

Plan of Study for the Basin and Range Regional Aquifer System

EXECUTIVE SUMMARY

The Basin and Range regional aquifer system consists primarily of unconsolidated basin-fill aquifers bounded by consolidated rock mountain ranges and fractured carbonate-rock aquifers. It underlies parts of Nevada, Utah, Arizona, Idaho, and California and is ranked third in withdrawals for domestic and public drinking-water supply among the 16 principal aquifer systems.

The objective of the Basin and Range Regional Aquifer System (BARRAS) Planning Team is to develop a work plan for the coordinated study of water-quality conditions in the Basin and Range regional aquifer system that best addresses the main water-quality issues and yields the best characterization and understanding of water-quality conditions and trends within the available budget.

The basin-fill aquifers are the principal source of ground water for domestic and municipal supply and for irrigated agriculture in the Basin and Range region. Most basins are topographically and hydraulically closed by low permeability bedrock or are only partially drained by perennial streams or by flow through basin-fill deposits or permeable bedrock. Contaminants reaching these aquifers are more likely to be retained and concentrated.

Carbonate rocks form a regional aquifer system in the eastern part of the Great Basin that includes the eastern part of Nevada and the western part of Utah. The carbonate-rock aquifers are comprised of thick sections of carbonate and clastic sedimentary rocks that constitute an extensive hydrogeologic unit. Ground water is transmitted mostly through faults and fractures. Ground water generally flows from the mountains and basin-fill deposits to the underlying and adjacent carbonate rock, resulting in large regional flow systems that encompass numerous topographic basins and circulation depths of several thousand feet.

A meeting to discuss a regional ground-water quality design for study units in the Basin and Range physiographic province was held in Salt Lake City at the Utah District office on June 5-6, 2001. Based on the regional and local hydrogeological conditions, it was determined that the main water-quality issues common among the GRSL, NVBR, and CAZB study units are:

1. Increased dissolved solids concentrations in ground water.
2. Effects of urbanization on ground water.
3. Adverse effects on human and aquatic-life health and water use because of drainage from agricultural lands and from past and current mining activities.
4. Natural sources of trace elements and radionuclides at concentrations of public-health concern in ground water.
5. Adverse effects of imported water and water reuse on the continued suitability of ground-water supplies for beneficial uses.

Based on a discussion of what studies are proposed for study units in Cycle II of NAWQA by the NAWQA Implementation Team (NIT), an evaluation of environmental framework information (hydrogeology, water use, and land use) among study units, and the main water-quality issues and information gaps identified, a proposed multiple-study unit, multiple-year study design for the Basin and Range regional aquifer system was developed.

Proposed Study Design for Cycle II

Cycle II Status Goal

- MAS of the carbonate-rock aquifer system in the Basin and Range area, NVBR and GRSL. *The planning team has placed a higher priority on the need for the carbonate-rock aquifer system MAS than on the need for resampling the MAS of the Las Vegas area basin-fill aquifer as was proposed by the NIT.*
- MAS of the basin-fill aquifer in agricultural area between Phoenix and Tucson, CAZB
- Urban LUS in the Reno/Eagle Valley area, NVBR
- Drinking Water Source Water Assessment Study of basin-fill aquifer in West Salt River Valley, CAZB

Cycle II Trend Goal

- Resample MAS of basin-fill aquifer in Reno-Sparks/Eagle Valley expanded area, NVBR
- Resample MAS of basin-fill aquifer in West Salt River Valley, CAZB
- Resample composite MAS of basin-fill aquifers, GRSL
- Resample urban LUS in Salt Lake Valley, GRSL
- Resample Drinking Water Source Water Assessment Study of basin-fill aquifer in Salt Lake Valley, GRSL

Cycle II Understanding Goal

- Transport of contaminants to public water supplies in basin-fill aquifer in Reno/Eagle Valley, NVBR
- Transport of contaminants to public-water supplies in basin-fill aquifer in Salt Lake Valley, GRSL
- Space for time (flow path study with an emphasis on unsaturated zone transport) study of basin-fill aquifer in West Salt River Valley or Upper Santa Cruz sub basin, CAZB

Plan of Study for the Basin and Range Regional Aquifer System

August 21, 2001

by the Basin and Range Regional Aquifer System Planning Team

INTRODUCTION

The Basin and Range regional aquifer system consists primarily of unconsolidated basin-fill aquifers bounded by consolidated rock mountain ranges and fractured carbonate-rock aquifers. It underlies parts of Nevada, Utah, Arizona, Idaho, and California (fig. 1). This aquifer system is ranked third in withdrawals for domestic and public drinking-water supply among the 16 principal aquifer systems in the United States selected for groundwater trend assessment in the second cycle of the National Water Quality Assessment (NAWQA) program.



The Basin and Range aquifers consist of primarily unconsolidated basin-fill sand and gravel, but fractured carbonate rocks also underlie some basins and form important aquifers.

EXPLANATION	
	Basin and Range basin-fill aquifers
	Basin and Range carbonate-rock aquifers

Figure 1. Location of Basin and Range basin-fill and carbonate-rock aquifers (http://capp.water.usgs.gov/aquiferBasics/ext_basranaa.html)

The Basin and Range regional aquifer system includes the NAWQA Nevada Basin and Range (NVBR), Great Salt Lake Basins (GRSL), and Central Arizona Basins (CAZB) study units (fig. 2). Major cities with surrounding urban areas within the Basin and Range are Las Vegas and Reno, Nevada; Phoenix and Tucson, Arizona; and Salt Lake City, Utah. All are experiencing large population growth and have limited supplies of water because of the arid to semiarid climate of the region. Ground-water withdrawals within the Basin and Range area in 1995 were 5.53 billion gallons per day. The area within the three NAWQA study units accounts for about 43 percent of this water use. Withdrawals for public supply from wells totaled about 1.0 billion gallons per day within the Basin and Range area with about 670 million gallons per day from within the NAWQA study unit boundaries.

