CHAPTER 5

Applying Aquifer Recharge Enhancement and Conjunctive Use Concepts

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APPLYING AQUIFER RECHARGE ENHANCEMENT AND CONJUNCTIVE USE CONCEPTS

In the previous chapter, we discussed the general concepts of conjunctive use. These [conjunctive use] concepts could be applied in Albuquerque to reduce dependence on the deep aquifer beneath the City, augment recharge of the aquifer, provide water storage, and protect or enhance water quality. In this chapter, we will present some more detailed and specific ideas which could be implemented in the Albuquerque area, placing emphasis on ways of maintaining or enhancing aquifer recharge. Some of these ideas involve simple changes in the management or operation of existing water systems. Other ideas would require significant construction or infrastructure modifications.

These conjunctive use concepts could be applied in Albuquerque to reduce dependence on the deep aquifer beneath the City, augment recharge of the aquifer, provide water storage, and protect or enhance water quality.

The structural and nonstructural alternatives presented here are tailored for the section of the Albuquerque Basin between Bernalillo and Isleta. They are intended to take advantage of unique hydrologic characteristics of the area to mitigate weaknesses in the system by drawing on the system's strengths. Each alternative offers potential for variation, and there is ample flexibility for incorporation into an overall conjunctive use management plan. Similar concepts could be tailored for other areas of the Basin.

Information and interpretation provided here describes alternatives at a reconnaissance level. Specific design details for most alternatives

A number of nonstructural management options would provide immediate

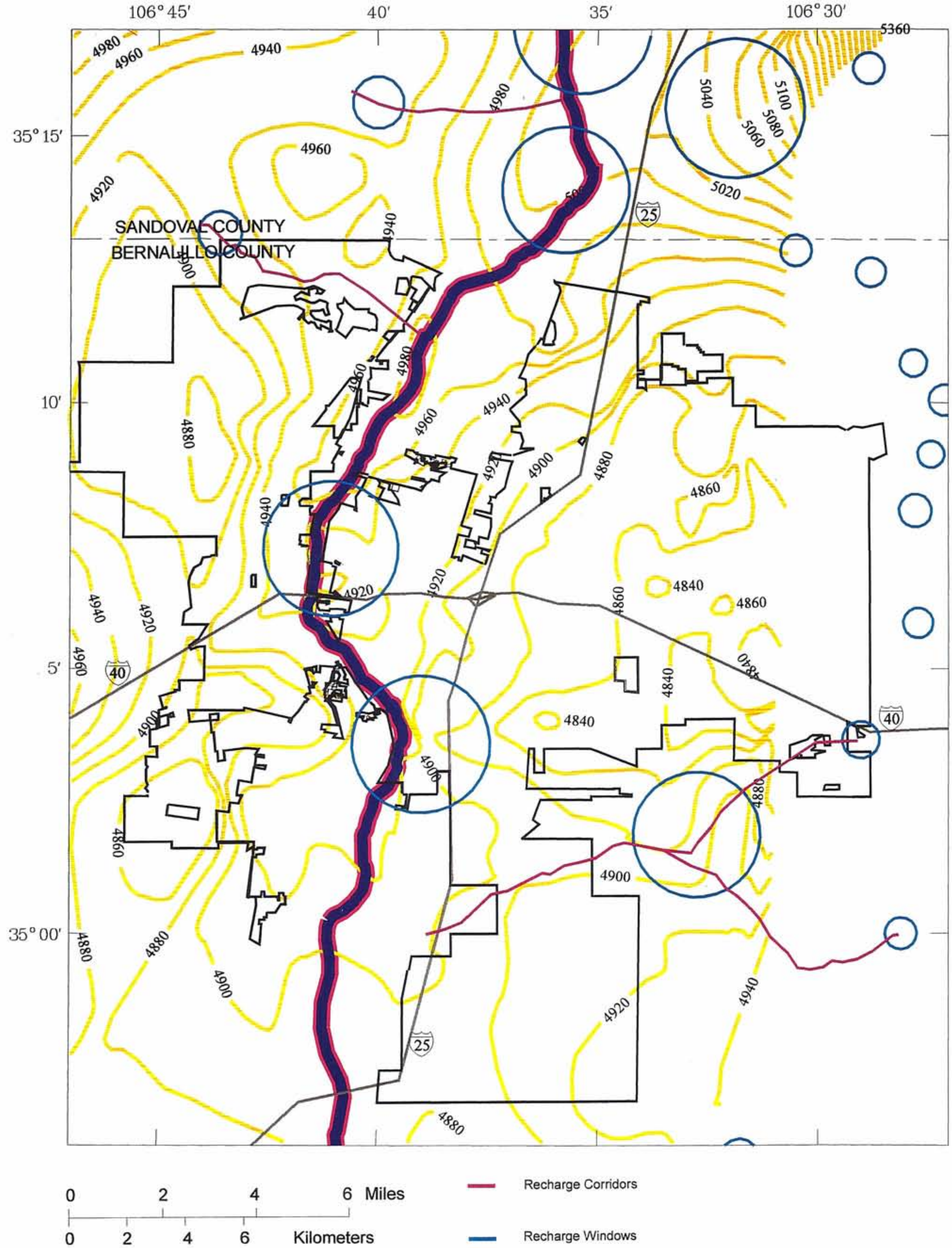

Figure 5-1.—Map showing relationship of recharge windows and corridors to the heavily pumped areas of the aquifer that most need recharge.

