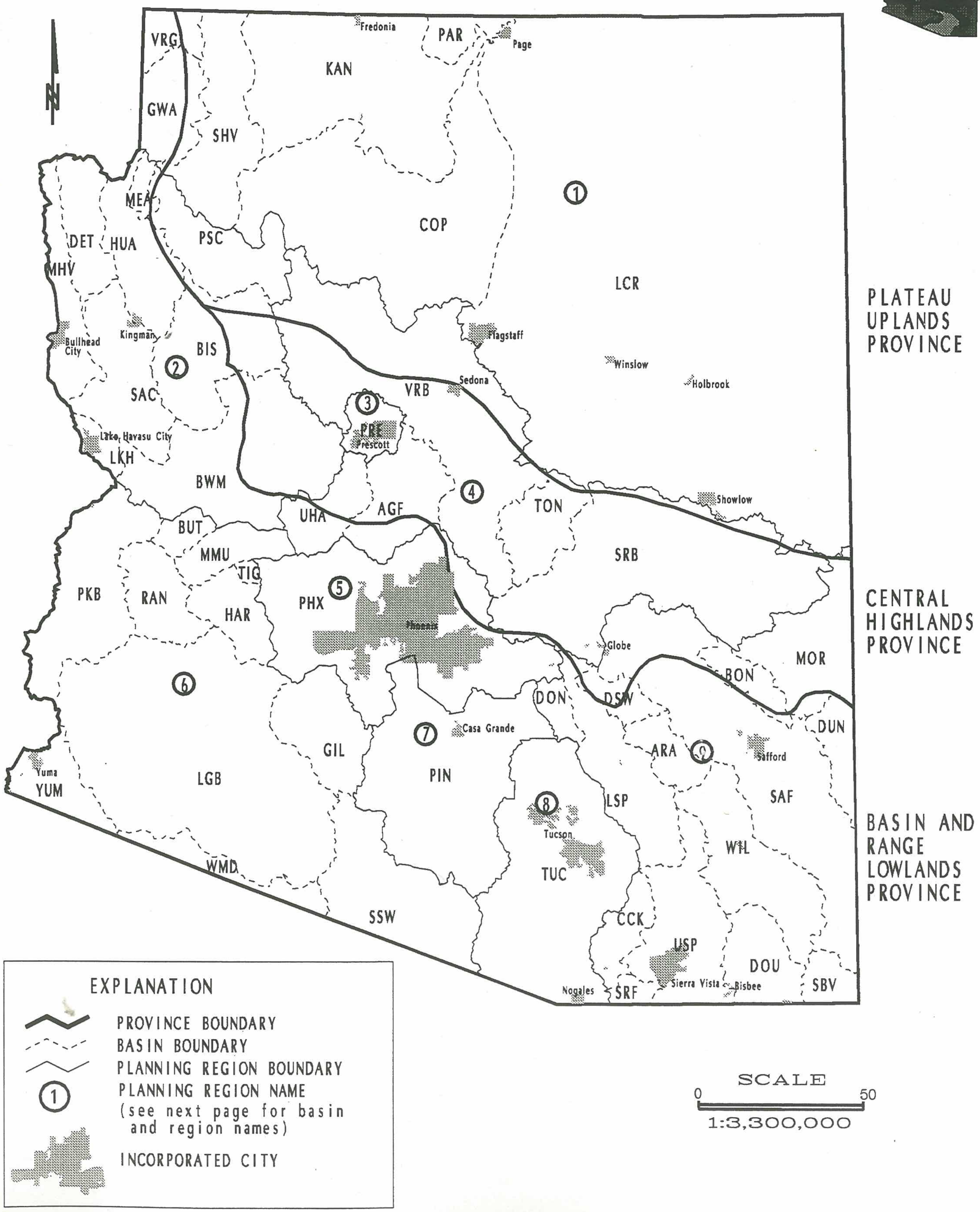

FIGURE 1 - ARIZONA'S GROUNDWATER BASINS AND PLANNING REGIONS (cont.)

Groundwater Basin Designations

AGF	Agua Fria Basin	MOR	Morenci Basin
ARA	Aravaipa Canyon Basin	PAR	Paria Basin
BIS	Big Sandy Basin	PHX	Phoenix A.M.A.
BON	Bonita Creek Basin	PIN	Pinal A.M.A.
BUT	Butler Valley Basin	PKB	Parker Basin
BWM	Bill Williams Basin	PRE	Prescott A.M.A.
CCK	Cienega Creek Basin	PSC	Peach Springs Basin
COP	Coconino Plateau Basin	RAN	Ranegras Plain Basin
DET	Detrital Valley Basin	SAC	Sacramento Valley Basin
DON	Donnelly Wash Basin	SAF	Safford Basin
DOU	Douglas Basin	SBV	San Bernardino Valley Basin
DSW	Dripping Springs Wash Basin	SHV	Shivwits Plateau Basin
DUN	Duncan Valley Basin	SRB	Salt River Basin
GIL	Gila Bend Wash	SRF	San Rafael Basin
GWA	Grand Wash Basin	SSW	San Simon Wash Basin
HAR	Harquahala Basin	TIG	Tiger Wash Basin
HUA	Hualapai Valley Basin	TON	Tonto Creek Basin
KAN	Kanab Plateau Basin	TUC	Tucson A.M.A.
LCR	Little Colorado River Basin	UHA	Upper Hassayampa Basin
LGB	Lower Gila Basin	USP	Upper San Pedro Basin
LKH	Lake Havasu Basin	VRB	Verde River Basin
LSP	Lower San Pedro Basin	VRG	Virgin River Basin
MEA	Meadview Basin	WIL	Willcox Basin
MHV	Lake Mohave Basin	WMD	W. Mexican Drainage Basin
MMU	McMullen Valley Basin	YUM	Yuma Basin

Planning Regions

1. Plateau
2. Upper Colorado River
3. Prescott Active Management Area
4. Central Highlands
5. Phoenix Active Management Area
6. Lower Colorado River
7. Pinal Active Management Area
8. Tucson Active Management Area
9. Southeast Arizona

land surface area. This province is characterized by broad alluvial basins bounded by long mountain ranges rising sharply from the desert floor. The basins are filled by great thicknesses of fine- and coarse-grained sediments eroded from the mountains. The sediments deposited in the basins show much variation laterally and vertically in groundwater storage and transmission properties. Groundwater occurs in confined, unconfined, and perched conditions. This basin-fill alluvium forms the most productive aquifers in Arizona, from which about 97 percent of all groundwater is pumped (Wilson, 1991). Depth to groundwater ranges from just below land surface to more than 1,000 feet.

Groundwater quality data collected from 1980 to 1991, primarily by ADEQ, ADWR, U.S. Geological Survey and other agencies and organizations, show that groundwater throughout the state generally meets drinking water standards. Despite this finding, many groundwater quality problems have been identified, due to both human-caused contamination and pollutants present at naturally elevated levels. Although groundwater contamination is a serious problem, it is stressed that the quality of water delivered in public supplies, including those supplied by groundwater sources, is strictly regulated and monitored to meet federal and state standards set to protect public health.

Groundwater quality problems in Arizona are diverse, reflecting the multiplicity of land uses and the differing hydrogeologic characteristics of Arizona's groundwater basins. Pollutants detected in groundwater include volatile organic compounds (usually solvents such as TCE, PCE and TCA), nitrate, sulfate, dissolved solids, metals (chromium, arsenic and others), pesticides (EDB and DBCP), petroleum hydrocarbons (usually gasoline or diesel), radionuclides (radon and other radiochemicals), and bacteria. **TABLE 1** lists the major groups of pollutants found in Arizona groundwater. Maps denoting known groundwater contamination problems within each water resource planning region, found in the Appendix, show the locations and types of pollutants. A total of 150 groundwater quality problems are indicated on the maps. A key accompanies the maps and indicates levels of pollutants associated with each groundwater contamination problem.

The four AMAs contain the greatest number of known and potential contamination sources, as they contain nearly 80 percent of Arizona's population and much of the agricultural land. Urban (including industrial) and agricultural activities represent the two land uses most associated with contaminated groundwater in Arizona.

Groundwater Pollutants

Groundwater pollution is closely related to land use; a minority of contamination cases are due to naturally occurring constituents. Contamination may occur as relatively well-defined plumes emanating from point sources (for example, landfills, waste lagoons and industrial dump sites) or it may exist as a general deterioration of water quality over a wide area due to nonpoint sources (for example, agricultural fertilizer and pesticide applications, septic systems, leaking sewer networks, and mining activities). Because groundwater quality degradation from nonpoint sources often affects large areas, it may be difficult to definitively pinpoint specific sources. Additional studies are needed to better relate

TABLE 1. MAJOR TYPES OF POLLUTANTS CONTAMINATING GROUNDWATER IN ARIZONA

POLLUTANT GROUP	POLLUTANT
Major Cations/Anions	Fluoride Dissolved Solids Sulfate
Metals	Arsenic Lead Chromium (Cr^{+3}, Cr^{+6}) Iron Manganese Barium
Nutrients	Nitrate
Volatile Organic Compounds	Trichlorethylene (TCE) Tetrachloroethylene (PCE) Chloroform 1,1,1-trichloroethane (TCA) Methylene chloride Freon-11®, Freon-12®, Freon-113® 1,1-dichloroethylene 1,2-dichloroethylene 1,1-dichloroethane (DCA) Vinyl chloride Benzene Toluene Ethylbenzene Xylene
Petroleum Hydrocarbons	Gasoline Diesel Jet Fuel
Pesticides	Ethylene dibromide (EDB) Dibromochloropropane (DBCP)
Radiological	Uranium Radium-226 and 228 Radon
Physical	pH
Microorganisms	Total Coliform Bacteria Fecal Coliform Bacteria

these dispersed human activities to regional groundwater quality.

The most widely documented sources of contamination in Arizona include agricultural activities, wastes from industries, leaking underground storage tanks (LUSTs), septic tanks, landfills, mining activities, and wastewater treatment plant effluent (ADEQ, 1992). A synopsis of the major pollutants found in Arizona groundwater follows.

Volatile Organic Compounds

Aside from gasoline leaks reaching groundwater, disposal of solvents has resulted in most of the state's documented cases of VOC-contaminated groundwater. High-technology manufacturing facilities (often electronics and aerospace), which use these solvents for degreasing, are generally located in urbanized areas where most of the VOC problems have been found. Disposal of solvents has been documented from the early 1950s and probably began earlier. Specific industrial waste disposal practices leading to groundwater contamination by VOCs include injection into dry wells and disposal into surface impoundments, leach fields, dry washes, and unregulated landfills (Graf, 1986). Many of the recently discovered VOC problems can be traced to disposal or leaks at dry cleaning facilities. Surface spills are less common causes of VOCs in groundwater. Public drinking water wells in the Phoenix and Tucson metropolitan areas and in Payson have been closed because of VOC contamination.

Nitrate

Nitrate is one of the most common pollutants in the state's groundwater and is associated with both human activities and natural nitrogen sources. Nitrate levels in groundwater have decreased in some areas where agricultural activities have been replaced with urbanization, but have increased in other areas. Percolation of nitrate-laden water from irrigation, septic tanks, wastewater treatment plants, concentrated animal feedlots and natural nitrate occurrences are likely causes of elevated nitrate levels (Brown and Caldwell, 1979; PAG, 1983). Nitrate is not significantly attenuated by the soil and therefore travels with the groundwater largely unchanged.

Large portions of aquifers within the Salt River Valley, including areas within Glendale, Mesa, Chandler, and Phoenix, contain groundwater with nitrate concentrations high enough to render the water unfit for potable use. In addition, high nitrate levels occur in Marana, St. David, Quartzsite, Bullhead City and other areas. Septic tank discharges are particularly prevalent nitrate sources in rural areas of Arizona and have often contaminated drinking water wells. Quartzsite, Bullhead City and Lake Havasu City are just a few locations with documented regional nitrate problems from septic tanks.

Major Cations and Anions (Dissolved Mineral Content)

Ambient groundwater quality can vary widely from basin to basin. Dissolved mineral content is one measure of ambient water quality and is expressed as the total dissolved solids (TDS) content. In Arizona, the TDS content, which can be used to gage potability, generally falls within the range of suitability for human consumption (500 to 1,000 milligrams per liter), although higher concentrations are relatively common. Some areas in the state, particularly in some alluvial basins and along the Gila River, exhibit much higher TDS concentrations (greater than 3,000 milligrams per liter), rendering the groundwater unsuitable for drinking and other uses.

Mining activities have been responsible for high levels of dissolved cations and anions (the individual constituents composing the dissolved mineral content) in groundwater. In some parts of the state, sulfate, TDS, and hardness are commonly elevated downgradient from mining operations and tailings ponds. Excessive amounts of sulfate and TDS in groundwater may also result from discharge of treated wastewater effluent and deep percolation of salts leached by irrigated agriculture.

Fluoride, which occurs naturally in groundwater, is found in moderate to high levels in some alluvial basins of the Basin and Range Province.

Metals

Heavy metals occur naturally in groundwater, and elevated levels are often associated with mineralized areas. For example, hexavalent chromium is found in groundwater at elevated levels in Paradise Valley and Kingman (Robertson, 1975; Robertson, 1986). Arsenic also occurs naturally in some areas at elevated levels.

Metals may also reach groundwater from anthropogenic sources. Chromium has been found in groundwater in several locations in the Phoenix and Tucson metropolitan areas due to industrial discharges from electronics, aviation, and plating firms.

Metals such as manganese, copper, iron, chromium, and others have been found in groundwater downgradient from mining operations and tailings ponds, particularly where acid drainage has developed. Groundwater downgradient from landfills commonly contains elevated concentrations of iron, manganese, and barium.