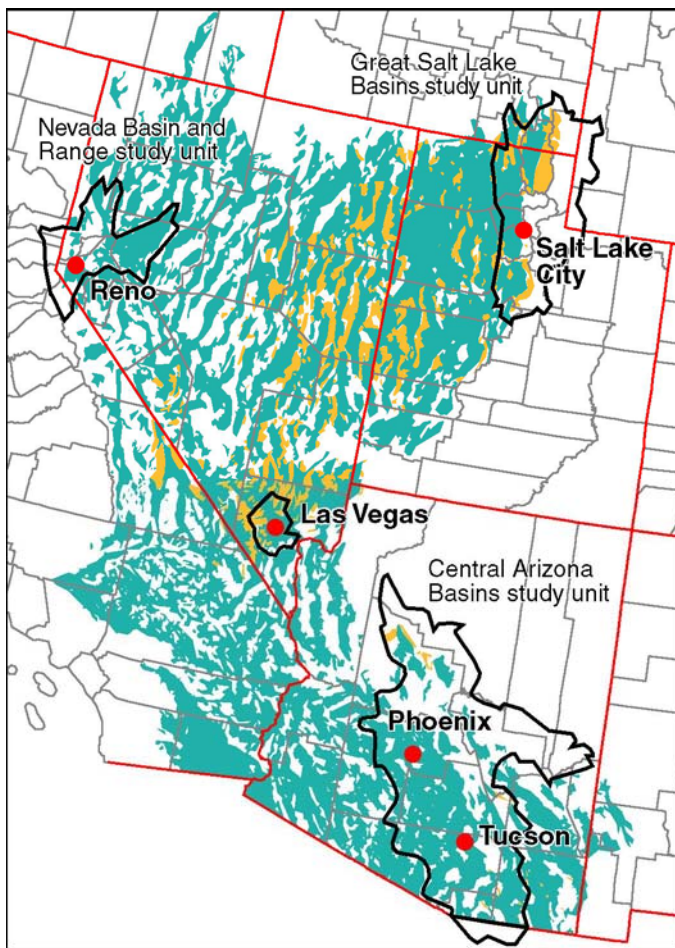


Figure 2. Location of Basin and Range regional aquifer system, Central Arizona Basins Study Unit, Great Salt Lake Basins Study Unit, and Nevada Basins and Range Study Unit, and major cities within the Basin and Range region

OBJECTIVE

The objective of the Basin and Range Regional Aquifer System (BARRAS) Planning Team is to develop a work plan for the coordinated study of water-quality conditions in the Basin and Range regional aquifer system that best addresses the main water-quality issues and yields the best characterization and understanding of water-quality conditions and trends within the available budget. Factors considered by the team in the design of this plan include:

1. the environmental framework for aquifers in the Basin and Range region,
2. identification of work done in Cycle I,
3. identification of information gaps,
4. identification of the principal ground-water issues that need to be addressed by the study units in Cycle II,
5. and the distribution of study components proposed for Cycle II among the study units in a regional context.

A meeting to discuss a regional ground-water quality design for study units in the Basin and Range physiographic province was held in Salt Lake City at the Utah District office on June 5-6, 2001. Attending were Marc Sylvester (Western Region and representing SANA ground-water hydrologist), Bill Wilbur (NLT), Wayne Lapham (NLT), Sue Thiros (GRSL ground-water hydrologist), Rob Baskin (GRSL database/GIS), Kidd Waddell (GRSL project chief), Michael Rosen (NVBR project chief), Don Schaefer (NVBR ground-water hydrologist), and Alissa Coes (CAZB ground-water hydrologist). This group comprises the BARRAS planning team.

ENVIRONMENTAL FRAMEWORK

Three main factors comprise the environmental framework for studying water quality in the area covered by the Basin and Range regional aquifer system: hydrogeologic setting, water use, and land use. The primary hydrogeologic setting and the one most common among the GRSL, NVBR, and CAZB study units in the Basin and Range regional aquifer system are the unconsolidated basin-fill aquifers. This setting has been and will continue to be the focus of study for these NAWQA study units.

The Basin and Range regional aquifer system occurs within the Basin and Range physiographic province of Fenneman and Johnson, (1946). The province covers about 200,000 square miles characterized by generally parallel, north- to northeast-trending mountain ranges separated by broad alluvial desert basins that are a result of Cenozoic extensional faulting. Topographic relief between the mountains and the adjacent basins is generally 1,000 to 5,000 feet. The Great Basin is in the northern Basin and Range, largely in Nevada and Utah. Streams within the Great Basin drain internally to terminal lakes, except for an area of southeastern Nevada that is tributary to the Colorado River.

The basin-fill aquifers are the principal source of ground water for domestic and municipal supply and for irrigated agriculture in the Basin and Range region. These uses of water account for most of the water use in this region. Most basins are topographically and hydraulically closed by low permeability bedrock or are only partially drained by perennial streams or by flow through basin-fill deposits or permeable bedrock. Contaminants reaching these aquifers are more likely to be retained and concentrated.

The source of recharge water to the basin-fill aquifers is an important attribute of the hydrogeologic framework that needs to be considered in the study design. Basin-fill deposits usually range in thickness from zero at margins of valleys to several thousand feet in valley lowlands. Recharge primarily occurs along the mountain front in the NVBR and GRSL study units whereas the primary source of recharge in the CAZB study unit is streambed recharge within the basins.