maintaining current drainage conditions with minimal recharge to achieving maximum recharge, even to the point of exceeding recharge that existed prior to construction of the drains. In some areas, this could more than double the current rate of recharge from the riparian corridor. The cost of constructing a water control check structure in the riverside drain would range from about $70,000 for a manual stoplog check structure to over $150,000 for an automated radial gate structure. The size and number of structures needed would depend on the location and recharge capacity desired. Operation of these structures could be integrated with other systems, such as the infiltration galleries, which will be discussed in some detail later.

Potential for additional recharge that could be available through modification of the riverside drains along the 15-mile reach between Paseo del Norte and Rio Bravo can be estimated by using data collected during the Assessment's ground-water studies (Hansen, in press[b]). Potential for increased recharge varies from 0.5 to 2 cfs per mile along the east side of the river. Conditions along the west riverside drain have not been investigated, but they are probably similar.

Figures 5-2, 5-3, and 5-4 show shallow ground-water profiles along three cross sections of the riparian corridor: one at Paseo del Norte, one at Interstate 40, and one at Rio Bravo Boulevard. These profiles illustrate the effects of the riverside drain and the ground-water gradients away from the river and toward the City's pumping centers. The ground-water gradient at the Interstate 40 site is the steepest of the three, evidencing a higher rate of ground-water movement toward the City wells than the flatter gradients at the sites north and south of the City center.

Ground-water level measurements made on May 10, 1994, shown in figures 5-5 and 5-6, shows ground-water profiles extending eastward to the margins of the valley floor, indicating an eastward movement of ground water toward pumping centers amounting to 1.6 cfs per mile at Paseo del Norte and 0.6 cfs per mile at Rio Bravo. Raising the water surface in the drain with control structures to the elevation of the river could have increased recharge rates to 2.2 and 1.1 cfs per mile, respectively. Similarly, on March 3, 1995, at a site between Interstate 40 and Central Avenue Bridge (figure 5-3), near an area of deeper depression of the water table caused by municipal pumping, ground water migrated eastward from the riverside drain at a rate of 2 cfs per mile. Raising the water surface in the drain to the level of the river at that site could have increased the ground-water recharge rate to about 4 cfs per mile. At some locations, it would be possible to check the drain's water surface to a level even higher than the river, thereby increasing recharge above the natural potential.

As described in chapter 2, a tilted fault block along Interstate 25 between Tramway Boulevard and Interstate 40 creates a barrier to eastward ground-water movement. Therefore, recharge benefits from riparian corridor enhancements would be primarily limited to areas west of Interstate 25.

Riverside drain management alternatives could be incorporated into a "riverwalk."

Riverside drain management alternatives could be incorporated into a recreational "riverwalk" which has been most recently proposed by Albuquerque Mayor, Martin Chavez. This concept has been studied in