Pesticides

Only two pesticides have been detected repeatedly in groundwater - dibromochloropropane (DBCP) and ethylene dibromide (EDB). To date, these pesticides have been found in groundwater in the Yuma area and in the Salt River Valley. DBCP and EDB were applied from the 1950s through the 1970s to soils in citrus and cotton fields as fumigants for the control of nematodes (Daniel, et al., 1988). EDB is also used as an anti-knock component in gasoline and may contaminate groundwater via leaking underground storage tanks. Once commonly used, these pesticides have been banned because of their potential carcinogenicity. DBCP and EDB have contaminated over 80 drinking water wells in Arizona.

Petroleum Hydrocarbons

Leaking underground storage tanks (LUSTs), primarily those containing petroleum fuels, are a significant source of groundwater contamination in Arizona. LUSTs are located throughout the state, but are concentrated in urban areas. Of the 20,723 underground storage tanks reported to ADEQ by January 1, 1991, a total of 1,473 were reported as leaking and 312 were successfully remediated. From 10 to 20 percent of the reported tank leaks have affected groundwater quality.

Over half of the reported LUST sites were located at service stations. Other locations included utility, transportation and shipping companies; municipal facilities; pipelines; and mining, food, lodging, high technology, and paint companies. Benzene, toluene, ethylbenzene, and xylene (BTEX), which are aromatic hydrocarbon components of petroleum fuels, are the most commonly detected LUST-related chemicals in groundwater. At some LUST sites, total petroleum hydrocarbons (TPHC) and EDB have also been detected.

Radionuclides

Radioactive elements such as uranium, radon, and radium occur naturally in the soil and water at locations throughout Arizona, sometimes in concentrations elevated enough to be of concern. Anthropogenic contamination of groundwater has also resulted from uranium mining activities (waste dumps and mine tailings) and mine dewatering. These uranium mining activities have mainly occurred in the Plateau Uplands Province.

Bacteria

Effluent from septic tanks may contaminate groundwater by bacteria and nitrate. The 1980 census estimated that approximately 280,000 septic tank systems are operating in Arizona, serving nearly 17 percent of the population. Contamination of groundwater by microorganisms may result when the tanks are installed in areas with inadequate soils or shallow depth to groundwater, especially where limestone or fractured bedrock aquifers are present. Bacterial contamination of groundwater has been noted near Sedona, Dewey, and Pinetop-Lakeside. Poor well construction and well seals can also lead to the entrance of microorganisms into groundwater. Generally, however, most microorganisms will be removed after passing through a few feet of soil.

III. EFFECTIVENESS OF GROUNDWATER PROTECTION PROGRAMS ESTABLISHED BY TITLE 49, CHAPTER 2

Title 49, Chapter 2 of the EQA established broad authorities for management, control, remediation, and regulation of point and nonpoint sources of pollution. The explicit goal of the statute is to preserve and protect groundwater quality for all present and reasonably foreseeable future uses. Both preventive and remedial strategies are employed to achieve this objective.

This section assesses the effectiveness of programs in Title 49, Chapter 2 for preserving and protecting groundwater quality. A brief description of each groundwater program is presented, followed by a discussion of the effectiveness of the program. Because of the importance of Best Management Practices (BMPs) and Best Available Demonstrated Control Technology (BADCT) in protecting groundwater quality, these control measures are discussed separately in Section IV.

The effectiveness of groundwater programs can be measured either by analyzing groundwater quality trends or by reviewing major implementation milestones of the programs. In this report, the second approach is taken because groundwater protection programs have not been in effect long enough to permit trend analysis. However, the groundwater protection programs established in Title 49, Chapter 2 have demonstrably prevented new discharges to groundwater while ushering in cleanup of existing contamination sites. It is emphasized that most existing contamination sites are due to discharges that had occurred prior to the establishment of the Title 49 programs.

Arizona's groundwater protection programs are highly regarded by many states and agencies, including the U.S. Environmental Protection Agency, as comprising one of the most comprehensive approaches in the nation. The Arizona Department of Environmental Quality continues to work in partnership with the public, the regulated community and EPA and other agencies to improve groundwater protection efforts.

Aquifer Boundaries and Aquifer Water Quality Standards

Description

Under Title 49, ADEQ has the responsibility to define the boundaries of all aquifers in the state (A.R.S. § 49-224.A). To this end the agency has adopted the groundwater basin boundaries promulgated by ADWR as the limiting boundaries of the various aquifers of the state. Within these boundaries, any geologic unit capable of yielding five gallons or more of water per day is regarded as an aquifer and protected by statute.

Title 49 initially classified all aquifers of the state as drinking water aquifers. Thus, they are to be protected for drinking water use. While there is a statutory provision for reclassifying aquifers designating other uses, ADEQ has not received any petitions for reclassification.

Title 49 also adopted primary drinking water Maximum Contaminant Levels (MCLs) as aquifer water quality standards for aquifers protected for drinking water use. The statute requires ADEQ to adopt within one year as aquifer quality standards any newly promulgated drinking water MCLs. If aquifers are designated for other uses, ADEQ must adopt aquifer water quality standards appropriate for those uses.

Effectiveness

- Aquifers statewide were delineated and classified by rule for drinking water use.

- Numeric Aquifer Water Quality Standards (AWQS) were established in rule; numeric standards are equivalent to federal primary drinking water MCLs.

- Narrative aquifer water quality standards were established in rule.

- Two rulemakings were undertaken to adopt newly promulgated drinking water MCLs as AWQSs.

- No petitions for aquifer re-classification have been received, therefore all aquifers in the state continue to be protected for drinking water use.

- Health-Based Guidance Levels (HBGLs) were developed for ingestion of contaminants in drinking water of pollutants for which standards have not been set. HBGLs also support remedial activities with cleanup goals. A list of draft HBGLs for 230 chemicals was published; this was followed by a final document listing HBGLs for 268 chemicals.

- The adoption by ADEQ of aquifer boundaries and AWQSs, which protect entire aquifers to drinking water standards, has laid the foundation for effective implementation of all state groundwater protection programs.

Aquifer Protection Permit Program

Description

The Aquifer Protection Permit (APP) program is the cornerstone of Arizona's groundwater protection strategy (Hastings and Hood, 1989). This permit program replaced the Groundwater Quality Protection Permit (GWPP) program which was implemented in 1984.

Under the APP program, any individual responsible for discharge or potential discharge of a pollutant to an aquifer, the land surface or to the vadose zone, which has reasonable probability of reaching groundwater, must obtain an APP from ADEQ. Facilities which are regulated by this program include wastewater treatment facilities, mines, landfills, surface impoundments, groundwater recharge projects using wastewater effluent, land treatment facilities, and injection wells. New facilities must obtain an APP prior to initiating operations. Existing facilities are prioritized for permitting. All existing facilities must be brought into compliance with the APP program by 2001. Facilities closed prior to enactment of the EQA, where groundwater contamination exists, are to be addressed under the Water Quality Assurance Revolving Fund (WQARF), often referred to as the State Superfund Program.

Two types of permits are issued under the APP program: General permits and individual permits. General permits are issued by rule for activities which are large in number, where cost to issue individual permits is not justified by any environmental or public health concern, where the practices are similar in nature, and in which the activities would generally meet the requirements of an individual APP permit. Currently, there are four categories of general permits:

1. On-site sewage disposal (septic) systems;

2. Pilot recharge and underground storage and recovery projects;

3. Agricultural application of wastewater sludge; and

4. Other facilities (a variety of other sources such as placer mining and hydrostatic tests of pipelines).

For individual permits, the APP rules provide a formal application process which requires the applicant to supply facility design details, discharge characteristics, and site information including hydrogeologic studies. Applicants must make three demonstrations:

1. Facility will not cause or contribute to violation of AWQSs at downgradient point of compliance;

2. Facility is designed utilizing Best Available Demonstrated Control Technology (BADCT); and

3. Applicant is technically and financially capable of meeting APP requirements.

Conditions that ADEQ may include in a permit and that may be proposed by applicants include alert levels, discharge limitations, location of points of compliance, monitoring plan, contingency plan, compliance schedule (if necessary), and closure and post-closure plans.

ADEQ charges fees for individual permits according to the amount of staff time required to process a facility's application. The current rule (A.A.C. R18-9-123) sets maximum fees ranging from $3,450 for small wastewater treatment plants to $15,750 for municipal solid waste landfills.

Effectiveness

- Rules for the permit process were certified in September 1989.

- Transition from GWPPs to APPs was accomplished. Many later GWPPs were already incorporating APP-required elements in anticipation of the impending APP program. The following two tables show the number of facilities ADEQ has permitted.

Number of Facilities Permitted Under the Groundwater Protection and Aquifer Protection Permit Programs

Facility Type	GWPPs	APPs
Landfills	15	4
WWTPs	246	17
Mines	34	12
Industrial & Other	38	22
Total	333	55

APPs Issued by Year

	YEAR APP ISSUED		
Facility Type	1990	1991	1992
Landfills	1	1	2
WWTPs	3	6	8
Mines	4	8	0
Industrial & Other	2	13	7
Total	10	28	17

- During 1992, ADEQ developed a new accounting and permit application tracking system.

- Also in 1992, ADEQ developed "boilerplate" language for permit conditions to increase processing efficiency.

- Over 900 existing facilities were prioritized for APP permitting by the year 2001.

- Processing was begun on 141 existing facilities during 1992.

- BADCT and BMPs have been developed for both individual and general permit aspects of the APP program. See Section IV for a detailed description of their effectiveness.

- In 1992, EPA approved Arizona's Wellhead Protection Program, which builds on the APP program and AWQSs by encouraging local authorities to further protect groundwater quality utilizing local zoning and other wellhead protection efforts.

- While permit fees are assessed to meet program costs, they do not fully cover all administrative, technical review, and inspection expenses incurred by ADEQ.

- The establishment of the APP program has provided controls on discharges of nearly every type of groundwater pollutant, including those not addressed under other state and federal programs. The APP program also has had an indirect deterrent effect, as some facilities have ceased discharging rather than be subject to the APP regulatory process.

Drywell Program

Description

A drywell regulation program is provided for under A.R.S. § 49-331, et. seq. Drywells are defined as injection wells that are designed and constructed specifically for the disposal of stormwater. All drywells installed after August, 1986, must be registered within 30 days of beginning operation. Since July, 1987, owners have been required to register all existing drywells; those not currently registered are subject to the same compliance orders and penalties as new drywells. Generally, drywells that do, or have the potential to, receive discharges other than stormwater runoff, especially hazardous materials, must also obtain an APP.

Effectiveness

- Approximately 5,000 drywells are registered, but ADEQ estimates that more than 11,000 exist.
- Because only registration is required, the drywell program has minimal statutory authority to directly prohibit injection of pollutants into drywells.
- The EQA gives ADEQ authority to adopt rules for drywell design, construction, operation, performance, closure, facility location, and inspection, but rules for drywells have not yet been written.
- ADEQ has worked with EPA in its Underground Injection Control Program to establish guidelines for closure and site inspection at potentially contaminated drywells.

WQARF (State Superfund) Program

Description

The Water Quality Assurance Revolving Fund (WQARF) program complements the Federal CERCLA program by addressing sites not on EPA's National Priority List. WQARF consists of legislative appropriations, monies obtained as civil or criminal penalties, monies recovered from responsible parties for cleanup costs, and special fee collections. Under the EQA, WQARF may be used to investigate, assess, mitigate, abate, and clean up pollution of waters of the state caused by past activities. The EQA gives ADEQ the authority to collect monies from responsible parties, and defines liability for contamination of groundwater from hazardous substances as strict, joint, several, and retroactive. WQARF is replenished mainly by fees collected from responsible parties and by legislative appropriations.

WQARF supports ADEQ activities and provides loans to other agencies and political subdivisions to coordinate cleanup efforts. WQARF provides funding which may be used for identification of responsible parties, monitoring, risk assessment, legal support, matching federal Superfund monies and the cleanup of hazardous substances from sites where the responsible party is unknown or refuses to take action. WQARF funding has also been used for emergency cleanup actions.

ADEQ prepares an annual WQARF Priority List (WPL) of proposed remedial action sites. The priority list is subject to public review and comment. As of Fall 1992, the program does not have the funds to add any more sites to the list due to elimination in FY 92 and FY 93 of special fee collections and the $2,900,000 annual appropriation. However, ADEQ is required by law to continue the annual ranking system even if there are no resources to address newly listed sites. Currently, 24 sites are on the WPL. WQARF program personnel also oversee voluntary cleanup actions undertaken by responsible parties.

After ADEQ designates a WQARF site, it attempts to identify the party or parties responsible (RPs) for the contamination. This process, which typically involves a combination of records searches and field investigations, can take years and, even then, sometimes might not conclusively identify RPs. Once RPs are identified, they are directed to develop a Remedial Action Plan (RAP). The RAP must address contaminated groundwater, generally considered to be an exceedance of an AWQS. The WQARF program also uses HBGLs as benchmarks in cleanup negotiations. Groundwater remediation strategies typically address both the polluted groundwater itself, as well as the continuing sources of contamination in the soil. Soil vapor extraction, combined with air stripping of pumped groundwater, are the most common cleanup technologies employed for VOCs. For nonhazardous substances, mitigation is pursued.

The WQARF and APP programs are designed to interface in circumstances where an existing facility has contributed to groundwater contamination in the past. In such instances, an APP issued for continued operation of the facility must incorporate a compliance schedule that includes a RAP developed in accordance with the WQARF process. A WQARF Order for cleanup also may be written for the facility.

Effectiveness

- 24 contamination sites are currently listed on the WQARF Priority List (WPL). ADEQ nominated 13 of these sites and political subdivisions nominated the other 11.

- All of the largest VOC groundwater contamination sites in Arizona not on the CERCLA National Priority List are being addressed as WQARF WPL sites.