Carbonate rocks form a regional aquifer system in the eastern part of the Great Basin that includes the eastern part of Nevada and the western part of Utah. The carbonate-rock aquifers are comprised of thick sections of carbonate and clastic sedimentary rocks that constitute an extensive hydrogeologic unit. Ground water is transmitted mostly through faults and fractures. This aquifer system consists of several major flow systems (Prudic and others, 1995, p. D49) that are bounded by intruded or faulted impermeable rocks and by ground-water divides. Ground water generally flows from the mountains and basin-fill deposits to the underlying and adjacent carbonate rock, resulting in large regional flow systems that encompass numerous topographic basins and circulation depths of several thousand feet.

The carbonate-rock aquifers are not currently utilized for public supply because of their remoteness and depth to water. As population growth continues in arid areas with limited water supplies, these aquifers are likely to be drawn upon to meet future water needs in the region. Characterization of the water quantity and quality of the carbonate-rock aquifers would be advisable. NAWQA should make every effort to make available the resources to undertake this characterization. To encourage this effort, a proposal to do a Major Aquifer Study of the carbonate-rock aquifers in the Basin and Range has been forwarded to the NLT. The Nevada and Utah Districts should also pursue studies of the carbonate-rock aquifers with state or other federal agencies in order to more fully characterize water-quality conditions within the Great Basin part of the Basin and Range region.

The other hydrogeologic settings in the Basin and Range regional aquifer system (basalt and volcanic-rock aquifers and sandstone aquifers) are not aerially extensive, do not supply much of the water used, with the exception of the Fallon area in Nevada, and are not common among the GRSL, NVBR, and CAZB study units.

Besides hydrogeology, land use and the corresponding water use are the other main factors in determining the environmental framework for the Basin and Range region. Urban and agricultural land uses are the most important because of their effects on water quality. The parts of the Basin and Range region covered by NAWQA study units are

rapidly urbanizing (greater than 21% increase in population in Phoenix, the fastest growing city in the Nation during the last 10 years) with major land areas changing from rural and agricultural use to urban. About half of the population in the Basin and Range area study units gets their water from wells (fig. 3), except the Las Vegas area, which receives most of its water from Lake Mead.

Urbanization is the most prominent land use activity affecting water quality in the GRSL, NVBR, and CAZB study units, and it is coincident with the main areas of ground-water withdrawal from basin-fill aquifers for domestic and municipal uses. In addition, urbanization is proceeding up alluvial fans into mountain front recharge zones where most of the water is recharged in the Nevada and Utah portions of the region and along alluvial valleys where most of the water is recharged in the CAZB portion of the region. Thus, urbanization is occurring where the basin-fill aquifers are most susceptible to contamination.

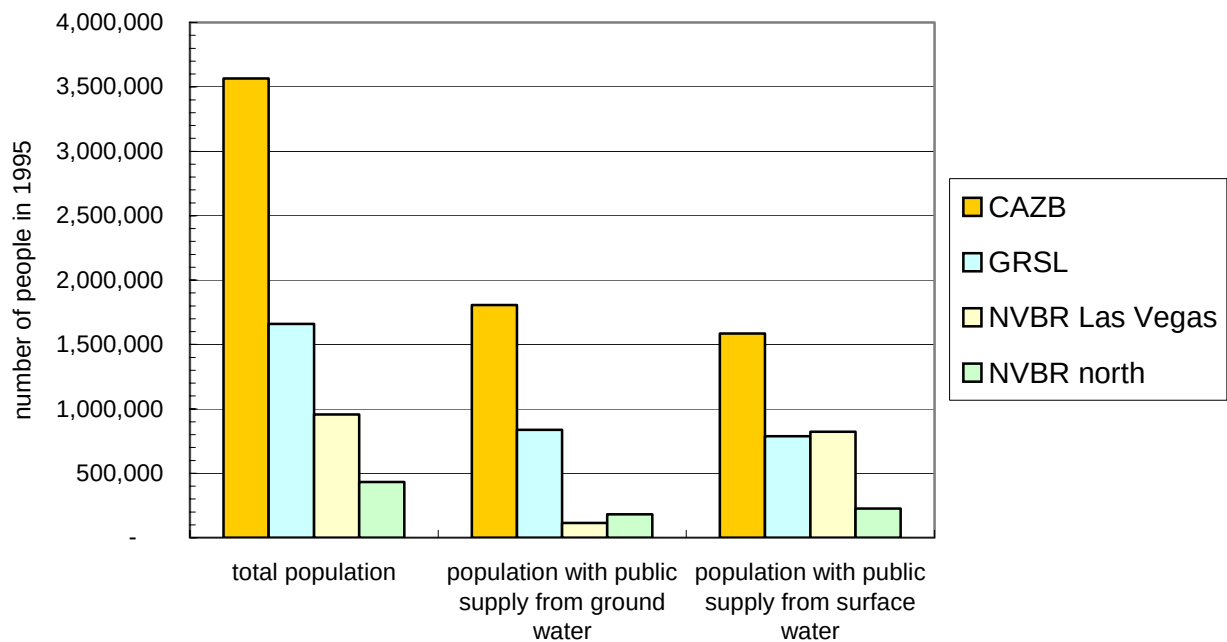


Figure 3. Population in the CAZB, GRSL, and NVBR study units
(Data from USGS National Water-Use Information Program, 1995 water-use data files, <http://water.usgs.gov/watuse>)

Most of the ground and surface water used in the Basin and Range region is applied as irrigation to crops or is used for public supply (fig 4). Crops in the region generally must be irrigated with either surface or ground water or a combination of both. Ground water, surface water imported from the Colorado River by the Central Arizona Project, and treated sewage effluent are the main sources of irrigation water in the CAZB. Cotton is the main crop grown in the CAZB (365,000 acres in 1995). Multiple applications of

fertilizers and pesticides used on cotton annually resulted in more than 67 million pounds of fertilizer and 2.9 billion pounds of pesticides and other chemicals being applied to cotton fields in 1995. Alfalfa and hay, the main crops grown in the Nevada and Utah parts of the Basin and Range, typically do not require fertilizer or large quantities of pesticides. The main impacts of agricultural land use on water quality in the region are from the runoff of dissolved salts from irrigated land to streams and lakes, and the accumulation of salts and chemicals in ground water. Mining also impacts ground-water quality but the impact is not as intensive or extensive as urban and agricultural land uses.