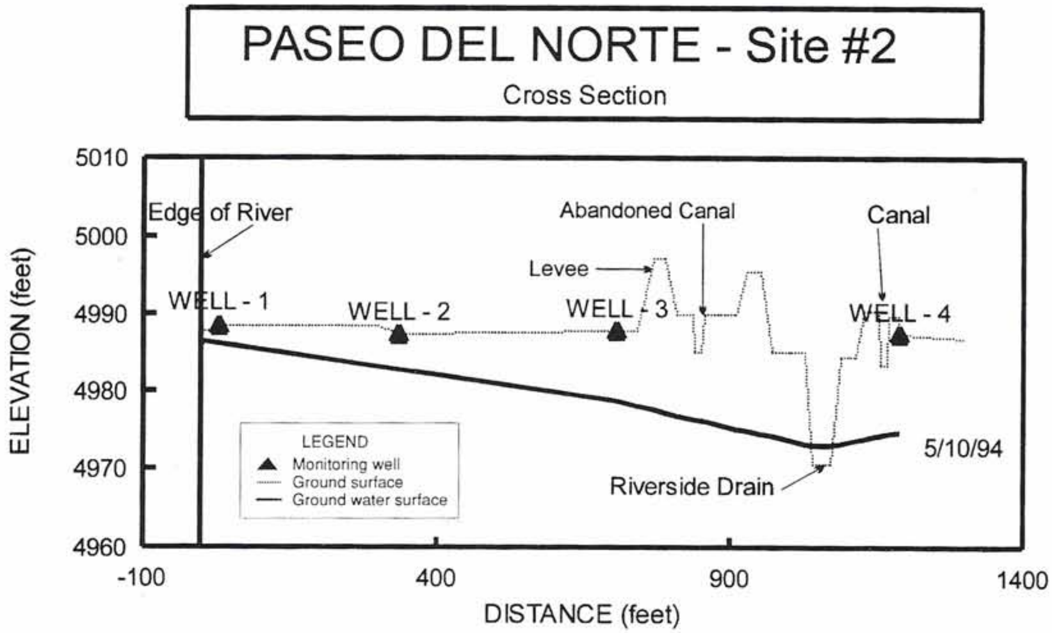

Figure 5-2.—Ground-water profile at Paseo Del Norte, Site No. 2.

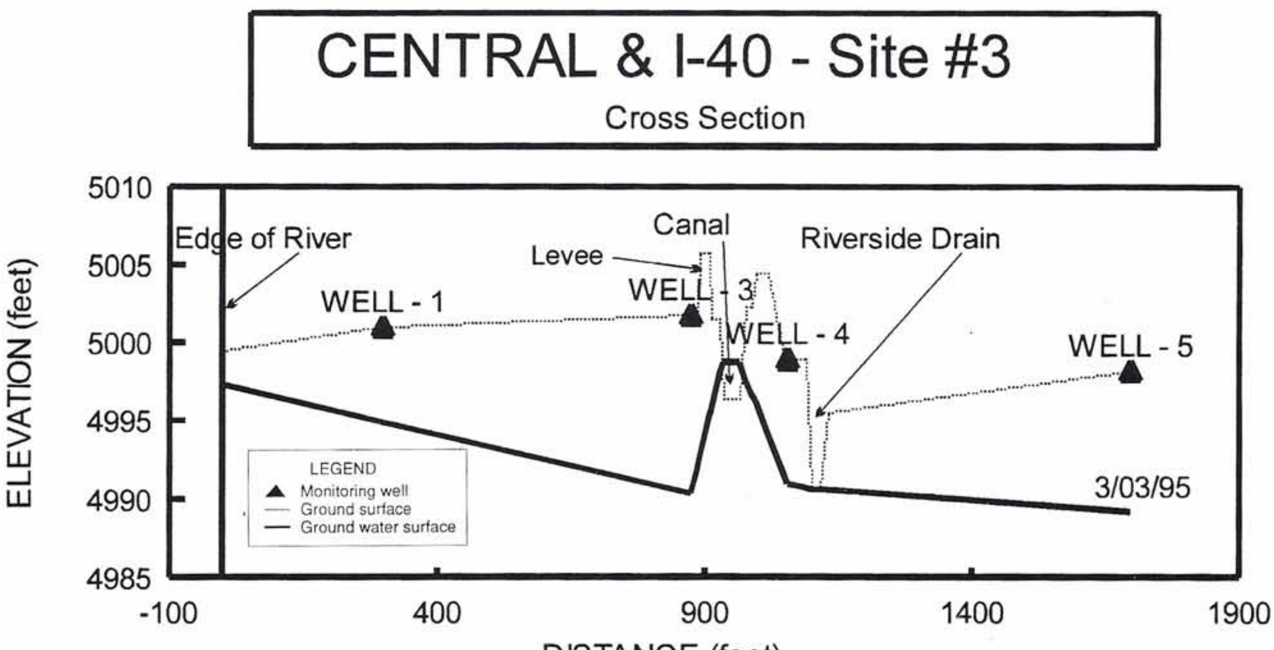

Figure 5-3.—Ground-water profile at Central and I-40, Site No. 3.
Note the ground-water mound under the canal at this site.