- Four WPL sites have been fully remediated.

- Two WPL sites have been dropped from the list because remedial investigations showed contamination below regulatory levels.

- 30 emergency cleanup actions have been conducted.

- ADEQ hired four prime contractors to carry out ADEQ-directed, WQARF-funded work at WPL sites.

- 66 WQARF-funded groundwater monitoring wells, totaling 10,954 feet of drilling, have been constructed to date.

- WQARF-funded monitoring wells have provided information that would not otherwise have been acquired in a timely manner (if at all) had ADEQ waited for action by potentially responsible parties. WQARF monitor wells served to:

  1. Determine direction of groundwater flow for identification of source areas,

  2. Define lateral and vertical extent of groundwater contamination,

  3. Identify potentially responsi-

ble parties and prompt them to perform remedial investigations/ remedial actions (thus allowing ADEQ to recover original investigation costs),

4. Characterize aquifer conditions necessary to develop remedial designs.

- WQARF-funded soil and soil-gas investigations, along with other field and records search activities, have also helped identify RPs at WPL sites.

- Results of WQARF-funded investigations at WPL sites have compelled 24 facilities to undertake remedial activities.

- Another 25 RP-conducted voluntary cleanups outside of WPL sites are being overseen by ADEQ, although this number changes as newly discovered contamination sites come to ADEQ's attention and sites are cleaned up.

- Since inception of ADEQ in 1986, WQARF has received $1,082,130 from responsible parties for restitution for ADEQ emergency and remedial costs.

- Funding levels limit number of WPL sites and ADEQ-initiated work that can be performed.

Pesticide Program

Description

ADEQ's Pesticide program is designed to prevent contamination of groundwater, soils, and the vadose zone from pesticides. A major component of the program is to identify those pesticides which, based on chemical characteristics, have the potential to leach to groundwater. Manufacturers of agricultural pesticides used in the state are required to register each pesticide and to submit information on the physical and chemical characteristics that describe the environmental fate of each pesticide's active ingredients.

Allowable threshold values (Specific Numeric Values) for environmental fate characteristics have been established (A.A.C. R18-6-103). All pesticides that exceed these values are deemed to have potential to pollute groundwater and are included on the Groundwater Protection List (GWPL). Anyone who applies a pesticide with a listed ingredient for agricultural use directly to the soil is required to provide ADEQ with information regarding the application and use on a revised Form 1080. Pesticide dealers must also make quarterly reports to ADEQ of sales of all agricultural use pesticides that contain one or more of the active ingredients on the list.

Within one year of a pesticide being listed, ADEQ must monitor soil and groundwater to determine whether the pesticide has migrated to groundwater. If the pesticide is found in groundwater and is a known carcinogen, mutagen, teratogen, or is toxic to humans, ADEQ shall notify the Arizona Department of Agriculture to cancel the registration of the pesticide or change the label requirements for applying the pesticide.

Effectiveness

- Data submittal completed. This five-year effort to gain information on the environmental fate of active ingredients in pesticides acquired data on 266 active ingredients.
- Groundwater Protection List completed, containing 158 pesticides.
- Draft Pesticides State Management Plan completed to coordinate activities among state agencies dealing with pesticides.
- Computer program completed to tabulate and analyze physical and chemical data and information submitted on the revised 1080 forms.
- First phase of pesticide data base completed.
- Registrations for more than 20 active ingredients have been cancelled due to lack of manufacturer's environmental fate data.
- 395 wells sampled statewide for pesticides.
- No pesticides on GWPL have been detected in groundwater.

Nonpoint Source Program

Description

ADEQ established the State Nonpoint Source Management Plan, approved by EPA in 1990, to comply with Section 319 of the Clean Water Act. The plan identifies ten categories of surface water and groundwater pollution that must be addressed either through regulatory programs provided for in the EQA or through memoranda of understanding (MOUs) or other agreements with federal, state, or local agencies involved in land and resource management:

1. Agriculture
2. Silviculture
3. Construction
4. Urban Runoff
5. Resource Extraction
6. Land Disposal, e.g., septics, sludge, wastewater reuse, recharge
7. Hydrologic and Habitat Modification
8. Recreation
9. Other Sources, e.g. natural origin
10. Unknown Sources

Many of the source categories listed are covered by the APP program, such as mines, landfills, septic systems, and agricultural fertilizer application. For other sources, the Nonpoint Source program has developed BMPs, often working with federal agencies. An example is ADEQ's joint development of Arizona-specific BMPs with the U.S. Forest Service and the U.S. Bureau of Land Management.

Effectiveness

- The APP program is the centerpiece of Arizona's NPS program for groundwater protection. Since most facilities discharging to surface water must also obtain an APP, the APP program helps to control many surface water sources that are nonpoint in nature.

- Specific controls for surface water pollution are included in APPs to a limited extent.

- MOUs have been established with the U.S. Forest Service and U.S. Bureau of Land Management for implementation of BMPs for activities on Federal lands.

- An Intergovernmental Agreement has been established with Arizona Game & Fish for BMPs.

- ADEQ has overseen four NPS demonstration projects directly related to improving groundwater quality:

  1. Town of Quartzsite Septic System Impact

  2. Town of Cave Creek Stormwater Recharge & Aquifer Mitigation

  3. Cooperative Extension Agricultural BMP Development and Education (actually four different projects)

  4. Prescott Mining Project to address abandoned mines

- Rules for control of nonpoint source discharges to navigable waters pursuant to A.R.S. § 49-203.A.3 have not been developed.

- Aside from BMPs for facilities within the APP program, ADEQ has not defined BMPs for all nonpoint source categories in rule as authorized under A.R.S. § 49-246.B & C.

Compliance Program

Description

Under the APP program, both civil and criminal penalties can be assessed to enforce permit conditions. The EQA added criminal penalties and expanded the civil penalties that can be prescribed for violation of groundwater quality regulations (A.R.S. § 36-3561). For example, a person who, with criminal negligence, discharges without obtaining an APP or violates an APP condition, is guilty of a felony under the EQA. In addition, the EQA empowers ADEQ to issue compliance orders, to obtain injunctive relief, and to recover litigation costs to enforce the APP.

Effectiveness

- A compliance data tracking database was established in 1990 for APP and other facilities.

- A compliance case priority system has been implemented.

- More than 200 site inspection and sampling audits of wastewater and APP facilities have been conducted yearly.

- From 1990-92, the period for which database information has been available, 99 enforcement cases have been closed, nine compliance orders have been issued, and 10 cases referred to the Office of the Attorney General for further legal action.

- From 1990-92, ADEQ has assessed $179,000 in penalties against non-complying wastewater and other facilities.

Ambient Monitoring Program

Description

Ambient monitoring provides information on quality of groundwater and movement of groundwater contaminants on a regional scale. Monitoring networks, consisting of water quality index wells, are being established within principal aquifers statewide to provide information on baseline groundwater quality conditions and water quality trends (or lack of trends). This long-term data acquisition supports ADEQ's groundwater protection programs and conforms with legislative mandates to monitor, assess, and report groundwater quality conditions statewide (A.R.S. §49-225). Ambient monitoring also provides vital background information for site-specific studies which are frequently initiated to delineate and remediate contaminated areas.

Effectiveness

- Established Groundwater Quality Monitoring Strategy.

- Forty water quality index wells within three basins are presently in the monitoring network. Expansion of the ambient monitoring network is currently limited by funding.

- Each index well is sampled annually for inorganics, metals, and volatile organic compounds.

- Sampling activities are coordinated with ADWR and other agencies.

- Four annual reports have been completed on the results of groundwater quality sampling as required by A.R.S. §49-225.D.

- Five water quality assessment reports have been completed as required by the federal Clean Water Act.

- ADEQ is participating in the national Interagency Task Force on Monitoring Water Quality (ITFM) along with the U. S. Geological Survey (USGS), U.S. EPA, and other federal and state agencies, which should lead to improving Arizona's groundwater monitoring program.

- Sampling procedures were established, documented, and updated in ADEQ's Quality Assurance Project Plan (approved yearly by EPA).

- Training was provided to ADEQ staff and others in sampling protocols and procedures.

Groundwater Quality Database

Description

As required by A.R.S. § 49-225 and necessary to meet the reporting requirements of A.R.S. § 49-249 and provisions of the Clean Water Act, the ADEQ Groundwater Hydrology Section has developed a groundwater quality database (GWQDB). This database is a basic resource for all ADEQ groundwater programs and was designed to store, retrieve, and evaluate large amounts of groundwater data, hydrogeologic site characteristics, and geographic information. The GWQDB is being implemented for online access by staff and the public from any location within the agency. The GWQDB will potentially store millions of analytical results and water well information collected from groundwater sampling conducted by ADEQ and regulated facilities, and ancillary monitoring by the U.S. Geological Survey, Arizona Department of Water Resources, Salt River Project, municipalities and other entities. The GWQDB will provide capabilities for data access, exchange, and manipulation.

A key component of data management activities at ADEQ is the Geographic Information System (GIS). The GIS analyzes and displays spatially referenced information. Once data from the GWQDB or other databases is linked to a geographic location, digitized, and stored within the GIS, the data can be combined and displayed with other natural and cultural information. This GIS, in combination with the GWQDB, will allow the Department to comprehensively analyze environmental data and coordinate protection, cleanup, and assessment activities among ADEQ programs.

Effectiveness

- Responded to 40 to 50 data requests each quarter.
- Established a comprehensive groundwater database containing data on 39,508 wells.
- Loaded groundwater quality data into the database from 23,662 samples totaling 179,899 separate test results.
- Produced a variety of maps from the GWQDB and GIS, including statewide arsenic contamination, ADWR registered wells, and Superfund site maps.
- Installed Sun 690 data processing system, enabling Department-wide access to GIS and environmental databases.
- Developed data sharing agreements with the U.S. Geological Survey, ADWR and other agencies.
- Developed electronic data submittal reporting requirements to simplify loading data into the GWQDB.
- Utilized Global Positioning System (GPS) equipment to provide accurate locations of wells and facilities to facilitate GIS use.

IV. BEST MANAGEMENT PRACTICES (BMPs) AND BADCT

Implementation of Best Management Practices is the key preventative element to water quality regulation under the EQA. The EQA defines Best Management Practices as:

...those methods, measures or practices to prevent or reduce discharges and include structural and nonstructural controls and operation and maintenance procedures. Best management practices may be applied before, during and after discharges to reduce or eliminate the introduction of pollutants into receiving waters. Economic, institutional and technical factors shall be considered in developing best management practices.

BMPs are used throughout ADEQ's regulatory programs as established standards of practice that will reduce or eliminate pollutant loads on surface waters and groundwater. While water quality standards may be a measure of performance used to judge the appropriateness of an application of BMPs, the effectiveness of BMPs may go beyond meeting numeric water quality standards. BMPs are used in general permits in which design standards and operating criteria are specified in rule. BMPs are used in approval programs such as ADEQ's certification of Corps of Engineers 404 Permits under Section 401 of the Clean Water Act. ADEQ also establishes BMPs for activities conducted on Federal or State Lands, requiring through the MOU the application of those BMPs during permitting or approval processes of agencies like the U.S. Forest Service or U.S. Bureau of Land Management. Such entities will include BMPs when approving operational plans submitted by lessees seeking approval of proposed activities like logging or grazing.

BADCT

Description

The APP program requires that each permitted facility utilize Best Available Demonstrated Control Technology, or BADCT, a subset of BMPs established by the EQA. BADCT, established on a site-specific and facility-specific basis, assures that any facility with potential to discharge to groundwater will be designed, constructed, and operated to ensure the greatest degree of pollutant reduction. Reducing pollutant levels to AWQSs alone may not satisfy BADCT requirements if cleaner discharges are possible. Where possible, a goal of no discharge should be set.

ADEQ has described what constitutes BADCT for discharging facilities in guidance documents, rather than in rule, in order to allow for incorporating new developments in design technologies. The BADCT documents were developed by ADEQ staff with input from an external technical advisory committee for each facility type. Each document outlines "state-of-the-art" design elements used by each facility type throughout the particular industry. Some adaptation has been made where specific technologies are not practicable or applicable within Arizona. ADEQ distributed the BADCT documents to the public and held public meetings to present the concepts and receive public comment. In ADEQ's APP permit review process, a proposed design for a facility is compared to the optimal design as specified in the BADCT guidance documents. Applicants must incorporate BADCT elements or demonstrate equivalent discharge-reduction performance. Treatment technology costs and water conservation measures are taken into account when BADCT is determined for a facility. For existing facilities, cost is weighed against gains in discharge reduction to determine the need to upgrade the design of the facility.

<u>Effectiveness</u>

- ADEQ has developed the following BADCT Guidance documents:

    1. Landfills: A no-discharge strategy was the basis for establishing an optimal BADCT configuration of double liner with leachate collection system, surface water diversion and storm-water collection, and a closure configuration of an impermeable cap with vegetated cover.

    2. Municipal Wastewater Treatment Plants: Numeric standards were set based on treatment levels that can usually be expected for a system utilizing secondary treatment followed by nitrogen removal, filtration, and disinfection. Pretreatment to control organic solvents is also specified.

    3. Mining: A flexible format for establishing optimal design for controlling mine discharges is provided because of varied conditions of site characteristics, facility size, ore composition, and cost factors common to the Arizona mining industry.

    4. Industrial Facilities: Guidance for these facility types relies heavily on wastewater treatment standards and technologies promulgated by EPA through the Clean Water Act. More specific BADCT guidance will be developed on a case-by-case basis.

- Since implementation of BADCT, ADEQ has noted significant improvement in facility design with regard to pollution control.