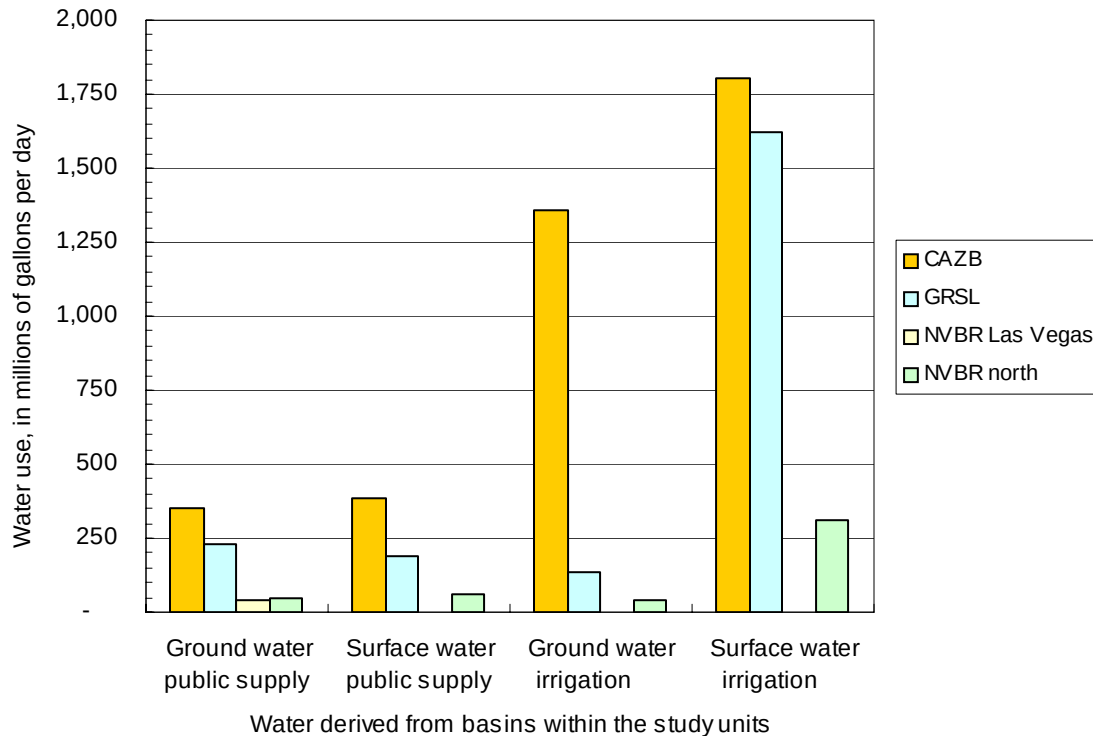


Figure 4. Water use in the CAZB, GRSL, and NVBR study units
(Data from USGS National Water-Use Information Program, 1995 water-use data files, <http://water.usgs.gov/watuse>)

WATER-QUALITY ISSUES

The main water quality issues common among the GRSL, NVBR, and CAZB study units are:

1. Increased dissolved solids concentrations in ground water used for municipal and domestic water supplies caused by the concentration of salts in irrigation water that recharges ground water, the accumulation of salts in ground water and soils where through-flowing drainage is minimal, urban runoff to ground water, transport of contaminants from naturally, salty rock formations and water-bearing

- units induced by pumping, and importation and recharge of surface water containing greater concentrations of dissolved solids than local ground water.
2. Effects of urbanization (the extension of urban land into rural and agricultural areas and increased density of development) on the amount and kind of water use and water quality due to land and stream-channel disturbance, chemical use, changes in the amount of water applied for irrigation and its distribution, increased traffic and impervious surfaces, and increased waste discharges to surface and ground water.
 3. Adverse effects on human and aquatic-life health and water use because of infiltration of irrigation water containing pesticides applied to crops.
 4. Adverse effects on human and aquatic-life health and water use from past and current mining activities.
 5. Natural sources of trace elements and radionuclides at concentrations of public-health concern in ground water.
 6. Adverse effects of use and recharge of imported water and water reuse on the continued suitability of ground-water supplies for beneficial uses (mainly as a result of increased concentrations of dissolved solids but also the introduction of anthropogenic chemicals to water supplies).

With the resources available, NAWQA cannot address all of these issues. Meeting attendees agreed that the most important issues common to the GRSL, NVBR, and CAZB study units were increased dissolved-solids concentrations and urbanization. In focusing on these issues NAWQA also will be able to partially address some of the other issues such as natural sources of trace elements and radionuclides where study areas dealing with increased dissolved-solids concentrations and urbanization overlie these source areas. Also, as the population, area, and intensity of urbanization increase in these study units, the amount of imported water and water reuse and reclamation is likely to increase. Thus, studies dealing with urbanization will also encompass to some degree the effects of water importation and reuse.