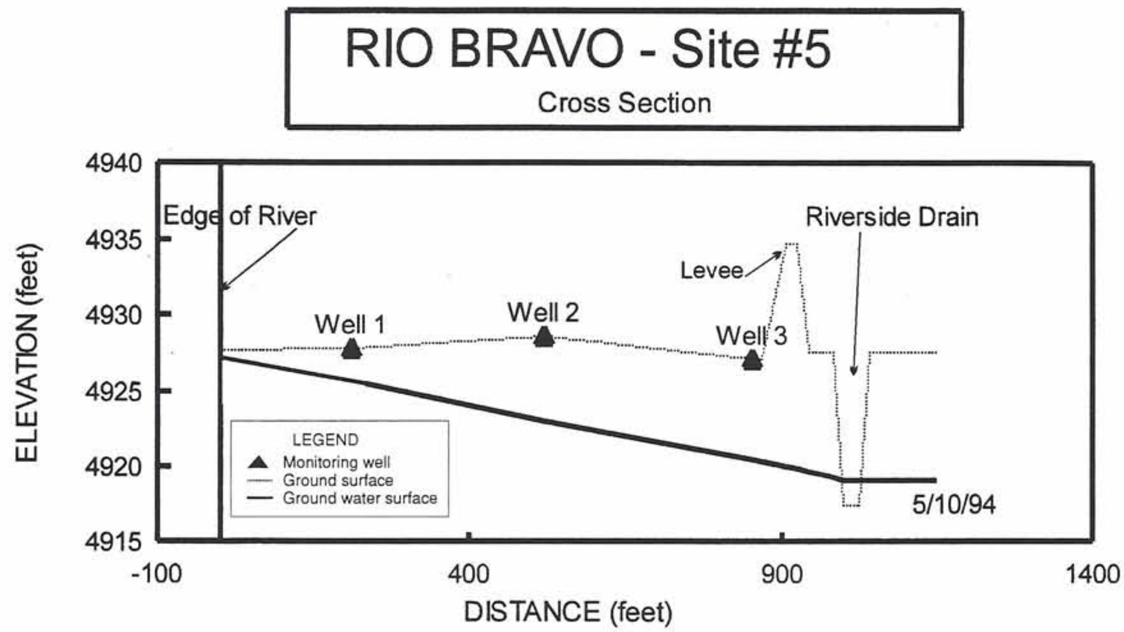

Figure 5-4.—Ground-water profile at Rio Bravo, Site No. 5.

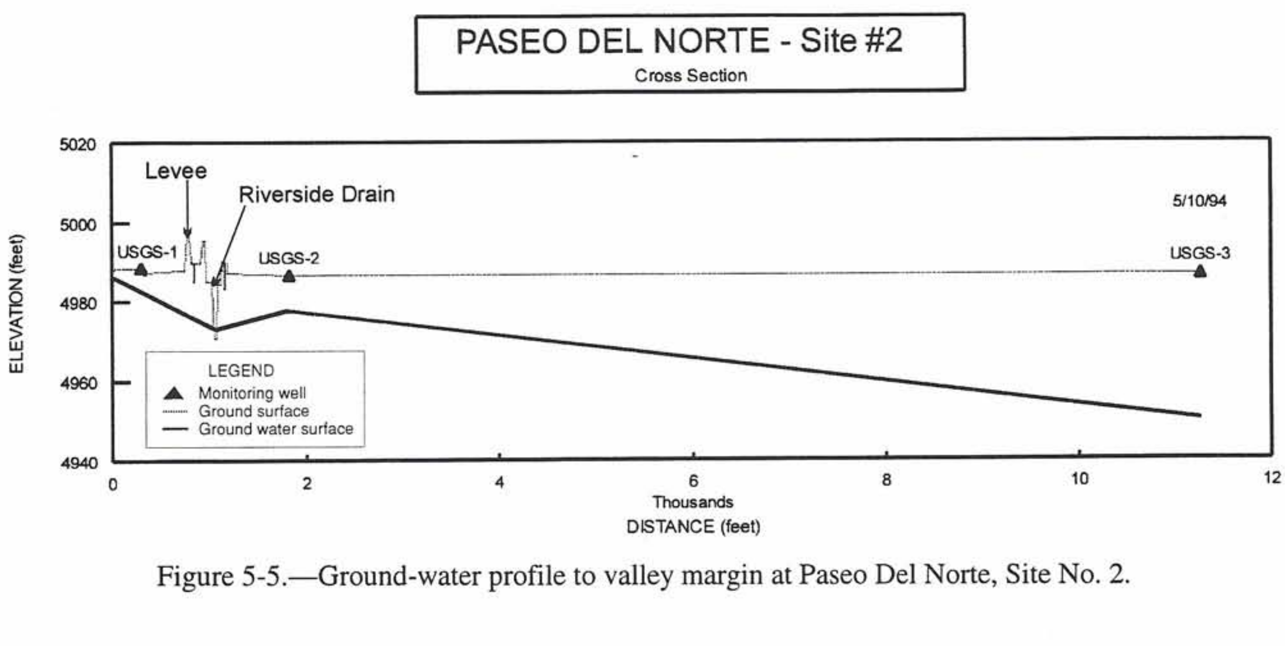

Figure 5-5.—Ground-water profile to valley margin at Paseo Del Norte, Site No. 2.