BMP Development

<u>Description of Agricultural BMPs</u>

Two aspects of agricultural activities in the State are specifically singled out in the EQA for general permit development and establishment of BMPs by rule:

1. Nitrogen Fertilizer Applications
2. Concentrated Animal Feeding Operations

Since 1987, ADEQ has worked with a technical advisory group appointed by the Governor for each of these two categories to develop rules identifying the BMPs and to review and approve BMP guidance documents. As with BADCT, general goals for agricultural practice are expressed in rule, while specific technologies for achieving these goals are identified in guidance documents. The guidance document for nitrogen fertilizer application was completed by the University of Arizona Cooperative Extension Service in 1991. A similar document for concentrated animal feeding operations has been completed in draft form and will be finalized by the University in May, 1993.

Description of Other Areas of BMP Development

As a part of the APP program, a general permit was established for individual wastewater systems with a capacity of less than 20,000 gallons per day. Along with development of the general permit rule, ADEQ rewrote, in 1989, Engineering Bulletin No. 12, Minimum Requirements for the Design and Installation of Septic Tank Systems and Alternative On-site Disposal Systems. This bulletin describes BMPs for facilities meeting general permit criteria.

Other BMP manuals being developed by ADEQ include:

1. Grazing Activities on Rangeland
2. Sand and Gravel Extraction
3. Stormwater and Urban Runoff

The manual for grazing activities is scheduled for completion in late 1993. BMPs for sand and gravel extraction are to be developed by a technical advisory group which was convened by ADEQ in 1992.

Effectiveness of BMPs as Groundwater Protection

In many instances the effectiveness of BMPs for groundwater protection has not been directly demonstrated in Arizona. In assembling BMPs (and BADCT) for an industry or facility type, ADEQ has utilized information and technologies that have been implemented elsewhere and shown to be effective. To this end, ADEQ has relied on industry data, EPA guidance, university research, and technical publications of case studies. Where improvements in water quality can be measured at the end of the pipe, such as at wastewater treatment plants implementing BADCT, a clear improvement in discharge can be seen that will be reflected in groundwater quality in years to come.

Until this year, the APP program focused efforts on permitting new facilities. While this program has prevented additional groundwater degradation, groundwater quality will not improve significantly until existing discharging facilities are brought into the permitting program and required to implement BADCT. Recent legislation requires that ADEQ process all existing facilities for APPs by the year 2001.

Many facilities where BMPs are implemented are nonpoint sources, where the groundwater quality impact is of a regional nature. In such areas it may be a long time before improvements are seen because of the long percolation period before cleaner discharges show up in the aquifer. Current ambient groundwater data actually reflects the impact of historical discharges and sets a baseline for future measurement of trends of improvement.

Three projects funded by EPA under Section 319(h) of the Clean Water Act and overseen by the Nonpoint Source Unit of ADEQs Water Assessment Section are directed at evaluating the effectiveness of BMPs for agriculture in Arizona. These projects are being conducted by the University of Arizona Cooperative Extension Service:

a. Validation and Refinement of Agricultural Best Management Practices - Maricopa, Arizona

b. Validation and Refinement of Agricultural Best Management Practices - Yuma & Safford, Arizona

c. Implementation of Best Management Practices Through Continuing Education

Data gathered during these projects will be used by ADEQ to adjust BMPs based on field evaluations. Also, ADEQ will obtain information regarding the acceptance and degree of implementation of BMPs at agricultural facilities, so that future outreach can be better directed.

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APPENDIX

Map of Groundwater Contamination in the Plateau Planning Region (Planning Region 1)

Map of Groundwater Contamination in the Upper Colorado River
Planning Region (Planning Region 2)

Map of Groundwater Contamination in the Prescott Active Management Area (Planning Region 3)

Map of Groundwater Contamination in the Central Highlands (Planning Region 4)

Map of Groundwater Contamination in the Phoenix Active Management Area (Planning Region 5)

Map of Groundwater Contamination in the Lower Colorado River
Planning Region (Planning Region 6)

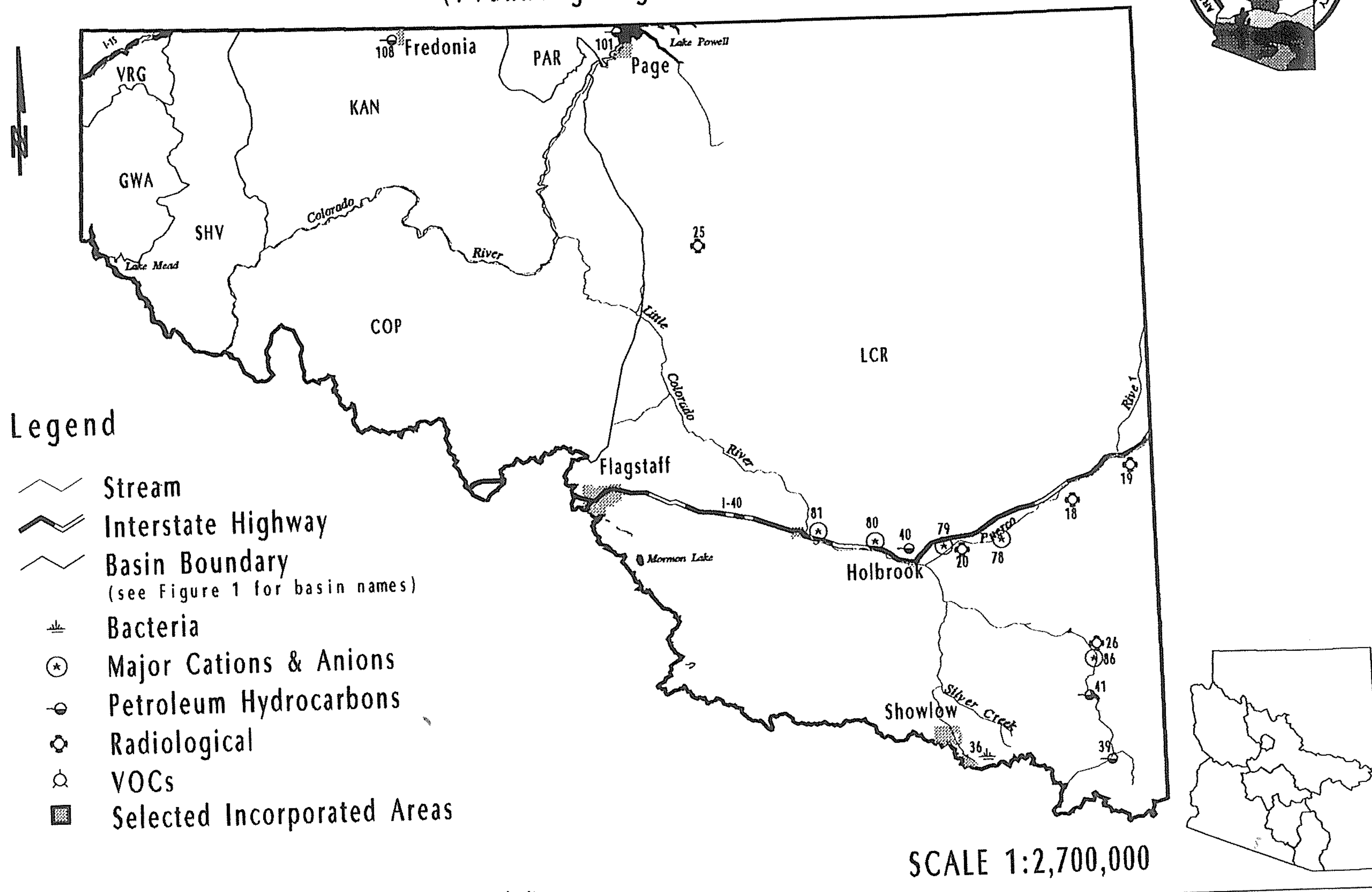
Map of Groundwater Contamination in the Pinal Active Management Area (Planning Region 7)

Map of Groundwater Contamination in the Tucson Active Management Area (Planning Region 8)

Map of Groundwater Contamination in the Southeast Arizona Planning Region (Planning Region 9)

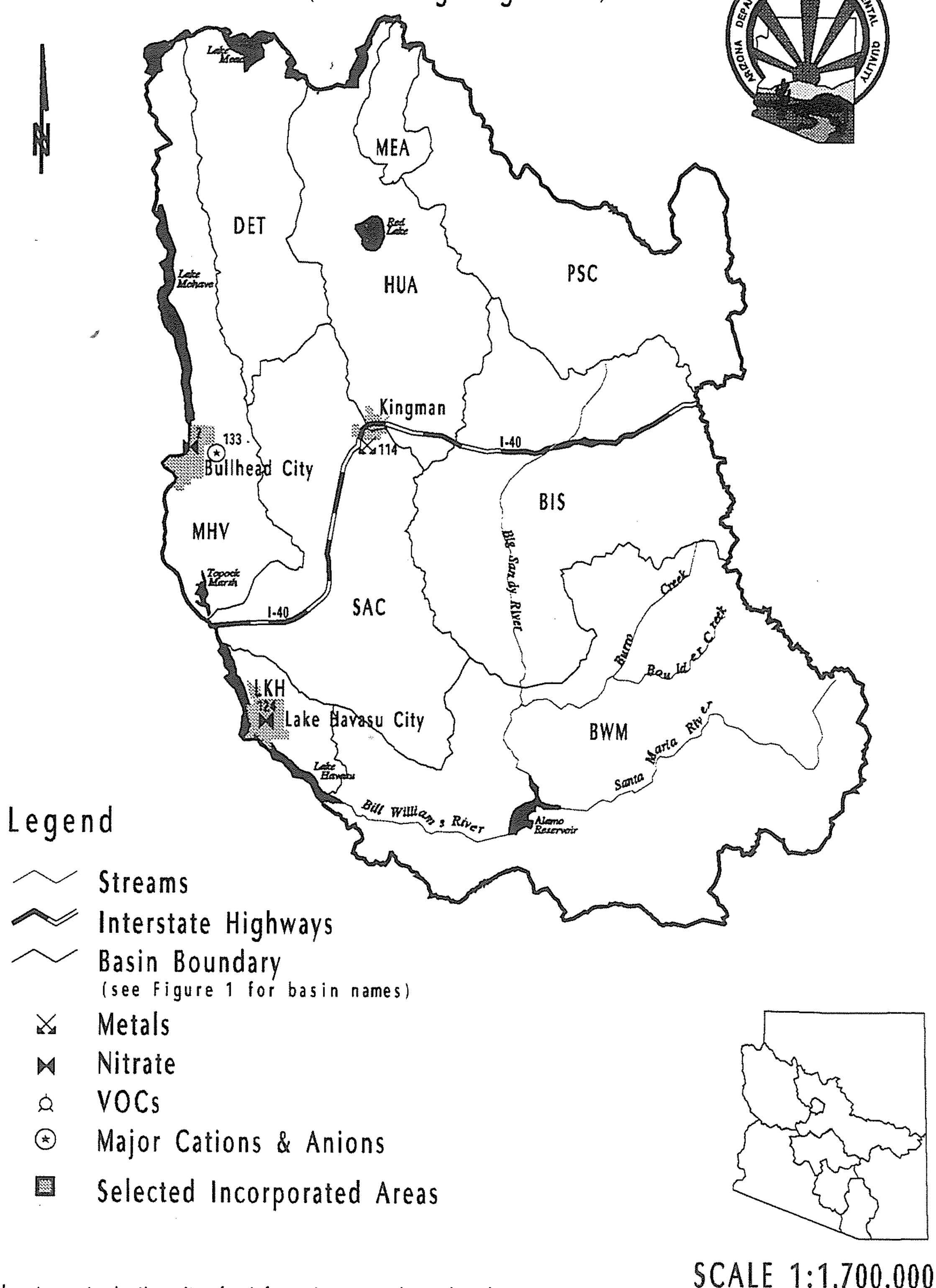
Key to Contamination Sites

Groundwater Contamination in the Plateau Planning Region
(Planning Region 1)



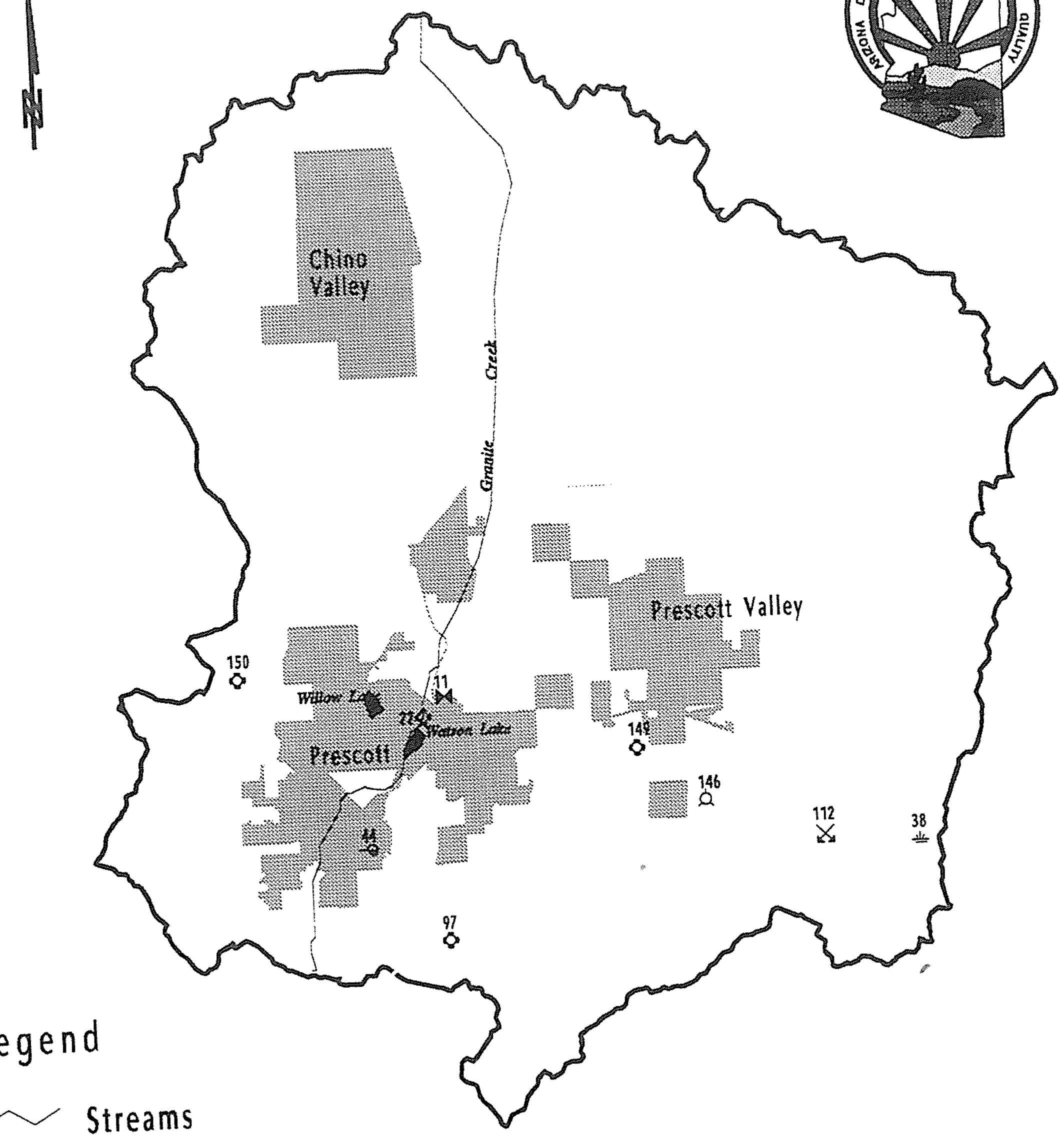
* See Key to contamination sites for information on each numbered site