CYCLE I STUDIES

Study-Unit Surveys

The objective of the study-unit survey is to provide a broad overview of the occurrence and distribution of ground-water quality in the major aquifers within a study unit (Gilliom and others, 1995). The three study units designed the extent and focus of the study-unit surveys in different ways, although they all sampled the deeper basin-fill aquifers used for public or domestic supply. The study-unit surveys located in the Basin and Range regional aquifer system completed in cycle I are listed in table 1. The NVBR sampled wells in the Carson Valley agricultural area (17 wells), Reno-Sparks urban area (18 wells), and the Las Vegas urban area (22 wells). These areas were chosen on the basis of predominant land use and the type of recharge to the basin-fill aquifers (Lico, 1998). The CAZB did study-unit surveys in the West Salt River Valley (35 wells sampled), the Upper Santa Cruz Basin (29 wells sampled), and the Sierra Vista subbasin (19 wells

sampled). These surveys were designed to study different degrees of human activities on ground-water quality and were delineated by basin boundaries (Cordy and others, 2000, p. 26). The GRSL did two study-unit surveys on the basis of hydrologic conditions within the basin-fill aquifers: the unconfined part (27 wells sampled) and the confined part where the hydraulic-head gradient is downward (28 wells sampled). The sampled wells were distributed throughout the study unit within the aerial extent of each hydrologic condition, but were not constrained by basin boundaries or land use.

Land-Use Studies

The objective of the land-use study is to assess the quality of recently recharged shallow ground water associated with regionally extensive combinations of land use and hydrogeologic conditions. The land-use studies located in the Basin and Range regional aquifer system completed in cycle I are listed in table 2. Urban land-use studies were done in the Reno-Sparks, Nevada area (28 wells sampled); the Las Vegas, Nevada area (32 wells sampled); and in Salt Lake Valley, Utah (30 wells sampled). Agricultural land-use studies were done in Carson Valley, Nevada (20 wells sampled); Carson Desert, Nevada (10 wells sampled); and the western part of the West Salt River Valley, Arizona (9 wells sampled). The major crops in the Nevada and Utah parts of the Basin and Range region are alfalfa and pasture which do not require heavy use of fertilizers or pesticides. Cotton, a crop that requires multiple applications of fertilizers and pesticides annually, is the principal crop in CAZB.

Other Studies

The drinking-water source assessment study underway in Salt Lake Valley, Utah (table 2) serves as a pilot for similar Cycle II studies. Thirty public-supply wells were sampled, 15 of which are the largest producers in the valley. Flow path studies were done in two residential areas on the east side of Salt Lake Valley, Utah to determine the sources of recharge to and movement of water in the shallow, unconfined aquifer in a residential area.

INFORMATION GAPS

Based on an assessment of what was done in cycle I of NAWQA and what has been studied by other agencies, the meeting attendees identified several information gaps. The main gaps common to two or more of the study units within the Basin and Range region are:

- The main information gap regarding the characterization of water quality in the Basin and Range is the paucity of information for the carbonate-rock aquifers in Nevada and Utah. Some major-ion and nitrate concentration data are available from reconnaissance studies done of these aquifers during the 1960s and 1970s, although these studies focused on determining aquifer hydrogeologic conditions and quantities of ground water.

- For the basin-fill aquifers in the GRSL, NVBR, and CAZB study units, where most of the water use and urban and agricultural development occurs, the main information gaps are:
 - (1) an insufficient characterization of the water quality of municipal, water-supply aquifers, the regional ground-water flow system, and sources of contamination; and
 - (2) little understanding of flow paths for contaminant transport from recharge areas to municipal water-supply wells and the transformation, fate, and effects of contaminants along these flow paths. The role of the unsaturated zone in contaminant storage and transport is important in all three study units but most important in the CAZB where the most arid conditions occur and the depth to ground water is greatest.

Other information gaps, specific to each study unit, were identified:

- Trends in water quality of basin-fill aquifers used for public supply in the GRSL
- Effects of past and current mining activities on water quality in the NVBR
- Characterization of water quality of the basin-fill aquifer in the Pahrump Valley adjacent to Las Vegas, Nevada
- Characterization of water quality of basin-fill aquifers in agricultural areas (e.g. alfalfa in Diamond Valley and potatoes in Paradise Valley) outside of the NVBR study unit boundaries
- Characterization of water quality of basin-fill aquifers overlain by small urbanizing areas (e.g. Elko and Ely, Nevada) outside of the NVBR study unit boundaries
- Characterization of ground-water quality in a cotton growing area between Phoenix and Tucson in the CAZB
- Characterization of ground-water quality in the East Salt River Valley and Central Highlands of CAZB.

An analysis of cycle I ground water data among the GRSL, NVBR, and CAZB study units would be advisable based on the discussion of information gaps. Such a retrospective effort would help in developing the design of study for the Basin and Range regional aquifer system and would provide a foundation upon which cycle II studies could build.

PROPOSED STUDY DESIGN FOR CYCLE II

Based on a discussion of what studies are proposed for study units in Cycle II of NAWQA by the NAWQA Implementation Team (NIT), an evaluation of environmental framework information (hydrogeology, water use, and land use) among study units, and the main water-quality issues and information gaps identified, a proposed multiple-study unit, multiple-year study design for the Basin and Range regional aquifer system was developed. The proposed distribution of study components among the NVBR, CAZB,

and GRSL study units in cycle II is listed in tables 1 and 2 and is described in this section.