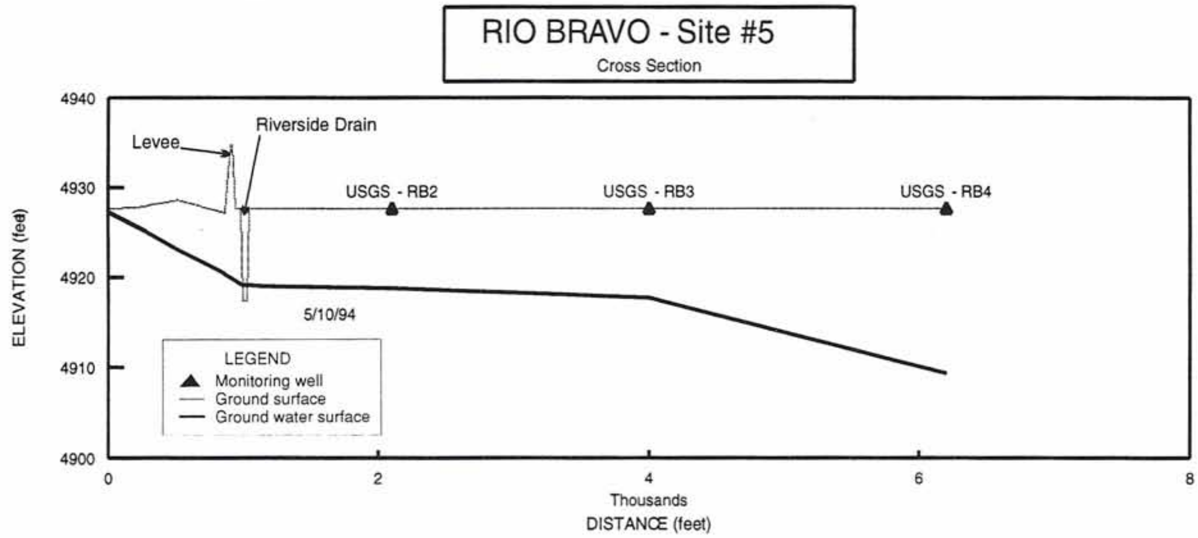

Figure 5-6.—Ground-water profile to valley margin at Rio Bravo, Site No. 5.

some detail by the Middle Rio Grande Conservancy District, "Riverwalk Feasibility Study," (Mimbres Enterprises, Inc., 1991). The District planning report contains designs, cost estimates, and evaluation of funding mechanisms.

Infiltration Galleries

Infiltration galleries are one way to make San Juan-Chama Project allocations available for distribution to City water users.

Infiltration galleries are one possible way to collect and divert surface water, such as that from the San Juan-Chama Project, and make it available for distribution to City water users. Sometimes known as horizontal wells, the galleries would be perforated pipes laid underground to intercept the large volumes of water seeping from the Rio Grande through the highly conductive alluvium. Galleries could be placed under the existing maintenance roads that run along the riverside drains between the bosque and the drains. Additional collection capacity could be provided by secondary collectors branching from a gallery trunk line or by checking up the water levels in the adjacent drains. Water would be collected in the galleries, treated, and pumped into existing municipal water delivery lines. If the quantity of water collected exceeded demand, it could be used for aquifer recharge by injection or by other means.

The infiltration gallery concept has several environmental advantages. It serves the purpose of a diversion dam but eliminates fish passage and entrainment concerns. Infiltration galleries would also avoid the backwater or flooding potential and public safety liabilities associated with a surface diversion dam. They would also provide water with better clarity than surface diversions. Placement of galleries under maintenance roads along the riverside drains would allow the bosque to satisfy its water needs while naturally removing nitrates and other nutrients from the water. Appropriate alluvial conditions and gravel envelope design could provide an initial stage of filtration toward treatment to potable water quality standards.

Infiltration galleries could be sized, positioned, and managed to intercept most or just a portion of the ground water moving inland, allowing recharge to continue as it did before the galleries were constructed. If used in conjunction with surface water control structures in the riverside drains, galleries could be constructed in the dry and returned to a dry condition for maintenance. Increased head potential made available by raising water surface elevations in nearby drains would dramatically increase extraction capacity of infiltration galleries while also providing enhanced recharge from the drains.

Assessment studies include reconnaissance level analysis of the potential for collecting water in infiltration galleries (Busch, 1995). The analysis is based on average alluvial aquifer characteristics measured during Assessment investigations and assumes no enhancement by raising the water level in the riverside drain. A hypothetical 7,000-foot-long infiltration gallery located under the maintenance road along the east riverside drain could collect about 28 cfs, or about 21 cfs per mile. The gallery would be built using commonly available pipe sizes starting at an 18-inch-diameter line and progressing to a 42-inch line. Reclamation's recent subsurface drain installation experience below Cochiti Dam and at Isleta suggests that installation costs would be about $500,000 per mile. Such a gallery system could be expanded substantially and strategically located to deliver water for treatment and introduction into the existing municipal delivery system at various locations along the river.

Upland Alternatives for Enhancing Recharge

Favorable recharge conditions exist in many areas along the mountain fronts bordering the Albuquerque Basin on the east. Midreaches of some of the large arroyos draining to the Rio Grande also have some natural recharge windows.

Favorable recharge conditions exist in many areas along the mountain fronts.