Groundwater Contamination in the Upper Colorado River Planning Region
(Planning Region 2)



* See key to contamination sites for information on each numbered site

Groundwater Contamination in the Prescott Active Management Area
(Planning Region 3)

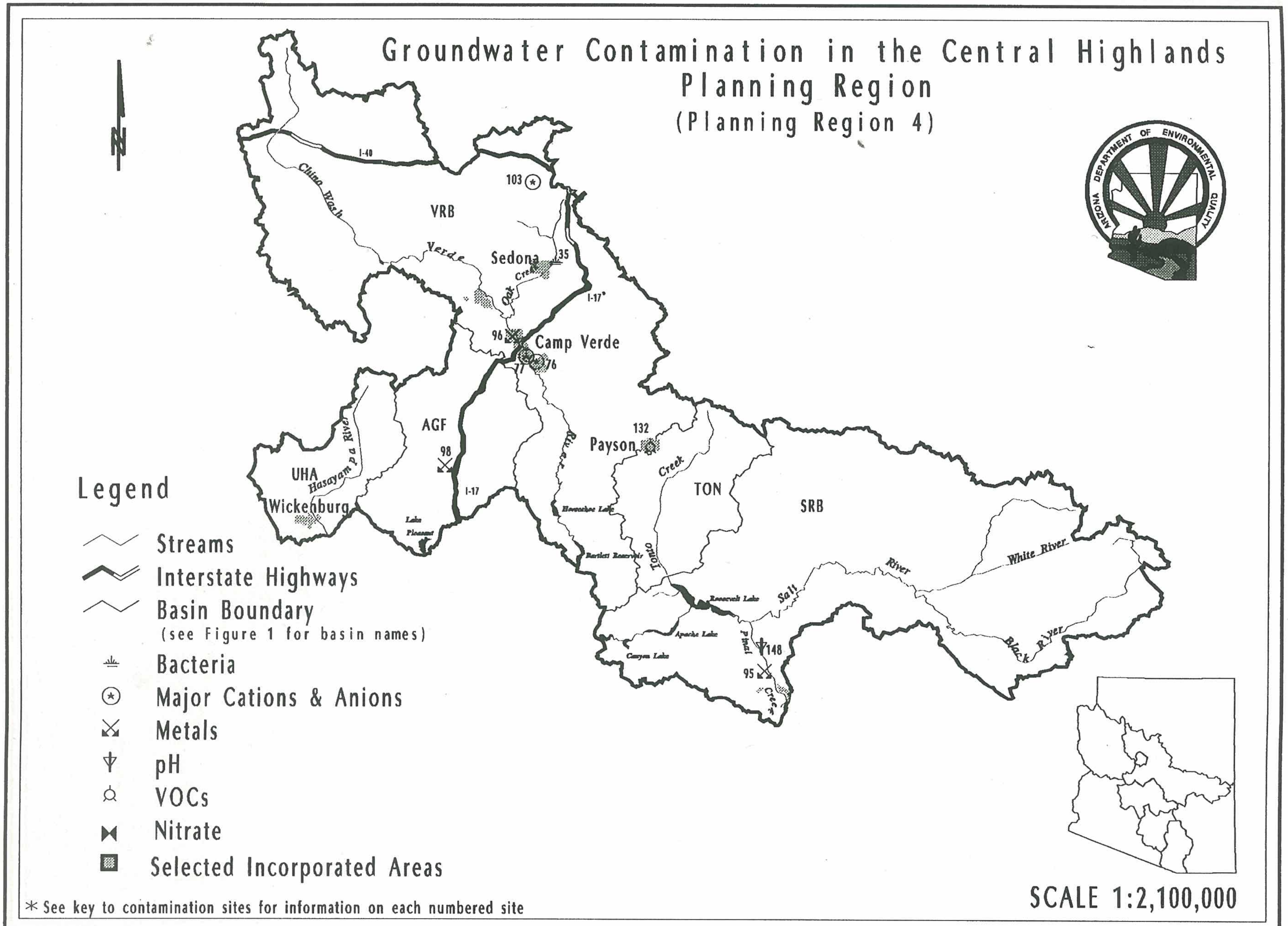


Legend

- Streams
- Bacteria
- Metals
- Nitrate
- Petroleum Hydrocarbons
- Radiological
- VOCs
- Selected Incorporated Areas

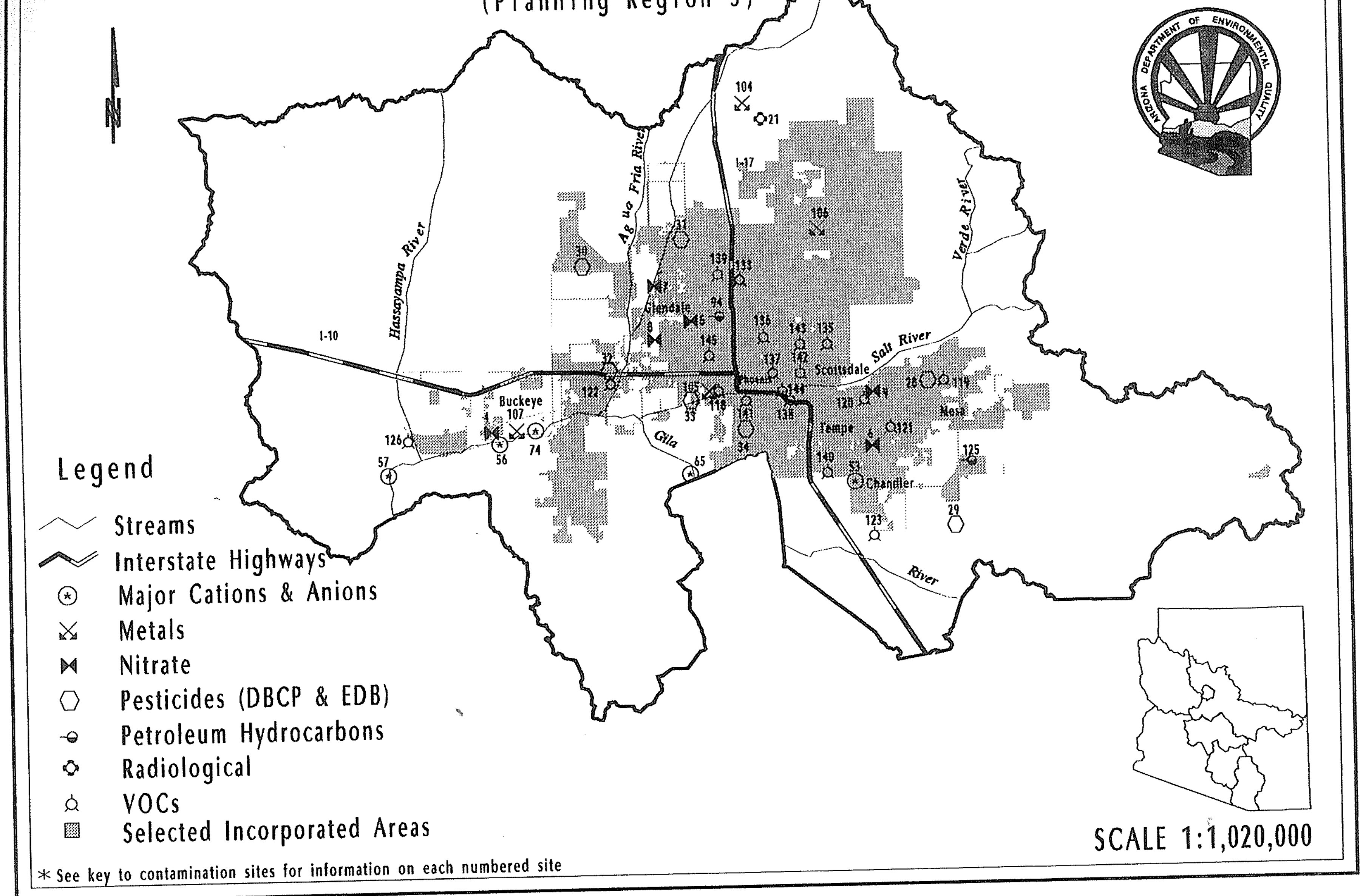
SCALE 1:325,000

* See key to contamination sites for information on each site

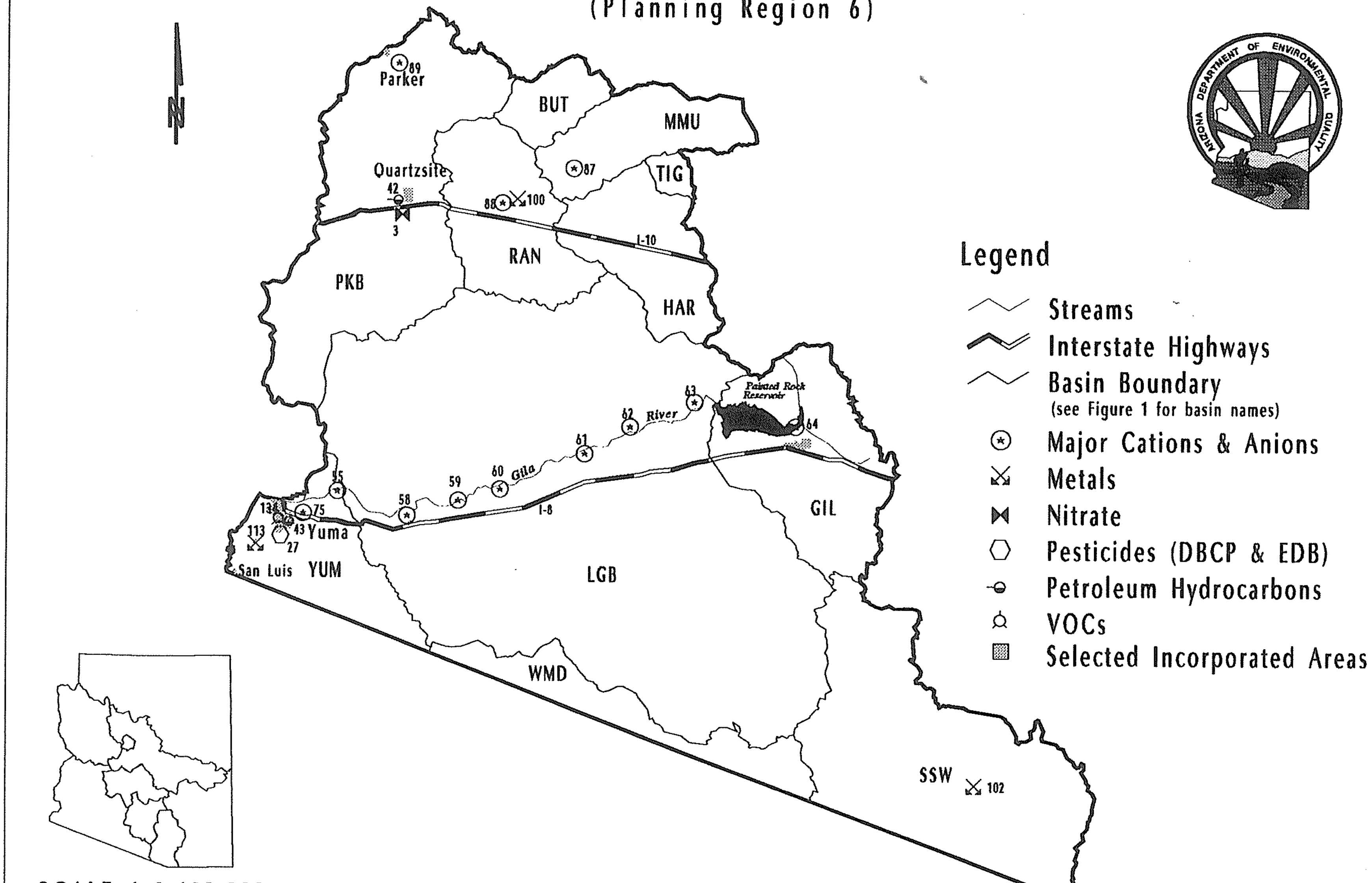

Groundwater Contamination in the Central Highlands
Planning Region
(Planning Region 4)
ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
N
I-40
Chino Wash
VRB
103
Verde
Sedona
Oak Creek
35
I-17
96
Camp Verde
77
76
AGF
98
I-17
UHA
Hassayampa River
Wickenburg
Lake Pleasant
Payson
132
Creek
TON
SRB
Horseshoe Lake
Bartlett Reservoir
Tonto
White River
River
Salt
Roosevelt Lake
Apache Lake
Canyon Lake
Pinal Creek
148
95
Black River
Legend
Streams
Interstate Highways
Basin Boundary
(see Figure 1 for basin names)
Bacteria
Major Cations & Anions
Metals
pH
VOCs
Nitrate
Selected Incorporated Areas
* See key to contamination sites for information on each numbered site
SCALE 1:2,100,000