Cycle II Status Goal (new ground-water studies to characterize water quality)

- MAS of the carbonate-rock aquifer system in the Basin and Range region, NVBR and GRSL (*proposed by planning team*)
- MAS in the Eloy Basin, an agricultural area between Phoenix and Tucson, CAZB (*instead of resampling the agricultural LUS in the Carson Valley, NVBR as proposed by NIT for the ground-water trends network*)
- Urban LUS in the Reno/Eagle Valley area, NVBR (*instead of an urban LUS in the Las Vegas area, NVBR as proposed by NIT*)
- Drinking Water Source Water Assessment Study of the basin-fill aquifer in Salt Lake Valley, GRSL (*Cycle I pilot study*)
- Drinking Water Source Water Assessment Study of the basin-fill aquifer in West Salt River Valley, CAZB (*proposed by planning team*)

Cycle II Trend Goal (resampled ground-water studies to determine changes and trends in water quality)

- MAS of basin-fill aquifer in Reno-Sparks/Eagle Valley area, NVBR (*expanded area for Reno-Sparks area MAS instead of resampling the MAS of basin-fill aquifer in Carson Valley area, NVBR as proposed by NIT*)
- MAS of basin-fill aquifer in West Salt River Valley, CAZB (*proposed by NIT*)
- MAS of combined unconfined and confined parts of basin-fill aquifers, GRSL (*modified by planning team from what was proposed by NIT*)
- Urban LUS in Salt Lake Valley area, GRSL (*proposed by NIT*)
- Drinking Water Source Water Assessment Study of basin-fill aquifer in Salt Lake Valley, GRSL (*resampling of Cycle I pilot study proposed by planning team*)

Cycle II Understanding Goal (topical studies to gain understanding of water-quality conditions)

- Transport of contaminants to public water supplies in basin-fill aquifer in Reno/Eagle Valley, NVBR
- Transport of contaminants to public water supplies in basin-fill aquifer in Salt Lake Valley, GRSL
- Space for time (flow path study with an emphasis on unsaturated zone transport) study of basin-fill aquifer in West Salt River Valley or Upper Santa Cruz subbasin, CAZB

The reasons for including studies proposed by the NIT are provided in the NIT documentation. The reasons for including studies that are proposed by the planning team or not proposed by the NIT are provided in the following sections.

MAS of the carbonate-rock aquifer system in the Basin and Range, NVBR and GRSL

Carbonate-rock aquifers composed of clastic sedimentary rocks underlie a large part of the Basin and Range area in Nevada and Utah. None of the NAWQA cycle I studies addressed the carbonate-rock aquifers resulting in an incomplete assessment of the Basin and Range regional aquifer system. Urbanization and limited water supplies will likely increase the use of these aquifers in the future. A major aquifer study of the carbonate-rock aquifers to characterize water quantity and quality is proposed by the planning team. To encourage this effort, a proposal to do a major aquifer study of the carbonate-rock aquifer system has been forwarded to the NLT (Attachment A).

The BARRAS planning team has placed a higher priority on the need for the carbonate-rock aquifer system MAS than on the need for resampling the MAS of the Las Vegas area basin-fill aquifer as was proposed by the NIT. The carbonate-rock aquifers MAS is favored for the following reasons: 1) a greater need for the study because of a lack of water-quality data on the carbonate-rock aquifers in the Basin and Range province, 2) the study would be more beneficial to Las Vegas because of the need for additional water supplies in the future, and 3) it allows Basin and Range study units to work more closely together on a common goal.

MAS in the agricultural area between Phoenix and Tucson, CAZB

A new major aquifer study of the agricultural area in the Eloy Basin, between Phoenix and Tucson, is proposed in the CAZB for cycle II by the planning team. This is an important agricultural area (cotton) that was not studied in cycle I. The quantity of ground water pumped for irrigation in the CAZB study unit is much greater than the sum of ground water withdrawn from the GRSL and NVBR study units for irrigation. The quantity of chemical use also is greater in the CAZB than in the NVBR and GRSL because of the type of crops grown. This study will provide a comprehensive and consistent data set that establishes current water-quality conditions for a basin containing a large agricultural area with more than half a century of agricultural development. It will also provide data on background water-quality conditions as this area is urbanized.

The proposed MAS in the Eloy Basin could take the place of trend work proposed by the NIT for the agricultural LUS in Carson Valley, NVBR. Repeating the agricultural LUS on alfalfa/hay done in Carson Valley was not considered a high priority for study by the planning team because little change is anticipated and little contamination was found in the study. An agricultural LUS in the Eloy Basin is not possible because of large depths to water and high drilling costs. Expanding the agricultural LUS in the West Salt River Valley done in cycle I was determined to be infeasible by CAZB personnel because of the small size of the agricultural area and the continued conversion from agricultural to urban land use in the area.

Urban LUS in the Reno/Eagle Valley area, NVBR

The planning team favored an urban LUS in the Reno/Eagle Valley area of the NVBR instead of an urban LUS in the Las Vegas area of the NVBR as was proposed by the NIT because:

1. The drinking-water supply aquifer in the Las Vegas area is not susceptible to contamination (except due to injected Colorado River water or poorly sealed abandoned wells) because there are thick confining beds of clay and caliche that inhibit the vertical transmission of water and contaminants from the land surface and the surficial aquifer;
2. An urban LUS study was done in the Las Vegas area during cycle I of NAWQA using domestic wells;
3. The water quality of the surficial aquifer in the Las Vegas area can be monitored by sampling an urban IFS (also a surface-water trend site) because it is drained by the Las Vegas Wash;
4. The basin-fill aquifer used for drinking water in the Reno/Eagle Valley area is vulnerable to contamination because the confining layer is discontinuous. Contamination associated with urbanization is likely because urbanization is rapidly occurring in mountain front and valley recharge areas overlying this aquifer;
5. The Reno/Eagle Valley area is representative of Basin and Range areas that have experienced rapid urbanization within the last 10 years and in which urbanization is accelerating. It includes the major urbanized areas Reno, Sparks, and Carson City. It is less urbanized than the Las Vegas area, but more similar in urbanization to the Salt Lake Valley of the GRSL where cycle II ground-water status, trend, and understanding studies are proposed;
6. An urban LUS in the Reno/Eagle Valley area is nested within a MAS to be resampled as part of the NAWQA ground-water trends network; and
7. Ground water is an important source of drinking water in the Reno/Eagle Valley area.