Impoundment or temporary detention of flood waters could be used to increase infiltration time and induce recharge in arroyo channels and their flood plains. Studies by USGS (Thomas, 1995) show that flash flood events currently contribute little to recharge because the short hydrograph durations do not allow surface flows time to infiltrate to depths beyond reach of phreatophytes and other riparian vegetation. However, if these flows could be impounded in deep pits known as charcos (Flory, circa 1930-40), diverted into recharge basins behind

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Various types of recharge enhancements can be supplied and managed with existing infrastructure.

Use of existing canal and drain infrastructure in recharge enhancement schemes offers great appeal because of simplicity and being a "ready to go" nonstructural alternative. Various types of recharge enhancements can be supplied and managed with existing infrastructure including: (1) enhanced canal seepage, (2) water farming on idle irrigated lands or during the winter, (3) deep recharge pits using old sand and gravel pits or new excavations supplied through the irrigation and drainage system, and (4) management of unneeded segments of the drainage network for recharge

Agricultural-related recharge amounts to about 31,000 acre-feet per year, and the consequence of losing this recharge source could be severe.

Preserving currently irrigated acreage through various incentives is an obvious nonstructural and low-cost alternative which should receive immediate attention from city, county, and State government. Agricultural-related recharge amounts to about 31,000 acre-feet per year, and the consequence of losing this recharge source could be severe. Some specific segments of the canal and drain system can be identified as being particularly important for recharge.

Sandia Recharge Window

As described in chapter 2, the Rio Grande riparian corridor recharges pumping centers in northeast Albuquerque via a small area on the Pueblo of Sandia that we have called the "Sandia Recharge Window." It centers about 1.7 miles upstream from the Albuquerque metropolitan Arroyo Flood Control Authority's North Diversion Channel outfall. This window connects the Rio Grande to Albuquerque's east mesa pumping centers through buried ancient river deposits running under the mesa. Recharge potential of the Sandia Recharge Window has not been fully investigated, but Assessment investigations a few miles to the south (Cummins, 1993) found alluvial deposits in the area having horizontal hydraulic conductivities greater than 350 feet per day. This indicates that optimal recharge window characteristics may exist.

By happenstance, the existing operation of the Bernalillo Riverside Drain already provides some level of recharge enhancement through the Sandia Recharge Window. A check structure in the drain is used to raise the water level and divert water into the Albuquerque Main Canal. This operation provides additional head to increase the rate of water movement into the ground-water system.

Heavy pumping from Albuquerque's well fields in the East Heights subbasin has resulted in a trough of depression in the water table that has now expanded far enough northward to affect the water table under Pueblo of Sandia lands (White, 1993). The ground-water gradient between the Sandia Recharge Window and the East Heights well fields will increase as the trough of depression continues to enlarge northward. Ground-water movement from the north, including from the Pueblo, into the East Heights subbasin will consequently also increase.

In view of these considerations, the Pueblo of Sandia, the City, and the District may find it desirable to pursue mutually beneficial agreements to maximize recharge through the Sandia Recharge Window and to buffer Pueblo lands against the expanding zone of aquifer drawdown. Actions should be taken as soon as possible to prevent this strategic recharge area from being developed or altered in ways which might preclude preserving or enhancing its contributions to the ground-water system.

A detailed study covering all potential recharge elements in the area should be considered. In addition to the river and the Bernalillo Riverside Drain, other riverside drains, the Sandia Acequia, irrigated lands, and gravel pits on the margins of the valley would have potential as recharge features.

Because limited natural recharge for east mesa well fields is causing a rapidly expanding trough of ground-water depression impacting Pueblo of Sandia water tables, the Sandia Recharge Window merits detailed investigation.

The Sandia Acequia may offer both structural and nonstructural recharge opportunities for the Sandia Recharge Window. This high line canal serves about 200 acres of irrigated lands located on the recharge window, and it passes a number of sand and gravel pits located just east of its alignment. If depths to shallow ground water and flow gradients are enabling, recharge alternatives are available that could greatly increase the amount of recharge entering the ground-water system through the Sandia Recharge Window.

The Sandia Acequia crosses about 2 miles of the window on the eastern margin of the valley. Although testing was not conducted in this area, the Assessment's canal seepage investigations (Hansen and Gould, 1994) give some indication of the quantity of additional water that could be contributed to recharge through the Sandia Acequia. Under existing conditions and operations, this reach of canal probably contributes about 170 acre-feet of recharge through the window per irrigation season. This contribution might be increased to about 520 acre-feet annually simply by keeping the canal full throughout the year.