Groundwater Contamination in the Phoenix Active Management Area

(Planning Region 5)



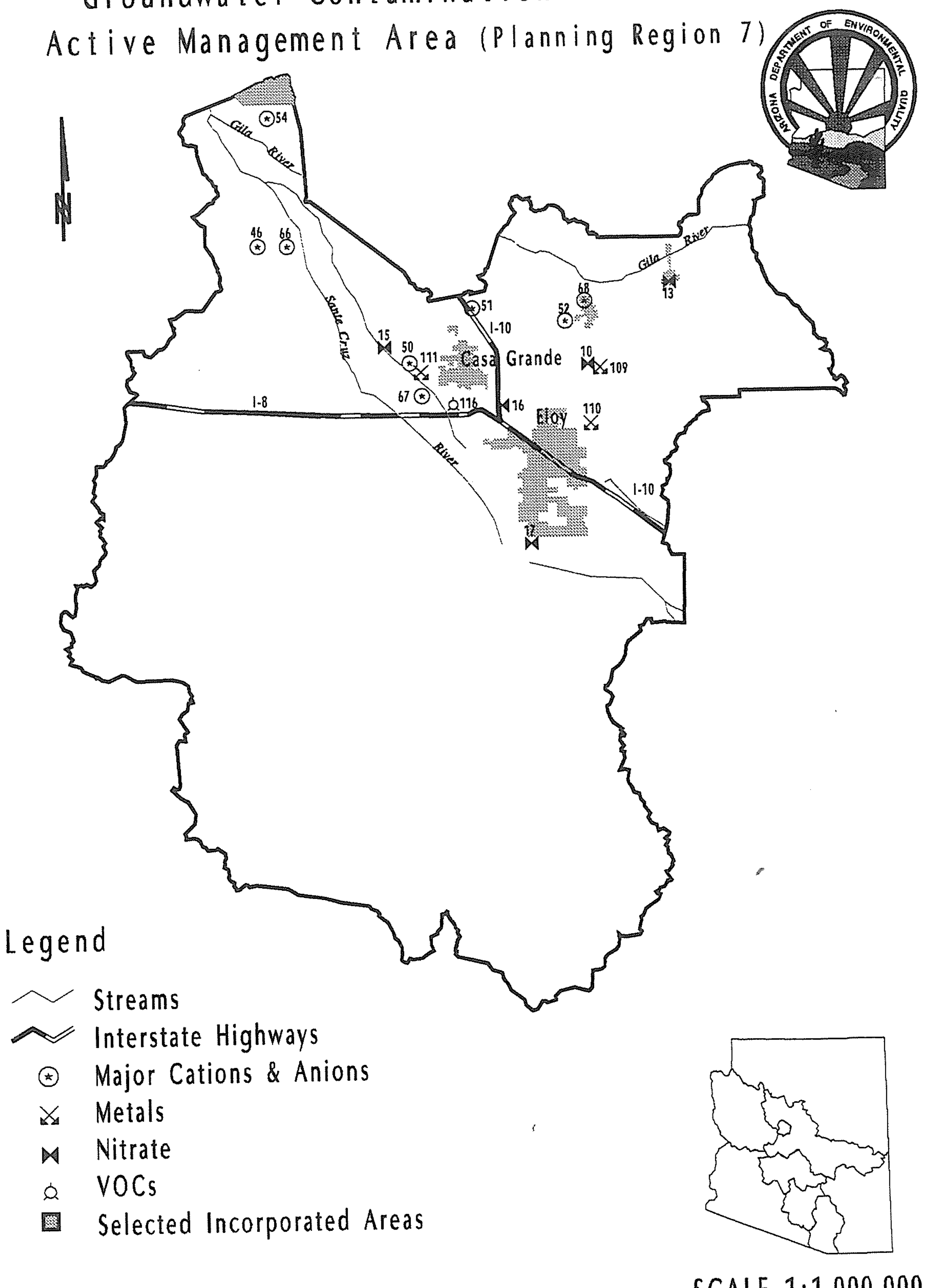
Groundwater Contamination in the Lower Colorado River Planning Region
(Planning Region 6)



SCALE 1:2,100,000

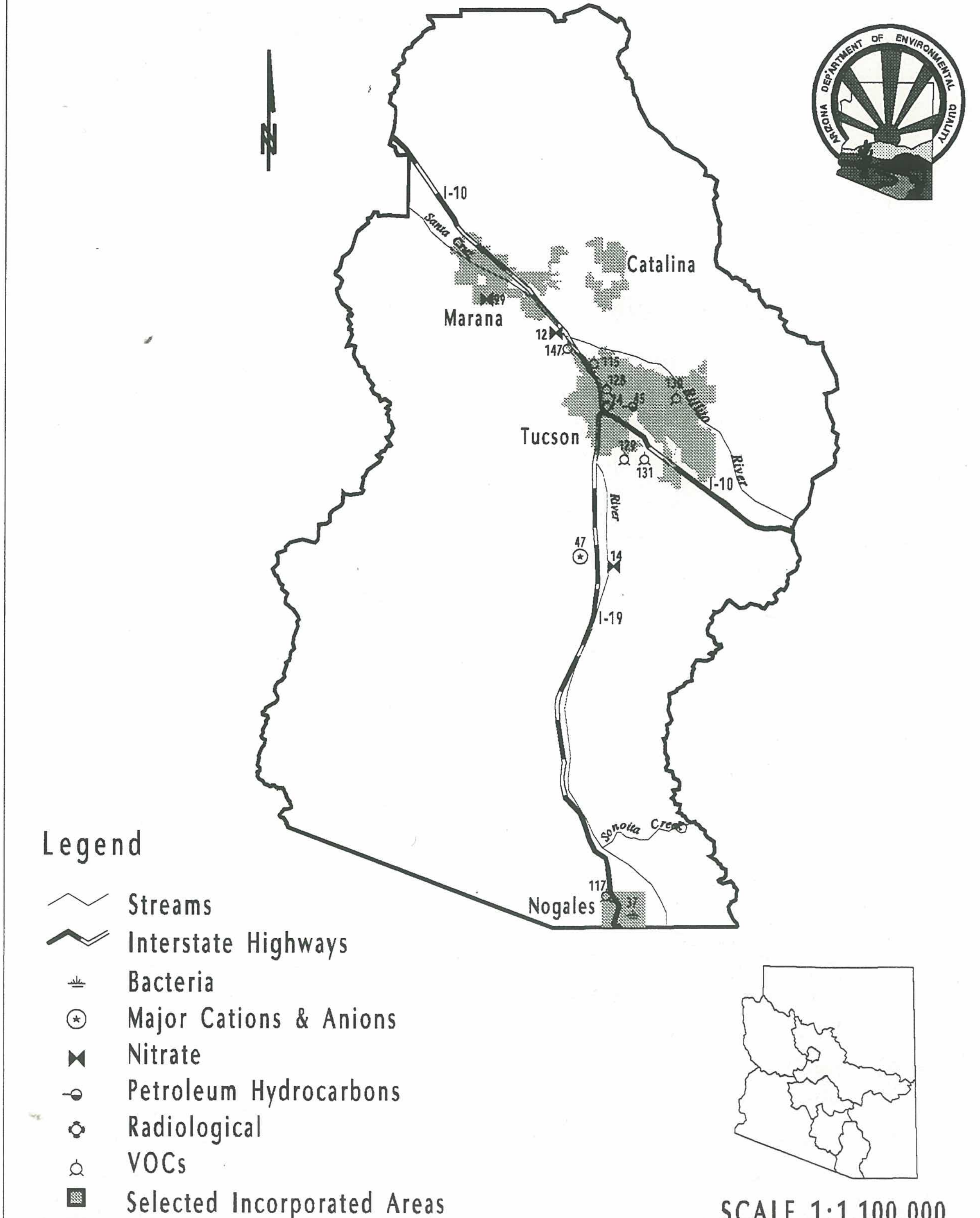
* See key to contamination sites for information on each numbered site

Groundwater Contamination in the Pinal Active Management Area (Planning Region 7)



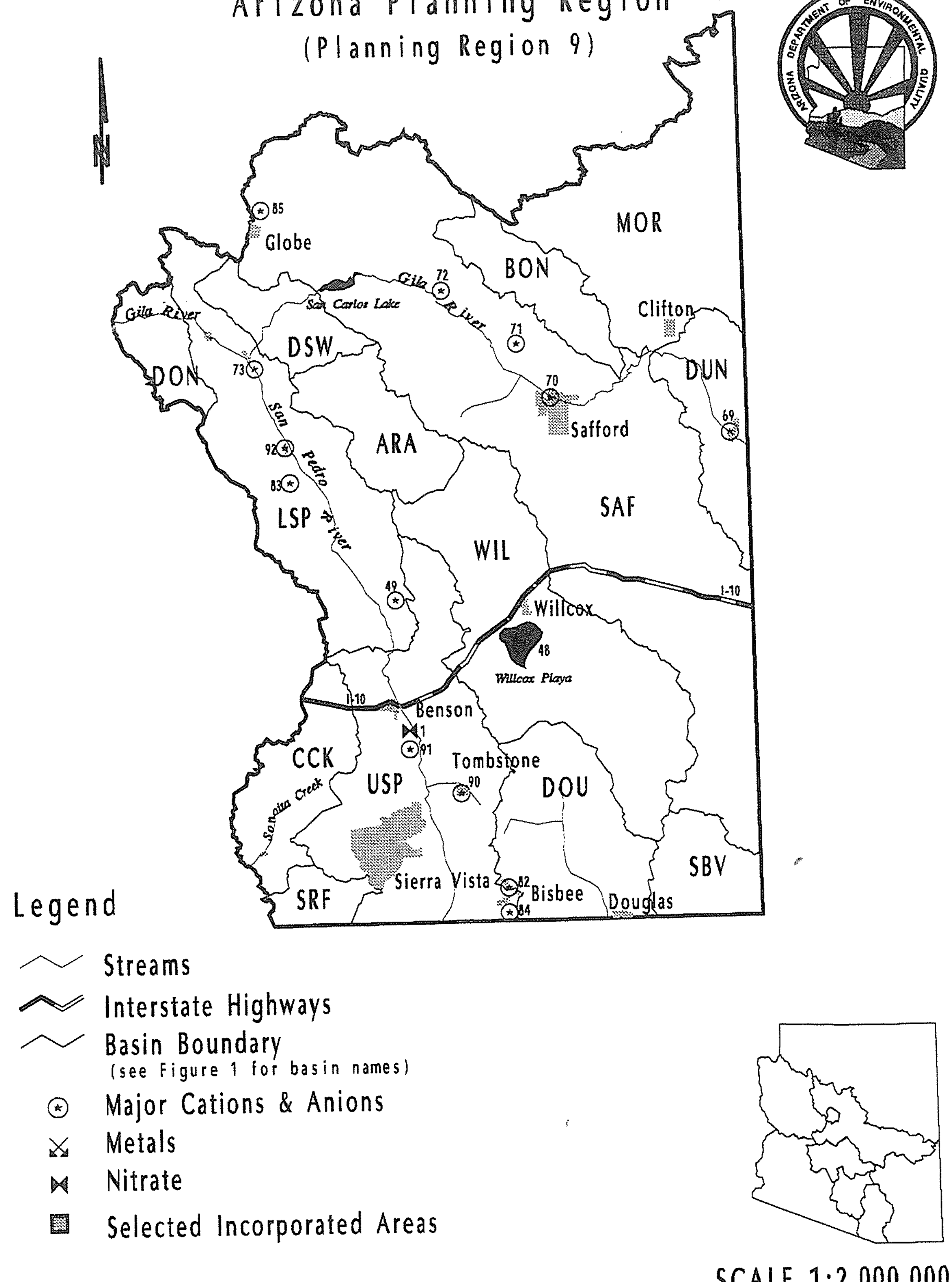
* See key to contamination sites for information on each numbered site

Groundwater Contamination in the Tucson Active Management Area (Planning Region 8)



* See key to contamination sites for information on each numbered site

Groundwater Contamination in the Southeast Arizona Planning Region
(Planning Region 9)