Drinking Water Study of the basin-fill aquifer in the West Salt River Valley, CAZB

A Drinking Water Source Water Assessment study is proposed for the basin-fill aquifer in the West Salt River Valley in CAZB because this aquifer is a major source of drinking water for Phoenix. The quantity of ground water withdrawn in the CAZB study unit for public supply is slightly more than the sum of ground water withdrawn for public supply in the GRSL and NVBR study units. This study would nest within and build from the information gained from the MAS done in West Salt River Valley during cycle I and repeated in cycle II.

Resample composite MAS of basin-fill aquifers in GRSL

The unconfined and confined parts of the basin-fill aquifers that receive primary and secondary recharge in the GRSL will be combined for the major aquifer study to be

resampled as part of the ground-water trends network. Both parts of the aquifers are used for drinking water, are similar hydrogeologically, and have the same land uses: agriculture, urban, and urbanizing land and, thus, the same contamination sources.

Expanded area for Reno-Sparks area MAS, NVBR

Eagle Valley (the Carson City area) will be included in the Reno-Sparks area MAS to be resampled as part of the ground-water trends network to provide a more comparable MAS to that of the unconfined and confined parts of the basin-fill aquifers in the GRSL. Also, this will provide a broader, more representative spectrum of land uses including a greater gradient of urbanization than restricting the MAS to the Reno-Sparks area. This trend study would replace the Carson Valley MAS trend work proposed by the NIT.

Resample Drinking Water Study of the basin-fill aquifer in Salt Lake Valley, GRSL

Repeating the Drinking Water Source Water Assessment Study of the basin-fill aquifer in Salt Lake Valley in GRSL (cycle I pilot study) will be the first opportunity the NAWQA program has to assess trends in drinking-water quality of a major municipal water-supply aquifer in the Nation. Thus, the planning team considered this repeat study an important addition to the NIT proposed ground-water trends network.

Proposed studies addressing understanding goal

The NIT did not recommend any specific studies for the understanding themes in cycle II of NAWQA. Instead the NIT selected 5 topics of focus for FY01 study units and listed some possible focus topics for subsequent sets of study units. Of the 5 topics addressing understanding themes for cycle II of NAWQA for FY01 study units, the principal one applicable to the Basin and Range regional aquifer system is: “Transport of Contaminants to Public Supply Wells”. The three studies shown in the bulleted list above for the understanding goal were considered by the planning team to be the most applicable to the drinking water topic based on the selection factors mentioned previously. In addition, the study components were nested with other studies to facilitate their integration and to maximize the transferability of information. These studies are considered to be an important component of the cycle II plan because of the reliance of ground water for public supply in urban areas within the Basin and Range aquifer system and the need to understand the major factors that affect water quality within these areas.

RETROSPECTIVE WORK

Data for selected chemical constituents and compounds collected from ground-water sites within the Basin and Range regional aquifer system could be compiled and analyzed as a set to better understand the occurrence and distribution in the region. The NAWQA Data Warehouse contains data collected by the study units in the region and most of the other USGS data is contained within the NWIS QWDATA database. Some data may be in other databases such as those maintained by the EPA and state agencies that manage water quality. Constituents of regional interest include arsenic, selenium, mining related trace metals, perchlorate from rocket fuel manufacturing facilities, and total dissolved solids.

REFERENCES

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Proposal for a Major Aquifer Study in the Carbonate Rock Province, Nevada and Utah

Introduction

The Great Basin area of the western United States covers an area of about 140,000 square miles and from a ground water use perspective is primarily a system of basin fill aquifers. Within the Great Basin, an aquifer composed of Paleozoic carbonate rocks, accounts for approximately 70 percent of the total area (figure 1). The bulk of the carbonate-rock aquifer (60 percent) lies within Nevada with the remainder (40 percent) in Utah. As population stresses continue to rise in both states, public water supply purveyors will begin to look in earnest to the carbonate-rock aquifer as a source of drinking water. Some estimates of potential water in storage in just the Nevada portion of the carbonate rocks exceed 800 million acre-feet.

Problem

Although the basin fill aquifers supply the majority of drinking water supplies in the Great Basin, expanding population centers such as Las Vegas, NV and Salt Lake City and the northern portion of Utah may soon be looking at increasing ground water supplies with water from the carbonate-rock aquifer systems. The aquifer system is divided into several flow systems that are controlled by structure and lithology. The aquifer system in both states was studied in some detail during the Great Basin RASA study and the MX missile siting study done by contractors for the Air Force. Most recently, the southern portion of the carbonate-rock aquifer in Nevada was studied in great detail as a possible source of additional ground water. All these studies included some chemical analysis. A major aquifer study on the carbonate system as a whole would allow greater insight into the flow systems and create a baseline data set for future investigations and aquifer use.

Objective

The objective of this MAS would be to sample a spatially distributed set of wells that tap the carbonate system to provide baseline water quality information. These data would be important for possible future use of the water in the carbonate system by rapidly expanding population centers.

Scope

Approximately 30 wells that penetrate the carbonate-rock aquifer would be sampled. Based on areal distribution of the carbonate system between the two states, ideally 18 wells would be selected in Nevada and 12 would be sampled in Utah. This distribution of sampled wells may change because of the availability of wells completed in the aquifer.