Although the Bernalillo Riverside Drain is already checked up and used to divert irrigation supplies into the Albuquerque Main Canal, modifying its operation and management to include winter operations offers an additional low-cost, nonstructural recharge alternative which should receive serious consideration. If high ground-water problems potentially created in the surrounding irrigated areas by this operation were mitigated, it would be in the best interest of both the Pueblo of Sandia and the City to assure that the drain, as well as the Sandia Acequia, remains full and checked up throughout the year to maintain maximum recharge potential. Associated diversions of water from the drain into the Albuquerque Main Canal during winter months could also provide a supplemental source of recharge for middle valley portions of the aquifer downstream.

Water farming is another alternative which might be possible and could be profitable for area farmers. This concept would place irrigators under contract to put large amounts of water on idle farmland to augment recharge. If water table depths and gradients allowed, this practice could be followed in the winter only, while normal crop irrigation continued during the rest of the year. Careful evaluation of this method would be needed because, depending on soil type and condition, moving large amounts of water through agricultural lands could decrease soil fertility and possibly damage soil structure. At a minimum, continued irrigation should be encouraged on this recharge window.

Adapting the nearby existing sand and gravel pits or specially constructing ponds or lakes could also allow large quantities of water to move into the aquifer through the Sandia Recharge Window. These kinds of facilities could be fed through the canal system. They would be relatively easy to manage, and resulting recharge would be simple to measure. Recharge ponds might offer recreational opportunities and wildlife habitat as additional benefits.

Albuquerque Main Canal and Alameda Lateral

The Albuquerque Main Canal and the Alameda Lateral also cross about 1.5 miles of the Sandia Recharge Window, but at a lower elevation and closer to the river. If gradients into the window are sufficient, these canals could also be managed in concert with the Bernalillo Riverside Drain to enhance seepage into the window while providing conveyance capacity for delivery of water to downstream recharge locations.

Middle Valley and West Mesa Recharge

Favorable recharge conditions exist along the valley margins, so the high line canals may contribute significantly to recharge.

The Corrales Main Canal and the Alameda Lateral are diverted upstream and well north of present ground-water drawdown problem areas and follow along the east and west margins of the valley. By gravity, these canals carry surface water from the Rio Grande at the highest elevation and greatest distance possible from the riparian corridor. This arrangement provides capability to deliver supplies of surface water to strategically located recharge enhancement facilities almost anywhere on the valley floor between Alameda Boulevard and the valley constriction at Isleta Pueblo. Also, as described in chapter 2, favorable recharge conditions exist along the valley margins, so the high line canals contribute significantly to recharge, even under existing conditions and operations.

The following examples illustrate enhanced recharge potential for high line canals and nearby interior drains in the Albuquerque Reach between Corrales and Rio Bravo Boulevard. Estimates provided here are based on findings of the Assessment's canal seepage investigations (Hansen and Gould, 1994).

On the west side of the river, the Corrales Main Canal runs from the north end of Corrales to a point near Montano Road. There, it flows into the Corrales Riverside Drain Extension which goes into the river at the Oxbow by Saint Pius High School. The canal and drainage system is then discontinued on the west side between the Oxbow and the abandoned Atrisco Heading north of Central Avenue. The Corrales Main Canal conveys water to the Calabacillas Arroyo and Oxbow Recharge Window areas.

The Atrisco Siphon running under the river north of Central Avenue substitutes for the Atrisco Heading. The siphon supplies water from the east side to the Arenal Canal which runs along the west side of the valley south of Central Avenue.

The 14-mile reach of high line canal system on the west side between the north end of Corrales and Rio Bravo could be managed to recharge about 5 cfs if operated at full capacity. Assuming year-round operation, this could result in an increase of about 2,500 acre-feet annually over recharge attributable to canal seepage under existing operating conditions. Or, if it were managed for recharge only during the 4 winter months of November through February, additional recharge could be about 1,200 acre-feet. If these canals also delivered water to the 9 miles of Isleta and Atrisco main interior drains for recharge, an additional 1,600 acre-feet of recharge could result on an annual basis or 800 acre-feet for winter only operations.

Recharge on the west side of the valley may play an important role in controlling or reducing eastward migration of ground water with naturally occurring high arsenic concentrations from the western margin of the valley. Enhancing recharge here might provide a means to slow this migration or dilute arsenic concentrations.

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East of the river, the Alameda Lateral, Barrelas Ditch, and San Jose Lateral comprise about 17 miles of high line canal system between Sandia Pueblo and Rio Bravo Boulevard. If operated for recharge in a manner similar to that described for the high line canals on the west side, potential recharge increases could be 3,000 acre-feet for full capacity year-round operation or 1,500 acre-feet for winter only operations. The 11 miles of Alameda Drain could contribute an additional 1,900 acre-feet with year-round recharge management or about 1,000 acre-feet with winter only operations.