* See key to contamination sites for information on each numbered site

KEY TO CONTAMINATION SITES

MAP ID#	LOCATION	POLLUTANT GROUP	SELECTED POLLUTANT OF CONCERN	POLLUTANT CONCENTRATION	BENCHMARK FOR COMPARISON	BENCHMARK TYPE*	COMMENTS
1	ST. DAVID (APACHE POWDER CERCLA SITE)	Nutrients	Nitrate (as N)	650.0 mg/L	10 mg/L	MCL, AWQS	Discharge from explosives and fertilzer plant.
2	BULLHEAD CITY	Nutrients	Nitrate (as N)	15.9 mg/L	10 mg/L	MCL, AWQS	Discharging septic systems.
3	QUARTZSITE	Nutrients	Nitrate (as N)	57.0 mg/L	10 mg/L	MCL, AWQS	Discharging septic systems.
4	BUCKEYE	Nutrients	Nitrate (as N)	up to 29 mg/L	10 mg/L	MCL, AWQS	Most likely due to agriculture.
5	GLENDALE	Nutrients	Nitrate (as N)	up to 29 mg/L	10 mg/L	MCL, AWQS	Most likely due to agriculture.
6	CHANDLER/GILBERT	Nutrients	Nitrate (as N)	up to 30 mg/L	10 mg/L	MCL, AWQS	Most likely due to agriculture.
7	PEORIA	Nutrients	Nitrate (as N)	up to 18 mg/L	10 mg/L	MCL, AWQS	Most likely due to agriculture.
8	WEST PHOENIX	Nutrients	Nitrate (as N)	up to 30 mg/L	10 mg/L	MCL, AWQS	Most likely due to agriculture.
9	MESA	Nutrients	Nitrate (as N)	up to 16 mg/L	10 mg/L	MCL, AWQS	Most likely due to agriculture.
10	LA PALMA	Nutrients	Nitrate (as N)	up to 90 mg/L	10 mg/L	MCL, AWQS	Most likely due to agriculture.
11	WATSON LAKE	Nutrients	Nitrate (as N)	11.8 mg/L	10 mg/L	MCL, AWQS	Discharge from municipal sewage treatment plant.
12	SANTA CRUZ RIVER	Nutrients	Nitrate (as N)	greater than 10 mg/L	10 mg/L	MCL, AWQS	Discharge from municipal sewage treatment plant. Exceeds MCL over a large area.
13	FLORENCE	Nutrients	Nitrate (as N)	10 to 90 mg/L	10 mg/L	MCL, AWQS	Most likely due to agriculture.
14	GREEN VALLEY	Nutrients	Nitrate (as N)	greater than 1 mg/L	10 mg/L	MCL, AWQS	Most likely due to agriculture.
15	CASA GRANDE	Nutrients	Nitrate (as N)	up to 28 mg/L	10 mg/L	MCL, AWQS	Most likely due to agriculture.
16	ARIZOLA	Nutrients	Nitrate (as N)	up to 28 mg/L	10 mg/L	MCL, AWQS	Most likely due to agriculture.
17	FRIENDLY CORNERS	Nutrients	Nitrate (as N)	up to 28 mg/L	10 mg/L	MCL, AWQS	Most likely due to agriculture.
18	RIO PUERCO	Radiological	Radium-226 Radium-228	not in excess of 5 pCi/L	5 pCi/L	MCL, AWQS	Wells exhibit radium-226 and radium-228. Concentrations in excess of 5pCi/L in 1 of 14 wells.
20	RIO PUERCO	Radiological	Gross alpha activity	304 pCi/L	15 pCi/L	MCL, AWQS	Wells adjacent to river exhibit gross alpha up to 304 pCi/L. Radon from 500 to 1000 pCi/L in 25 wells.

* Federal/State primary drinking water quality standards (MCLs) are adopted as Aquifer Water Quality Standards (AWQS)
Health-Based Guidance Level (HBGL) developed for drinking water based on health risks due to ingestion
Federal/State secondary drinking water quality standards (SMCL) affect aesthetic factors only

KEY TO CONTAMINATION SITES (continued)

MAP ID #	LOCATION	POLLUTANT GROUP	SELECTED POLLUTANT OF CONCERN	POLLUTANT CONCENTRATION	BENCHMARK FOR COMPARISON	BENCHMARK TYPE *	COMMENTS
21	NEW RIVER/CAVE CREEK	Radiological	Radon	260 to 5800 pCi/L	300 pCi/L	MCL under Federal consideration	Radon from 260 to 5,800 pCi/L in 27 wells.
22	GRANITE DELLS	Radiological	Gross alpha activity	up to 83 pCi/L	15 pCi/L	MCL, AWQS	Due to uranium-rich granite, many wells show elevated gross alpha levels.
24	SOUTH TUCSON	Radiological	Radon	200 to 1800 pCi/L	300 pCi/L	MCL under Federal consideration	Radon of 200 to 1800 pCi/L in 87 wells due to uranium-rich limestone.
25	TUBA CITY	Radiological	Gross alpha activity	860 pCi/L	15 pCi/L	MCL, AWQS	Leachate from uranium tailings pile has contaminated underlying aquifer.
26	ST. JOHNS	Radiological	Gross alpha activity	61 pCi/L	15 pCi/L	MCL, AWQS	Four subdivision supply wells contain radium concentration up to 20 pCi/L and gross alpha up to 61 pCi/L.
27	YUMA	Pesticides	DBCP	137.0 ug/L	0.20 ug/L	MCL, AWQS	DBCP and EDB found in 69 wells. DBCP and EDB concentrations up to 137 ug/L and up to 0.019 ug/L respectively.
28	MESA FALCON FIELD AREA (WQARF SITE)	Pesticides	DBCP	4.74 ug/L	0.20 ug/L	MCL, AWQS	DBCP up to 4.74 ug/L. Treatment plan under construction.
29	CHANDLER HEIGHTS	Pesticides	DBCP	1.5 ug/L	0.20 ug/L	MCL, AWQS	Several wells contaminated.
30	EL MIRAGE	Pesticides	DBCP	0.031 ug/L	0.20 ug/L	MCL, AWQS	Several wells contaminated.
31	DEER VALLEY	Pesticides	DBCP EDB	0.8 ug/L 8.0 ug/L	0.20 ug/L 0.05 ug/L	MCL, AWQS	Several wells contaminated.
32	GOODYEAR/LITCHFIELD PARK	Pesticides	DBCP	0.4 ug/L	0.20 ug/L	MCL, AWQS	Several wells contaminated.
33	PHOENIX	Pesticides	EDB	10.0 ug/L	0.05 ug/L	MCL, AWQS	Several wells contaminated.
34	SOUTH PHOENIX	Pesticides	DBCP	up to 4.5 ug/L	0.20 ug/L	MCL, AWQS	Several wells contaminated.
35	SEDONA	Bacteria	Fecal coliform	10 cfu	1 cfu/100 ml	MCL, AWQS	Discharge from septic systems.
36	PINETOP/LAKESIDE	Bacteria	Total Coliform	50 cfu	1 cfu/100 ml	MCL, AWQS	Discharge from septic systems.
37	NOGALES WASH (WQARF SITE)	Bacteria	Total Coliform	4 to 20 cfu	1 cfu/100 ml	MCL, AWQS	Contaminatin detected in only a limited number of wells

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KEY TO CONTAMINATION SITES (continued)

MAP ID #	LOCATION	POLLUTANT GROUP	SELECTED POLLUTANT OF CONCERN	POLLUTANT CONCENTRATION	BENCHMARK FOR COMPARISON	BENCHMARK TYPE *	COMMENTS
38	DEWEY	Bracteria	Total coliform	greater than one cfu	1 cfu/100 ml	MCL, AWQS	Discharge from septic systems. Total coliform detected in 10 of 18 wells sampled.
39	EAGER	Petroleum hydrocarbons	Benzene	5.05 mg/L	0.005 mg/L	MCL, AWQS	UST loss of approximately 25,000 gallons of gasoline and diesel fuel within last two years.
40	HOLBROOK	Petroleum hydrocarbons	Benzene	1.3 mg/L	0.005 mg/L	MCL, AWQS	UST leask has resulted in free product (gasoline) on water table.
41	LYMAN LAKE	Petroleum hydrocarbons	Benzene	Free product on water table	0.005 mg/L	MCL, AWQS	Lyman Lake State Park supply well closed due to gasoline contamination.
42	QUARTZSITE	Petroleum hydrocarbons	Benzene	0.12 mg/L	0.005 mg/L	MCL, AWQS	LUST at ADOT facility has affected public supply well. Another LUST affects at least 3 wells.
43	YUMA MARINE CORPS AIR STATION	Petroleum hydrocarbons	Benzene	8.2 mg/L	0.005 mg/L	MCL, AWQS	140,000 gal of jet fuel lost from 1982 pipeline spill has ponded as free product. Also, 150,000 gallon diesel fuel spill in 1980.
44	PRESCOTT	Petroleum hydrocarbons	Benzene	1.9 mg/L	0.005 mg/L	MCL, AWQS	Three LUST's within city limits.
45	TUCSON	Petroleum hydrocarbons	Benzene	32.0 mg/L	0.005 mg/L	MCL, AWQS	Up to 3 feet of free diesel product on perched water table in vicinity of railroad yard.
46	MARICOPA	Major cations and anions	Total dissolved solids	over 10,000 mg/L	500 mg/L	SMCL	
47	GREEN VALLEY	Major cations and anions	Sulfate	over 1200 mg/L	250 mg/L	SMCL	Elevated sulfate levels due to mine activities.
48	WILLCOX PLAYA	Major cations and anions	Total dissolved solids	over 10, 000 mg/L	500 mg/L	SMCL	
49	EAST OF CASCABEL	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 10,000 mg/l.
50	CASA GRANDE	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 5,000 mg/l.

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KEY TO CONTAMINATION SITES (continued)

MAP ID #	LOCATION	POLLUTANT GROUP	SELECTED POLLUTANT OF CONCERN	POLLUTANT CONCENTRATION	BENCHMARK FOR COMPARISON	BENCHMARK TYPE*	COMMENTS
51	NORTH OF CASA GRANDE	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 10,000 mg/L.
52	COOLIDGE	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 10,000 mg/L.
53	CHANDLER	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 10,000 mg/L.
54	EAST OF KOMATKE	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 10,000 mg/L.
55	KINTER	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 5,000 mg/L.
56	ALLENVILLE (Gila River)	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 10,000 mg/L.
57	ARLINGTON (Gila River)	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 10,000 mg/L.
58	WELLTON (Gila River)	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 10,000 mg/L.
59	TACNA (Gila River)	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 10,000 mg/L.
60	GROWLER (Gila River)	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 5,000 mg/L.
61	GILA RIVER	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 5,000 mg/L.
62	AGUA CALIENTE (Gila River)	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 5,000 mg/L.
63	PAINTED ROCK DAM (Gila River)	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 10,000 mg/L.
64	GILA BEND (Gila River)	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 10,000 mg/L.
65	KOMATKE	Major cations and anions	Sulfate	up to 500 mg/L	250 mg/L	SMCL	Elevated sulfate, especially to the east of Komatke.
66	MARICOPA	Major cations and anions	Sulfate	up to 500 mg/L	250 mg/L	SMCL	Elevated sulfate in scattered areas around Maricopa.

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KEY TO CONTAMINATION SITES (continued)

MAP ID #	LOCATION	POLLUTANT GROUP	SELECTED POLLUTANT OF CONCERN	POLLUTANT CONCENTRATION	BENCHMARK FOR COMPARISON	BENCHMARK TYPE *	COMMENTS
67	STANFIELD	Major cations and anions	Sulfate	up to 800 mg/L	250 mg/L	SMCL	Elevated sulfate levels.
68	COOLIDGE	Major cations and anions	Sulfate	up to 800 mg/L	250 mg/L	SMCL	Elevated sulfate in scattered areas around Coolidge.
69	DUNCAN (Gila River)	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 10,000 mg/l.
70	SAFFORD (Gila River)	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 10,000 mg/l.
71	PIMA (Gila River)	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 10,000 mg/l.
72	BYLAS (Gila River)	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 10,000 mg/l.
73	WINKELMAN	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 10,000 mg/l.
74	LIBERTY (Gila River)	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 5,000 mg/l.
75	SOUTH GILA VALLEY	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 5,000 mg/l.
76	WEST CLEAR CREEK	Major cations and anions	Total dissolved solids	over 10,000 mg/L	500 mg/L	SMCL	TDS over 10,000 mg/l.
77	CAMP VERDE	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 10,000 mg/l.
78	ADAMANA	Major cations and anions	Total dissolved solids	over 10,000 mg/L	500 mg/L	SMCL	TDS over 10,000 mg/l.
79	SUN VALLEY	Major cations and anions	Total dissolved solids	over 10,000 mg/L	500 mg/L	SMCL	TDS over 10,000 mg/l.
80	JOSEPH CITY	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3,000 - 5,000 mg/l.
81	HIBBARD	Major cations and anions	Total dissolved solids	over 3,000 mg/L	500 mg/L	SMCL	TDS 3.,000 - 5,000 mg/l.
82	BISBEE/WARREN	Major cations and anions	Sulfate	over 650 mg/L	250 mg/L	SMCL	Elevated sulfate due to leachate from mine tailings.