Both the NVBR and GRSL NAWQA study units would participate in the sampling effort. Since it is cost prohibitive to run the random distribution program and drill new wells, an effort will be made to pick wells that are randomly distributed throughout the province. Preference would be given to wells that already have pumps installed. Probably one third

of the wells, however, would have to have temporary pumps installed for sampling. Depths to water in the carbonate system are generally large, often up to 1000 ft, so contracting for pump installation will be required.

Analyses would include the standard schedules for a NAWQA MAS. The estimated analyses cost does not include the Radium Gross Alpha/Beta schedule and the pesticide schedule 2060. These can be added at the discretion of the appropriate National Synthesis Teams. Age dating analyses would be done on all of the samples. Based on limited previous age dating done in some wells and springs of the carbonate aquifer, tritium analysis would probably not be effective. Carbon-14 and the stable isotopes Oxygen-18 and Hydrogen-2 analyses would be done instead.

Timing

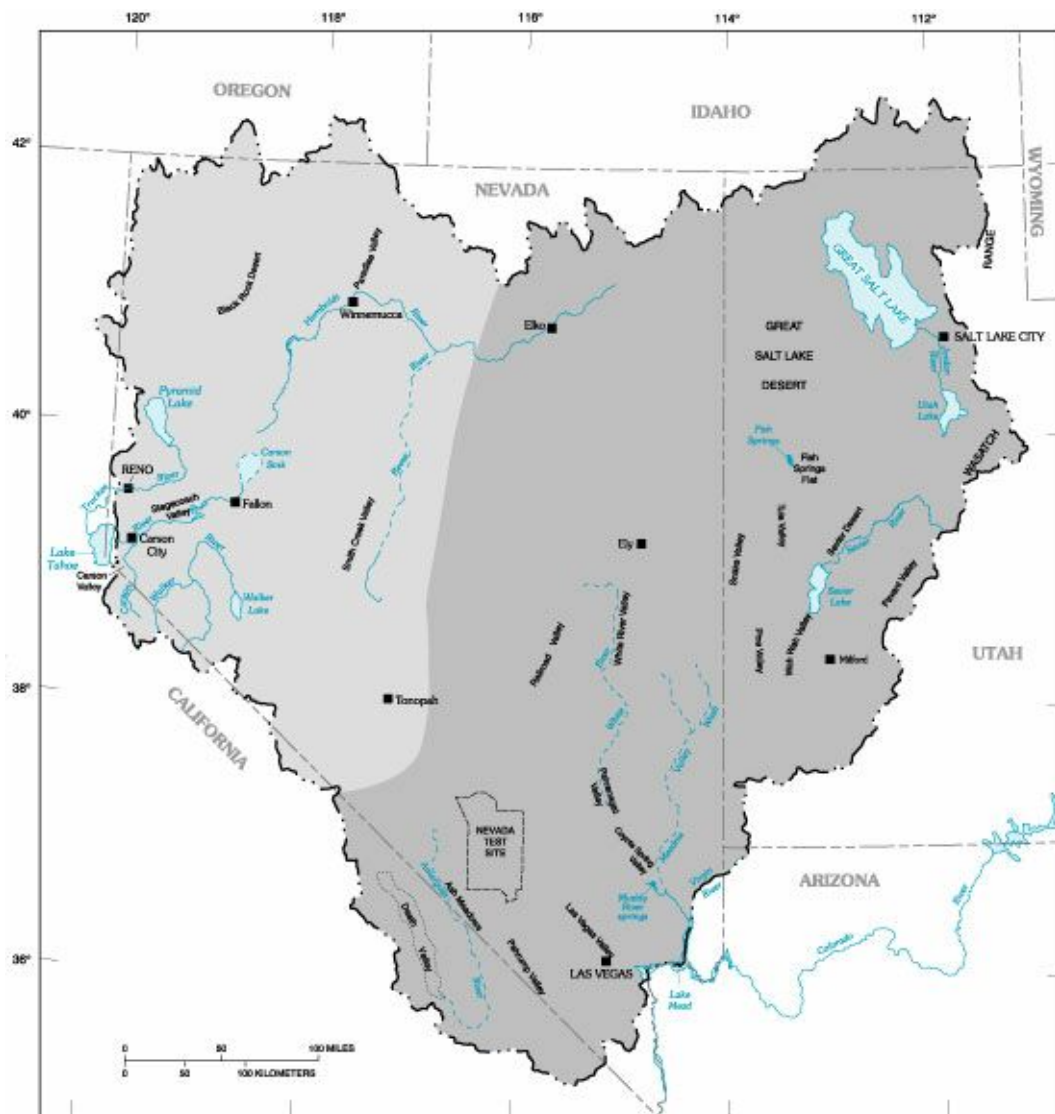
Sampling of the wells with pumps, as well as the contract for pump installation in the wells without pumps, would be done in the first year. A report summarizing the results would be written during the second year.

Costs

Year	1	2
Analyses	\$80,000	\$5,000
Travel	\$10,000	\$1,000
Contract	\$50,000	
Misc ¹	\$5,000	\$20,000

¹ Includes report costs in second year

Costs do not include overhead, salaries would be covered under NAWQA



Base from U.S. Geological Survey digital data, 1:100,000, 1978-85, and 1:250,000, 1987
 Albers Equal-Area Conic projection
 Standard parallels 29°30' and 45°30', central meridian -114°00'

EXPLANATION

- Western depositional facies
- Eastern and transitional depositional facies—Corresponds to carbonate-rock province
- Boundary of study area, Great Basin Regional Aquifer System

Figure 1.—Location of Great Basin area and carbonate rock province