The features used in this example represent only about 20 percent of the canal system and 20 percent of the interior drain system between Sandia Pueblo and Rio Bravo Boulevard. Recharge from these segments alone could be increased by up to 4,500 acre-feet for the winter operation option or 9,000 acre-feet for the year-round option. Recharge can be further increased in selected areas by cleaning of canal prisms to reduce the effects of silt sealing. Silt sealing reduces seepage rates by a factor of 10 in some areas (Hansen and Gould, 1994). Silt sealing might be reduced by using clear water from drain accretions for recharge.

These projections have not taken into account existing canal lining or perched ground-water conditions that limit seepage. Therefore, projections for the canals could be somewhat optimistic. Projections for the drains assume that some flows would already be in the drains and would be seeping into the ground water. If the drains are actually dry, then these estimates would be conservatively low.

Limitations

Institutional and legal constraints must be resolved, and cooperative partnerships would have to be formed before many of these alternatives could be implemented.

The alternatives described in this chapter are based on resource management need and technical feasibility without consideration of other constraints. Institutional and legal constraints must be resolved, and cooperative partnerships would have to be formed before many of these alternatives could be implemented. These alternatives do not offer a complete solution to Albuquerque's water resource problems. They are only some of the elements that should be considered for incorporation into a broad strategy for development and sustainable use of the Basin's water.

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In the previous chapter, we discussed the general concepts of conjunctive use. These [conjunctive use] concepts could be applied in Albuquerque to reduce dependence on the deep aquifer beneath the City, augment recharge of the aquifer, provide water storage, and protect or enhance water quality. In this chapter, we will present some more detailed and specific ideas which could be implemented in the Albuquerque area, placing emphasis on ways of maintaining or enhancing aquifer recharge. Some of these ideas involve simple changes in the management or operation of existing water systems. Other ideas would require significant construction or infrastructure modifications.

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Information and interpretation provided here describes alternatives at a reconnaissance level. Specific design details for most alternatives would have to be developed during advanced planning after adequate site-specific design data have been acquired. However, a number of nonstructural management options that can be pursued in the interim would provide immediate and measurable recharge enhancement results at little cost and with minimal risk.

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Targeting Enhanced Recharge in the Albuquerque Area

As discussed in chapter 2, the hydrogeologic framework of the Basin defines areas of maximum aquifer recharge potential or, as we have called them, recharge windows and recharge corridors. In addition, there are aquifer zones that are isolated from surface water but that would be suitable for recharge via injection wells. These are all areas where recharge enhancement efforts would be most effective. The most important recharge areas are along the Rio Grande. Others are in upland areas, primarily along mountain front reaches of tributary streams. Because of faulting and other geologic conditions, careful positioning of recharge enhancement facilities would be essential to obtaining the best results.

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Figure 5-1 illustrates the relationship of recharge windows and corridors to the heavily pumped areas of the aquifer that most need recharge. Recharge windows, corridors, and contaminated areas are shown on the map overlying 1994-95 water level contours that illustrate depressions in the water table caused by heavy pumping (Kernodle, 1996).

Using the Riverside Drains to Enhance Recharge

Modifying the riverside drains or their operation would allow larger volumes of water to move horizontally into the shallow ground-water system.

Promising opportunities exist along the entire riparian corridor from Bernalillo to Isleta for enhancement of ground-water recharge or for diversion of surface water from the San Juan-Chama Project or from other sources. Management of the riverside drains for recharge enhancement could be an important element of a conjunctive use strategy. The Assessment's Riparian Corridor Steady-State Groundwater Analyses for 1993 shows that seepage from the river moving eastward averaged about 7 cfs[1] per mile and ranged from about 1.6 to 21 cfs per mile during the study. The riverside drains intercept about 80 percent of this water and return it to the river or divert it to the irrigation canal system. The drains also flatten the ground-water gradients sloping away from the river toward pumping centers and so reduce ground-water recharge from the riparian corridor to about half of its natural predrain potential. In many areas of the valley, modifying the riverside drains or their operation would allow larger volumes of water to move horizontally into the shallow ground-water system. This potential is due to the unusually high horizontal hydraulic conductivity of the alluvial deposits along the river (Cummins, 1993).

One way to increase recharge would be to remove the riverside drains entirely in areas where they are no longer needed for control of high ground-water conditions. The simplicity of this alternative is appealing, but it would eliminate the possibility of operating the drains for management of recharge or for other purposes. Without the riverside drains, recharge would be controlled only by conditions in the river, which would not always be desirable. Additionally, these features are an integral part of the irrigation conveyance system and provide a supply source for diversion to irrigated lands. The riverside drains also have value as elements of a system that could provide a means to move water throughout the valley for delivery to various recharge enhancement facilities.

Water control structures in the riverside drains could provide flexibility to manage them for either recharge or drainage.

Another possibility would be to install water control structures in the riverside drains that would regulate the water level in the drains and provide flexibility to manage them for either recharge or drainage anywhere along either side of the river. Objectives could range from

[1] One cfs is approximately equivalent to 700 acre-feet per year.