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KEY TO CONTAMINATION SITES (continued)

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83	SAN MANUEL	Major cations and anions	Sulfate	up to 1500 mg/L	250 mg/L	SMCL	Elevated sulfate due to leachate from mine tailings.
84	NORTHEAST OF NACO	Major cations and anions	Sulfate	over 650 mg/L	250 mg/L	SMCL	Elevated sulfate due to leachate from mine tailings.
85	GLOBE/MIAMI	Major cations and anions	Sulfate	up to 4600 mg/L	250 mg/L	SMCL	Elevated sulfate due to leachate from mine tailings.
86	ST.JOHN's	Major cations and anions	Fluoride	over 2.4 mg/L	4.0 mg/L 2.0 mg/L	MCL, AWQS SMCL	Naturally occurring.
87	WENDON/SALOME	Major cations and anions	Fluoride	7.6 mg/L	4.0 mg/L	MCL, AWQS	Naturally occurring.
88	RANEGRAS BASIN	Major cations and anions	Fluoride	21.0 mg/L	4.0 mg/L	MCL, AWQS	37 out of 48 wells exceed water quality standards. Naturally occurring.
89	PARKER	Major cations and anions	Fluoride	5.2 mg/L	4.0 mg/L	MCL, AWQS	Naturally occurring.
90	TOMBSTONE	Major cations and anions	Cyanide	94 mg/L	0.15 mg/L	HBGL	Cyanide contamination in one monitoring well.
91	ST. DAVID	Major cations and anions	Fluoride	6.4 mg/L	4.0 mg/L	MCL, AWQS	Naturally occurring.
92	MAMMOTH	Major cations and anions	Fluoride	over 30 mg/L	4.0 mg/L	MCL, AWQS	Naturally occurring.
94	PHOENIX	Petroleum Hydrocarbons	Benzene	up to 2.2 mg/L	.005 mg/L	MCL, AWQS	LUST at City of Phoenix refueling facility; 500,000 gallon leak. Free product pool on water table is 1500 ft. long.
95	PINAL CREEK (WQARF SITE)	Metals	Lead Flroride Cadmium	10 - 65 ug/L .07 - 39 mg/L 5 - 384 mg/L	50 ug/L 4.0 mg/L 5.0 mg/L	MCL, AWQS MCL, AWQS MCL, AWQS	MCLs for lead, flouride and cadmium exceeded as well as SMCLs for iron, manganese, and copper due to acid mine drainage.
96	VERDE VALLEY	Metals	Arsenic	1 - 240 mg/L	0.05 mg/L	MCL, AWQS	Over 30% of wells sampled exceeded MCL of 0.05 mg/L. Naturally occurring.
97	PRESCOTT	Radiological	Radon	2,120 pCi/L	300 pCi/L	MCL under Federal consideration	Naturally occurring.

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KEY TO CONTAMINATION SITES (continued)

MAP ID #	LOCATION	POLLUTANT GROUP	SELECTED POLLUTANT OF CONCERN	POLLUTANT CONCENTRATION	BENCHMARK FOR COMPARISON	BENCHMARK TYPE*	COMMENTS
98	BLACK CANYON CITY	Metals	Arsenic	0.076 mg/L	0.05 mg/L	MCL, AWQS	Naturally occurring.
99	MARANA	Nutrients	Nitrate (as N)	up to 41 mg/L	10 mg/L	MCL, AWQS	Most likely due to agriculture and infiltration of sewage plant effluent.
100	RANEGRAS BASIN	Metals	Chromium	3.0 mg/L	0.1 mg/L	MCL, AWQS	Thirteen wells exceeded MCL for chromium. Naturally occurring.
101	LAKE POWELL	Petroleum Hydrocarbons	Benzene	up to 0.23 mg/L	.005 mg/L	MCL, AWQS	Heavy soils and fuel also in groundwater.
102	SAN SIMON WASH, TOHONO O'ODHAM RESERVATION	Major cations and anions	Arsenic	0.2 mg/L	0.05 mg/L	MCL, AWQS	Naturally occurring.
103	NAVAJO ARMY DEPOT	Metals	Sulfate	628 mg/L	250 mg/L	SMCL	Apparent increased sulfate and nitrate levels; extent of groundwater contamination unknown.
104	NEW RIVER/CAVE CREEK	Metals	Arsenic	0.05 - 0.20 mg/L	0.05 mg/L	MCL, AWQS	MCL for arsenic exceeded in 4 wells. Naturally occurring.
105	PHOENIX (19th AVE. LANDFILL CERCLA SITE)	Metals	Barium	2.8 mg/L	2.0 mg/L	MCL, AWQS	MCL for barium and SMCL for iron and manganese exceeded.
106	PARADISE VALLEY	Metals	Chromium	greater than 0.05 mg/L	0.1 mg/L	MCL, AWQS	Naturally occurring.
107	BUCKEYE	Metals	Boron	greater than 2 mg/L	0.63 mg/L	HBGL	Elevated levels of boron in areas around Buckeye.
108	FREDONIA	Pretroleum Hydrocarbons	Benzene	up to 16 mg/L	.005 mg/L	MCL, AWQS	Benzene in groundwater due to oil refining and asphalt manufacturing.
109	RANDOLPH	Metals	Selenium	over 0.01 mg/L	0.05 mg/L	MCL, AWQS	Levels of selenium elevated above background.
110	NORTH OF ELOY	Metals	Selenium	over 0.01 mg/L	0.05 mg/L	MCL, AWQS	Levels of selenium elevated above background.
111	STANFIELD/CASA GRANDE	Metals	Arsenic	over 0.05 mg/L	0.05 mg/L	MCL, AWQS	
112	DEWEY	Metals	Arsenic	0.065 mg/L	0.05 mg/L	MCL, AWQS	One well exceeded MCL.
113	SOMERTON	Metals	Iron	1.85 mg/L	0.3 mg/L	SMCL	SMCLs for iron and manganese exceeded due to landfill.

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KEY TO CONTAMINATION SITES (continued)

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114	KINGMAN	Metals	Chromium	0.06 - 0.14 mg/L	0.1 mg/L	MCL, AWQS	Naturally occurring.
115	TUCSON (MIRACLE MILE WQARF SITE)	VOCs	PCE	170 ug/L	5.0 ug/L	MCL, AWQS	TCE; PCE; Freon 12; Freon 11; and 1,1-DCE in groundwater from industry and landfills.
116	CASA GRANDE	VOCs	TCE	up to 11.0 ug/L	5.0 ug/L	MCL, AWQS	TCE in groundwater from landfill.
117	NOGALES (WQARF SITE)	VOCs	TCE 1,1,1-TCA	up to 410 ug/L up to 9800 ug/L	5.0 ug/L 200.0 ug/L	MCL, AWQS MCL, AWQS	TCE; 1,1,1-TCA; 1,1-DCE; and 1,2-DCA in groundwater from industrial facility.
118	PHOENIX (WEST VAN BUREN WQARF SITE)	VOCs	PCE TCE	5.0 - 800 ug/L 5.0 - 800 ug/L	5.0 ug/L 5.0 ug/L	MCL, AWQS MCL, AWQS	TCE; PCE; 1,1-DCE and 1,1,1-TCA in groundwater.
119	MESA (MOTOROLA MESA FORMER CERCLA SITE)	VOCs	PCE	up to 110 ug/L	5.0 ug/L	MCL, AWQS	TCE; PCE; and 1,1,1-DCE in groundwater.
120	MESA (NORTHEAST MESA WQARD SITE)	VOCs	TCE	70 ug/L	5.0 ug/L	MCL, AWQS	TCE, PCE, and 1,1-DCE in groundwater.
121	MESA (SOUTH MESA WQARF SITE)	VOCs	PCE	87 - 180 ug/L	5.0 ug/L	MCL, AWQS	TCE, PCE, and 1,1-DCE in groundwater.
122	GOODYEAR (PHOENIX-GOODYEAR AIRPORT CERCLA SITE)	VOCs	TCE	up to 180,000 ug/L	5.0 ug/L	MCL, AWQS	TCE and PCE in groundwater due to aerospace industry discharges.
123	CHANDLER	VOCs	PCE	up to 23.6 ug/L	5.0 ug/L	MCL, AWQS	PCE in groundwater.
124	LAKE HAVASU CITY	Nutrients	Nitrate (as N)	up to 15 mg/L	10 mg/L	MCL, AWQS	Most likely due to septage.
125	WILLIAMS AIR FORCE BASE (CERCLA SITE)	Petroleum hydrocarbons	Benezene	up to 24.0 mg/L	0.005 mg/L	MCL, AWQS	Several hundred thousand gallons of SP-4 jet fuel floating as free product on the water table.cleaning facility.
126	HASSAYAMPA LANDFILL (CERCLA SITE)	VOCs	1,1-DCE	10 to 400 ug/L	7.0 ug/L	MCL, AWQS	1,1-DCE; 1,1-DCA; 1,1,1-TCA; TCE; PCE; Freon 11 and Freon 113 in groundwater from landfill.
128	TUCSON	VOCs	PCE	6100 ug/L	5.0 ug/L	MCL, AWQS	TCE; PCE; 1,2-DCA; 1,1-DCE; and benzene in groundwater; dry cleaning facility.

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KEY TO CONTAMINATION SITES (continued)

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129	TUCSON (TUCSON AIRPORT AREA CERCLA SITE)	VOCs	TCE	11600 ug/L	5.0 ug/L	MCL, AWQS	TCE; TCA; and 1,1-DCE in groundwater due to aerospace industries. TCE up to 130,000 ug/L has been found in perched aquifer.
130	TUCSON (BROADWAY LANDFILL WQARF SITE)	VOCs	PCE	38 ug/L	5.0 ug/L	MCL, AWQS	TCE and PCE in groundwater from landfill.
131	TUCSON (LOS REALES LANDFILL WQARF SITE)	VOCs	PCE	14 ug/L	5.0 ug/L	MCL, AWQS	PCE; TCE; trichlorofluoromethane; dichlorofluoromethane; chloroethane; 1,1-DCE; methylene chloride; and 1,1-DCA in groundwater from landfill.
132	PAYSON (WQARF SITE)	VOCs	PCE	542-13600 ug/L	5.0 ug/L	MCL, AWQS	VOCs in groundwater due to dry cleaning disposal.
133	BULLHEAD CITY	Major cations and anions	Cyanide	2.2 mg/L	0.15 mg/L	HBGL	Cyanide in groundwater due to mine heap leaching.
134	YUMA MARINE CORPS AIR STATION (CERCLA SITE)	VOCs	TCE	3.0 ug/L	5.0 ug/L	MCL, AWQS	1,1-DCE; 1,1-DCA; and chloroform in groundwater.
135	SCOTTSDALE (INDIAN BEND WASH CERCLA SITE)	VOCs	TCE	up to 16,000 ug/L	5.0 ug/L	MCL, AWQS	TCE; PCE; DCE; TCA; and DCA in groundwater due electronics and metal plating industries.
136	PHOENIX (EAST CENTRAL WQARF SITE)	VOCs	PCE	up to 100 ug/L	5.0 ug/L	MCL, AWQS	TCE; 1,2-DCA; and PCE in groundwater; multiple dry-cleaning releases.
137	PHOENIX (EAST WASHINGTON WQARF SITE)	VOCs	TCE PCE	up to 670 ug/L up to 100 ug/L	5.0 ug/L 5.0 ug/L	MCL, AWQS	TCE; PCE; 1,1-DCE; 1,1,2-TCA; chloroform; Freon 11; 1,2-DCA; trans 1,2-DCE; and vinyl chloride in groundwater.
138	PHOENIX (ESTES/BRADLEY LANDFILLS)	VOCs	TCE Vinyl chloride	20 to 100 ug/L 240 to 1300 ug/L	5.0 ug/L 2.0 ug/L	MCL, AWQS	TCE; 1,1-DCE; trans-1,2-DCE; vinyl chloride in groundwater due to landfill.
139	PHOENIX (HONEYWELL DEER VALLEY COMPUTER PARK)	VOCs	TCE	up to 1250 ug/L	5.0 ug/L	MCL, AWQS	TCE in groundwater.

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KEY TO CONTAMINATION SITES (continued)

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140	PHOENIX (INTEL)	VOCs	1,1,1-TCA	0.8 ug/L	200 ug/L	MCL, AWQS	TCA in groundwater from semi-conductor industry.
141	PHOENIX (19th AVE LANDFILL CERCLA SITE)	VOCs	1,1-DCE	27 ug/L	7.0 ug/L	MCL, AWQS	1,1-DCE in groundwater.
142	PHOENIX (MOTOROLA 52ND ST CERCLA SITE)	VOCs	TCE	5 - 200,000 ug/L	5.0 ug/L	MCL, AWQS	Twenty seven chemicals including TCE; PCE; TCE; 1,1-DCE; trans-1,2-DCE; and Freon 113 in groundwater from electronics and semi-conductor industry.
143	PHOENIX (MOTOROLA 56TH ST)	VOCs	TCE	up to 1400 ug/L	5.0 ug/L	MCL, AWQS	TCE; PCE; 1,1-DCE; chloroform; and Freon-113 in groundwater.
144	PHOENIX (EAST WASHINGTON WQARF SITE)	VOCs	1,1,1-TCA TCE Benzene	26,000 ug/L up to 500 ug/L	200 ug/L 5.0 ug/L 5.0 ug/L	MCL, AWQS MCL, AWQS MCL, AWQS	TCE; PCE; 1,1-DCE; trans- 1,2-DCE; 1,1,1-TCA; 1,1-DCA; benzene; and toluene in groundwater.
145	PHOENIX (WEST CENTRAL) PHOENIX WQARF SITE)	VOCs	PCE	up to 87,000 ug/L	5.0 ug/L	MCL, AWQS	TCE; PCE AND 1,1-DCE in groundwater.
146	PRESCOTT VALLEY	VOCs	TCE	less than 5.0 ug/L	5.0 ug/L	MCL, AWQS	VOC contamination of groundwater from landfill.
147	TUCSON (EL CAMINO DEL CERRO LANDFILL)	VOCs	PCE TCE 1,2-DCE Vinyl Chloride	480 ug/L 180 ug/L 260 ug/L 120 ug/L	5.0 ug/L 5.0 ug/L 70.0 ug/L 2.0 ug/L	MCL, AWQS MCL, AWQS MCL, AWQS MCL, AWQS	TCE; PCE; 1,1-DCA; sis-1,2-DCE; and vinyl chloride in groundwater due to landfill.
148	PINAL CREEK (WQARF SITE)	Physical parameters	pH	as low as 3.4 standard units	6.5 - 8.5 standard units	SMCL	Low pH due to mine drainage.
149	PRESCOTT VALLEY	Radiological	Radon	2,730 pCi/L	300 pCi/L	MCL under Federal consideration	Radon of 2730 pCi/L in one well.
150	PRESCOTT	Radiological	Radon	22,300 pCi/L	300 pCi/L	MCL under Federal consideration	Radon of 22,300 pCi/L in one well.

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